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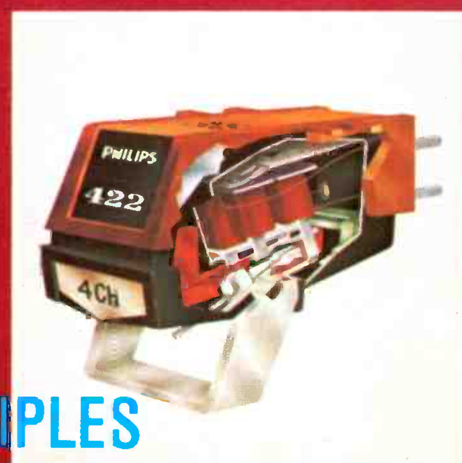


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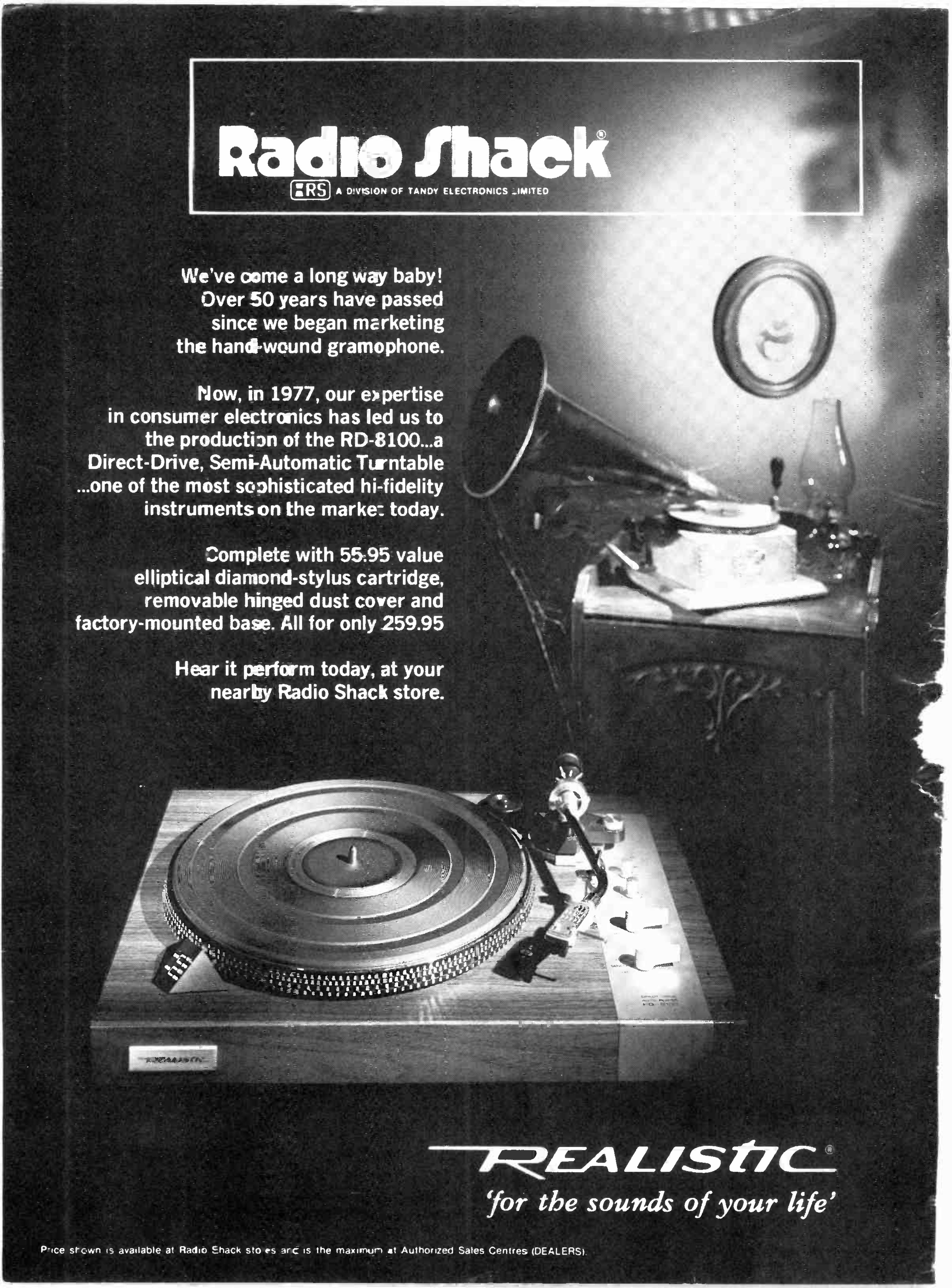
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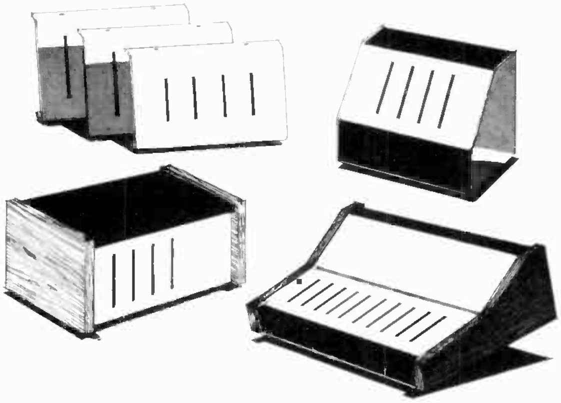

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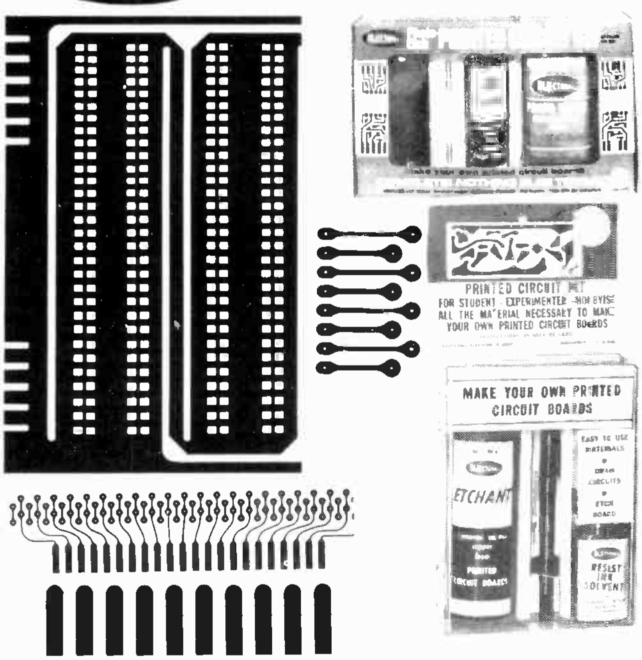


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## Features



## Projects



## Information






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# NEWS DIGEST

## ICE AGE

It is now possible to monitor ice condition on rivers by satellite. NOAA (National Oceanic and Atmospheric Administration) monitored 14 major sections of the Ottawa River covered by ice, using imagery from their two satellite systems and the NASA Landsat — 2. By this means scientists were able to view the day to day changes in the length of the ice covered segments on the river.

The way things are going they will soon be able to see when the president takes his vacation!

## SAILBOATS IN SPACE

It is not something we know much about but NASA is considering a heligyro spinning-sail concept for solar light-pressure propelled spacecraft. Apparently they envisage a 12 bladed sail spacecraft as an interplanetary automated shuttle in the 1980's. The 12 sails would be made of aluminized plastic film, would be 4.5 miles (yes miles) long and 28 feet wide. These would be deployed in two tiers and spun out by centrifugal force after launch. The slowly spinning craft would be propelled by the suns photon radiation and rotate once every three minutes. The solar sail will now compete with a proposed solar electric spacecraft system for NASA consideration.

The next thing will be naval officers training in sailing to go up and command a 9 mile diameter ship!

## MORE BOARD FOR YOUR BREAD!

New bread boards have appeared from A.P. Products Ohio. These new versions utilize A P Terminal Strips with double rows of terminals each having 5 tie-points. This configuration is ideal for breadboarding LSI integrated circuits. A P's original Unicards, which are being obsoleted, have 4 tie-points. The new Unicards offer the added feature of 5 tie-points at no increase in Unicard pricing.

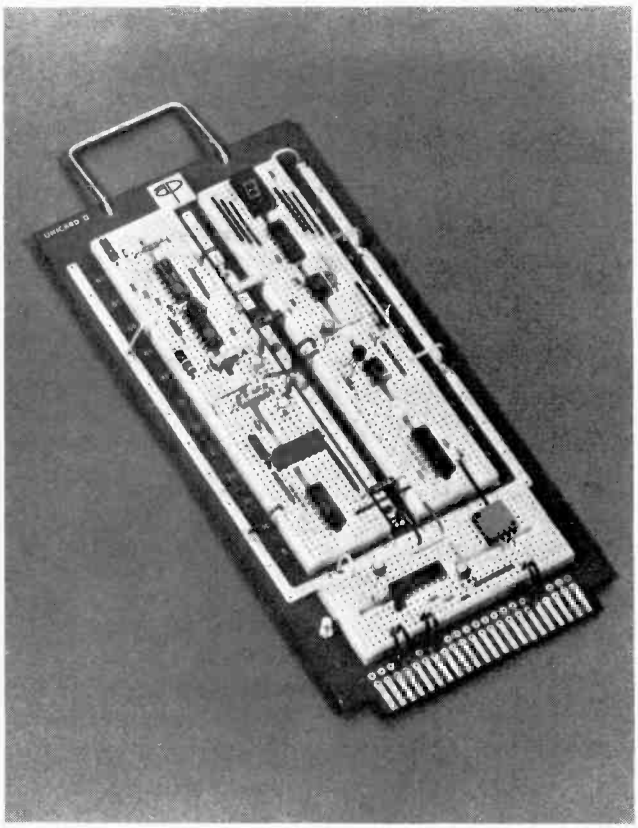
The cards provide solderless, plug-in tie-points on universal 0.1 inch matrix. They require no special patch cords and plug into standard 5¼ inch card racks.

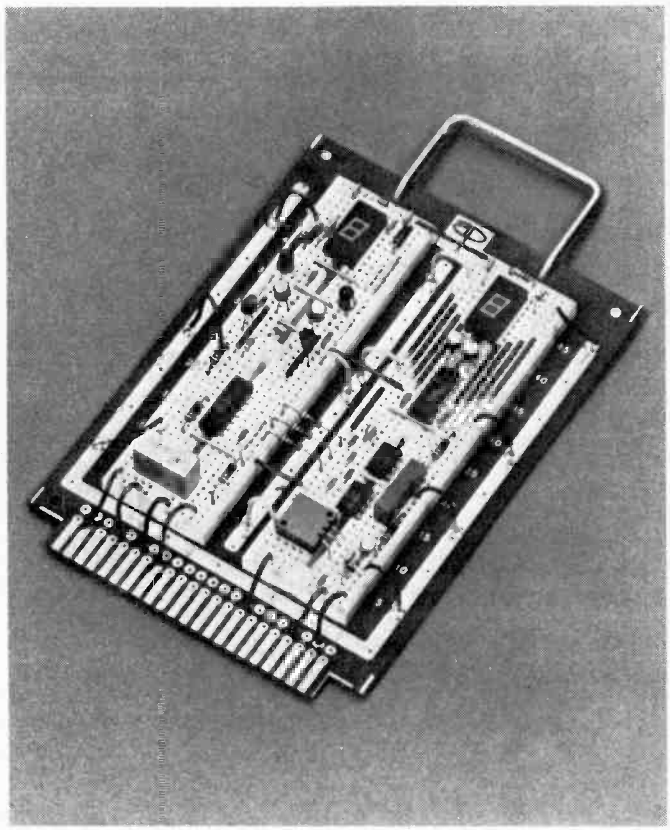
The new version of Unicard I has 960 tie-points (192 terminals each with 5 points) while Unicard II offers 1620 tie-points (324 terminals each with 5 points).

Heavy printed circuit distribution buses are predrilled for quick front surface soldering. The integral ground plane on the back of the card provides a low magnetic profile for high-speed or noise-sensitive circuitry. The connector finger pattern is industry standard 0.156 inch center spacing 22-position double readout type; front surface feed-thru holes are provided for connection to the rear finger pattern. All printed circuits are tin-plated two-ounce copper.

Additional features on the Unicards include rubber feet for protection during bench work and extractor handles for easy withdrawal from card racks.

Approximate prices for these cards are Unicard I $45, Unicard II $80. Information and cards are available from *Weber Electronics Inc., 1111 Finch Ave. W., Suite 154, Downsview, Ontario, M3J 2E5, Tel. (416) 638-1322*. This company also have an outlet in Montreal, Tel. (514) 861-2014.





## MIDGET DIGIT PRINTER

Sharp Electronics of Canada Ltd. recently added a third, hand-held vertical printer/display calculator to its line, the EL-1163. This is a ten-digit model with summation memory.

Priced at $129.95 (or less), the EL-1163 has a running sub-total logic that works similarly to that used in display calculators and has complete punctuation on the display for easier reading of the numbers. By use of the independent print key, this model can be operated as a combination print/display or display mode only.

Other features of the EL-1163 include a high speed/low noise printer, decimals of 0, 2, 3, floating and add mode, per cent key, add-on and discount calculation and built-in rechargeable Ni-Cad batteries plus an AC adaptor/charger.

This new 10-digit EL-1163 joins Sharp's two eight-digit hand held vertical printer/display models, EL-8151 (with summation memory) and EL-8051, and is available from Sharp dealers across Canada.

*Sharp's Model EL-1163 printing calculator.*

## 6800 SYSTEM

The full Southwest Technical Products SwTPC 6800 micro-computer line is now being distributed in Canada by *SDS Technical Devices Ltd., 1138 Main St., Winnipeg, Manitoba, Canada, R2W 3F3.*

The SwTPC 6800 microcomputer system is suited to engineering development, research, educational, small business systems and hobbiest markets. The SwTPC 6800 is a complete system built around the Motorola 6800 microprocessor. It is packaged in a heavy duty anodized aluminum case complete with power supply. All you need to get going is an I/O device.

Available software includes an editor, an assembler and 4K and 8K BASIC (with user call to machine language instructions). The system features a line of pheripherals: keyboard, alphanumeric printer, alphanumeric and graphic TV interfaces, cassette interface, parallel and serial I/O interfaces.

The SwTPC system can be used directly with the MSI FD-8 floppy disk system for those that require an FDOS capability.

In addition to the 6800 system SDS are now marketing a range of I/O devices for what they term real world applications. The range consists of the TL68 traffic light model, the CS68 control station for on/off control of d.c. loads, the MAL68 motor/alarm kit and the NR68 numeric readout board.

This company is also developing an educational/training package aimed at the College, University and industrial training market. The package is based on the SwTPC 6800 system and includes a text book covering programming, interfacing and application of the M6800 microprocessor, a laboratory manual and a line of I/O control modules.

This package should be available by the time you read this.

## ACCURATE DVM

A 0.1 percent, DC accuracy, portable, 3½ digit multimeter is available from Sencore. The new DVM37 was designed to satisfy the needs of the technician and engineer that requires more accuracy in portable installations and doesn't want to invest in a separate instrument for the bench. Features include 15 megohms input impedance, rather than the conventional 10 megohms, high/low power ohms on all resistance ranges through 20 megohms, battery saving feature with a push-to-test switch on the test probe, auto polarity, auto zero, auto over-range, and fully protected circuits. The DVM37 operates from standard "C" cells or from the AC line with a separate power adapter. Suggested user price is $399.95. Also from Sencore are five new product line brochures.

The six-page "mini-catalogs" feature (1) Digital Multimeters, (2) Communications and CB instruments, (3) Oscilloscope & Power Supplies, (4) Transistor & Tube Testers, and (5) TV & Radio Service Equipment.

Each brochure details applications and uses for each instrument, plus complete specifications for easy reference.

For information and products from Sencore contact *Superior Electronics Inc., 1330 Trans Canada Hwy. S., Montreal, Quebec, H9P 1H8.* Whilst mentioning this company they have informed us that the Canadian price for the Motorola HEP Educator II mentioned in our May issue is $279.95. The price of $169.95 quoted was in fact the U.S. price, so readers can see the premium they are having to pay for U.S. products to cross the border! We apologise for any inconvenience caused by this error.

## PERSONAL AT A PRICE

A new line of personal computing products for the hobbyist has been announced by Heathkit.

The new line, is designed around two computers, the H8 and the H11 The H8 is an 8-bit computer based on the popular 8080A microprocessor. It features an intelligent front panel with octal data entry and display, and a resident monitor with built-in bootstrap for one-button program loading or storing. The H11 is a 16-bit computer using the Digital Equipment Corporation (DEC) LSI-11 with 4k memory, a built-in backplane and regulated switching power supply. System compatible peripherals include a CRT terminal, paper-tape reader/punch, serial and parallel interfaces, a "hard-copy" printing terminal and a cassette player/recorder. Input/output interfaces, additional memory and supplementary software packages complete the initial product offerings.

Heath Company will back up their computer with complete documentation and service support, self-instructional programming courses, and a Heath User's Group (HUG). Heathkit H11 computer owners are also eligible for DECUS, the DEC user's organization.

The mail order price for the H8 of $599.95 includes a fully wired and tested CPU and complete assembly and operations documentation, as well as all systems software in audio cassette form. Memory and I/O interface accessories include an 8K board with 4K of static RAM ($249.95), at 4K expansion chip set ($179.95), a serial I/O interface board with 1200 baud audio cassette interface ($189.95), and a three port parallel interface ($259.95).

The H11 features include a 16-bit LSI central processing unit (fully-wired and tested) with 4K x 16 dynamic RAM. Memory is expandable to 20K. The unit includes built-in backplane, power supply with switching regulators and full circuit protection, and flexible I/O interface accessories. A complete DEC system software package is also included. It contains editor, PAL-11 assembler, linker, on-line debug package (ODT), input/output executive, BASIC and FOCAL. The mail order price of the H11 is $2,395.00.

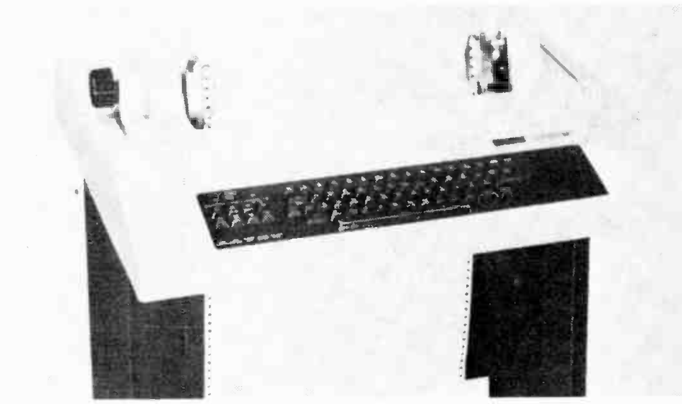
Accessories include a 4K x 16 static RAM memory board ($459.95), a flexible serial interface ($179.95), and parallel interface ($179.95).

For more information on the H11 and Heath's other computer products, write *Heath Company, 1480 Dundas Hwy. E., Mississauga, Ontario, L4X 2R7, for the "Computer Information Package".*

*The H8 computer*

*Heathkit H11*

*CRT terminal type H9.*



*Heathkit DEC Writer II keyboard printer terminal.*

## BUG PLAN

A top secret plan designed to protect telephone calls from bugging is being developed by the Carter Administration. The problem has been created by the USSR who, using advanced equipment have been recording long distance microwave calls of the air, using computers to decipher each call and locate any sensitive information — presumably by some type of word recognition system.

Intelligence experts have warned that the USSR and others now pick up and sort economic data and that as equipment techniques improve the extent to which this is done by national and private organizations will greatly increase. The problem is further compounded by the fact that the National Security Agency has also been monitoring some domestic calls — the legality of this has never been decided.

Obviously similar bugging networks could be used our side of the border and it could just be that the US and USSR know what is happening in government before we do!

## NEW PERSONAL COMPUTER FROM CUBEX

A new personal computer system — the Cubex Mark II — has been announced by Cubex, 1585 Britannia Road East, Unit 2A in Mississauga, Ontario. The system is available in kit form to the hobbyist in minimal configuration for $765.00. It has been designed around an 8080A micro-processor and uses the well known S-100 bus.

## COMPETITION

Perhaps you guys are more interested in electronics than writing, and the offer of $12 back is of no interest? Anyway that's what it looks like to us because of a large number of subscriptions from the June issue we received almost no captions for the cartoon we published. Because of this we have decided to give a free subscription to all entries — even those posted after the deadline but before this was written (August 4). So if you sent one in you will be getting your money back.

### DIGITAL VOLTMETER PARTS

The following are the prices that should have appeared for the Ferranti Electric chips used in the Digital Voltmeter project of the July issue.

| | |
|---|---|
| ZNA 116E | US $10.50 |
| ZN 423T | 4.00 |
| ZN 424E | 2.55 |
| Postage and Handling | .50 |

# AUDIOPHILE

SINCE WE ARE getting a fair amount of information on both general and more complex types of audio equipment and find that there is a high level of interest in general audio among our readership we have decided to introduce this section to *News Digest*. In this way all the audio news and information will be kept together and will thus form an interesting section for the audiophile and also for those with a passing general interest.

We would direct such readers to the *VFET's for Everyone*, feature that starts in our next issue,since this topic will be developed to show how these devices, which are now available, can be used in various audio applications. In addition to this series there is our special pickup feature this month that will help to fill in those gaps in knowledge of the principles behind the subject. During research on this article we ran across a new (to us anyway) pickup from Decca, some details of which are given in the text.

## CARTRIDGE

This new cartridge, the Decca Mk VI, works on an unusual principle and is said to provide excellent transient response due to its low dynamic mass — the stylus is not used to move coils or magnets or to displace any semiconductor so that its mass is kept to the absolute minimum. The cartridge is available in two models — gold eliptical at a cost of $149.50 and plum spherical at $129.50 both are suggested list price. For more information write to *Rocelco Inc., 160 Ronald Dr., Montreal, P.Q., H4X 1M8, phone (514) 489-6841.*

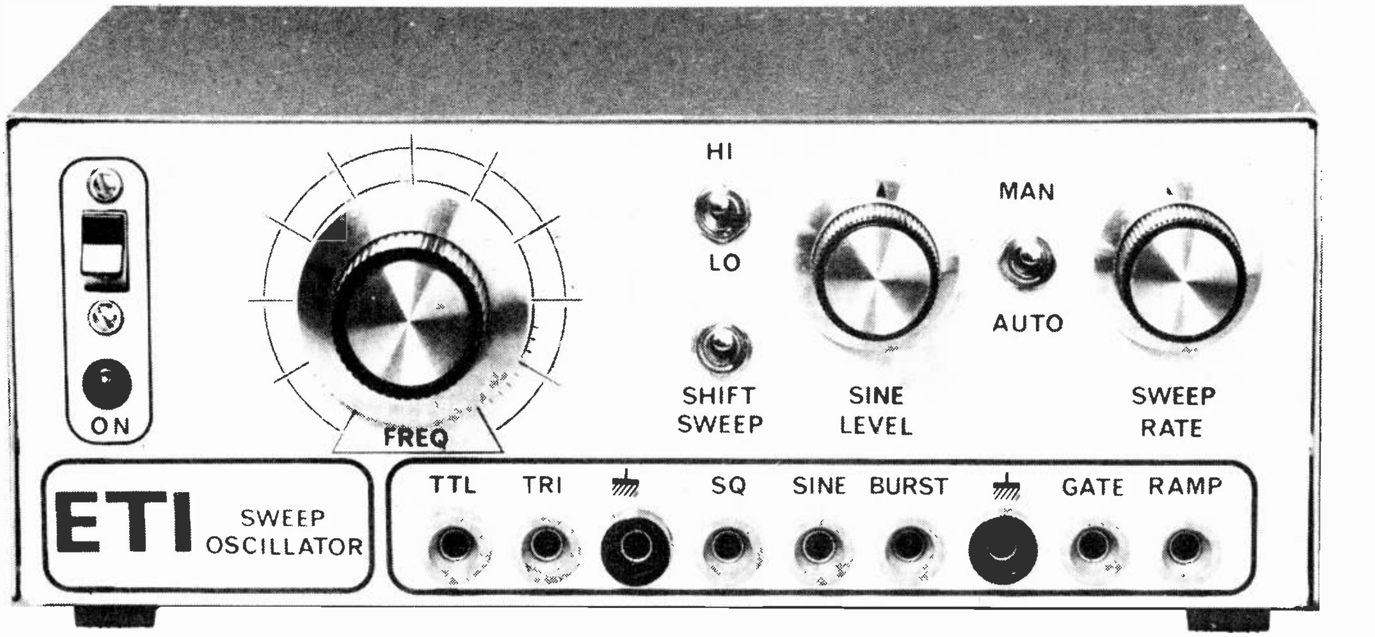
## SONY'S SHARE OF AUDIO

Sony of Canada Ltd. unveiled new models in all product lines in Toronto recently. This included five direct drive turntables, four cassette recorders, two reel-to-reel tape decks, an 8" addition to the Trinitron colour TV line, speakers and other equipment.

*The Sony PS-X7 turntable lists for $399.95.*

The top of the line turntable, the PS-X7, is speed controlled by a crystal oscillator — phase lock loop combination driving the brush and slot-less (BSL) motor. The feedback signal representing rotation speed is derived from a magnetic pattern in the edge of the platter. This is claimed to contribute to excellent initial drift, load/speed, SNR, wow and flutter characteristics. Other features of interest are the carbon fibre material used in the tonearm, and the use of LEDs for function indication.


*Reel to reel Sony TC-765 4-track tape deck, $1250.*




# SWEEP OSCILLATOR

**Invaluable test unit at less than one fifth of the commercial cost!**

**By Tim Orr and P. Wielk**

SWEEP oscillators are generally considered to be a rather fancy piece of test equipment and usually attract a fancy price. Units similar to the one to be described sell for around $200 to $300. It produces square and triangle waveforms from a voltage controllable oscillator, which can be internally swept by the machine's own ramp generator, (which is itself controllable), or it can be connected to an external control voltage source. Thus various frequency modulations can be performed, the most useful one being a wide range logarithmic sweep for resolving the frequency response of various networks and filters. To do this, a swept sinusoidal waveform must be synthesised. The triangle waveform is bent, by passing it through a diode function generator, until it closely resembles a sinewave.

Another waveform provided by the function generator is a tone burst output. This gates the sinewave signal on and off and thus generates a burst of sinewaves followed by a period of silence. Tone bursts are very useful for analysing the dynamic responses, (as opposed to the steady state responses), of networks such as filters, compressors, expanders, loudspeakers, etc. The last waveform provided is a square wave suitable for driving TTL circuits. This output uses a current sinking transistor, so that up to about 30 TTL unit loads can be driven by it.

## Selecting IC's

The function generator needs fast op-amps to buffer the signals to the external world. These op-amps should also remain stable when connected to various reactive loads. Several devices were tried. The 741S, a fast version of the 741 made by Motorola; the 748, an uncompensated version of the 741; the CA3130 and the CA3140 made by RCA, both of which are fast CMOS devices. Also the LM318, a fast (50v/$\mu$S) slew rate op-amp made by National Semiconductors; and the NE531v, another fast device made by Signetics. Not all of these proved successful, particularly when driving reactive loads. Also some of them require external frequency compensation and so the PCB was designed to accept various capacitors. You can use any of the op-amps, but I feel that the best will be obtained by using the suggested devices. In fact you can use the ordinary 741, but this will result in degraded waveforms. Recommended ICs are shown.

## Using The Machine

Generally try to keep the load impedances presented to the machine as high as possible. The current driving capabilities of all the outputs are limited, particularly at high frequencies and so you may find that outputs become degraded as the frequency increases.

If you want to investigate the frequency response of a filter design, to get a non flickering display, you may have to use a fast sweep rate, say 20 times a second. This could result in a 'time-smeared' display due to the ringing time of the filter. The display will be a cross between the filters dynamic and steady state response. To overcome this problem, there are two possible solutions. One, use a slow sweep speed, if you have a storage scope then this will be OK. Two, frequency scale the filter up in frequency, so that say, a 100Hz bandpass filter becomes a 1kHz filter. You can then increase the sweep speed by a factor of times 10. However this is generally only possible when you are designing a filter and when you know that there is a sufficient bandwidth margin still available.

## Construction

Even though this is electronically a complex project, construction is reasonably straightforward! Main points to note are as follows — first insert and solder all the wire links, followed by the trimpots. The link near RV1 is insulated. It's a good idea to use terminal pins for all the off board leads, saves trouble if you have to move a wire. Next the resistors, capacitors and diodes can be fitted. C3 only needs to be fitted if you can't get C2 on the board. Q7 needs its base lead bending underneath to fit the board. The only IC that really needs a socket is IC15, but sockets can save hours if used for all ICs — if a fault develops.

All off board connections should be soldered before inserting IC15 anyway. Shielded wire should be used to the controls — but only the socket end should be grounded otherwise nasty hum loops can develop. The external voltage control socket was mounted on the rear panel. The transformer specified has twin windings which are used in parallel. IC1 does not need any heat sink, as very little of its capacity is used. Last and by no means least, R16 and R34 are both mounted off the main board — good luck!

## Setting Up And Alignment

Having built and tested the generator it now only remains for you to align the six trimpots. **RV1, frequency bias.** Set switch SW2 to manual and switch SW4 to the high frequency range. By turning the frequency control knob, the output of the machine should range from approximately 20Hz to 20kHz. However the transistors in the transistor array IC3 are only matched to within + or — 5mV

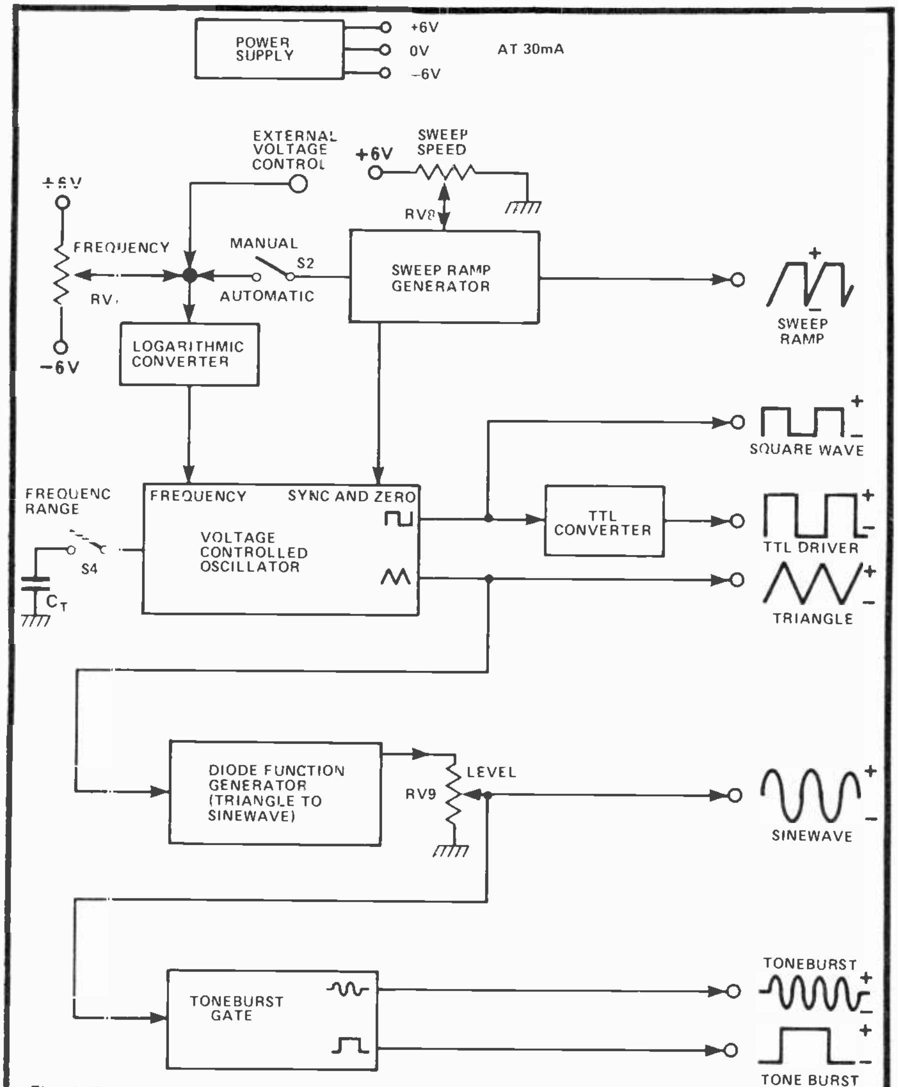


*Fig. 1 General System organization of the sweep oscillator.*

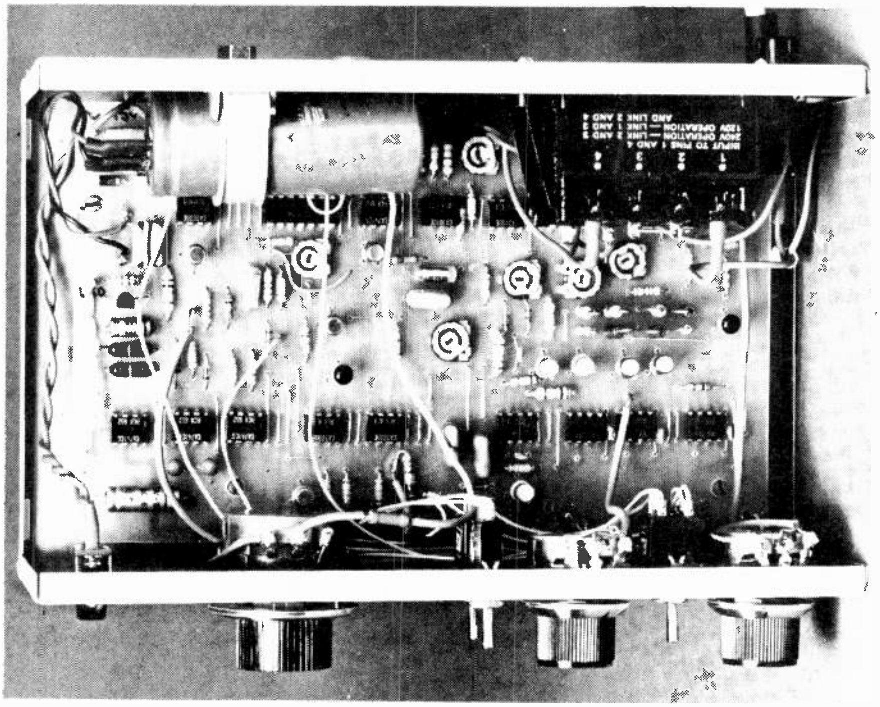


*Fig. 2 Internal view of the completed unit.*

and this can shift the generator's operating range. So to counteract this mismatch adjust RV1 until the manual operating range is as near to 20Hz to 20kHz as possible.

**RV2, triangle time symmetry.** The time symmetry of the triangle wave form may not be exactly 1 to 1, and if it is not then the sinewave will have a large THD. The root cause of any time asymmetry is IC5, which is a CA3080. If the time symmetry varies significantly when the frequency is changed then IC5 will have to be changed until a suitable output is obtained. To align RV2, set the operating frequency to 1kHz, look at the triangle waveform and rotate RV2 until the best symmetry is obtained. This preset should be readjusted later on when the THD alignment is being performed. Move the frequency throughout its range and check that the symmetry is well maintained.

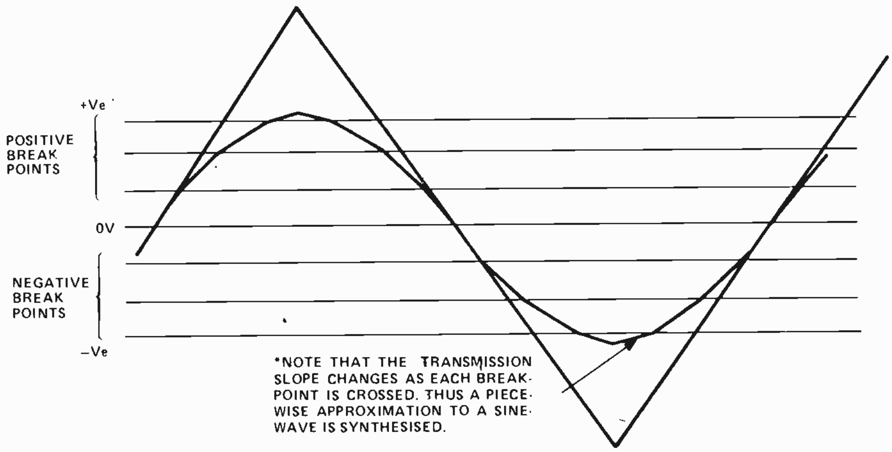



*Fig. 3 Technique used to synthesise sine wave for triangle wave form.*

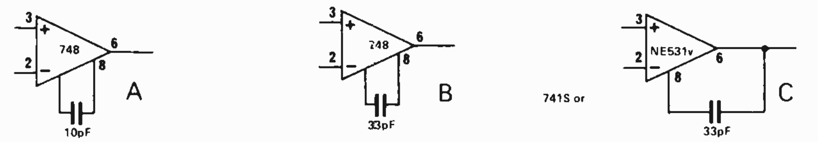



*Fig. 4 Suggested ICs for IC11, 12, 13, 16 with correct equalization capacitors. IC11 is C, IC12 is A. IC13, 16 are B.*

## Ears and Things

**THD minimisation RV3, 4, 5, 6.** As it was not practical to use low tolerance components and matched diodes in this design, it is necessary to perform several alignments to produce the best possible sinewave. The way in which you align this generator depends on the equipment at your disposal. Here are four methods.

**First,** by ear. Your hearing apparatus is surprisingly accute to matters of frequency and harmonic structure. For instance if you listen to the square wave output on a good pair of headphones (high impedance preferably), then you can adjust the time symmetry (RV2) by ear with far more accuracy than you can with a direct visual display on an oscilloscope.

As RV2 is adjusted and the symmetry changes there comes a null point where all the even harmonics disappear, which can be distinctly heard. You can also try to align RV3, 4, 5, 6 by listening to the sinewave output at a frequency of say 400Hz. As you adjust each pot you should be able to minimise the harmonics and generally converge upon settings that give the purest tone.

**Second,** using an oscilloscope. Look at the sinewave (set to 1kHz) on the oscilloscope and adjust RV6 so that the waveform, whatever it looks like, is vertically symmetrical. RV6 merely compensates for any loss of DC offset that has occurred in the production of the triangle. Presets RV3, 4,5, can now be used to adjust the breakpoint slopes. By careful adjustment of them it is possible to converge upon a waveform that looks very nearly sinusoidal.

**Third,** using a distortion meter. This device is merely a tuneable notch filter. The sinewave is connected to this device and the fundamental is notched out leaving only the harmonics, which you can see and measure. The procedure is to set the frequency to 1kHz and adjust the distortion meter so that the 'sinewave' fundamental has been removed. Look at the residue with an oscilloscope and/or millivoltmeter and adjust RV3, 4, 5 until this residue is at a minimum.

If you don't happen to own a distortion meter you can construct a notch filter at about 1kHz, (see ETI, 'Active filters' and notch out the fundamental by altering the function generator's frequency.

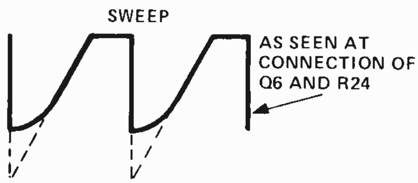
**Lastly,** using a real time spectrum analyser. These devices are quite cheap, usually about $10,000 each. The analyser will display all the harmonics, and so the effect of adjusting RV2, 3, 4, 5, 6 will be instantaneously displayed.

## Problems likely to be Encountered

The power supply can be a problem source. The 12V regulator can be responsible for many deviations from the predicted performance, due to the ±5% spread in output voltage. This could cause the sweep range to be larger or smaller, or it can effect the distortion of the sinewave. Here is a list of some common problems and their solutions.

**Reduced frequency range.** If the manual or swept frequency range is less than expected then increase R12 from 1k to 1k1. This will provide approximately an increase of one octave. If the range is too large then reduce R12 to 910 ohms

**Clipped Triangle.** This could be caused by a low power supply rail or a large Vp in Q3. Either change Q3 for a low Vp FET or reduce R17 to 470 ohms. Similarly, if the sweep output waveform (output 19) is bent on its negative end, change Q6 for a low Vp device or reduce R24 to 4k7.



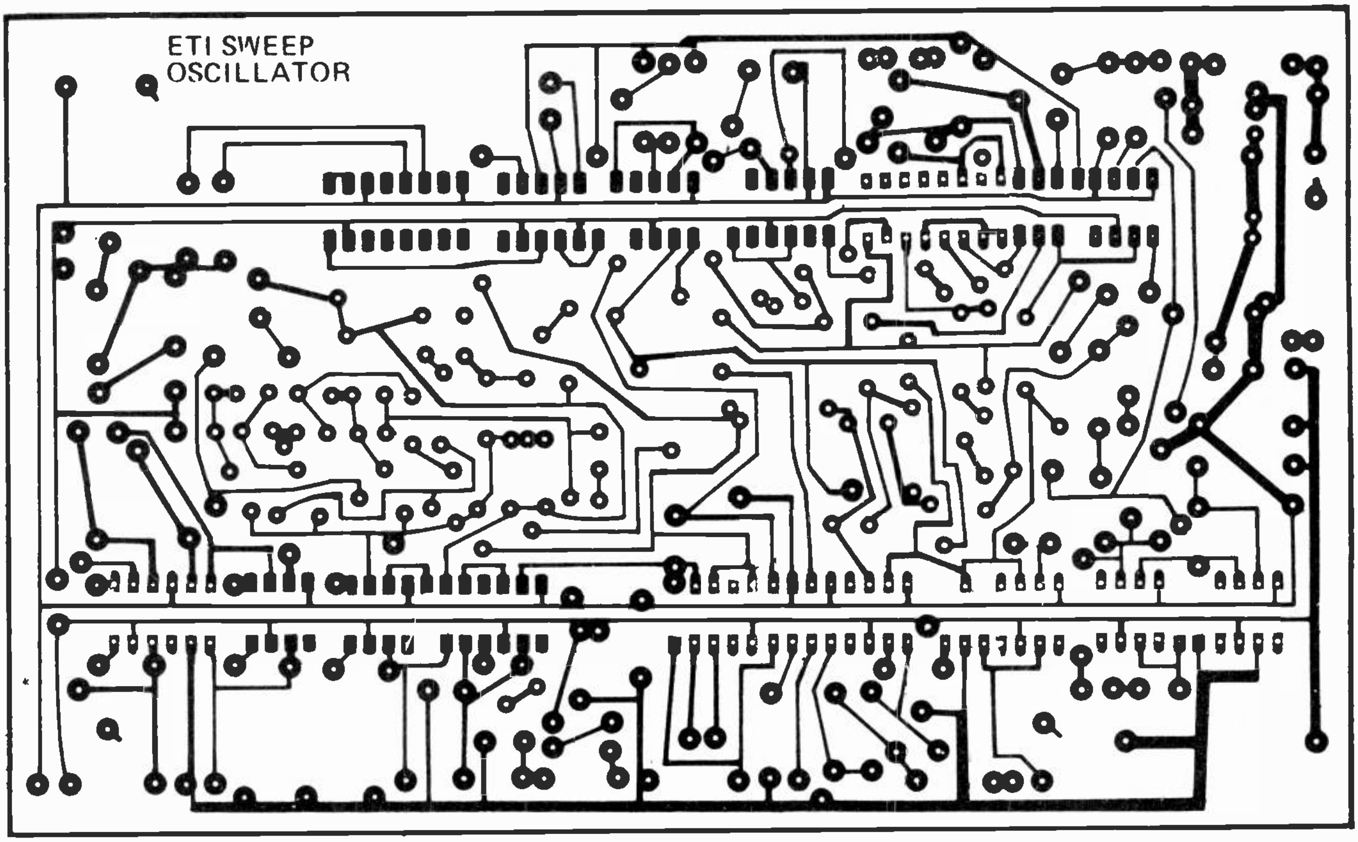
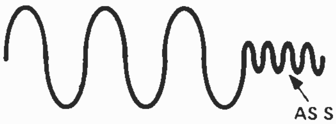
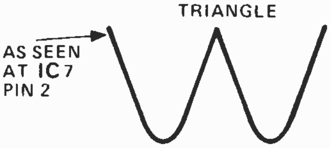



*Fig. 5 Full size pattern for the PCB.*

**Tone burst does not shut off.** This is because Q12 will not switch off. Change Q12 for a low Vp device.




**Sine wave has a high THD.** If the THD cannot be trimmed to about 1% then it is likely that the diode function generator has the wrong gain. If the sinewave looks more like a triangle(a), then increase R42 to 20k. If it has flattened ends(b), then decrease R42 to 16k. Note, very small changes in R42 have a large effect on the THD figure.




| | | | |
|---|---|---|---|
| **SINE WAVE (Variable 0-4V)** | **THD<1.5%** | **TONEBURST GATE** | **12V Fixed** |
| **TONE BURST (Variable 0-4V)** | **16Hz on 48Hz off** | **X SWEEP RAMP** | **1V9 Fixed** |
| **TRIANGLE (3V5 Fixed)** | **Summetry ±2% (better than)** | **CONTROL INPUT** | **+1V/Octave +3V3/Decade** |
| **SQUAREWAVE (3V5 Fixed)** | **Markspace 1:1 ±2% (better than)** | **SWEEP RANGE (Logarithmic)** | **1000:1** |
| **TTL (5V, pulldown to zero)** | **Markspace 1:1 ±2% (better than)** | **RAMP RANGE (30Hz to 0.06Hz)** | **500:1** |
| | | **HIGH RANGE** | **20Hz to 20kHz** |
| | | **LOW RANGE** | **0.2Hz to 200Hz** |
| | | **(Manual or Automatic Sweep)** | |

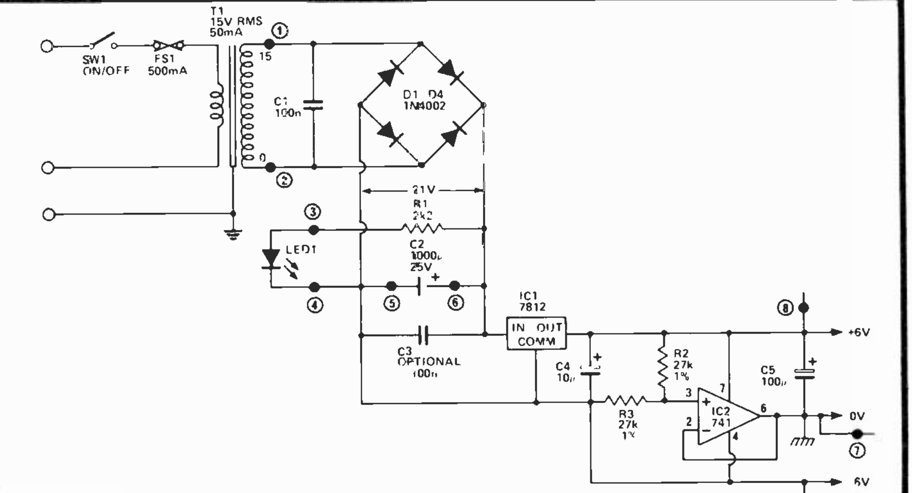



*Fig. 6 Power supply circuit diagram.*

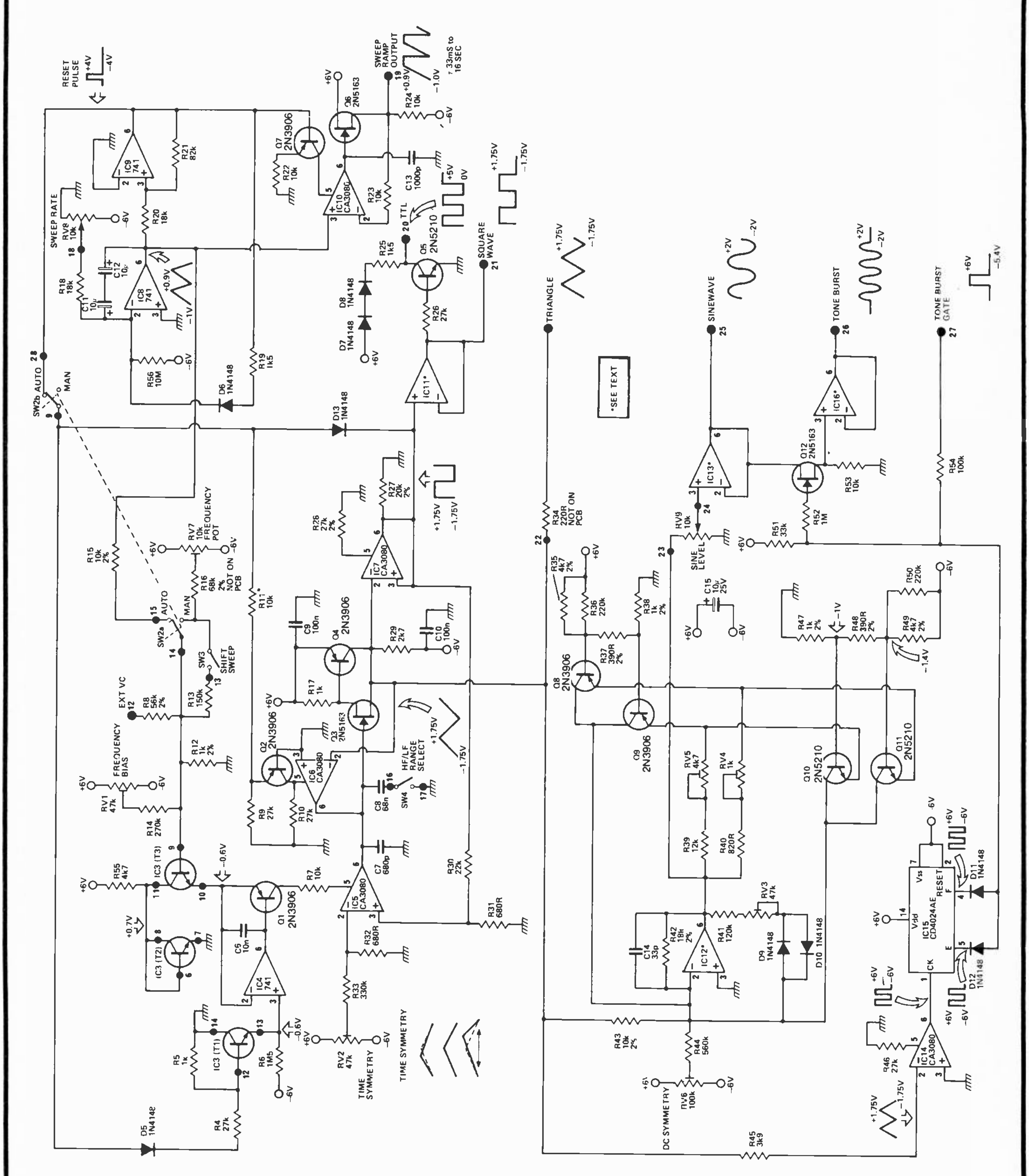



*Fig. 7 Main circuit diagram, see page 12 for details of IC11, 12, 13, 16 and compensation capacitors.*

# How it works

The general system diagram is shown in Fig 1. The heart of the generator is the voltage controlled oscillator shown in more detail in Fig 3 and in the circuit diagram, fig 7. This is the well known triangle square wave oscillator made from an integrator and a schmitt trigger. A control current, (this determines the oscillating frequency), is fed into a current steering device IC5. When a positive voltage is applied to the non-inverting terminal, this control current comes out of IC5 and charges up the timing capacitors C7 and C8. When C8 is switched so that it is in parallel with C7, this selects the low frequency range of operation, (0.2Hz-200Hz). If the applied voltage is negative, then a current equal to the control current is 'sunk' into IC5 and the timing capacitors are discharged. Thus IC5 can either charge or discharge the capacitors, this being determined by the steering voltage.

The speed at which the capacitors charge or discharge is determined by the magnitude of the control current. If this current is constant then the capacitor voltage will increase or decrease linearly. The voltage on the timing capacitor is buffered by a high impedance buffer, Q3,Q4. The FETQ3, has such a high impedance that it hardly takes any current from the timing capacitor, so that it does not affect the charging or discharging operation. Q4 is arranged to drive Q3 at constant current, and the pair, (Q3, Q4), form a high input impedance voltage follower, with a DC shift caused by the FET characteristics. In fact it would be advisable to use low pinch off voltage FET's throughout so as to minimise the effects of these offset voltages.

The way in which oscillation occurs is as follows. Control current is injected into IC5 and the voltage on the timing capacitor rises. This voltage is buffered and presented to the schmitt trigger IC7. When this voltage reaches the upper hysteresis level, the schmitt flips over to its low state and thus the steering voltage becomes reversed. The timing capacitor voltage then ramps down until the lower hysteresis level is reached and then the schmitt flips back to its original state. Thus the timing capacitor voltage ramps up and down between these two hysteresis levels, the speed at which this occurs being determined by the control current. Switching in another capacitor C8, will reduce the ramp rate and hence the frequency of operation. This circuit produces triangles and square waves with a 1 to 1 time symmetry and symmetry about OV.

IC6 and Q2 are used to 'zero' the triangle output for the start of sweep. IC6 adjusts the voltage on the timing capacitor so that the triangle output is at OV. It does this only when Q2 supplies it with current.

The triangle output has a 220ohm resistor connected in series to prevent any damage caused by possible short circuits. The square wave output is buffered by A11 which has a fast slew rate. Q5 is the TTL driver stage. When switched on, it will pull down almost any load to a voltage near to OV. If a faster pull up is required the 1K5 resistor can be reduced.

Next the logarithmic converter. This device converts the sum of all the control voltages into a current, (the control current), to which it is logarithmically related. That means that for every 1V increase of external control voltage the control current and hence the operating frequency will double. This logarithmic relationship is very useful for audio work, because when using a swept output, (displayed on an oscilloscope), the X axis is in octaves and decades rather than being linear. The circuit that does the conversion is known as an exponentiator and works in the following manner (see IC3, (T1,2,3,) IC4 and Q1).

IC3 is a CA3046 which is a transistor array providing us with a set of well matched devices at a low cost. Transistor IC3, (T1), has a current of 3.5μA passing through it and this produces a reference voltage of about −600mV at its emitter. IC4 and Q1 adjust themselves so that the emitter of IC3 (T3), is also held at this reference voltage. There are three control voltages, from the frequency pot wiper, the external control voltage terminal and the internal sweep ramp. These are resistively summed together and presented to the base of IC3, (T3). This transistor converts the control voltage into a current which flows out through the emitter, completely through Q1 and then to IC5. This is the control current. The voltage at the base of IC3, (T3) is logarithmically related to its emitter current. A voltage increase of about 18mV will double this current. However, this process is very sensitive to temperature changes which would result in drift in the function generators operating frequency, and so the arrangement of IC3 (T1) and IC3 (T3) has been used to provide temperature compensation. Also to keep self-heating effects to a minimum, IC3 (T2) is used to clamp the collector voltage of IC3 (T3) to +0.7v and thus reduce the power dissipated in the transistor array.

The next section to be discussed is the internal sweep ramp generator, (IC8,9,10,Q6,Q7). IC8, 9 form another triangle/square wave oscillator, having a controllable rise time and a fast reset time. IC8 is the integrator, IC9 the schmitt trigger. The output of IC8 ramps up at a rate largely determined by the sweep rate pot setting. When the upper hysteresis level is reached, IC9 output goes high, D6 becomes forward biased and the integrator ramps down very rapidly, reaches the lower hysteresis level, the schmitt trigger flips over and the process repeats itself. The ramp output is then used to drive the base of IC3 (T3), eventually sweeping the oscillator over a frequency range of 1000:1. This is approximately 10 octaves which requires a change in Vbe IC3 (T3) of about 180mV.

The ramp waveform can be used to drive the X axis on an oscilloscope but it needs some slight modifications to make it suitable. It needs to have a very fast reset of the order of a few microseconds to make the fly back invisible. This is achieved with the track and hold circuit Q6, 7, IC10. During the sweep the output of this circuit follows the input. However, during the reset period, IC10 is 'held' by virtue of the fact that no current is supplied to it. When the reset period is over, current returns to IC10 but its input has the 'start' ramp waveform presented to it, but its output has the stored value of the 'finish' ramp waveform. The output jumps as fast as it can, (within a few microseconds) to the input voltage and proceeds to track it. The process repeats itself. The reset voltage is used (in the sweep mode only), to perform three other tasks. **One,** it sets the schmitt trigger IC7 into a high state so that it always starts a new sweep with the same phase, (via the D13 route). This stops jitter on the display. **Two,** the reset is used to activate the zeroing switch mechanisms Q2 and IC6. **Three,** the control current is reduced during reset, due to the connection of D5. This helps the zeroing process. When switch SW2 (this is a double pole switch) is in the automatic position, both the sweep wave form and the reset pulse are routed to their respective sections of the circuit, and a logarithmically swept output is generated. The manual frequency control knob has no effect on the process, except when switch SW3 (the shift sweep), is closed.

This enables the sweep to be manually displaced up or down the frequency axis by a factor of about 5 times. That is if the sweep were between 20Hz to 20kHz it could be shifted up to 100Hz to 100kHz or down to 4Hz to 4kHz, thus enabling the useful range of the generator to be greatly extended. When switch SW2 is in the manual position, the sweep and reset signals are disconnected and so the generators output frequency is entirely determined by the manual control knob, plus any external control voltages and of course the position of the range switch SW4.

Next the diode function generator IC12, Q8, 9, 10, 11 and D9, 10. This circuit converts the triangle waveform into one that approximates a sinewave, see fig. 3. It is called a diode function generator, although four of these supposed diodes are transistors, Q8,9,10,11. The triangle is applied to an op-amp with several feedback routes, the purpose of which are to change the gain of the section, depending upon the instantaneous signal level. As the triangle waveform (which is symetrical about OV) goes positive, the output of IC12 goes negative. When it exceeds −0.6V, diode D9 begins to turn on and in doing so, the overall feedback resistance is reduced and so therefore the transmission slope is also reduced. This is known as the first break point. Transistors Q10,11 have their bases biased to voltages of −1.0v and −1.4v respectively. These transistors will provide further feed back routes when the output of IC12 exceeds -1.6v and 2.0v, and this extra feedback will decrease even more the transmission slope. Thus, the triangle waveform is gradually bent to resemble a sinewave in the negative excursion of IC12.

However there is also a complementary set of feedback routes for positive excursions via D10,Q9 and Q8 and so a complete sinewave is synthesised. This process is far from perfect and the best THD figure that can be obtained by careful adjustment of RV3, 4, 5, 6 is about 1.0% at 1kHz. This compares with a figure of about 0.2 to 0.5% THD for moderately expensive commercial function generators. These lower figures can only be obtained by having a precision regulated power supply, good tolerance resistors (0.5%) and a more elaborate set of MATCHED diodes. Also, some high quality equipment will be needed to make the final adjustments to the sinewave.

The sinewave from IC12 is passed through a manual level control and is buffered by the voltage follower IC13 to the output terminal. The sinewave also goes to the **toneburst section.** IC14, 15, 16 and Q12 FET Q12 is used as an analogue switch between the sinewave and the voltage follower/buffer IC16. This switch is turned on for 16 cycles of the sine wave and off for 48 cycles. The switching occurs synchronously as the waveform passes through OV. The control for the FET switch is generated by IC14 and 15. IC14 is used as a voltage comparator which determines whether the triangle waveform is positive or negative. It generates a square wave of + and −6V state as the triangle waveform passes through OV. This square wave is used to clock a seven stage CMOS counter, IC15. The divide by 32 and 64 outputs are AND'd together to generate the voltage control for the FET switch. This voltage is high (FET switch on) for 16 cycles and low (FET switch off) for 48 cycles and is used as an output (tone-burst gate) to trigger, say, an oscilloscope.

The last piece of circuitry to be described is the power supply, IC1, 2. This delivers + and −6V at about 30mA. The transformer delivers 15V RMS which produces about 21V of unregulated supply. A 12VRMS transformer would be rather low and you might experience problems of the supply dropping out.

# Parts List

**RESISTORS** (all ¼ W 5% unless otherwise stated)

| | |
|---|---|
| R1 | 2 k 2 |
| R2,3 | 27 k 1% |
| R4,9,10,26,46 | 27 k |
| R5,17 | 1 k |
| R6 | 1 M 5 |
| R7,11,22,23,24,53 | 10 k |
| R8 | 56 k 2% |
| R12,38,47 | 1 k 2% |
| R13 | 150 k |
| R14 | 270 k |
| R15,43 | 10 k 2% |
| R16 | 68 k 2% |
| R18,20 | 18 k |
| R19,25 | 1 k 5 |
| R21 | 82 k |
| R27 | 20 k 2% |
| R28 | 27 k 2% |
| R29 | 2 k 7 |
| R30 | 22 k |
| R31,32 | 680 R |
| R33 | 330 k |
| R34 | 220 R |
| R35,49 | 4 k 7 2% |
| R36,50 | 220 k |
| R37,48 | 390 R 2% |
| R39 | 12 k |
| R40 | 820 R |
| R41 | 120 k |
| R42 | 18 k 2% |
| R44 | 560 k |
| R45 | 3 k 9 |
| R51 | 33 k |
| R52 | 1 M |
| R54 | 100 k |
| R55 | 4 k 7 |
| R56 | 10 M |

**CAPACITORS**

| | |
|---|---|
| C1,3,9,10 | 100 n polyester |
| C2 | 1000 u 25 V elect |
| C4,11,12,15 | 10 u 25 V tant. |
| C5 | 100 u 25 V elect. |
| C6 | 10 n polyester |
| C7 | 680 p polystyrene |
| C8 | 68 n polyester |
| C13 | 1 n polystyrene |
| C14 | 33 p ceramic |

**TRANSFORMER**

T1 120V 30V ct ½A
Hammond 260 E30 or similar

**MISCELLANEOUS**

500MA fuse and holder, shielded wire, stranded wire, pcb as pattern, line cord, 8 red sockets, 2 black, knobs, case etc.

**POTENTIOMETERS**

| | |
|---|---|
| RV1,2,3 | 47 k Hor. min. trim |
| RV4 | 1 k " " " |
| RV5 | 4 k 7 " " " |
| RV6 | 100 k " " " |
| RV7 | 10 k lin. carbon pot |
| RV8,9 | 10 k log. carbon pot. |

**SWITCHES**

| | |
|---|---|
| SW1 | off-on rocker etc. 3 A 120V |
| SW2 | D.P.D.T. toggle |
| SW3,4 | S.P.S.T. Toggle |

**SEMICONDUCTORS**

| | |
|---|---|
| Q1,2,4,7,8,9 | 2N3906 or 2N5086 |
| Q3,6,12 | 2N 5163 or 2N 3819 (N type FET) |
| Q5,10,11 | 2N5210 |
| D1-4 | 1N 4002 |
| D5-13 | 1N 4148 |
| LED1 | .2" type |
| IC1 | 7812 |
| IC2,4,8,9 | 741 |
| IC3 | CA 3046 or CA 3146 |
| IC5,6,7,10,14 | CA 3080 |
| IC11,12,13,16 | see text |
| IC15 | CD4024AE |

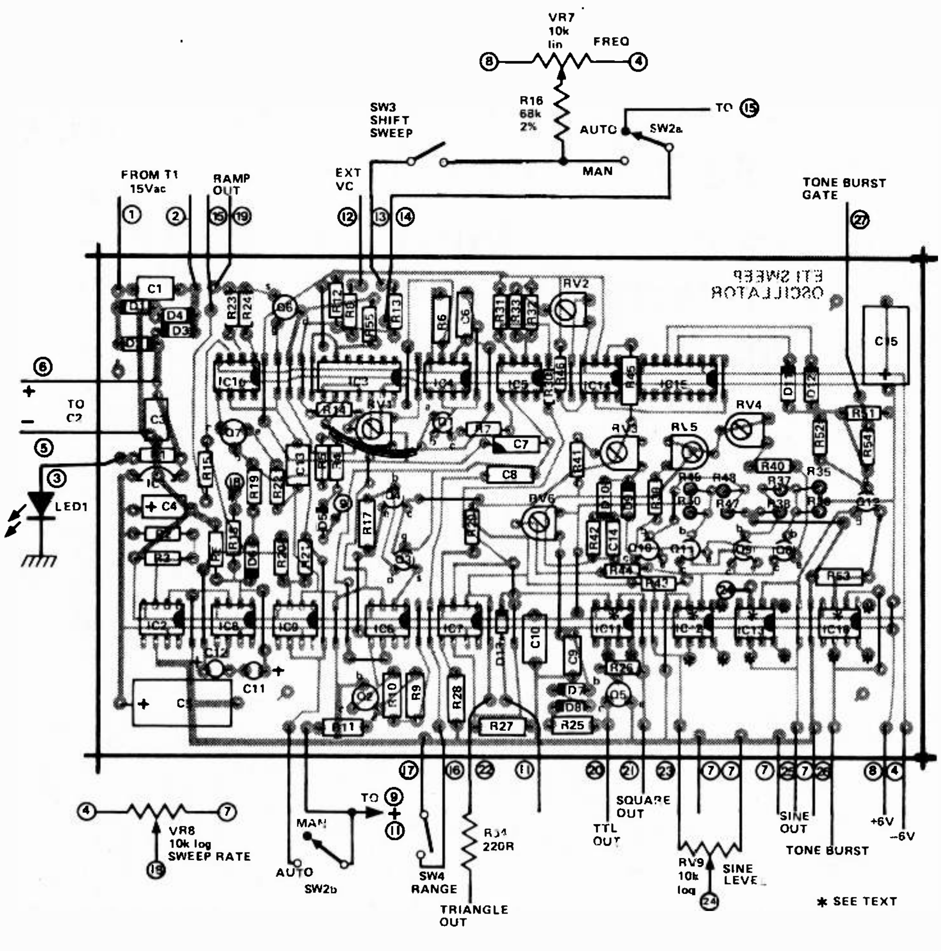



*Fig. 8 Overlay and interconnection pattern.*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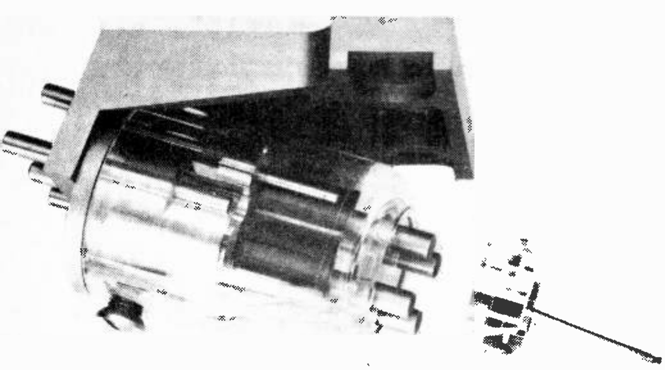
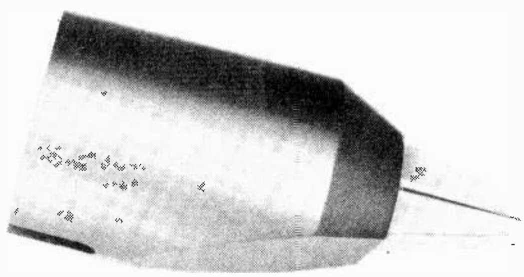


# PICKUP



# PRINCIPLES

**Ron Harris explains the workings of Hi-Fi's smallest black box**

FOR ALL THE continuing sophisti--cation within the electronics of the hi-fi chain, no viable method has been offered up to extract the mechanical information from the good old L.P. other than the trusty electro-mechanical cartridge.

This in itself generates an order of magnitude more distortion than any hi-fi component, but for some as yet unexplained reason, people seem more ready to accept some quite quirky behaviour from cartridges than from anything else.

After all if a particular brand of amplifier needed its wires cleaning before every usage, its sales would remain nicely static at zero.

The term electro-mechanical can be seen to excuse a multitude of sins.

## INDUCTION

Most pickups owe thier existance to Mr Faraday and his laws of induction. If you move a wire relative to a magnet within its field, you will generate an emf across that wire. It matters little whether you move the magnet or the coil of wire.

Various methods and variations have of course been evolved to utilise this principle to obtain an amplifiable voltage from the ups and downs of the vinyl.

Not all cartridges operate on this principle, just 90% of them!Ceramic devices are the main exception but these have completely faded from hi-fi usage, as the quality is no longer of comparitively high enough standard for the enthusiast.

The most common types are;

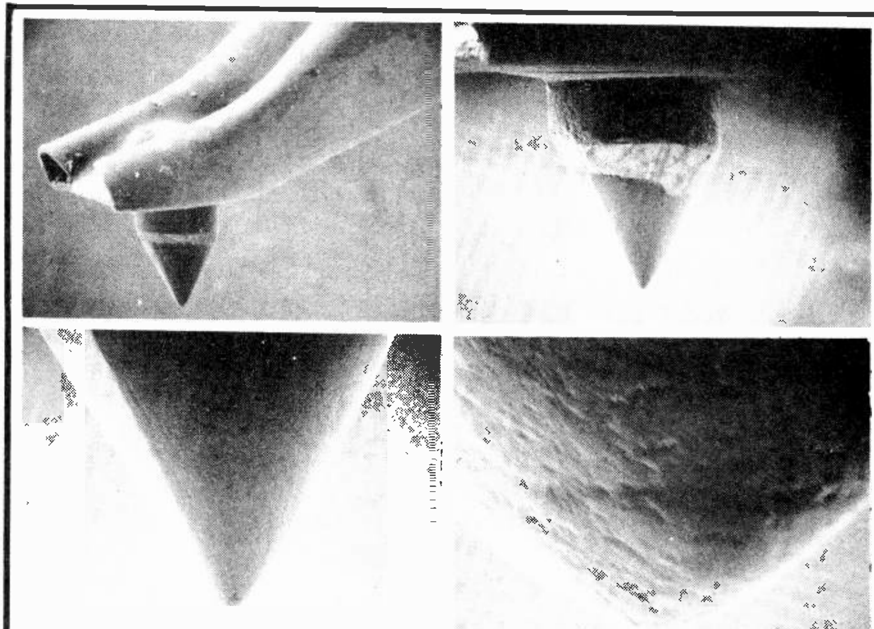
(i) Moving magnet
(ii) Moving coil
(iii) Moving iron Induced magnet
(iv) Electret

We shall be considering each type in turn.

The centre section of this article refers to such universal parameters as tip mass,compliance of cantilever, etc.

Such things are of paramount importance, but have little to do with the operating principles behind the cartridges themselves.

We mention them now lest you think we had forgotten, or worse still were ignorant of them!



*Every home should have one! Every cartridge does, but not this size. Shown here are four extreme magnification shots of a Stanton stylus. From top, left to right, 50X, 100X, and on the bottom 400X and 2000X.*
*And you thought that diamond was smooth eh?*

# MOVING MAGNET

By far the most common method. Fig I shows the basic operation of a Phillips 412 super M pickup, which can be considered typical of the bar magnet variety.

The pole pieces PL and PR are composed of mu-metal. When the stylus moves following the groove wall at say the left channel signal, the magnet will follow a similar path such that movement takes place parallel to PR, varying the distance relative to PL. This causes an emf to be set up across the left channel coils. Since that movement takes place parallel to the right channel coil, no emf is generated across that coil.

Since the coils are detecting minute changes in flux, sheilding from external influences must be good so that these are not registered as signals. Transformers must be kept well away from all pickup cartridges, which is why your deck will invariably work better on one side of your amplifier than on another!

A variation on this theme has been penned by Audio Technica, who use one magnet for each channel, set at $45^{o}$ to the record surface which makes them perpendicular to the groove walls. This does imitate the return of the cutting head pretty closely. The magnets are much smaller than usual, being around 25% of the mass normally utilised.

Since each channel was a totally separate motor assembly, stereo separation cannot help but be enhansed. Perhaps the most famous sons of the moving magnet are Shure, led by the VI5 111. This flagship design uses a laminated core structure, increasing the efficiency.

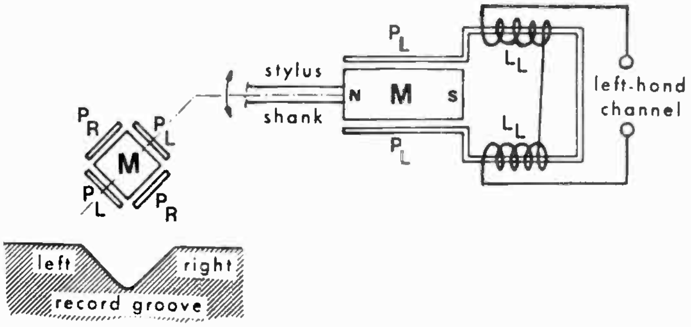
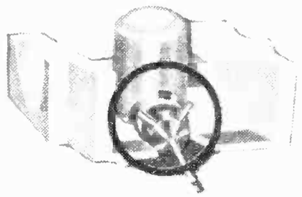
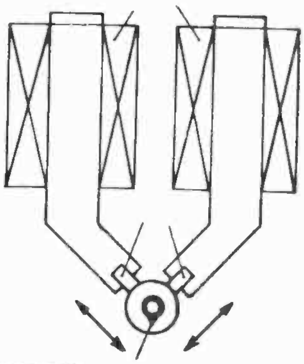
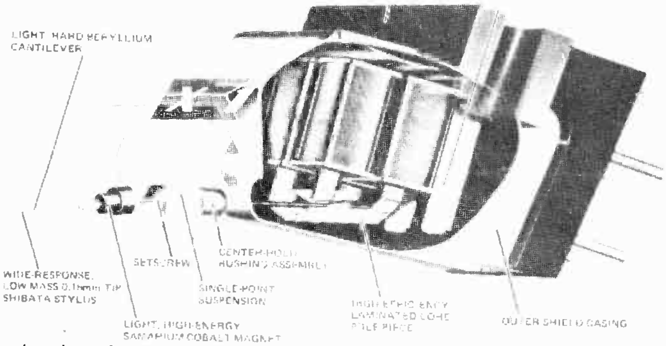



*Figure 1. The workings of a moving magnet cartridge, which in this case is a Philips 412. The bar magnet is marked 'M', and PL and PR are the pole pieces for each channel.*





*Audio Technica's dual magnet system. On the left an actual stylus assembly, and on the right how that bit in the circle operates, copying the cutting head movements.*




*A cutaway drawing of the JVC XI cartridge. This device has an extended h.f. response to allow it to produce CD4 records, a task for which it has become the standard machine!*


*Surely this needs no introduction? The Shure V15 Mk3, probably the most famous moving magnet cartridge and arguably the most transparent in reproduction.*

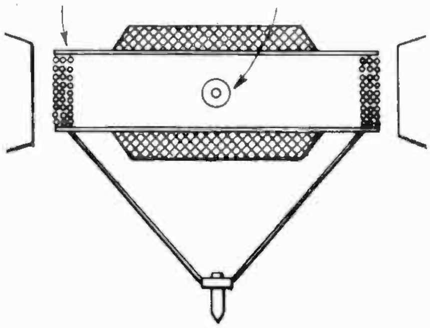

*A Philips 422 Super M. Very under-rated device this, people tend to only use them in Philips decks! The diagram in Fig 1 refers to this cartridge.*

# MOVING COIL

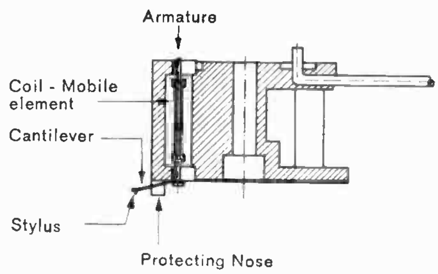
The oldest form of pickup cartridge. Originally developed by Ortofon, and now carried on by such adherents as Satin, Fidelity Research (and even Sony!).

The principle is extremely simple. The magnets are held in a fixed position within the cartridge body, and the coils for each channel are attached to the stylus assembly. The basic design is shown below. As the stylus follows the groove, the coils are forced to move next to the relevant magnets, thus inducing an emf in each.

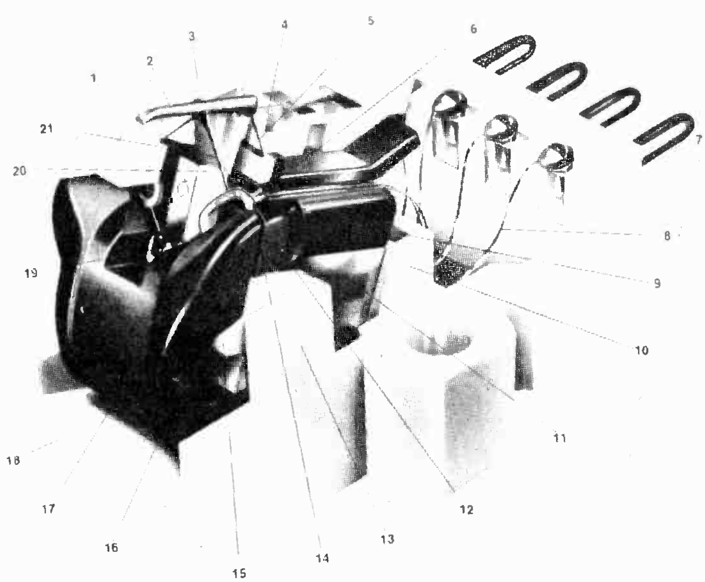
The main drawback is the low output, roughly 0.5 mV, as compared to 2 - 5 mV for the moving magnet designs. There are exceptions, notably Satin and Ultimo which produce outputs around 2mV. In order to raise this low level to one which can be fed to a normal input, a transformer or booster amp is required between cartridge and amplifier. However a tiny, but increasing number of amplifiers are now incorporating moving coil input to negate this requirement.



*A highly simplified model of how a moving coil cartridge works. The blocks to either side represent the magnets, and the little flocks of circles are the coils.*




*Cutaway drawing of an early Ortofon moving coil device. An interesting feature is the vertical armature mounting. Note the protective nose mounted to safeguard the stylus!*

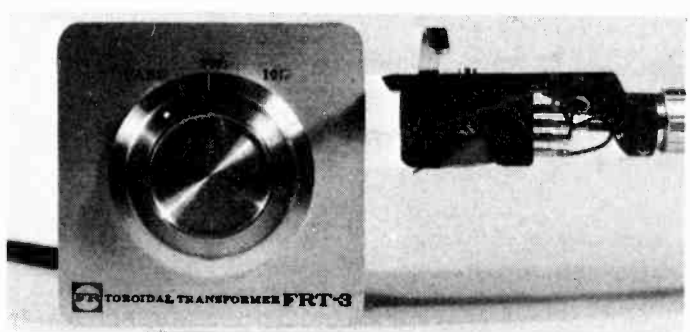


1. Stylus tip
2. Cantilever
3. Stylus housing
4. Tension wire
5. Plate spring
6. Stylus mounting magnet
7. Output terminals
8. Connecting wire
9. Oscillating block resonance damper
10. Oscillating block restriction wall
11. Magnet
12. Pole piece
13. Oscillating block restriction wall
14. Magnetic gap
15. Gap spacer
16. Yoke
17. Moving coil
18. Cartridge main housing
19. Armature positioning pin
20. Armature support
21. Pantograph-type armature

*Above is an internal peek at a Satin moving coil pickup. This is one of the high-output cartridges which does not need a transformer or booster amp to be used with normal amplifiers.*

*If you're setting up a hi-fi system based on a moving coil cartridge, check out the Yamaha 1010 amplifier, it already possesses a high quality moving coil pre amp!*

*And in the right corner . . . a Fidelity Research device with its booster transformer. This Japanese device has picked up quite a few followers in its short but glorious career in Britain.*



# PROPERTIES

## Important Properties of Pick-Up Elements

Pick-ups are small but very complex electro-mechanical devices, and their performance as transducers can be described by a variety of different properties of a mechanical as well as an electrical nature. Many of these properties are interrelated, which means that to assess the merits of a certain pick-up, it is important not only that it earns good ratings for its various properties but also that these ratings are correctly related to one another.

A particular difficulty in measuring pick-up elements is further that a number of measurements can only be made with the aid of a test record. Unfortunately the various makes of test records often have different characteristics, to the extent that the outcome of measurements under exactly identical conditions with different test records, may show appreciable differences too.

### Response curve

The response curve gives the output of the pick-up as a function of the frequency. The output is usually plotted in dB with respect to a reference level.

It is measured by means of a test record, and thus the response characteristic depends upon the properties both of the pick-up and of the record itself; the recording characteristic of the record should be known in order to make the response curve significant.

It is obvious that the response curve should be as smooth as possible, but due to resonances in the moving system there is a tendency to more or less pronounced peaks and dips at various frequencies. In a well designed pick-up these peaks and dips are flattened by a well-chosen, effective method of damping. This is accomplished by the suspension block, whose geometry, mounting and elastic properties are vital for the flatness of the response curve and hence for linear and distortion-free sound reproduction in the frequency range up to 20 kHz.

For pick-up elements suitable for application in carrier wave quadraphonic systems the response curve has to be extended considerably to well over 40,000 Hz and special measures have to be taken in the construction of the pick-up for this purpose. Since these carrier wave systems use frequency modulation in the high bands, it is not so much the flatness of the response curve which is of interest in the frequency region around the carrier wave frequency of 30 kHz, but the linearity (the lack of sharp bends in the frequency response between 20 and 40 kHz) which determines the proper functioning of the phase-sensitive quadra demodulators.

### Sensitivity

Sensivitity is the output voltage of the pick-up when connected to a prescribed load resistance while tracing a record groove of specified frequency at a specified velocity. It is expressed in millivolts per cm per second.

### Output asymmetry

The difference between the output of the two channels when both are activated by identical groove modulation is the output asymmetry. The asymmetry is expressed in dB at 1 kHz.

### Channel separation

Channel separation (opposite: crosstalk) is the ratio, expressed in dB, measured in one channel of a stereo system between a signal belonging to that channel and the influence of that signal in the other channel. Adequate channel separation is important for good stereo reproduction.

Apart from the internal construction of a pick-up element there are mainly two other factors which influence channel separation. In the first place, the plane of symmetry of the cartridge should be perpendicular to the surface of the record. Even a slight deviation (camber) will have an unfavourable influence on separation. This is mainly a matter of accurate tone arm design although a similar phenomenon occurs if the stylus alignment is incorrect (Fig. 1 and 2).

In the second place, the cutting angle of the record groove may deviate from 90°. Obviously this is an imperfection in the record and is the main reason why the same type of pick-up measured with different test records shows fairly divergent channel separation figures.

### Distortion

Distortion is expressed as a percentage of the desired signal. In pick-ups, as opposed to amplifiers, distortion is largely frequency dependent and may change considerably if the frequency is changed only a little. For this reason the interpretation of distortion measurements is difficult and the final judgement, as in so many cases, can only be given by the ear. The distortion may originate within the pick-up, but it may also result from the fact that the shape of the playback stylus is not identical with that of the recording stylus (tracing distortion) and from the fact that the axis of the pick-up head is not always at a tangent to the groove (tracking distortion). In view of tracing distortion an elliptical stylus is to be preferred to a spherical one. Tracking distortion is determined by the shape of the tone arm and is of a very low value in a correctly designed record player.

The distortion usually measured is frequency intermodulation distortion (FIM). This measurement is carried out by means of a test record, the groove of which is modulated by two frequencies 300 Hz and 3000 Hz, with a modulation depth ratio of 4 : 1.

In the case of non-linearity, sum and difference frequencies of respectively 3300 Hz and 2700 Hz will be present. The amplitude of.

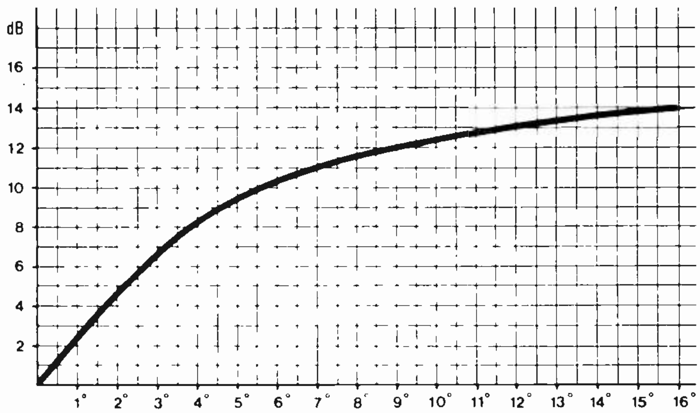
these is measured in relation to the 3000 Hz signal and this figure expressed as a percentage is the FIM distortion. According to DIN 45 500, FIM distortion has to be 1% measured at reference level of —6dB (3000 Hz).

## Compliance

Compliance is the displacement of the stylus tip per unit of applied force. It is thus the opposite of stillness and expressed in mm/N or in cm/dyne and its numerical value should be so high that the stylus can follow all the movements which are derived from the resonance frequency of the system. The values often published are static values, which are usually higher than those measured dynamically. For that reason static compliance is mentioned along with dynamic compliance, although in practice only the latter values are relevant for the behaviour of the system. As the highest amplitudes appear on the record at the lowest frequencies, it follows from the definition of compliance that this is a particularly important property at low frequencies.

## Dynamic mass

The dynamic mass at the stylus tip is the apparent mass which causes the stylus tip to resist acceleration. All moving components, stylus, stylus shank and magnet contribute to dynamic mass, but since the excursions of these parts while tracking a record are of a different magnitude, values are reduced to an apparent mass at the stylus tip normally called dynamic mass. It should have a low value, and as the highest accelerations are encountered at the higher frequencies, the



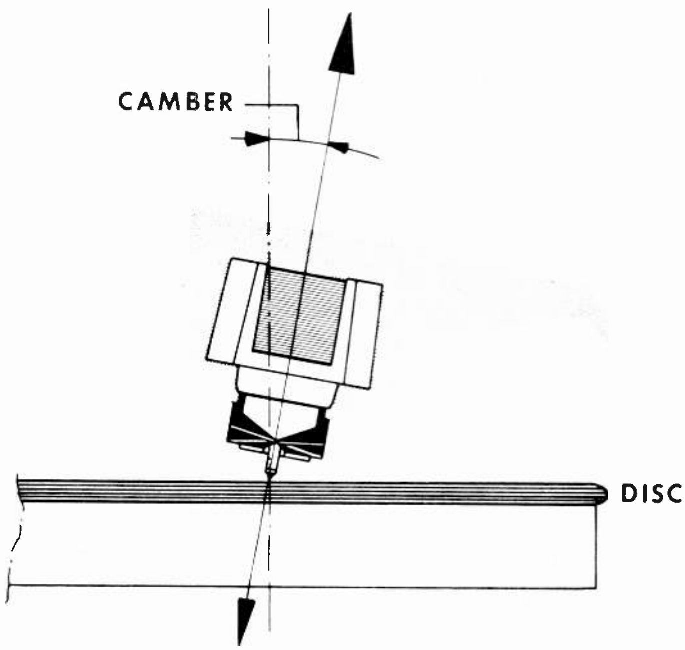




*Fig. 1 Channel separation deteriorates if the cartridge is not perpendicular to the record.*

*Fig. 2 Decrease in channel separation as a function of camber for a cartridge with an initial separation of 25 dB.*

impressed upon it by the record groove. The compliance should not be so high that it causes the mechanical resonance frequency of the resonant system (tone-arm mass with pick-up compliance) to drop to the region where this resonance can be excited by mechanical vibration. This would lead to an undesirable increase in flutter phenomena.

It has been found that the static measurement of compliance does not give adequate information about the dynamic behaviour of the system since the elasticity characteristics of, say, the rubber suspension may differ fairly considerably for stylus velocities that may be encountered even with relatively low frequencies. For this reason compliance is now being measured dynamically by some manufacturers. In the case of the Philips Super M cartridges the value is obtained by means of a measuring instrument where the dynamic compliance is a value

## Tracking or trackability

Tracking is the capability of the stylus to follow the undulations of the groove without losing contact with the groove walls. It is measured by making use of a test record modulated with a given frequency — e.g. 300 Hz — in steps of increasing amplitude. The resulting signal can be observed by means of an oscilloscope which makes it possible to judge that maximum amplitude can be tracked without distortion. The consumer is able to judge the trackability by means of listening tests with the aid of records, which are on the market for this purpose.

Trackability is mainly determined by the compliance at the lower end of the frequency spectrum while dynamic mass is a limiting factor at the higher frequencies.

dynamic mass is an important property with respect to high-frequency response. This explains all the efforts to further reduce mass, particularly of the stylus and stylus shank. In practice the dynamic mass cannot be measured, but only calculated theoretically. Moreover, it is a somewhat frequency-dependent quantity because of a small shift in the pivoting point of the moving system with increasing frequency. It is normal therefore to specify the directly measurable stylus-tip mass, a quantity which largely determines the dynamic mass.

## Stylus force

Stylus force, usually measured in gramforces, is the vertical force with which the needle tip bears down onto the record. The stylus force should be high enough to prevent high amplitudes or great accelerations from causing the needle tip to lose contact with the groove walls, as this would result in distortion and even groove jumping.

On the other hand, it should be low enough to prevent record wear through friction and through plastic deformation, that is, the stylus still leaves marks on the record without abrading the material.

In reality it is not so much the stylus force but the stylus pressure, the force per unit of contact area between stylus and record, that is of importance. This contact area is the area of elastic deformation of the groove wall resulting from the force of the stylus tip on the groove walls. The contact area is smaller for styli with smaller contact radii as is the case, for example, with elliptical styli. These styli therefore have to be used with a lower stylus force.

## Vertical tracking angle

The vertical tracking angle is the angle included between the record's surface and the line which connects the stylus point to the turning point of the shank. In order to minimize crosstalk and distortion the vertical tracking angle of playback pick-up and cutter should be approximately the same. Today it is standardized at 20° ±5° (Fig. 3).

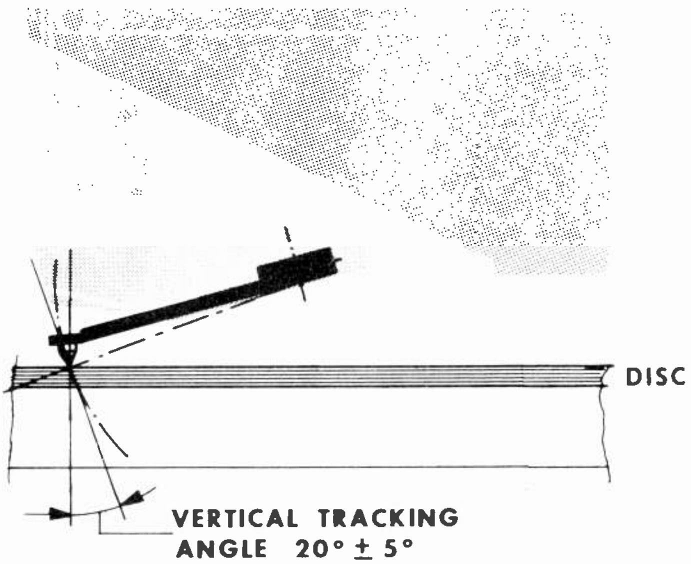



*Fig. 3 Vertical tracking angle*

## Recommended load impedance

Load impedance corresponds to amplifier input impedance, today mostly around 50 kOhm. The value is not very critical, however.

## Weight and mounting distance

The weight of a pick-up cartridge is important since it also determines the size of the counterbalance weight and thus the weight of the total tone arm. The mounting distance for pick-up cartridges is at present standardized at ½" (12.7 mm).

## Internal impedance

The internal impedance is composed of the ohmic resistance and the self inductance of the pick-up. A low impedance is particularly advantageous for pick-up elements for quadraphonic discs recorded with a (high frequency) carrier wave system.

## Recommended cable capacitance

An electrically screened cable is used for the connection between record player and amplifier. Its capacitance should not surpass a certain value otherwise high frequencies will be attenuated. Special low capacitance cables are also recommended for quadraphonic carrier wave discs.

## ACKNOWLEDGEMENT

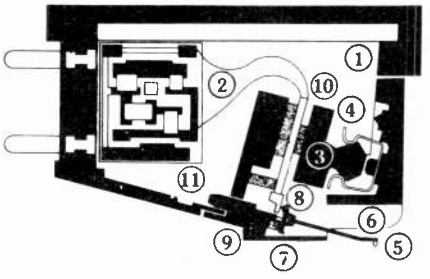
**We wish to thank Philips for their assistance in the preparation of this article and their permission to publish certain sections originated by them.**

# ELECTRET

Just as a quartz crystal is capable of producing an output under stress so are some semiconductor substances. An 'electret' is a permanently polarized block of material which, when stressed, produces an output voltage directly proportional to the force causing the stress.

In the Micro-Acoustics QDC 1E cartridge, a conventional stylus assembly joins with a pyramid shaped chunk of material which is pivoted in the centre of the base, and supported by two elastomer blocks, at each corner, where the actual electret contacts the pyramid.

Output impedence is around 8K, which shunts the usual 47K of amplifier inputs down. Micro claim this engenders their cartridges with lower noise figures. Phase shift characteristics should certainly be good, since the output impedence will be almost pure resistance, with very little capacitance present, and no inductance. The signs are that this system will be used increasingly as time goes on.

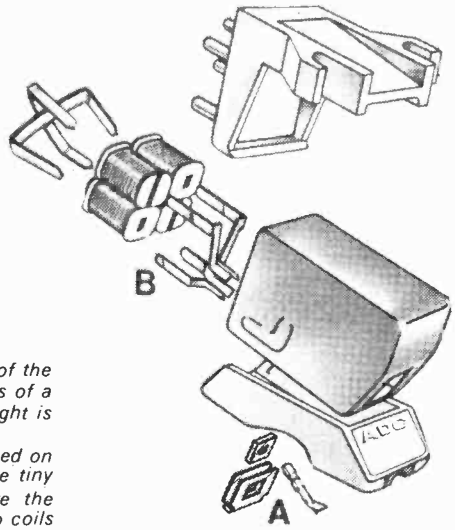


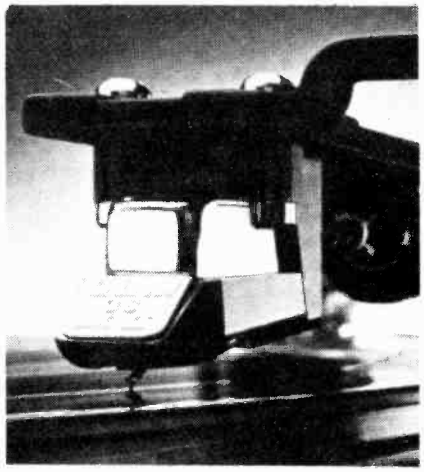

*The drawing shows the insides of a Micro Acoustics 2002 electret cartridge. This is the cheaper version of the QDC 1E referred to in the text. To explain the numbers: 1, Total device possesses a mass of 4.0 grams; 2, Internal connecting wires to the matching circuit; 3, Dampers (mechanical); 4, Retainer spring for the stylus assembly; 5, Stylus assembly; 6, Beryllium cantilever; 7, Bearings and resolver; 8, Stylus to electret coupling; 9, User replaceable stylus assembly; 10, The actual electret transducer; 11, Passive matching circuit (matching to phono inputs).*

# INDUCED MAGNET -MOVING IRON

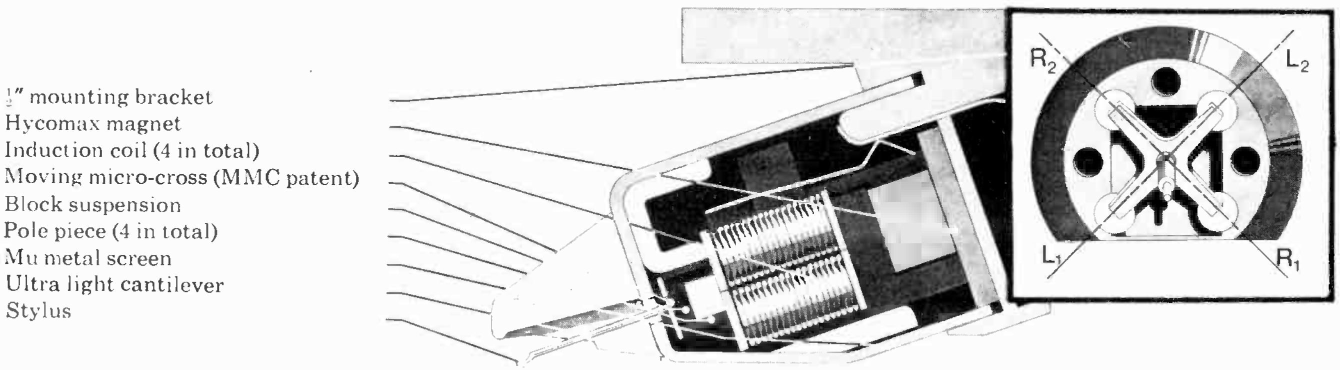
Replacing the moving magnets is a single high permeability armature which itself moves with the stylus within the field of the (fixed) magnets. As there is no mechanical linkage the mass of the stylus is reduced. ADC are the prophets of this system.

Bang and Olufsen have an innovation on the market in the form of the MMC range. Here a small 'cross' is attached to the armature and this influences the 4 induction coils, to obtain that emf.



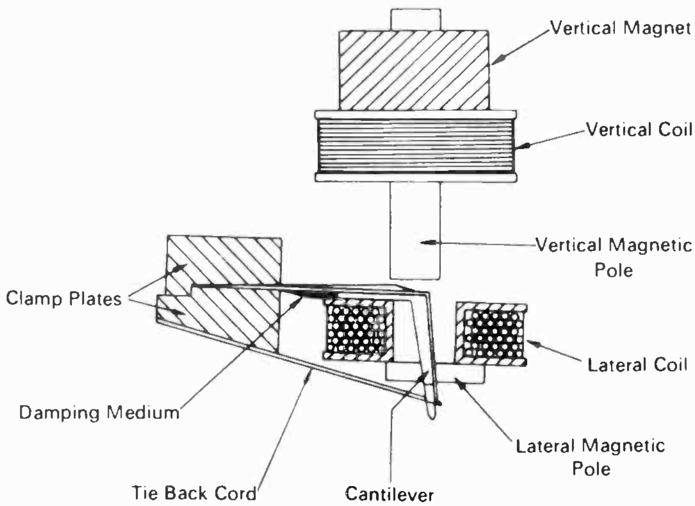
*Right: ADC are the main exponents of the art of the induced magnet. The drawing shows the vitals of a Q36 pickup following this doctrine. Further right is how it looks when in use and in one piece.*
*Below: Bang and Olufsen MMC is heavily based on the moving iron principle, but incorporates the tiny little cross (shown as an insert) to improve the transfer from armature to coils. Note that two coils per channel are used.*




One cartridge which falls in the above category is the Decca Mk VI. This cartridge works without a conventional cantilever and movement of the stylus is sensed by an overhead magnet with a vertical and lateral coil.

The mass of the "cantilever" is kept to the minimum because no armature, is displaced by its movement. The diagram of the system, shown in Fig. 1, illustrates how the basic concept works. The stylus cantilever is clamped in place between two plates, is restricted in movement by a damping medium and by a tie back cord which prevents fore and aft movement of the stylus.

The movement of the stylus is traced at the stylus point by the coils above it. Overcoming the normal problems encountered with a rubber type pivot in the elimination of fore and aft movement whilst allowing the rear section of a normal cantilever to precisely follow the movements of the stylus.



# SCIENTIFIC CALCULATOR REVIEW

IF YOU HAVE CONSIDERED buying a scientific calculator recently then you will have been faced with a bewildering choice. One of the larger retail outlets lists 28 different models in the scientific category with prices ranging from about $20 to over $600. This survey sets out to cover the more common models though the models chosen can only be representative of those available — however this survey will enable comparisons to be made with any new or not so common models that may be found.

Early in 1972 Hewlett-Packard introduced the HP-35, one of the first pocket sized scientific calculators, which then cost $450. The HP-35's calculating power was contained in 5 MOS I.C.'s.

During 1976, the same company introduced the HP-21, a calculator with a slightly ***greater*** calculating power than the HP-35 but selling at only $100. This dramatic price reduction has been, and still is, common to all calculator manufacturers

These price reductions have been due to several factors, one of which is obviously competition, as most serious calculator manufacturers now have a scientific in their model range. Another factor has been the steady advance in semiconductor technology during the very recent past. The HP-21 uses more logic circuitry than the original HP-35 yet contains only two I.C.'s against the five of the HP-35.

One new development which appears as exciting as the introduction of the first scientific is the recent introduction of the programmable scientific calculator. There are now at least three major manufacturers offering programmables covering a price range from $60 to $600. Programmables are extremely valuable for the solution of repetitive calculators involving a large number of calculating steps having to be performed on many items of separate data. This may well occur when handling experimental data or tabulating a graph for instance. Most manufacturers offer a library of standard programs with their machines. The individual program steps are stored in either a solid state memory or on a magnetic card which is fed into the calculator by a small motor.

## CHOOSING A SCIENTIFIC CALCULATOR

With such a vast range of scientifics available in more or less every price range, it is important that the right

*Texas 59*

*Texas SR-51-II*

factors are considered before money is invested in the calculator of your choice. The first decision is which type of calculator will meet your needs -- usually the cheaper mpdels do not offer the option of scientific notation and so are limited in their calculating range to numbers between $10^8$ and $10^{-8}$. If you want to handle numbers outside this range then a machine which handles full scientific notation will save the bother of keeping a separate note of the powers of 10 involved, this may well happen when handling calculations in electronics with microfarads, nano seconds, giga hertz etc. being involved.

For purposes of this review we have restricted ourselves to those calculators which are chiefly "scientific" in the nature of their functions, and have mantissa — exponent type display. The most popular features are compared in the chart.

The programmable calculator is at present being hailed as the answer to everybody's dream of infinite, instant calculating power but in general they are considerably more expensive than their non-programmable equivalents.

Having chosen the type of calculator required then the available range of that type must ne carefully examined for there are several important differences between models of the same basic type.

The most important decision to be made when choosing a scientific is that of which number entry system the calculator should use. The two systems found are Algebraic and Reverse Polish Notation (RPN), sometimes called Post Fixed Operators. The difference can be seen clearly by following the sequence of keystrokes needed to add two numbers together:

**ALGEBRIAC**

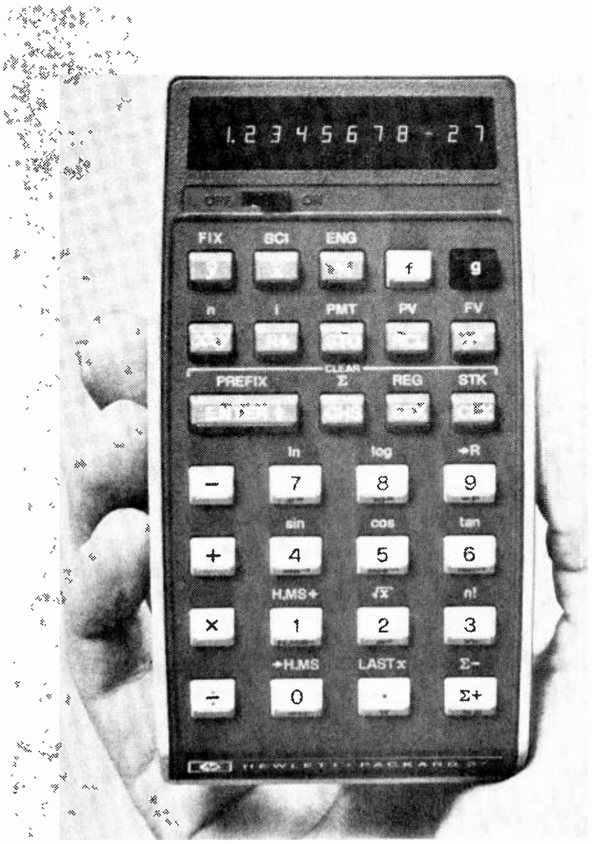
| Key | Display |
|---|---|
| 2 | 2 |
| + | 2 |
| 3 | 3 |
| = | 5 |

**RPN**

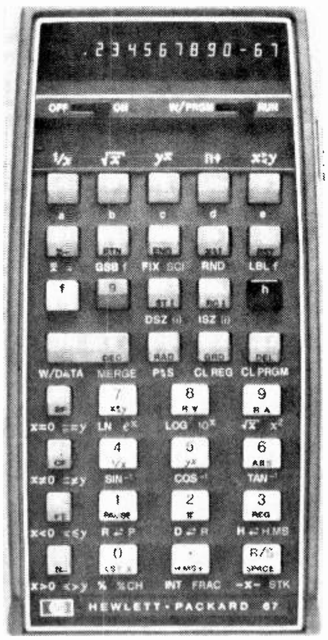
| Key | Display |
|---|---|
| 2 | 2 |
| enter | 2 |
| 3 | 3 |
| + | 5 |

This sum requires the same number of keystrokes in each system but the algebraic systems operates the keys in the same order as the sum would be read aloud whereas the RPN system has this mysterious "ENTER" key. Algebraic is certainly a simpler system to operate initially but RPN has a lot going for it, especially in the field of complex scientific calculators. If combined with a working stack of data registers, RPN system gives a very great calculator power with instant access to parentheses without keying in and out of them. A four level stack is equivalent to three levels of parenthesis (brackets). However the operator of a RPN machine needs to be able to transform a complex equation such as:- $x=\tan^{-1}((3.5^3 + 8\sin 37^o) + 6(\cos 53^o) + 2(1+\ln 3.55))^{\frac{1}{3}})$ into a number of 'enter' keystroke whilst the algebraic machine operator can, if he has sufficient 'brackets' available, enter the problem as written.

A good argument can be made out for each system and the choice must be made on your ability to *understand* what you are doing. But do not dismiss RPN as too difficult to understand, have it demonstrated to you and then try some problems yourself — you might be surprised at the ease with which you can pick up a new system.



H.P. 27



H.P. 67

| | | | logic type | no. of brackets | no. of levels in stack | auto constant | no. of memories | pi | x squared | root x | reciprocal x | y to the x | log x | 10 to the x | ln x | e to the x | degrees | radians | grads | trig functions | hyperbolic | Gaussian | binomial |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Basic Functions** | | | | | | | | | **Angle Modes** | | | | | | |
| SCI. NON. PROG. | CANON | F 41 | A | | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. NON. PROG. | CANON | F 51 | A | | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | Y | | |
| SCI. NON. PROG. | CANON | F 61 | A | 2 | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | CANON | F 71 | A | 6 | | Y | 5 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | CASIO | fx 21 | A | | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | CASIO | fx 1000 | A | | | Y | 1 | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | CASIO | fx 2000 | A | | | Y | 1 | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | CASIO | fx 110 | A | | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | COMMO | 9190 | A | | | | | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | Y | Y | Y |
| SCI. NON. PROG. | H P | HP 21 | R | | 4 | | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | | | |
| SCI. NON. PROG. | H P | HP 27 | R | | 4 | | 10 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | |
| SCI. NON. PROG. | NATIONAL | 201R | A | 2 | | Y | 1 | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | | | |
| SCI. NON. PROG. | NATIONAL | 852 | A | 2 | | Y | 1 | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | | | |
| SCI. NON. PROG. | NATIONAL | 4640 | R | | 4 | | 3 | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | | Y | | | |
| SCI. NON. PROG. | NATIONAL | 4650 | A | 2 | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | | Y | | | |
| SCI. NON. PROG. | NATIONAL | 4660 | A | 2 | | Y | 3 | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | | Y | | | |
| SCI. NON. PROG. | SHARP | EL 5000 | A | | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. NON. PROG. | SHARP | EL 5801 | A | | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. NON. PROG. | SHARP | EL 5804 | A | | | Y | 1 | Y | | Y | Y | Y | Y | | Y | Y | Y | | Y | Y | | | |
| SCI. NON. PROG. | TEXAS | SR 40 | A | 15 | | Y | 1 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. NON. PROG. | TEXAS | SR 51-II | A | 9 | | Y | 3 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | |
| SCI. PROG. NO X MEM. | | PR 100 | A | | | | | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | | Y | Y | | |
| SCI. PROG. NO X MEM. | | 19C/29C | R | | 4 | | 30 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. PROG. NO X MEM. | | 25/25C | R | | 4 | | 8 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. PROG. NO X MEM. | | TI 57 | A | 9 | | Y | 8 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. PROG. X MEM. | | TI 58 | A | 9 | | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. PROG. X MEM. | | TI 59 | A | 9 | | Y | | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. PROG. X MEM. | | NAT 7100 | A | 3 | | | 32 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |
| SCI. PROG. X MEM. | | HP 67 | R | | 4 | | 26 | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | |

| Statistical: Poisson | Chi square | permutation | combination | factorial | mean | standard deviation | Linear Regression: slope | intercepts | correlation coefficients | Conversions: decimal degrees - DMS | rectangular - polar | Imperial - SI | V ratio - dB | Programming: no. of steps | Merged | data registers | subroutine levels | Editing: editings: insert | editings: delete | labels | Conditional Branch: no. in single register | no. in double register | Display: no. of digits (mantissa only) | mantissa + 2 exponents | eng notation | round off function | type of digits | standard power | price |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Y | | | | | | | | | | | | | 8 | 5 | | | F | P | |
| | | | | | | | | | | Y | | | | | | | | | | | | | 8 | 8 | | | F | P | |
| | | | | | Y | Y | | | | Y | Y | | | | | | | | | | | | 8 | 8 | | | F | P | |
| | | | | | Y | Y | Y | | Y | Y | Y | | | | | | | | | | | | 10 | 10 | | | F | P | |
| | | | | Y | | | | | | Y | | | | | | | | | | | | | 8 | 6 | | | F | P | |
| | | | | Y | Y | Y | | | | Y | | | | | | | | | | | | | 8 | 6 | | | C | P | |
| | | | | Y | Y | Y | | | | Y | | | | | | | | | | | | | 8 | 6 | | | C | S | |
| | | | | Y | Y | Y | | | | Y | | | Y | | | | | | | | | | 10 | 8 | | | F | P | |
| Y | Y | Y | Y | Y | Y | Y | Y | Y | | | Y | 8 | | | | | | | | | | | 10 | 10 | | | E | R | 50 |
| | | | | | | | | | | Y | Y | | | | | | | | | | | | 10 | 8 | | Y | E | R | 100 |
| | | | | | Y | Y | Y | Y | Y | Y | Y | | | | | | | | | | | | 10 | 8 | Y | Y | E | R | 200 |
| | | | | | | | | | | | | | | | | | | | | | | | 8 | 5 | | | F | R | 32 |
| | | | | | | | | | | | | | | | | | | | | | | | 8 | 5 | | | E | P | 17 |
| | | | | Y | Y | Y | | | | Y | Y | 6 | | | | | | | | | | | 10 | 10 | Y | | E | R | 50 |
| | | | | | | | | | | | Y | | | | | | | | | | | | 8 | 8 | | | E | R | 40 |
| | | | | Y | Y | Y | | | | Y | Y | 8 | | | | | | | | | | | 10 | 10 | | | E | R | 50 |
| | | | Y | Y | Y | Y | | | | Y | Y | | | | | | | | | | | | 10 | 10 | | | | | 50 |
| | | | | Y | | | | | | Y | | | | | | | | | | | | | 8 | 8 | | | | | 30 |
| | | | | | | | | | | Y | | | | | | | | | | | | | 8 | 6 | | | C | S | 40 |
| | | | | | | | | | | Y | | | | | | | | | | | | | 8 | 5 | | | E | R | 50 |
| | | | | Y | Y | Y | Y | Y | Y | Y | Y | 4 | | | | | | | | | | | 10 | 10 | Y | Y | E | R | 80 |
| | Y | Y | Y | Y | Y | Y | Y | Y | | Y | Y | 3 | | 72 | | 10 | | Y | Y | | | | 8 | 8 | Y | | E | R | 160 |
| | | | | | Y | Y | | | | Y | Y | | | 98 | Y | 30 | 3 | Y | Y | Y | | 4 | 10 | 8 | Y | Y | E | R | 250/525 |
| | | | | | Y | Y | | | | Y | Y | | | 49 | Y | 8 | | | | | | 4 | 10 | 8 | Y | Y | E | R | 160/250 |
| | | | | | Y | Y | | | | Y | Y | | | 150 | | 8 | 2 | Y | Y | Y | | 4 | 10 | 8 | | Y | E | R | 100 |
| | | | | | Y | Y | | | | Y | Y | | | | | | 6 | Y | Y | Y | | 4 | 10 | 8 | Y | Y | E | R | 150 |
| | | | | | Y | Y | | | | Y | Y | | | | | | 6 | Y | Y | Y | | 4 | 10 | 8 | Y | Y | E | R | 370 |
| | | | | Y | Y | Y | | | | Y | Y | 6 | | | | 32 | | Y | Y | Y | 3 | | | | Y | Y | E | R | 600 |
| | | | | | | | | | | Y | | | | | Y | 26 | 3 | Y | Y | Y | | 4 | 10 | 10 | Y | Y | E | R | 575 |

One of the arguments advanced in favour of the RPN system is that it is consistent when dealing with the more complex keyboard functions such as the trig functions, logs etc. If you wish to find the 'sin' of 30° then the key sequence for each type of machine is the same- '30' 'sin' which indeed is the sequence expected for a RPN machine, but the reverse of that expected for the algebraic machine — you might find this an inconsistency.

Manufacturers of both types of machines usually offer a separate memory as well as an multi-level stack in the RPN machine or one or more sets of 'brackets' in the algebraic models. Often the choice may be one level parenthesis plus two separate memories or two levels of parenthesis plus one memory.

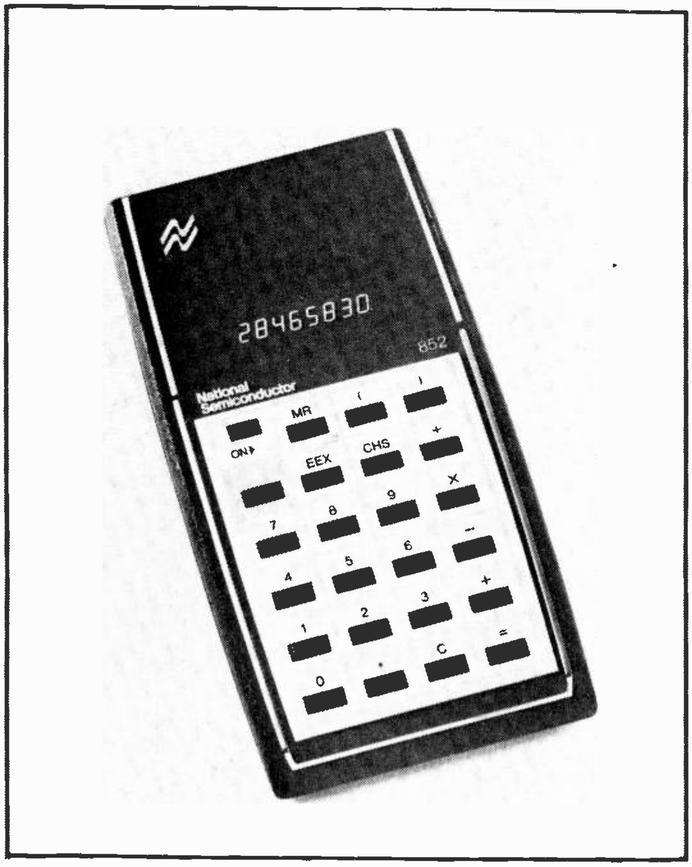
Having made this decision, which is the most important one, then the next factor to be considered is the type of display and number of digits to be displayed. The most popular type of display is the LED type which is usually red in colour. The cheaper models of calculators use small LED displays with magnifying lenses fixed in front. These lenses tend to narrow the viewing angle (the angle over which the display may easily be read). This is fine in a small pocket calculator but not as satisfactory in an expensive scientific model. Another, not so common type of display is the flourescent type — this is a green display which generally is larger than the LED type and the whole display is built into an evacuated glass envelope. The basic display is more expensive than a LED type and does require more complex additional circuitry (high voltage generators etc) but has the advantage of extremely low power consumption.

Finally there is the liquid crystal display which reflects, rather than emits, light, and has an even more miniscule power need.

Having mentioned power consumption it is a useful next point for consideration; if your choice of calculator is available with or without rechargeable batteries then the extra outlay on the rechargeable version may well be worth considering. With the current required by some of the more complex calculators (especially those with LED displays) it will not take all that long to run down a battery and so the extra cost of the rechargeable batteries is soon made up.

The next factor for consideration is the keyboard and its layout. The lesser number of keys, the smaller the calculator and thus the more easily pocketable but with the disadvantage that there are often two keystrokes required for access to a scientific function. Thus if you are going to use the full range of the calculator fairly often then you might well find double function keys awkward to use. The only double function keys which are obvious are those of trig and inverse trig function keys. Pressing 'arc' 'sin' seems a good use of the double function key and saves two keys on the keyboard.

Whilst discussing keyboards, it is worth considering the *feel* of each key and whether there is any 'breakaway' action to a keystroke or whether the key has a 'spongy' feel to it. There is particular advantage to either system and it is really a matter of personal choice, though it does seem as though the more expensive the machine, the more positive the action of the keys. Again the recommendation is to try several different models and see which you like.



*National 852*

*National 4660*

In the tables it has been impossible to list every function for each model so the tables have only the main functions

The more exotic functions are too numerous to mention. Commodore makes three calculators each with a formidable array of 55 to 60 keys, most dual function. These three are specialized for statistician, mathematician or navigator.

A recent feature introduced on the latest range of Commodore scientifics is worthy of note, especially to electronic enthusiasts, is the provision of two keys marked 'EE↑' and 'EE↓'. These keys are used when the machine is being operated in the scientific notation to increase or decrease the value of the exponent whilst shifting the position of the decimal point in the mantissa. This feature appears to be very useful in electronic calculations when we tend to come across component values whose unit values are separated by a factor of $10^3$. Thus if a time constant calculation is being carried out and the answer comes out a a required capacitor of '$3.3 \times 10^{-10}$' Farads then by pressing the 'EE↓' key twice the display will show '$330 \times 10^{-12}$' or more simply 330pF.

As may be seen from the tables, several manufacturers are now offering statistical functions on their more expensive models. These are usually the mean and standard deviation of a set of numbers and these are very useful when handling a set of experimental results and trying to analyse some trend or conclusion from them. The one problem with statistical functions in a scientific calculator is that some of them use the calculator memories during the computation of the statistic so those memories are not available for other use during the finding of statistical functions.

## PROGRAMMABLES

The current scene of greatest excitement in calculators lies with programmable models because of the great potential power of programmability.

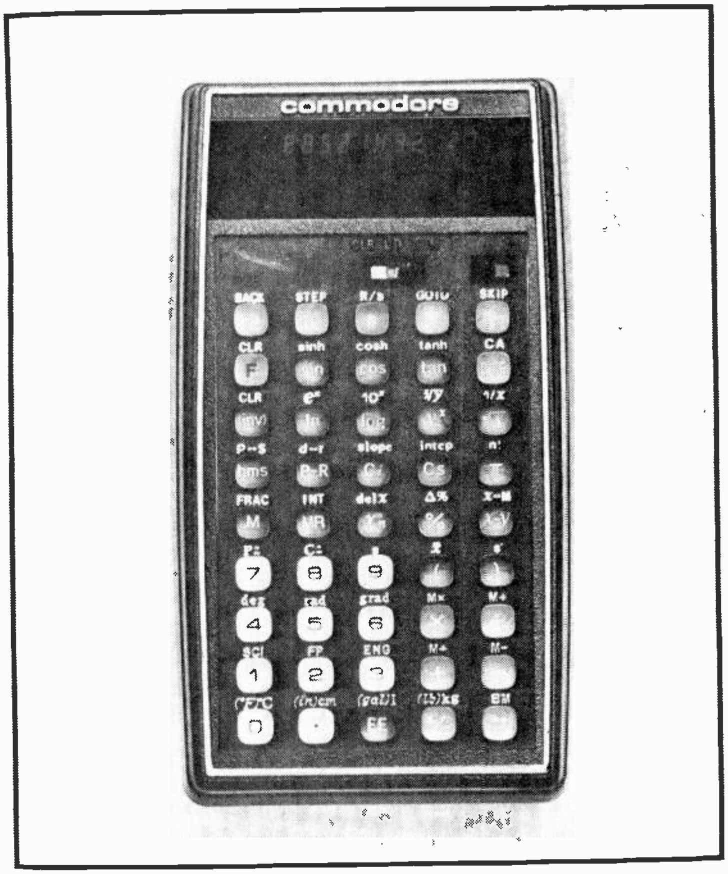
Briefly — "programmable" means that the calculator is able to store a sequence of keystrokes which can then be executed at a later time, and repeated as many times as needed.

In order to be able to do this, numbers used in the calculations are not entered from the keyboard, while the program runs, but instead are stored before hand in the calculator's registers. The program then refers to the registers for its data, and similarly deposits results in other registers.

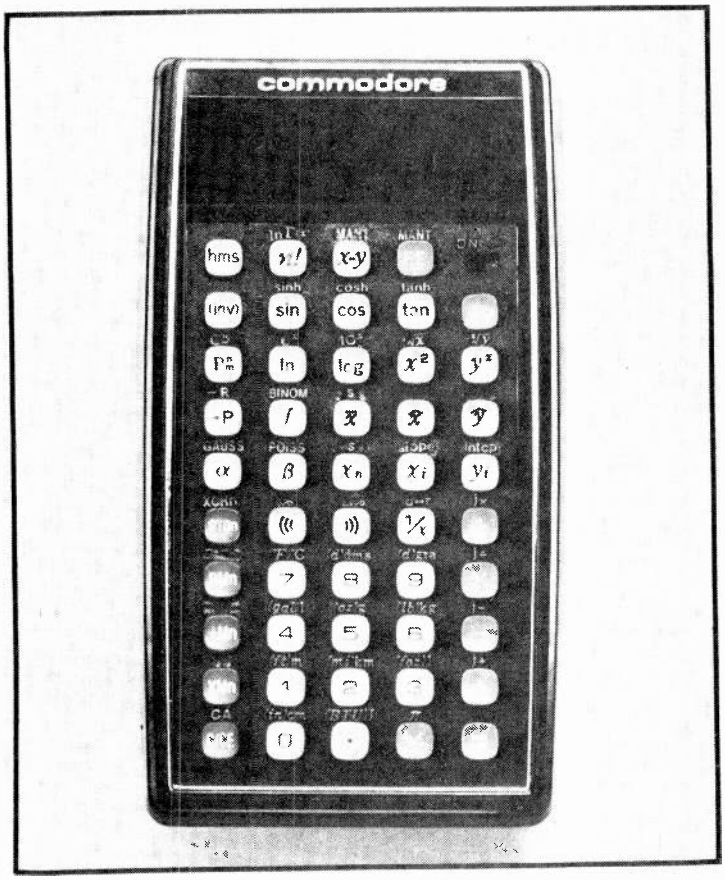
## BRANCHING OFF

More refined features include branching and looping. Since the program operates much faster than a human, the operator has no chance to make decisions as to the next calculation to make, as the program runs. Thus various "decision" features are built in. These are either one or two register types. The single register type typically asks "is x greater, less than or equal to zero". Based on the result of this question a "branch" to a new section of the program takes place. The two register decision is similar, but compares two registers, and although this is actually not more powerful, it does save steps in many situations.

Several type of branch are available, such as -1 absolute; to a certain location in program memory; relative — forwards or backwards a certain number of steps, and by labels, where a specific place in the program is given a reference name, and this is used to go to. Labels are useful in long programs where editing can easily change the absolute or relative positions of program step. Indirect addressing is




*Commodore PR100*




*Commodore SR9190R*

also offered on some calculators.

Looping is used where it is desired to repeat a program segment a number of times. Usually a statement such as Decrement and Skip on Zero (DSZ) is used. The programmer in some manner sets a register to a predetermined number. When the program reaches DSZ, the register is decremented, and if not yet zero the program proceeds to the next statement. This is usually written to be a "go to" some previous part of the program, which will be repeated. Finally the register decrements to zero and DSZ causes the subsequent "go to" to be skipped, and the loop has been escaped.

## SUBROUTINES

On a higher level than loops is the subroutine. This may be considered a mini program, used by the main program and written separately from it. It is used just as a function such as "log" might be, but it is defined by the user. Subroutines are an extremely useful feature for organized programming. "Levels of nesting" refers to the number of times one subroutine can call another which calls another etc.

## EDITING

To facilitate writing a program the calculator is placed in "learn or edit" mode, where it remembers the keys pressed. All programmables allow the user to change statements, but only some arrange for the insertion or deletion of several at one location. In order to display the stored program the calculator will typically display the step number and a "key code" for the key used in that step.

Finally the "single step" facility allows observing your program running in very slow motion — useful for debugging.

## MEMORY AND STORAGE

The most touted feature of programmables is their memory space. This is the amount of space devoted to storing data and program. Memory may be internal or external to the calculator, and may be volatile or non volatile, (i.e., items store do/do not disappear with power off). The non-external memory calculators we have listed all have volatile memories except the HP "C" series.

The run down of the external memory calculators is as follows:

TI 58 Internal memory shared between program and data, allowing up to 480 steps or 60 data to be stored. The plug in factory programmed software module expands capacity to 5,000 steps.

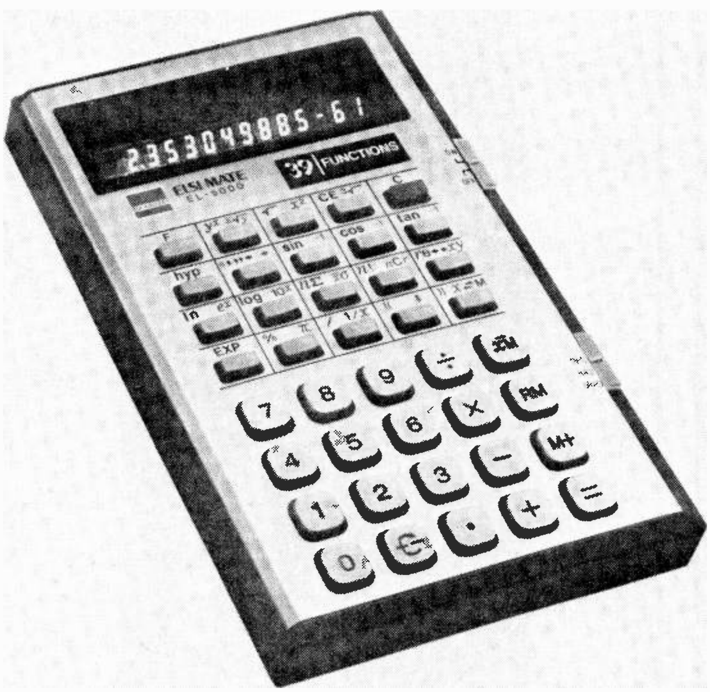
TI 59 Similar to the TI 58, up to 960 steps or 100 data memories are available, and again 5,000 steps on software module. In addition magnetic cards with 480 step capacity may be used.

National 7100, 240 steps non volatile internal program memory with cartridges providing either an additional 240 steps, or 4000 steps of preprogrammed software, 32 non volatile data locations are provided.

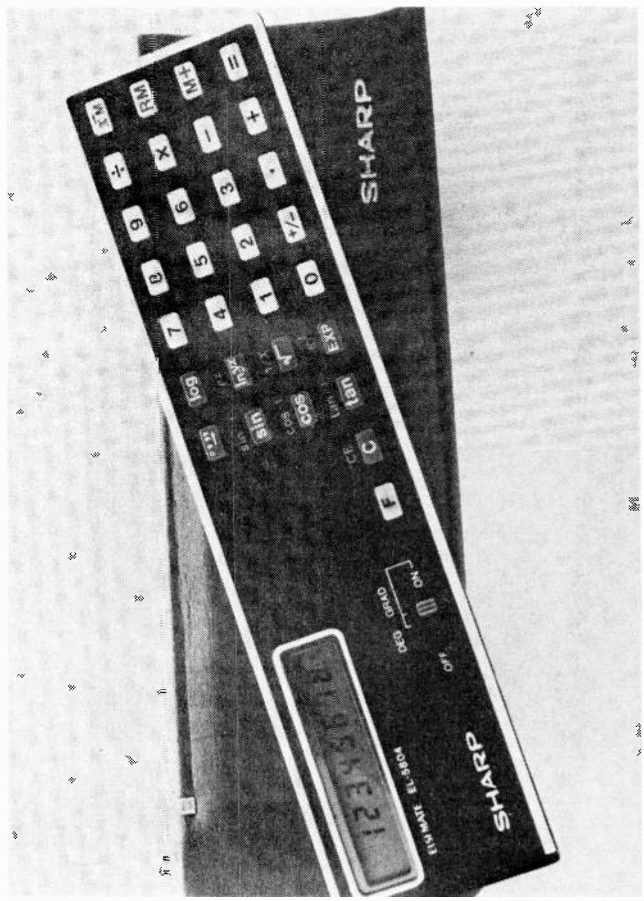
HP67 - 224 step programs are possible, but it should be noted that these are "fully merged" steps, each can contain up to 3 keystrokes. For further details see ETI Canada March 77.

We should note that while many functions are not available on the keyboard, these are obtainable in the extensive software packages that are either provided, or sold as accessories.

Finally, we have been unable to include absolutely all the features of each calculator, and some of the more complex features are not comparable in different models in any case. The best idea is to use this review to give an



Sharp EL 5000




Sharp EL 5804

idea of what's available, and then zero in on the area suited closest to your needs. Armed with a typical problem or two that you will be wanting to solve, visit your local calculator emporium and try each likely model to see how the machine is to actually use, get involved with the instruction booklet etc. Good luck!!

## GLOSSARY OF SCIENTIFIC CALCULATORS TERMS

**Some of the terms associated with scientific calculators originated in the computer world and are therefore may be new to many engineers. Some of the terms commonly found in calculator handbooks and advertisements are given in this glossary together with brief explanations.**

**REGISTERS:** The names of the memories in which data is stored whilst it is being operated on or used as a longer term store known as a memory. The X register is the register that is used to hold the data that is shown in the display. Thus the X register holds the last keyboard entry during a calculation or the answer when the calculation is terminated.

The Y register is used to store the second number during those operations requiring two variables ($+, -, \div, y^x$).

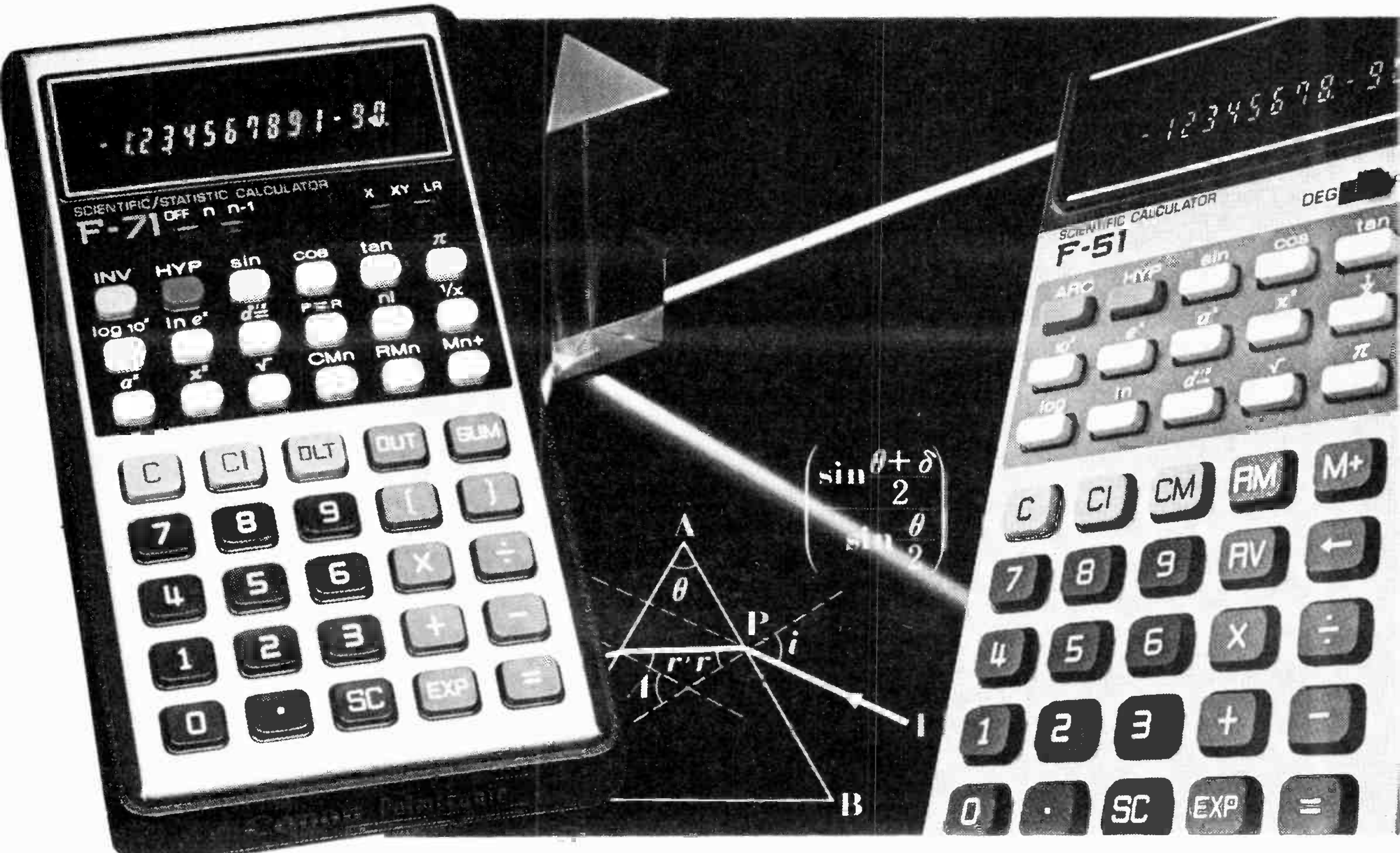
**STACK:** A series of extra data registers, found especially in calculators using Reverse Polish Notation. The stack is used as a 'first-in, last-out' type of memory. Data is shifted into the stack by pressing the enter key, or by entering a new number after pressing an operational key, and is shifted down by pressing an operational key. The lowest registers of the stack are the X and Y registers described above and any subsequent registers become temporary storage registers on a non-randomly accessible basis to allow storage of intermediate results prior to their re-use with a later completing operation. Thus, access to parenthesis (brackets) is automatic upon pressing of the 'enter' key. A four level stack (X,Y,Z,t) has the capability of three levels of parenthesis (three sets of brackets).

**MEMORY:** One or more sets of data registers all of which are randomly accessible. It is often possible to act upon the data contained in the memory with the data in the X register by using keys such as M+, M−, Mx, M÷, and sometimes data in the memory and data in the X register can be interchanged by using the M↔X key. X↔Y is the key which directly interchanges the contents of registers X and Y. This key is mainly used when using the function XY, although it can also be used when interchanging the terms in a division or a subtraction.

**STANDARD DEVIATION:** A statistical measure used most often when analysing experimental data. The standard deviation of a set of data is the measure of the dispersion of data values about the mean.

**LINEAR REGRESSION:** This is a statistical function used again when handling experimental data. It is especially used when using an experiment to find a mathematical relationship between two variables. Linear regression is the name of the procedure which is used to find the line which best fits the set of data points which have been found experimentally. The procedure usually finds the equation of the straight line and also a parameter called the correlation coefficient which indicates how well the data fits the line.

**RADIANS:** A measure of angle like the degree; 1 radian = 57.3° approx, and 2$\pi$radians = 360°. Many problems use, or give results directly in radians. Thus a calculator capable of handling degrees and radians is extremely useful as is an easy conversion between the two.




Canon F71

Canon F51

# BITS, BYTES and BAUDS

by Bill Johnson VE3APZ

IT SEEMS THAT every radio amateur is talking about some kind of data transmission or other. There are two standard ways of sending data over radio used by amateurs today. Baudot, named after its inventor, was the earliest form of Teletype code and is still used internationally today, both in commercial and amateur service.

## Baudot

Baudot comprises of five "bits" or levels of information per character, which are sent one bit at a time. Each bit is in either the "on" or "1" state or the "off" or "0" state, and in Teletype this represented by a "mark" or "space". "Mark" refers back to the days when morse was recorded on paper tape, and refers to the line being energized, thus marking the paper. Space indicates no current.

Over radio circuits, these marks and spaces are translated into audio tones, such as 2125 Hz and 2975 Hz. The difference between the frequencies of these tones is called the "shift".

If the bits from each character were just sent out right after the bits from the previous, very careful count would have to be kept at the receiving end to determine which was the last bit of one character and the first bit of the next. In practice this would lead to the impossible situation where one noise burst would lead to the destruction of the entire message!

To counteract this problem, "start" and "stop" bits were introduced. A start bit is always a one-bit transition from mark to space and back. This tells the receiving machine to receive the next five bits and decode them as data. When the data bits are sent, the sending machine restores the line to the mark condition, where it will stay until the next start pulse comes along. This means that when the machines are sitting idle, there is always current on the line. When you are sending at the maximum rate, there is always at least 1½ bits of STOP time (STOP time is when the line is MARKING after each character). This allows the receiving machine to get ready for the next character.

This START/STOP mode of operation is the simplest form of mechanical telegraphy signal, and most widely used at slow and medium speeds. Since any timing errors in the receiving machine are compensated for in the STOP time, there is no need to synchronise machines, other than their speed. For this reason, this method is called ASYNCHRONOUS transmission.

## Asynchronous

Asynchronous transmission has few disadvantages — and they only become apparent at very high speeds. One such problem is the inefficiency of wasting time sending the START and STOP bits, when they are not needed for data purposes. However, at speeds used by amateurs, this is a small price to pay for the integrity of data.

One problem that became apparent with the proliferation of computers, and special codes for weather symbols, etc., was the limited number of codes able to be transmetted by Baudot. If you figure it out, there is a maximum of $2^5$, or 32 codes possible with Baudot, so how do we code anything beyond that? The answer lies in the use of the LTRS (letters) and FIGS (figures) keys. These keys give the Baudot system 64 characters. Each key has two characters, lower and upper.

When the LTRS key is pressed, a character is sent which tells the receiving end that the codes that follow are ordinary letters. When it is desired to send numbers you have to precede them with the FIGS character. Each of these FIGS and LTRS signals is a full character and takes a whole seven-and-a-half bit time to send. As you can see, this could severely reduce the actual speed of transmission if you had a lot of letters interspersed with a lot of numbers or figures.

This became apparent over years of use, and led to the introduction of ASCII, the second code used by amateurs (**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange). This code can legally be used by Canadian amateurs but is restricted in many other parts of the world, including the U.S. It consists of eight bits, of which seven are actual data and one is a PARITY BIT, or check bit. This PARITY BIT is either sent as a MARK or SPACE, to make the number of MARK bits EVEN. By counting the number of MARK bits and checking to see if the number of them is EVEN, the receiving station has a pretty good idea if any data has been damaged by noise. Not all systems use the parity bit, in which case it is usually a MARK. The actual character coding only uses five bits still, and the sixth bit tells whether or not the code sent is a letter or a figure; its presence as a MARK indicates that this character is a *figure*. Thus FIGS and LTRS keys are not needed.

This leaves one bit to be discussed, and this is called the CONTROL bit. This bit must be a MARK for all PRINTING functions, i.e. all normal characters that will be printed at the other end. If you want to send a code into a computer, for instance, to tell it that the words to follow constitute the address of a message, you can send a character that could normally be a part of the message, but drop the CONTROL bit. The computer will not include the character in the message, but will understand that you want to tell it that the address of the message follows. This can be very handy as it means you can send control codes into a computer and not have to worry about the computer accidentally reading out part of the message as a control code. In the older Baudot system you had to make up weird combinations of three or four characters that could not normally be found in common English.

Some examples of common usage:

| ASCII | BAUDOT | MEANING |
|---|---|---|
| control D | "NNNN" | end of message |
| control P | "figs figs HH" | end of address |

## Distributor

So we have a Teletype machine sitting there waiting for some signals to turn it on. As you will know, all the action starts when the line goes open for a moment (9.09 milliseconds at 110 baud). This moment is called the *start time*, and it readies the machine to receive the character. From hereon I will refer to a speed of *110 baud* when I mention any timings, since this is a standard speed in data communications. Immediately after the *start bit* has finished, there follow eight bits of data. Each one of these data bits is strobed into the machine by a *rotating distributor* which was started by the start bit. The result is that the code bars will be set or reset in the machine at the correct time. For instance, when the signal condition representing the first bit is presented to the machine along the signal line, the distributor arm will be touching the connection to the circuitry for the first bit and it will be conditioned to either *mark* or *space* by the signal. At the end of this bit, the arm will have moved around to the beginning of the copper plate that is connected to the circuitry for the second bit, and so this circuitry will be conditioned to either the mark or space state by the signal from the line. And so, in this manner, the state of each bit along the line will be sent to a different part of the Teletype machine by the rotating distributor, and at the start of the stop bits, the machine will mechanically turn the data into a printable character.

The keyboard works in a similar manner, except in reverse. As soon as you press a key, in effect you are setting eight little switches to either the closed or open state. Moments later, the keyboard rotator starts rotating (what else would you expect it to do?) and sends the condition of each of these switches in turn as either a mark or space along the line, each bit taking the customary 9.09 milliseconds.

## Definitions

What I have described above is the simplest form of serial-to-parallel conversion and parallel-to-serial conversion. In modern telecommunications equipment, these mechanical functions are replaced by solid-state logic. After telling you that, I think a few definitions are in order. *Parallel data* is data that is presented simultaneously on eight wires. These wires, for instance, could be connected to the eight switches on the keyboard that I mentioned earlier. It would be the simplest thing in the world to just connect these wires to the eight electromagnets that condition the mechanical bars of the printer, and in fact this is done in some computer sites where there are short distances involved. This is called *parallel transmission*. However, things being what they are in the business world, money comes first, and it would be eight times as expensive to string eight channels across the country as just one, so the serialization idea came into effect. *Serial data* just means that the bits are sent out one after another all on one wire as described above.

I mentioned earlier that this *serial, asynchronous* method is used most universally on low speed circuits. The reason is that mechanical equipment proliferates and this cannot be adjusted as finely as electronic equipment. The reason for the two start bits is to allow the mass of the rotor to come to rest and stay there awhile before going off on another trip around the circuit. Because the receiving machine starts each cycle at the same time as the sending machine, a slight variation in the speed of the receiving machine would not be serious.

## Rate

Each bit in the above example takes 9.09 milliseconds to send, so it would seem only logical that to get the number of bits per second one would simply divide this into one second, and arrive at 110. However, it is not that simple. There is such a quantity, but it is called the *baud rate*. The actual name "bits per second" has been defined as the number of data bits that can be sent at this speed. As you will remember, for every eight bits just to keep the machine happy. These bits cannot be counted as data bits because they cannot be visibly seen to do anything at the other end. While the system is sending 110 bits per second, only eighty of them are data bits, so if you were to refer to this speed in bits per second, the value would be eighty BPS.

At slow speeds, this terminology is rarely used, since the *baud rate* is more meaningful in *asynchronous transmission*, because it relates more closely to the scientific quantities involved, whereas a businessman would be more interested in how soon he could get the latest Dow-Jones figures, so he would be more interested in the bit rate. To the uninitiated, it is just like comparing RMS power to music power, or peak power, by the hi-fi salesman.

As speeds get faster, mechanical monsters are replaced with solid-state equipment. Since there is no moving rotor to slow down and start again, many of these machines reduce the number of stop bits to one. The machine knows that the tenth bit after one start bit will be the start bit of the next character. In this case, the baud rate would be only slightly higher than the bits per second rate because 33 percent of the dummy bits have been eliminated.

To take this one step further, you could completely eliminate the start and stop bits. When you do this, however, you are changing things just a little too far, and you do not have asynchronous transmission anymore. You now have *synchronous* transmission. This is only used at very high speeds because any small error, would require the resending of the whole block of data.

## Modem

Now that you know what a teletype signal is, how it becomes a series of pulses, and how these pulses are timed, wouldn't it be nice if you could send them to somebody and have some device at the other end make them into teletype signals again?

Well, this is accomplished by a device called a Modem. The word MODEM is a contraction of MOdulator-DEModulator. The modulator portion takes the teletype signal from the teletype machine and converts it to two tones. When there is no current in the loop, a tone designated a "space" is sent. When current flows, a tone designated as "mark" is sent.

On the normal amateur teletype channels, such as on the short wave bands, these two tones are 2125 Hz and 170 or 850 Hz above it. (Both with

# BITS BYTES and BAUDS

respect to the carrier frequency, which is usually suppressed). At this point I would like to break from standard nomenclature. On UHF and VHF, we have the unique ability to communicate full-duplex (both ways at the same time). If both stations are using the same tones, difficulties will arise because under some circumstances a receiver may pick up signals from its own transmitter causing a garbled printout at the originating station. This problem arose many years ago in the North American TWX network (Teletype Writer Xchange) service. A standard was devised using two separate pairs of tones, one for use by the ORIGINATING station, and one for the use ANSWERING station. When stations are listening for calls, they are in the ANSWER mode, listening on the pair of tones that the ORIGINATING station is sending on. (1270 Hz mark/1070 Hz space).

While the originating station is sending using 1270 Hz and 1070 Hz, it is also listening on the answer mode transmit frequencies of 2225 Hz for a mark and 2025 Hz for a space.

If station A originates a message to station B, and station B decides he is getting a wrong message, or the printout at his end is garbled, station B can talk back to station A without waiting for him to end his message.

Remember a while ago I talked about the parity bit? If a computer is sending some data to another computer, this full-duplex arrangement will allow the receiving computer to tell the sending computer about any parity errors as soon as they occur. On receipt of this interrupt, the sending computer needs only to resend the bits that the listener did not get correctly, without having to wait until the end and resend the whole block.

Another use of this full duplex operation is the so-called ECHO feature used by most computers. When you send a character to a computer, the computer "echoes back" the character. The character prints on your printer only after it has been to the computer and back, via the full-duplex modems. You can thus immediately tell what the computer received — a feature very handy if you are loading programs and want to be sure that the remote computer got your typing correctly.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HAM EQUIPMENT
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SPEAKERS
ALARMS
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FIFTY CENTS EACH
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VU

# New Products. From: SGS-ATES SEMICONDUCTOR CORPORATION

## LINEAR INTEGRATED CIRCUITS

### Audio amplifiers

| TYPE | $V_S$ max (V) | VOLTAGE GAIN (dB) (open loop) | $P_o$ (W) | @ DISTORTION (%) | and $R_L$ (Ω) | and $V_S$ (V) | OUTPUT PEAK CURRENT (A) | PACKAGE | NOTE | PRICE EA. |
|---|---|---|---|---|---|---|---|---|---|---|
| TBA 800 | 30 | 74 | 5 | 10 | 16 | 24 | 1.5 | DIP E | | $ 2.25 |
| TBA 810S/ | 20 | 80 | 7<br>6 | 10<br>10 | 4<br>4 | 16<br>14.4 | 2.5 | DIP E, | Thermal shut-down | 2.50 |
| TDA 2010 | ± 18 | 100 | 12<br>9 | 1<br>1 | 4<br>8 | ± 14<br>± 14 | 3.5 | DIP C | Fully protected | 5.95 |
| TDA 2020 | ± 22 | 100 | 20<br>16.5 | 1<br>1 | 4<br>8 | ± 18<br>± 18 | 3.5 | DIP C | Fully protected | 6.95 |
| TDA 2002 | 18 | – | 8<br>6 | 10<br>10 | 2<br>3.2 | 14.4<br>14.4 | 3 | Pentawatt ® | Thermal shut-down | 3.95 |

DIP E — DIP C with spacer — Pentawatt ®

### Voltage regulators

| TYPE | $V_o$ (V) | REGULATED $I_o$ (mA) | PACKAGE | PRICE EA. |
|---|---|---|---|---|
| L 129 | 5 | 850 | TO-126 (1) | $ 1.50 |
| L 130 | 12 | 720 | TO-126 (1) | 1.50 |
| L 131 | 15 | 600 | TO-126 (1) | 1.50 |

*L200 ADJUSTABLE MONOLITHIC VOLTAGE & CURRENT REGULATOR*
*OUTPUT VOLTAGE 3–30 VOLTS*
*OUTPUT CURRENT 1.8 AMPS* 3.00
PACKAGE Pentawatt ®

### Special functions

| | | | |
|---|---|---|---|
| L 120 | Phase control for TRIAC and SCR triggering | DIP J | 6.00 |
| L 121 | Burst control for TRIAC and SCR triggering | DIP J | 6.00 |
| L 202 | High-voltage, high-current darlington transistor array | DIP J | 2.95 |
| TDA 1054 | Preamplifier for tape recorder with ALC | DIP I | 2.50 |
| TBA 231 | Dual operational amplifier | DIP G | 1.50 |

DIP G

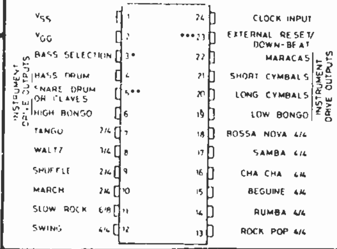
| TYPE | DESCRIPTION | TECHNOLOGY | CHANNELS (n°) | $V_{DD}$ (V) | POWER CONS. (mW) | TEMP. RANGE (°C) | PACKAGE | |
|---|---|---|---|---|---|---|---|---|
| M 1025* | TV remote control receiver | 3 | 30 | -17 | 400 | 0-70 | DIP J | 14.95 |
| M 1024* | TV remote control transmitter | CMOS | 30 | + 8 | 20 | 0-70 | DIP J | 17.95 |

DIP J

## M 253 $ 16.50

**RHYTHM GENERATOR**

M 253 B1AA for standard music content




## POWER TRANSISTORS

### Epitaxial-base

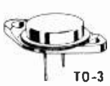
#### Plastic


TO-126


TO-220 AB

| TYPE NPN | PNP | $V_{CEO}$ (V) | $h_{FE}$ min/max | $V_{CE\,(SAT)}$ (V) | $I_C$ max (A) | $P_D$ (W) @ $T_C$ = 25°C | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|---|---|---|
| BD437 | BD438 | 45 | 40 | 0.6 | 4 | 36 | TO-126 | $ .56 |
| MJE223 | MJE233 | 60 | 20 | 2.5 | 4 | 15 | TO-126 | .89 |
| TIP31A | TIP32A | 60 | 25 | 1.2 | 3 | 40 | TO-220 | .69 |
| BD709 | BD710 | 80 | 15–150 | 1 | 12 | 75 | TO-220 | 1.30 |

#### Metal can


TO-3

| TYPE NPN | PNP | $V_{CEO}$ (V) | $h_{FE}$ min/max | $V_{CE\,(SAT)}$ (V) | $I_C$ max (A) | $P_D$ (W) @ $T_C$ = 25°C | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|---|---|---|
| 2N3055 | | 60 | 20–70 | 1 | 15 | 117 | TO-3 | $ 1.59 |
| 2N3055U | | 70 | 20–70 | 0.5 | 15 | 150 | TO-3 | 1.95 |
| 2N3442 | | 140 | 20–70 | 1 | 10 | 117 | TO-3 | 2.50 |
| BDW51C | BDW52C | 45 | 20–150 | 3 | 15 | 125 | TO-3 | 2.75 |

### Epitaxial-base darlingtons - Plastic

| TYPE NPN | PNP | $V_{CEO}$ (V) | $h_{FE}$ min/max | $V_{CE\,(SAT)}$ (V) | $I_C$ max (A) | $P_D$ (W) @ $T_C$ = 25°C | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|---|---|---|
| 2N6037 | 2N6034 | 40 | 750–15000 | 2 | 4 | 40 | TO-126 | $ 1.39 |
| 2N6038 | 2N6035 | 60 | 750–15000 | 2 | 4 | 40 | TO-126 | 1.59 |
| 2N6039 | 2N6036 | 80 | 750–15000 | 2 | 4 | 40 | TO-126 | 1.79 |
| BDX53A | BDX54A | 60 | 750 | 2 | 8 | 60 | TO-220 | 2.25 |
| BDX53C | BDX54C | 100 | 750 | 2 | 8 | 60 | TO-220 | 2.95 |

#### Metal can

| TYPE NPN | PNP | $V_{CEO}$ (V) | $h_{FE}$ min/max | $V_{CE\,(SAT)}$ (V) | $I_C$ max (A) | $P_D$ (W) @ $T_C$ = 25°C | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|---|---|---|
| 2N6057 | 2N6050 | 60 | 750–18000 | 2 | 12 | 150 | TO-3 | $ 2.75 |
| 2N6059 | 2N6052 | 100 | 750–18000 | 2 | 12 | 150 | TO-3 | 3.25 |

### High voltage - Plastic

| TYPE | POLARITY | $V_{CBO}$ (V) | $h_{FE}$ min | $V_{CE\,(SAT)}$ (V) | $I_C$ max (A) | $P_D$ (W) @ $T_C$ = 25°C | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|---|---|---|
| BU407 | NPN | 330 | 10 | 1 | 7 | 60 | TO-220 | $ 3.00 |

#### Metal can

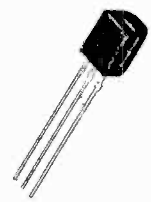
| TYPE | POLARITY | $V_{CEO}$ (V) | $h_{FE}$ min/max | $V_{CE\,(SAT)}$ (V) | $I_C$ max (A) | $P_D$ (W) @ $T_C$ = 75°C | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|---|---|---|
| BUX97 | NPN | 350 | 10 | 5 | 6 | 90 | TO-3 | $ 4.95 |

# Central Semiconductor

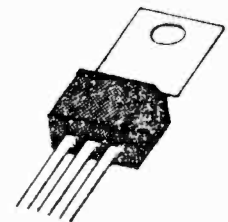
NEW

## SCR's

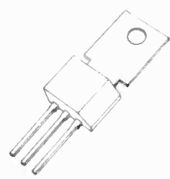
| TYPE NO | $V_{DRM}$ (VOLTS) | $I_{F(RMS)}$ (AMPS) | $I_{GT}$ (μA) | $V_{GT}$ (VOLTS) | PACKAGE | PRICE |
|---|---|---|---|---|---|---|
| 2N5062 | 100 | 0.8 | 200 | 0.8 | TO-92 | .75 |
| 2N5064 | 200 | 0.8 | 200 | 0.8 | TO-92 | .85 |
| C103B | 200 | 0.8 | 200 | 0.8 | TO-92 | .69 |
| C106B | 200 | 4 | 200 | 0.8 | TO-202 | 1.29 |
| C106D | 400 | 4 | 200 | 0.8 | TO-202 | 1.39 |



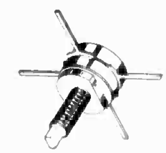
TO-92



TO-202



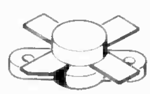
## SOLID STATE SCIENTIFIC INC.



### RF POWER TRANSISTORS

14-30 MHz, CB/AMATEUR TRANSISTORS

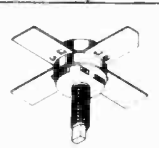
| DEVICE TYPE | Pout OUTPUT POWER WATTS | Gpe POWER GAIN dB MIN | Vcc SUPPLY VOLTAGE VOLTS | PACKAGE | PRICE EACH |
|---|---|---|---|---|---|
| RF2146 | 1.0 | 10.0 | 6.0 | TO202 | $ 3.50 |
| RF2147 | 5.0 | 8.5 | 6.0 | TO202 | 3.75 |
| SD1289 | 50.0 | 10.0 | 12.5 | 500-4LFL | 31.75 |



NEW

130-175 MHz, HIGH BAND VHF FM TRANSISTORS

| | | | | | |
|---|---|---|---|---|---|
| SD1156 | 1.5 | 10.0 | 12.5 | TO117SL | 11.95 |
| SD1256 | 3.0 | 8.5 | 12.5 | TO117 | 13.95 |
| SD1143 | 10.0 | 10.0 | 12.5 | MT72 | 20.50 |
| RF1004 | 30.0 | 5.7 | 12.5 | 380-4LFL | 29.75 |



NEW

156-162 MHz, VHF MARINE RADIO FM TRANSISTORS

| | | | | | |
|---|---|---|---|---|---|
| SD1012 | 6.0 | 5.0 | 12.5 | MT72 | 13.75 |
| SD1133 | 12.0 | 10.0 | 12.5 | MT72 | 19.45 |
| SD1229 | 30.0 | 6.0 | 12.5 | MT72 | 29.00 |

## DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# MICRO ELECTRONICS LTD.

## SEMICONDUCTOR PRODUCTS

### HIGH SPEED SWITCHING TRANSISTORS

| TYPE NO. NPN | Maximum Ratings PD @ TA+25°C | IC | Electrical Characteristics @ TA=25°C | hFE mm/max | ton toff max | CASE | PRICE EA. |
|---|---|---|---|---|---|---|---|
| 2N2221A | 500mW | 500mA | 40V | 40/120 | 35ns 285ns | TO-18 | $.29 |
| 2N2222A | 500mW | 500mA | 40V | 100/300 | 35ns 285ns | TO-18 | .32 |
| 2N3904 | 310mW | 200mA | 40V | 100/300 | 70ns 250ns | TO-92A | .25 |

| TYPE NO. PNP | Maximum Ratings PD @ TA+25°C | IC | Electrical Characteristics @ TA=25°C | hFE min/max | ton toff max | CASE | PRICE EA. |
|---|---|---|---|---|---|---|---|
| 2N3905 | 310mW | 200mA | 40V | 50/150 | 70ns 260ns | TO-92A | $.33 |
| 2N3906 | 310mW | 200mA | 40V | 100/300 | 70ns 300ns | TO-92A | .36 |
| 2N3136 | 400mW | 600mA | 35V | 100/300 | 75ns 100ns | TO-18 | .29 |
| 2N4403 | 310mW | 60mA | 40V | 100/300 | 35ns 255ns | TO-92A | .37 |

### SMALL SIGNAL TRANSISTORS

| TYPE NO. NPN | Maximum Ratings PD @ 25°C | $I_C$ | LV CEO | Electrical Characteristics @ TA=25°C $H_{FE}$ min/max | $f_T$ min | NF max | CASE | PRICE EA |
|---|---|---|---|---|---|---|---|---|
| 2N2482 | 360mW | 50mA | 60V | 100/150 | 60MHz | 3dB | TO-18 | $.38 |
| 2N3565 | 200mW | — | 25V | 150/600 | 40MHz | — | TO-106 | .25 |
| 2N3707 | 250mW | 30mA | 30V | 100/400 | — | — | TO-92B | .25 |
| 2N3825 | 250mW | 100mA | 15V | 20/- | 800MHz | — | TO-92B | .28 |
| 2N5172 | 200mW | — | 25V | 100/500 | — | — | TO-106 | .25 |
| BC107 | 300mW | 200mA | 45V | 125/500 | 300MHz | 10dB | TO-18 | .29 |
| BC182LB | 375mW | 200mA | 50V | 200/450 | 150MHz | 10dB | TO-92B | .32 |

| TYPE NO. PNP | Maximum Ratings PD @ | $I_C$ | LV CEO | Electrical Characteristics @ TA=25°C $h_{FE}$ min/max | $f_T$ min | max | CASE | EA. |
|---|---|---|---|---|---|---|---|---|
| BC557B | 500mW | 200mA | 45V | 220/475 | 150MHz | 4dB | TO-92F | $.25 |
| MA0462 | — | 40V | | 100/300 | 500MHz | — | TO-18 | .32 |
| | 300mQ | 200mA | 50V | 200/400 | 200MHz | 10dB | TO-92B | .32 |
| BC251 | 300mW | 100mA | 45V | 125/900 | 130MHz | 10dB | TO-92F | .25 |

### GENERAL PURPOSE TRANSISTORS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2N3019 | 800mW | 1A | 80V | 100/300 | 100MHz | — | TO-39 | $.59 |
| 2N3706 | 350mW | 800mA | 20V | 30/600 | 100MHz | — | TO-92B | .29 |
| BC337-25 | 500mW | 500mA | 45V | 160/400 | 70MHz | — | TO-92F | .29 |
| BC547B | 500mW | 100mA | 45V | 200/450 | 300MHz | 10dB | TO-92F | .25 |
| BC548 | 500mW | 100mA | 20V | 110/800 | 300MHz | 10dB | TO-92F | .25 |
| MH8213 | 2.5W | 2A | 80V | 100/240 | 50MHz | — | TO-220B | .75 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2N3703 | 300mW | 500mA | 30V | 30/150 | 100MHz | — | TO-92B | $.24 |
| 2N4033 | 800mW | 1A | 80V | 100/300 | 150MHz | — | TO-39 | .59 |
| BC327-25 | 625mW | 500mA | 45V | 160/400 | 100MHz | — | TO-92F | .29 |

### DARLINGTON AMPLIFIERS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2N5308 | 600mW | 300mA | 30V | 30000/- | 60MHz | — | TO-92F | .50 |
| MPSA13 | 500mW | 300mA | 30V | 10000/- | 125MHz | 2dB | TO-92A | .33 |
| BC517 | 500mW | 300mA | 30V | 30000/- | — | 15dB | TO-92F | .45 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BC516 | 500mW | 300mA | 30V | 30000/- | — | 15dB | TO-92F | .46 |

### GENERAL PURPOSE FIELD EFFECT TRANSISTORS

| TYPE NO. | $BV_{GSS}$ min | $I_{DSS}$ min/max | $Y_{fs}$ min/max | VGS (off) max | PRICE EA. |
|---|---|---|---|---|---|
| MEF 3819 | 25V | 2.0/20.0mA | 2000/6500 | 8.0V | $.45 |
| HEF 4341 | 50V | 3.0/9.0mA | 2000/4000 | 6.0V | .52 |

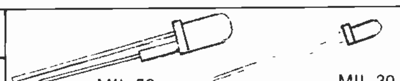
### SWITCH AND CHOPPER

| TYPE NO. | BV GSS min | $I_{DSS}$ min/max | rds (ON) max | ID (OFF) max | ton | t off | PRICE EA. |
|---|---|---|---|---|---|---|---|
| MEF 4391 | 40V | 50/150mA | 30 ohms | 0.10nA | 20ns | 35ns | $.65 |
| HEF 4393 | 40V | 5/30mA | 100 ohms | 0.1nA | 20ns | 80ns | .60 |

### PROGRAMMABLE UNIJUNCTIONAL TRANSISTORS

| TYPE NO. | IA max | BV KAD min | VT max | IP max | IV max | PRICE EA. |
|---|---|---|---|---|---|---|
| 2N6027 | 20mA | 40V | 1.6V | 200nA | 70uA | $.75 |
| 2N6028 | 20mA | 40V | 0.6V | ·1500nA | 25uA | .80 |

### RED LED




| | PRICE EA. |
|---|---|
| MIL50, 30 Hardware | $.29 |
| MIC 51 | .08 |
| MIC 31 | .10 |

### PACKAGES


### RECTIFIERS

1.0 AMP SILICON RECTIFIER DIODE

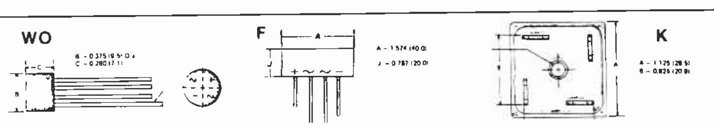
| TYPE NO. | VRRM Volts | IFSM Amps | IO Amps | PACKAGE | PRICE EA. |
|---|---|---|---|---|---|
| IN4002 | 100 | 35 | 1.0@75°C |  | $.15 |
| IN4003 | 200 | 35 | 1.0@75°C | | .16 |
| IN4004 | 400 | 35 | 1.0@75°C | | .20 |

| TYPE NO. | VRRM Volts | IFSM Amps | IO Amps | PACKAGE | PRICE EA. |
|---|---|---|---|---|---|
| IN5401 | 100 | 200 | 3.0@50°C |  | $.29 |
| IN5402 | 200 | 200 | 3.0@50°C | | .31 |
| IN5404 | 400 | 200 | 3.0@50°C | | .36 |

### BRIDGE RECTIFIERS

| TYPE NO. | V RRM Volts | V rms Volts | I FRM Amps | IO r Load Amps | PRICE EA. |
|---|---|---|---|---|---|
| WO 02 | 200 | 140 | 15 | 1.5 | $ .82 |
| WO 04 | 400 | 140 | 15 | 1.5 | .95 |
| F 01 | 100 | 70 | 40 | 5.0 | $1.95 |
| F 02 | 200 | 140 | 40 | 5.0 | 2.15 |
| K 01 | 100 | 70 | 60 | 25 | $7.50 |
| K 02 | 200 | 140 | 60 | 25 | 8.95 |

OUTLINE



# Resistors & Capacitors

## Resistors

| 1/4W | | | 1/2W | | 1W | 2W | |
|---|---|---|---|---|---|---|---|
| 9.1 | 18K | 39 | 13K | 3.3 | 16K | 33 | 2.2K |
| 11 | 22K | 56 | 15K | 10 | 18K | 39 | 2.7K |
| 12 | 27K | 68 | 16K | 33 | 20K | 47 | 3.3K |
| 15 | 56K | 75 | 18K | 56 | 22K | 82 | 4.7K |
| 16 | 82K | 82 | 27K | 82 | 27K | 100 | 5.6K |
| 18 | 100K | 91 | 30K | 100 | 33K | 180 | 6.2K |
| 20 | 130K | 120 | 33K | 220 | 39K | 270 | 6.8K |
| 22 | 150K | 130 | 36K | 270 | 47K | 330 | 8.2K |
| 27 | 160K | 180 | 39K | 330 | 56K | 560 | 13K |
| 30 | 180K | 220 | 43K | 390 | 68K | 680 | 15K |
| 33 | 220K | 270 | 62K | 470 | 150K | 820 | 16K |
| 36 | 300K | 330 | 82K | 560 | 180K | 1K | 18K |
| 39 | 330K | 390 | 150K | 680 | 390K | 1.5K | 22K |
| 43 | 390K | 510 | 160K | 1.5K | 820K | 1.8K | 33K |
| 68 | | 620 | 180K | 2.7K | 1 meg | | 82K |
| 100 | 1 meg | 750 | 300K | 3.9K | 1.2 meg | | 820K |
| 110 | 2 meg | 820 | 330K | 4.7K | 1.5 meg | 1.8 meg | |
| 180 | **1/2W** | 910 | 360K | 5.1K | 1.8 meg | 2.7 meg | |
| 300 | 3.16 | .1K | 390K | 5.6K | 2.2 meg | 4.7 meg | |
| 390 | 3.3 | 1.2K | 620K | 7.5K | 2.7 meg | | |
| 430 | 3.9 | 1.5K | 680K | 8.2K | 4.7 meg | | |
| 470 | 5.1 | 1.6K | 1 meg | 12K | 5.6 meg | | |
| 680 | 5.6 | 1.8K | 1.2 meg | 15K | 15 meg | | |
| 2.2K | 7.5 | 2.2K | 1.5 meg | | | | |
| 3.3K | 12 | 2.4K | 1.6meg | | | | |
| 3.9K | 13 | 2.7K | 1.8 meg | | | | |
| 4.3K | 15 | 3K | 2.7 meg | | | | |
| 4.7K | 18 | 3.3K | 3.3 meg | | | | |
| 5.1K | 22 | 3.6K | 3.9 meg | | | | |
| 5.6K | 24 | 5.1K | 4.7 meg | | | | |
| 6.8K | 28 | 5.6K | 5.6 meg | | | | |
| 9.1K | 30 | 6.8K | 6.8 meg | | | | |
| 10K | 33 | 8.2K | 7.5 meg | | | | |
| 12K | 35 | 9.1K | 8.2 meg | | | | |
| 15K | 36 | 12K | 15 meg | | | | |

### Resistors

| | |
|---|---|
| 1/4W, 1/2W | 3½¢ |
| 1 W, 2 W | 5¢ |

## Disc Ceramics — 5¢ EA.

| | | | | | |
|---|---|---|---|---|---|
| 3 | 500v | 39 | 5Kv | 100 | 500v |
| 3.3 | 500v | 39 | 500v | 100 | 1.4Kv |
| 5.6 | 500v | 39 | 2Kv | 110 | 4Kv |
| 6 | 500v | 39 | 3Kv | 110 | 6Kv |
| 6.8 | 500v | 40 | 6Kv | 120 | 5Kv |
| 6.8 | 3Kv | 43 | 500v | 120 | 6Kv |
| 7 | 500v | 47 | 500v | 121 | 500v |
| 8 | 500v | 47 | 100v | 127 | 500v |
| 8.2 | 500v | 47 | 500v | 130 | 4Kv |
| 9 | 500v | 47 | 1Kv | 135 | 500v |
| 10 | 500v | 47 | 2Kv | 150 | 500v |
| 12 | 500v | 51 | 6Kv | 160 | 500v |
| 13 | 500v | 56 | 500v | 170 | 100v |
| 13.5 | 500v | 56 | 2.5Kv | 180 | 200v |
| 15 | 500v | 58 | 200v | 200 | 500v |
| 17 | 500v | 62 | 500v | 210 | 500v |
| 18 | 500v | 68 | 500v | 320 | 500v |
| 18 | 2Kv | 68 | 500v | 330 | 2.5Kv |
| 20 | 6Kv | 68 | 500v | 370 | 500v |
| 22 | 500v | 68 | 1Kv | 390 | 1.5Kv |
| 22 | 500v | 68 | 3Kv | 660 | 500v |
| 24 | 1Kv | 68 | 4Kv | 680 | 500v |
| 27 | 500v | 70 | 500v | 882 | 500v |
| 27 | 200v | 80 | 500v | 1000 | 200v |
| 27 | 500v | 82 | 100v | 1200 | 500v |
| 29 | 5Kv | 82 | 1Kv | 2200 | 200v |
| 30 | 500v | 82 | 6Kv | 2200 | 500v |
| 33 | 500v | 91 | 500v | 2500 | 500v |
| 33 | 500v | 91 | 500v | 3900 | 500v |
| 33 | 1Kv | 95 | 3Kv | .005 | 500v |

## Trimmer Capacitors

**15¢**

SINGLES

- 0-5 Pfd.
- 0-6 Pfd.
- 0-85 Pfd.
- 0-100 Pfd.
- 4.5-25 Pfd.
- 5-75 Pfd.
- 5-80 Pfd.
- 7-85 Pfd.
- 20-130 Pfd.
- 30-200 Pfd.

DUALS

- 0-100 Pfd.
- 0-100 Pfd.
- 15-120 Pfd.
- 15-120 Pfd.

**25¢**

- 60-220 Pfd.
- 60-220 Pfd.
- 200-200 Pfd.
- 200-200 Pfd.
- 350-500 Pfd.
- 75-110 Pfd.

## Potentiometers

- 10K w/sw
- 100K
- 300K
- 470K Linear
- 500K w/sw

- 1.5 meg
- 2 meg Linear
- 3 meg
- 4 meg Screw adjust
- 5 meg Screw adjust

- 500K & 500
- 50K & 2 meg log
- 150K with 4 pos. sw
- 50K & 2 meg Linear
- 1meg & 5 meg
- 1 meg & 500K w/switch

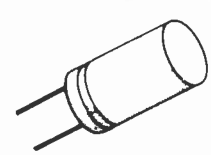
- 300K & 100K w/s
- 50K & 500
- 15K & 250K
- 800 & 100
- 3 meg & 1.5 meg w/dpst
- 5 meg & 1.5 meg w/sw
- 1 meg & 400 w/sw
- 50K & 250K w/sw
- 500K & 50K w/sw
- 1 meg & 500
- 1 meg & 300
- 50K & 500K w/sw
- 50K & 10K w/sw
- 50K & 250K

Singles 20¢

Duals 35¢

Dual w/sw. 50¢

## Electrolytic Capacitors



25¢ EACH

| | |
|---|---|
| PC Cap. 10MFD. 16V | PC Cap. 4.7MFD. 25V |
| PC Cap. 22MFD. 16V | PC Cap. 10MFD. 25V |
| PC Cap. 33MFD. 16V | PC Cap. 22MFD. 25V |
| PC Cap. 47MFD. 16V | PC Cap. 33MFD. 25V |
| PC Cap. 100MFD. 16V | PC Cap. 4 7MFD. 25V |
| PC Cap. 220MFD. 16V | PC Cap. 100MFD. 25V |
| PC Cap. 470MFD. 16V | PC Cap. 220MFD. 25V |

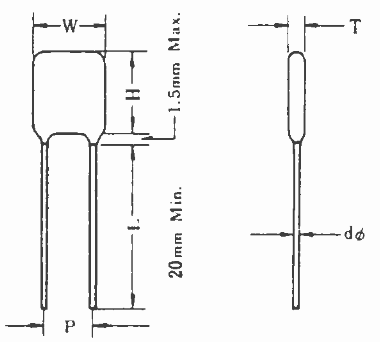
# NISSEI

## TYPE AMS

NEW

Epoxy dipped
(GREEN)

POLYESTER FILM CAPACITORS




Extension of paint on leads: 1.5mm (Max.)

### Characteristics

| | |
|---|---|
| Operating temperature range | −40° ~ +85°C |
| Rated voltage | 100V.DC |
| Standard capacitance value | 0.001 μF ~ .22 μF |
| Standard capacitance tolerance | ±10% |
| Insulation resistance | 20,000MΩ Min. |
| Dissipation factor | 1.0% Max. |

NEW

### Features

★Lead wire being electrically welded to the electrode, steady equal dissipation factor can be obtained.
★Completely protected against moisture by thorough coating of epoxy resin, done by fully automatic vacuum dipping machine.
★Highly reliable capacitors, produced by our special way and technique.
★Very light miniature type.

NEW

| CAP uf | PRICE EA. | CAP uf | PRICE EA. | CAP uf | PRICE EA. |
|---|---|---|---|---|---|
| .0010 | $ .12 | .0068 | $ .12 | .047 | $ .19 |
| .0012 | .12 | .0082 | .12 | .056 | .20 |
| .0015 | .12 | .010 | .12 | .068 | .23 |
| .0018 | .12 | .012 | .12 | .082 | .24 |
| .0022 | .12 | .015 | .14 | .10 | .27 |
| .0027 | .12 | .018 | .14 | .12 | .29 |
| .0033 | .12 | .022 | .14 | .15 | .34 |
| .0039 | .12 | .027 | .15 | .18 | .38 |
| .0047 | .12 | .033 | .16 | .22 | .44 |
| .0056 | .12 | .039 | .17 | | |

NEW

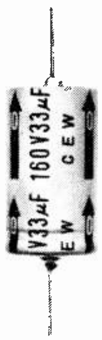
DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# ELNA

## ELECTROLYTIC AND TANTALUM CAPACITORS

### AXIAL LEAD



| wv (sv) / uf c | 16 (20) | 25 (32) | 50 (63) | 80 (100) |
|---|---|---|---|---|
| 1 | | | .15 | |
| 2.2 | | | .15 | |
| 3.3 | | | .15 | |
| 4.7 | | | .15 | |
| 10 | .15 | .15 | .20 | .25 |
| 22 | .20 | .20 | .25 | .30 |
| 33 | .20 | .25 | .25 | .30 |
| 47 | .25 | .25 | .30 | .35 |
| 100 | .25 | .30 | .40 | .50 |
| 220 | .30 | .35 | .50 | .60 |
| 330 | .35 | .45 | .60 | |
| 470 | .40 | .50 | .70 | .90 |
| 1000 | .50 | .60 | .90 | 1.10 |
| 2200 | .65 | .90 | | |
| 3300 | .90 | 1.20 | | |
| 4700 | 1.20 | 1.50 | | |

### RADIAL LEAD

| wv (sv) / uf c | 16 (20) | 25 (32) | 50 (63) | 80 (100) |
|---|---|---|---|---|
| 1 | | | .10 | |
| 2.2 | | | .10 | |
| 3.3 | | | .15 | |
| 4.7 | | .10 | .15 | |
| 10 | .15 | .15 | .15 | .20 |
| 22 | .15 | .15 | .20 | .20 |
| 33 | .15 | .20 | .20 | .25 |
| 47 | .20 | .20 | .25 | .30 |
| 100 | .20 | .20 | .30 | .35 |
| 220 | .20 | .25 | .40 | .50 |
| 330 | .25 | .30 | .50 | |
| 470 | .30 | .35 | .70 | |
| 1000 | .45 | .60 | | |
| 2200 | .60 | | | |

### POWER SUPPLY TYPE

| wv (sv) / uf c | 16 (20) | 25 (32) | 50 (63) | 100 (125) |
|---|---|---|---|---|
| 2200 | | 1.80 | 2.50 | 4.00 |
| 3300 | 1.80 | 2.20 | 3.00 | 5.50 |
| 4700 | 2.00 | 2.50 | 3.50 | 6.00 |
| 6800 | 2.50 | 3.00 | 4.50 | 8.50 |
| 10000 | 3.00 | 3.50 | 6.00 | |
| 15000 | 3.50 | 4.50 | 8.50 | |
| 22000 | 4.50 | 5.50 | | |
| 33000 | 5.50 | | | |
| 47000 | 6.50 | | | |

*PRICE INCLUDES MOUNTING CLAMPS*

*Note: WV – Rated Voltage (V)*
*SV – Surge Voltage (V)*
*C – Rated Capacitance (uf)*


### DIPPED SOLID TANTALUM

*Capacitance Tolerance −20 +20%*

*DC Leakage Current (uA) 0.02 or 1.0*

| wv (sv) / uf c | 16 (20) | 25 (32) | 35 (46) |
|---|---|---|---|
| 0.22 | | | .25 |
| 0.33 | | | .25 |
| 0.47 | | | .25 |
| 0.68 | | | |
| 1.0 | | | .25 |
| 1.5 | | | .25 |
| 2.2 | | | .25 |
| 3.3 | | | .25 |
| 4.7 | .25 | | .30 |
| 6.8 | .25 | | .30 |
| 10 | .30 | .35 | .30 |
| 15 | .30 | .35 | .50 |
| 22 | .30 | .50 | .70 |
| 33 | .50 | .70 | 1.10 |
| 47 | .70 | 1.10 | 1.50 |
| 68 | 1.10 | 1.50 | |
| 100 | 1.50 | 1.90 | |

### ATTENTION !

**SAVE MONEY ON VOLUME BUYS**

*RADIAL & AXIAL LEAD ELECTROLYTIC CAPACITORS*
- 100 of each value – LESS 10 %
- 1000 mixed values – LESS 15 %
- 1000 of each value – LESS 20 %

*POWER SUPPLY CAPACITORS*
- 25 of each value – LESS 10 %
- 100 mixed values – LESS 15 %
- 100 of each value – LESS 20 %

*TANTALUM CAPACITORS*
- 50 of each value – LESS 10 %
- 100 mixed values – LESS 15 %
- 100 of each value – LESS 20 %

*ALL ABOVE ARE PER UNIT PRICES*

**DOMINION RADIO & ELECTRONICS COMPANY**

# FILM CAPACITORS

PHILIPS

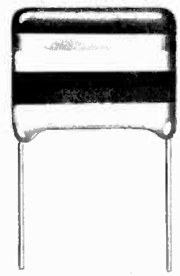
### 280 METALLIZED FILM TYPE, DIPPED FLAT WITH RADIAL LEADS

### ALL TYPES 10% STD.

Popularly called "flat foil" capacitors, this series is ideal for mounting on Printed Circuit Boards having lead spacings based on 2.54mm (0.1") grid system. They are widely used as coupling and decoupling capacitors and their almost negligible capacitance change with temperature makes them preferable to ceramic capacitors in many applications.

All metallized foil capacitors have self healing properties. They are designed to withstand temporary over voltages of 40%, thus avoiding the necessity of specifying 400V capacitors in tube circuits.

| TYPE NO. | Capacitance uF | DC Working Voltage 5th BAND | PRICE |
|---|---|---|---|
| **CH SERIES: 100V working** | | | |
| 280CHA1M | 1 0 | brown | .39 |
| 280CHA1M5 | 1 5 | brown | .59 |
| 280CHA2M2 | 2 2 | brown | .69 |
| 280CHA3M3 | 3 3 | brown | .89 |
| 280CHA4M7 | 4 7 | brown | 1.19 |
| 280CHA6M8 | 6 8 | brown | 1.69 |
| **AE SERIES: 250V working** | | | |
| 280AEA10K | 0 010 | red | .10 |
| 280AEA15K | 0 015 | red | .10 |
| 280AEA22K | 0 022 | red | .10 |
| 280AEA33K | 0 033 | red | .10 |
| 280AEA47K | 0 047 | red | .10 |
| 280AEA68K | 0 068 | red | .10 |
| 280AEA100K | 0 10 | red | .15 |
| 280AEA150K | 0 15 | red | .15 |
| 280AEA220K | 0 22 | red | .15 |
| 280AEA330K | 0 33 | red | .25 |
| 280AEA470K | 0.47 | red | .25 |
| 280AEA680K | 0 68 | red | .35 |
| 280AEA1M | 1.0 | red | .60 |
| 280AEAIM5 | 1 5 | red | .70 |
| 280AEA2M2 | 2 2 | red | .90 |



| TYPE NO. | Capacitance uF | DC Working Voltage 5th Band | PRICE |
|---|---|---|---|
| **CF SERIES: 400V working** | | | |
| 280CFA10K | 0 010 | yellow | .15 |
| 280CFA15K | 0 015 | yellow | .15 |
| 280CFA22K | 0 022 | yellow | .15 |
| 280CFA33K | 0.033 | yellow | .15 |
| 280CFA47K | 0.047 | yellow | .15 |
| 280CFA68K | 0.068 | yellow | .15 |
| 280CFA100K | 0 10 | yellow | .20 |
| 280CFA150K | 0 15 | yellow | .20 |
| 280CFA220K | 0 22 | yellow | .25 |
| 280CFA330K | 0 33 | yellow | .30 |
| 280CFA470K | 0 47 | yellow | .40 |
| 280CFA680K | 0 68 | yellow | .50 |
| 280CFA1M | 1 0 | yellow | .70 |
| **CG SERIES: 630V working** | | | |
| 280CGA10K | 0.010 | blue | .15 |
| 280CGA15K | 0.015 | blue | .15 |
| 280CGA22K | 0.022 | blue | .20 |
| 280CGA33K | 0.033 | blue | .20 |
| 280CGA47K | 0.047 | blue | .25 |
| 280CGA68K | 0.068 | blue | .30 |
| 280CGA100K | 0 10 | blue | .35 |
| 280CGA150K | 0 15 | blue | .40 |
| 280CGA220K | 0 22 | blue | .45 |
| 280CGA330K | 0 33 | blue | .50 |
| 280CGA470K | 0 47 | blue | .65 |

# ELECTROLYTIC CAPACITORS

PHILIPS

### 431 LARGE GENERAL PURPOSE TYPE – NOW WITH AN EVEN BIGGER RANGE

**Tolerance: −10/+50%. Temp. Range: −40 to +85°C**

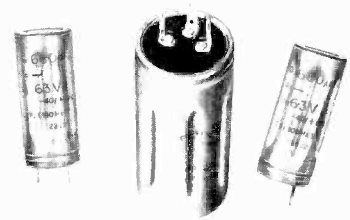
These capacitors are suitable for use in power supplies for transistorized equipment.

The can had longitudinal indents to fix the core and to promote heat transfer. Paralleled double capacitors may be preferred over single capacitors because they are shorter.

These capacitors are used in power supplies for professional and high quality entertainment equipment, power supplies in digital equipment, energy storage in pulse systems and filters in measuring and control apparatus.

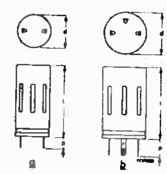
Low values of impedance and inductance are achieved by a special construction with several internal anode and cathode connections.

Aluminum foil with a high etching factor and new electrolytes provide a high C-V product. The aluminum cans are fully insulated and sealed by a synthetic resin disc with a vent, which releases in case of over pressure.



| TYPE NO. | WORKING VOLTAGE (V) | CAPACITANCE (µF) | CAN SIZE | PRICE |
|---|---|---|---|---|
| 431CR A10000 | 6.3 | 10000 | 6 | 3.50 |
| 431CR A15000 | | 15000 | 8a | 4.10 |
| 431CR A22000 | | 22000 | 9a | 5.20 |
| 431CR A33000 | | 33000 | 9 | 6.00 |
| 431CR A47000 | | 47000 | 10 | 6.90 |
| 431CR E3300 | 16 | 3300 | 5 | 2.70 |
| 431CR E4700 | | 4700 | 6 | 3.50 |
| 431CR E6800 | | 6800 | 8a | 3.70 |
| 431CR E10000 | | 10000 | 8 | 4.20 |
| 431CR E10000/9A | | 10000 | 9a | 5.20 |
| 431CR E15000 | | 15000 | 9 | 6.20 |
| 431CR E22000 | | 22000 | 10 | 6.90 |
| 431CR F2200 | 25 | 2200 | 5 | 2.70 |
| 431CR F3300 | | 3300 | 6 | 3.50 |
| 431CR F4700 | | 4700 | 8a | 3.70 |
| 431CR F6800 | | 6800 | 8 | 4.20 |
| 431CR F6800/9A | | 6800 | 9a | 5.20 |
| 431CR F10000 | | 10000 | 9 | 6.20 |
| 431CR F15000 | | 15000 | 10 | 6.90 |
| 431CR G1000 | 40 | 1000 | 5 | 2.70 |
| 431CR G2200 | | 2200 | 6 | 3.50 |
| 431CR G3300 | | 3300 | 8a | 3.70 |
| 431CR G4700 | | 4700 | 8 | 4.20 |
| 431CR G4700/9A | | 4700 | 9a | 5.20 |
| 431CR G6800 | | 6800 | 9 | 6.20 |
| 431CR G10000 | | 10000 | 10 | 6.90 |
| 431CR H680 | 63 | 680 | 5 | 2.70 |
| 431CR H1000 | | 1000 | 6 | 3.50 |
| 431CR H1500 | | 1500 | 8a | 3.70 |
| 431CR H2200 | | 2200 | 8 | 4.20 |
| 431CR H2200/9A | | 2200 | 9a | 5.20 |
| 431CR H3300 | | 3300 | 9 | 6.20 |
| 431CR H4700 | | 4700 | 10 | 6.90 |

Fig a & b



| CAN SIZE | FIG | DIMENSIONS (mm) & (ins)* d mm | d ins | l mm | l ins | p mm | p ins |
|---|---|---|---|---|---|---|---|
| 5 | a | 21 | 0 84 | 50 | 2 0 | 12 | 0 47 |
| 6 | a | 25 | 1 0 | 50 | 2 0 | 12 | 0 47 |
| 8a | a | 30 | 1 2 | 50 | 2 0 | 12 | 0 47 |
| 8 | a | 30 | 1 2 | 80 | 3 2 | 12 | 0 47 |
| 9a | b | 35 | 1 4 | 50 | 2 0 | 12 | 0 47 |
| 9 | b | 35 | 1 4 | 80 | 3 2 | 12 | 0 47 |
| 10 | b | 40 | 1 6 | 80 | 3 2 | 12 | 0 47 |

*Measurements in inches approximate only
N.B. Can sizes 9 & 9a do not have lugs

| CLAMP TYPE NO. | CAN SIZE | PRICE |
|---|---|---|
| CCR20 | 5 | 30¢ |
| CCR25 | 6 | |
| CCR30 | 8a, 8 | |
| CCR35 | 9a, 9 | |
| CCR40 | 10 | |

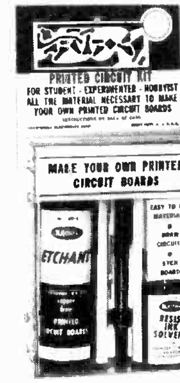
# INJECTORALL ELECTRONICS CORPORATION

## KIT 500

### For Printed Circuits

$10.60

KIT 500 is a low cost kit that comes complete with all materials to make a printed circuit board. Consists of two copper clad boards, a resist ink pen, resist ink solvent, a 6 oz. bottle of etchant, a 1/16" drill bit and a 5 x 7 x 2" plastic case in which the boards are etched. Comes with complete directions. Packaged on a display card. Weight 2 lbs.




## KIT 650

### Photo-Etch Kit for Printed Circuits

KIT 650 is a complete kit using a photographic method to produce professional quality printed circuits. No dark room is necessary. Contains 2 photo-sensitized 3 x 4" phenolic boards, a photographic test negative & an ultraviolet light source. Materials are included to make negatives of magazine layouts. Also contains exposure glass, clamps, developer, etchant, trays, resist remover, drill and complete instructions. Ideal for solid-state and integrated circuits. Packed in a display box. Weight 3 lbs.

$21.25

$1.20

## TAPE HEAD CLEANING STICKS

TAPE HEAD CLEANING STICKS are 6 inch cotton-tipped wooden swabs. They are excellent to reach dirty recorder heads without taking the tape recorder apart. Packed 100 on a hanging package.

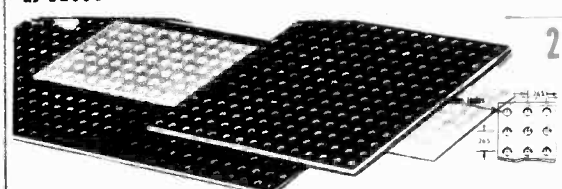
No. 255 • 100 wooden swabs

## "BREADBOARDING" AND PRINTED CIRCUIT DESIGN

LJ-12006

LJ-12006 Perfect for prototypes, breadboards, hobby and science projects. Made of tough plastic with clean-punch holes. Size 6¼" x x¾"

2 FOR $2.10



PERFORATED PLASTIC CIRCUIT BOARDS

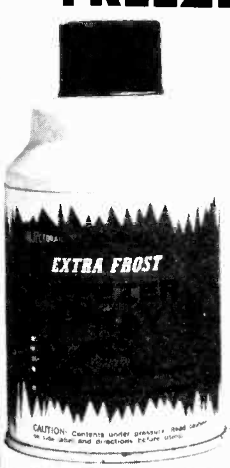
Unexcelled for prototypes, breadboards, hobby or science projects. Made of tough mil-spec phenolic with clean punched holes.


$2.10

## TAPE HEAD CLEANER

### For Tape Recorder Heads

## *Extra Frost* FREEZER



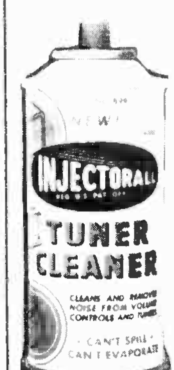

$5.80

## PHONO GRIP-WELL


$2.10

## TUNER CLEANER

### Cleaner and Lubricant




$2.00

## DRIVE WHEEL CLEANER

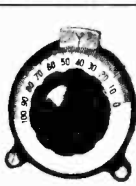

$2.10

PRECISION VERNIER DIALS

1½" $1.60 ea

2" $2.15 ea

3" $2.55 ea



# VERNIER SALE

| Stock No. | Diameter Inches | MM | Reading |
|---|---|---|---|
| 5232 | 1½" | 36 | 0 to 10 |
| 5233 | 2" | 50 | 0 to 100 |
| 5234 | 3" | 70 | 0 to 100 |

Precision planetary drive vernier dials with 8 to 1 ratio in 180 degrees. Front surface mounting. Set Screw bushing accomodates 1/4" shafts. Metal dial has brushed silver finish with deeply etched black numerals. Scales calibrated counter-clockwise from zero to maximum setting

# DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

535 YONGE STREET
TORONTO 5, ONTARIO

FOR A COMPLETE CATALOGUE ON THE INJECTROL LINE OF CHEMICALS AND PC EQUIPMENT, PLEASE CIRCLE #7 ON THE ORDER FORM PAGE.

# INJECTORALL ELECTRONICS CORPORATION

## PRINTED CIRCUIT BOARDS

| | | | | |
|---|---|---|---|---|
| **1 oz. COPPER-CLAD BAKELITE LAMINATES—one side copper** | | | | |
| **PC1** | 1/16" | XXXP bakelite | 3" x 4½" | 1.05 |
| **PC2** | 1/16" | XXXP bakelite | 4" x 6" | 1.35 |
| **PC3** | 1/16" | XXXP bakelite | 6" x 9" | 2.90 |
| **PC4** | 1/16" | XXXP bakelite | 12" x 18" | 8.00 |
| **1 oz. G-10 EPOXY GLASS BASE LAMINATES—one side copper** | | | | |
| **PC5** | 1/16" | G-10 epoxy glass | 3" x 4½" | 1.45 |
| **PC6** | 1/16" | G-10 epoxy glass | 4" x 6" | 2.70 |
| **PC7** | 1/16" | G-10 epoxy glass | 6" x 9" | 5.00 |
| **PC8** | 1/16" | G-10 epoxy glass | 12" x 18" | 5.65 |
| **2 oz. G-10 EPOXY GLASS BASE LAMINATES—one side copper** | | | | |
| **PC9** | 1/16" | G-10 epoxy glass | 3" x 4½" | 1.50 |
| **PC10** | 1/16" | G-10 epoxy glass | 4" x 6" | 2.95 |
| **PC11** | 1/16" | G-10 epoxy glass | 6" x 9" | 5.90 |
| **PC12** | 1/16" | G-10 epoxy glass | 12" x 18" | 19.70 |
| **1 oz. G-10 EPOXY GLASS BASE LAMINATES—two sides copper** | | | | |
| **PC40** | 1/16" | G-10 epoxy glass | 3" x 4½" | 2.00 |
| **PC41** | 1/16" | G-10 epoxy glass | 4" x 6" | 4.05 |
| **PC42** | 1/16" | G-10 epoxy glass | 6" x 9" | 8.00 |
| **PC43** | 1/16" | G-10 epoxy glass | 12" x 18" | 26.60 |
| **PC44** | 1/32" | G-10 epoxy glass | 3" x 4½" | 1.45 |
| **PC45** | 1/32" | G-10 epoxy glass | 4" x 6" | 2.70 |
| **PC46** | 1/32" | G-10 epoxy glass | 6" x 9" | 5.00 |
| **PC47** | 1/32" | G-10 epoxy glass | 12" x 18" | 13.15 |

## PRINTED CIRCUIT BOARDS

### Light Sensitized Coated Boards

| | | | | | |
|---|---|---|---|---|---|
| **1 oz. COPPER-CLAD BAKELITE LAMINATES—one side copper** | | | | | |
| **PC13** | 1/16" | XXXP bakelite | 3" x 4½" | sensitized | 1.50 |
| **PC14** | 1/16" | XXXP bakelite | 4" x 6" | sensitized | 2.00 |
| **PC15** | 1/16" | XXXP bakelite | 6" x 9" | sensitized | 4.65 |
| **PC16** | 1/16" | XXXP bakelite | 12" x 18" | sensitized | 15.85 |
| **1 oz. G-10 EPOXY GLASS BASE LAMINATES—one side copper** | | | | | |
| **PC17** | 1/16" | G-10 epoxy glass | 3" x 4½" | sensitized | 2.00 |
| **PC18** | 1/16" | G-10 epoxy glass | 4" x 6" | sensitized | 4.05 |
| **PC19** | 1/16" | G-10 epoxy glass | 6" x 9" | sensitized | 7.90 |
| **PC200** | 1/16" | G-10 epoxy glass | 12" x 18" | sensitized | 26.60 |
| **2 oz. G-10 EPOXY GLASS BASE LAMINATES—one side copper** | | | | | |
| **PC9S** | 1/16" | G-10 epoxy glass | 3" x 4½" | sensitized | 2.35 |
| **PC10S** | 1/16" | G-10 epoxy glass | 4" x 6" | sensitized | 4.35 |
| **PC11S** | 1/16" | G-10 epoxy glass | 6" x 9" | sensitized | 10.60 |
| **PC12S** | 1/16" | G-10 epoxy glass | 12" x 18" | sensitized | 29.60 |
| **1 oz. G-10 EPOXY GLASS BASE LAMINATES—two sides copper** | | | | | |
| **PC40S** | 1/15" | G-10 epoxy glass | 3" x 4½" | sensitized | 3.00 |
| **PC41S** | 1/15" | G-10 epoxy glass | 4" x 6" | sensitized | 5.30 |
| **PC42S** | 1/16" | G-10 epoxy glass | 6" x 9" | sensitized | 11.25 |
| **PC43S** | 1/16" | G-10 epoxy glass | 12" x 18" | sensitized | 39.55 |
| **PC44S** | 1/32" | G-10 epoxy glass | 3" x 4½" | sensitized | 2.00 |
| **PC45S** | 1/32" | G-10 epoxy glass | 4" x 6" | sensitized | 4.05 |
| **PC46S** | 1/32" | G-10 epoxy glass | 6" x 9" | sensitized | 8.00 |
| **PC47S** | 1/32" | G-10 epoxy glass | 12" x 18" | sensitized | 26.60 |

## ETCHANT

### For Printed Circuit Boards

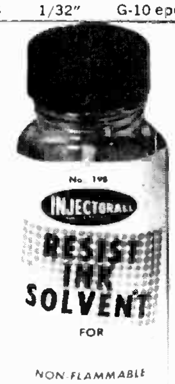

Injectorall's ETCHANT is a ferric chloride solution to remove excess copper from printed circuit boards. It is an electronic-grade solvent from which solvent impurities have been carefully removed to meet the most stringent requirements of the electronic industry. It is packaged in a plastic bottle.

**ETCHANT •**

| | |
|---|---|
| No. 199-6 • 6 oz. plastic bottle | 2.00 |
| No. 199P • 1 pint plastic bottle | 3.15 |
| No. 199Q • 1 quart plastic bottle | 4.90 |
| No. 199G • 1 gallon plastic bottle | 16.80 |

## RESIST INK SOLVENT

### For Printed Circuit Boards




RESIST INK SOLVENT is an excellent solvent for removing inks, markings and surplus flux. It is non-flammable, non-toxic and evaporates quickly after use.

**RESIST INK SOLVENT •**

| | |
|---|---|
| No. 198 • 2 oz. glass bottle | 2.25 |
| No. 198G • 1 gallon can | 21.95 |

## PHOTO RESIST SPRAY

### For Sensitizing Boards


For coating printed circuit boards. Photo Resist is a high quality resist which will cause less pin-holing and has less sensitivity to white light exposure than other resists.

**PHOTO RESIST**

| | |
|---|---|
| No. PC194-3 • 3 oz. spray can | 5.30 |
| No. PC194-16 • 16 oz. spray can | 14.80 |
| No. PC194G • 1 gallon | 222.00 |

## RESIST INK PEN

### For Printed Circuit Boards


Injectorall's felt-tip RESIST INK PEN makes resist circuits directly on printed circuit boards. Injectorall's pen enables the application of resist ink as easily as if using any felt marker pen. It is available in black only, in fine and medium widths. Dries instantly and remains until removed with any resist ink remover or fine steel wool. Blister-packed.

**RESIST INK PEN •**

| | |
|---|---|
| No. 195 • Black-fine tip, blister-packed | 2.05 |
| No. 196 • Black-medium tip, blister-packed | 2.05 |

## PHOTO RESIST DEVELOPER

### For Photo-Sensitized Boards


PHOTO RESIST DEVELOPER is a specially prepared solvent for developing photo resist images. It can be used for printed circuits, semiconductor parts and electroplating stopoff. Compatible with Kodak KPR resists.

**PHOTO RESIST DEVELOPER**

| | |
|---|---|
| No. D2-8 8 oz. can | 3.90 |
| No. D2G 1 gallon can | 24.25 |

## BREADBOARDS

### PERFORATED PLASTIC BOARDS

Made of 1/16" polyester glass with holes either regularly spaced or staggered for transistors.

| | HOLE SIZE | | | |
|---|---|---|---|---|
| No. B653 | .062 | alternate | 3x4" | 1.95 |
| No. B655 | .062 | alternate | 3x6" | 2.70 |
| No. B656 | .062 | alternate | 4x8" | 4.40 |
| No. B657 | .093 | straight | 3x4" | 1.85 |
| No. B658 | .093 | straight | 3x6" | 2.55 |
| No. B659 | .093 | straight | 4x8" | 4.05 |
| No. B663 | .038 | IC Breadboard | 3x4" | 1.85 |
| No. B664 | .038 | IC Breadboard | 3x6" | 2.20 |
| No. B665 | .038 | IC Breadboard | 4x6" | 2.70 |
| No. B666 | .038 | IC Breadboard | 4x8" | 3.45 |

# DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

535 YONGE STREET
TORONTO 5, ONTARIO

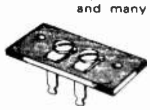
FOR A COMPLETE CATALOGUE OF PC ACCESSORIES AND CHEMICALS FROM INJECTROL, PLEASE CIRCLE #7 ON THE ORDER FORM PAGE.

# Terminal Strips

| | |
|---|---|
| 1 Terminal....... | 2¢ |
| 2 Terminal....... | 4¢ |
| 3 Terminal....... | 6¢ |
| 4 Terminal....... | 8¢ |
| 5 Terminal....... | 10¢ |
| 6 Terminal....... | 12¢ |
| 7 Terminal....... | 14¢ |
| 8 Terminal....... | 16¢ |
| 9 Terminal....... | 18¢ |
| 10Terminal....... | 20¢ |
| 11Terminal....... | 22¢ |

## 'SCREW TERMINAL STRIPS

**TERMINAL BOARD.** High insulation bakelite with twin screw terminals. Standard replacement for most TV sets, and many other applications.

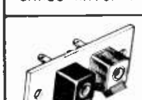


| | |
|---|---|
| 2 SCREW TERMINAL...... | 15¢ |
| 3 SCREW TERMINAL...... | 20¢ |
| 4 SCREW TERMINAL...... | 25¢ |

## FLEXIBLE TERMINAL BLOCKS

99¢

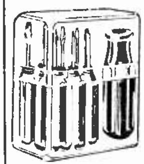
FLEXIBLE TERMINAL BLOCKS WILL CONFORM TO IRREGULAR SURFACE AND CAN BE EASILY CUT TO SIZE. LONG LEAKAGE PATHS ARE PROVIDED BY THE MOULDED POLYETHELENE INSULATION. BOLTS AND SLEEVES ARE OF BRASS WHICH HAS BEEN NICKEL PLATED.



| | |
|---|---|
| 2 TERMINAL.. | $ .75 |
| 4 TERMINAL.. | $1.50 |
| 8 TERMINAL.. | $2.95 |

5136. **SPEAKER TERMINALS.** Spring loaded, push-button terminals mounted on bakelite strip for positive and instant connect/disconnect.

## Tool Sets With Power Handle



$1.99

J-4766. Includes 3 standard drivers in small, medium and large sizes; 3 Phillips drivers; one special tool with awl tip; and one special tool with 'corkscrew' tip. All tools measure 3¼" long and have colour coded hex handles. Torque amplifier handle is 3" long. Complete with unbreakable plastic carrying case.

## CHASSIS PUNCH SET

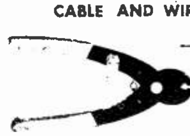
$12.98

Complete set of punches in a featherette carrying case. All precision machined of top grade steel. Following sizes: ½", ⅝", ¾", 1", 1⅛", plus burring reamer.

99¢

4720. **RETRACTABLE STEEL RULE.** Spring loaded for self-retract, extends to 78-3/4" (2 meters). Rule is 1/2" wide and has both metric and inches scale. Metal and plastic case, push button for automatic retract.

## CABLE AND WIRE STRIPPER

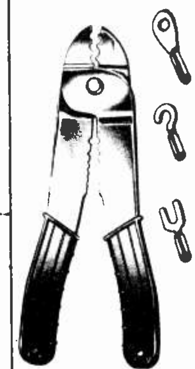


$1.89

J-4742. ECONOMY WIRE STRIPPER. Cuts or strips at any point. Tempered steel, insulated handles. Pawl lock for wire sizes 12 through 22.

# Shop Tools *Tiny Tool Sets*

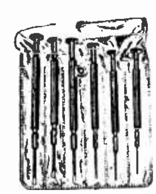
## CRIMP/STRIP TOOL



$4.95

J-5085. CRIMP/STRIP TOOL. Tempered steel with insulated handles, this handy tool will cut and strip all popular wire sizes from 10 to 22, and will crimp on solderless lugs. 7¼" length, assortment of lugs included.

## JEWELLERS SCREW DRIVERS



$1.98

J-4735. 6-PIECE JEWELLER'S KIT. Finely crafted drivers of tempered steel with free-turning barrels. Includes transparent vinyl carrying case.

## PLIERS AND CUTTERS

Imported

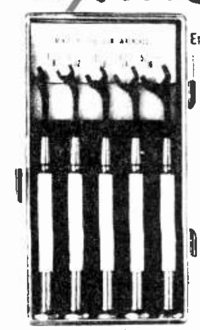
$3.95

**4" DIAGONAL SIDECUTTERS.** Quality drop-forged steel with insul-grip handles.

$3.95

**4" LONGNOSE PLIERS,** with sidecutters. Drop-forged steel with tempered nose and cutting edges. Precision ground for close tolerance. Insul-grip handles.

### Offset Open End Wrench Set

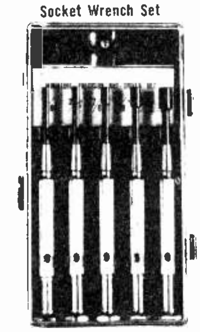


$3.95

#562

This Set #562 contains five precision wrenches with off-set open end. Blades made of hardened steel. Sizes: 1/8", 5/32", 3/16", 1/4", and 5/16".

### Socket Wrench Set



$3.95

# 563

This set #563 contains five precision Nut Drivers with torque hole and bar. Blades are made of hardened steel. Sizes: 5/64", 3/32", 7/64, 1/8", 5/32".

### Phillips Driver & Allen Type Wrench Set


$3.95

#564

This set#564 contains five drivers with torque hole and bar enadling you to set fastenings up tight. All blades are of hardened steel. Two cross recessed driver No. No. 1.
Three allen type wrenches: No. 4 - No. 6 - No. 8.

### Tiny Screw Driver & Awl Set

$3.95

#565

This set # 565 contains five interchangeable Tools. Three steel screw driver blades: 1/16", 3/32", 1/8", One cross recessed driver No.1 One awl, All heact treated. Chuck type handle.

# waldom

## SOLDERLESS TERMINALS AND CONNECTORS

## PRINTED CIRCUIT HARDWARE

## FASTENING DEVICES

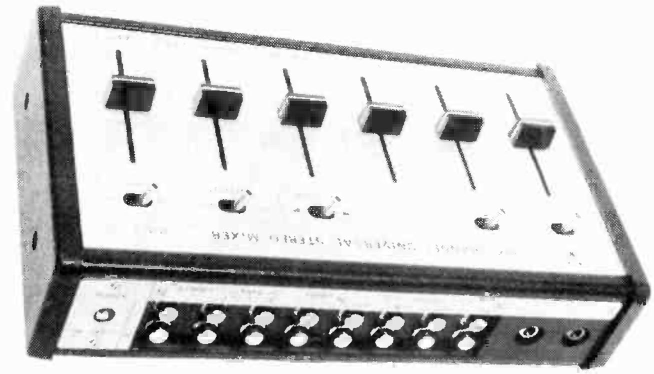
WE HAVE THE COMPLETE LINE OF WALDOM HARDWARE. FOR YOUR COPY OF THE WALDOM CATALOGUE, PLEASE CIRCLE #13 ON THE ORDER FORM PAGE.

IF YOU DON'T SEE WHAT YOU NEED IN OUR CATALOGUE, PLEASE DROP US A LINE AND ASK. BE IT OLD OR NEW, THERE IS A GOOD CHANCE THAT WE EITHER HAVE IT IN STOCK, OR WE MAY BE ABLE TO ORDER IT FROM ONE OF OUR SUPPLIERS. WE WANT YOUR BUSINESS.

# TENCO

STEREO MIKE MIXER WITH SLIDE CONTROLS.

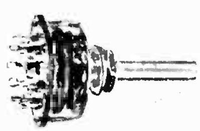
## Microphone Mixer




STEREO MONO SWITCH
DUAL IMPEDANCE
SIX INPUTS:-
- MIKE 1
- MIKE 2
- PHONO 1
- PHONO 2
- TUNER/TAPE 1
- TAPE 2

$84.95

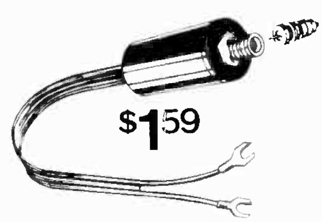
THE MM-1 MICROPHONE MIXER IS OUR LATEST MIXER IS LATEST MIXER FEATURING LOW NOISE LEVEL, HIGH RELIABILITY, VERSATILITY AND ECONOMY.



Useful for many audio, stereo and hi-fi applications. Spring loaded, shorting type, positive detent action. 1-1/4" diameter with 1-1/4" shaft length, plated lugs.

**5201.** 11 position, single pole
**5202.** 12 position, single pole
**5203.** 5 position, 2-pole
**5204.** 6 position, 2-pole
**5205.** 3 position, 3-pole
**5206.** 4 position, 3-pole
**5207.** 2 position, 4-pole
**5208.** 3 position, 4-pole
**5209.** 2 position, 6-pole

$1.09



$1.59

N-9065. CATV MATCHING TRANSFORMER. Now you can match the impedance of any CATV co-axial line to the impedance of your TV or FM receiver. Converts 75 ohms CATV output to 300 ohms FM/TV input. Hardware and F-59 connector included.

N-9066. Same as above but with slimline ½" casing.

### CATV/MATV HARDWARE

$3.95

N-9067. 75 OHM SPLITTER. Splits incoming 75 ohm line to dual 75 ohm outputs, for use with TV-FM combination, etc. Standard F-61 connectors, all-metal casing.

N-9068. As above, 3 outputs. 4.95
N-9069. As above, 4 outputs. 5.95

25¢

N-F59.

N-F59. MALE CONNECTOR. For use with RG-59/U cable. Fits F-61, F-61A, F-81 and F-81B Connectors. Ferrule supplied.

49¢

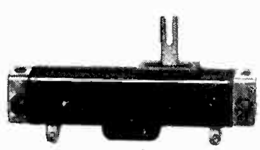
N-F61A.

N-F61A. FEMALE CONNECTOR. Fits F-59, F-59A and F-56 connectors. Complete with nut and washer.

69¢

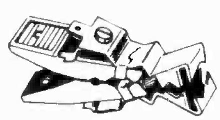
N-F81.

N-F81. FEMALE ADAPTOR. Mates with F-59, F-59A and F-56 connectors.



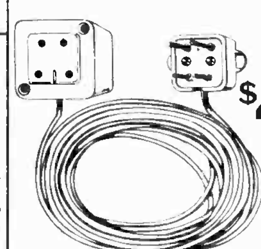
79¢

**TS302.** Ruggedly designed slide controls for a wide variety of general replacement and OEM applications. Solder lugs on all terminals, threaded end flanges for panel mounting. Available in 10K, 50K, 100K ohms — please specify when ordering. 2-1/4"L x 7/16"D x 5/16"W.



15¢

N-1015. TV ANTENNA CLIP. Strong plated springs with screw terminals and coloured plastic handles. Quick way to connect or disconnect antenna lead-in wires to TV set, FM radio etc.



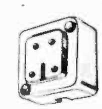
$4.95

N-4939. Plugs into standard telephone equipment, or for use with jacks and plugs shown below. White vinyl covered cable is 30 feet long with four colour coded conductors.

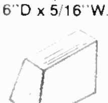
89¢

N-4936. Fits all single and 2-line phones. Easy to attach without soldering.

89¢



N-4937. Mounts to wall with 2 wood-screws, included. Screw-type terminals.



Custom replacement knobs for above controls and other standard types.

GP10. BLACK, with marker. 49¢
GP16. Silver/chrome finish, n 59¢

Q4807

$1.59

**Q4807. TELEPHONE PICKUP.** Suction cup attaches to phone handle behind earpiece and picks up both sides of telephone conversation. Miniature phone plug connects to amplifier or tape recorder.

# DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

FOR A COMPLETE CATALOGUE ON TENCO PARTS AND ACCESSORIES, PLEASE CIRCLE # 5 ON THE ORDER FROM PAGE.

# NEW PLUGS JACKS & ADAPTERS

| | | | | |
|---|---|---|---|---|
| RCA PHONO PLUG 10¢ A1 | INSULATED RCA PHONO PLUG 15¢ A2 Red or Black | FINGER-GRIP RCA PHONO PLUG 15¢ A3 | INSULATED RCA PHONO PLUG 25¢ A4 | SHIELDED RCA PHONO PLUG 45¢ A5 |
| RCA PHONO JACK 15¢ A6 | CHASSIS MOUNT RCA PHONO JACK 25¢ A7 | INLINE RCA PHONO JACK 25¢ A8 | DUAL RCA PHONO JACKS 30¢ A9 | SHIELDED INLINE RCA PHONO JACK 45¢ A10 |
| ULTRS MINI ATURE PLUG 15¢ A11 | ULTRA MINIATURE LONG BARREL PLUG 25¢ A12 | MINIATURE PLUG 15¢ A13 | MINIATURE PLUG 25¢ A14 | CHROME MINIATURE PLUG 45¢ A15 |
| ULTRA MINIATURE CHASSIS MOUNT JACK 10¢ A15 | ULTRA MINIATURE INLINE LONG BARREL JACK 25¢ A17 | CHASSIS MOUNT JACK 15¢ #901 Closed Circuit #902 Open Circuit | MINIATURE INLINE JACK 25¢ A19 | CHROME MINIATURE INLINE JACK 45¢ A20 |
| STANDARD PHONE PLUG 45 A21 Black | SHIELDED PHONE PLUG 89 A22 | 90 STANDARD PHONE PLUG 99 A23 | 90 SHIELDED PHONE PLUG 99 A24 | CHROMED BARREL PLUG 1.19 A25 |
| INLINE PHONE JACK 45¢ A26 | SHIELDED INLINE PHONE JACK 89¢ A27 | CHASSIS MOUNT PHONE JACK 35¢ A28 Closed Circuit | CHASSIS MOUNT PHONE JACK 35¢ A29 Open Circuit | CHROMED BARREL INLINE JACK $1.19 A30 |
| STEREO PHONE PLUG 69¢ A31 | 90 STEREO PHONE PLUG $1.09 A32 | SHIELDED STEREO PHONE PLUG 99¢ A33 | STEREO PHONE JACK CIRCUIT CLOSING 45¢ A34 | 36 STEREO Y ADAPTOR $2.19 |
| INLINE stereo PHONE JACK 69¢ A35 | STEREO PHONE JACK 45¢ A36 | SHIELDED STEREO INLINE JACK 99¢ A37 | EPOXY STEREO PHONE JACK 99¢ A38 CIRCUIT CLOSING | STEREO Y ADAPTOR $2.99 |
| MINIATURE MALE INLINE MIKE CONNECTOR 79¢ A39 | MALE INLINE MIKE CONNECTOR 79¢ A40 | MIKE CONNECTOR TO PHONE PLUG ADAPTOR 79¢ A41 | SHIELDED PHONO JACK TO PHONO JACK ADAPTOR 79¢ A42 | PHONO JACK TO PHONO JACK ADAPTOR 69¢ A43 |
| MINIATURE MALE CHASSIS MOUNT MIKE CONNECTOR 49¢ A44 | MALE CHASSIS MOUNT MIKE CONNECTOR 49¢ 5/8 - 27 thread A45 | MIKE CONNECTOR TO PHONE JACK ADAPTOR 89¢ A46 | PHONO PLUG TO PHONE PLUG ADAPTOR 79¢ A47 | PHONO JACK TO PHONO JACK ADAP.TOR 79¢ A48 |
| MINIATURE FEMALE INLINE MIKE CONNECTOR 69¢ A49 | FEMALE INLINE MIKE CONNECTOR 5/8-27 thread 69¢ A50 | MIKE CONNECTOR TO PHONE JACK ADAPTOR 79¢ A51 | PHONO JACK TO MINIATURE PLUG ADAPTOR 79¢ A52 | ULTRA MINIATURE JACK TO MINIATURE PLUG ADAPTOR 79¢ A53 |
| MINIATURE JACK TO ULTRA MINIATURE PLUG 79¢ A54 | MINIATURE JACK TO PHONE PLUG ADAPTOR 79¢ A55 | 1" MINIATURE JACK TO PHONO PLUG ADAPTOR 79¢ A56 | PHONE JACK TO ULTRA MINIATURE PLUG ADAPTOR 79¢ A57 | ULTRA MINIATURE JACK TO STANDARD PHONE PLUG 79¢ A58 |
| PHONE JACK TO MINIATURE PHONE PLUG 79¢ A59 | PHONE JACK TO PHONO PLUG ADAPTOR 79¢ A60 | PHONE JACK TO PHONE JACK ADAPTOR 79¢ A61 | PHONE PLUG TO PHONE PLUG ADAPTOR 79¢ A62 | MIKE CONNECTOR TO PHONO JACK ADAPTOR 79¢ A63 |

# Here are the latest additions to our line of Hi-Fi and P.A. cable assemblies :

RCA plug - Bare Wires
W1 36" $ .89
W2 72" 1.20
W3 120" 1.49

RCA plug - Spade lugs
W4 36" .79
W5 72" 1.20

RCA plug - Aligator clips
W7 72" 1.20

RCA plug - RCA plug
W8 36" .89
W9 72" 1.20
W10 120" 1.49

RCA plug - 90 RCA plug
W11 72" 1.20
W12 120" 1.49

RCA plug - RCA jack
W15 36" .89
W16 72" 1.20

2 RCA plugs- 2 RCA plugs
W17 72" 2.19

RCA plug - ¼" phone plug
W18 36" .89
W19 72" 1.20

RCA plug - ¼" phone jack
W22 72" 1.50

MINI plug - Bare wires
W23 72" 1.20

MINI plug - Aligator clips
W24 72" 1.20

MINI plug - RCA plug
W25 72" 1.20

MINI plug - RCA jack
W26 72" 1.20

MINI plug - Mini plug
W27 72" 1.20

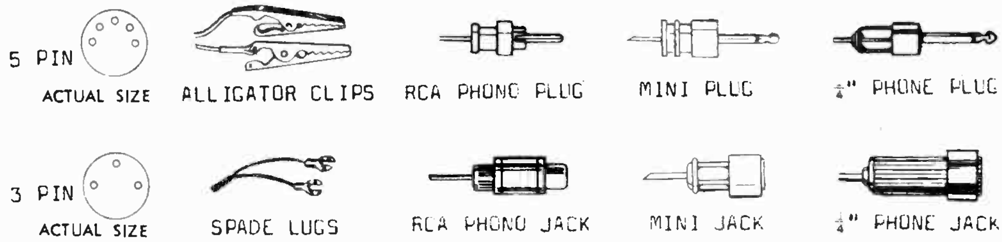
MINI plug - Mini jack
W28 72" 1.20

MINI plug - ¼" Phone plug
W29 72" 1.20

MINI plug - Phone jack
W30 72" 1.20

¼" Phone plug-RCA Jack
W31 72" 1.20

## DOMINION RADIO & ELECTRONICS CO




## Complete Cable Assemblies for Hi-Fi

### with European connectors

| NO. | CONNECTOR | CABLE | CONNECTORS | PRICE |
|---|---|---|---|---|
| W40 | 3 PIN DIN PLUG | 6' 2 COND & SHIELD | 2 PHONO PLUGS | 3.25 |
| W41 | 3 PIN DIN PLUG | 6' 2 COND & SHIELD | 2 PHONO JACKS | 3.25 |
| W42 | 3 PIN DIN PLUG | 6' 2 COND & SHIELD | 2 MINI PLUGS | 3.25 |
| W43 | 3 PIN DIN PLUG | 6' 2 COND & SHIELD | 3 PIN DIN PLUG | 3.25 |
| W44 | 3 PIN DIN PLUG | 6' 2 COND & SHIELD | 3 PIN DIN JACK | 3.25 |
| W45 | 5 PIN DIN PLUG | 6' 2 COND & SHIELD | 2 PHONO PLUGS | 3.25 |
| W46 | 5 PIN DIN PLUG | 6' 4 COND & SHIELD | 4 PHONO PLUGS | 3.95 |
| W47 | 5 PIN DIN PLUG | 6' 4 COND & SHIELD | 4 MINI PLUGS | 3.95 |
| W48 | 5 PIN DIN PLUG | 6' 4 COND & SHIELD | 5 PIN DIN PLUG | 3.95 |
| W49 | 5 PIN DIN PLUG | 6' 4 COND & SHIELD | 5 PIN DIN JACK | 3.95 |
| W50 | 4 RCA PLUGS | 6' 4 COND & SHIELD | 4 RCA PLUGS | 3.95 |

| | | | | |
|---|---|---|---|---|
| W51 | 1 RCA PLUG | - | 2 RCA JACKS | $1.10 |
| W52 | 1 RCA JACK | - | 2 RCA PLUGS | 1.10 |
| W53 | 1 RCA PLUG | - | 2 RCA PLUGS | 1.10 |
| W54 | 1 MINI PLUG | - | 2 RCA PLUGS | 1.10 |
| W55 | 1 MINI PLUG | - | 2 MINI JACKS | 1.10 |

## 3 WAY "Y" ADAPTERS

SHIELDED "Y" ADAPTOR

70¢

2 RCA jacks parallel connected to one RCA plug.

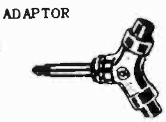
SHIELDED "Y" ADAPTOR

70¢

3 RCA jacks parallel connected

SHIELDED "Y" ADAPTOR

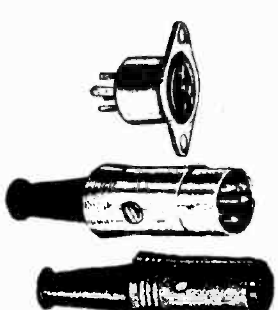
70¢



2 RCA jacks parallel connected to one ¼" phone plug.

NEW

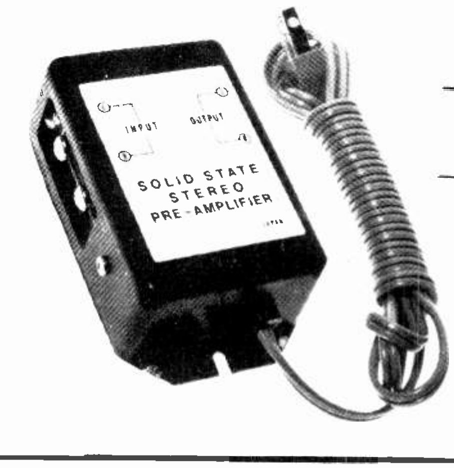
## CONTINENTAL CONNECTORS



| PINS | MALE | INLINE FEMALE | CHASSIS MOUNT |
|---|---|---|---|
| 2 | 1.29 72M Metal | 1.49 73F Metal | |
| 2 | 59 56M Plastic | | 59 57C Plastic |
| 3 | 79 58M Plastic | 79 59F Plastic | 59 66C Plastic |
| 5 | 89 60M Plastic | 99 61F Plastic | 59 67C Plastic |
| 5 | 1.89 76M Metal | 1.89 77F Metal | |
| 6 | 1.99 70M Metal | | 69 71C Metal |

# POPULAR ACCESSORIES

jana




$ 13^95

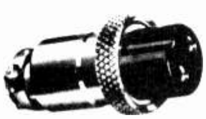
## STEREO PHONO PREAMP
## AJ 1306

Jana Stereo Phono Preamplifiers enable the Hi Fi enthusiast to use his magnetic cartridge with an amplifier that has only crystal or ceramic phono inputs.

### SPECIFICATIONS

| | |
|---|---|
| Frequency Response | — 30HZ to 20KHZ (RIAA) |
| Input Impedance | — 50K ohms |
| Max Input | — 30mv |
| Max Output | — 1.8V (at 1% H.D.) |
| Gain | — 10mv at .5V output |
| S/N Ratio | — better than 60db |
| Transistors | — 2SB175B x 4 |
| Power Input | — 117VAC |
| Dimensions | — 4¾ in. (12cm) H x 2⅝ in. (6.6cm) W x 1½ in. (3.8cm) |

# CB CONNECTORS and ADAPTERS

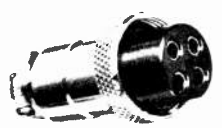


$1.29

2 CONDUCTOR INLINE MICROPHONE CONNECTOR
CJ 3154

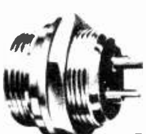
$1.39

3 CONDUCTOR INLINE MICROPHONE CONNECTOR
CJ 3152



$1.49

4 CONDUCTOR INLINE MICROPHONE CONNECTOR
CJ 3150



99¢

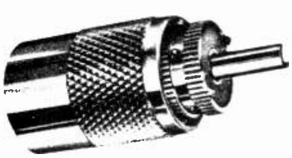
2 CONDUCTOR CHASSIS MICROPHONE CONNECTOR
CJ 3155

99¢

3 CONDUCTOR CHASSIS MICROPHONE CONNECTOR
CJ 3153

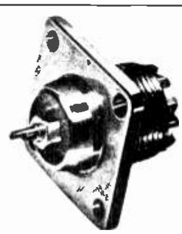
99¢

CONDUCTOR CHASSIS MICROPHONE CONNECTOR
CJ 3151



99¢

CABLE CONNECTOR
CJ 3800 (PL-259)



69¢

CHASSIS CONNECTOR
CJ 3804 (SO-239)

19¢

ADAPTER FOR (RG-58/U)
CJ 3801

ADAPTER FOR (RG-59/U)
CJ 3802

## REPLACEMENT CASSETTE POWER CORD
## AJ 1530

1^95

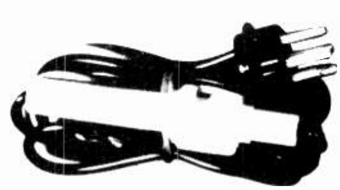
6 foot long, black line cord is the exact replacement for the most popular type. These cords are used in millions of portable tape recorders and phonos which are both battery and electric operated. Hard to find, but always needed.

## POWER SOCKET
## AJ 1529

79¢

Chassis Jack to mate with AJ 1530. Ideal for replacement in cassette recorders and for new installations in projects. Simply strip the insulation from the wire ends, insert into the hollow pins on the AJ 1529 and apply solder.

## TAPE PLAYER WIRING HARNESS



NEW
4 MODELS

CJ 3402 CJ 3404
$2^25
CJ 3401 CJ 3403

**STEREO HARNESS CABLE**
Stereo harness cables for use with your auto tape player, when connected to external power supply.

## DOMINION RADIO & ELECTRONICS COMPANY

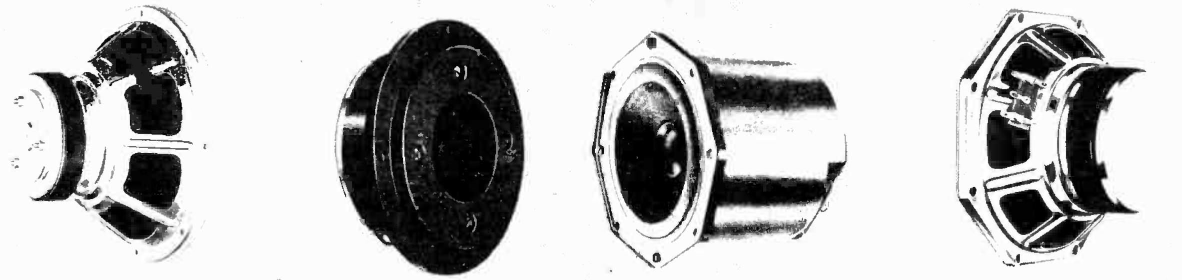
*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# DeForest

**DeForest loudspeakers...the heart of serious sound systems**

## LOUDSPEAKERS

PREMIUM QUALITY



These speakers have been specially designed for use in Hi-Fi equipment, where a high power-handling capacity, a very wide frequency-range and a negligible distortion level are required.

## High quality high fidelity, two and three-way systems

Used in airtight enclosures.

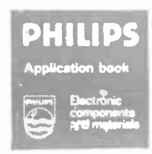
| NUMBER | TYPE | SIZE | RMS POWER | RES. | PRICE |
|---|---|---|---|---|---|
| AD 0160/T8* | Tweeter | 4" | 40w | 1kHz | $6.95 |
| AD 5060/SQ8* | Squaker | 5" | 40w | 250Hz | $11.95 |
| AD 5060/W8 | Woofer | 5" | 10w | 50Hz | $11.50 |
| AD 7066/W8 | Woofer | 7" | 40w | 28Hz | $19.50 |
| AD 8061/W8 | Woofer | 8" | 30w | 28Hz | $19.50 |
| AD 8066/W8 | Woofer | 8" | 40w | 28Hz | $23.00 |
| AD 10100/W8 | Woofer | 10" | 40w | 20Hz | $39.95 |
| AD 12100/W8 | Woofer | 12" | 40w | 19Hz | $42.50 |

* Also Available In 4 Ohms

## High quality full-range, single speaker systems (all types twin-cone)

Generally used in ported enclosures.

| NUMBER | TYPE | SIZE | RMS POWER | RES. | PRICE |
|---|---|---|---|---|---|
| AD 5061/M8 | Full Range | 5" | 10w | 85Hz | $11.50 |
| AD 7062/M8 | Full Range | 7" | 30w | 55Hz | $15.00 |
| AD 9710MC | Full Range | 8" | 20w | 50Hz | $25.95 |
| AD 1065/M8 | Full Range | 10" | 10w | 55Hz | $27.00 |
| AD12100/M8 | Full Range | 12" | 25w | 45Hz | $50.00 |
| AD12100/HP8 | Full Range | 12" | 50w | 60Hz | $50.00 |




Building hi-fi speaker systems VOL 6

This new 232 page publication reveals everything about speakers and associated enclosures. To be exact, it deals with 17 individual speaker systems ranging from one speaker up to a maximum of 20.

Furthermore this publication is an absolute must to any person wishing to construct his own speaker system. It is obtainable for just **$3.95**

### Contents

- Room Placement
- Sound Reproduction
- Moving Coil Loudspeakers
- Multiway Speaker Systems
- Loudspeaker Enclosures
- Listning Room Acoustics
- Step By Step Construction of 7 Litre Enclosure
- 17 Tested Speaker Systems
- Frequency Response & Distortion in an Anechoic Chamber
- Energy Response in a Live Room
- Frequency Response in a Live Room
- Impedance

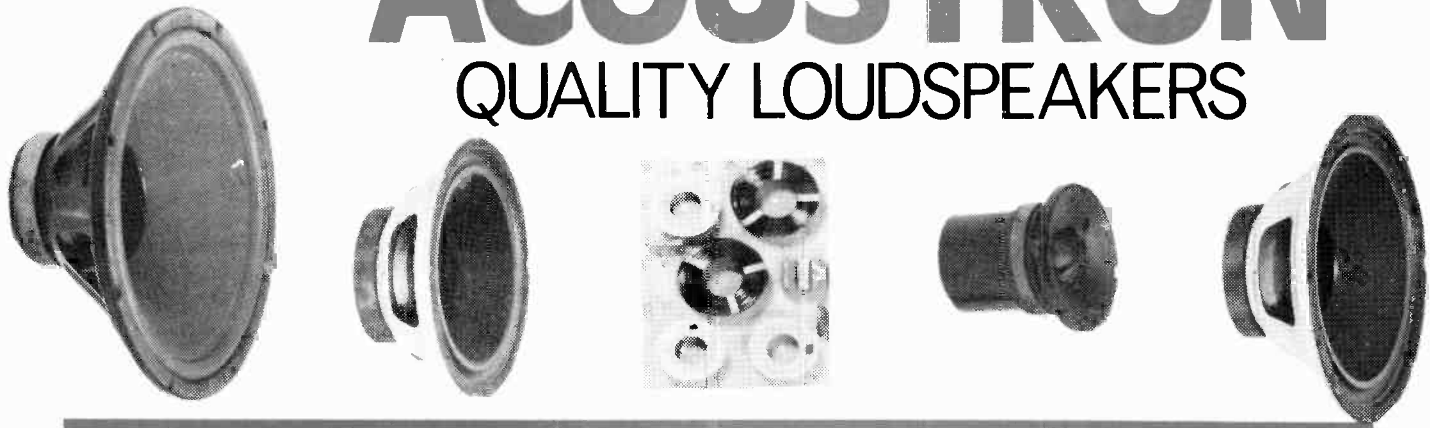
### Crossovers

| Number | Power | Crossover Freq. | Price |
|---|---|---|---|
| AD3WXB | 40 Watt | 500/4500 | 12.95 |
| AD3WXSP | 100 Watt | 700/2400 | 39.95 |
| AD2WXB | 40 Watt | 1800 | 6.95 |

**For a complete catalogue on Philips speakers, please circle #2 on the order form page.**

# PHILIPS ACOUSTRON

## QUALITY LOUDSPEAKERS



| Max. System Power (RMS) | Resonance Frequency (free air) | Magnet | Voice Coil | Type Number |
|---|---|---|---|---|
| **8" WOOFERS** | | | | |
| 20 W in .25 cu. ft. sealed enclosure (7ℓ) | 60 Hz treated fabric cone edge | 10 oz ceramic (.27kg) | 1" | AD081020W8 **$5.24** |
| 25 W in .75 cu. ft. sealed enclosure (22ℓ) | 45 Hz foam roll suspension | 10 oz ferrox-dure (.27kg) | 1" | AD8071W8 **$12.00** |
| 40 W in 1.2 cu. ft. sealed enclosure (38ℓ) | 25 Hz foam roll suspension | 20 oz ferrox-dure (.55kg) | 1.5" Al. | AD80100W8 **$24.00** |
| **10" WOOFERS** | | | | |
| 25 W in 1.2 cu. ft. sealed enclosure (38ℓ) | 25 Hz foam roll suspension | 10 oz ferrox-dure (.27kg) | 1" multi-layer | AD101025W8 **$13.75** |
| 50 W in 1.2 cu. ft. sealed enclosure (38ℓ) | 25 Hz foam roll suspension | 20 oz ferrox-dure (.55kg) | 1.5" multilayer | AD102050W8 **$27.50** |
| 70 W in 1.2 cu. ft. sealed enclosure (30ℓ) | 20 Hz foam roll suspension | 40 oz ferrox-dure (1.05kg) | 2" Al. | AD10240W8 **$42.00** |
| **12" WOOFERS** | | | | |
| 25 W in 2.4 cu. ft. sealed enclosure (80ℓ) | 25 Hz foam roll suspension | 10 oz ferrox-dure (.27kg) | 1" Al. | AD1271W8 **$15.00** |

| Max. System Power (RMS) | Resonance Frequency (free air) | Magnet | Voice Coil | Type Number |
|---|---|---|---|---|
| 50 W in 2.4 cu. ft. sealed enclosure (80ℓ) | 25 Hz foam roll suspension | 20 oz ferrox-dure (.55kg) | 1.5" Al. | AD122050W8 **$27.00** |
| 70 W in 2.4 cu. ft. sealed enclosure (80ℓ) | 19 Hz foam roll suspension | 40 oz ferrox-dure (1.05kg) | 2" Al. | AD12240W8 **$44.50** |
| **15" WOOFERS** | | | | |
| 80 W in 3.5 cu. ft. sealed enclosure (110ℓ) | 19 Hz foam roll suspension | 40 oz ferrox-dure (1.05kg) | 2" Al. | AD15240W8 **$54.95** |
| **5" MIDRANGE (sealed back)** | | | | |
| 40 W (crossover 1500 Hz or above) | 850 Hz | ferrox-dure 3 oz (85g) | 9/16" | AD5010SQ8 **$6.35** |
| 40 W (crossover 400 Hz or above) | 210 Hz | ferrox-dure 10 oz (.27kg) | 1" | AD5060SQ8 PHILIPS DEFOREST) also SQ4 4ohm **$11.95** |
| **TWEETERS (sealed back)** | | | | |
| 20 W (crossover 1500 Hz or above) 40 W (4500 Hz or above) | 1.2 KHz | ferrox-dure 5 oz (140g) | 1" Al./Cu. | AD0140T8 (PHILIPS DEFOREST) Also T4 4 ohm **$6.75** |

**DOMINION RADIO & ELECTRONICS COMPANY**

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**For complete specifications on Acoustron loudspeakers, please circle #2 on the order form page.**

# ULTRAFLEX LOUDSPEAKERS

Two Great Speaker Series Available

RSC AUDIO

**HIGH QUALITY**

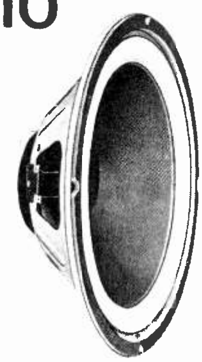
These driver units by RSC have been designed for use in sealed enclosures in order to achieve optimum response and power handling. To take full advantage of the five years of research designing these speakers, you are advised **not** to mix these components with any others. Specifications should not be changed. Your cabinet must have no air leaks . . . caulk all seams and speaker frames Speakers are to be mounted from the front and flush with the face of the baffle. The grille cloth should be an open weave material that you can breathe through easily . . . make sure the grille clears the speakers by at least 3/8″. Follow these specifications . . . and you'll have speakers offering you acoustical excellence.

**LOW PRICES**

**8"**

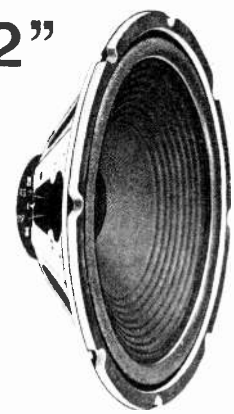
**80W8**

**10"**



**100W8**

**12"**



**120W8**

| NUMBER | TYPE | SIZE | RMS POWER | RES. | PRICE |
|---|---|---|---|---|---|
| 80W8 | WOOFER | 8″ | 10W | 75 | 13.95 |
| 100W8 | WOOFER | 10″ | 10W | 63 | 15.95 |
| 120W8 | WOOFER | 12″ | 10W | 60 | 17.95 |

**hi-compliance woofers**

DRE

**DOMINION RADIO & ELECTRONICS COMPANY**

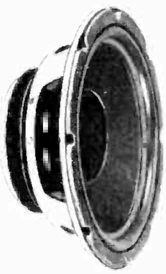
*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# ULTRAFLEX
# LOUDSPEAKERS

Two Great Speaker Series Available

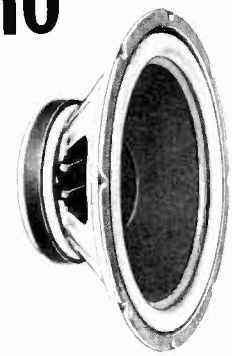
rsc AUDIO

## 8"



800W8

## 10"



1000W8

## 12"

1200W8

These driver units by RSC have been designed for use in sealed enclosures in order to achieve optimum response and power handling. To take full advantage of the five years of research designing these speakers, you are advised **not** to mix these components with any others. Specifications should not be changed. Your cabinet must have no air leaks . . . caulk all seams and speaker frames. Speakers are to be mounted from the front and flush with the face of the baffle. The grille cloth should be an open weave material that you can breathe through easily . . . make sure the grille clears the speakers by at least 3/8". Follow these specifications . . . and you'll have speakers offering you acoustical excellence.

ULTRA-HIGH-QUALITY

| NUMBER | TYPE | SIZE | RMS POWER | RES. | PRICE |
|---|---|---|---|---|---|
| 800W8 | WOOFER | 8" | 35W | 55Hz | 25.95 |
| 1000W8 | WOOFER | 10" | 40W | 47Hz | 39.95 |
| 1200W8 | WOOFER | 12" | 45W | 42Hz | 42.95 |

**hi-compliance woofers**

DRE

DOMINION RADIO & ELECTRONICS COMPANY

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# ULTRAFLEX
# LOUDSPEAKERS

Two Great Speaker Series Available

rsc AUDIO

## MID RANGE

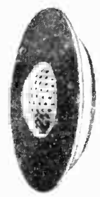
*400 - 7000 Hz*
*40 Watts*

$11.95

## TWEETER

*3000 - 20000 Hz*
*40 Watts*

$8.95

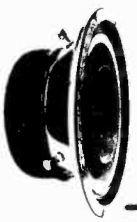


As we went to press with our new September 1977 catalogue, final details of the new ULTRAFLEX crossover and their new handbook on Speaker Construction Projects were not yet available. Customers who are interested in either of these items are requested to write for them using the order form at the back of the catalogue or on their own note paper.

Specifications and/or descriptive literature will be forwarded on receipt.

## FULL RANGE

These driver units by RSC have been designed for use in reflex enclosures for optimum response and power handling. Specifications should not be changed. Your cabinet must have no air leaks other than the vent . . . caulk all seams and speaker frames. Speakers are to be mounted from the front and flush with the face of the baffle. The grille cloth should be an open weave material that you can breathe through easily . . . make sure the grille clears the speaker by at least 3/8". We suggest you line the cabinet with two inches of damping material making sure the front and vent are clear. Follow these specifications . . and you'll have speakers delivering you acoustical exellence.



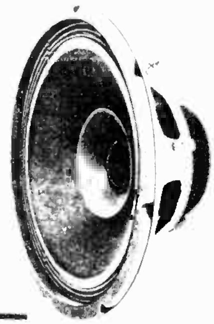
8"
$15.95

20 WATTS RMS

DRE DC8

8 OHM

12"
$24.95



DRE DC12

**DOMINION RADIO & ELECTRONICS COMPANY**

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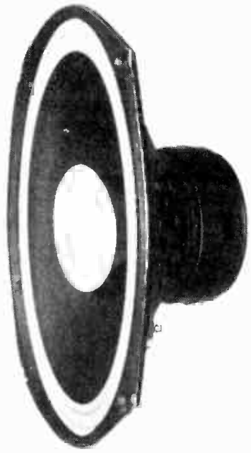
# Marsland Speakers

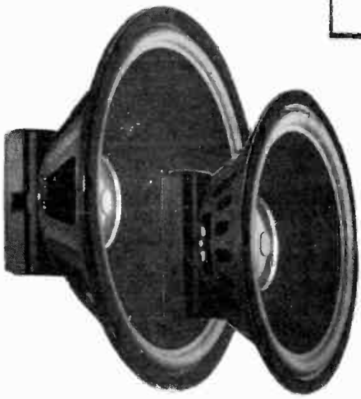
## *Linear 'A'* 6 x 9



SPECIAL ~~$15.95~~

30 Hz — 20 KHz
25 Watts RMS

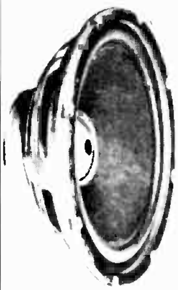
ANNOUNCING **VHP**
VERY HIGH POWER



VHP — 1500
$84.95
15 Hz — 4 KHz
100 Watts RMS

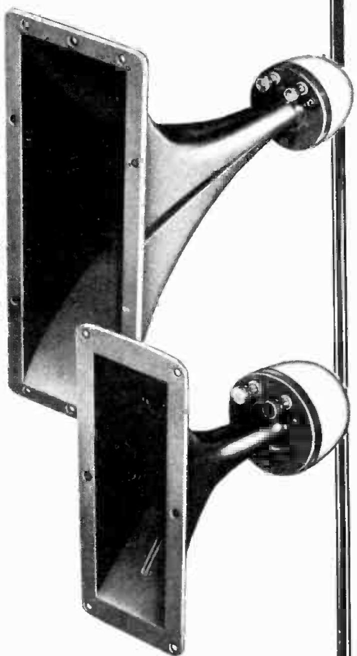
VHP — 1200
$74.95
18 Hz — 4 KHz
100 Watts RMS

## *Linear 'B'* *10" Woofer*



$16.95 Ea.
**Case of 4**
**$59.00**
20 Hz — 5 KHz
40 Watts RMS

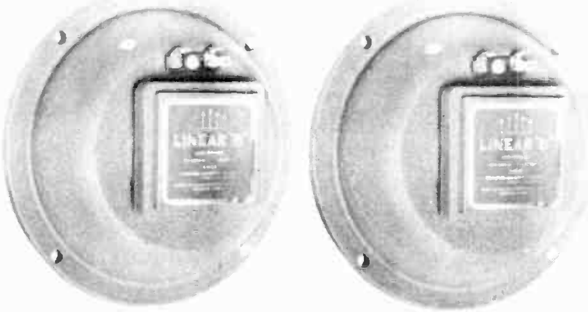
## HORN TWEETERS



2" x 6"
$19.95 Ea.
3 — 20 KHz
25 Watts RMS

4" x 10"
$24.95 Ea.
1 — 20 KHz
25 Watts RMS

## *Linear 'B'* MID DRIVER



$18.95 Pr.
600 Hz — 8 KHz
60 Watts RMS

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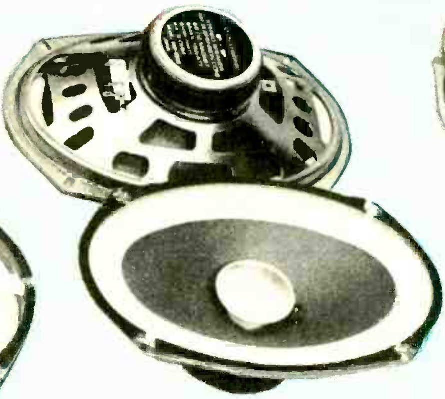
# DYNATRONIC®

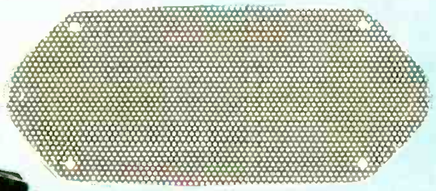
## Replacement Speakers

BS 6912CX
BS 6920CX
BS 6930CX

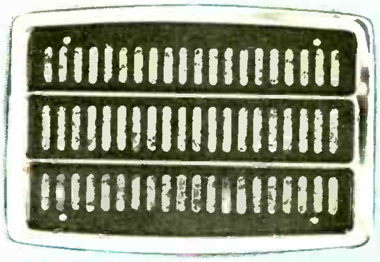


NRS 6903A
NRS 6908


BS 503
BS 506
BS 506
BS 512



SG 410
metal
$1.29

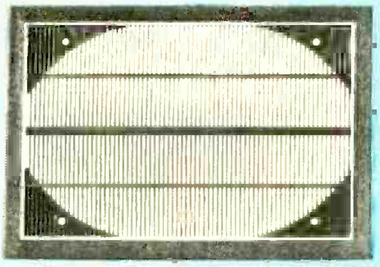


SG 69S
metal
$2.79

NEW

$39.95

NEW
6" x 9" THREE WAY SUPER DELUXE speaker (woofer, midrange, tweeter) with 20 oz. ceramic magnet. Floating AIR SUSPENSION multi-colour cone with urethane foam rolled edge. Separate 3" midrange and 2" tweeter. Available in bulk pack and in multi-colour display package kit with super deluxe grille, wire and mounting hardware. Display package kit Model No. RSP-69TRX



SG 69P
plastic
$2.29

| MODEL NO. MODÈLE NO. | DESCRIPTION | SPEAKER HAUT-PARLEURS | CERAMIC MAGNET AIMANT EN CÉRAMIQUE | SORTIE MAXIMUM OUTPUT (WATTS) | IMP. (OHMS) | PRICE |
|---|---|---|---|---|---|---|
| BS-503 | | 5" with dustcover / avec couvercle | 3 oz | 5 | 8 | $ 3.95 |
| BS 506 | Pin Cushion / Épingle de coussin Replacement / Remplacement | 5" | 6 oz | 10 | 4-8 | $ 5.95 |
| | | 5" | | | 4-8 | |
| BS-512 | | 5" AIR SUSPENSION / SUSPENSION ACCOUSTIQUE | 12 oz | 15 | 4-8 | $ 9.95 |
| NRS-6903A | Standard replacement / Remplacement | 6" x 9" | 3 oz | 8 | 8 | $ 5.95 |
| NRS-6908 | Replacement / Remplacement | 6" x 9" AIR SUSPENSION SUSPENSION ACCOUSTIQUE | 8 oz | 15 | 4-8 | $10.95 |
| BS-6912CX | Deluxe | 6" x 9" CO-AXIAL AIR SUSPENSION SUSPENSION ACCOUSTIQUE 2 way / deux manières (6" x 9" woofer & 3" tweeter) | 12 oz CO-AXIAL | 25 | 4-8 | $15.95 |
| BS-6920CX | Super Deluxe | | 20 oz CO-AXIAL | 35 | 4-8 | $18.95 |
| BS-6930CX | Grande Deluxe | | 30 oz CO-AXIAL | 50 | 4-8 | $24.95 |

DOMINION RADIO & ELECTRONICS COMPANY

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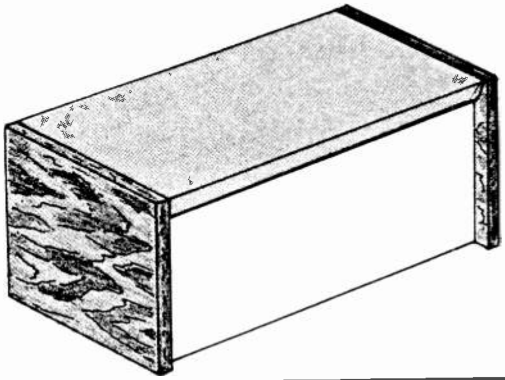
# DELUXE ALUMINUM UTILITY CABINETS



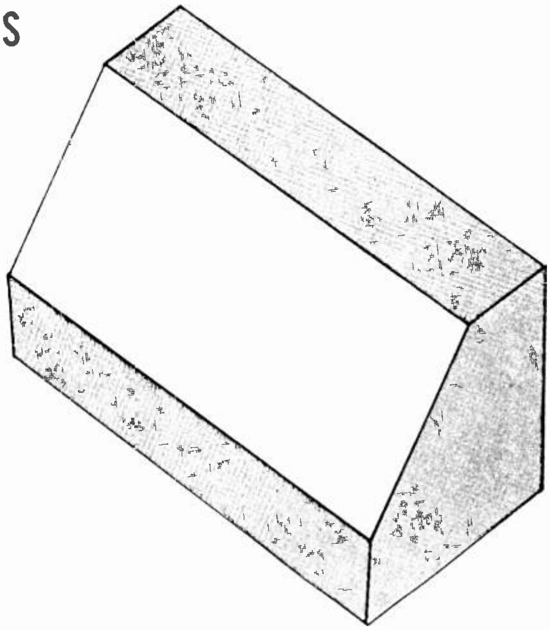
* Utility cabinets made of 18 guage aluminium covered in black leatherette.
* All cabinets complete with walnut veneer end plates.
* All cabinet exclude front plate which are listed in rear of brochure.

| PART NO. | PRICE | WIDTH | HEIGHT | DEPTH |
|---|---|---|---|---|
| EC6 | 5.95 | 6 | 4½ | 5 |
| EC8 | 6.95 | 8 | 4½ | 5 |
| EC10 | 10.95 | 10 | 4½ | 8 |
| EC12 | 11.95 | 12 | 4½ | 8 |

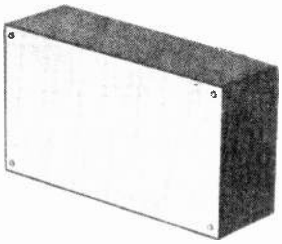
# NEW BLACK LEATHERETTE METER CASES

* New style leatherette covered aluminium 18 guage sturdy meter cabinets.
* Excellent visibility of meter or other displays on the 45° sloping panel.
* Matching panels may be selected from rear of brochure. (Note-cabinet less panel)

| PART NO. | PRICE | WIDTH | HEIGHT | FRONT HT. | PANEL HT. |
|---|---|---|---|---|---|
| SC6 | 6.95 | 6 | 5 | 1 3/4 | 5 |
| SC8 | 7.95 | 8 | 5 | 1 3/4 | 5 |
| SC10 | 8.95 | 10 | 5 | 1 3/4 | 5 |
| SC12 | 9.95 | 12 | 5 | 1 3/4 | 5 |

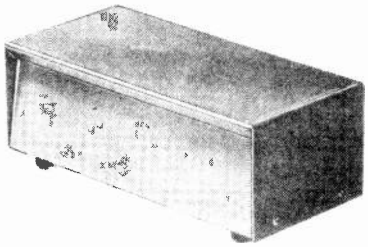


# UTILITY BOXES



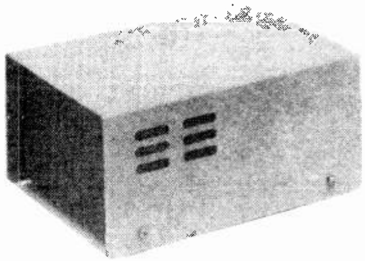
STURDY COMPACT BLACK PLASTIC CABINETS WITH ALUMINUM TOPS. ESPECIALLY SUITABLE FOR TRANSISTORIZED RECEIVERS, CODE OSCILLATORS, METERS & MANY OTHER APPLICATIONS. ALUMINUM PANEL REMOVES FOR EASY ACCESS TO COMPONENTS.

#UC-1 3¼"x2 1/8"x1 1/8"D $1.59
#UC-2 4"x2 5/8"x1 5/8"D 1.79
#UC-3 5 1/8"x2 5/8"x1 5/8"D 2.49
#UC-4 6¼"x3 3/4"x2"D 2.99
#UC-5 7 3/4"x4 3/8" x2 3/8"D 3.29



COMPLETELY ENCLOSED 2 PIECE STEEL BOX IN HANDSOME GOLD FINISH. UNLIMITED USE FOR HOBBYISTS, BUILDERS, AUDIO & SHOP PROJECTS. IDEAL FOR RF PROJECTS.

#UC-6 4"x2"x1⅓"D $1.99
without rubber feet
#UC-7 4"x1⅓"x1⅓"D 2.59
with rubber feet
#UC-8 6"x2"x1⅓"D 2.99
with rubber feet

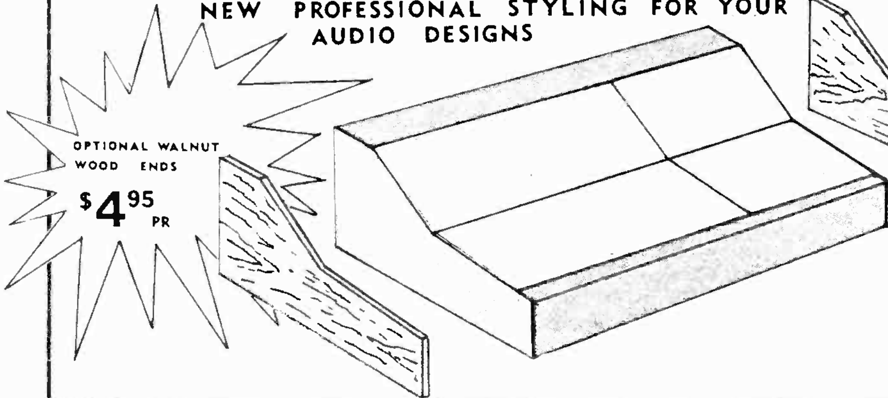


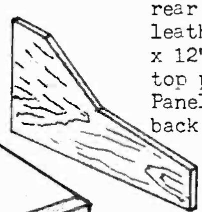
OUR NEWEST CABINETS FEATURE A STRONG 2 PIECE STEEL COVER OVER AN ALUMINUM CHASSIS, FINISHED IN GREY MATTE. PERFECT FOR POWER SUPPLIES, COLOUR ORGANS AND MANY OTHER APPLICATIONS.

#UC-9 4"x2"x3 3/16"D $2.79
#UC-10 5 7/8"x2⅓"x4"D 3.69
#UC-11 6"x2 3/4"x5¼"D 4.29
#UC-12 7¼"x2 5/8"x6¼"D 4.79

## SLOPING MIXER CONSOLE

### NEW PROFESSIONAL STYLING FOR YOUR AUDIO DESIGNS



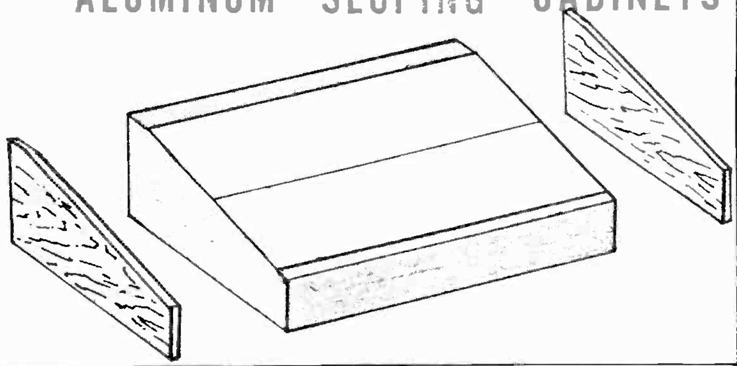
An economical miniature console for audio projects made of 18 guage sturdy aluminum complete with rubber feet. Front edge & rear panels are covered with black leatherette. Consoles come in 10½" depth x 12" 18" & 24". All consoles exclude top panels & wooden walnut ends. Panels for above console are listed on back cover.

| PART NO | PRICE | WIDTH | DEPTH | FR-HT | R HT |
|---|---|---|---|---|---|
| L MX-12 | 12.95 | 12" | 10½" | 2" | 5" |
| L MX-18 | 15.95 | 18" | 10½" | 2" | 5" |
| L MX-24 | 19 95 | 24" | 10½" | 2" | 5" |

## ALUMINUM SLOPING CABINETS

* Front & back plates leatherette covered.
* All sloping cabinets made for 18 guage aluminium.
* All cabinets come less top panels, listed at rear of this brochure.
* Walnut ends optional at $4.50 per pair.

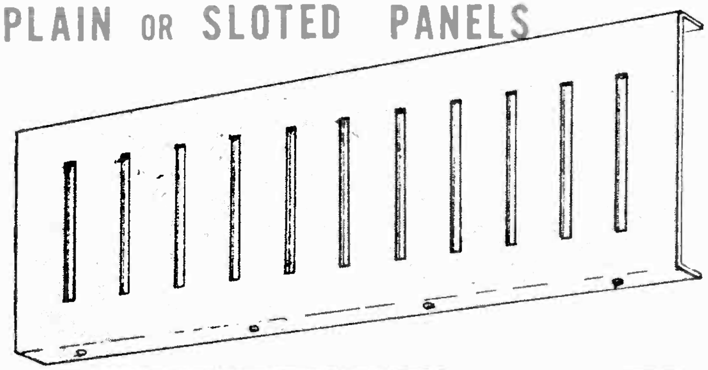
| PART NO. | PRICE | WIDTH | DEPTH | FR. HT. | REAR HT. |
|---|---|---|---|---|---|
| S MX-12 | $ 9 95 | 12" | 10½" | 2" | 3½" |
| S MX-18 | $12.95 | 18" | 10½" | 2" | 3½" |
| S MX-24 | $17.95 | 24" | 10½" | 2" | 3½" |



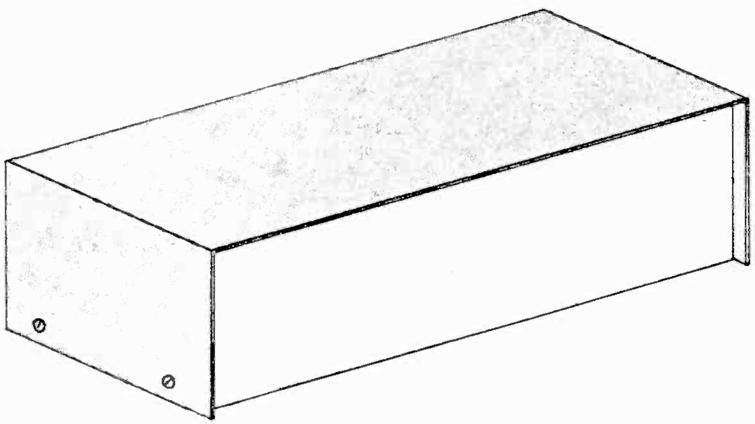
## UNIVERSAL PLAIN OR SLOTED PANELS

* Universal heavy guage plastic protected aluminium panels. (Plastic may be removed).
* Panels come in plain or punched depending on application. Slots are for 60mm slider pots for 4 or 10 slots.

| PART NO. | SIZE | PLAIN | FOUR SLOTS | TEN SLOTS |
|---|---|---|---|---|
| TP-6 | 4½ X 6 | 2.00 | 2.80 | 3.50 |
| TP-8 | 4½ X 8 | 2.25 | 3.05 | 3.80 |
| TP-10 | 4½ X 10 | 2.50 | 3.30 | 4.25 |
| TP-12 | 4½ X 12 | 2.75 | 4.00 | 4.75 |



## LARGE ALUMINUM UTILITY BOXES



* A modern cabinet for instrument applications 4" in height.
* All top covers are leatherette 18 guage aluminium.
* Cabinet comes complete with rubber feet. All sides & srews.

| PART NO | PRICE | WIDTH | HEIGHT | DEPTH |
|---|---|---|---|---|
| UT104 | 4.95 | 6 | 4 | 5 |
| UT106 | 5.95 | 10 | 4 | 5 |
| UT110 | 7.95 | 10 | 4 | 8 |
| UT112 | 9.95 | 14 | 4 | 8 |

# VISTA DC POWER SUPPLIES

## VISTA IV


CSA approved
Homologation ACNOR

$26⁹

* SUPPLIES 2 AMPS @ 12 VDC - 4 AMP SURGE
* AUTOMATIC CIRCUIT BREAKER
* CSA APPROVED

Converts home 115 VAC to 12 VDC. Now you can enjoy car tape players in you home by using this, our most popular power supply. The unit is overload protected, includes automatic circuit breaker, neon indocator light, on/off switch. Size: 3¼"H x 5"W x 5"D. CSA approved.

## VISTA CB-IIIR

* 3 AMP REGULATED POWER SUPPLY
* FULL POWER OUTPUT FOR CB
* SOLID STATE OVERLOAD PROTECTION

Integrated circuit regulated.
Converts 115 VAC to 13.8 VDC ±.5 volts.
This power supply is regulated and will deliver maximum power from your CB rig, with a surge of 5 amps. Also can be used to trickle-charge 12 volt batteries.
Special features: Neon indicator light, on/off switch, circuit breakers. Canadian made, CSA approved.
Size: 3¼"H x 5"W x 5"D.

$41⁹

FULL CB POWER!


CSA approved
Homologation ACNOR

## VISTA CB-IVR


CSA approved
Homologation ACNOR

$74⁹⁵

FULL CB POWER!

* 4 AMP REGULATED POWER SUPPLY – 6 AMP SURGE
* SOLID STATE DUAL OVERLOAD PROTECTION
* CROWBAR OVERVOLTAGE PROTECTED

Converts 115 VAC to 13.8 VDC ±.5 volts.
A heavy duty power supply for use with all types of transistor equipment requiring 4 amps or less. Will operate radios, intercoms, recorders, car stereo tape players, CB transceivers, etc. Features neon indicator light, on/off switch. Size: 4"H x 6½"W x 8"D. CSA approved.

## VISTA X-R

* 10 AMP REGULATED POWER SUPPLY – 12 AMP CPR*
* DUAL OVERLOAD PROTECTED
* CROWBAR OVERVOLTAGE PROTECTED

Converts 115 VAC to 13.8 VDC +.5V.
A heavy duty regulated power supply designed for use with Ham, CB and marine mobile radio stations. Also for linear amplifiers up to 200 watts P.E.P. Size: 4¼"H x 6½"W x 8"D.

* CPR: Continuous Periodic Rating-Duty Cycle 3 min. on, 1 min. off.

$99⁹⁵


## ZENON STROBE

$39⁹⁵

The longest lasting, most dependable strobe ever developed.

We unconditionally guarantee everything including flash-tube for 6 months. (And we're the only ones to do so!).

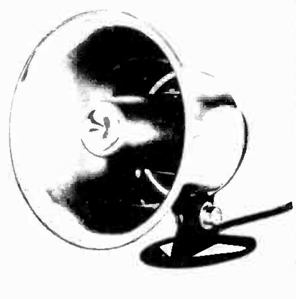
No-drift feature controls flash-rate up to 10 flashes per second.

## 5" Indoor-Outdoor Paging Speaker

$11⁹⁵

| | |
|---|---|
| Frequency Response: | 400-7,000 Hz |
| Power Rating: | 5 Watts |
| Air Column Length: | 3¼" |
| Bell Diameter: | 5" |
| Horn Length: | 5-3/8" |
| Driver: | Permanent Magnet |
| Weight: | 1 Lb |

–8-Ohm



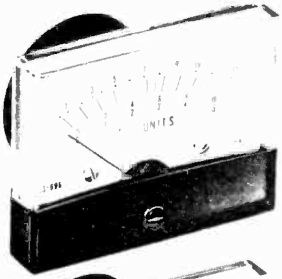
FOR A COMPLETE CATALOGUE ON THE VISTA LINE OF POWER CONVERTORS AND POWER INVERTORS, PLEASE CIRCLE #12 ON THE ORDER FORM PAGE.

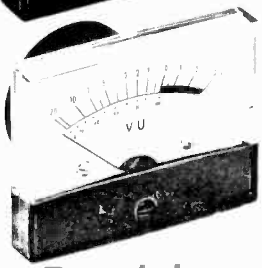
**DOMINION RADIO & ELECTRONICS COMPANY**

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

jana

# WIDE VIEW PANEL METERS





## Precision WIDE-VIEW Panel Meters

•

**Highly Readable and Accurate Design**

MODEL NUMBER TABLE

| RANGE | 2" | PRICE | 4" | PRICE |
|---|---|---|---|---|
| **DC MICROAMMETERS** | | | | |
| O-30 uA | | | HJ-8801 | 9.95 |
| O-50 uA | HJ-8202 | 10.95 | HJ-8802 | 12.95 |
| 50-O-50 uA | HJ-8203 | 10.95 | HJ-8803 | 12.95 |
| O-100 uA | HJ-8204 | 10.95 | HJ-8804 | 12.95 |
| O-200 uA | HJ-8205 | 9.95 | HJ-8805 | 9.95 |
| O-300 uA | HJ-8207 | 9.95 | | |
| O-500 uA | | | HJ-8806 | 9.95 |
| **DC MILLIAMMETERS** | | | | |
| O-1 mA | HJ-8301 | 10.95 | HJ-8811 | 10.95 |
| O-5 mA | | | HJ-8812 | 10.95 |
| O-10 mA | | | HJ-8813 | 11.95 |
| O-100 mA | HJ-8303 | 10.95 | HJ-8814 | 11.95 |
| O-200 mA | HJ-8304 | 10.95 | HJ-8815 | 11.95 |
| O-300 mA | | | HJ-8816 | 12.95 |
| O-500 mA | HJ-8306 | 10.95 | HJ-8817 | 9.95 |
| **AC VOLT METERS** | | | | |
| O-15 V | HJ-8401 | 9.95 | HJ-8821 | 12.95 |
| O-150 V | HJ-8402 | 10.95 | HJ-8822 | 10.95 |
| O-250 V | | | HJ-8823 | 10.95 |
| **DC VOLT METERS** | | | | |
| O-10 V | | | HJ-8831 | 11.95 |
| O-15 V | HJ-8502 | 9.95 | HJ-8832 | 12.95 |
| O-50 V | HJ-8503 | 9.95 | | |
| O-100 V | HJ-8504 | 6.95 | HJ-8834 | 11.95 |
| O-300 V | HJ-8505 | 6.95 | HJ-8835 | 9.95 |
| O-500 V | HJ-8506 | 10.95 | HJ-8836 | 9.95 |
| **"S" METER** | | | | |
| | HJ-8701 | 9.95 | HJ-8841 | 11.95 |
| **ILLUMINATED "S" METER** | | | | |
| | HJ-8703 | 9.95 | | |
| **"VU" METER** | | | | |
| | HJ-8702 | 10.95 | | |
| **ILLUMINATED "VU" METER** | | | | |
| | HJ-8704 | 11.95 | HJ-8851 | 13.95 |
| **DC AMMETERS** | | | | |
| O-15 A | HJ-8601 | 10.95 | HJ-8861 | 13.95 |
| O-30 A | HJ-8602 | 10.95 | HJ-8862 | 10.95 |

## INDUSTRIAL MULTITESTER

* 10 AMP D.C. SCALE
* 20K OHM/VOLT D.C.
* 10K OHM/VOLT A.C.
* CARRYING CASE
* 40$\mu$A METER MOVEMENT
* STURDY BAKELITE CASE

$25.95

**20,000-ohm/V Multitester**

**Specification:**

| | |
|---|---|
| DC Volt: | -5-25-125-500-1000 (20K ohm/Volt) |
| AC Volt: | 10-50-250-1000 (10K ohm/Volt) |
| DC Current: | 50uA-2.5mA-250mA and 10A |
| Resistance: | Rx10, (30K) Rx100, (.3m) Rx1000 (3m) (Center Scale 30 ohms) |
| Decibels: | Decibels: -20dB to +22 dB |
| Dimensions: | Dimensions: 3¾" x 4⅝" x 1⁵⁄₁₆" |

HJ-8010

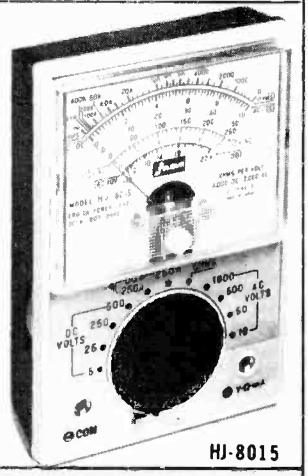
## POCKET MULTITESTER

* IDEAL FOR THE HOBBYIST
* 4K OHM/VOLT DC
* 2K OHM/VOLT AC
* 11 RANGES
* 2 JEWELS
* WHITE EASY TO READ FACE
* COMPLETE WITH TEST LEADS

$13.95

**SPECIFICATIONS:**

| | |
|---|---|
| DC Volt: | 0-5-25-250-500 |
| AC Volt: | 0-10-50-500-1000 |
| DC Current: | 0-250uA, 250mA |
| Resistance: | 0-600K (7000-ohm center) |
| Decibels: | —10 dB to + 22dB |
| Dimensions: | 2¼" x 3⁹⁄₁₆" x 1⅛" |



HJ-8015

# LEADER TEST INSTRUMENTS

## LBO-506
### 5" DUAL TRACE OSCILLOSCOPE

**$687^{50}**

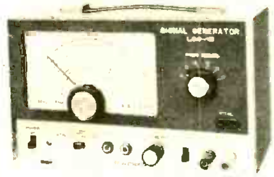
- Automatic Vertical input gain & Automatic trigger.
- Compact, lightweight with low power consumption.
- Direct input for RF signals up to 100MHz.
- X-Y display, less than 3° phase shift.

## LBO-310A
### 3" OSCILLOSCOPE

**$247^{50}**

- Bandwidth, DC to 4 MHz, usable to 6MHz.
- Waveform monitoring up to 450MHz with direct connections.

## LSG-16
### SIGNAL GENERATOR



**$121^{00}**

Here is a compact solid-state RF signal generator designed for the hobbyist, service bench and technical instruction. The generator is most suited for checking and aligning the IF circuits and tuners in AM, FM and TV sets.

## LAG-26
### AUDIO GENERATOR

**$141^{90}**

The stable generator for testing all types of audio circuits, from the simple to hi-fi amplifiers. Operating controls are functionally laid out for ease in handling.

## NEW, DELAYED SWEEP, DUAL TRACE 25MHz OSCILLOSCOPE

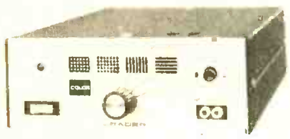
**$1826^{00}**

**LBO-515**

*including probes and accessories*

A significant advance in oscilloscope technology that provides close tolerance accuracy and control procedures at an outstanding cost/value payout ratio. This wideband, 25MHz, dual trace 5" scope features a built-in delay circuit continuously variable from 1$\mu$sec to 5sec coupled with a high sensitivity of 5mV/Div. Thus, the LBO-515 allows the user to view the leading edge of a pulse or pulse train and quickly helps determine functional characteristics. It has an easy to read, rectangular CRT in a space saving, horizontal package ideally suited for research & development, production, quality control, and service requirements. It

## LCG-391
### COLOR BAR PATTERN GENERATOR



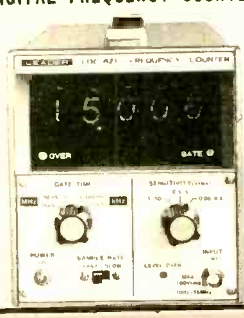
**$188^{10}**

- White raster pattern for purity and white balance tests.
- Square crosshatch for raster linearity tests.
- Four basic patterns dots, crosshatch, vertical lines, and horizontal lines for tests and adjustments of convergence and raster alignments.

NEW

# LEADER
**"Put us to the test"**

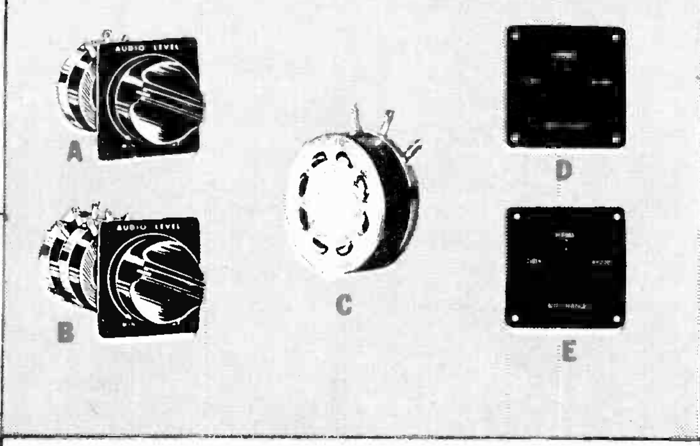
## LDC-821
### DIGITAL FREQUENCY COUNTER



FOR A COMPLETE CATALOGUE ON LEADER TEST EQUIPMENT AND ACCESSORIES, PLEASE CIRCLE #3 ON THE ORDER FORM PAGE.

**DOMINION RADIO & ELECTRONICS COMPANY**

# 8 OHM AUDIO PADS




**A**
**MONO 8 OHM L PAD**

**$2.95 ea.**

**10 WATTS**

**B**
**STEREO 8 OHM L PAD**

**$3.95 ea.**

**10 WATTS**

**C HEAVY DUTY MONO 8 OHM L PAD** **$7.95 ea.**
**100 WATTS**

**D**
**TWEETER CONTROL**

**$4.95 ea.**

**20 WATTS**

**E**
**MID RANGE CONTROL**

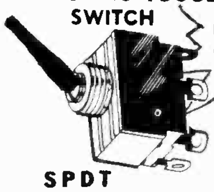
**$4.95 ea.**

**20 WATTS**

## SWITCHES
**Miniature**

| Cat. No. | Type | PRICE |
|---|---|---|
| DJ-4030 | SPST | $1.29 |
| DJ-4031 | SPDT | $1.49 |
| DJ-4034 | DPDT | $1.69 |
| DJ-4032 | SPDT Center Off | $1.89 |
| DJ-4033 | DPDT Center Off | $2.09 |

**LUCAS TOGGLE SWITCH** **99c ea**



**SPDT** **amp 20a**

**TOGGLE SWITCH** **59c S.P.S.T.**


**99c D.P.D.T.**
**$1.59 D.P.D.T. CENTER OFF**

**PUSH SWITCH**

**S.P.S.T. $1.29**
**S.P.D.T. $1.49**
**D.P.D.T. $1.69**

## PIHER SLIDER CONTROLS

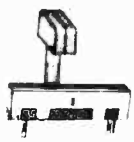
**60mm Travel**

**$2.95 ea.**

**Available in**
**10 K ohms**
**50 K ohms**
**100 K ohms**
**log or linear taper**

**Matching Knob** **59c ea**

## jana CONTROLS



| MODEL | | TRAVEL | |
|---|---|---|---|
| JJ-10006 | 10K | 30mm | $1.49 EA |
| JJ-10006B | 100K | 30mm | |
| JJ-10006C | 500K | 30mm | |
| JJ-10006D | 1 MEG | 30mm | |
| JJ-10007 | 10K | 45mm | $1.89 EA |
| JJ-10007A | 50K | 45mm | |
| JJ-10007B | 100K | 45mm | |
| JJ-10007C | 500K | 45mm | |
| JJ-10007D | 1 MEG | 45mm | |

**Available in log taper only**

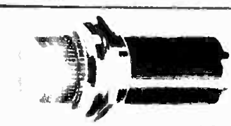
**Knob included**

## PANEL LIGHTS

**120V PANEL LAMP**
**JJ-10027R — Red**
**JJ-10027A — Amber**
Built in resistor for 120VAC

Head diameter ½"

**$1.19**



**$1.29**

**PANEL LAMP FOR BAYONET BASE LAMPS**
**JJ-10018 — Red Dome**
**JJ-10019 — Green Dome**
**JJ-10020 — Amber Dome**

## NEON PILOT LIGHT

**99¢**

Resistors not supplied

## ATTENTION

FOR COMPLETE LISTING ON PANEL LAMPS & SWITCHES, CIRCLE # 9 ON THE ORDER FORM

# DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

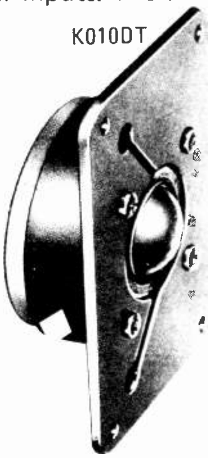
# Peerless Audio Manufacturing

## NEW DOME TWEETER

The KO10DT is Peerless' newly developed dome tweeter, designed specifically for use in loudspeaker systems where the highest accuracy of reproduction is essential:

**Features:** Very wide frequency range. Smooth sound pressure response and excellent dispersion, resulting in near-level power response curve. High efficiency. High power handling capacity. Very low distortion. Excellent durability and reliability. Simple mounting. The design and placement of the dome provides outstanding sound dispersion. The dome is made from a specifically developed fabric that protects against degradation of performance even after prolonged heavy loading. The voice coil is wound on an aluminum former to withstand high power inputs. The whole assembly is mounted on a precision, rigid die-cast plate for permanent alignment.

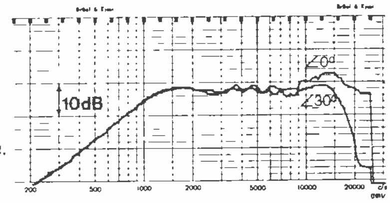
K010DT



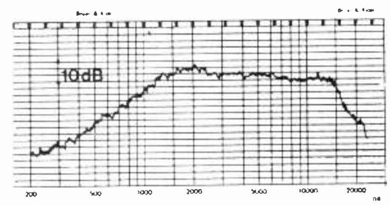
| | |
|---|---|
| Dimensions: | 4 5/32" x 4 5/32" |
| Depth: | 1 1/16" |
| Diameter of voice coil and dome: 1" | |
| Max.-Input: | 10 watts sine wave above 1500hz. |
| Resonance Frequency: | |
| Frequency: | 1000 Hz. |
| Frequency Range: | 1500-20000 hz. |
| Air Gap Induction: | 15000 Gauss (1.5 $Wb/m^2$) |
| Impedance: | 8 Ohms |

**$17.95**

Sound pressure response curve for dome twetter K010DT measured in anechoic room on axis and 30° off axis. Input: Constant sine wave voltage. Mounting: Wall.

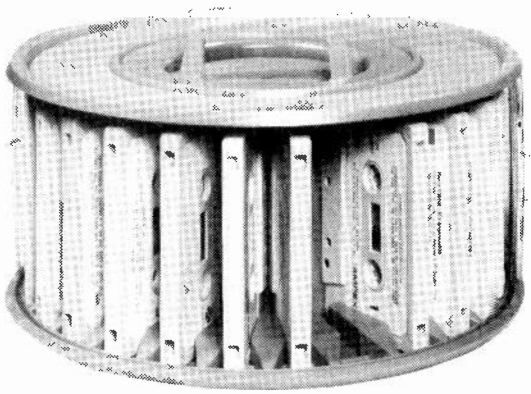



Power response curve for dome tweeter K010DT, i.e. total radiated sound power versus frequency in a 90 $m^3$ measuring room with reverberation time approximately 1 second. Input: Gliding 30hz band-noise constant voltage r.m.s. Recorded with rotating measuring microphone. Unit placed unbaffled, 40 cm above the floor.




# TAPE STORAGE UNITS

## CASSETTE CAROUSEL



| | |
|---|---|
| CAROUSEL | $ 9.95 |
| WITH 6 X C-60 Tapes | 13.95 |
| WITH 25 X C-60 Tapes | 29.95 |

## CARRYING CASE

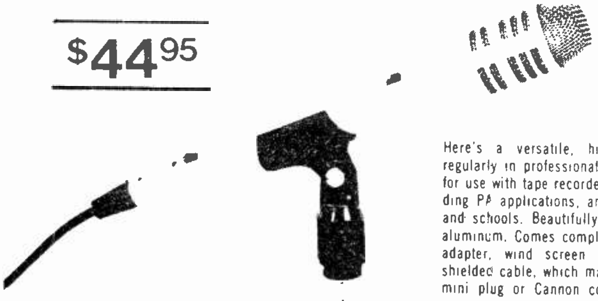
| | |
|---|---|
| CASSETTE | $5.95 |
| WITH 4 X C-60 TAPES | 7.95 |
| 8-TRACK | 5.50 |
| ..ITH 2 X 90 MIN TAPES | 7.50 |

DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# ELECTRET CONDENSER MICROPHONE

**$44.95**



*jana* ELECTRET CONDENSER MICROPHONES

**AJ-1015**

Here's a versatile, high-quality microphone. Used regularly in professional recording studios and perfect for use with tape recorders, for rock groups, for demanding PA applications, and for lectern use in churches and schools. Beautifully finished in textured, brushed aluminum. Comes complete with a swivel mount stand adapter, wind screen and a 20-foot two-conductor shielded cable, which may be fitted with a phone plug, mini plug or Cannon connector

**SPECIFICATIONS:**

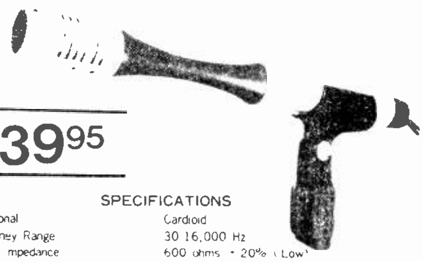
Directional: Cardioid or Uni-directional
Frequency Range: 30-16,000 Hz.
Output Impedance 600 ohms ±20%
Output Level —68 dB ±2.5 dB at 1K Hz
Max. Sound Pressure Level. 125 dB
Equivalent Noise Level. Less than 30 dB SPL
Signal to Noise Ratio: More than 44 dB at 1K Hz
Dynamic Range: Up to 98 dB
Power Supply. AA type, UM-3 (1.5V)
Current Consumption: 200uA ∓ 50 uA
Battery Life 8,000 hours continuous
Cable: 20-ft., 2-conductor shielded
Accessories. Stand holder
Optional Crade suspension

BATTERY LIFE One new UM-3 (1.5V) battery powers this microphone for 8,000 to 10,000 hours (almost for a year)

# ELECTRET CONDENSER MICROPHONE

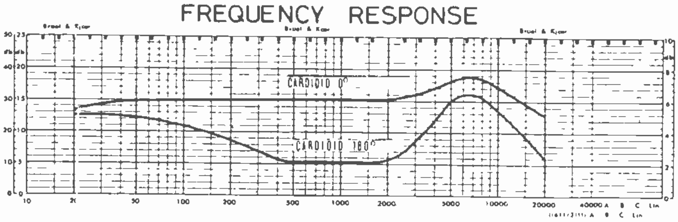
Here's a versatile, high-quality microphone. Used regularly in professional recording studios and perfect for use with tape recorders, for rock groups, for demanding PA applications, and for lectern use in churches and schools. Beautifully finished in textured, brushed aluminum. Comes complete with a swivel mount stand adapter, wind screen and a 20-foot one conductor shielded cable, which may be fitted with a phone plug, mini-plug, or Cannon connector.

**BATTERY LIFE** One new UM-3 (1.5V) battery powers this microphone for 8,000 to 10,000 hours, (almost for a year.)



**$39.95**

FREQUENCY RESPONSE




SPECIFICATIONS

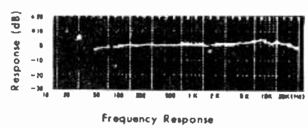
| | |
|---|---|
| Directional | Cardioid |
| Frequeney Range | 30 16,000 Hz |
| Output Impedance | 600 ohms ± 20% (Low) |
| Output Level | 70 dB ± 2.5 dB at 1K Hz (Low) |
| Max Sound Pressure Level | 125 dB |
| Equivalent Noise Level | Less than 30 dB SPL |
| Signal to Noise Ratio | More than 44 dB at 1K Hz |
| Dynamic Range | Up to 98 dB |
| Power Supply | AA type UM 3 (1.5V) |
| Current Consumption | 200 uA ∓ 50 uA |
| Battery Life | 8 000 hours continuous |
| Cable | 20 foot, 1 conductor shielded with plug |
| Accessories | Stand holder and wind screen |

# OMNI-DIRECTIONAL ELECTRET CONDENSER MICROPHONE

**$19.95**

NO.6486

Response Curve




Specifications

| | |
|---|---|
| Frequency Response | 40 18,000Hz |
| Impedance | 600 ohms |
| Sensitivity | −65dB ± 3dB |
| Operating Voltage | 1.1 to 1.5 Volts |
| Consumption Current | 160 μA |
| Continuous hours | 10,000 hours |
| Cable | 16.5Ft with phone plug |
| Dimentions | 0.87 × 6.38 in |
| Weight | 6.7 ounces |
| Accessories | Built in talk switch<br>Mike holder Lavalier,<br>Wind screen and<br>Battery (UM-3) |

## DESK STAND MICROPHONE
Model SOM 260

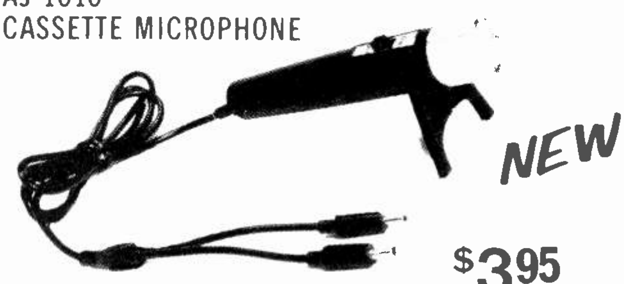
**$44.95**

Omnidirectional electret condenser mike for desk top use. FET preamp and battery are in base. On-off switch. Response 60-13,000 Hz, -66 db output. Battery life over 600 hours continuous use.

SPECIFICATIONS

| | |
|---|---|
| Polar Pattern: | Omni-directional |
| Frequency Response: | 50–13,000 Hz |
| Power Supply: | Internal 1.3 mercury battery (Toshiba HS-D) |
| Amplifier: | FET Impedance convertor |
| Output level: (1,000 Hz) | −66 dB ± 3 dB |
| Generating Element: | Electret Condenser |
| Output Impedance: | Low Z (600 ohms) |
| S/N Ratio: | Greater than 44 dB |
| Equivalent Noise Level: | Less than dB SPL |
| Current Consumption: | 200 uA ± 50 uA |
| Battery Life: | 600 hours |
| Cable: | 20-ft., shielded |

## AJ 1010
## CASSETTE MICROPHONE



NEW

**$3.95**

SPECIFICATIONS

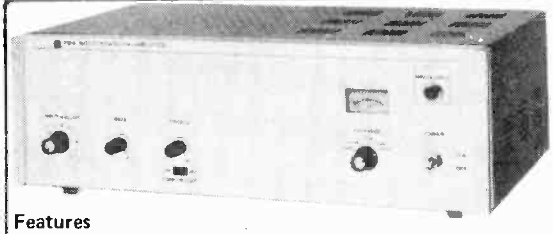
| | |
|---|---|
| Impedance | — 200 ohms |
| Sensitivity | — 74 dB 1 KHz |
| Frequency Response | — 200Hz — 10 KHz |

# DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# TOA 900 SERIES SOLID-STATE PA AMPLIFIERS

PA systems



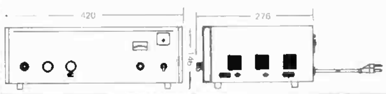
APPROVED:

UL America · CSA Canada

### Features

- All-solid-state, all silicon circuitry design.
- Full frequency range response, 20 ~ 20,000 Hz.
- High-pass filter switch.
- Bass tone control, Treble tone control.
- Tone defeat switch.
- AC circuit breaker/speaker fuse.
- Peak clipping light.
- Balanced outputs complete with 4, 8 and 16 ohms, and 70 and 25 volts.
- Built-in VU meter.
- VU meter range switch.
- Portable or rack-mounting type.

**Dimensional diagram**

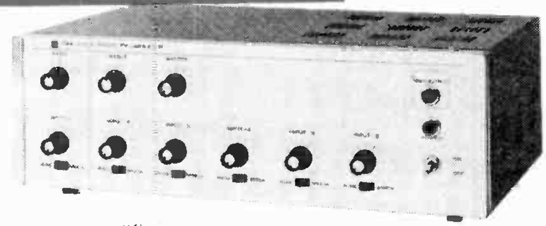


## TA-907
60-watt Solid State Amplifier

**$325^05**

## TA-908
100-watt Solid State Amplifier

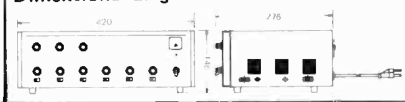
**$413^40**



### Features

- 6-channel mixer power amplifier.
- All-solid-state, all-silicon circuitry design.
- Full frequency range response, 20 ~ 20,000 Hz.
- Speech-music selector switch for each input.
- Bass tone control, Treble tone control.
- Bridging output-input.
- Signal processing output-input.
- Mute circuit on Input #6.
- AC circuit breaker/speaker fuse.
- Peak clipping light.
- Balanced outputs complete with 4, 8 and 16 ohms, and 70 and 25 volts.
- Receptacled plug-in input units.
- Portable or rack-mounting type

**Dimensional diagram**



## TA-956
30-watt Solid State Amplifier

**$277^45**

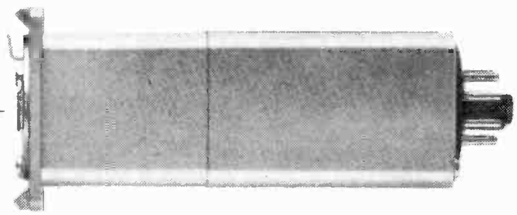
## TA-957
60-watt Solid State Amplifier

**$361^15**

## TA-958
100-watt Solid State Amplifier

**$446^00**

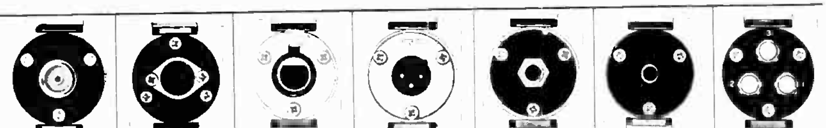
## Receptacled Plug-in Input Units



### Features

- All-solid-state, all silicon.
- No interconnecting wiring required.
- Rapid installation.
- High reliability.
- Variety of receptacles.

Front view

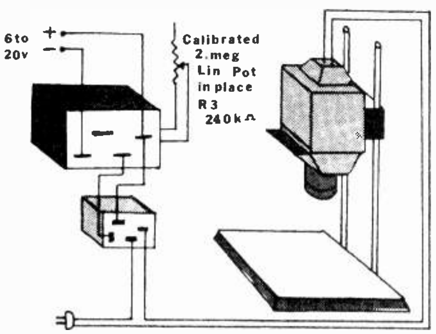


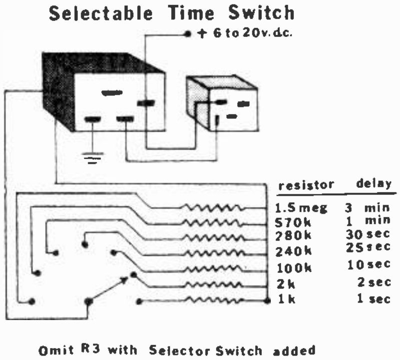
| | Receptacle | Amphenol (A) | DIN 5P/3P (D) | Cannon XLR-3-13 (F) | Cannon XLR-3-14 (M) | Phone Jack (P) | RCA Phono Jack (R) | 3P Screw terminal (S) |
|---|---|---|---|---|---|---|---|---|
| High Z microphone unbalanced 50,000Ω | HAU-10 series | HAU-10A | HAU-10D | HAU-10F | HAU-10M | HAU-10P | HAU-10R | – |
| Equalized Mag. phono unbalanced 50,000Ω | HAU-20 series | HAU-20A | HAU-20D | HAU-20F | HAU-20M | HAU-20P | HAU-20R | – |
| High Z Auxiliary unbalanced 0.5MΩ | HAU-30 series | HAU-30A | HAU-30D | HAU-30F | HAU-30M | HAU-30P | HAU-30R | HAU-30S |
| Low Z microphone with transformer balanced 200Ω | HAU-60 series | – | HAU-60D | HAU-60F | HAU-60M | HAU-60P | – | HAU-60S |
| Low Z microphone with differential amp. balanced 200Ω | HAU-70 series | – | HAU-70D | HAU-70F | HAU-70M | HAU-70P | – | HAU-70S |
| Line matching Transformer balanced 600Ω | LTU-01 series | – | LTU-01D | LTU-01F | LTU-01M | LTU-01P | – | LTU-01S |
| Bridging transformer balanced 10,000Ω | BTU-01 series | – | BTU-01D | BTU-01F | BTU-01M | BTU-01P | – | BTU-01S |
| Lo Z microphone with transformer balanced 200Ω | HAU-80 series | – | HAU-80D | HAU-80F | HAU-80M | HAU-80P | – | HAU-80S |

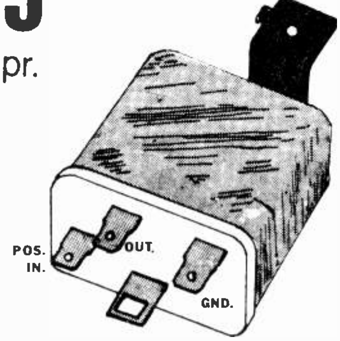
# FOR THE HOBBYIST SOLID STATE TIMERS

## APPLICATIONS

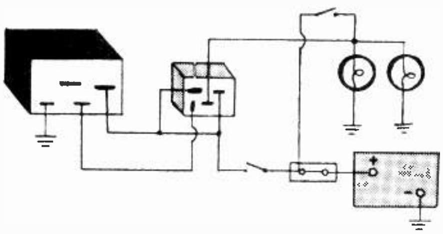
$ 3.95 pr.

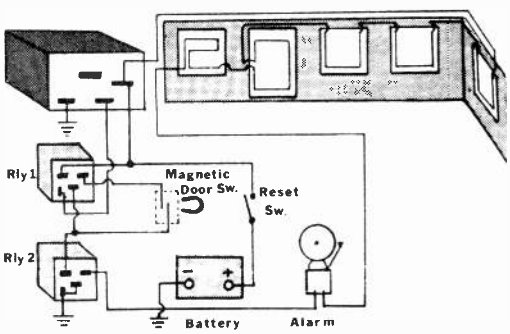


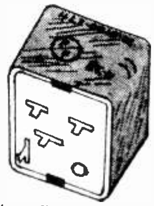




25 Second Turn On SOLID STATE AUTO TIMER



Normally Closed SPST Relay

## jana EDUCATIONAL KITS

| GROCK NO. | NAME KIT | NET |
|---|---|---|
| 3449-0075-2 | 12V Hi Power Flasher | 8.00 |
| 3449-0120-1 | 6V Power Supply | 10.95 |
| 3449-0125-2 | 9V Power Supply | 10.95 |
| 3449-0130-9 | 0 - 24V 1A Power Supply | 17.95 |
| 3449-0175-9 | Tone Generator | 6.95 |
| 3449-0230-5 | Crystal Radio | 5.50 |
| 3449-0240-2 | "Bug Shoo" | 4.95 |
| 3449-0251-8 | Auto Headlight Reminder | 4.95 |
| 3449-0280-1 | Code Oscillator | 6.95 |
| 3449-0301-8 | Single Channel Color Organ 300 Watts | 6.25 |
| 3449-0310-7 | Battery Operated Flourescent Light Kit | 13.95 |
| 3450-3759-4 | 3 Channel Color Organ | [illegible].95 |
| 3449-0025-6 | Loud Mouth Siren | 9.95 |
| 3449-0041-8 | Xenon Strobe | 11.50 |
| 3449-0030-2 | Roulette Wheel | 11.95 |

FOR COMPLETE CATALOGUE OF JANA KITS, PLEASE CIRCLE #6 ON THE ORDER FORM PAGE.

## DOMINION RADIO & ELECTRONICS COMPANY

*THE HOME OF RADIO & ELECTRONIC SUPPLIES*

# RECEIVING TUBES

***ONE YEAR UNCONDITIONAL GUARANTEE***

| TUBE NUMBER | PRICE |
|---|---|
| 1AY2A | 5.45 |
| 1B3GT/1G3GT | 2.50 |
| 1BC2 | 2.65 |
| 1G3GT/1B3GT | 2.50 |
| 1K3A/1J3 | 3.55 |
| 1R5(DK91) | 4.55 |
| 1S2A(D487) | 2.25 |
| 1V2 | 1.85 |
| 1X2B/C | 2.25 |
| 2AV2 | 2.20 |
| 2DS4 | 6.30 |
| 2GKS/2FQ5A | 2.50 |
| 2HA5/2HM5 | 2.80 |
| 3A3C | 4.00 |
| 3AT2B | 3.00 |
| 3AW2A | 3.45 |
| 3BH2(GY501) | 6.05 |
| 3BW2/3BS2/3BT2 | 4.90 |
| 3BZ6 | 1.90 |
| 3CB6/3CS6 | 1.50 |
| 3CU3/3DC3 | 4.85 |
| 3CX3/3DH3/3DA3 | 5.10 |
| 3DB3/3CY3 | 4.15 |
| 3DC3/3CU3A | 4.85 |
| 3DF3 | 4.15 |
| 3DH3/3CX3/3DA3 | 5.10 |
| 3DJ3 | 4.55 |
| 3EJ7(XF184) | 2.50 |
| 3GK5/3FQ5 | 2.50 |
| 3HA5/3HM5 | 2.45 |
| 3HQ5 | 3.25 |
| 3JC6A | 2.80 |
| 3KT6 | 3.25 |
| 3V4(DL94) | 3.80 |
| 4AU6 | 2.45 |
| 4BZ6 | 1.95 |
| 4CB6 | 1.85 |
| 4DT6A | 2.60 |
| 4EH7(LF183) | 2.85 |
| 4EJ7(LF184) | 2.85 |
| 4HA5/4HM5 | 2.40 |
| 4JC6A | 5.80 |
| 4JD6 | 2.80 |
| 4KE8 | 4.55 |
| 4LJ8 | 3.15 |
| 5AQ5A | 1.95 |
| 5AR4(GZ34) | 4.00 |
| 5AS4/5U4GB | 3.40 |
| 5CG8 | 2.25 |
| 5GH8A | 2.40 |
| 5GJ7(LCF801) | 2.90 |
| 5GS7 | 2.90 |
| 5GX7 | 3.05 |
| 5HZ6 | 2.30 |
| 5KE8 | 3.35 |
| 5LJ8 | 3.45 |
| 5U4GB/5AS4A | 3.40 |
| 5Y3GT | 3.15 |
| 6AC10 | 4.50 |
| 6AD10 | 6.75 |
| 6AF9 | 5.05 |
| 6AG9 | 6.10 |
| 6AJ8(ECH81) | 5.05 |
| 6AK5(EF95) | 3.00 |
| 6AK6 | 4.15 |
| 6AL3(EY88) | 2.40 |
| 6AL5(EAA91) | 1.65 |
| 6AM8A | 3.15 |
| 6AN8A | 2.80 |
| 6AQ5(EL90) | 1.65 |
| 6AQ8(ECC85) | 2.40 |
| 6AU6A | 1.50 |
| 6AU8A | 3.80 |
| 6AV6 | 1.65 |
| 6AW8A | 2.50 |
| 6AX3 | 4.10 |
| 6AX4GTB | 2.70 |
| 6AX5GT | 3.65 |
| 6AY3B/6BS3Z | 2.40 |
| 6BA6(EF93) | 2.05 |

| TUBE NUMBER | PRICE |
|---|---|
| 6BA11 | 4.75 |
| 6BC4 | 6.95 |
| 6BC5/6CE5 | 2.20 |
| 6BE6(EK90) | 2.20 |
| 6BF11 | 4.70 |
| 6BH6 | 2.50 |
| 6BJ6 | 3.35 |
| 6BK4C/6EL4A | 5.80 |
| 6BL8(ECF80) | 2.05 |
| 6BM8(ECL82) | 2.70 |
| 6BN6/6KS6 | 3.45 |
| 6BN8 | 4.10 |
| 6BN11 | 5.85 |
| 6BQ5(EL84) | 2.25 |
| 6BQ6GTB/6CU6 | 4.40 |
| 6BQ7A/6BS8/6BZ7 | 2.70 |
| 6BS3A/6AY3B | 2.40 |
| 6BS8/6BZ7/6BQ7A | 2.70 |
| 6BU8A | 3.00 |
| 6BW3/CD3/CE3/CG3/DQ3 | 3.05 |
| 6BW4 | 4.50 |
| 6BX6(EF80) | 2.45 |
| 6BX7GT | 4.70 |
| 6BZ6 | 1.45 |
| 68Z7/6BQ7/6BS8 | 2.70 |
| 6C4(EC90) | 2.25 |
| 6C9 | 5.30 |
| 6C4A(EZ81) | 2.70 |
| 6CA7(EL34) | 5.35 |
| 6CB6A/6CF6 | 1.65 |
| 6CD3/CE3/CG3/DT3/DQ3 | 3.05 |
| 6CE5/6BC5 | 2.20 |
| 6CF6/6CB6A | 1.65 |
| 6CG3/CE3/CD3/DT3/DQ3 | 3.05 |
| 6CG7/6FQ7 | 1.65 |
| 6CG8A | 2.30 |
| 6CL3/CH3/CJ3/CK3/DW4B | 2.60 |
| 6CL6 | 3.95 |
| 6CL8A | 2.40 |
| 6CM3 | 4.90 |
| 6CM7 | 2.50 |
| 6CQ6(EF92) | 5.70 |
| 6CS6(EH90) | 2.40 |
| 6CU5 | 2.45 |
| 6CU6/6BQ6GTB | 4.40 |
| 6CW4 | 8.85 |
| 6CW5(EL86) | 2.50 |
| 6CY5/6EA5 | 2.40 |
| 6DJ8(ECC88) | 3.25 |
| 6DK6 | 2.05 |
| 6DK5(EL95) | 4.10 |
| 6DN3 | 3.90 |
| 6DQ3/TD3CD3/CE3/CG3 | 3.05 |
| 6DQ6B/6GW6 | 6.00 |
| 6DS4 | 10.90 |
| 6DT3/DQ3/CD3/CE3/CG3 | 3.05 |
| 6DT5 | 2.70 |
| 6DT6A | 1.95 |
| 6DW4/CL3/CK3/CJ3/CH3 | 2.60 |
| 6DX8(ECL84) | 2.90 |
| 6AE5/6CY5 | 2.40 |
| 6EA7/6EM7 | 4.60 |
| 6EA8 | 2.30 |
| 6EX4A(EY500) | 5.50 |
| 6EH7(EF183) | 2.50 |
| 6EJ7(EF184) | 2.45 |
| 6EL4A/6BK4A | 5.80 |
| 6EM7/6EA7 | 4.60 |
| 6ES8(EXX189) | 4.10 |
| 6EU7 | 3.40 |
| 6EW6 | 2.10 |
| 6FM7 | 4.00 |
| 6FQ5/6GK5 | 2.70 |
| 6FQ7/6CG7 | 1.65 |
| 6GB5(EL500) | 5.65 |
| 6GE5 | 4.50 |
| 6GF7A | 3.65 |
| 6GH8A | 1.90 |
| 6GH8A/PA3601 | 2.80 |
| 6GJ7(ECF801) | 3.00 |

| TUBE NUMBER | PRICE |
|---|---|
| 6GK5/6FQ5A | 2.70 |
| 6GK6 | 2.70 |
| 6GM6 | 2.65 |
| 6GS7 | 3.55 |
| 6GU7 | 2.30 |
| 6GV8(ECL85) | 3.65 |
| 6GW6/6DQ6B | 6.00 |
| 6GW8(ECL86) | 3.25 |
| 6GX6/6GY6 | 1.85 |
| 6GX7 | 4.10 |
| 6GY6/6GX6 | 1.85 |
| 6H6(EB34) | 4.70 |
| 6HA5/6HM5 | 2.25 |
| 6H87 | 3.45 |
| 6HE5/6JB5 | 5.85 |
| 6HM5/6HA5 | 2.25 |
| 6HQ5 | 2.50 |
| 6HS8 | 3.25 |
| 6HV5A | 8.15 |
| 6HZ6 | 1.85 |
| 6J6A | 2.65 |
| 6J10/6Z10 | 5.30 |
| 6JA5 | 5.15 |
| 6JB5/6HE5 | 5.85 |
| 6JB6A | 4.35 |
| 6JB6A | 3.00 |
| 6JD6 | 2.45 |
| 6JE6C/6LQ6 | 6.60 |
| 6JF6 | 6.55 |
| 6JH6 | 2.30 |

## ANTIQUE COLLECTORS

**We have a large stock of '<u>OLD TUBES & PARTS</u>' in our warehouse. For complete details, please circle number 8 on the order form page.**

| TUBE NUMBER | PRICE |
|---|---|
| 6GH8 | 4.55 |
| 6JS6C | 6.45 |
| 6JT8 | 5.05 |
| 6JU6 | 6.55 |
| 6JU8A | 3.15 |
| 6JW8(ECF802) | 2.60 |
| 6JZ6 | 5.05 |
| 6JZ8 | 3.20 |
| 6KA8 | 3.60 |
| 6KD6 | 7.70 |
| 6DK8/6U8A | 2.05 |
| 6KE8 | 3.60 |
| 6KG6A(EL505) | 8.15 |
| 6KM6 | 8.00 |
| 6KN6 | 8.10 |
| 6KS6/6BN6 | 3.45 |
| 6KT8 | 4.60 |
| 6KZ8 | 2.60 |
| 6L6 | 15.30 |
| 6LGC(EL37)(DL37) | 4.70 |
| 6L36 | 7.60 |
| 6LE8 | 5.70 |
| 6LF6/6LX6 | 7.30 |
| 6LF8 | 3.75 |
| 6LJ8 | 3.80 |
| 6LN8(LCF80) | 2.20 |
| 6LQ6/6JE6C | 6.60 |
| 6LT8 | 3.75 |
| 6LU8 | 7.75 |
| 6LX6/6LF6 | 7.30 |

| TUBE NUMBER | PRICE |
|---|---|
| 6LX8(LCF802) | 2.70 |
| 6MG8 | 3.00 |
| 6ML8 | 4.30 |
| 6SJ7 | 4.50 |
| 6SL7GT | 3.75 |
| 6SN7GTB | 3.90 |
| 6U8A/6KD8 | 2.05 |
| 6U9(ECF201) | 5.50 |
| 6U10 | 3.65 |
| 6V6 | 8.65 |
| 6V6GTA | 3.80 |
| 6W6GT | 4.75 |
| 6X4(EZ90) | 2.05 |
| 6X5GT(EZ35) | 3.05 |
| 6X8A | 2.45 |
| 6X9(ECF200) | 5.25 |
| 6Y9(EFL200) | 4.30 |
| 6Z10/6J10 | 5.30 |
| 7KY6 | 4.30 |
| 8AW8A | 2.90 |
| 8B10 | 3.95 |
| 8BM11 | 5.80 |
| 8FQ7/8CG7 | 1.75 |
| 8GJ7 | 3.45 |
| 8JU8A | 3.15 |
| 8JV8 | 3.05 |
| 8LT8 | 3.40 |
| 8U9(PCF201) | 5.15 |
| 8X9(PCT200) | 5.85 |
| 9AQ8(PCC85) | 4.00 |
| 9ED4 | 10.25 |
| 9GH8A | 2.65 |
| 9JW8(PCF802) | 2.60 |
| 10CW5(LL86) | 2.60 |
| 10DE7 | 3.25 |
| 10EB8/10GN8 | 3.60 |
| 10GF7A | 4.50 |
| 10GK6 | 2.70 |
| 10GN8/10EB8 | 3.60 |
| 10GV8(LCL85) | 4.40 |
| 10JV8 | 2.85 |
| 10KR8 | 3.40 |
| 10LW8 | 5.50 |
| 11AF9 | 5.35 |
| 11BM8 | 5.35 |
| 11HM7 | 4.55 |
| 11LQ8 | 4.75 |
| 11MS8 | 3.95 |
| 12AT7(ECC81) | 2.25 |
| 12AU6(HF94) | 1.90 |
| 12AU7A(ECC82) | 1.75 |
| 12AV6(HBC91) | 1.50 |
| 12AV7 | 3.95 |
| 12AX4GTB | 2.25 |
| 12AX7A/7025A(ECC83) | 1.70 |
| 12AY3A/12BS3A/12DW4A | 5.30 |
| 12AX7A | 2.90 |
| 12B4A | 3.00 |
| 12BA6 | 1.65 |
| 12BE6 | 1.75 |
| 12BH7A | 1.75 |
| 12BS3A/12DW4A/12AY3A | 5.30 |
| 12BY7A/12BV7/12DQ7 | 2.05 |
| 12C512CU5 | 2.65 |
| 12CL3 | 4.15 |
| 12CU5/12C5 | 2.65 |
| 12DQ6/12GW6 | 3.80 |
| 12DQ7/12BV7/12BY7A | 2.05 |
| 12DW4/12BS3A/12AY3A | 5.30 |
| 12FQ7 | 2.45 |
| 12FX5 | 2.40 |
| 12GN7/12HG7 | 3.75 |
| 12GW6/12DQ6B | 3.80 |
| 12HG7/12GN7 | 3.75 |
| 12HL7 | 4.20 |
| 12SK7 | 5.35 |
| 12SN7GTA(B31) | 3.15 |
| 13CM5(XL36) | 6.10 |
| 13EM7/15EA7 | 4.20 |
| 13GF7A | 3.80 |

| TUBE NUMBER | PRICE |
|---|---|
| 14BL11 | 8.85 |
| 14BR11 | 6.80 |
| 14GW8 | 2.85 |
| 15BD11A | 7.15 |
| 15CW5(PL84) | 2.20 |
| 15DQ8(PCL84) | 2.70 |
| 15EA7/13EM7 | 4.20 |
| 16A8(PCL82) | 2.80 |
| 16LD6 | 12.85 |
| 17AX4GTA | 2.40 |
| 17AY3A/17BS3A/17DW4A | 2.90 |
| 17BE3/17B23 | 3.55 |
| 17BF11 | 4.60 |
| 17BR3/17RK19 | 2.90 |
| 17BS3A/17AY3A/17DW4A | 2.90 |
| 17BZ3/17BE3 | 3.55 |
| 17CT3 | 2.60 |
| 17DQ6B/17GW6 | 5.90 |
| 17DW4A/17AY3A/17BS3A | 2.90 |
| 17GE5 | 4.60 |
| 17GW6/17DQ6B | 5.90 |
| 17JN6 | 3.80 |
| 17JZ8/A | 3.55 |
| 17KV6A | 7.20 |
| 17KW6 | 6.10 |
| 17RK19/17BR3 | 2.90 |
| 17Z3A(PY83) | 2.85 |
| 18GV8 | 3.80 |
| 19CG3/19DQ3 | 3.05 |
| 20AQ3(LY88) | 3.15 |
| 21GY5 | 5.10 |
| 21HB5A | 4.75 |
| 21JS6/23JS6A | 6.75 |
| 21JZ6 | 5.45 |
| 21KA6 | 5.30 |
| 21LR8 | 5.45 |
| 21LU8 | 7.75 |
| 22JF6 | 5.60 |
| 22JR6 | 4.95 |
| 22JU6 | 6.20 |
| 23JS6A/21JS6 | 6.75 |
| 23Z9 | 4.70 |
| 24LQ6/24JE6C | 7.00 |
| 25CG3 | 3.65 |
| 27GB5 | 5.85 |
| 29KQ6(PL521) | 6.75 |
| 30AE3(PY88) | 2.85 |
| 30KD6 | 8.50 |
| 31JS6C | 7.05 |
| 31LQ6 | 7.15 |
| 33GY7A | 5.70 |
| 34CE3/34DE3 | 3.65 |
| 35C5A | 1.90 |
| 35LR6 | 9.30 |
| 35W4 | 1.45 |
| 35Z5GT | 2.50 |
| 36KD6/40KD6 | 7.80 |
| 36MC6 | 11.20 |
| 38HE7 | 6.20 |
| 38HK7 | 6.55 |
| 40DK6/36DK6 | 7.80 |
| 40KG6(PL505) | 8.75 |
| 42EC4(PY500) | 4.85 |
| 50C5A(HL92) | 1.95 |
| 50EH5 | 2.40 |
| 50L6GH(KT71) | 3.20 |
| 5879 | 6.25 |
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| 7025A/12AX7A | 1.70 |
| 7027A | 7.30 |
| 7199 | 4.70 |
| 7591/A | 3.95 |
| 7868 | 5.45 |
| 8417 | 9.50 |
| PQ3601/6GH8A | 2.80 |

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## 5055

The NIKKO model 5055 is an all new stereo multiplex receiver featuring direct-coupled OCL pure complementary power amplifier, phase lock loop multiplex circuit, a quadrature detector, and phase linear ceramic filters.

**The amplifier section carries a minimum RMS power rating per channel of 18 watts, both channels driven, 20-20kHz into 8 ohms at no more than 0.8% total harmonic distortion.** The FM tuner section features a sensitivity of 2.0uV, a selectivity of 55dB and a capture ratio of 1.5dB.

## 6065 NIKKO

The NIKKO 6065 all new stereo multiplex receiver, features a direct-coupled OCL all pure complementary power amplifier, phase lock loop multiplex circuit, a quadrature detector and phase linear ceramic filters.

**The amplifier section carries a minimum RMS power rating per channel of 30 watts, both channels driven, 20-20kHz into 8 ohms at no more than 0.5% total harmonic distortion.** The FM tuner section has a sensitivity of 2.0uV, a selectivity of 55dB and a capture ratio of 1.5dB.

## 9095

The NIKKO 9095 stereo multiplex receiver features a direct-coupled OCL pure complementary power amplifier, a phase lock loop multiplex circuit and a phase linear ceramic filter.

**The amplifier section contains a minimum RMS power rating per channel of 68 watts, both channels driven, 20-20kHz into 8 ohms at no more than 0.3% total harmonic distortion.** The FM tuner section has a sensitivity of 1.8uV, a selectivity of 70dB and a capture ratio of 1.6dB.

## *THE AUDIO REFLEX MR-110*

### SPECIFICATIONS:

| | |
|---|---|
| TYPE | Belt-drive automatic record player |
| POWER SOURCE | AC 120 V, 60Hz |
| POWER CONSUMPTION | 12 watts |
| DIMENSIONS | 457(W) x 355(D) x 179 *mm* (Approx.) 17¾" x 13¾" x 7" (Approx.) |
| WEIGHT | 6.8kg (15 lbs.) (Approx.) |
| DRIVE SYSTEM | Belt-drive system |
| MOTOR | 4-pole synchronous motor |
| TURNTABLE SPEED | 33⅓ & 45 r.p.m. |
| SIZE | 30*cm*. dia. aluminum alloy diecast |
| S/N RATIO | Better than 48 dB |
| WOW & FLUTTER | Less than 0.1% (WRMS) |
| (CARTRIDGE) | |
| TYPE | Moving magnet (MM) type |
| OUTPUT VOLTAGE | Standard, 3 mV at 1 KHz |
| SEPARATION | 20 dB (at 33⅓ r.p.m., 1 KHz) |
| STYLUS | 0.7 *mm* diamond stylus |
| STYLUS PRESSURE | 2.0g ± 0.5g |
| FREQUENCY RESPONSE | 20 — 25,000Hz |
| COMPLICANCE | 6 x $10^{-6}$ *cm*/dyne |
| LOAD RESISTANCE | 47 — 100 Kohms |
| (TONE ARM) | |
| TYPE | Static balance type |
| OVERHAND | 15 *mm* |
| ADJUSTABLE RANGE OF STYLUS PRESSURE | 0 — 3g |

AUDIO REFLEX

ags

## *TRANSCRIPTION TURNTABLES*

*The MR-110 turntable is similar in quality excellence and design to the MR-116. This belt-drive system was designed with the music connoisseur in mind.*

## *THE AUDIO REFLEX MR-116*

### SPECIFICATIONS:

| | |
|---|---|
| TYPE | Belt-drive full automatic record player |
| POWER SOURCE | AC 120V /60Hz |
| POWER CONSUMPTION | 12 watts |
| DIMENSION | 500(W) x 360(D) x 190(H) *mm* (Approx.) 19½" x 14" x 7½" (Approx.) |
| WEIGHT | 8.5kg (18.5 lbs.) (Approx.) |
| DRIVE SYSTEM | Belt-drive system |
| MOTOR | 4-pole synchronous motor |
| TURNTABLE SPEED | 33⅓ & 45 r.p.m. |
| SIZE | 30cm dia. aluminum alloy diecast |
| S/N RATIO | Better than 48 dB |
| WOW & FLUTTER | Less than 0.1% (WRMS) |
| (CARTRIDGE) | |
| TYPE | Moving magnet type |
| OUTPUT VOLTAGE | 3 mV at 1 KHz |
| SEPARATION | 20 dB |
| STYLUS | 0.7 *mm* diamond stylus |
| STYLUS PRESSURE | 2.0 g ± 0.5 g |
| FREQUENCY RESPONSE | 20 — 25,000Hz |
| LOAD RESISTANCE | 47 — 100K Ohms |
| (TONE ARM) | |
| TYPE | Static balance type |
| OVERHAND | 11 *mm* |
| ADJUSTABLE RANGE OF STYLUS PRESSURE | 0 — 3 g |

## SPECIFICATIONS — MARSLAND SPEAKERS

| Speaker Complement | LTC 8 MK IV | LTC 10 MK IV | LTC 12 MK IV |
|---|---|---|---|
| | • One 8" Hi-Compliance Bass Driver • One 1¾" Phenolic Ring Flare Dome Hi-Driver | • One 10" Hi-Compliance Bass Driver • One 1¾" Phenolic Ring Flare Dome Hi-Driver | • One 12" Hi-Compliance Bass Driver • One 5" Hi-Compliance Closed back Mid-Driver • One 1¾" Phenolic Ring Flare Dome Hi-Driver |
| Cross-Over Type | LC 2-way 2500 Hz | LC 2-way 2500 Hz | LC 3-way 1000 and 5000 Hz |
| Frequency Response | 35 — 22,000 Hz | 30 — 22,000 Hz | 25 — 22,000 Hz |
| Resonance | 65 Hz | 50 Hz | 50 Hz |
| Power Handling | Watts Rms 35 Watts Music 50 | 50 70 | 75 100 |
| Efficiency — Power required to produce 90 DB SPL @ 6 feet | 2.5 Watts | 2.5 Watts | 2.5 Watts |
| Impedance | 8 Ohms | 8 Ohms | 8 Ohms |
| Dimensions and Weight | 21" · 11¼" · 9½" 21 lbs. | 24" · 13¾" · 11¼" 30 lbs | 26½" · 15½" · 12" 37 lbs |

LTC enclosures are warranteed for five years against manufacturing defects.

| | | | |
|---|---|---|---|
| RECEIVER | NIKKO 5055 - 36 WATTS RMS | NIKKO 6065 - 60 WATTS RMS | NIKKO 9095 - 136 WATTS RMS |
| TURNTABLE | AUDIO REFLEX MR - 110 | AUDIO REFLEX MR - 116 | AUDIO REFLEX MR - 116 |
| SPEAKERS | 2 X LTC-8 MK IV | 2 X LTC-10 MK IV | 2 X LTC-12 MK IV |
| | $ 499.00 | $ 699.00 | $ 899.00 |

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# 25 — 240 Watts!

## HY5
**Preamplifier**

The HY5 is a mono hybrid amplifier ideally suited for all applications All common input functions (mag Cartridge tuner etc) are catered for internally the desired function is achieved either by a multi way switch or direct connection to the appropriate pins The internal volume and tone circuits merely require connecting to external potentiometers (not included) The HY5 is compatible with all I L P power amplifiers and power supplies To ease construction and mounting a P C connector is supplied with each pre amplifier

**FEATURES**: Complete pre-amplifier in single pack — Multi function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo

**APPLICATIONS**: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address

**SPECIFICATIONS**:
INPUTS Magnetic Pick up 3mV Ceramic Pick up 30mV Tuner 100mV Microphone 10mV Auxiliary 3-100mV input impedance 47kΩ at 1kHz
OUTPUTS Tape 100mV Main output 500mV R M S
ACTIVE TONE CONTROLS Treble ± 12dB at 10kHz Bass ± at 100Hz
DISTORTION 0 1% at 1kHz Signal/Noise Ratio 68dB
OVERLOAD 38dB on Magnetic Pick up SUPPLY VOLTAGE ± 16-50V

$17^{85}$

## HY50
**25 Watts into 8Ω**

The HY50 leads I L P s total integration approach to power amplifier design The amplifier features an integral heatsink together with the simplicity of no external components During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World

**FEATURES**: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components

**APPLICATIONS**: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier

**SPECIFICATIONS**: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm

$23^{20}$


## HY120
**60 Watts into 8Ω**

The HY120 is the baby of I L P s new high power range designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design

**FEATURES**: Very low distortion — Integral heatsink — Load line protection — Thermal protection — Five connections — No external components

**APPLICATIONS**: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ

**SPECIFICATIONS**
INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 04% at 60W at 1kHz
SIGNAL NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz —3dB SUPPLY VOLTAGE ± 35V
SIZE 114 50 85mm

$50^{35}$

NEW

## HY200
**120 Watts into 8Ω**

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance

**FEATURES**: Thermal shutdown — Very low distortion — Load line protection — Integral heatsink — No external components

**APPLICATIONS**: Hi-Fi — Disco — Monitor — Power slave — Industrial — Public Address

**SPECIFICATIONS**
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 05% at 100W at 1kHz
SIGNAL/NOISE RATIO 96 dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V
SIZE 114 100 85mm

$72^{85}$

## HY400
**240 Watts into 4Ω**

The HY400 is I L P s Big Daddy of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications If the amplifier is to be used at continuous high power levels a cooling fan is recommended The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module

**FEATURES**: Thermal shutdown — Very low distortion — Load line protection — No external components

**APPLICATIONS**: Public address — Disco — Power slave — Industrial

**SPECIFICATIONS**
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V
INPUT SENSITIVITY 500mV SIZE 114x100x85mm

$99^{90}$

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- ALL POWER SUPPLIES ARE FOR STEREO APPLICATIONS EXCEPT THE HY-120K.
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|---|---|---|---|---|---|---|---|---|
| HY 50 | HY 50T 36VCT 3A | $19^{95}$ | 2X4700 40 V | $4^{95}$ | BR3A1 3A 100V | $1^{95}$ | HY50K | $26^{85}$ |
| HY 120 | HY 120T 50VCT 2A | $18^{95}$ | 2X4700 40 V | $4^{95}$ | BR 3A1 3A 100V | $1^{95}$ | HY120K | $25^{85}$ |
| HY 200 | HY 200T 64VCT 4A | $29^{95}$ | 2X4700 63 V | $10^{95}$ | BR 4A1 4A 100V | $5^{95}$ | HY200K | $46^{85}$ |
| HY 400 | HY400T 64VCT8A | $44^{95}$ | 2X4700 63 V | $10^{95}$ | BR 8A1 8A 100V | $7^{95}$ | HY400K | $63^{85}$ |

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# The hi-fi of the eighties...TODAY!

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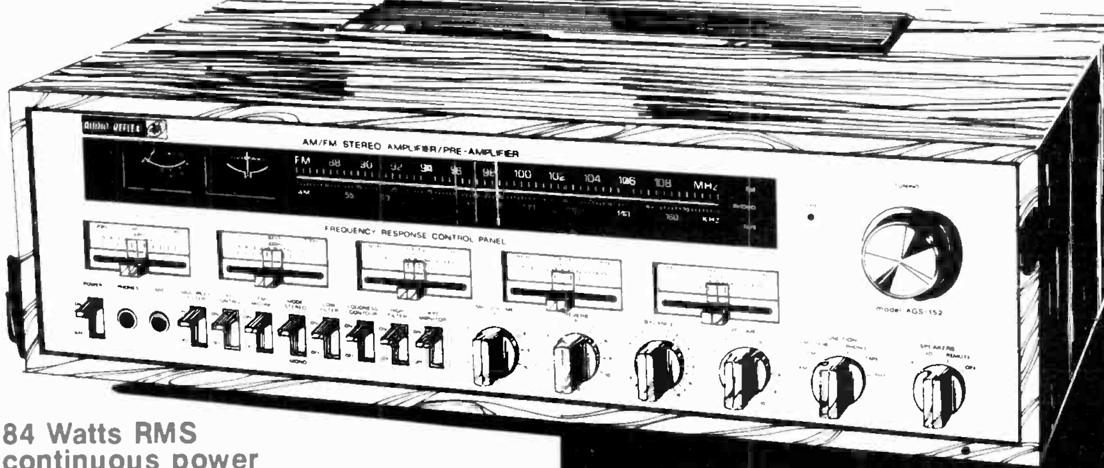
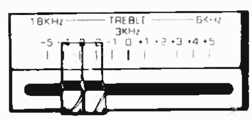



## 84 Watts RMS continuous power

FREQUENCY RESPONSE CONTROL PANEL: Five slide tone controls boost or cut signals around 80 Hz, 300 Hz, lk Hz, 3k Hz, and 10k Hz, giving complete control over the entire audio spectrum. Additional switches for low filter, high filter and loudness complete this comprehensive control system.

REVERBERATION: This feature is built into the receiver for generating and adding an echo effect.




SOUND MIXING: Controlled by the Mic volume control.

"FOUR DIMENSIONAL" sound and speaker selection.

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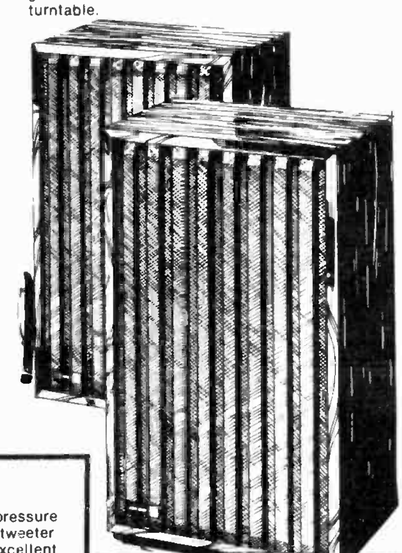
## High pressure Dome speakers

Air suspension 3 way 3 speaker system using 1 - 12" woofer, 1 - 5-1/4" dome mid range and 1 - 4-1/8" dome tweeter.

Frequency response, 30 Hz — 22k Hz within 10 dB.

Power handling 50 watts per speaker. Walnut grain cabinet finish to match the receiver and turntable.



## Fully Automatic Transcription Turntable

AUTOMATIC START AND STOP: After placing a record on the turntable simply position the lever to 'START' the pick up arm will gently and accurately lower onto the record. After the completion of play the tone arm automatically returns to the 'REST' position and the mechanism will shut off.

AUTO CUT: By pushing the 'AUTO CUT' at any point during play, the tone arm will automatically lift, return to the 'REST' position' and the mechanism will shut off.

REPEAT: This feature allows for continuous play of any selected record. Ideal for background music.

- Hydraulically damped cueing.
- 4 pole synchronous motor, belt drive system.
- Tone arm. Long 'S' curved tone arm has excellent tracking characteristics.
- Magnetic cartridge included.

12" high quality woofer with a huge 64 oz. magnet.

High pressure dome tweeter with excellent sound characteristics.

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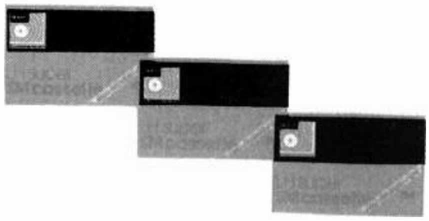
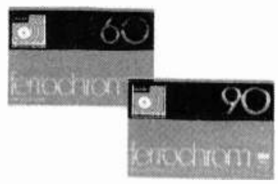






**FERROCHROM MULTI-LAYER CASSETTE — HIGHEST QUALITY CASSETTE**

| DESCRIPTION | TYPE | RECORDING TIME | STANDARD CARTON | SUGGESTED LIST PRICE | OUR PRICE | SAVE |
|---|---|---|---|---|---|---|
| Fe/$CrO_2$ SP SM | C 60 | 30 minutes each side/chaque côté | 12 | $4.97 | 4.47 | 10% |
| Fe/$CrO_2$ SP SM | C 90 | 45 minutes each side/chaque côté | 12 | 6.37 | 5.63 | |

**$CrO_2$ — CHROMDIOXID FORMULATION — FOR THE DISCRIMINATING AUDIOPHILE**

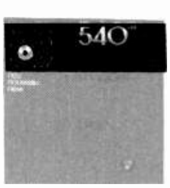
| DESCRIPTION | TYPE | RECORDING TIME | STANDARD CARTON | SUGGESTED LIST PRICE | OUR PRICE | SAVE |
|---|---|---|---|---|---|---|
| $CrO_2$ SP SM | C 60 | 30 minutes each side/chaque côté | 12 | $4.47 | 4.03 | 10% |
| $CrO_2$ SP SM | C 90 | 45 minutes each side/chaque côté | 12 | 5.97 | 5.37 | |
| $CrO_2$ SP SM | C 120 | 60 minutes each side/chaque côté | 12 | 7.97 | 7.17 | |

**LH super — LOW NOISE/HIGH OUTPUT — SUPER EFFECT CASSETTE WITH SPECIAL 'MAGHEMITE' OXIDE FORMULATION**

| DESCRIPTION | TYPE | RECORDING TIME | STANDARD CARTON | SUGGESTED LIST PRICE | OUR PRICE | SAVE |
|---|---|---|---|---|---|---|
| LHS SP SM | C 60 | 30 minutes each side/chaque côté | 12 | $3.87 | 3.40 | 12% |
| LHS SP SM | C 90 | 45 minutes each side/chaque côté | 12 | 4.87 | 4.28 | |
| LHS SP SM | C 120 | 60 minutes each side/chaque côté | 12 | 6.37 | 5.60 | |

**LH CASSETTES LOW NOISE/HIGH OUTPUT**

| DESCRIPTION | TYPE | RECORDING TIME | STANDARD CARTON | SUGGESTED LIST PRICE | OUR PRICE | SAVE |
|---|---|---|---|---|---|---|
| LH SP SM | C 60 | 30 minutes each side/chaque côté | 12 | $2.87 | 2.00 | 30% |
| LH SP SM | C 90 | 45 minutes each side/chaque côté | 12 | 3.87 | 2.70 | |
| LH SP SM | C 120 | 60 minutes each side/chaque côté | 12 | 4.97 | 3.47 | |




**BASF REEL-TO-REEL TAPES — POLYESTER BACKED**


| LP 35 LH SUPER — HIGH DENSITY OXIDE — "MAGHEMITE" — 1.0 MIL | | | OUR PRICE | SAVE |
|---|---|---|---|---|
| 5" 900' | 20 | 8.97 | 6.72 | 25% |
| 7" 1800' | 20 | 13.47 | 10.10 | |
| 5" 1200' | 20 | 11.57 | 8.68 | |
| 7" 2400' | 20 | 16.97 | 12.70 | |

# introduction to THE OSCILLOSCOPE

## 2 The refinements

MANY MEASUREMENTS IN electronics can be handled by the relatively unsophisticated oscilloscopes described in the last part of this series. More capability can be provided at greater cost and this can be valuable if the user understands how to make the most of it. This part describes refinements that will be encountered in more advanced oscilloscopes.

### IMAGE STORAGE

**Screen persistence:** Repetitive signals, such as a sinewave signal, can be made to repeat on the screen overlapping the previous trace produced. If the timebase frequency is sufficiently high – from thirty or forty hertz upward – the screen provides an apparently stationary signal of constant and adequate intensity. This is primarily because the eye cannot detect individual scans (as in motion pictures and television) and secondly because the phosphor, at frequencies above a few hundred hertz, is re-energized before its light emission due to the previous scan, has decayed away.

Phosphors with large time-constants are available (such as P2, which takes one second to reduce to 10% of original brightness and P7 which takes three seconds) and oscilloscopes have been manufactured which use these to enable signals of less than one hertz to be studied. This feature, however, largely restricts the use of the instrument to low frequency work because medium and high-frequency signals that are not well synchronised will produce separate traces which remain and add up with time to produce an unclear picture. This method of studying slow-transient phenomena has not been developed to any great degree because of this and other factors (such as poor resistance to burning). In addition the retained-image times are still inadequate for many applications.

### CAMERAS

Storage requirements fall into two classes – those where the transient is unique and therefore needs to be recorded only long enough to allow the trace to be studied and those where a permanent record is needed.

The oscilloscope fulfils both these needs. Until the advent of the Polaroid-Land process this involved a time-consuming development process before the operator was certain of having even recorded the trace. Most oscilloscope makers now offer specially built trace-recording cameras that fasten onto the large bezel surrounding the screen.

Such cameras use a Polaroid-Land film pack of some kind and often incorporate a 35 mm roll film facility also. A Dumont unit is shown in Fig.1. The user sets the CRO controls until satisfied that the trace will be as needed. This is done using the viewing aperture which reflects the screen image to the observer via a mirror. It is essential that the camera has the correct focal distance set for the CRO concerned, so in general cameras relate to specific units. Some models incorporate adjustable object-image ratios; a few are fixed ratio. With experience it is even possible to capture multiple trace events (by multiple exposure) for comparison purposes.

A considerable amount of film and patience can be consumed trying to record once-only events. Cameras can be quite expensive – several hundred dollars – but they do provide a permanent record for reports which no other storage system can provide, and the price of a camera is not as great as the extra cost of the variable – persistence storage units to be discussed later.

### STORAGE OSCILLOSCOPE

Most of the objections of the above storage methods, with the exception of permanent photographic reproduction, are overcome by using an advanced form of the basic CRO tube.

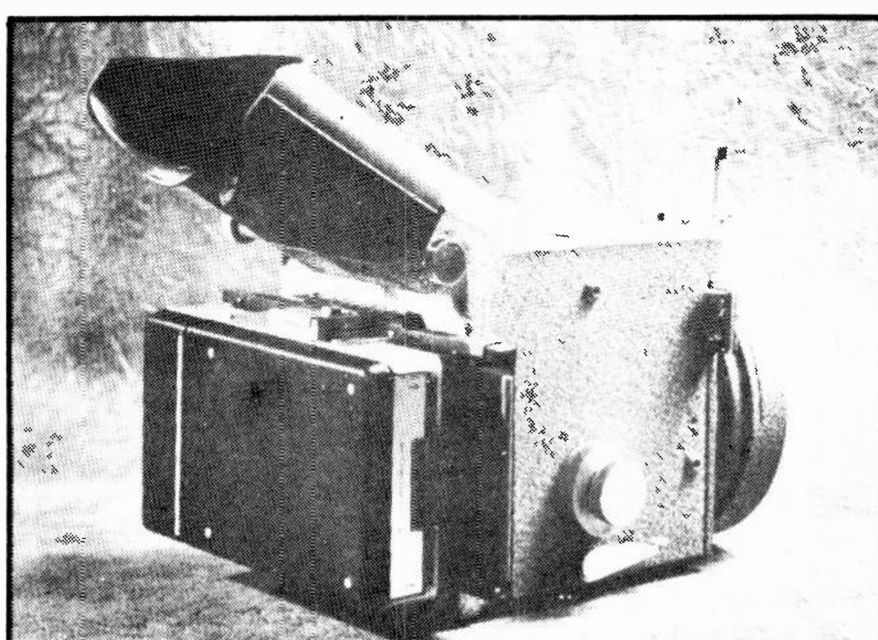


*Fig. 1. Recording camera using Polaroid film pack.*

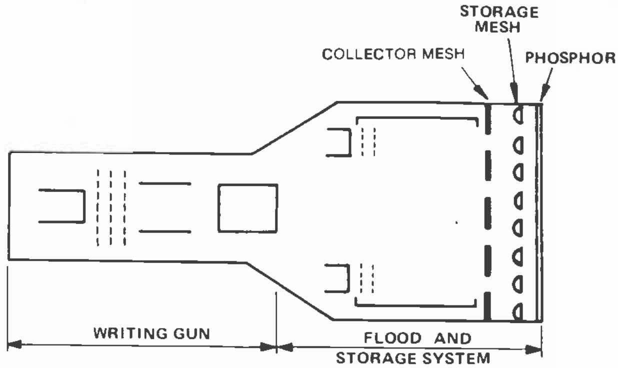



*Fig. 2. Schematic construction of storage cathode ray tube.*

It is called a variable persistence storage tube and is a development of early 1950's storage tubes in which the waveform could only be held at a constant intensity (without the feature of gradual fade out). In fact variable persistence is a feature of tube operating circuitry not the tube itself.

The construction of a typical storage tube is given in Fig.2. The phosphor viewing screen (having 0.1 s persistence time from P31 material) and the writing electron gun shown are similar to those used in the simple cathode ray tube. Additional components are the flooding electron gun system, a storage mesh which is coated with a non-conducting, highly-resistive material such as magnesium fluoride, and a collector mesh which is held at a positive potential.

To store a trace the writing gun is scanned over the storage surface. Where the beam strikes the storage mesh electrons are knocked loose leaving a positive-charge pattern. The high-resistivity of the surface prevents the charges moving toward a neutral state: the scan is thus stored – and can be held for at least an hour (one maker offers four hours) in a reduced intensity mode.

To make the trace visible, low velocity electrons are sprayed by the flood guns onto the entire mesh surface. These electrons are allowed to pass through to the phosphor in proportion to the amount of positive charge at each aperture of the storage mesh. The positive field pulls many electrons through causing them to pass on to hit the phosphor.

The collector mesh is provided to help accelerate the flood electrons; to repel the positive ions generated by the flood guns; (which would otherwise write the whole screen bright) and to absorb the emitted secondary-emission electrons produced whilst writing is in operation. It is not possible to store the trace in the view mode for as long as in the store mode: one to ten minutes of viewing time are typical for various makers' designs.

Erasure is done by applying a large positive voltage to the storage mesh which charges capacitively to the same value. The mesh voltage is then brought back to a small positive value whereupon the flood guns reduce the voltage to zero. A small sudden negative excursion is finally applied to the mesh making it ready to write. (This procedure is automatically initiated at the single action of a switch.)

Variable persistence is incorporated by changing the time taken to erase the picture. In the Hewlett-Packard unit, shown in Fig.3, this is achieved by using a variable-width pulse generator that applies erase voltage pulses to the storage mesh. The positive-ions created by the flood-guns limit this mode to a maximum of 10 minutes persistence.

Storage oscilloscopes can be used as conventional units by applying about 30 volts to the storage and collector meshes. Long persistence has many virtues – it enables successive traces resulting from adjustments to a system response to be overlaid together for comparison purposes. It also allows us to see very low-frequency scans, and to plot scans of spectrum analysers. Long persistence also finds use in time-domain reflectometry where the time between send and receive pulse needs measuring.

By stacking sweeps on top of each other a long persistence time can be used to integrate or average a set of traces. Variable-persistence storage oscilloscopes are extremely versatile but the high price restricts their use to large laboratory groups.

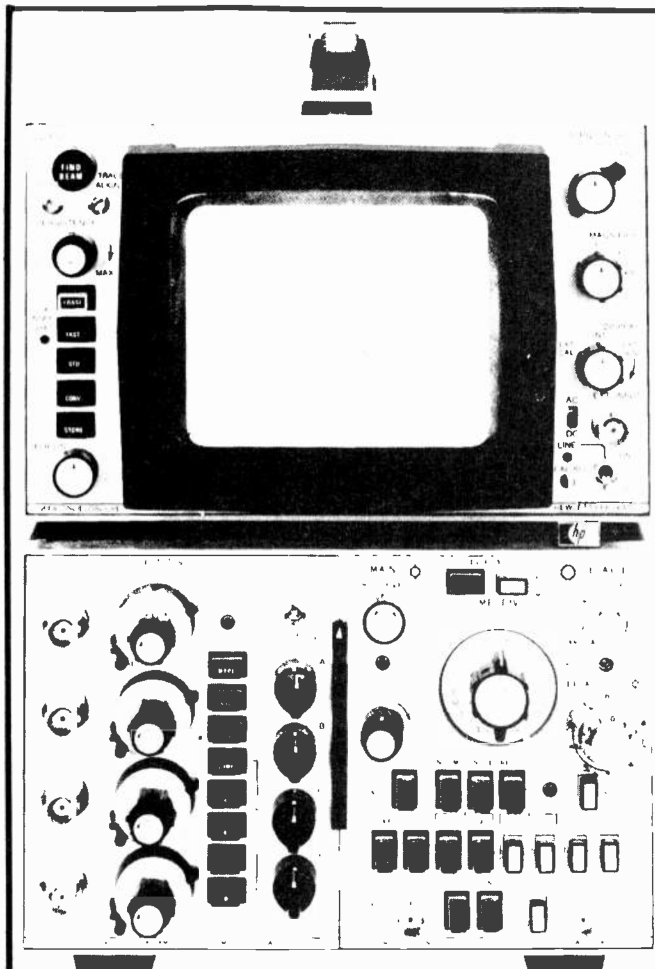


*Fig. 3. Hewlett Packard Model 184A variable persistence and storage oscilloscope. Controls for storage are on the left-hand side of the screen.*

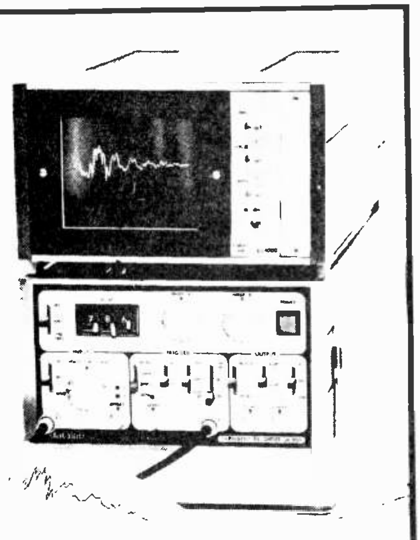


*Fig. 4. Storage can also be obtained using a digital memory to capture the event which can be displayed at will on an oscilloscope or recorder (Datalab DL 905).*

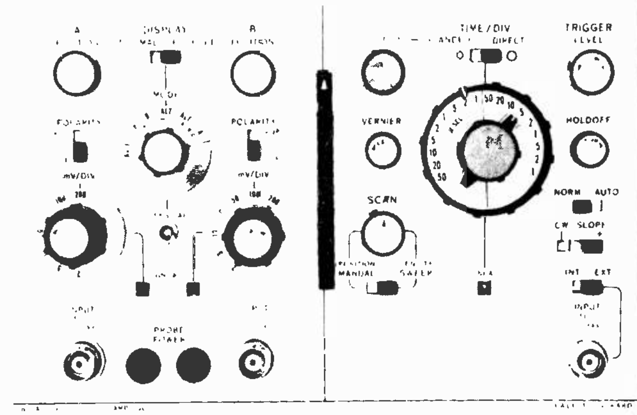
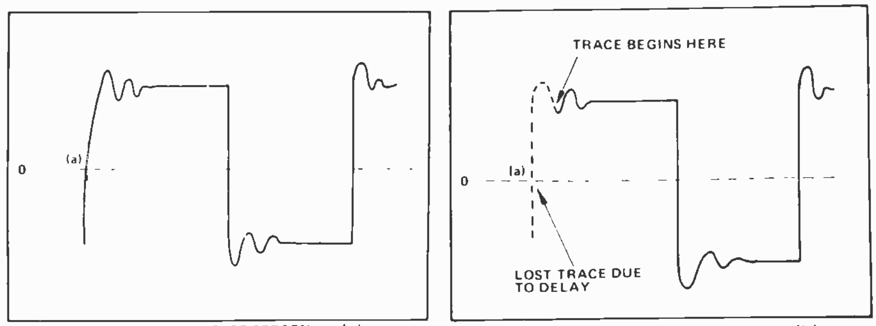



*Fig. 6. 1 GHz dual-channel sampling plug-in. (Hewlett Packard Model 1810A). The controls are designed to provide operation as for those on normal real-time oscilloscopes. With such a unit it is possible to view nanosecond rise time signals of repetitive nature.*




OSCILLOSCOPE SCREEN (a) (b)

*Fig. 7. Inherent trigger delay, if not compensated for, will lose the leading edge of a waveform.*

## STORAGE USING DIGITAL MEMORY

Figure 4 shows a unit marketed around 1972. The transient recorder unit accepts the analogue signal, converts it to a digital equivalent with respect to time and stores the values in digital registers. Readout can be obtained by using digital-to-analogue conversion of the stored increments which are scanned sequentially, the resultant analogue voltage being fed to an oscilloscope or chart recorder. Digital print-out is taken direct from the scanned store locations.

This method is less common than the storage oscilloscope alternative but the ever-reducing cost of digital methods may put this technique into a competitive price region.

Another method of capturing difficult to see, once-only transient signals, and very slowly changing waveforms is to record the level of the signal, increment by increment, as the signal occurs, using a digital memory. The concept is simple and the method offers certain advantages. These include ability to speed up or slow down the timescale of the original event, ease of providing a permanent numerical printout and the facility to process the signal before display.

## SAMPLING OSCILLOSCOPES

How to capture a very fast repetitive event, say near to the GHz region where scan times of 0.1 ns/division are needed, is a problem because the electron beam cannot transfer enough energy into the phosphor to obtain a useable trace brilliance. Further it becomes increasingly difficult to deflect the beam at such speeds. The sampling oscilloscope offers a solution to these problems.

The sampling oscilloscope makes use of the stroboscope concept to look at a waveform, which must therefore be repetitive (as shown in Fig.5). The beam is set to illuminate the screen at point 1 in the diagram, waiting there until the next cycle where it moves to point 2 — and so on. The trace therefore gradually works its way through the complete cyclic waveform and because the scan speed is slower than with a conventional sweep system the cathode-ray tube system can operate with a lower bandwidth than the signal. The waveform produced is an average of many so the display is not only sharper but more uniform. (This may be a disadvantage in some applications for the sampling unit is effectively smoothing the unknown true original signal). Sample and hold methods were discussed in the previous part discussing D-A and A-D conversion.

In practice a sampling oscilloscope is a normal high quality scope which can accept a sampling plug-in. Fig.6 is the panel of a dual sampling unit.

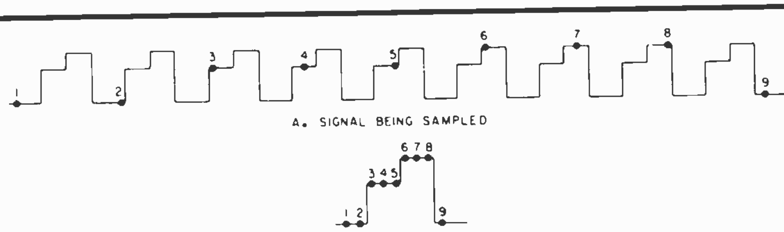



*Fig. 5. The sampling oscilloscope builds up the waveform on the screen from sampled values taken from the original.*

## DELAY FACILITIES

Often one needs to study a certain part of a repetitive waveform — the very beginning, for instance. An example is the ringing of a non-ideal square wave shown in Fig.7a. The trace is triggered, to begin the sweep, by a fast-going edge. Due to circuit response-times, the trace does not begin to sweep at exactly that time but begins a little later. The result is loss of the leading edge region of the wave as shown in Fig.7b. The following waveform may provide the information sought but attempts to widen the waveform in the horizontal direction lead to the second front disappearing. The simplest solution to this problem is to incorporate an appropriate fixed delay into the triggering circuits and this is often provided within the circuits. A slightly better method is to provide an adjustable delay control on the trigger panel.

A more difficult problem is capturing a point on the signal train that is remote from the triggering transient. Consider the signal shown in Fig.8(a), where the problem is to investigate the spike transient on the pedestals of the square wave. Triggering is best achieved by using the edge (a). But this means that scale expansion puts the spike off scale when the horizontal expansion scale is great enough to provide information about the spike structure.

Variable delayed sweep is the answer. The trigger circuit is set by the (a) edge but trace scan does not begin until after a period, as in 8(b). Thus the trace captures the spike at the left-hand side of the screen and scale expansion will now be possible as in 8(c).

To make this workable in practice the operator must know just where triggering occurs for there may be several somewhat similar events along the trace. It is vital to know which one is being viewed. A refinement provided in variable delay circuits is to brighten the original display from the point where triggering will begin. Taking the idea one step further leads to a second delay that effectively decides where the trace stops Fig. 9 shows the waveform brightened to show the portion that will be expanded and the second trace of the dual-beam unit is used to show the expanded part. Another useful feature is to be able to use a trigger point not on the origin of the first trace set up — as in Fig.10. Here a marker dot is provided to help the operator.

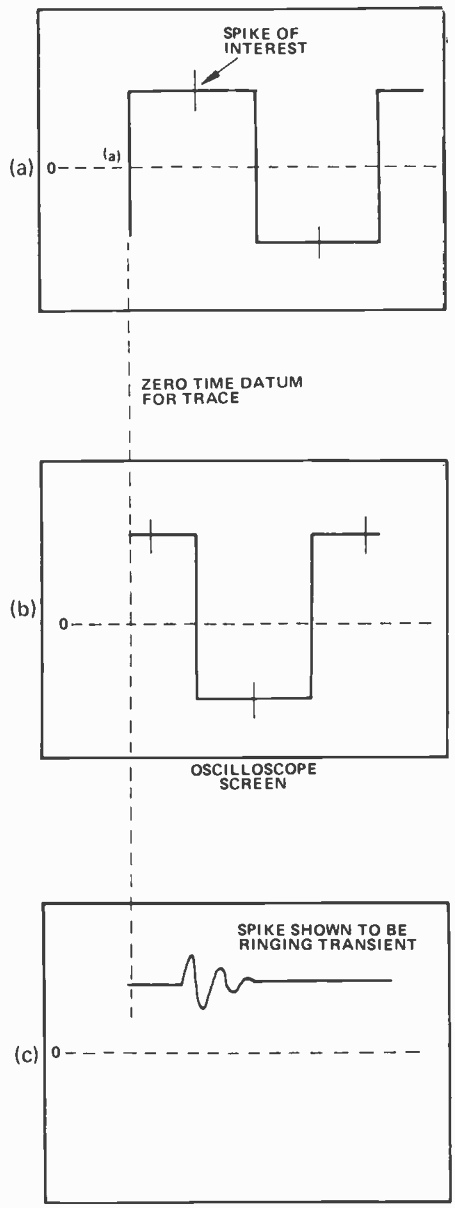



*Fig. 8. Use of introduced delay in triggering to enable an event away from trigger transient to be investigated.*
*(a) Original spike on pedestal of square wave.*
*(b) Delay introduced to bring spike back to time origin.*
*(c) Scale expanded to reveal true nature of spike.*

## PROBES

Passive probes for voltage measurement: In many situations it is important to provide the right matching conditions between two electronic systems. This is also important when connecting an oscilloscope to a circuit, for each output and input has certain resistive and reactive conditions which must be properly combined to get realistic signal transfer.

The oscilloscope can be represented as an ideal termination shunted by a large R and an adequately small C value — or at least they appear this way at first sight. Fig. 11 is the most common approximate equivalent circuit, (others used include 50 ohms with negligible reactance in certain applications). Referring to the chart in Fig. 12, it can be seen that with 20pF at 10 mHz the circuit being measured must have the equivalent output resistance of no more than 8 ohms!

For high frequencies, those above 100 kHz say, we therefore need a better connection method. To further compound the problem the oscilloscope input leads can easily increase the equivalent C value to 100 pF — leads for 1:1 connection must therefore be carefully designed to ensure known loading conditions which can

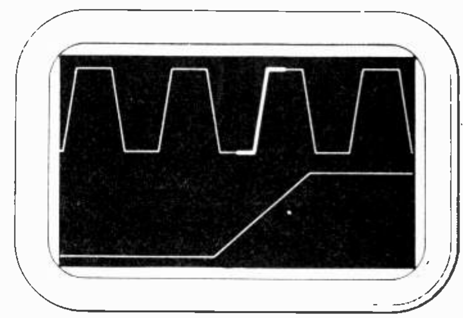
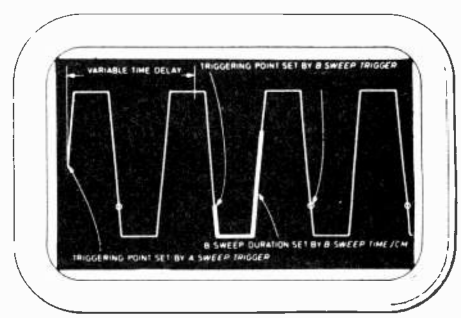
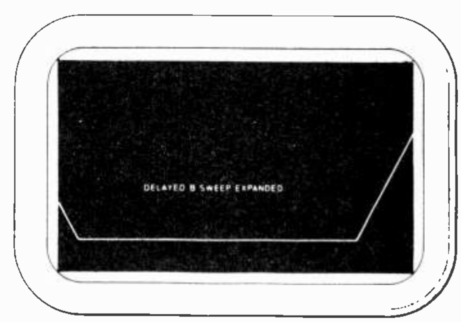


*Fig. 9. Trace brightening is used to show which part of the waveform is to be expanded. In this display the expanded portion is also displayed on the second trace of the CRO.*




*(a)*




*(b)*

*Fig. 10. Use of dual delayed triggering point. (a) original (b) expanded.*

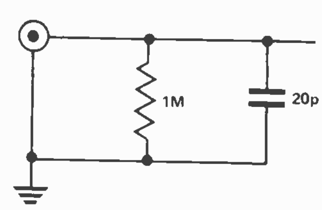



***Fig.11.*** *Most oscilloscopes have this input equivalent circuit. Although the values seem insignificant, at high frequencies they become dominant requiring the use of special probes.*

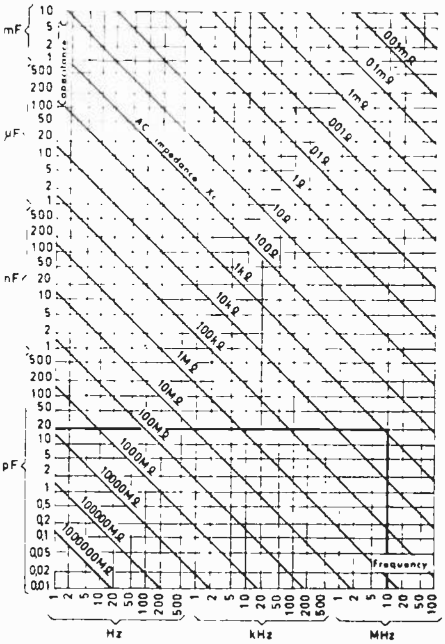



*Fig. 12. Chart for obtaining reactance of capacitors at various frequencies of operation.*

be allowed for in signal measurement corrections. It is very bad practice to use any piece of coaxial cable and connector for frequencies beyond 100 kHz.

The first improvement is to use a probe which has 10:1 attenuation built in, for these are designed to have a lower effective cable capacitance — see Fig. 13(a). Still better is a special correction arrangement that balances the shunt against series capacitance to provide a wider bandwidth — see Fig. 13(b). By the use of inductive tuning a further improvement in bandwidth can be obtained — Fig. 13(c). Probes with division ratio of 100:1 also are manufactured — these can provide equivalent termination conditions of 5K/0.7 pF, 10M/1.8 pF, 1 M/1 pF. The reason for different pair combinations arises from the need to alter the trade-offs between rise time and signal loss in high-frequency and very fast transient measurements.

There is no easy answer to the question of which attenuator probe to use. These guides are the start. For amplitude measurements select a minimum-impedance source point to measure from. The best probe to use here is one with the highest impedance at the frequency of interest. Capacitance is less important here than resistance for it alters edge shapes, not amplitude.

For fast risetime measurements again select a low impedance source point and use a probe with lowest effective capacitance — signal attenuation is less important than transient edge shape changes.

## ACTIVE PROBES FOR VOLTAGE MEASUREMENT

The above probes make use of passive matching arrangements. But for the extremes of frequency and/or risetime measurements the values of components required in passive probes become impractical. However active amplifiers interposed between the circuit and the oscilloscope can be used to improve performance by increasing input resistance and lowering capacitance (short leads). FET probes are marketed to meet this.

## OTHER PROBES

Voltage measurements are by far the most frequent measurements made but in some instances it may not be possible to determine voltages, and current measurement is used instead. An example is the current flowing in a direct-coupled Darlington pair configuration where no significant resistance exists over which a voltage can be developed. DC current probes (see Fig. **14**) clip over the wire in question coupling the dc magnetic field created by the current flowing in the wire into a Hall effect transducer which generates a voltage equivalent to the current flowing. These will also measure ac currents. The maker specifies the conversion constant — typically 1 mV/mA. AC only, current probes are also made using a current-transformer principle.

Probes for use in digital circuits are also available. These may incorporate a logic gate that combines the outputs from up to 6 circuit points as shown

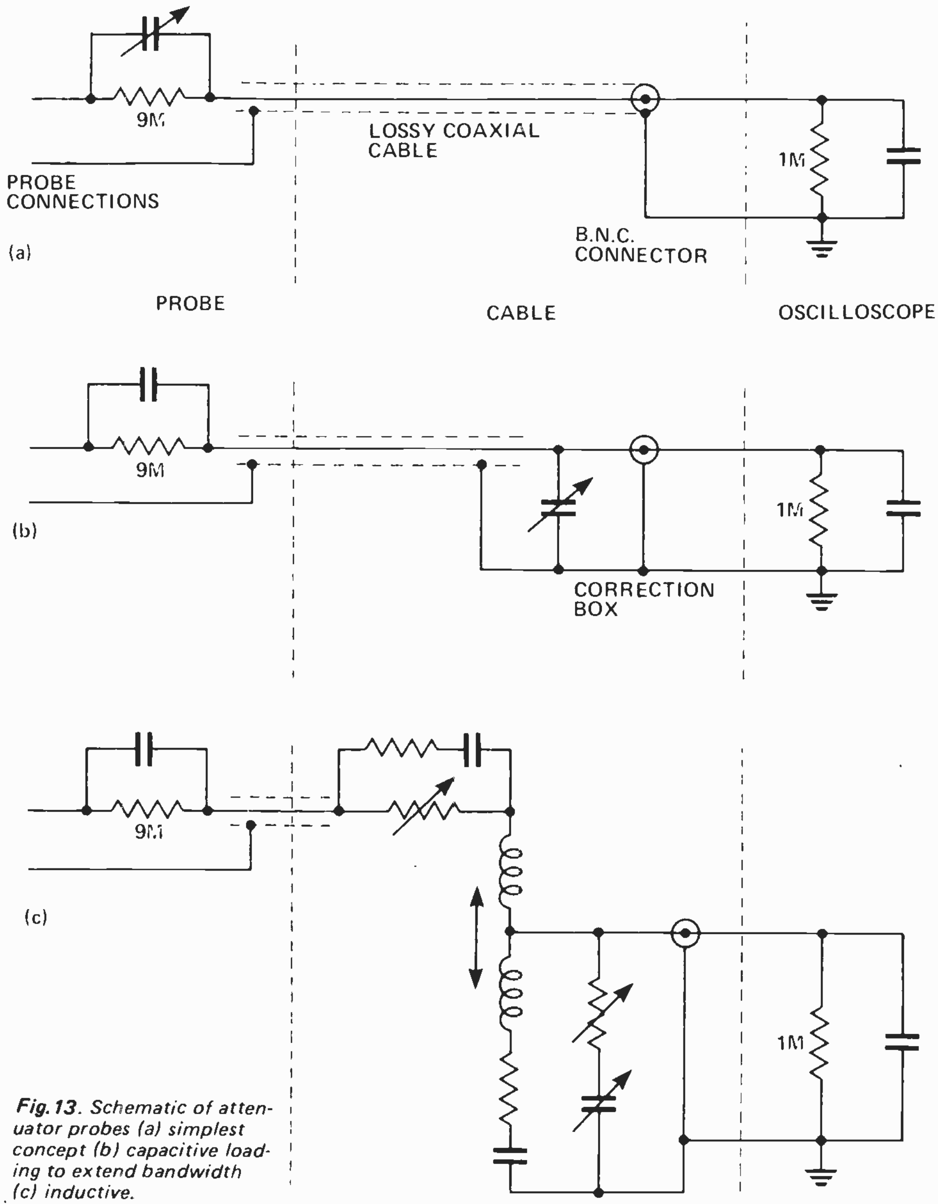



*Fig. 13. Schematic of attenuator probes (a) simplest concept (b) capacitive loading to extend bandwidth (c) inductive.*

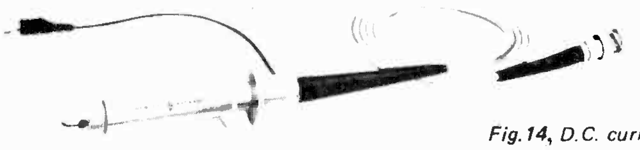


*Fig. 14, D.C. current probe.*

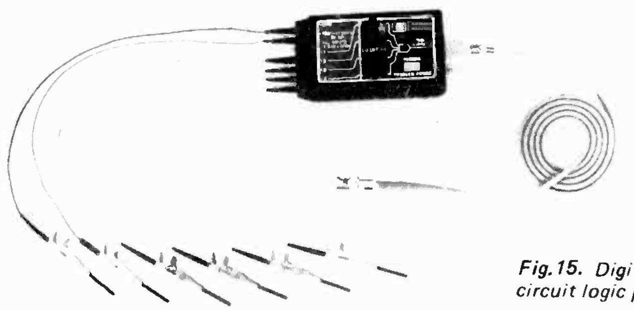


*Fig. 15. Digital circuit logic probe.*

in Fig. 15. Power for the gate is obtained from the circuit under test

## SPECIAL PLUG-INS

The oscilloscope, due to its extensive flexibility, can form a major part of many test systems, thereby reducing the overall price of advanced measurement systems where a suitable CRO already is available. Special plug-ins are offered (to suit certain main-frames) that will convert an oscilloscope into a spectrum analyser or into a semiconductor characteristic-curve tracer. Another plug-in is offered that converts the CRO into a four-trace unit.

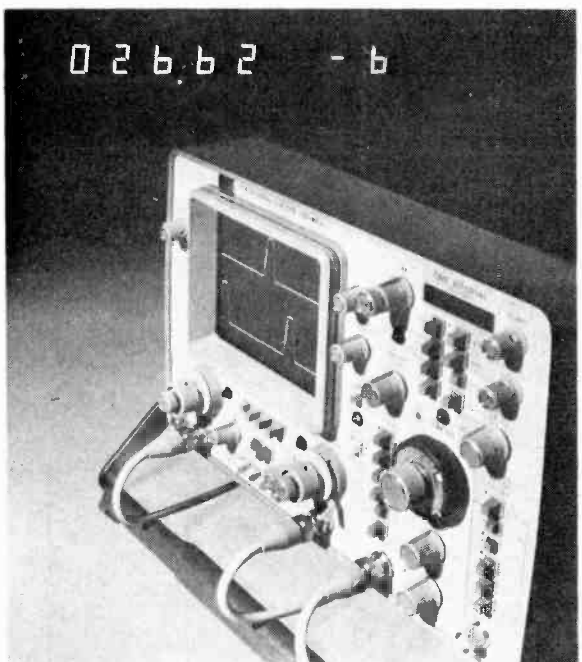
A basic need in manual measurement is the provision of output form that best suits the operator. In many tasks a visual output in the form of a picture or graph is better than having to view many traces of a time sequence taken over the whole system. Already we have logic analysers which display space-plane information on the CRO screen, multi-meter CRO units that write digital values on the screen and units that provide axes information on screen graphs. With the reducing cost of advanced processing it will not be long before the micro-processor and memory (already in use in very sophisticated units) are introduced into quite moderately priced oscilloscopes for converting the information taken from the circuit into better forms of display. Display monitors are already available with many display forms. The next stage must be the marrying of the basic CRO unit to such capability via a wider range of sophisticated plug-ins. The colour oscilloscope will also soon be with us extending the information rate at which the operator can be informed about a system via a CRO.

The only weak link in present systems (as far as robustness, life and cost is concerned) is the CRT itself for it is just about the last remnant of thermionic device technology remaining in general use. This too will soon be replaced by a solid-state equivalent. Perhaps this will take the form of a matrix of three-colour, LEDs in a flat display — making maximum use of the low-cost production advantages of LSI techniques.

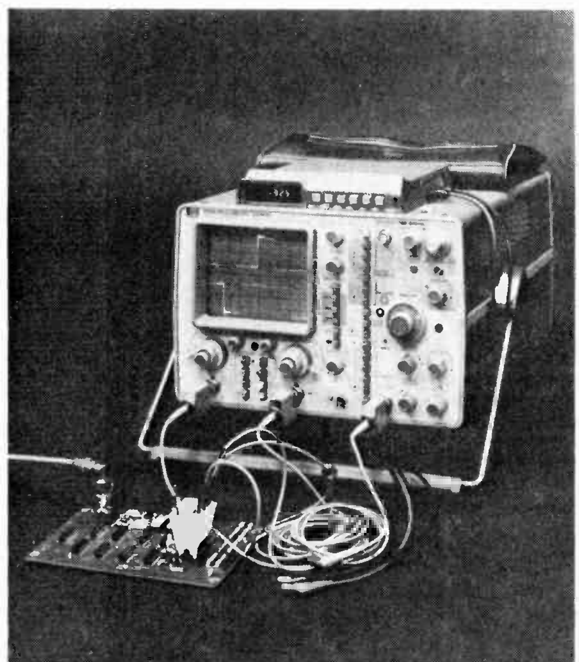
## FURTHER READING

Due to the versatility of the oscilloscope most books on electronic instrumentation include basic descriptions of how oscilloscopes work and how to perform basic measurements with them. Many books are devoted entirely to the oscilloscope.

General considerations are discussed in "Test and measuring instruments — 1974 Catalogue", (Philips). Tektronix, Hewlett-Packard, Dumont and Marconi outlets also provide basic articles on the selection and use of oscilloscopes. ●



*The H.P. 1743A oscilloscope with built in averaging counter*



*The H.P. 1715A oscilloscope with direct readout for time interval measurements.*

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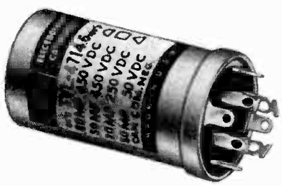

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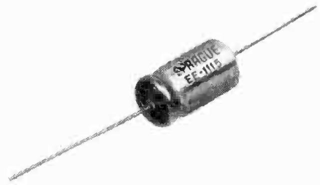

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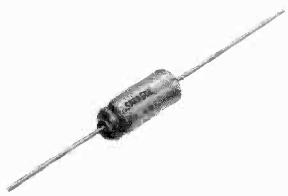

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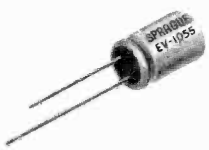

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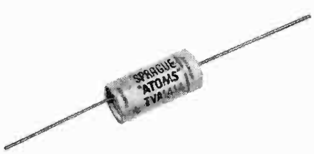

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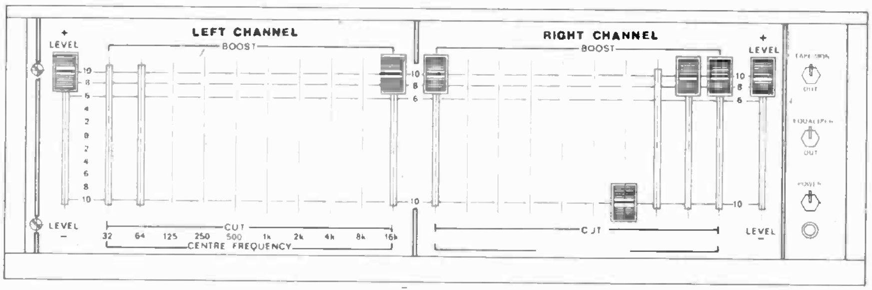
## SOMETHING FOR EVERYONE IN THE OCTOBER ISSUE

# Graphic Equaliser



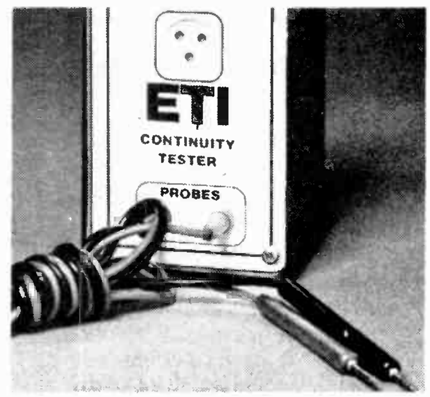

THERE ARE OCCASIONS when ordinary tone controls are just not good enough. The room you listen to your hi-fi in will have more effect on the sound pouring forth from the speakers than anything else.

It has been acknowledged for some time that to really 'get through to the music' one must cancel this detrimental effect somehow. Graphic Equalisers are the tool to do the job! Basically an equaliser is a ten/twenty channel tone control system, allowing for greater flexibility in tailoring the overall sound of a system. They can be employed for special effects, like picking the voice out of a 'too-heavy' backing, or bringing out a guitar solo from the boring bass track — but being purists we shan't mention that.

Next month we publish full details of a revolutionary new design for such a device, a 20 channel equaliser with a spec that includes it in the 'super-fi' class, and NO COILS! Our equaliser uses gyrator circuits to replace all the inductors which are usually so messy and so expensive.

With this to add to your hi-fi, some systems will be more equal than others!

# CONTINUITY TESTER




NOT your hackneyed multivib with a break in the supply rail but a properly designed unit which will tell you if there's continuity and very little else — no voltages to turn on transistors etc.

# LOUDHAILER

NOT a megaphone, but a hand-held amplifier and very efficient horn speaker together with the microphone separated. A 12V supply is used which can be taken from internal batteries or external supply from a car battery.

Two IC's are used enabling a good microphone to be used and giving 2½W. Now this output may sound pathetic to those associating this power with regular, highly inefficient speakers but it's more than adequate when using a good horn speaker.

# STEREO SIMULATOR

ADD LIFE to those dull mono sounds with this circuit. When used between a mono signal source and a stereo amplifier this unit gives an extra something — we're not sure what it is — but we like it.

# MICROCOMPUTERS

Next month we start an in-depth look at just what is available in this vast and ever-changing field. We hope to show you who produces what to do which and where else it's used in other systems. We will also be taking a look at more general developments apparent from recent trade shows.

The articles described here are in an advanced state of preparation, but circumstances may necessitate changes in the issue that appears.

# VFETS for EVERYONE

In 1906, Lee DeForest first used high-vacuum tubes as amplifiers in the repeaters of the first transcontinental telephone network, officially opened in 1915. In 1924, Bell labs first demonstrated electrical recording. The next year Victor and Columbia each released its first electrical recording. In that same year Victor sold 42,446 Orthophonic acoustical Victrolas, but only 11 of its new all electric phonographs.

Over the years the ratio has changed, to put it mildly, with an ever-increasing search for perfection, accompanied by numerous milestones along the way: new circuits, transducers, tube types, semi-conductors. The newest milestone is the subject of this article, a new power amplifier technology.

# SHORT CIRCUITS

# SOIL MOISTURE INDICATOR

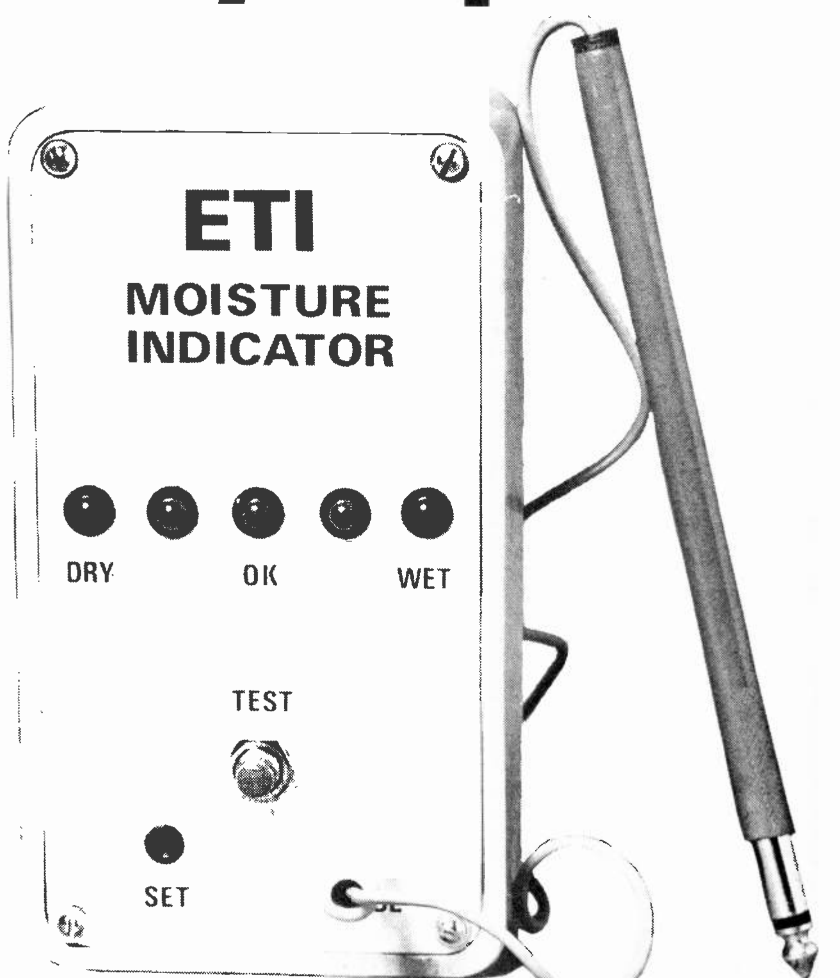
TO A GREENHOUSE OWNER, or indeed to many indoor and outdoor gardeners the degree of moisture within a plant pot's soil is important but relatively unknown. When pots were made of fired clay an expert could rap the pot with his knuckles and the 'ring' or 'thud' would show the need for watering! Nowadays however, the use of polythene sleeves and plastic containers gives too variable a sound for adequate guidance.

This circuit was developed to give an easy and accurate indication of the need for water or - just as important, very often - of a state of excess that tends to drown the roots of a plant.

## Development

Ohmmeter measurements between probes in various soils showed a surprising range of resistances, from about 3 kΩ to about 30 kΩ and further enquiry proved (as might have been expected) that soil acidity and probe dimensions also varied the readings; in particular the use of dissimilar metals for the probe tips gave enormous variations. Indeed some soil-probe combinations seemed to be trying to produce a reverse resistance reading when used in one way and then nearly full-scale — zero resistance — when the probe connections were reversed. The probe electrodes *must* be of the same metal, preferably solid and not plated.

Initial circuitry suggested that a fairly sensitive micro-ammeter would be needed, or at least an amplifier to drive a less sensitive instrument. A gardener could easily drop the completed apparatus and this could be an expensive accident; also, a pointer-type instrument led to queries about the 'needle is 2 mm further than last time', and 'not the same reading as last week' when (potted?) field trials were carried out in greenhouses. An LED display was therefore chosen as being cheaper, very robust and giving sufficiently repeatable results.




## Construction

All the components with the exception of the LEDs, PB1, and SK1, which are mounted onto the front panel, are carried by the PCB. RV1, the sensitivity adjustment potentiometer, is made accessible via a hole drilled in the case.

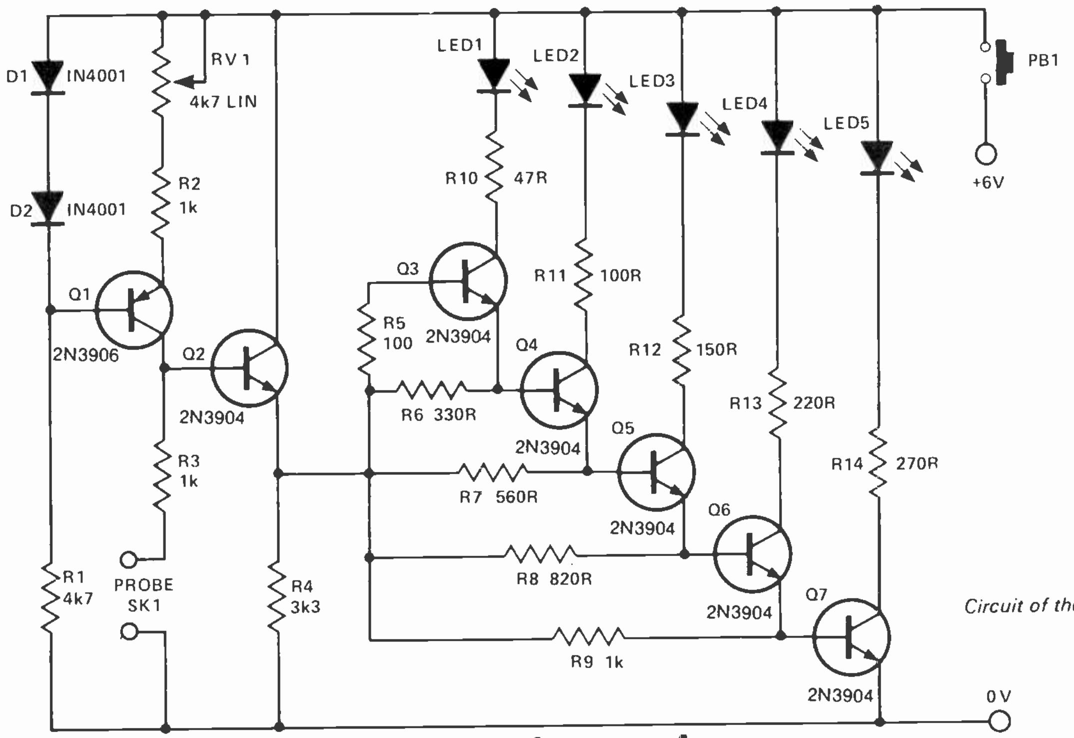
The most taxing part of constructing the device is the actual 'building up' of the probe. Ours was fabricated from a Japanese ¼" mono phone plug. Remove the cap, and upon inspecting the contents within, you will see that the tip contact is held in place by what appears to be a splayed rivet.

Take a file to this until the contact comes away freely. You can now remove the tip contact, earth contact and a spacing washer. However, we've not done yet. Hold the knurled 'body' of the plug in a vice or strong pliers, and physically pull the barrel out of it! (It may be necessary to make a small saw cut across the thread in order to achieve this.)

The barrel and tip portion is all you need for this job. A plastic sleeve is now visible over the central rod, and this too can be pulled out. Solder the probe lead to this as shown below, fixing the rod in a central position with some epoxy some epoxy or similar adhesive.

Mounting the probe assembly is largely up to you, but we found that a ballpoint case which is a cheap and universally available device, accepted the barrel.

Wiring from the probe to the box should be strong but as flexible as possible, so that continued use does not take its toll and incorrectly monitored moisture drowns both your plant and reputation as a genius!




*Circuit of the moisture indicator*

# How it works

Fig.1 is the basic diagram of the system. A constant current (preset to suit local soil conditions) through the probe tips, and the moist soil, produces a volt drop that is proportional to the resistance of the soil. This voltage then turns on an LED, which typically requires some 2 V at 15 mA for adequate brightness. A soil

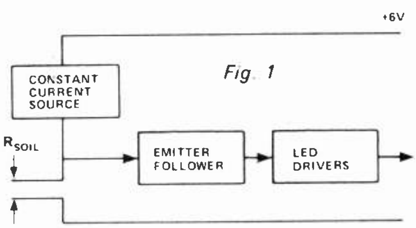



*Fig. 1*

resistance that is higher or lower than that given by the correct moisture content should also be indicated, so five LEDs are incorporated to cover the range of 'too wet' to 'too dry'.

Using silicon transistors, an emitter-base voltage of about 0.6 V is sufficient to turn on the emitter-collector current of Q7 and further increase in voltage (or base current) then results in additional emitter-collector current flow if the load allows. By connecting Q6 emitter to Q7 base, Q6 base needs to be 0.6 V more positive than Q7 case, hence at about 1.2 V (at the base) Q6 as well as Q7 is conducting. Similarly Q5, 4, 3 will conduct at base voltages of 1.8, 2.4, and 3.0 V respectively.

The current through an LED is limited to 15-20 mA by an additional series resistor (R10-14); the transistors Q3-7 are bottomed at this preset collector current, a collector voltage then being only slightly more positive than its emitter when an LED is at full brilliance.

Resistors R5-9 are included to prevent the various base-emitter diodes from clamping the output of Q2 to a low value. The inclusion of these resistors and the required currents through them taken by the various bases means that the 0.6 V steps of voltage that should turn on Q3-7 are modified slightly. When the LEDs are illuminated the total base current drive for Q3-7 is in the order of 10-20 mA and this is supplied by Q2, an emitter follower.

A quick revision of theory reminds us that the collector characteristics of a transistor, Fig.2, shows a nearly constant-

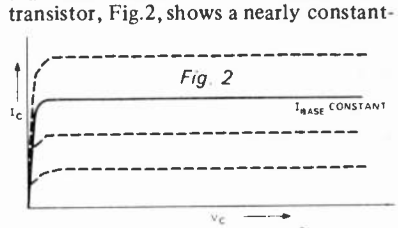



*Fig. 2*

current curve when the base is supplied with a steady value of current and voltage, this voltage being about 0.6 V. In Fig.3 the base voltage is clamped or set by a zener diode to a particular value, say Vz, and the emitter voltage is therefore about (Vz – 0.6) V. The emitter current (and, for all practical purposes,

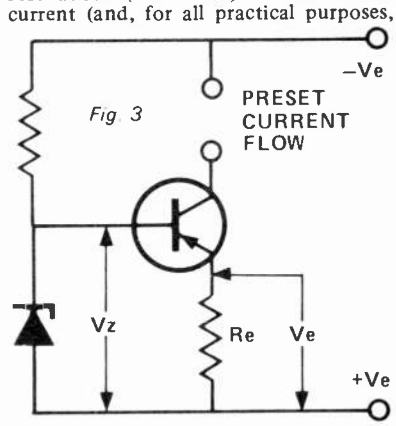



*Fig. 3*

the collector current too) is thus defined as Ie = VeRe and by selection of Re the value of Ie (or Ic) is determined. As long as there is about one volt between emitter and collector the collector current remains constant at this chosen value - or at least until a resistor or load of too large a value is connected and so robs the collector of its working voltage.

With only a 6 V supply Vz must be as small as possible and once again the fact that a forward biased silicon diode drops about 0.6 V is used. The two series-connected diodes D1-2 maintain Q1 base at about –1.2 V and the voltage drop across R2-RV1 is about 0.6 V.

# Short Circuits

## Parts List

RESISTORS (all ¼ W 5%)

| | |
|---|---|
| R1 | 4 k 7 |
| R2,3,9 | 1 k |
| R4 | 3 k 3 |
| R5,11 | 100 R |
| R6 | 330 R |
| R7 | 560 R |
| R8 | 820 R |
| R10 | 47 R |
| R12 | 150 R |
| R13 | 220 R |
| R14 | 270 R |

POTENTIOMETER
RV1 4 k 7 hor. min. type

SEMICONDUCTORS

| | |
|---|---|
| Q1 | 2N3906 |
| Q2-7 | 2N3904 |
| D1, 2 | IN 4001 |
| LED1-5 | .2" type |

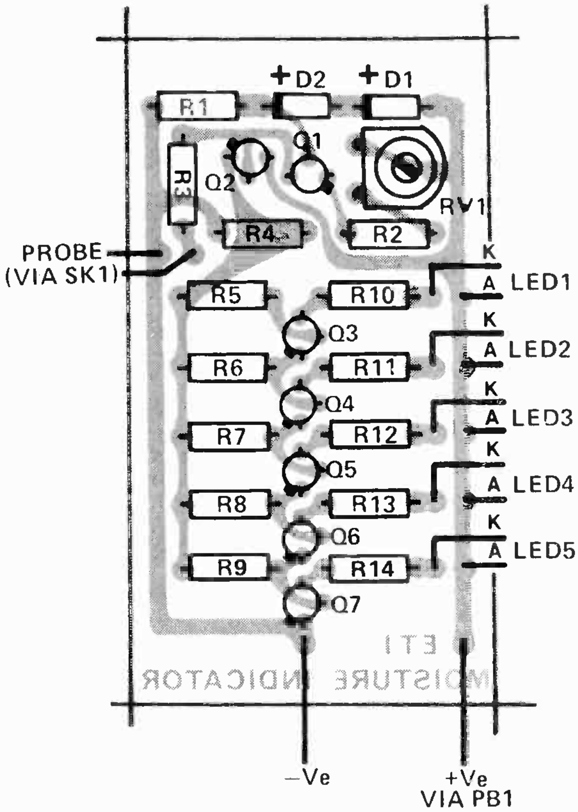
SWITCH
P.B.1 Push to test type

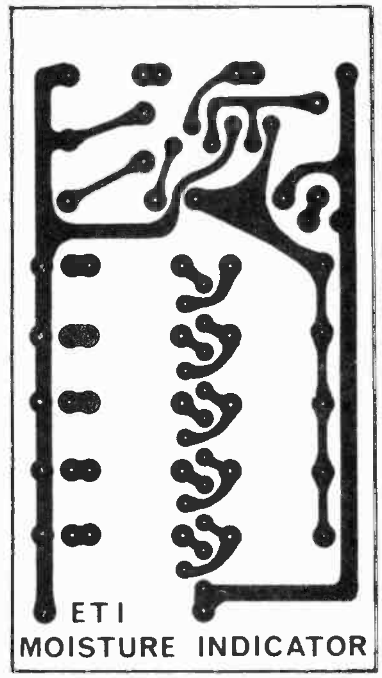
SOCKET
SK1 3.5 mm panel phone socket

PROBE
See text (¼" mono jap. type phone plug.)

CASE
5¼" x 2⅞" x 1½" / 134 x 73 x 38 mm

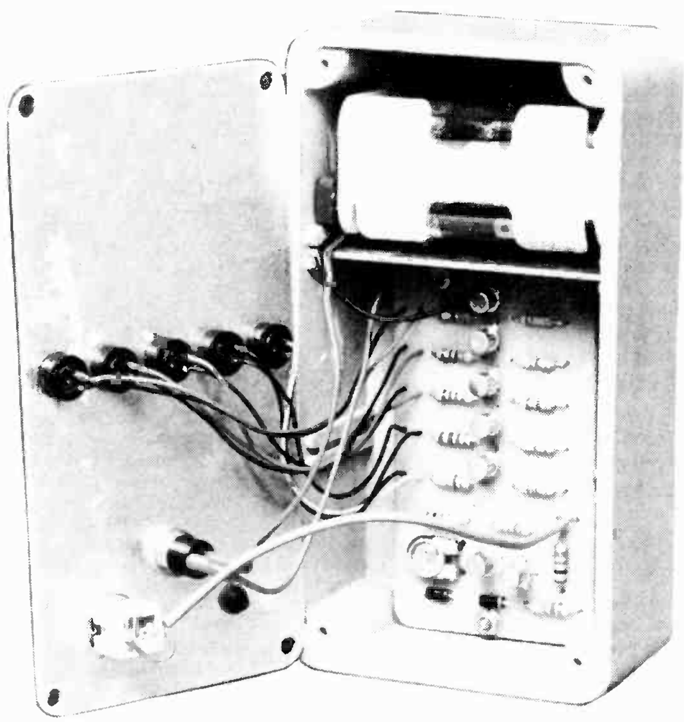
MISCELLANEOUS
Battery holder (4 x AA), battery clip, screened wire, wire, 3.5 mm phone plug, pcb as pattern.



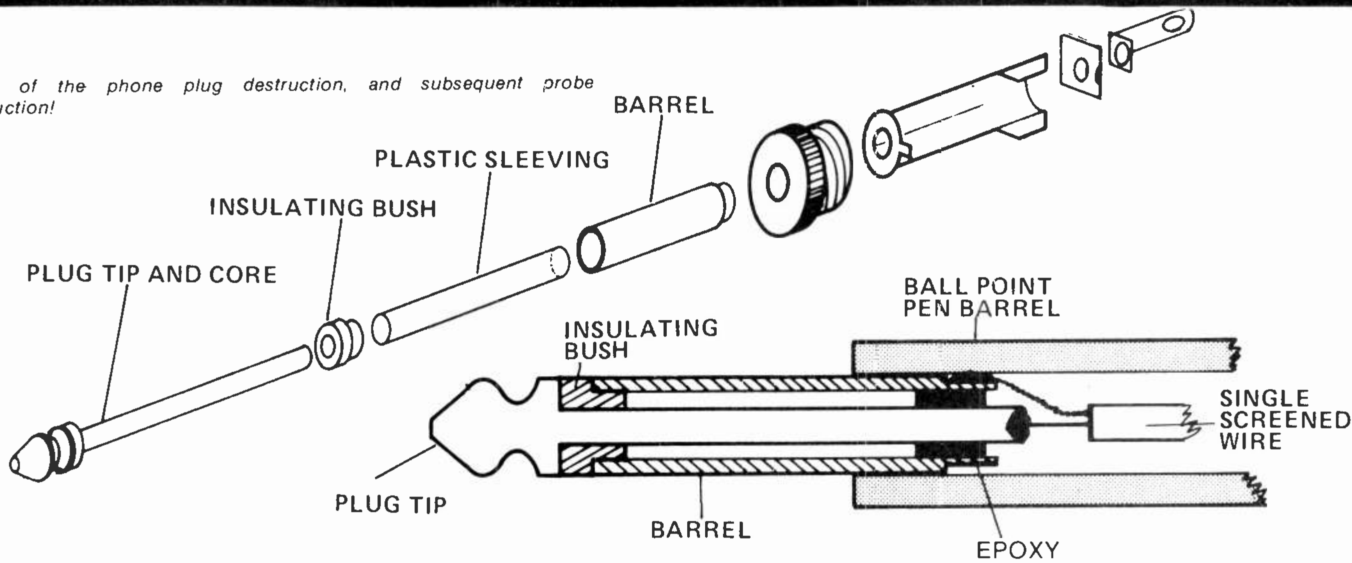




*Above left: Component overlay for our Soil Moisture Indicator. The only thing to be careful of here is the orientation of the semiconductors. Above right: Full size foil pattern for the PCB.*

*Below: Just to prove it works! A shot of the unit actually in use at the ETI Rubber Plant Department, being deftly weilded by our resident doddering old bearded gardener!*



*Details of the phone plug destruction, and subsequent probe construction!*




## Testing and Using

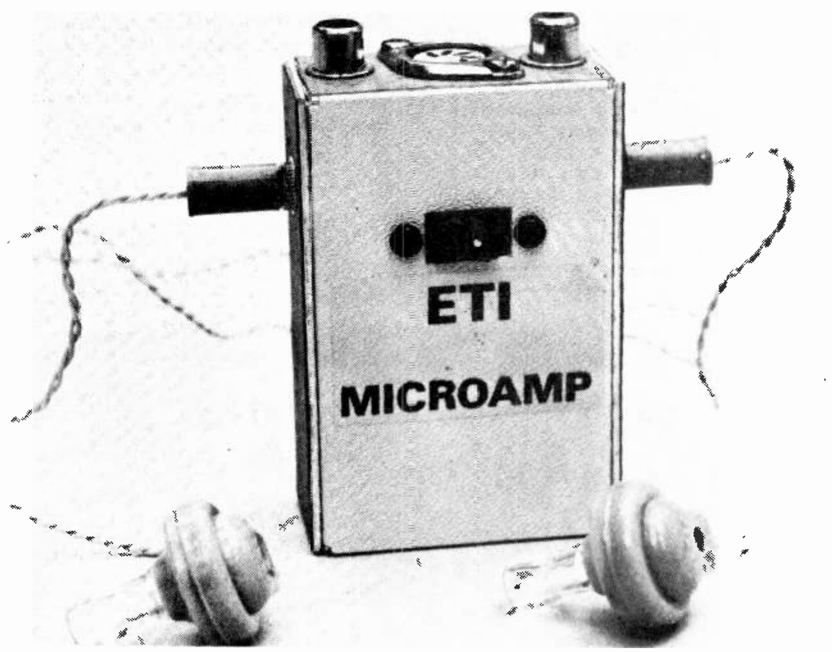
Before connecting the supply to the board, check carefully there are no 'bridges' present lest they lead you to troubled waters.

With the probe 'dry' all the LEDs should come on. With a short-circuit across it (i.e. VERY wet!) not one should be lit. Check the range of current in the probe, by short-circuiting with a milliammeter, to be about 0.1 mA to 0.6 mA approx.

Push the probe into soil of what you consider correct moisture, and adjust RV1 to light three LEDs. More moisture than this then lights *fewer* LEDs, whilst a drier soil lights more.

Perhaps one usage for this would be if you trotted off on holiday, leaving some willing person to take care of the plant-life while you sample the night-life. Once set the indicator could ensure that your instructions are carried out faithfully, and you don't return to see your favorite rubber plant impersonating a water-lily.

# microAMP




THERE IS OFTEN A NEED for a piece of equipment which can give a reliable answer as to another unit's state of being. In audio, for instance, a repaired amplifier might need to be tried without risking a pair of expensive monitor loudspeakers, or even headphones (which are worth a few dollars themselves these days!).

Our micro-amp is designed to be a portable stereo test amp, capable of betraying any faults or distortions inherent in the suspect unit. The transducers utilised are low-cost crystal earpieces, for which the design has been optimised. Although there are only a handful of components in the design, the amp gives exceptionally good sound quality suitable, say, in checking whether that cassette deck in 'Rip-Off Hi-Fi' has 1% or 100% distortion.

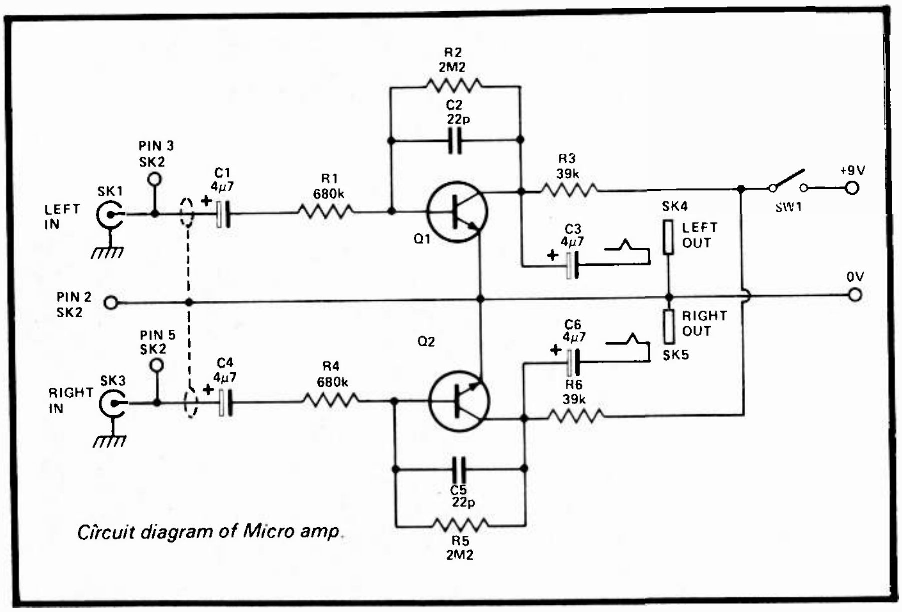
Quality is ultimately limited by the earpieces, but they are capable of doing better than the two-transistor portable radios to which they are more usually mated.

## In and Out and In . . .

In the prototype, sockets were provided for a 'tape input' type of signal, i.e. from a cassette recorder at the DIN socket pins 3 and 5. If a signal is to be input from a tuner or amplifier, either use the phono sockets or pins 1 and 4 so that you keep things standard.

Input level is ideally around 100 mV; if vastly different to this, R1 can be juggled in value to compensate. Increase if the level is higher.

# Short Circuits




*Circuit diagram of Micro amp.*

## Parts List

RESISTORS (all ¼ W 5%)
R1,4 680 k
R2,5 2M2
R3,6 39 k

CAPACITORS
C1,3,4,6 4u7 tantalum
C2,5 22 p polystyrene

SEMICONDUCTORS
Q1,2 The following types are suitable: MPS 6515, SE4010

SWITCH
SW1 On-off rocker, or slide type

SOCKETS
SK1,3 Chassis phono sockets (Doram: 478 093 red, or: 477 848 black)
SK2 Chassis 5 pin DIN 180° socket
SK4,5 3.5 mm chassis jack socket

CASE
Norman type AB12 or similar (3 x 2 x 1")

MISCELLANEOUS
9V battery, clip to suit,
Miniature screened wire
Nuts, bolts, spacers etc.
PCB as pattern
2 off crystal earpieces with 3.5 mm jack plugs.

## How it works

Q1 and Q2 are base biased single stage amplifiers. The feedback capacitors C2 and C5 are there to provide high frequency correction, and experimentation with the value will change the resultant sound quite noticeably.

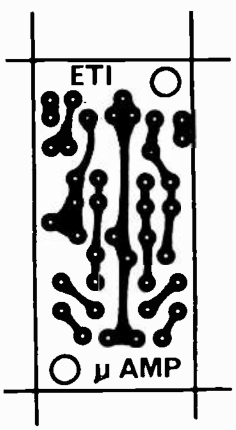
C1 and C4 decouple the input from preceding circuits, and the resistors R1 and R4 will set the level seen by the amplifier, and hence by the earpieces. No volume controls are provided, as none proved to be necessary with the prototype. C3 and C6 serve to decouple output from dc. Crystal earpieces only are recommended.

## Power and Construction

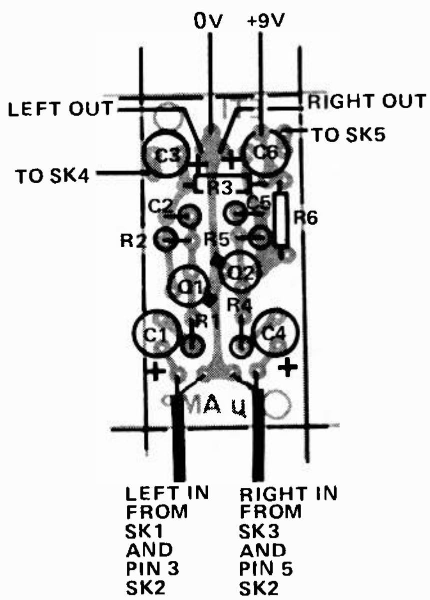
A PP3 is all that will fit into our box and is all that is needed. Current drain is around 300 uA (hence the name!) and so even this will have a life-span approaching that which it *would* have enjoyed had you left it sat sitting merrily on a shelf.

The PCB is smaller than most, so take care when soldering it up: too long with the iron in one place, and the track will become emotionally attached to the bit, and not wish to leave it!

Hi gain (hfe) transistors must be used to give a high enough output from the specified input. Surplus transistors will obviously work, but don't blame us if the sound is bad!




*Foil pattern of PCB is shown full size.*



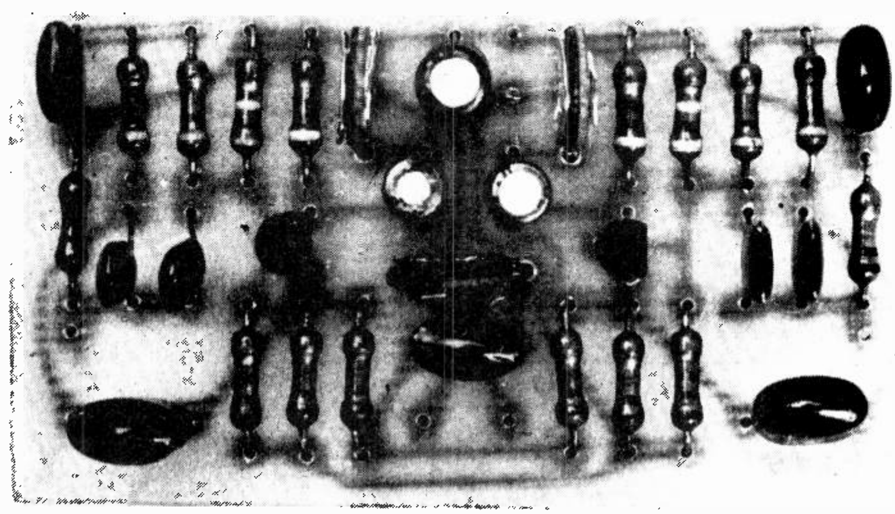

*Component overlay of Micro amp.*

# ELECTRONIC BONGOS!

MANY musical instruments can be simulated with sometimes astonishing accuracy by electronic circuitry. Complex circuits in the form of electronics synthesizers, can reproduce virtually any sounds that one can imagine.

Regrettably though at the present state of technology even a basic music synthesizer is an expensive and complex undertaking, and is beyond the scope of a series such as this. Nevertheless providing one attempts only to simulate a limited range of sounds some extremely realistic effects can be obtained without too much complication.

This article shows how to build up a circuit which simulates the sound of bongo drums. The finished unit is played in basically the same manner by tapping one's fingers on a pair of plates — one for each 'drum'.



## Construction

The touch plates may be made of any electrically conductive material — copper, brass, stainless steel, aluminium, etc. Size and shape is not critical — they need to be at least 50 mm across but they may be much larger than this if desired — and round, square, triangular or whatever you will!

The finished unit may be housed as you wish in a box — built into another instrument — or even made up as a full-size or miniature replica of a bongo drum. But if you use a metal case you must have the touch plates insulated from the case and spaced away from any metal surface by at least 25 mm.

Potentiometers RV1 and RV3 are used only in the initial setting up procedure — easy access is not essential. Potentiometer RV2 controls the level of sound output and is required if the unit is to drive an amplifier which has no built-in volume control. If desired this potentiometer may be omitted from the board and replaced by a larger rotary potentiometer located away from the circuit itself. If you do this you'll need a 50k half watt rotary device (logarithmic curve). Connect it as if you were using the original potentiometer — except that now you're doing it via three bits of wire.

When the unit is assembled check out all connections and check all tracks to ensure there are no solder 'bridges'.

## Setting up

Connect the unit to a suitable amplifier and loudspeaker. Connect the battery and then switch on the amplifier — keeping the volume control at a low setting.

Rotate RV1 to minimum setting and RV2 to about mid-way. Transistor Q1 should now be oscillating and you should hear a sound from the loudspeaker. Now turn RV1 until the oscillation just stops and touch the associated touch plate momentarily. This should cause the circuit to produce a 'bong' sound which then decays away. Continue to adjust RV1 until a realistic bongo sound is reproduced.

Now repeat the operation for the second oscillator by adjusting RV3. Turn the amplifier up loud and play away!

## Extending the circuit

The components specified will result in frequencies of about 290 Hz and 400 Hz. These frequencies are determined by C1, C2 and C4 (for the left hand part of the circuit) and the corresponding C9, C10 and C11. The frequency produced is inversely proportional to the values of these capacitors. Thus doubling their value will halve the 'bong' frequency. If you change the frequency maintain the same approximate ratios between capacitor values.

If you are ingenious and/or have some knowledge of electronics it is quite possible to extend this circuit so that you have a whole series of oscillators of different frequencies. The circuit is totally symmetrical except for the capacitor values mentioned above, so all you do to build up 'half circuits' — all connected to the common battery — and with their outputs connected to the point on the circuit which is the junction of R8, R9 and R6.

It is also possible to build the circuit using a range of switched capacitors to provide the tonal range you require.

# Short Circuits

## How it works

The circuit consists of two twin-T type sine-wave oscillators. Each is virtually identical - there is one per touch plate.

Each oscillator has a filter in the feedback loop. If the loop gain is greater than unity the circuit will oscillate. In this application the gain is adjusted to be just less than unity. Touching 'touch plate' force starts the oscillator but the moment one's finger is removed from the touch plate oscillations will die away. The rate of decay is of course a function of circuit gain and this is controlled by RV1 (and RV3).

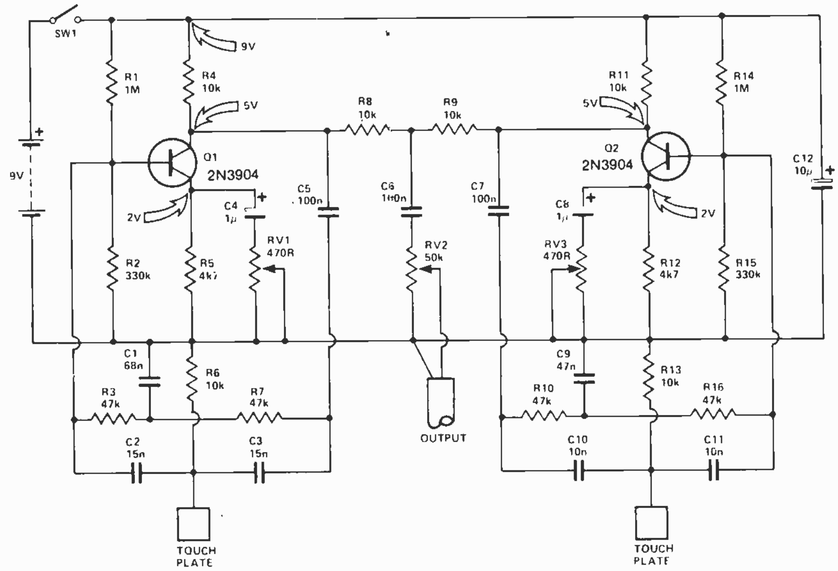
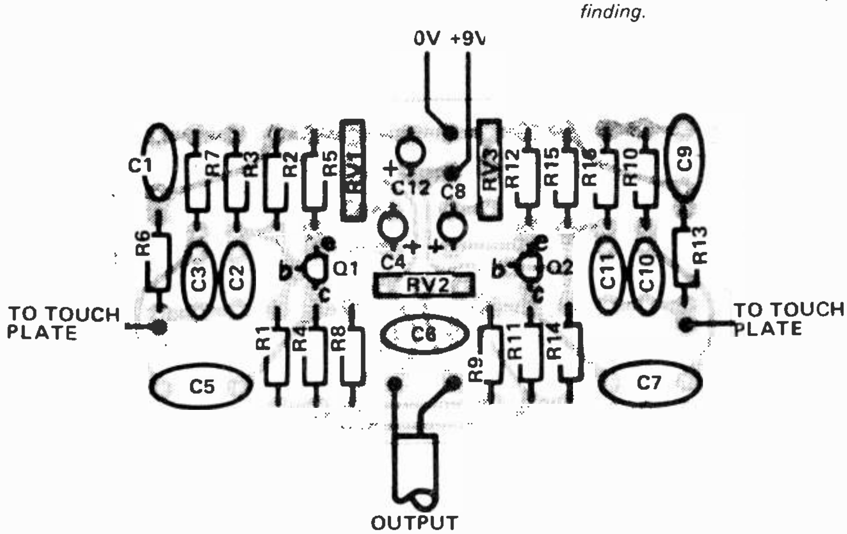
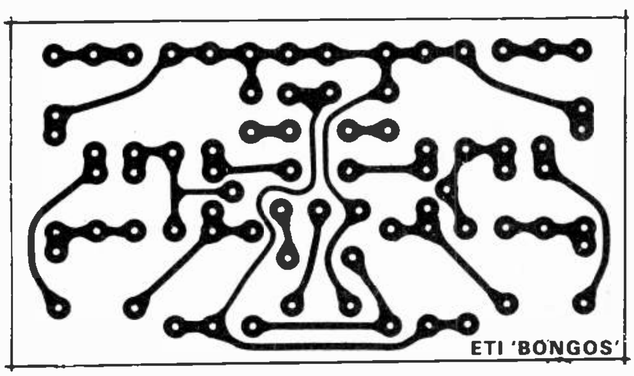



*Fig. 1. Circuit diagram for the bongo circuit. Note that the voltages given around the circuit are all with respect to ground, and are intended as an aid to fault finding.*




*Above: The component overlay for the design. The board is symmetrical which may or may not make it easier to get working as there is a good chance one half will work first time! No case details are shown as the board will probably be built into something else.*
*Below: The foil pattern, shown full size.*




## Parts List

RESISTORS (all ¼ W 5%)

| | |
|---|---|
| R1,14 | 1 M |
| R2,15 | 330 k |
| R3,7,10,16 | 47 k |
| R4,6,8,9,11,13 | 10 k |
| R5,12 | 4 k 7 |

CAPACITORS

| | |
|---|---|
| C1 | 68 n polyester |
| C2,3 | 15 n polyester |
| C4,8 | 1 u 16 V electrolytic |
| C5,6,7 | 100 n polyester |
| C9 | 47 n polyester |
| C10,11 | 10 n polyester |
| C12 | 10 u 16 V electrolytic |

SEMICONDUCTORS

| | |
|---|---|
| Q1,2 | 2N3904 |

POTENTIOMETERS

| | |
|---|---|
| RV1,3 | 470 R vert. trim type |
| RV2 | 50 k vert. trim type |

SWITCH

| | |
|---|---|
| SW1 | off-on rocker or toggle |

MISCELLANEOUS

pcb as pattern, 9V battery and clip, screened wire, metal for touch plates.

**KEEP THIEVES AWAY — WITH OUR INVALUABLE**

# ALARM ALARM


ONE PROBLEM WITH BURGLAR alarms is that they don't 'go off' until the burglar has broken in, but here is a project which can be installed in a car to warn thieves that a burglar alarm is operating. It should warn a thief to go and find a car which is not owned by an ETI reader! Even if there is actually no burglar alarm, the 'alarm alarm' can still be used. It's what the car thief believes that counts — and he's not going to investigate to see whether there really is an alarm.

The unit is simply a box containing two lamps which flash slowly on and off, together, and shine through a Plexiglas panel to illuminate the words ALARM ACTIVE. It uses a 555 timer IC, which is used as an astable multivibrator.

As the circuitry is isolated from the box this alarm can be used with any car having a 12 volt battery - whether the positive or negative terminal is connected to the chassis. Take care to see that the unit is correctly connected.

## Installation

The unit can be permanently mounted in a car near one corner of the windscreen and the wiring neatly run to a switch below the dashboard. Alternatively it may simply be placed in position when required, and plugged in to the cigarette lighter socket. To work effectively it should be prominent day or night.

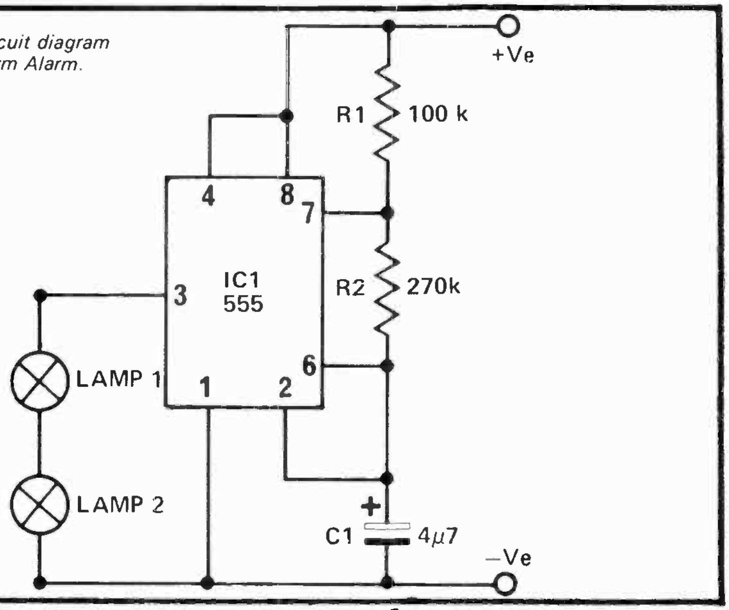
## Construction

We mounted the components on an 'L' shaped bracket which is ideal for fitting to the dashboard. Lamps 1 and 2 are push fitted into two rubber grommets mounted on an aluminium bracket, and arranged to illuminate the plexiglas panel as shown. We used Letraset for the panel lettering.

The components are assembled onto the small PCB according to the component overlay, taking care that the 555 and C1 are correctly orientated.

We fitted an On/Off switch but if the car actually has a burglar alarm,

*Fig. 1. Circuit diagram of the Alarm Alarm.*




## How it works

The 555 IC is used as an astable (i.e. not stable) multivibrator. As soon as it is connected to the supply it starts to oscillate (slowly in this case) and the output voltage at pin 3 changes regularly and suddenly from high to low and low to high as the capacitor is charged and discharged.

The charge time (during which the output is high and the lamps are on) is given by the formula:

Tc = 0.69 (R1 + R2) x C and is in seconds when R1 and R2 are in megohms and C is in microfarads. So

Tc = 0.69 (0.1 + 0.27) x 4.7
 = 1.2 seconds.

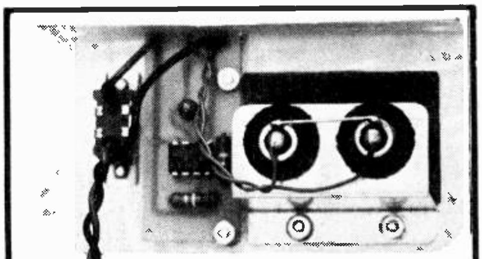
The discharge time (during which the output is low and the lamps are off) is given by the formula:

Td = 0.69 x R2 x C
 = 0.69 x 0.27 x 4.7
 = 0.88 seconds.

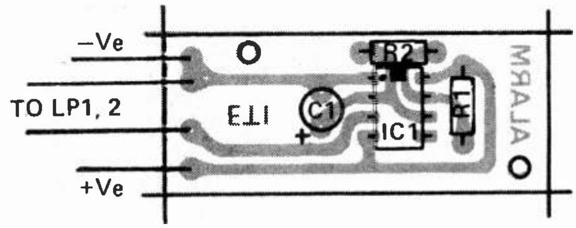
Total time of one oscillation = Tc + Td = 2.08 seconds. So, we have a flasher which is on for about 1 second in 2. The exact timing depends on the actual capacitance of the capacitor C, and this may differ from its rated value by as much as −20% and +50%.

The rate of flashing may be changed by changing the values of R1 and R2. Higher values cause slower flashing.

# Short Circuits



Picture showing method of mounting LP1, 2 on angled bracket.



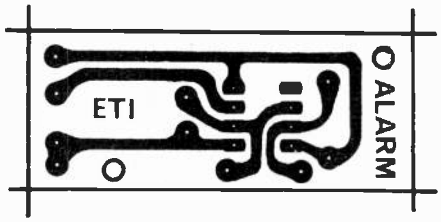

*Component overlay of Alarm. Because of the small size, miniature components should be used.*

then this device should be connected so that it is activated as the burglar alarm is energised.

The parts list specifies two 6 volt lamps of 60 mA rating which are connected in series. The current consumption is so low that the unit could be left operating for many hours without any danger of running down a car battery.

The IC is actually capable of switching up to 200 mA through pin 3, so there is no reason why two or even three slave units (with lamps only) should not be run in parallel with the lamps in the master unit. This could provide warnings at all vulnerable points in a car.

This same device can be used in windows of homes as a discouragement to house burglars. In this case it could be operated from a simple power supply running from the line.




*Foil pattern shown full size.*

## Parts List

RESISTORS (all ¼ W 5%)
R1 100 k
R2 270 k

CAPACITOR
C1 4u7 16 V tantalum

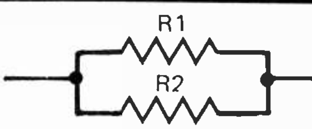
SEMICONDUCTOR
IC1 555 timer

LAMPS
LP1,2 6 V .06 A type

SWITCH
See text

MISCELLANEOUS
Nuts, bolts, spacers, etc.
Aluminium for front panel and bracket
Grommets, wire, red plexiglas
PCB as pattern.

# DATA




## Resistors in Parallel

| R2 \ R1 | 10 | 12 | 15 | 18 | 22 | 27 | 33 | 39 | 47 | 56 | 68 | 82 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 5.00 | 5.45 | 6.00 | 6.43 | 6.88 | 7.30 | 7.67 | 7.96 | 8.25 | 8.48 | 8.72 | 8.91 | 9.09 |
| 12 | 5.45 | 6.00 | 6.67 | 7.20 | 7.76 | 8.31 | 8.80 | 9.18 | 9.56 | 9.88 | 10.20 | 10.47 | 10.71 |
| 15 | 6.00 | 6.67 | 7.50 | 8.18 | 8.92 | 9.64 | 10.31 | 10.83 | 11.37 | 11.83 | 12.29 | 12.68 | 13.04 |
| 18 | 6.43 | 7.20 | 8.18 | 9.00 | 9.90 | 10.80 | 11.65 | 12.32 | 13.02 | 13.62 | 14.23 | 14.76 | 15.25 |
| 22 | 6.88 | 7.76 | 8.92 | 9.90 | 11.00 | 12.12 | 13.20 | 14.07 | 14.99 | 15.79 | 16.62 | 17.35 | 18.03 |
| 27 | 7.30 | 8.31 | 9.64 | 10.80 | 12.12 | 13.50 | 14.85 | 15.95 | 17.15 | 18.22 | 19.33 | 20.31 | 21.26 |
| 33 | 7.67 | 8.80 | 10.31 | 11.65 | 13.20 | 14.85 | 16.50 | 17.88 | 19.39 | 20.76 | 22.22 | 23.53 | 24.81 |
| 39 | 7.96 | 9.18 | 10.83 | 12.32 | 14.07 | 15.95 | 17.88 | 19.50 | 21.31 | 22.99 | 24.79 | 26.43 | 28.06 |
| 47 | 8.25 | 9.56 | 11.37 | 13.02 | 14.99 | 17.15 | 19.39 | 21.31 | 23.50 | 25.55 | 27.79 | 29.88 | 31.97 |
| 56 | 8.48 | 9.88 | 11.83 | 13.62 | 15.79 | 18.22 | 20.76 | 22.99 | 25.55 | 28.00 | 30.71 | 33.28 | 35.90 |
| 68 | 8.72 | 10.20 | 12.29 | 14.23 | 16.62 | 19.33 | 22.22 | 24.79 | 27.79 | 30.71 | 34.00 | 37.17 | 40.48 |
| 82 | 8.91 | 10.47 | 12.68 | 14.76 | 17.35 | 20.31 | 23.53 | 26.43 | 29.88 | 33.28 | 37.17 | 41.00 | 45.05 |
| 100 | 9.09 | 10.71 | 13.04 | 15.25 | 18.03 | 21.26 | 24.81 | 28.06 | 31.97 | 35.90 | 40.48 | 45.05 | 50.00 |
| 120 | 9.23 | 10.91 | 13.33 | 15.65 | 18.59 | 22.04 | 25.88 | 29.43 | 33.77 | 38.18 | 43.40 | 48.71 | 54.55 |
| 150 | 9.38 | 11.11 | 13.64 | 16.07 | 19.19 | 22.88 | 27.05 | 30.95 | 35.79 | 40.78 | 46.79 | 53.02 | 60.00 |
| 180 | 9.47 | 11.25 | 13.85 | 16.36 | 19.60 | 23.48 | 27.89 | 32.05 | 37.27 | 42.71 | 49.35 | 56.34 | 64.29 |
| 220 | 9.57 | 11.38 | 14.04 | 16.64 | 20.00 | 24.05 | 28.70 | 33.13 | 38.73 | 44.64 | 51.94 | 59.74 | 68.75 |
| 270 | 9.64 | 11.49 | 14.21 | 16.88 | 20.34 | 24.55 | 29.41 | 34.08 | 40.03 | 46.38 | 54.32 | 62.90 | 72.97 |
| 330 | 9.71 | 11.58 | 14.35 | 17.07 | 20.63 | 24.96 | 30.00 | 34.88 | 41.14 | 47.88 | 56.38 | 65.68 | 76.74 |
| 390 | 9.75 | 11.64 | 14.44 | 17.21 | 20.83 | 25.25 | 30.43 | 35.45 | 41.95 | 48.97 | 57.90 | 67.75 | 79.59 |
| 470 | 9.79 | 11.70 | 14.54 | 17.34 | 21.02 | 25.53 | 30.83 | 36.01 | 42.73 | 50.04 | 59.41 | 69.82 | 82.46 |
| 560 | 9.82 | 11.75 | 14.61 | 17.44 | 21.17 | 25.76 | 31.16 | 36.46 | 43.36 | 50.91 | 60.64 | 71.53 | 84.85 |
| 680 | 9.86 | 11.79 | 14.68 | 17.54 | 21.31 | 25.97 | 31.47 | 36.88 | 43.96 | 51.74 | 61.82 | 73.18 | 87.18 |
| 820 | 9.88 | 11.83 | 14.73 | 17.61 | 21.43 | 26.14 | 31.72 | 37.23 | 44.45 | 52.42 | 62.79 | 74.55 | 89.13 |
| 1000 | 9.90 | 11.86 | 14.78 | 17.68 | 21.53 | 26.29 | 31.95 | 37.54 | 44.89 | 53.03 | 63.67 | 75.79 | 90.91 |

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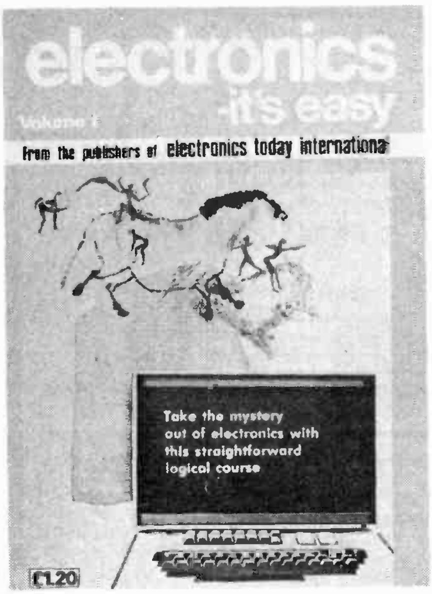


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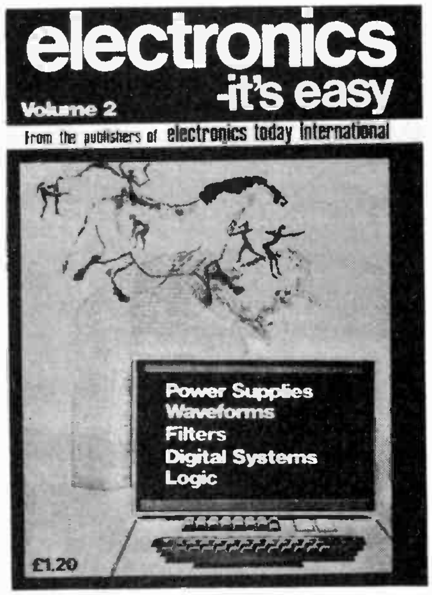


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# DESIGNING & USING

# ACTIVE FILTERS PART 2

**CONTINUING TIM ORR'S INSTRUCTIVE SERIES DESIGNED TO HELP THE HOME CONSTRUCTOR EMPLOY ONE OF THE MOST USEFUL CIRCUIT BLOCKS AVAILABLE**

**The following section contains all the information needed to be able to build low and high pass filters, of first, second, third and fourth order to Bessel, Butterworth and Chebyshev characteristics.**

## Low pass

Figure 1 shows a first order low pass filter. In all the examples to follow the filters have been designed for 1kHz operation. Equal component value 'Sallen and Key' filters have been used as the basic building blocks. If operation at a frequency other than 1kHz is required, then the resistor/s Rf should be scaled accordingly, (the Rd resistors are not altered). For example, if operation is required at 250Hz, then the Rf in the chart must be multiplied by

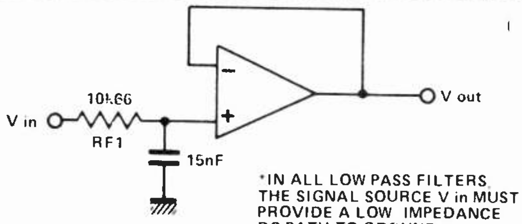
$$\frac{1000}{250}$$

which is

$$\frac{\text{(Normalised 1kHz)}}{\text{(Required frequency of operation)}} = 4.$$

Figure 2 shows second, third and fourth order filters. The design procedure is as follows:—

1. Decide which type of filter is required, high, low, bandpass or notch.
2. In the case of high or low pass, decide which type of response is required, Bessel, Butterworth or Chebyshev.
3. Next, what filter order is needed. This will have led you to a particular order filter with components designed for 1kHz operation.
4. Scale the Rf components so that the filter will operate at the required frequency.
5. Build and test the filter.

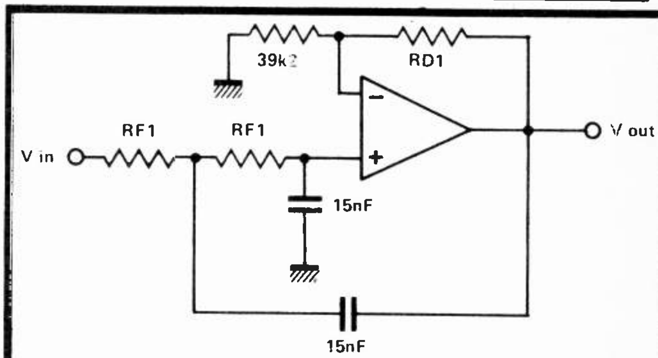



*IN ALL LOW PASS FILTERS THE SIGNAL SOURCE V in MUST PROVIDE A LOW IMPEDANCE DC PATH TO GROUND

| | RF1 | GAIN IN dB | COMPONENT TOLERANCES |
|---|---|---|---|
| BESSEL | 10k66 | 0 | 10% |
| BUTTERWORTH | 10k66 | 0 | 10% |
| CHEBYSHEV | 10k66 | 0 | 10% |

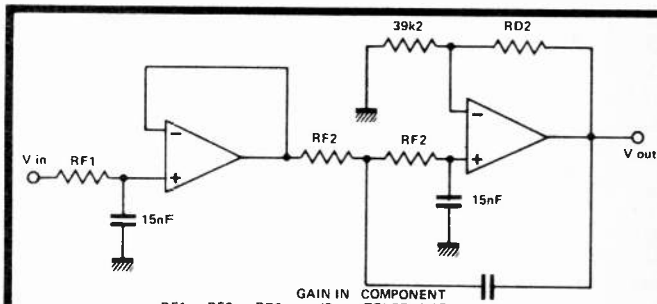
ALL THE RESPONSES ARE THE SAME FOR A FIRST ORDER FILTER

*Fig. 1. A general circuit for a first order low pass filter.*



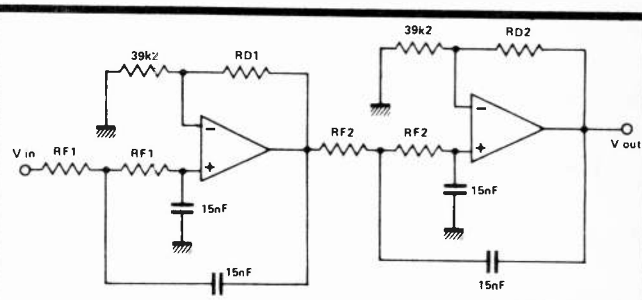

| | RF1 | RD1 | GAIN IN dB | COMPONENT TOLERANCE |
|---|---|---|---|---|
| BESSEL | 8k39 | 10k5 | 2.3 | 10% |
| BUTTERWORTH | 10k66 | 22k6 | 4.1 | 10% |
| CHEBYSHEV | 12k6 | 48k7 | 6.8 | 5% |

*Fig. 2a Second Order low pass filter design, break frequency = 1kHz.*




| | RF1 | RF2 | RD2 | GAIN IN dB | COMPONENT TOLERANCE |
|---|---|---|---|---|---|
| BESSEL | 8k | 7k26 | 21k5 | 4.1 | 10% |
| BUTTERWORTH | 10k66 | 10k66 | 39k2 | 6.0 | 10% |
| CHEBYSHEV | 35k41 | 11k73 | 66k5 | 8.6 | 2% |

*Fig. 2b Third Order low-pass filter. To alter break frequency (here 1kHz) scale resistors accordingly.*




| | RF1 | RD1 | RF2 | RD2 | GAIN IN dB | COMPONENT TOLERANCE |
|---|---|---|---|---|---|---|
| BESSEL | 7k45 | 3k24 | 6k60 | 29k4 | 5.6 | 10% |
| BUTTERWORTH | 10k66 | 5k9 | 10k66 | 48k7 | 8.3 | 5% |
| CHEBYSHEV | 24k11 | 42k2 | 11k20 | 71k5 | 15.3 | 1% |

*Fig. 2c Fourth Order Low Pass Filter.*

There are of course some problems which may occur. One is that these filters have a voltage gain in their passband. So you might find that although you have got the required frequency response there is an unexpected signal gain.

This may cause some problems with op-amp bandwidth. As a rule of thumb, the op amps should have 10 to 100 times more bandwidth than the product of the filters maximum operating frequency times the individual stage gain of each section. If the op amp runs out of bandwidth or introduces a phase shift then the filter is not going to work properly. For the examples given, if you use a 741 as the op amp then a frequency limit of approximately 10kHz should be imposed. (If an LM318 is used then the limit can go to 200kHz). Another problem is one of range of values of Rf. If Rf is made too small then large currents have to flow from the Op amp and this may effect the performance of the filter. If Rf is too large there may be hum pick-up problems and DC offset voltage problems due to bias currents. Therefore, keep Rf between 1k and 100k. If Rf needs to exceed this range, scale the capacitor as well.

## Charting examples

As an example of using the design tables, let us solve the following problem. Design an audio 'scratch' filter, having a break frequency of 7.5kHz and an attenuation at 15kHz of more than 20dB. The first decision to be made is what type of response do we want? A roll off of more than 20dB/octave is quite steep and so the Bessel filter is ruled out. The Chebyshev filter has a poor transient response and at 7.5kHz we would hear it ringing. Therefore a Butterworth response should be used. Next, the filter order. Third order gives us — 18dB/octave which is not sufficient, fourth order gives —24dB/octave. Hence what is needed is a fourth order Butterworth design (fig. 2c).

The break frequency is 7.5kHz and so the resistors Rf1 and Rf2 have to be *divided* by 7.5. This gives Rf1 = 1k42, Rf2 = 1k42, Rd1 = 5k9, Rd2 = 48k7 C=15nF, and the component tolerance is 5%. Now we must fit preferred values to the resistors.

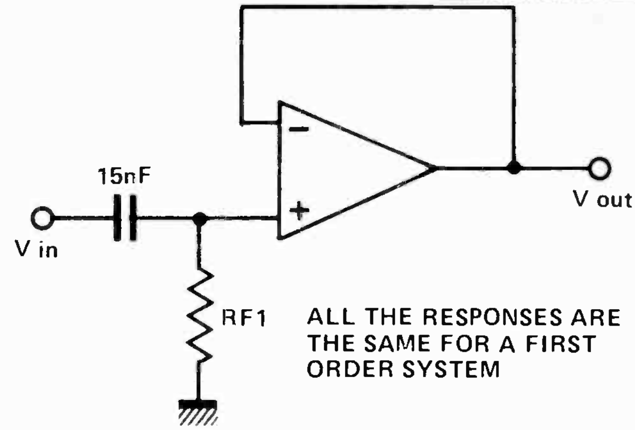
Rd2 becomes 47k, Rd1 becomes 6k2 (this is just over the limit of tolerance) Rf1 and Rf2 are a problem. Even when taken to the nearest 5% value they are outside the component tolerance allowed. There are two solutions; use the nearest 1% resistor or use 1k5. This will lower the break frequency by about 6%, but as this is only an audio filter no one will probably be any the wiser!

### High Pass

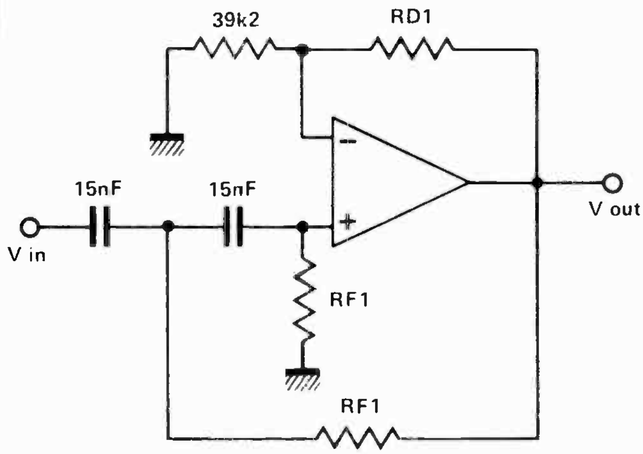
Figure 3 gives the design tables for high pass filters. The design procedure is exactly the same as that for low pass filters.

### Band Pass

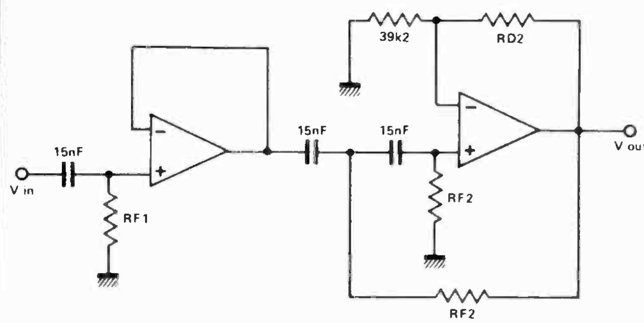
Several second order band pass filters can be cascaded to produce a different response shape which, like those discussed earlier for the low and high pass filters, can be optimised to give maximum roll off, or maximum pass band 'flatness'. However, these tend to get rather difficult to design and so only second order filters will be discussed.




| | RF1 | GAIN IN dB | COMPONENT TOLERANCE |
|---|---|---|---|
| BESSEL | 10k66 | 0 | 10% |
| BUTTERWORTH | 10k66 | 0 | 10% |
| CHEBYSHEV | 10k66 | 0 | 10% |




| | RF1 | RD1 | GAIN IN dB | COMPONENT TOLERANCE |
|---|---|---|---|---|
| BESSEL | 13k55 | 10k5 | 1.3 | 10% |
| BUTTERWORTH | 10k66 | 22k6 | 1.6 | 10% |
| CHEBYSHEV | 9k01 | 48k7 | 2.2 | 5% |

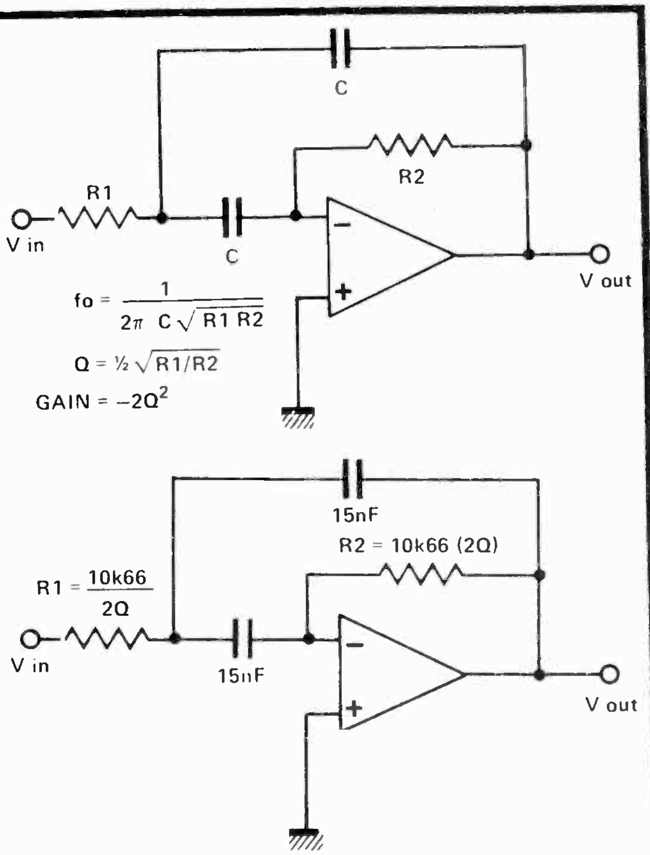



| | RF1 | RF2 | RD2 | GAIN IN dB | COMPONENT TOLERANCE |
|---|---|---|---|---|---|
| BESSEL | 14k19 | 15k68 | 21k5 | 4.1 | 10% |
| BUTTERWORTH | 10k66 | 10k66 | 39k2 | 6.0 | 10% |
| CHEBYSHEV | 3k21 | 9k70 | 66k5 | 8.6 | 2% |

*Fig. 3. From the top! First, second and third order high pass filters, break point 1kHz. Final roll off is 6, 12 and 18 dB/octave respectively.*

# ACTIVE FILTERS

Figure 4 shows a simple bandpass filter known as a multiple feedback circuit. This circuit can only provide low values of Q up to about 5. It will probably oscillate if it is designed to give a higher Q. Note that a high Q implies a large gain at the centre frequency. Therefore care must be taken to ensure the op amp has enough bandwidth to cope with the situation. Fig. 4 gives a design chart, normalised for 1kHz operation. First, choose a Q factor and then perform the frequency scaling: For instance, if the centre is 250Hz, then multiply *both* R1 and R2 by a factor of 4. If a high Q is required, then a multiple op amp circuit must be used. The 'state variable' and the 'Bi-Quad' are two such circuits and Q's as high as 500 may be obtained with them.




| Q | R1 | R2 | GAIN IN dB |
|---|---|---|---|
| 1 | 5k33 | 21k32 | 6 dB |
| 2 | 2k66 | 42k66 | 18.1dB |
| 3 | 1k77 | 60k40 | 25.1 dB |
| 4 | 1k33 | 85k33 | 30.1 dB |
| 5 | 1k06 | 106k66 | 34.0 dB |

*Fig. 4. A multiple feedback bandpass filter. The centre circuit is normalised for 1kHz. The table is the design table for this circuit. To change the centre frequency change $R_1$ and $R_2$ by an equal factor.*

Figure 5 shows a state variable filter. It has three major features which are

1. It can provide a stable high Q performance.
2. It is easily tuned.
3. It is versatile, providing bandpass, lowpass and highpass outputs simultaneously.

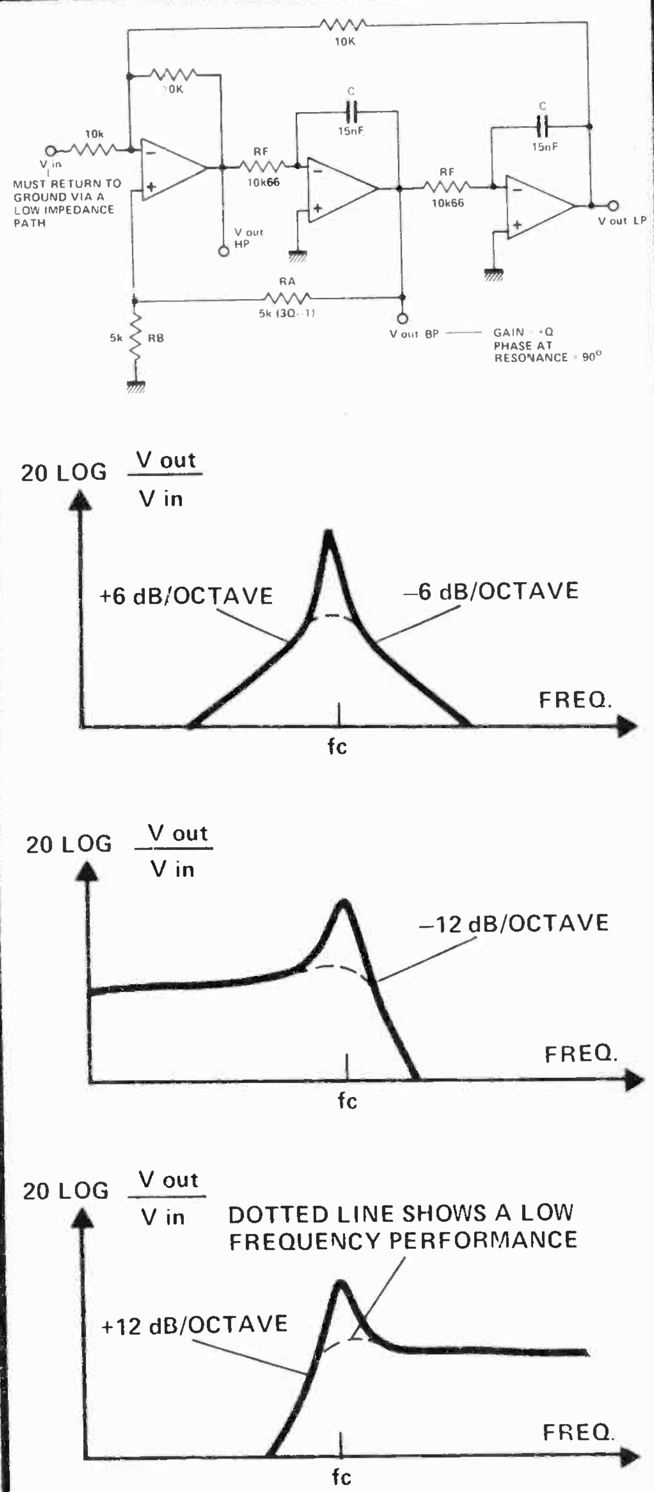



*Fig. 5. The state variable filter is called a universal filter because it can give bandpass, low and high pass outputs — as shown above. Note that all these responses are second order in nature.*

The Q is determined by the ratio of two resistors, RA and RB, where RA/RB = (3Q−1). The resonant frequency fc =

$$\frac{1}{2\pi R_f C}$$

Note that there are two C's and two Rf's in the circuit, and so if the filter is to be tuneable, then both Rf's should change by an equal amount (the Rf's can be a stereo pot).

You will note that Q and fc are independent of each other, and so as the resonant frequency is changed, Q remains constant, and visa versa.

## Op amps

The requirements placed upon the op amps in the filter, Fig. 5, are less than that for the multiple feedback circuit. The op amps need only have an open loop gain of 3Q at the resonant frequency. Say we have a Q of 100 and an fc of 10kHz. Therefore the open loop gain is 300, the frequency is 10kHz and so the gain bandwidth product needed is 3MHz. When using a high Q, care must be taken with signal levels. The gain of the filter is +Q at resonance, and so if you are filtering a 1V signal with a Q of 100 then you could expect to get a 100V output signal!

National Semiconductors manufacture an active filter integrated circuit, which is a four amp network that can be used to realise state variable filters with Q's up to 500, and frequencies up to 10kHz. The device is called AF100.

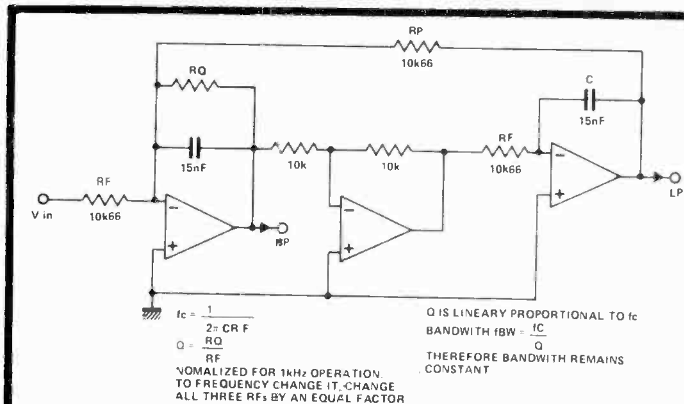
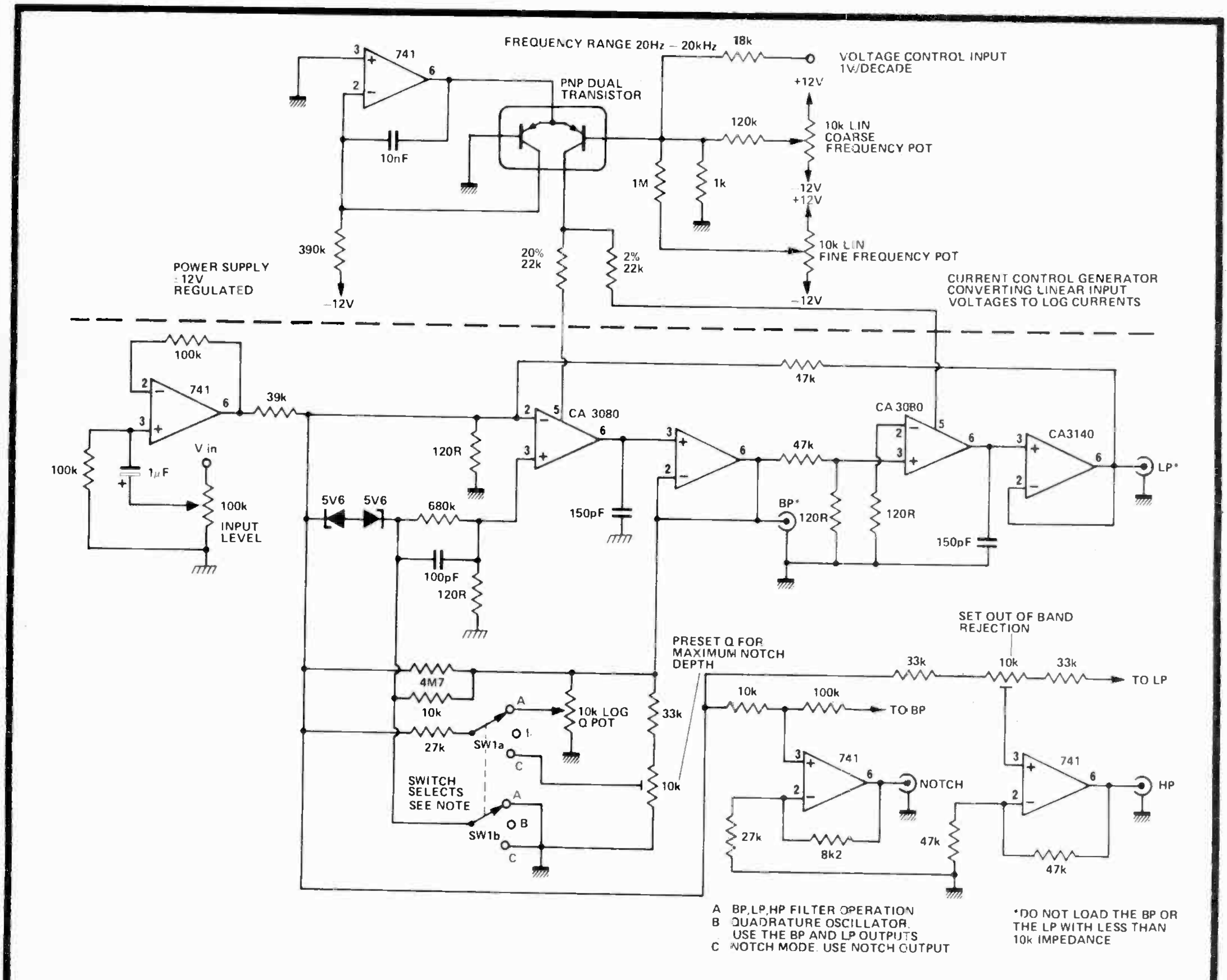



*Fig. 6. A Bi-Quad active filter design.*

Figure 6 shows a Bi-Quad active filter. It looks very similar to the state variable filter, but the small changes make it behave quite differently. It only has a bandpass and a low pass output. The resonant frequency is given by

$$f_c = \frac{1}{2\pi CR_f}$$

***Next month: Comb filters, delay lines and some practical circuits to build up.***




*The state variable filter can also be made to oscillate (as above). It is has a variable resonant frequency it becomes a variable frequency oscillator. This circuit produces two low distortion sinusoids in phase quadrature: ie, sine and cosine waveforms at low distortion.*

# tech-tips

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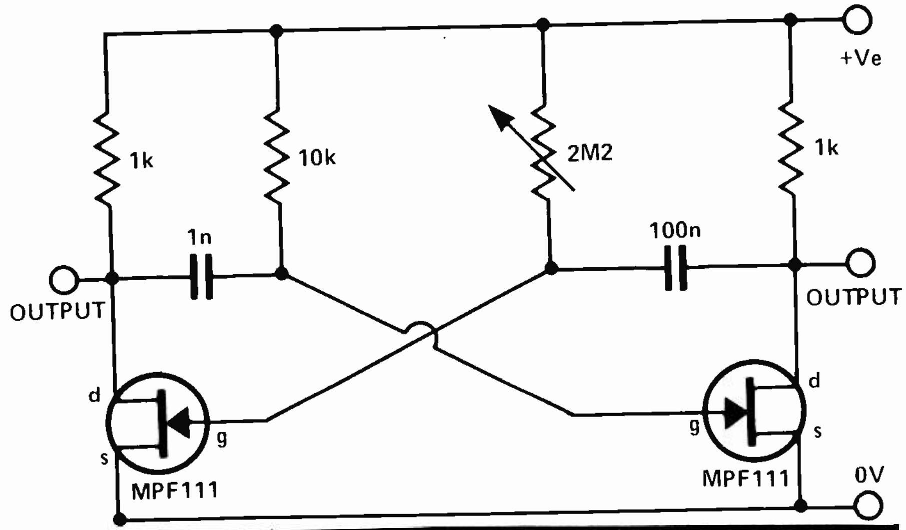


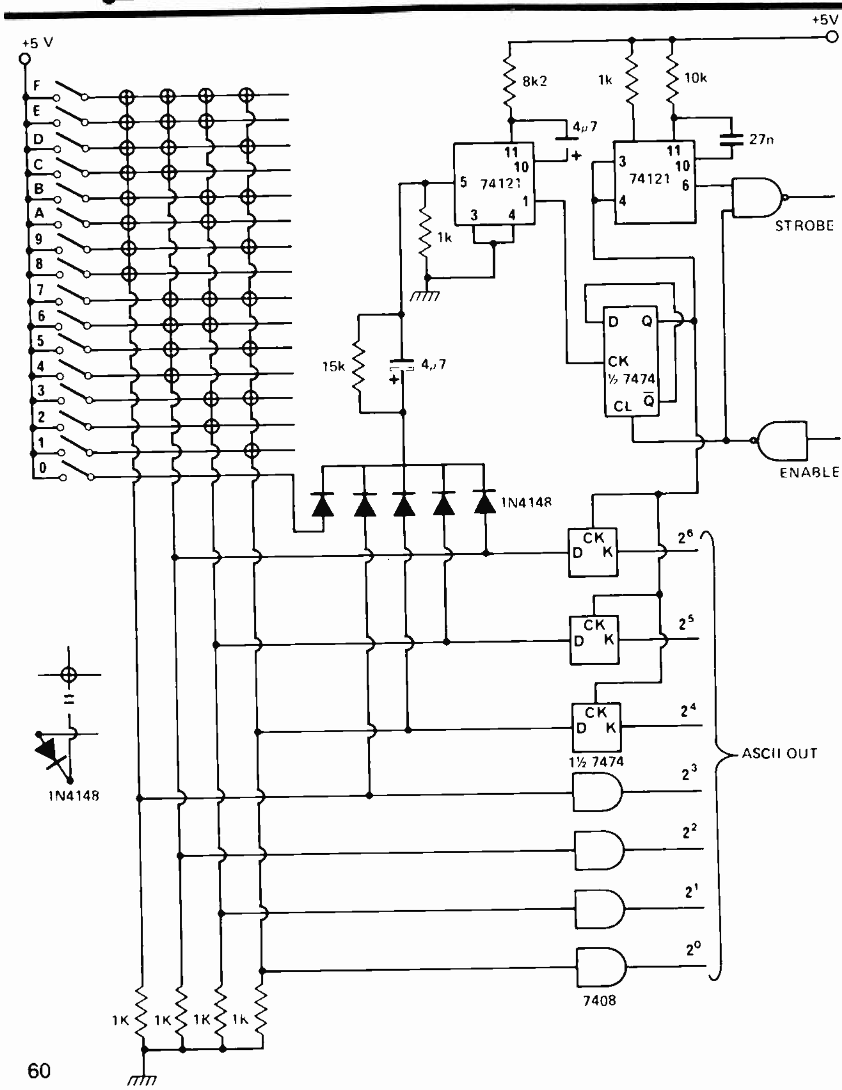

## Wide Range Astable

P. D. Maddinson

In a conventional astable, the bipolar transistors take a significant amount of base current, which limits the use of high value timing resistors. By replacing bipolar transistors with FET's, which consume a much smaller 'gate' current, we can use much higher values of timing resistor and hence get a much wider range.

N-channel FET's were chosen, so that a positive Vcc rail could be used, and with a 5V supply the circuit was able to drive TTL without trouble.

With the component values given one time constant was approx. 5 $\mu$S, and the other was variable from 5 $\mu$S to approx. 2mS; a range of 400:1.




## ASCII Keyboard

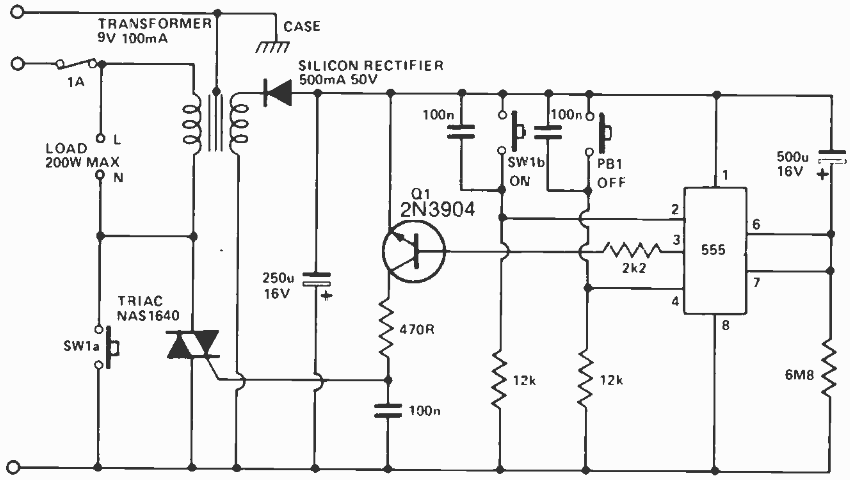
R. Barnett

This circuit uses a 16 key calculator keyboard to generate the 7 bit ASCII code, using two hex numbers to define ASCII character.

If, for example, the code for A (41 hex) is required, '4' is pressed first. After 10mS (to avoid switch bounce) the binary code from the diode matrix is latched into three D-type flip-flops. '1' is now entered. This time, after the 10mS delay, a 200uS pulse is produced by the second 74121. If the ENABLE input is low, a negative pulse appears on the STROBE output, while the ASCII code for A appears on the other outputs. If the enable input is high, the circuit remains in its initial state with the strobe pulse disabled.

## Automatic Night Light

C. N. Harrison




This circuit was devised to turn off a bedroom light after a period of an hour. It could, however, be used to control any load up to a maximum of 200W. At the end of the period the unit switches off both itself and the load.

The timing period is generated by a standard 555 timer in monostable mode controlled by SW1b and PB1. For reliable operation timing capacitor C should be selected for low leakage. The output of the timer switches Q1 which in turn controls the gate current for the triac. During the timing period the triac is fully turned on so there is no degradation of the waveform across the load or RFI due to switching transients.

To initiate the timing period mains must be applied to the transformer to provide a DC supply for the timing circuitry. This is achieved by momentarily bypassing the triac with one pole of the ON switch, SW1a. Because this switch must also provide power to the load it must be rated accordingly. SW1b is used to trigger the 555 and start the timing period. Q1 will then be turned on, providing gate current to turn on the triac. When SW1 is released the supply and the load is maintained until the end of the timing period. PB1 is provided so that the load can be switched off at any time. It may be omitted if this feature is not required.

Great care must be exercised with this circuit as all components are connected even when inactive.

# LOGIC/ MICROPROCESESSOR DATA

## TTL TO CMOS FUNCTIONAL EQUIVALENT TYPES
## HEXADECIMAL AND DECIMAL INTEGER CONVERSATION TABLE
## COMPARISON OF STANDARD LOGIC FAMILIES
## BASIC LOGIC SYMBOLS AND TRUTH TABLES
## LAWS OF BOOLEAN ALGEBRA
## MICROPROCESSOR GLOSSARY

### TTL TO CMOS FUNCTIONALLY EQUIVALENT TYPES

| TTL | CMOS | |
|---|---|---|
| 7400 | 4011 | |
| 7401 | 40107 | |
| 7402 | 4001 | |
| 7404 | 4009 | 4049 |
| 7406 | 4009 | 4049 |
| 7407 | 4010 | 4050 |
| 7408 | 4081 | |
| 7410 | 4023 | |
| 7411 | 4073 | |
| 7420 | 4012 | |
| 7425 | 4002 | |
| 7427 | 4025 | |
| 7428 | 4001 | |
| 7430 | 4068 | |
| 7432 | 4071 | |
| 7437 | 4011 | |
| 7440 | 4012 | |
| 7442 | 4028 | |
| 7445 | 4028 | |
| 7446 | 4511 | 4055 |
| 7447 | 4511 | 4055 |
| 7448 | 4511 | 4055 |
| 7449 | 4511 | 4055 |
| 7450 | 4085 | |
| 7453 | 4086 | |
| 7454 | 4086 | |
| 7470 | 4096 | |
| 7472 | 4095 | |
| 7473 | 4027 | |
| 7474 | 4013 | |

| TTL | CMOS | |
|---|---|---|
| 7475 | 4042 | |
| 7476 | 4027 | |
| 7477 | 4042 | |
| 7478 | 4027 | |
| 7483 | 4008 | |
| 7485 | 4063 | |
| 7486 | 4030 | 4070 |
| 7490 | 4518 | |
| 7491 | 4015 | 4094 |
| 7493 | 4520 | |
| 7494 | 4035 | |
| 7495 | 40104 | 40194 |
| 7499 | 40104 | 40194 |
| 74100 | 4034 | |
| 74104 | 4095 | |
| 74105 | 4095 | |
| 74107 | 4027 | |
| 74110 | 4095 | |
| 74111 | 4027 | |
| 74121 | 4047 | 4098 |
| 74122 | 4047 | 4098 |
| 74123 | 4098 | |
| 74125 | 4502 | |
| 74126 | 4502 | |
| 74132 | 4093 | |
| 74136 | 4030 | 4070 |
| 74141 | 4028 | |
| 74145 | 4028 | |
| 74148 | 4532 | |

| TTL | CMOS | |
|---|---|---|
| 74150 | 4067 | |
| 74151 | 4051 | 4097 |
| 74152 | 4051 | 4097 |
| 74153 | 4052 | |
| 74154 | 4514 | 4515 |
| 74155 | 4555 | 4556 |
| 74156 | 4555 | 4556 |
| 74157 | 4019 | |
| 74164 | 4015 | |
| 74165 | 4021 | |
| 74166 | 4014 | |
| 74167 | 4527 | |
| 74173 | 4076 | |
| 74178 | 4035 | |
| 74179 | 4035 | |
| 74180 | 40101 | |
| 74181 | 40181 | |
| 74182 | 40182 | |
| 74190 | 4510 | |
| 74191 | 4516 | |
| 74194 | 40104 | 40194 |
| 74195 | 4035 | |
| 74198 | 4034 | |
| 74200 | 4061 | |
| 74251 | 4051 | 4097 |
| 74279 | 4044 | |
| 74283 | 4008 | |
| 74290 | 4518 | |
| 74293 | 4520 | |

# HEXADECIMAL AND DECIMAL INTEGER CONVERSATION TABLE

| 8 | | 7 | | 6 | | 5 | | 4 | | 3 | | 2 | | 1 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hex | Decimal | Hex | Decimal | Hex | Decimal | Hex | Decimal | Hex | Decimal | Hex | Dec mal | Hex | Decimal | Hex | Decimal |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 268,435,456 | 1 | 16,777,216 | 1 | 1,048,576 | 1 | 65,536 | 1 | 4,096 | 1 | 256 | 1 | 16 | 1 | 1 |
| 2 | 536,870,912 | 2 | 33,554,432 | 2 | 2,097,152 | 2 | 131,072 | 2 | 8,192 | 2 | 512 | 2 | 32 | 2 | 2 |
| 3 | 805,306,368 | 3 | 50,331,648 | 3 | 3,145,728 | 3 | 196,608 | 3 | 12,288 | 3 | 768 | 3 | 48 | 3 | 3 |
| 4 | 1,073,741,824 | 4 | 67,108,864 | 4 | 4,194,304 | 4 | 262,144 | 4 | 16,384 | 4 | 1,024 | 4 | 64 | 4 | 4 |
| 5 | 1,342,177,280 | 5 | 83,886,080 | 5 | 5,242,880 | 5 | 327,680 | 5 | 20,480 | 5 | 1,280 | 5 | 80 | 5 | 5 |
| 6 | 1,610,612,736 | 6 | 100,663,296 | 6 | 6,291,456 | 6 | 393,216 | 6 | 24,576 | 6 | 1,536 | 6 | 96 | 6 | 6 |
| 7 | 1,879,048,192 | 7 | 117,440,512 | 7 | 7,340,032 | 7 | 458,752 | 7 | 28,672 | 7 | 1,792 | 7 | 112 | 7 | 7 |
| 8 | 2,147,483,648 | 8 | 134,217,728 | 8 | 8,388,608 | 8 | 524,288 | 8 | 32,768 | 8 | 2,048 | 8 | 128 | 8 | 8 |
| 9 | 2,415,919,104 | 9 | 150,994,944 | 9 | 9,437,184 | 9 | 589,824 | 9 | 36,864 | 9 | 2,304 | 9 | 144 | 9 | 9 |
| A | 2,684,354,560 | A | 167,772,160 | A | 10,485,760 | A | 655,360 | A | 40,960 | A | 2,560 | A | 160 | A | 10 |
| B | 2,952,790,016 | B | 184,549,376 | B | 11,534,336 | B | 720,896 | B | 45,056 | B | 2,816 | B | 176 | B | 11 |
| C | 3,221,225,472 | C | 201,326,592 | C | 12,582,912 | C | 786,432 | C | 49,152 | C | 3,072 | C | 192 | C | 12 |
| D | 3,489,660,928 | D | 218,103,808 | D | 13,631,488 | D | 851,968 | D | 53,248 | D | 3,328 | D | 208 | D | 13 |
| E | 3,758,096,384 | E | 234,881,024 | E | 14,680,064 | E | 917,504 | E | 57,344 | E | 3,584 | E | 224 | E | 14 |
| F | 4,026,531,840 | F | 251,658,240 | F | 15,728,640 | F | 983,040 | F | 61,440 | F | 3,840 | F | 240 | F | 15 |
| 8 | | 7 | | 6 | | 5 | | 4 | | 3 | | 2 | | 1 | |

## TO CONVERT HEXADECIMAL TO DECIMAL

1 Locate column of decimal numbers corresponding to left-most digit or letter of hexadecimal select from this column and record number that corresponds to position of hexadecimal digit or letter.
2 Repeat step 1 for next (second from left) position.
3 Repeat step 1 for units (third from left) position.
4 Add numbers selected from table to form decimal number

## TO CONVERT DECIMAL TO HEXADECIMAL

1 (A) se ect from table highest decimal number that is equal to or less than number to be converted.
(B) Record hexadecimal of column containing selected number.
(C) Subtract selected decimal from number to be converted.
2 Using remainder from step 1 (C) repeat all of step 1 to develop second position of hexadecimal (and remainder).
3 Using remainder from step 2 repeat all of step 1 to develop units position of hexadecimal.
4 Combine terms to form hexadecimal number.

# COMPARISON OF STANDARD LOGIC FAMILIES

| Logic family | Noise Immunity Volts | Prop. delay nS | Fan Out | Max. Toggle Speed MHZ | Supply Voltage Nominal V | Min. V | Max. V | Power Diss. per package mW (typ) | Decoupling and other requirements |
|---|---|---|---|---|---|---|---|---|---|
| 74 Series | 0.4 | 9 | 10 | 15 | 5.0 | 4.75 | 5.25 | 40 | 0.1 uF Ceramic |
| 74H Series | 0.4 | 6 | 10 | 40 | 5.0 | 4.75 | 5.25 | 60 | capacitor for every 8 |
| 74S Series | 0.3 | 3 | 10 | 125 | 5.0 | 4.75 | 5.25 | 40 | packages to eliminate |
| 74LS Series | 0.3 | 9 | 10 | 25 | 5.0 | 4.75 | 5.25 | 8 | switchingcurrentspike |
| CMOS | 4.5 | 30 | >50 | 10 | — | 3.0 | 18.0 | 0.01 | No special precautions |

### TTL BIPOLAR LOGIC

The 74 Series of transistor-transistor logic is a medium speed family of saturating integrated circuit logic designed for general digital logic application requiring clock frequencies to 30MHz and switching speeds in the 7-11 nS range under moderate capacitive loading.

The circuits are identified by a multiple emitter input transistor and an active "pull up" in the upper output network. Clamp diodes are provided at each input to limit the undershoot that occurs in typical system applications such as driving long interconnect wiring. The active pull-up output configuration provides low output impedance in the high output state. The resulting low impedances in both output states ensures excellent a.c. noise immunity and allows a high-speed operation with capacitive loads.

### COMPLEMENTARY MOS (CMOS)

Complementary MOS is the newest of the general-purpose logic families.

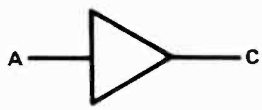
The following are primary design features of the whole of the COS/MOS and McMOS ranges.

— Double diode protection on all inputs.
— Noise immunity typically 45% of VDD, 30% of VDD minimum.
— Buffered output compatible with MHTL and Low Power TTL.
— Low quiescent power dissipation: 25nW typ. per package.
— Wide power supply voltage: 3-18 Volt dependent on type.
— Single supply operation.
— High fanout: greater than 50
— High input impedance: $10^{12}$ ohms typ.
— Low input capacitance: 5pf typ.

# BASIC LOGIC SYMBOLS AND TRUTH TABLES

BUFFER

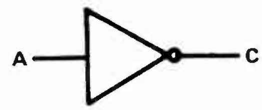
INPUT OUTPUT




| A | C |
|---|---|
| 0 | 0 |
| 1 | 1 |

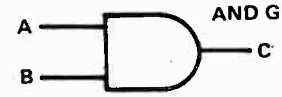
INVERTER

INPUT OUTPUT



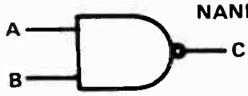

| A | C |
|---|---|
| 0 | 1 |
| 1 | 0 |

AND GATE



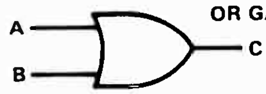

| A | B | C |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

NAND GATE



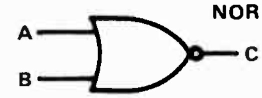

| A | B | C |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

OR GATE




| A | B | C |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 1 |

NOR GATE

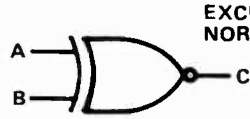



| A | B | C |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |

EXCLUSIVE OR GATE


| A | B | C |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

EXCLUSIVE NOR GATE




| A | B | C |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

LAWS OF BOOLEAN ALGEBRA

| | |
|---|---|
| A + 0 = A | A.A = A |
| A + 1 = 1 | A + $\overline{A}$ = 1 |
| A.0 = 0 | A.$\overline{A}$ = 0 |
| A + A = A | A.1 = A |

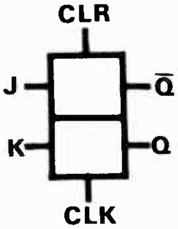
A.B + A.C = A(B + C)

A + B.C = (A + B)(A + C)

$\overline{A.B.C} = \overline{A} + \overline{B} + \overline{C}$

$\overline{A}.\overline{B}.\overline{C}. = \overline{A + B + C}$

J.K. Flip Flop




| INPUTS | | | OUTPUTS | | |
|---|---|---|---|---|---|
| CLR | CLK | J | K | Q | $\overline{Q}$ |
| 0 | X | X | X | 0 | 1 |
| 1 | ⎍ | 0 | 0 | Qo | $\overline{Qo}$ |
| 1 | ⎍ | 1 | 0 | 1 | 0 |
| 1 | ⎍ | 0 | 1 | 0 | 1 |
| 1 | ⎍ | 1 | 1 | TOGGLE | |

⎍ —HIGH LEVEL PULSE, DATA IS TRANSFERRED ON FALLING EDGE OF PULSE.

Qo —THE LEVEL OF Q BEFORE INDICATED INPUT CONDITIONS WHERE ESTABLISHED.

TOGGLE —EACH OUTPUT CHANGES TO ITS COMPLEMENT ON EACH ACTIVE TRANSIENT (PULSE OF CLOCK).

# MICROPROCESSOR GLOSSARY

ACCUMULATOR: The register where arithmetic or logic results are held. Most MPU instructions manipulate or test the accumulator contents.
ACCESS TIME: Time take for specific byte of storage to become available to processor.
ACIA: Asynchronous Communication Inter-face Adapter. Inter-face between asynchronous peripheral and an MPU.
ALU: Arithmetic and Logic Unit. The part of the MPU where arithmetic and logic functions are performed.
ASCII: American Standard Code for Information Interchange. Binary code to represent alphanumeric, special and control characters.
ASSEMBLER: Software which converts assembly language statements into machine code and checks for non valid statements or incomplete definitions.
ASSEMBLY LANG: Means of representing programme statements in mnemonics and conveniently handling memory addressing by use of symbolic terms.
ASYNCHRONOUS: Operations that initiate a new operation immediately upon completion of current one — not timed by system clock.
BASIC: Beginner's All Purpose Symolic Instruction Code. An easy to learn, widely used high level language.
BAUD: Measure of speed of transmission line. Number of times a line changes state per second. Equal to bits per second if each line state represents logic 0 or 1.
BAUDOT CODE: 5-bit code used to encode alphanumeric data.
BCD: Binary Coded Decimal. Means of representing decimal numbers where each figure is replaced by a binary equivalent.
BENCHMARK: A common task for the implementation of which programmes can be written for different MPUs in order to determine the efficiency of the different MPUs in the particular application.
BINARY: The two base number system. The digits are 0 or 1. They are used inside a computer to represent the two states of an electric circuit.
BIT: A single binary digit.
BREAKPOINT: Program address at which execution will be halted to allow debugging or data entry.
BUFFER: Circuit to provide isolation between sensitive parts of a system and the rest of that system.
BUG: A program error that causes the program to malfunction.
BUS: The interconnections in a system that carry parallel binary data. Several bus users are connected to the bus, but generally only one "sender" and one "receiver" are active at any one instant.
BYTE: A group of bits — the most common byte size is eight bits.
CLOCK: The basic timing for a MPU chip.
COMPILER: Software which converts high level language statements into either assembly language statements, or into machine code.
CPU: Central processor unit. The part of a system which performs calculation and data manipulation functions.
CROM: Control Read Only Memory.
CRT: Cathode Ray Tube. Often taken to mean complete output device.
CUTS: Computer Users Tape System. Definition of system for storing data on cassette tape as series of tones to represent binary 1's and 0's.
DEBUG: The process of checking and correcting any program errors either in writing or in actual function.
DIRECT ADDRESSING: An addressing mode where the address of the operand is contained in the instruction.
DMA: Direct Memory Access.
DUPLEX: Transfer of data in two directions simultaneously.
ENVIRONMENT: The conditions of all registers, flags, etc., at any instant in program.
EPROM: Electrically Programmable Read Only Memory. Memory that may be erased (usually by ultra violet light) and reprogrammed electrically.
EXECUTE: To perform a sequence of program steps.
EXECUTION TIME: The time taken to perform an instruction in terms of clock cycles.
FIRMWARE: Instructions or data permanently stored in ROM.
FLAG: A flip flop that may be set or reset under software control.
FLIP-FLOP: Two state device that changes state when clocked.
FLOPPY (DISK): Mass storage which makes use of flexible disks made of a material similar to magnetic tape.
FLOW CHART: A diagram representing the logic of a computer program.
GLITCH: Noise pulse.
HALF DUPLEX: Data transfer in two directions but only one way at a time.
HAND SHAKE: System of data transfer between CPU and peripheral whereby CPU "asks" peripheral if it will accept data and only transfers data if "answer" is yes.
HARD COPY: System output that is printed on paper.
HARDWARE: All the electronic and mechanical components making up a system.
HARD WIRE: Circuits that are comprised of logic gates wired together, the wiring pattern determining the overall logic operation.
HASH: Noisy signal.
HEXADECIMAL: The base 16 number system. Character set is decimal 0 to 9 and letters A to F.
HIGH LEVEL LANGUAGE: Computer language that is easy to use, but which requires compiling into machine code before it can be used by an MPU.
HIGHWAY: As BUS.
IMMEDIATE ADDRESSING: Addressing mode which uses part of the instruction itself as the operand data.
INDEXED ADDRESSING: A form of indirect addressing which uses an Index Register to hold the address of the operand.
INDIRECT ADDRESSING: Addressing mode where the address of the location where the address of the operand may be found is contained in the instruction.
INITIALISE: Set up all registers, flag, etc., to defined conditions.
INSTRUCTION: Bit pattern which must be supplied to an MPU to cause it to perform a particular function.
INSTRUCTION REGISTER: MPU register which is used to hold instructions fetched from memory.
INSTRUCTION SET: The repertoire of instructions that a given MPU can perform.
INTERFACE: Circuit which connects different parts of system together and performs any processing of signals in order to make transfer possible (ie, serial — parallel conversion).
INTERPRETER: An interpreter is a software routine which accepts and executes a high level language program, but unlike a compiler does not produce intermediate machine code listing but converts each instruction as received.
INTERRUPT: A signal to the MPU which will cause it to change from its present task to another.
I/O: Input/Output.
K: Abbreviation for $2^{10} = 1028$.
KANSAS CITY (Format): Definition of a CUTS based cassette interface system.
LANGUAGE: A systemmatic means of communicating with an MPU.
LATCH: Retains previous input state until overwritten.
LIFO: Last In First Out. Used to describe data stack.
LOOPING: Program technique where one section of program (the loop) is performed many times over.
MACHINE LANG: The lowest level of program. The only language an MPU can understand without interpreter.
MASK: Bit pattern used in conjunction with a logic operation to select a particular bit or bits from machine word.
MEMORY: The part of a system which stores data (working data or instruction object code).
MEMORY MAP: Chart showing the memory allocation of a system.
MEMORY MAPPED I/O: A technique of implementing I/O facilities by addressing I/O ports as if they were memory locations.
MICRO CYCLE: Single program step in an MPUs Micro program. The smallest level of machine program step.
MICRO PROCESSOR: A CPU implemented by use of large scale integrated circuits. Frequently implemented on a single chip.
MICRO PROGRAM: Program inside MPU which controls the MPU chip during its basic fetch/execute sequence.
MNEMONIC: A word or phrase which stands for another (longer) phrase and is easier to remember.
MODEM: Modulator/demodulator used to send and receive serial data over an audio link.
NON VOLATIVE: Memory which will retain data content after power supply is removed, e.g. ROM.
OBJECT CODE: To bit patterns that are presented to the MPU as instructions and data.
O/C: Open Collector. Means of tieing together O/P's from different devices on the same bus.
OCTAL: Base 8 number system. Character set is decimal 0-8.
OP CODE: Operation Code. A bit pattern which specifies a machine operation in the CPU.
OPERAND: Data used by machine operations.
PARALLEL: Transfer of two or more bits at the same time.
PARITY: Check bit added to data, can be odd or even parity. In odd parity sum of data 1's + parity bit is odd.
PERIPHERAL: Equipment for inputing to or outputting from the system (e.g., teletype, VDU, etc.).
PIA: Peripheral Interface Adapter.
POP: Operation of removing data word from LIFO stack.
PORT: A terminal which the MPU uses to communicate with the outside world.
PROGRAMS: Set of MPU instructions which instruct the MPU to carry out a particular task.
PROGRAM COUNTER: Register which holds the address of next instruction (or data word) of the program being executed.
PROM: Programmable read only memory. Proms are special form of ROM, which can be individually programmed by user.
PUSH: Operation of putting data to LIFO stack.
RAM: Random Access Memory. Read write memory. Data may be written to or read from any location in this type of memory.
REGISTER: General purpose MPU storage location that will hold one MPU word.
RELATIVE ADDRESSING: Mode of addressing whereby address of operand is formed by combining current program count with a displacement value which is part of the instruction.
ROM: Read Only Memory. Memory device which has its data content established as part of manufacture and cannot be changed.
SCRATCH PAD: Memory that has short access time and is used by system for short term data storage.
SERIAL: Transfer of data one bit at a time.
SIMPLEX: Data transmission in one direction only.
SOFTWARE: Programs stored on any media.
SOURCE CODE: The list of statements that make up a program.
STACK: A last in first out store made up of registers or memory locations used for stack.
STATUS REGISTER: Register that is used to store the condition of the accumulator after an instruction has been performed (e.g., Acc = 0).
SUB ROUTINE: A sequence of instructions which perform an often required function, which can be called from any point in the main program.
SYNTAX: The grammar of a programming language.
TRAP (Vector): Pre-defined location in memory which the processor will read as a result of particular condition or operation.
TRI STATE: Description of logic devices whose outputs may be disabled by placing them in a high impedance state.
TTY: Teletype.
TWO'S COMPLEMENT ARITHMETIC: System of performing signed arithmetic with binary numbers.
UART: Universal Asynchronous Receiver Transmitter.
VDU: Video Display Unit.
VECTOR: Memory address, provided to the processor to direct it to a new area in memory.
VOLATILE: Memory devices that will lose data content if power supply removed (i.e., RAM).
WORD: Parallel collection of binary digits much as byte.

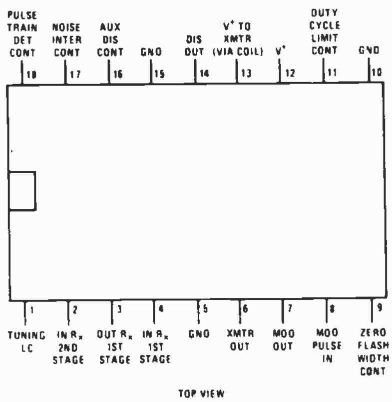
## LM1812 ULTRASONIC TRANSCEIVER

NATIONAL

The LM1812 is a special monolithic IC which consists of a 12W ultrasonic transmitter circuit, which uses novel circuitry to eliminate costly alignment adjustments, a selective receiver which uses only one external LC network, impulse noise rejection circuitry, a 10W display driver, and a keyed modulator. The system operates from a 12V battery, drives power into a transducer, receives an echo and drives a display lamp.

A single LC network is time shared between the receiver and the transmitter to reduce external parts, to eliminate alignment labour and to guarantee that the received signal is always of the proper frequency.

Dual-In-Line Package




### FEATURES

- Has special access pins (7 and 16) which allow adding an audible alarm feature to indicate an echo within a presettable maximum depth (or range).
- Does not require any heat sinking of the IC package
- Uses a built-in monostable multivibrator, with the capacitor on the chip, to pulse drive the transmitter for high efficiency and to minimize transducer interaction
- Has special circuitry to limit the maximum ON time of the display driver
- Can operate with a neon, a LED display device, a digital readout or a CRT

### TRANSDUCERS

Transducers are available for use either in water or air. The appropriate transducer is important for proper functioning in the intended application; for example, the high frequency attenuation in air usually requires a lower operating frequency. The modifications for a 40 kHz system are shown.

### LAYOUT

As the LM1812 contains both a transmitter and a receiver in proximity, PC layouts or breadboarding has to be done with special attention to ground loops and common coupling paths. The use of three ground pins on the IC package helps reduce grounding problems, but at the time of transmission, with the display driver also ON, there can be 1-2A of peak current passed into the ground trace.

### INTERFERENCE

Local sources of High energy impulse noise, if not locally shielded, can cause an unwanted display "blip."

A small valued capacitor (approximately 30 pF) can be connected across the first receive stage (between pins 3 and 4) to reduce the bandwidth and filter out these noise pulses.

Impulse noise is rejected by the combined action of the "Pulse Train Detector" and the "Integrator" circuits. The integrator requires a number of cycles of valid returns to be received before turning ON the display driver. The pulse train detector will dump the integrator if a continuous train of pulses is not received (if 2 or 3 are missing, the integration capacitor is discharged to ground).

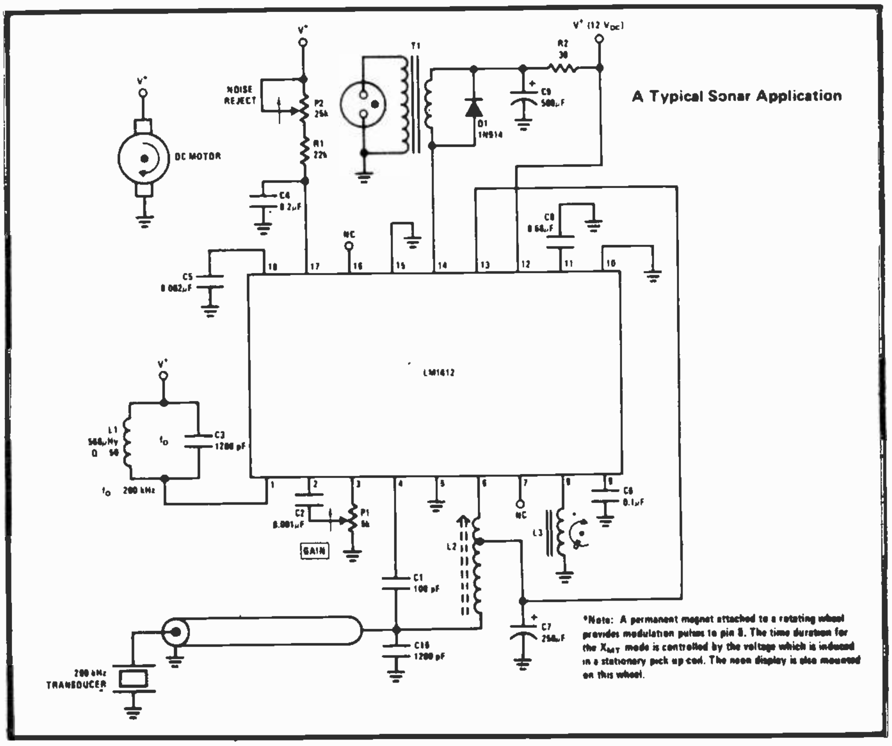
### POWER LEVELS

For ranging applications, large transmit power levels are necessary due to the two-way path and the resulting received echo power falling as the fourth power of range (additional external receiver gain can be used to extend the range). One way communication links can use reduced power. Transmit power can be checked by measuring the voltage swing across the transducer (of known impedance) during the transmit mode. The magnitude of the transmitter power depends on the transducer impedance as presented to the transmitter power amplifier (usually a transformer is used to couple the transducer to the power amplifier). A minimum value of 10Ω causes approximately 1A peak current pulses out of this power amplifier. The inductance of the secondary should be designed to resonate with the sum of the capacitance associated with the cable feeding the transducer and that of the transducer. The low Q resonance allows transducer replacement without tuning.

An internal one-shot multivibrator with a fixed time of 1 μs is used to drive the transmitter power amplifier into saturation for this time period once for each cycle of the transmit frequency. At a frequency of 200 kHz, this results in a high efficiency class-C type of operation for the power amplifier. The transmit frequency is equal to the natural resonance of the external LC network which is tied to pin 1. This network is also used to establish the centre frequency and the selectivity of the receiver.

### DISPLAY CONTROL

The collector of a grounded-emitter NPN transistor can be tied to pin 16 to allow an auxiliary control of the display driver. This transistor should normally be held OFF and should go ON for a time interval no longer than 1 ms if a neon display is used, due to the rapid current build-up in the primary of the step-up transformer. If a LED is used as a display device with a series limiting resistor, this ON time can be made longer as it is now limited only by the increased dissipation of the IC which results from the saturation




A Typical Sonar Application

*Note: A permanent magnet attached to a rotating wheel provides modulation pulses to pin 8. The time duration for the $X_{MIT}$ mode is controlled by the voltage which is induced in a stationary pick up coil. The neon display is also mounted on this wheel.

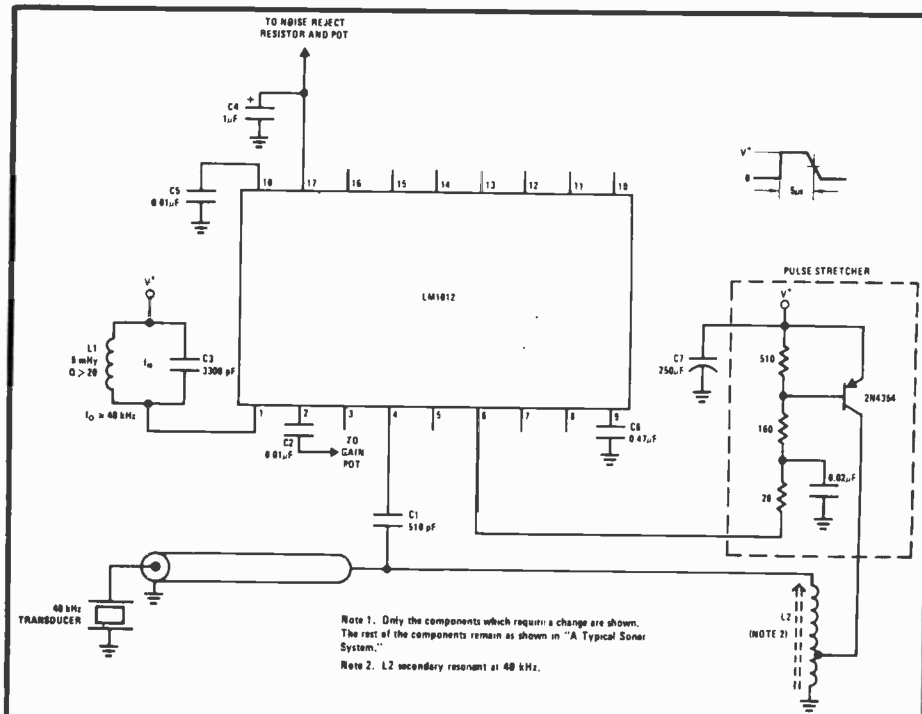
voltage at pin 14 and the ON current of the LED.

### AUDIO

An IC audio amplifier can be used to amplitude modulate the carrier for an AM communication link. A high input impedance detector and audio amplifier attach to pin 1 for the receiver. One audio amplifier can be switched between the modulator and the receiver section. FM or pulse modulation techniques can also be used to reduce the modulator power requirements.

### DIGITAL DISPLAY

A digital depth (or range) readout can be used with the OLM1812. This eliminates the requirement for the constant speed dc motor. The modulator, pin 8, is electronically pulled ON for approximately a 1 ms transmit time at a repetition rate which controls the updating of the displayed information. The "neon driver," pin 14, will provide a negative output pulse (from V+ to approximately +1Vdc) if a load resistor (5.1 kΩ is used from pin 14 to V+. This pulse is used to latch the output of a counter. This output is decoded and then drives a 7-segment LED display. The repetition rate of the clock input to the counter provides a direct conversion from elapsed time (total count) to depth (or range).




Component Changes for Operation in Air (40 kHz)

## LM 1830 FLUID DETECTOR — NATIONAL

The LM 1830 is a monolithic bipolar integrated circuit designed for use in fluid detection systems. The circuit is ideal for detecting the presence, absence or level of water, or other polar liquids. An AC signal is passed through two probes within the fluid. A detector determines the presence or absence of the fluid by comparing the resistance of the fluid between the probes with the resistance internal to the integrated circuit. An AC signal is used to overcome plating problems incurred by using a DC source. A pin is available for connecting an external resistance in cases where the fluid impedance is of a different magnitude than that of the internal resistor. When the probe resistance increases above the preset value, the oscillator signal is coupled to the base of the open-collector output transistor. In a typical application, the output could be used to drive a LED, loud speaker or a low current relay.

### Features

- Low external parts count
- Wide supply operating range
- One side of probe input can be grounded
- AC coupling to probe to prevent plating
- Internally regulated supply
- AC or DC output

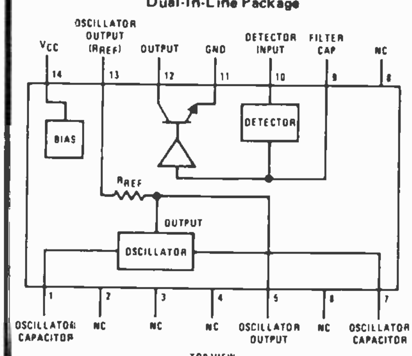
### Applications

- Beverage dispensers
- Water softeners
- Irrigation
- Sump pumps
- Aquaria
- Radiators
- Washing machines
- Reservoirs
- Boilers

### Absolute Maximum Ratings

| | |
|---|---|
| Supply Voltage | 28V |
| Power Dissipation | 300mW |
| Output Sink Current | 20mA |

Dual-In-Line Package




Order Number LM1830N

Fig. 1 Pinouts

### Applications

The LM 1830 requires only an external capacitor to complete the oscillator circuit. The frequency of oscillation is inversely proportional to the external capacitor value. Using 0.001μF capacitor, the output frequency is approximately 6 kHz. The output from the oscillator is available at pin 5. In normal applications, the output is taken from pin 13 so that the internal 13k resistor can be used to compare with the probe resistance. Pin 13 is coupled to the probe by a blocking capacitor so that there is no net DC on the probe.

Since the output amplitude from the oscillator is approximately 4 $V_{BE}$, the detector (which is an emitter base junction) will be turned "ON" when the probe resistance to ground is equal to the internal 13kΩ resistor. An internal diode across the detector emitter base junction provides symmetrical limiting of the detector input signal so that the probe is excited with $\pm 2$ $V_{BE}$ from a 13k source.

In cases where the 13k resistor is not compatible with the probe resistance range, an external resistor may be added by coupling the probe to pin 5 through the external resistor as shown in Fig. 2. The collector of the detecting transistor is brought out to pin 9 enabling a filter capacitor to be connected so that the output will switch "ON" or "OFF" depending on the probe resistance. If this capacitor is omitted, the output will be switched at approximately 50% duty cycle when the probe resistance exceeds the reference resistance. This can be useful when an audio output is required and the output transistor can be used to directly drive a loud speaker. In addition, LED indicators do not require DC excitation. Therefore, the cost of a capacitor for filtering can be saved.

### Probes

In a typical application where the device is employed for sensing low water level in a tank, a simple steel probe may be inserted in the top of the tank with the tank grounded. Then when the water level drops below the tip of the probe, the resistance will rise between the probe and the tank and the alarm will be operated. This is illustrated in Fig. 3. In situations where a non-conductive container is used, the probe may be designed in a number of ways. In some cases a simple phono plug can be employed. Other probe designs include conductive parallel strips on printed circuit boards.

In automotive and other applications where the power source is known to contain significant transient voltages, the internal regulator on the LM 1830 allows protection to be provided by the simple means of using a series resistor in the power supply line as illustrated in Fig 4. If the output load is required to be returned directly to the power supply because of the high current required, it will be necessary to provide protection for the output transistor if the voltages are expected to exceed the data sheet limits.

Although the LM 1830 is designed primarily for use in sensing conductive fluids, it can be used with any variable resistance device, such as light dependent resistor or thermistor or resistor or resistive position transducer.

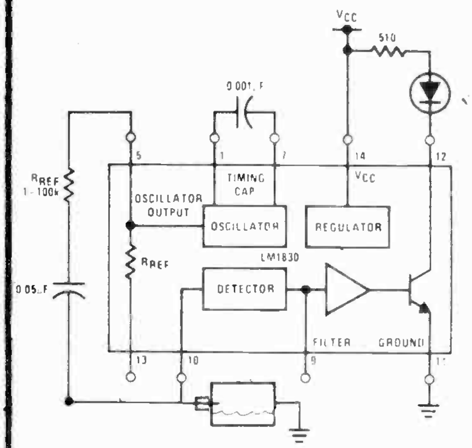



FIGURE 2. Application Using External Reference Resistor

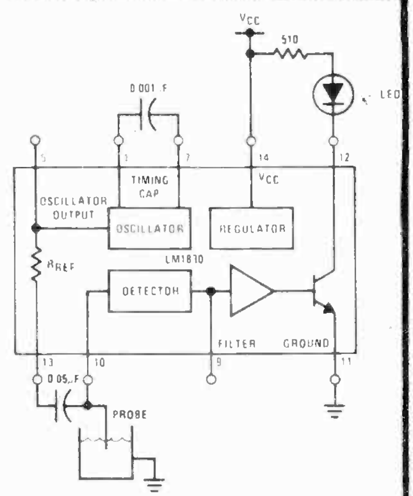
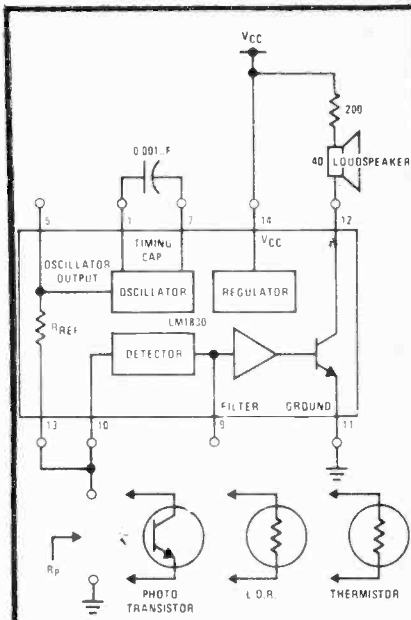



FIGURE 3. Basic Low Level Warning Device




Output is activated when $R_P \gtrsim 1/3\ R_{REF}$

FIGURE 4. Direct Coupled Applications

# INFORMATION

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Firstly decimal points are dropped and substituted with the multiplier, thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100n, 5600pF is 5n6. Other examples are 5.6pF = 5p6, 0.5pF = 0p5.

Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is 56k, 4.7kohms is 4k7. 100ohms is 100R, 5.6ohms is 5R6.

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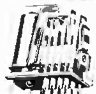
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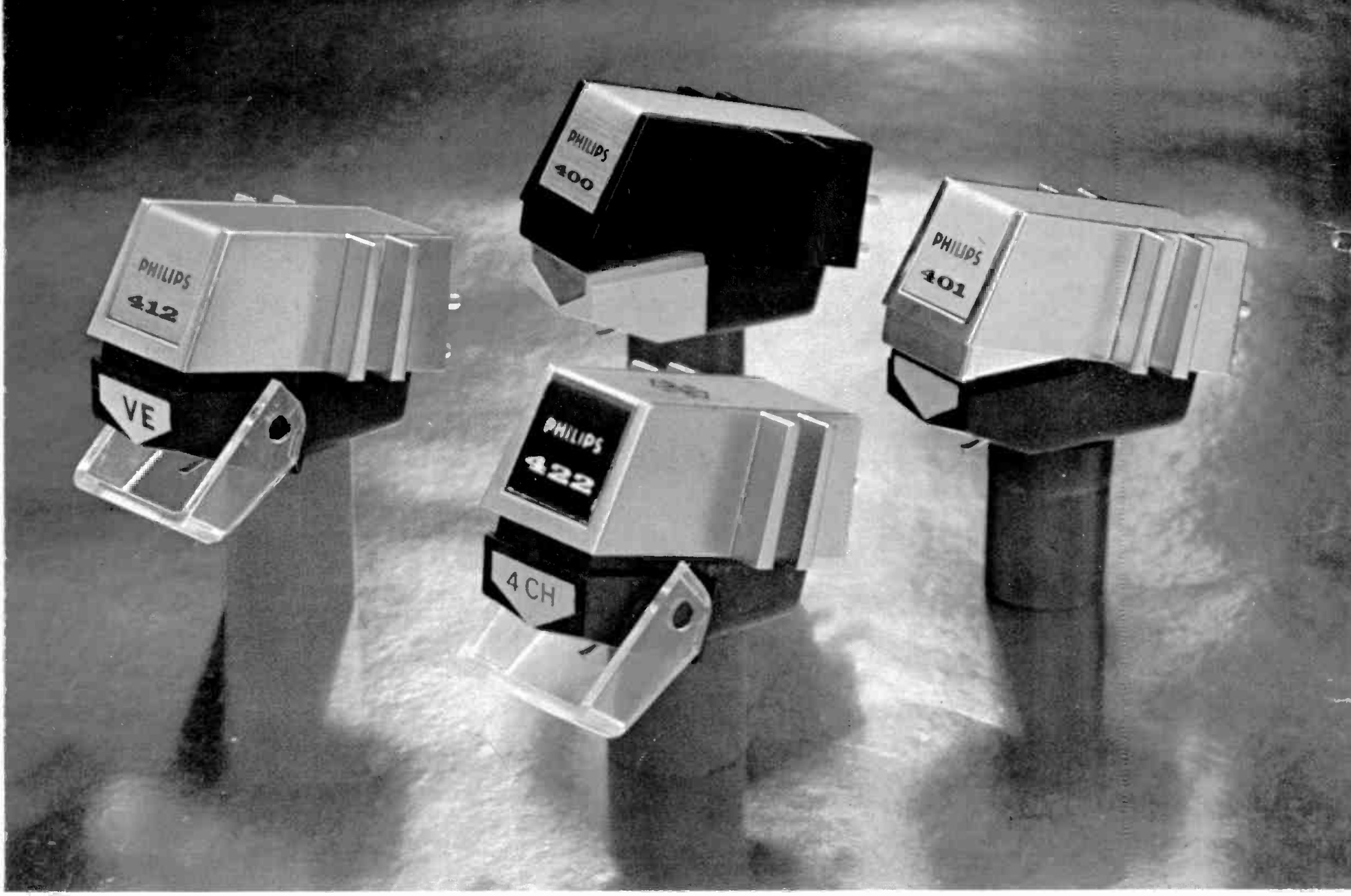


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