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RADIO & ELECTRONICS WORLD APRIL 1983

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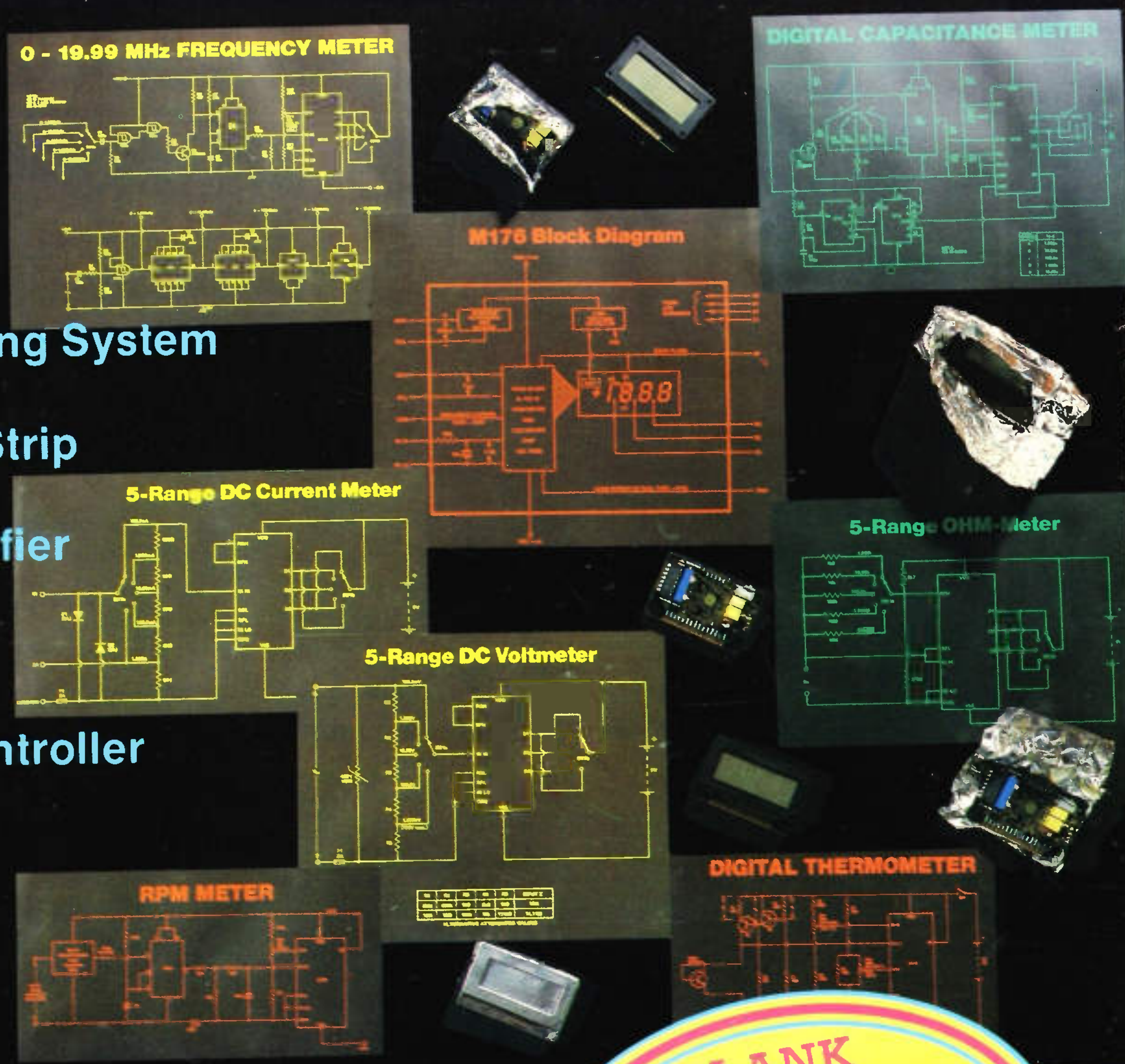

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APRIL 1983

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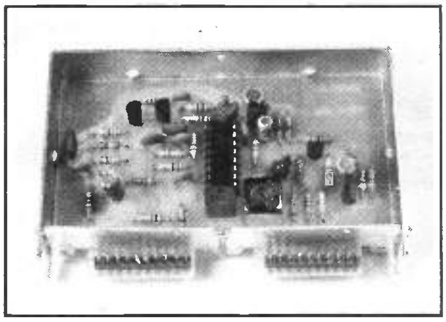

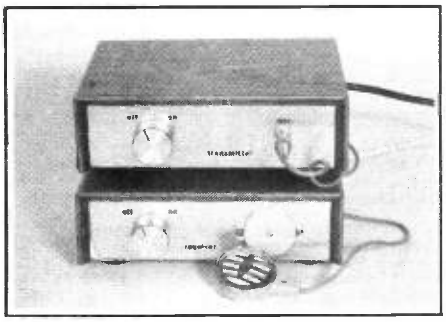

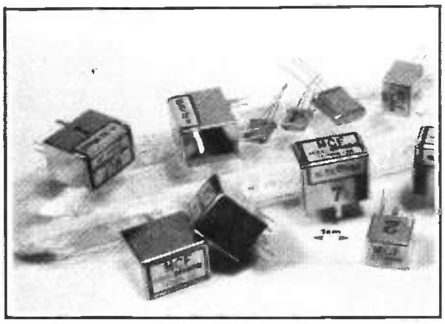

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Administration **(0277) 213819**
Accounts Jack Burrows FCA
Editorial Secretary Janet Capon

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BULLETIN BOARD

Z8000 For Commodore

Zilog Inc and Commodore International Limited have signed an agreement under which Commodore will use Zilog's 16-bit Z8000 microprocessor family in its next generation of microcomputer systems.

Under the terms of the technology exchange agreement between the two companies, Commodore will be licensed by Zilog to manufacture Zilog Z8000 CPU and related peripheral support circuits for use in Commodore microcomputers. In turn, Zilog will receive from Commodore, mask sets and manufacturing rights to selected custom circuits used in current and future Commodore products.

Fellowship For PyeMan

Pye Telecom's publicity manager, Bill Wheel, was among the guests of honour at a Sheraton Hotel dinner in New York recently, when the Radio Club of America presented him with a special award. Mr Wheel was made a lifetime Fellow of the Radio Club of America by club President, Fred Link, in recognition of his contribution to the mobile radio industry.

Cellular radio — an extension of the mobile communications network — is to be launched in Britain in 1985 and will eventually allow people all over the country to speak to each other direct on portable radio transceivers and from mobile units in their vehicles. Pye Telecom's sophisticated mobile automatic telephone system, MATS-E, which offers three times the subscriber capacity of other systems, is currently undergoing evaluation by the Department of Industry and the Home Office and Sectel and Racal-Millicom, the two companies that will operate the UK networks.

Jerrold SAWs For BT

A contract for the supply of two complete cable television headend signal processing systems, has been awarded to the Jerrold International Division of General Instrument by British Telecom. These units, key components in cable-distributed televised systems, will be used by Telecom at its Smallford trials establishment, to gain experience of cable television distribution equipment operations.

Jerrold will also provide assistance in installation and commissioning of the systems, together with ongoing service support and spares provisioning.

✱ ✱ ✱ Nota Bene ✱ ✱ ✱

Eagle-eyed readers, tuned to Channel 4 on the last day of January, will have spotted a rather 'different' advertisement appearing amongst other regular, high-budget offerings. Playing the starring role in a batch of commercials throughout the evening, was the March edition of **R&EW** complete with Editorial complement on the cover. Those of you who missed these spectacular and costly events can gain slight consolation from the 'off-screen' photograph above. Our next fo'ray into the world of TV advertising could be soon, so keep reading these pages for announcements.

Telephones Explained

We regret that the author's address was shown incorrectly at the end of last months article. It should be: 'Lynsted', Mole Hill, Wickhambrook, NEWMARKET, Suffolk CB8 8XZ.

SNIPPETS

Zilog Sales

Figures just released by Zilog (UK), show that the sales of their System 8000 family of advanced 16-bit microcomputers have far exceeded original predictions. In the marketplace for only one year, the total number of 8000s now in use is greater than 500. To satisfy the demand, new production equipment has been installed which has led to reduced costs. As a result, the recently introduced Model 11 has been reduced in price by 7.5%.

The System 8000 is suitable for both commercial and technical applications, and systems are currently installed in a wide range of well known UK companies including Shell, British Telecom, Local Authorities, Stockbrokers and Universities in the UK.

Panasonic Telecomms

When the Hollas Group of companies recently relocated their headquarters in large modern premises in Wynthenshawe, Manchester, they installed Panasonic's systems telephones in order to help establish an effective internal network of office communications. The system is believed to be the biggest installation of its type in the country.

The Hollas Group contains several companies, including importers and distributors of made-up garments, manufacturers of household textiles, merchants and processors of natural, synthetic and man-made fibres as well as insurance brokers.

Motorola Elections

Gary Tooker, Vice President of Motorola and General Manager of the company's semiconductor products sector, Phoenix, has been elected a Senior Vice-President by the company's board of directors.

NS Business

National Semiconductor Corporation today announced net sales for the second quarter ended December 12, 1982 of 277.5 million US dollars, compared to 254.9 million US dollars last year.

Sony And Pye

Sony (UK) Ltd approached Pye Telecommunications Ltd, about a year ago, for help with a new venture. The company planned to break into the TV rental business and wanted to equip their service engineers' vehicles with an efficient and inexpensive two-way radio system.

Better Quality

Over the last two years, Motorola has achieved impressive gains in the quality of its outgoing CMOS, TTL and LSTTL circuits. Instrumental in this success has been the consistent tightening of guaranteed accepted quality levels, which at Electrical of 0.1% and Visual/Mechanical of 0.15%, are believed to be the most aggressive in the semiconductor industry.

Merlin Magic

British Telecom Merlin is to enter the market for large office switchboards (call-connect systems), opened up to it by telecommunications liberalisation. These systems, with up to several thousand extensions, until now have been provided direct to business customers by their suppliers.

Merlin is British Telecom's business products marketing arm. Following agreement with Plessey Office Systems Ltd, it will distribute Plessey's new digital call-connect system launched by the company on January 18th. The new equipment, to be known as Merlin DX, will be available for installation from July.

Music Teacher

Dialogue Distribution has won a £100,000 order to supply Hitachi custom-designed liquid-crystal displays and LCD III integrated circuits for a novel musical teaching aid called the Prelude.

The Prelude, developed and manufactured in the UK by Speedyplain of Longton, Preston, is a chord computer which shows chords, scales and inversions in any key at the touch of a button. The portable, hand-held battery-powered unit is intended as a teaching aid for budding musicians learning to play a piano or electric organ.

Goonhilly 5

British Telecom's maritime satellite telecommunications terminal at Goonhilly Downs in Cornwall became operational on 1st February, 1983. Built for BT by Marconi Communication Systems, Goonhilly 5 is the first maritime coast earth station in the United Kingdom, and one of only seven in the whole world.

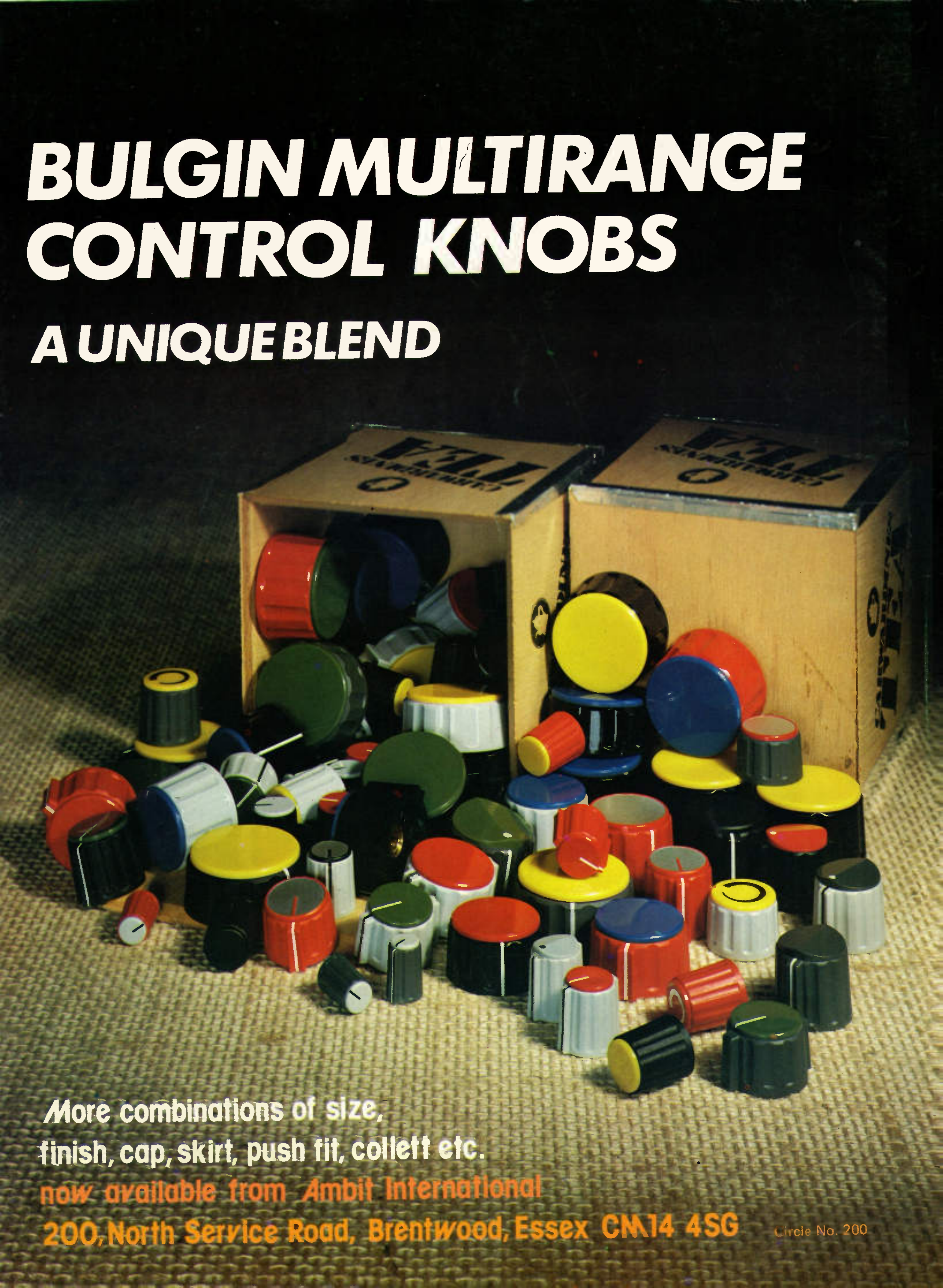
REWgrets

CB Noise Squelch (Sept. '82): details of the revised overlay are to be found on page 41 of the November '82 issue.

RGB Monitor (Jan '83): the recommended transformer for this conversion should be upgraded to 120VA, at 240V.

RS232 Interface (Feb '83): the third line up, within the text on page 78, should read POKEd to 16869 and 16873.

Notch Filter (March '83): the labels for RVA and RVB, in ***Fig. 2***, should be transposed. Also, the first figure reference in the text should be ***Fig. 2*** — the improved design being in block diagram form.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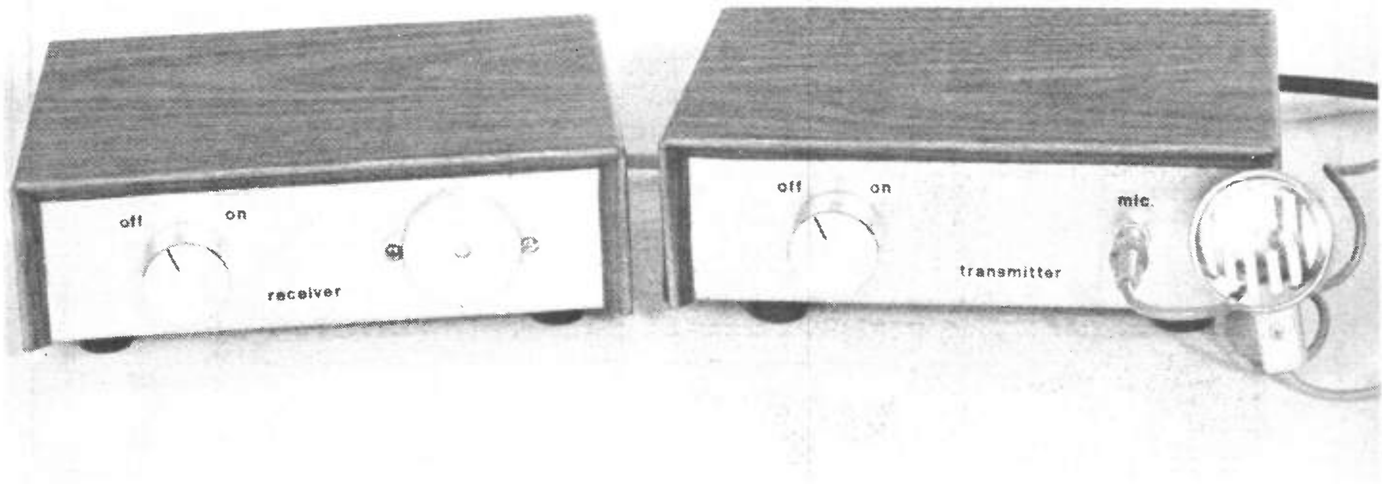


MAINS SIGNALLING SYSTEM

John Baker describes a novel system for remote monitoring of telephones and doorbells, utilising a 'through -mains' transmitter and receiver.

Normally remote monitoring systems consist of a unit which picks up the sound and transfers an alarm signal of some kind, to a loudspeaker located in another room. Although the direct sound of, say, a telephone bell may be easily missed by someone in this second room, the alarm signal from the remote unit is not. However, a drawback with conventional repeaters is the need for connecting wires between the pick-up unit and loudspeaker. This design solves the problem by using mains wiring to provide the link between the main unit and the remote one — a system similar to that employed in wire-less intercoms.

Apart from avoiding the need for connecting wires, this system has a couple of other advantages. One is that the remote unit can be moved from one room to another with ease, since it can operate in any room which has a mains outlet. The other advantage is that, if desired, a number of remote stations in different rooms can be used, and they will all respond to the signal from the main unit.

System Design

The basic arrangement of the system is quite straightforward as can be seen from the block diagram of ***Fig. 1***. A crystal microphone is used to pick up a given sound, and a preamplifier boosts the level to a few volts peak-to-peak. This signal is then smoothed and rectified to produce a positive DC bias, fed to a trigger circuit. In the presence of a suitable input bias, the trigger circuit activates an RF oscillator which operates at about 200kHz. The output of the oscillator is coupled to the "Neutral" mains lead via a low value high voltage capacitor.

The receiver picks up the 200kHz signal from the mains via a similar capacitor, which also provides first stage filtering of 50Hz mains signals. A bandpass filter then gives further filtering before the signal is applied to a phase-locked-loop tone decoder circuit. This has an output transistor which is switched on when the PLL detects and locks onto a 200kHz input signal, and this transistor activates an audio oscillator to drive a loudspeaker. A low frequency oscillator modulates the audio output so that a more effective alarm signal is generated.

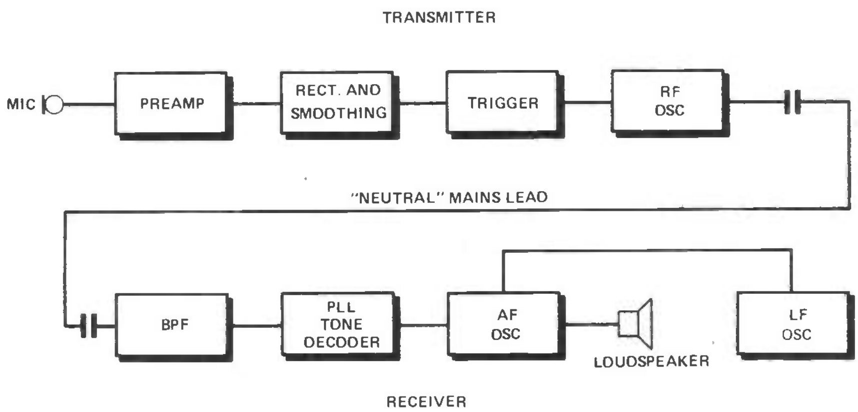


Figure 1: Block diagram of the complete signalling system.

▶

Circuit Description

Figure 2 shows the full circuit diagram of the transmitter. The mains power supply is a simple non-regulated type using push-pull rectification and giving an approximate loaded output of ten volts. IC2 is used in the two stage microphone preamplifier. The first amp is configured as an inverting amplifier, with voltage gain of 20dB. The second is used in the non-inverting mode with a gain of approximately 32dB.

The microphone, being an inexpensive crystal type, requires no DC blocking capacitor. The input impedance (100k) of the circuit is somewhat lower than would normally be used with such a microphone, but in this application good bass response is not required and a higher input impedance is unnecessary.

A capacitor (C8) couples the output of the preamplifier to the rectifier and smoothing circuit, and a non-electrolytic component is used here to ensure low leakage. The trigger circuit uses IC1 as a comparator, with a small amount of hysteresis (to prevent instability and erratic operation) introduced by R4. Under stand-by conditions the output of IC1 is low, but in the presence of a suitable input signal it triggers to the high state and supplies power to the RF oscillator, built around Q1. This transistor (an emitter follower) is provided with positive feedback and a stepped-up voltage via T2, so that oscillation is produced. T2 is an IF transformer having a nominal operating frequency of 455kHz. In this application a somewhat lower operating frequency is more convenient, so C3 is placed in parallel with the internal tuning capacitor of T2, to reduce the output frequency to around 200kHz.

C2 couples the output from the secondary winding of T2 to the mains "neutral" via an on/off switch (SW1). The capacitor is a fairly low value type to provide a reasonably efficient coupling at 200kHz. However, at 50Hz it has a high impedance and reduces the coupling of 50Hz mains signal into the secondary winding of T2.

The receiver circuit diagram appears in ***Fig. 3***. C1 couples the signal from the "neutral" mains lead to a bandpass filter, consisting of a tuned circuit formed by the main winding of T2, plus its internal tuning capacitor and external capacitor C3. The signal is coupled by C4 and C5 to the input of the phase-locked-loop, and additional filtering is provided by these two capacitors in conjunction with R1 and the input impedance of IC1 (D3 and D4 protect IC1 against an excessive input voltage).

IC1 is a 567 phase-locked-loop. It requires only a few discrete components: R2,R3 and C7 are the RC network which set the centre frequency of the VCO, (R3 is adjusted to give the correct frequency), and C8 is the capacitive element of the lowpass filter. IC2 provides IC1 with a regulated 5 volt supply, ensuring stable operation and preventing IC1 from receiving an excessive supply voltage.

Under stand-by conditions the NPN common emitter output transistor of IC1 is switched off. When the circuit locks onto the 200kHz input signal this transistor switches on and biases Q1 into conduction, supplying power to the audio oscillator (a simple 555 pulse generator). This directly drives LS1 — a ceramic resonator rather than a normal moving coil loudspeaker.

The LF oscillator uses IC4 in a well known configuration, and the roughly triangular waveform produced across C13 is coupled to pin 5 of IC3 via R8 — it frequency modulates the tone generator. This gives an alarm signal which is very effective, despite meagre power requirements.

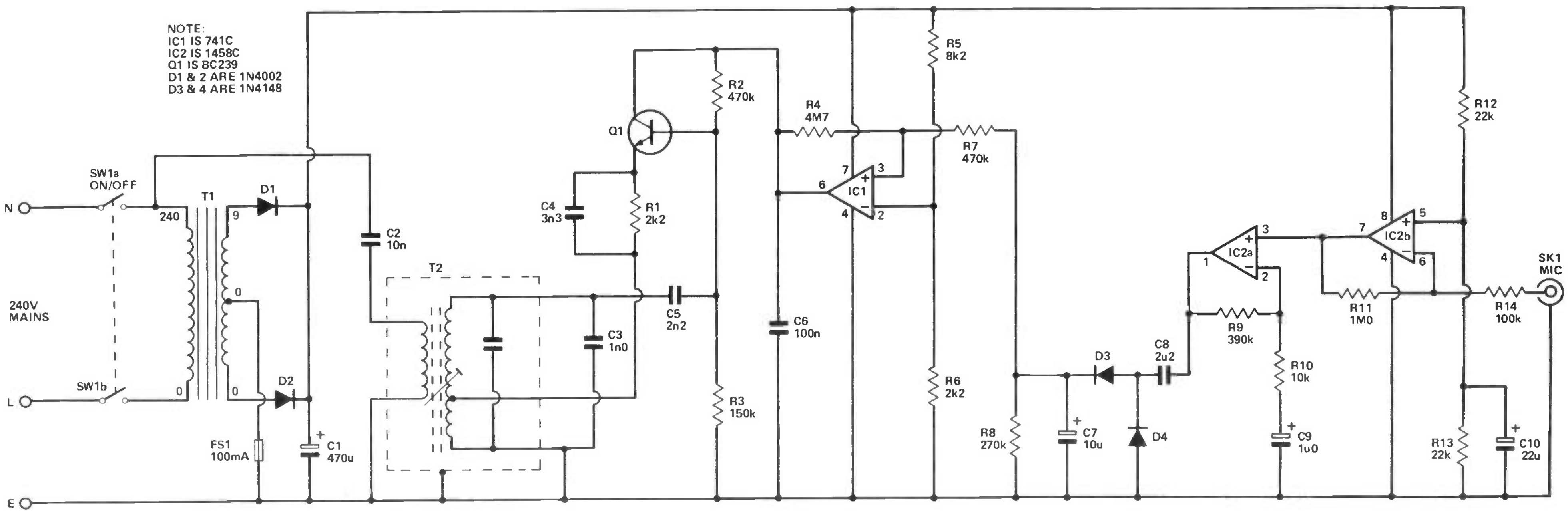


Figure 2: Circuit of the transmitter.

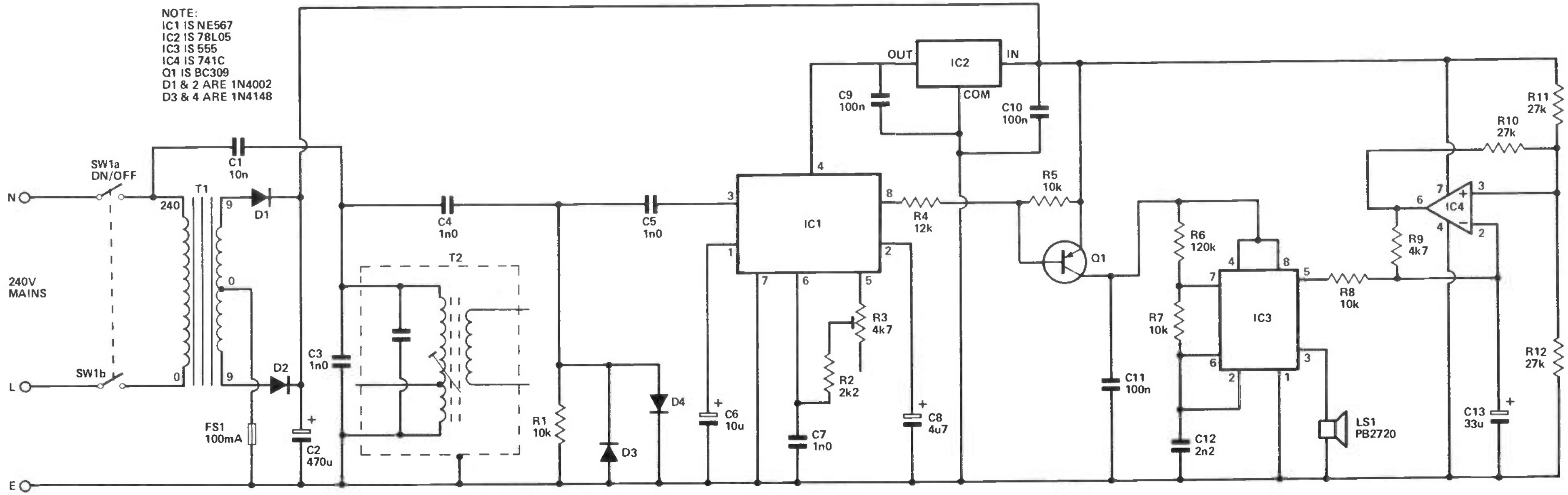
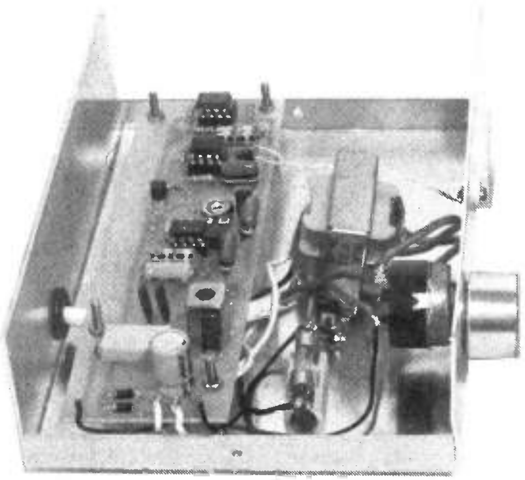


Figure 3: The receiver circuit diagram.



Internal view of the completed receiver. The flat disc in the top right is a piezo transducer.

Construction

Details of the printed circuit and wiring of the transmitter are shown in ***Fig. 4***. Most of the components are mounted 'on-board', except T1, which is chassis mounting, and FS1 with its holder.

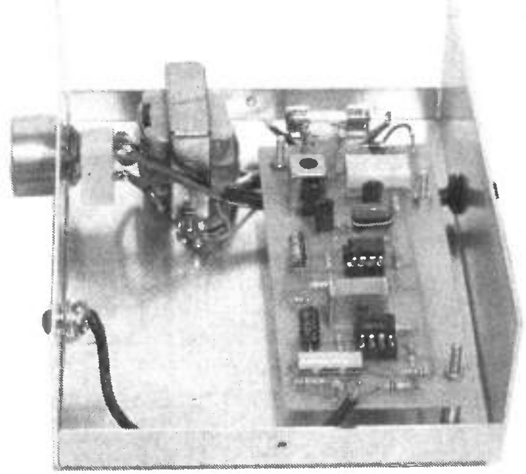
Probably the best type of microphone to use with the unit is a crystal type, supplied with a suitable length of screened lead terminated in a 3.5mm jack plug. Satisfactory results should be obtained with the microphone placed fairly near to the source, though the unit is not so sensitive that background sounds are likely to cause spurious triggering.

The receiver is constructed along much the same lines as the transmitter (see ***Fig. 6***). In both units the PCB should be mounted so that it is well away from the metal case and there is no danger of the connections on the underside of the board (particularly the connection to the "neutral" mains lead) coming into contact with the case.

The ceramic resonator can be mounted on the rear of the front panel. It requires a 30mm cut-out in addition to the two small holes for mounting bolts. An easier option is to mount the resonator on the front of the panel as this avoids the need for the large cutout.

Setting Up

When initially testing and adjusting the unit it is necessary to *activate* the transmitter. One way of achieving this is to feed a signal from an AF signal generator into SK1. Alternatively, a crocodile clip lead could be used to temporarily connect the positive terminal of C7 to the positive supply.



The prototype transmitter, with mic socket and mains on/off switch (the high surge current type is not essential).

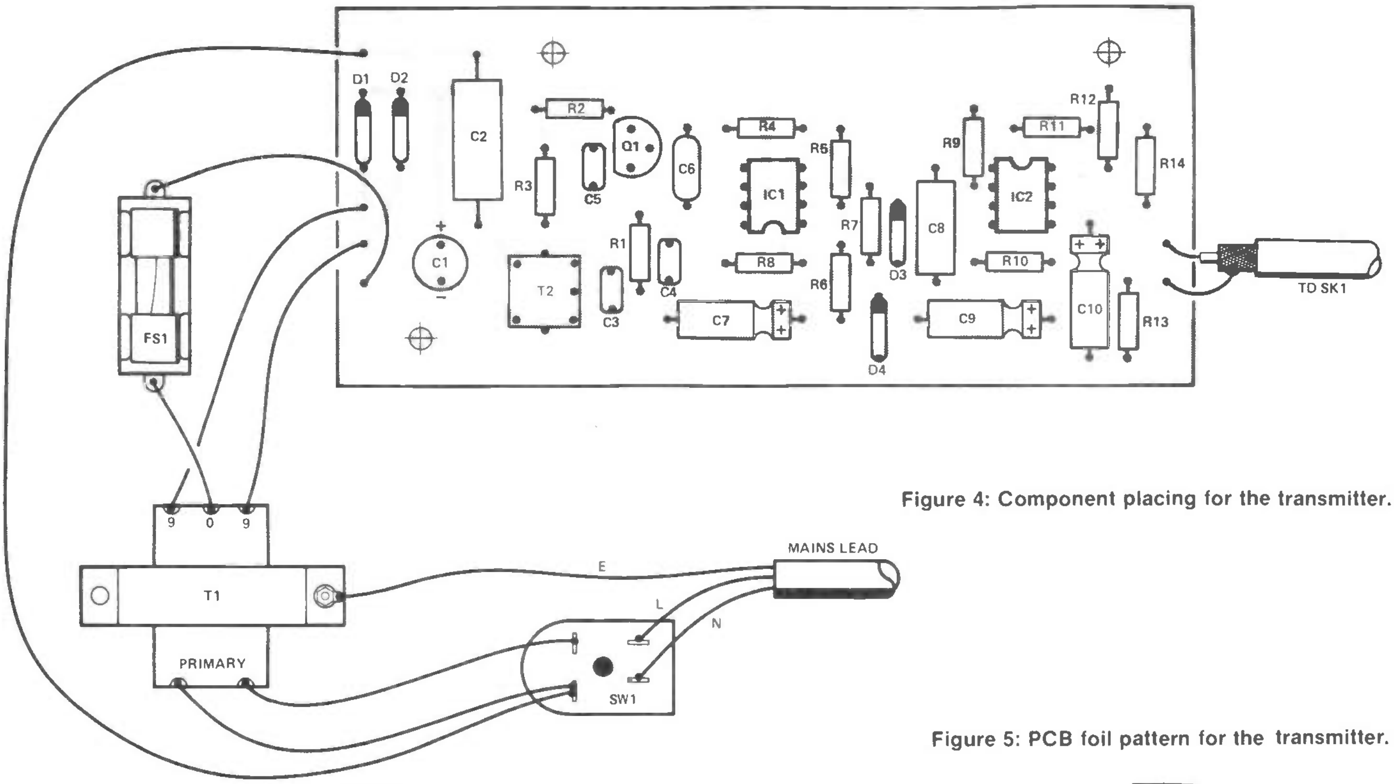


Figure 4: Component placing for the transmitter.

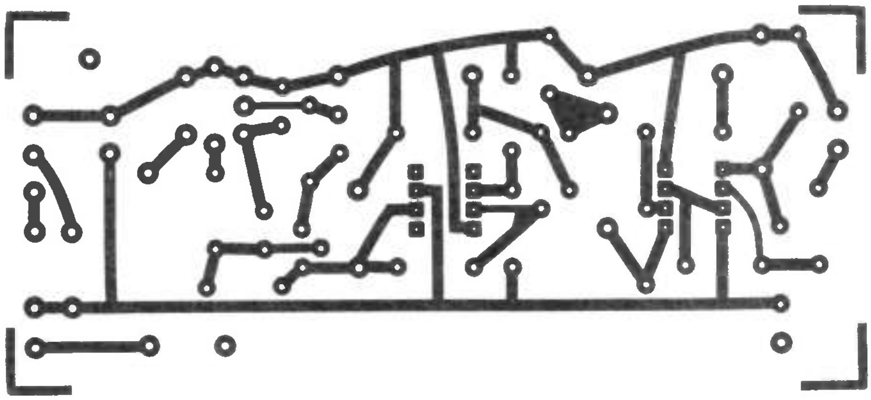


Figure 5: PCB foil pattern for the transmitter.

PARTS LIST

TRANSMITTER

Resistors

R1,6	2k2
R2,7	470k
R3	150k
R4	4M7
R5	8k2
R8	270k
R9	390k
R10	10k
R11	1M
R12,13	22k
R14	100k

Capacitors

C1	470u 16V radial
C2	10n 250V AC
C3	1n mylar
C4	3n3 mylar
C5	2n2 mylar
C6	100n polyester
C7	10u 25V axial
C8	2u2 polycarbonate
C9	1u 50V axial
C10	22u 16V axial

Semiconductors

Q1	BC239
D1,2	1N4002
D3,4	1N4148
IC1	741C
IC2	1458C

Miscellaneous

T1	9-0-9 volt 75mA
T2	Toko YHCS11100AC
SK1	3.5mm jack socket
FS1	20mm 100mA quick-blow fuse
SW1	Rotary mains switch

Chassis mounting holder for FS1,PCB, case (152 X 114 X 44mm),Microphone with lead and 3.5mm plug,knob,mains lead,cabinet feet,wire,etc.

With the transmitter activated, and the receiver connected to the mains and switched on, slowly adjust R3 from minimum to maximum resistance. At some point the unit will 'lock' onto the signal from the transmitter and trigger the audio alarm circuit. Lock should be achieved over a small range of settings, and reliable results follow with R3 set roughly at the centre of this range.

It is possible that the operating frequency of the transmitter will be outside the operating range of the receiver (though this is not likely). If a frequency meter is available this can be used to measure the output frequency of the oscillator in the transmitter (taking the output signal from the emitter of Q1), so that the core of T2 can be set for an operating frequency of about 200kHz. Although the signal radiated by the unit is very weak, and in use the RF oscillator will be inoperative for the vast majority of the time, it is strongly advised to offset

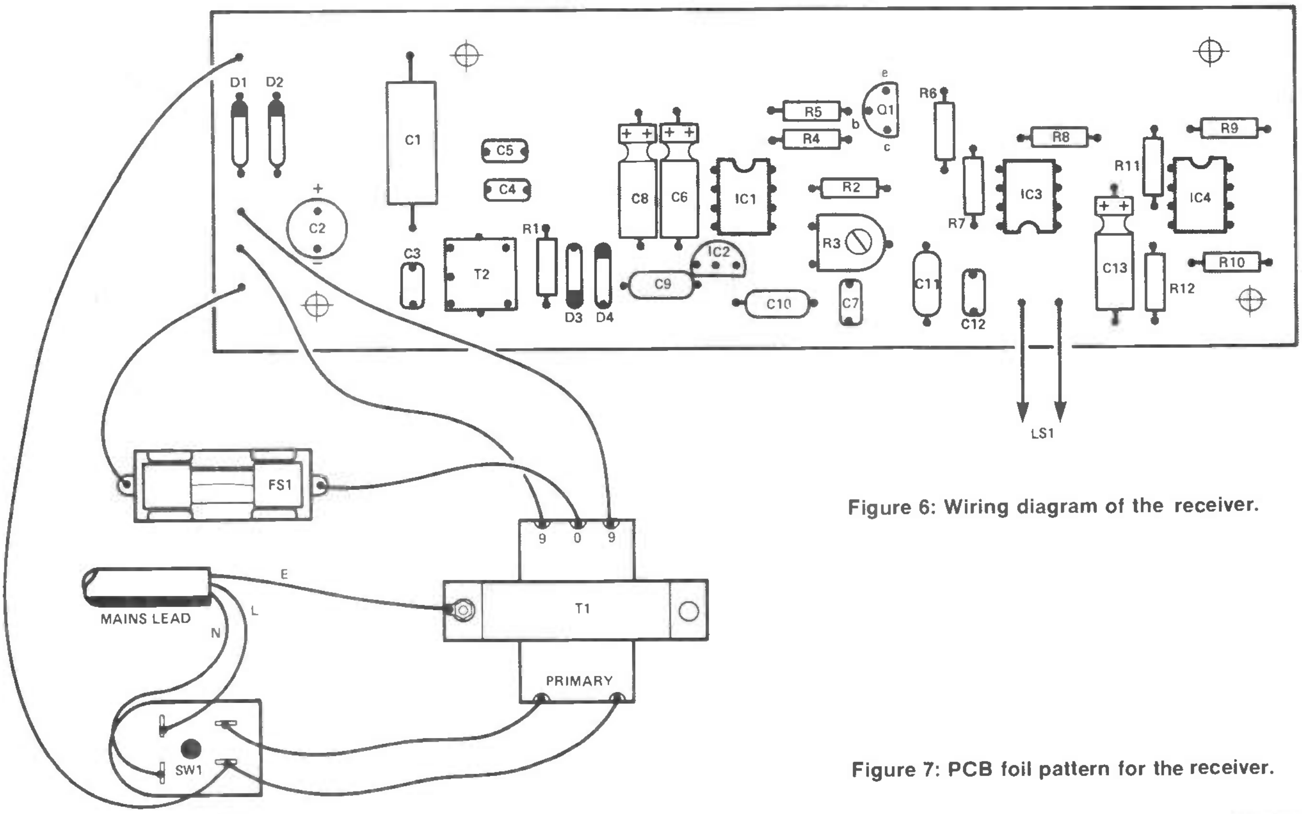
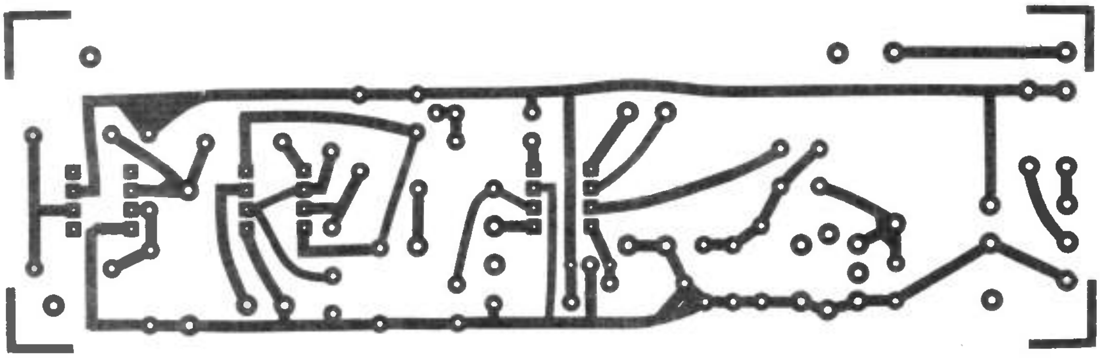


Figure 6: Wiring diagram of the receiver.

Figure 7: PCB foil pattern for the receiver.



the operating frequency from 200kHz by a few kilohertz to eliminate any risk of interference being caused to the 200kHz Radio 4 transmission.

If a frequency meter is not available a simple alternative is to place an ordinary transistor radio tuned to the 200kHz longwave Radio 4 transmission near to the transmitter. By adjusting the core of T2 in the transmitter it should then be possible to obtain a heterodyne tone from the receiver when the RF oscillator is near to a 200kHz operating frequency. T2 is then adjusted to offset the operating frequency just far enough to eliminate the heterodyne. Adjustment of R3 should then lock the receiver onto the signal from the transmitter. The core of T2 in the receiver could be adjusted to peak the received signal, but as the bandwidth of this tuned circuit is quite wide this is not essential.

■ R&EW

PARTS LIST

RECEIVER

Resistors (all ¼W 5% except R3)

R1,5,7,8	10k
R2	2k2
R3	4k7 0.15W horizontal preset
R4	12k
R6	120k
R9	4k7
R10,11,12	27k

Capacitors

C1	10n 250V AC
C2	470u 16V radial
C3,4,5,7	1n mylar
C6	10u 25V axial
C8	4u7 50V axial
C9,10,11	100n polyester
C12	2n2 mylar
C13	33u 16V axial

Semiconductors

Q1	BC309
D1,2	1N4002
D3,4	1N4148
IC1	NE567
IC2	78L05
IC3	NE555
IC4	741C

Miscellaneous

T1	9-0-9 volt 75mA
T2	Toko YHCS11100AC
LS1	PB2720 ceramic resonator
FS1	100mA 20mm quick-blow fuse
SW1	Rotary mains switch.

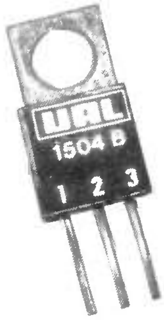
Chassis mounting holder for FS1,PCB, Case (152 X 114 X 44mm),knob,mains lead,cabinet feet,wire, etc.

R&EW Data Brief

UAL CSR RANGE

Power thyristors for AC control

Control of AC powered devices such as resistors, lamps, blowers etc has hitherto relied heavily on the use of various control circuits all built around triacs and associated circuitry. As can be seen from ***Fig. 1*** even simple lamp dimmers can be fairly complex in terms of component usage.



FEATURES

- An Integrated Functional Component offering power capacity up to 3000 watts @ 240 Volts.
- Available in 10 and 15 ampere rating
- A 3-terminal device containing all necessary active and passive components for a complete AC Phase Control
- Inherently high thermal efficiency, electrical isolation, and environmental protection is provided by use of glassivated devices and transfer moulded construction
- Flexibility of mounting: rivet directly to a heat-sink, or attach directly by the controlling potentiometer to panel
- Double time-constants result in low hysteresis effect
- Low cost: below that of equivalent discrete component material cost
- Isolated tab, can be earthed

▼ Table 1. Specification of power control IC.

SPECIFICATIONS	UNIT	1004A	1004B	1504A	1504B
RMS max on I (tab 70°C)	Amps	10	10	15	15
Peak one cycle surge I	Amps	120	120	150	150
Off state leakage I max	mA	2			
Minimum holding load I	mA	30			
RMS input voltage 50/60Hz	Volts	240			
Repetitive peaks voltage (tap 70°C)	Volts	400			
Forward volt drop at max I	Volts	1.8			
Hysterisis (typical)	%	5			
Total conduction phase angle (typ)	Degrees	0 to 160			
Controlled conduction phase angle	Degrees	30 to 160			
Power transfer at max I	%	99			
Tab surface operating range	°C	- 40 to +70			
Storage temp	°C	- 55 to +125			
Insulation withstand (tap 70°C)	Volts	1600 for 1min			
Mtg. hole diameter	mm	3.6	10.3	3.6	10.3

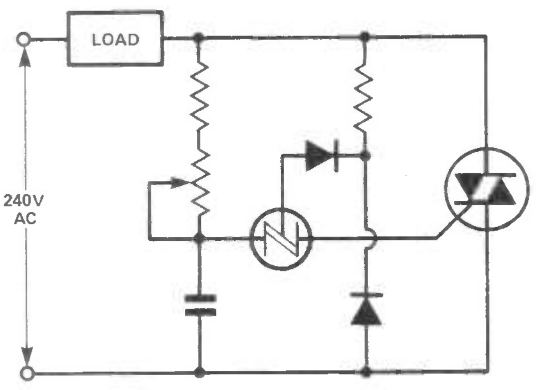


Figure 1: Typical lamp dimmer circuit using discrete circuitry.

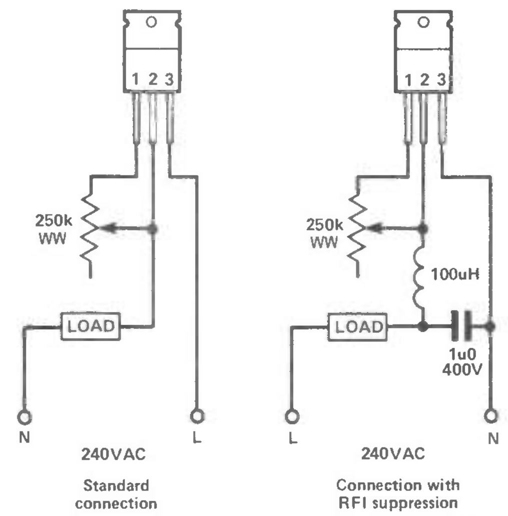


Figure 2: Basic controller connections.

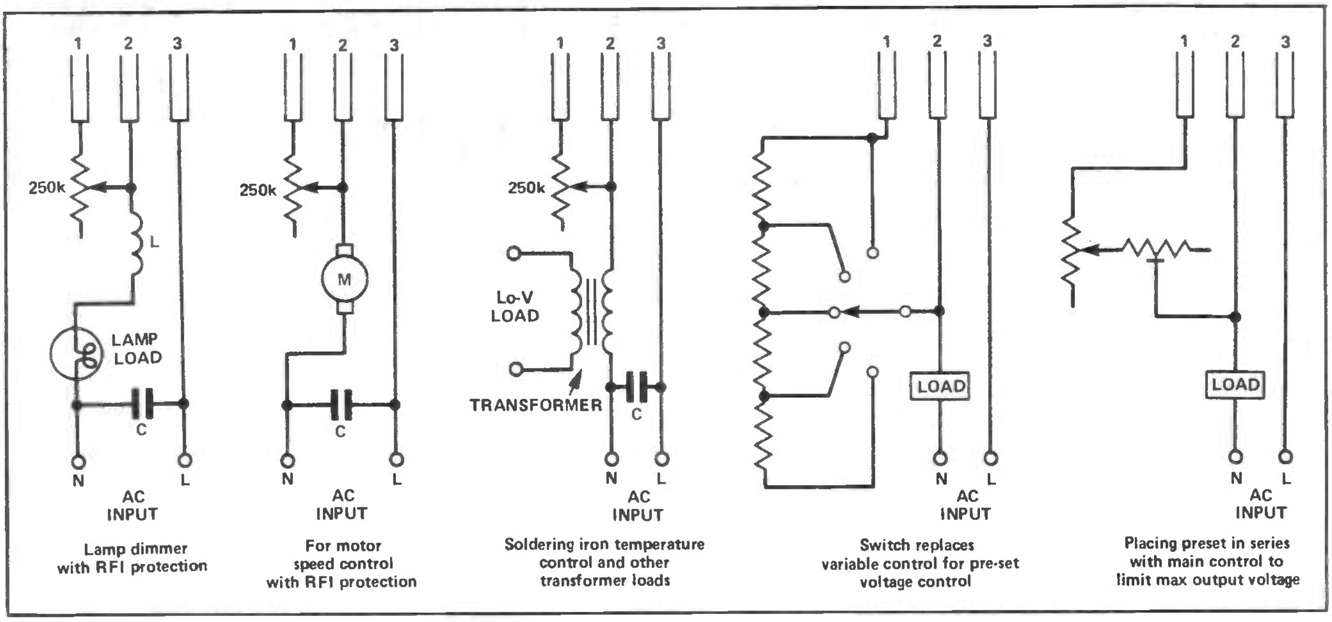


Figure 3: Typical applications for controller.

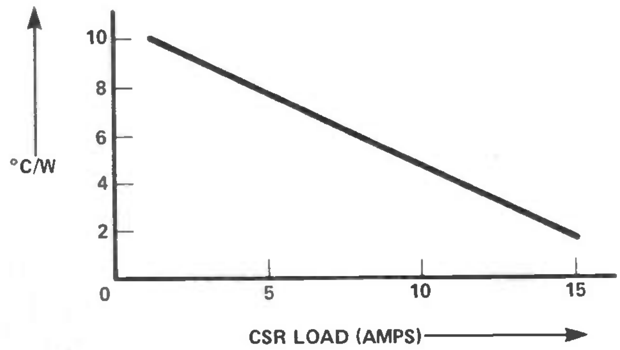


Table 2: Heatsink rating vs. Current

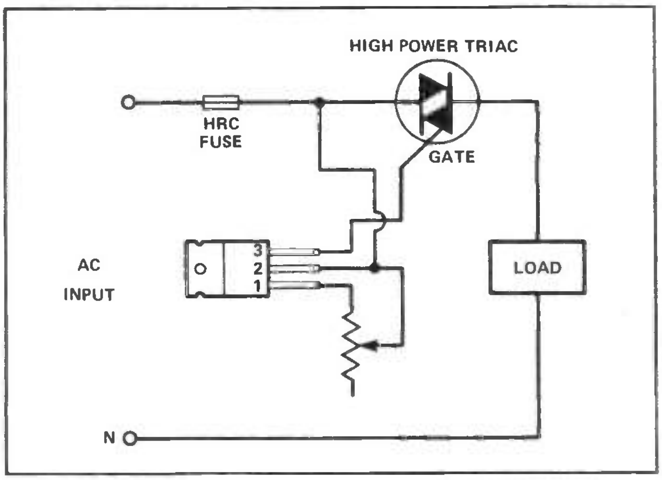
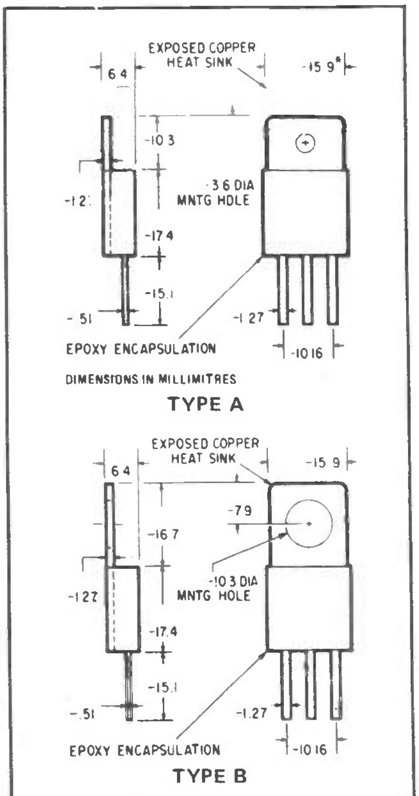
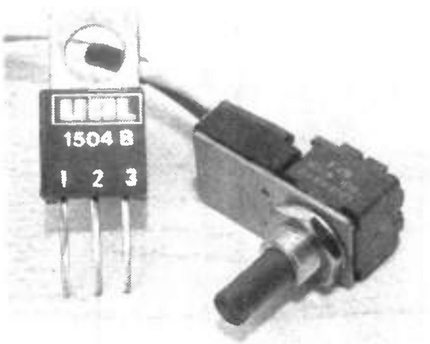


Figure 4: Drive circuit for high power triacs.



Dimensions of the power controller ICs.

Recently introduced, the UAL CSR range of power controller IC's have now reduced total component count to one IC — the CSR itself. This is an integrated functional component offering power handling up to 3kW at 240 volts. It is available in 10 and 15A rating and is a 3-terminal device containing all necessary active and passive components for complete AC phase control.



The device has inherently high thermal efficiency, electrical isolation, with environmental protection provided by glassivated devices and transfer moulded construction. This gives flexibility of mounting — it can be riveted directly to a heatsink (A version) or attached directly by the control pot to a panel (B version). Full specifications of the range are shown in ***Table 1***.

Just a few applications in which the CSR offers superior performance economically are in speed control for fans, blenders, power tools, electric mowers, conveyor belt drive motors, winding machines etc. Also of interest are temperature control of soldering irons and heated elements, and dimming applications for incandescent lamps.

Compared to a typical 15A rotary variable transformer the CSR is less expensive, smaller and lighter, with an overall reduction of over 50 to 1.

Basic connections are shown in ***Fig. 2***. Care should be taken to provide adequate heat sink arrangements for the load required (see ***Table 2***).

Various circuit ideas are shown in ***Fig. 3***. In the event that 15A max current is not enough, the CSR can be used on the drive circuit for high power triacs < 15A.(Typical connections are shown in ***Fig. 4***).

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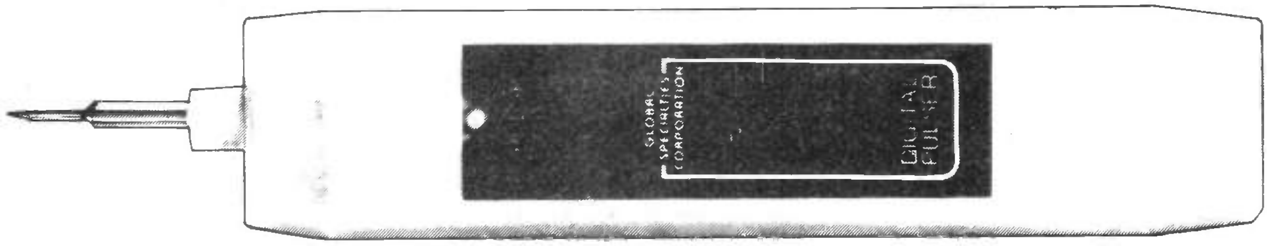

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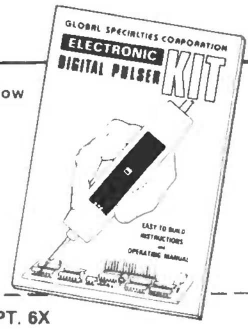

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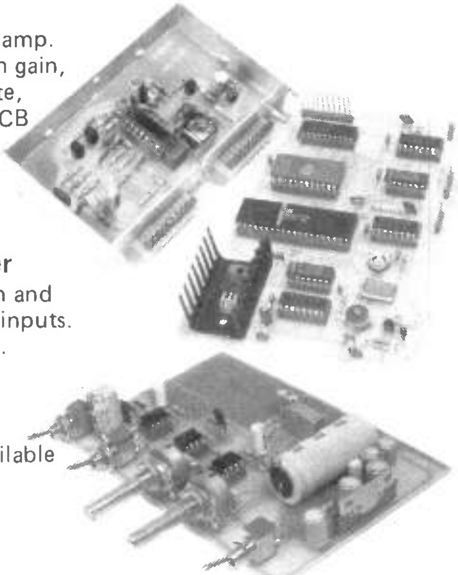

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MEMORY AND PERIPHERAL INTERFACING

MEMORY ORGANIZATION

As a microprocessor, the Z8000 requires external memory to hold data and programs. Because the Z8000's architecture defines a 16-bit wide data path to and from the outside world, its memory is organized in the same way — as segments containing 32K *words* each (K = 1024). Only 15 bits of address are needed for a word access in memory. Of the address bits A15:0 (the offset in the Z8001), only A15:1 are propagated to address-decoder circuitry in memory hardware.

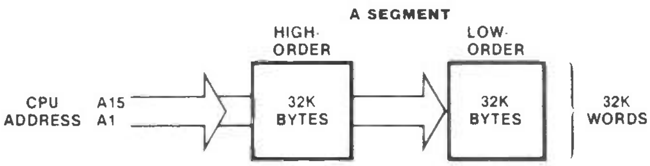


Figure 1
Word Accessing

The Z8000 can, however, address particular bytes in memory, as well as words. This is precisely the purpose of the lowest address bit, A0. Each 64K-byte segment of memory can thus be constructed as *two banks* of 32K bytes each, with word rows addressed by A15:1 and a byte within a word selected by A0. As we shall see, the need for A0 is even more limited than this.

Another important feature of the Z8000's architecture is that, while bits in bytes and words are numbered in the traditional fashion, right to left, bytes in words are addressed *left to right.* The low-order byte in a word is the rightmost, but it is addressed with A0 = 1. The high-order byte (leftmost) is addressed with A0 = 0. This convention is the opposite of many machines, but it allows bytes and larger, compound structures to be sequentially addressed as generalized strings. In the long run, this design simplifies many problems in data-structure storage and access.

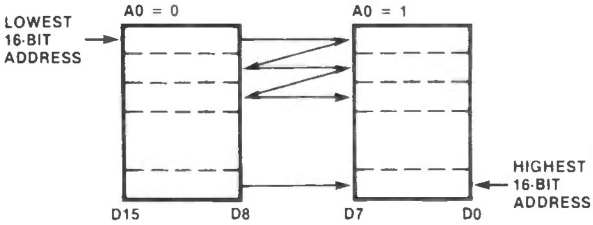


Figure 2
Sequencing of Bytes in Memory

Memory Interface Circuitry

A general scheme of memory hardware for the Z8000 can be drawn:

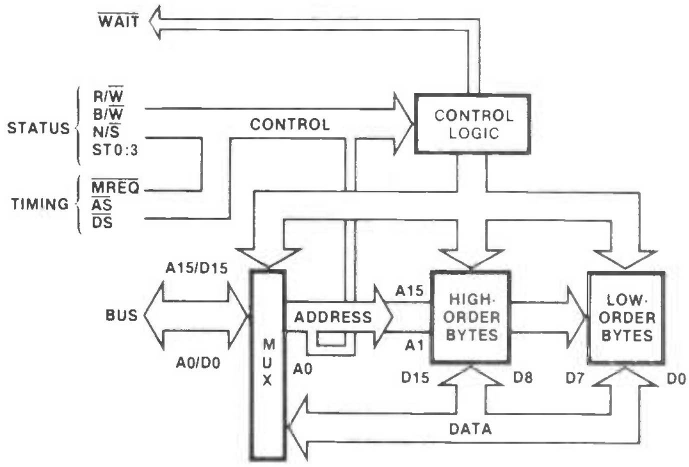


Figure 3
Typical Memory Interface

A hypothetical memory-control circuit, built by the Z8000 user, receives status and timing signals from the CPU and appropriately manages the multiplexing/demultiplexing of addresses and data, the accessing of bytes, and, perhaps, the delaying of data transfers with $\overline{WAIT}$.

Recalling some basic principles of Z-Bus operation, this controller latches A15:1 into address decoders and reads A0 and all status lines when $\overline{AS}$ goes high. Of this latched information, READ/$\overline{WRITE}$ (R/$\overline{W}$) will establish data-bus direction when $\overline{DATA\ STROBE}$ ($\overline{DS}$) goes low; BYTE/$\overline{WORD}$ (B/$\overline{W}$), R/$\overline{W}$ and A0 will define byte transfers. NORMAL/$\overline{SYSTEM}$ (N/$\overline{S}$) and the ST lines will be decoded to provide up to six distinct addressing spaces or to distinguish I/O and refresh from standard cycles. Though not a standard Z-Bus signal, $\overline{MREQ}$ also can be used to distinguish memory from other cycles. It provides an earlier point, when it goes low, at which status lines may be sampled.

Segmentation in the Z8001 allows the inclusion of extended addresses on the Z-Bus: (see Fig.4)

It may be necessary to delay $\overline{AS}$ to address-decoder circuitry so that the controller has sufficient time to analyze status and exercise proper access control. This depends on the exact design of memory hardware and the way in which N/$\overline{S}$ and/or ST3:0 are used to establish distinct memory spaces. Normally, however, the rising edge of $\overline{AS}$ should be used to sample all address and status lines, because they all become valid at about the same time in T1 (see below).

When $\overline{DS}$ goes low, the controller can latch data to or from the bus depending on the observed state of R/$\overline{W}$. In the case of a write to memory, data from the CPU is valid while $\overline{DS}$ is low and may be sampled when it goes

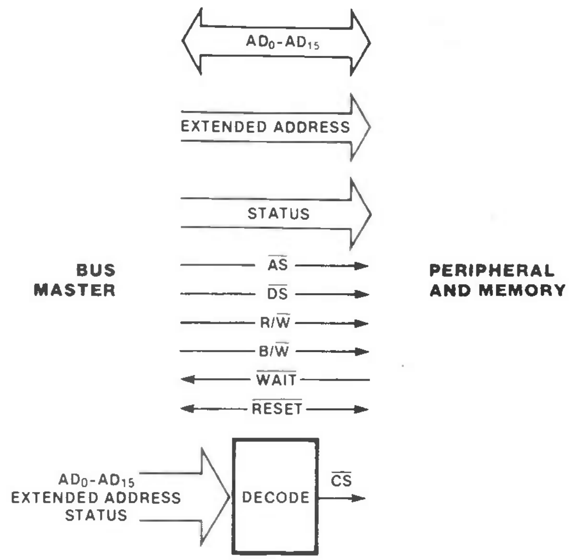


Figure 4
Primary Z-Bus Signals

high. For read cycles, data must be provided at least from T3 (see below) until $\overline{DS}$ goes high. Data strobe may be delayed by pulling $\overline{WAIT}$ low at T2.

Memory Cycle Timing

Important edges in *Memory-Cycle* Timing are emphasized below:

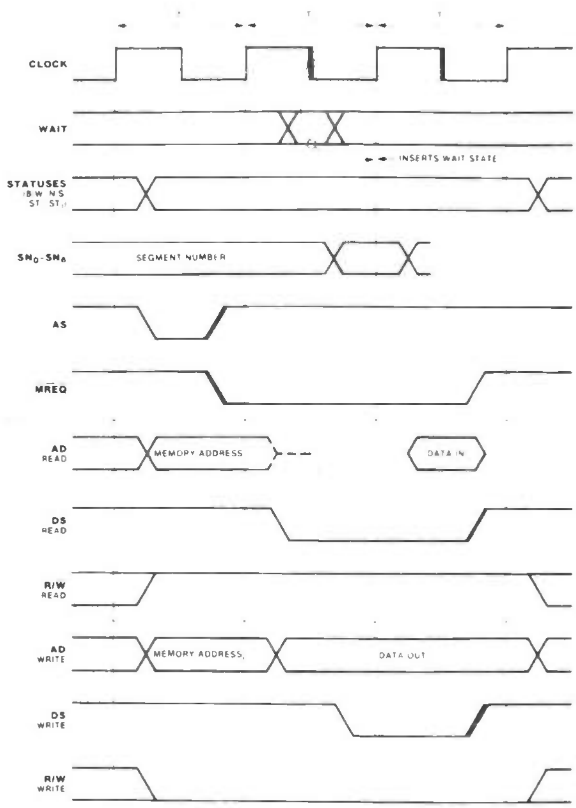


Figure 5
Memory Cycle Timing

Without wait states, and depending on whether $\overline{AS}$ or $\overline{MREQ}$ is used, the access time (to $\overline{DS}$ rising) is 340 to 350 ns.

The timing of *all* memory cycles during instruction execution follows the description just given. This feature makes the Z8000 different from the Z80; the Z8000 can, in part, use memory devices somewhat slower than those usable in Z80 designs.

Segmented Memories

The memory controller illustrated earlier was shown to be accessing only one of six possible memory spaces, one segment in size. However, the Z8001's architecture provides seven additional segment lines. These can be used in large memory designs to distinguish as many as 128 segments (8M bytes) in each of the six possible spaces. These spaces include: system data, stack, and program and normal data, stack, and program. Thus 48M bytes of memory are addressable, assuming the existence of an appropriate memory controller or memory manager. Because general memory management may require relocation of segments to any physical area in memory, a memory-management device will need additional time to calculate the location of each segment before the exact cell identified by A15:0 can be accessed. For this reason, the segment lines (SN6:0) are emitted and valid before address strobe occurs (see timing diagram above). In fact, they are available to a memory manager during the last clock period of the preceding instruction's execution.

Accessing Bytes

Despite the fact that Z8000 system memory is essentially word organized, byte access makes only simple demands of memory-control circuitry. The *only* case involving a special demand is when a *byte is written* to memory:

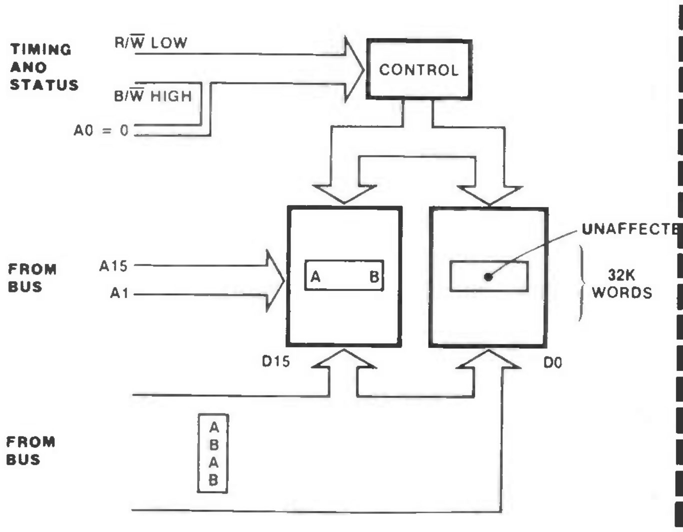


Figure 6
Writing a Byte to Memory

Similarly, writing the low byte will leave the high byte unaffected. This is, in fact, the *only* case in which a memory controller needs to observe the value of A0. If A0 is high, the low-order byte in the word addressed by A15:1 is written over; otherwise the high-order byte is written. Note that all memory cycles require a word transfer regardless of the B/$\overline{W}$ output from the CPU. The Z8000 simplifies byte writes by *duplicating* the byte on both halves of the bus. This way memory need *not* undergo a read-modify-write cycle. The Z8000 simplifies byte reads by accepting the appropriate word and *internally selecting* the proper byte according to A0. Reading and writing words, of course, involve no use of A0 at all. Thus, a proper RAM memory controller will *only* observe the B/$\overline{W}$ line if the R/$\overline{W}$ line is low (write); then only if B/$\overline{W}$ is high (byte) will it use A0 and write half of the data bus into the addressed word. ROM accesses will only be reads, so in that case A0 is meaningless.

By using byte or word accessing, the Z8000 is able to load its registers with values that can be considered to be more complex operands by particular instructions. The full range of these is indicated below, ranging from bits to long words:

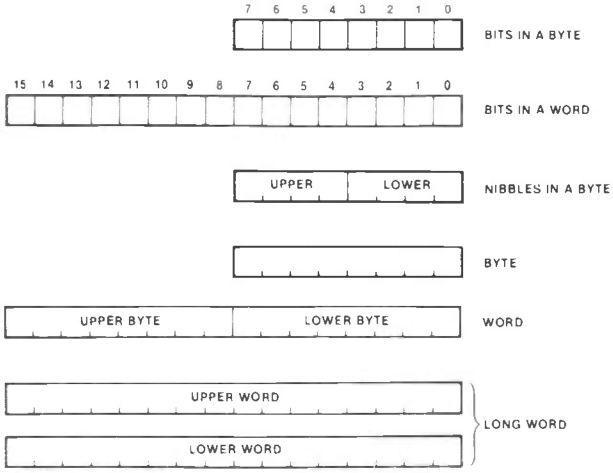


Figure 7
Data Types

Except for BCD digits, all these may also be addressed in memory by various instructions.

A further consequence of the Z8000's design is that all word accesses to memory are *aligned* at even addresses. This is because A0 never reaches address-decoder circuitry and exactly one word is always referenced at location A15:1. It is *not* possible to consider a word made up of the low byte of one location and the high byte of the next. Because instruction fetches are also word accesses, a Z8000's program counter will normally contain an even value.

PERIPHERAL INTERFACE

The Z8000 addresses its peripherals in a separate space but in the *same* manner as memory: even addresses in byte mode access the high-order byte of the data bus, while odd addresses refer to the low-order byte. When writing to a peripheral in byte mode, the sent byte is duplicated on both halves of the bus automatically. Peripherals are thus assumed to be *word organized*. Those that are byte organized, such as Z80 devices, must use the appropriate half of the bus for data transfers, and the configuration is dependent on whether they are at even or odd addresses.

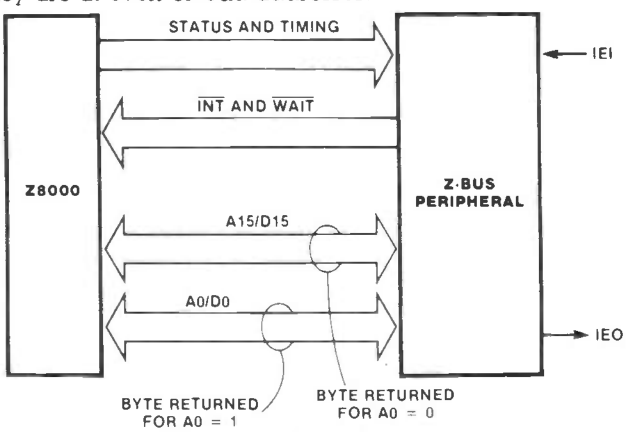


Figure 8
Z8000 Peripheral Interface

All 16 bits of addressing are therefore available to Z8000 I/O instructions. As many as 65,536 peripherals can be used, and each may be byte or word oriented. The ST lines also distinguish *two* kinds of I/O, standard and special, which allows further expansion of I/O space. But this is primarily intended for use with special CPU-support devices such as the Z8010 memory management unit.

Peripherals follow the basic requirements of Z-Bus communication and are thus *asynchronous;* they use $\overline{AS}$ and $\overline{DS}$ (as do memory controllers) to time data transfers. In addition, the ST lines provide codings to signal interrupt acknowledgement when peripherals are used in conjunction with the $\overline{NMI}$, $\overline{NVI}$, or $\overline{VI}$ interrupt inputs to the Z8000. Therefore, not the ST lines themselves, but a decoded output for the appropriate *interrupt acknowledge* will be passed on the bus to corresponding peripherals. Furthermore, if *priority* among peripherals is established using a standard *daisy-chain* scheme, then the interrupt enable in (IEI) and out (IEO) lines become part of the Z-Bus connections as well:

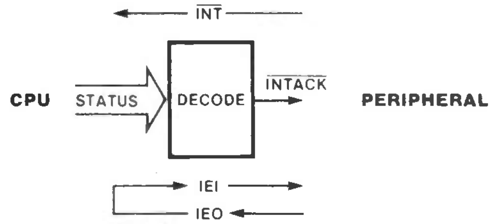


Figure 9
Z-Bus Interrupt Signals

The minimum Z-Bus configuration for general peripheral interfacing therefore contains $\overline{AS}$, $\overline{DS}$, R/$\overline{W}$, AD15:O, and appropriate $\overline{INT}$, $\overline{INTACK}$ and IEI-IEO lines. Chip selects are derived from addresses, and $\overline{WAIT}$ and special bus-control lines might also be included.

Timing for Z8000 I/O accesses is very nearly the same as for memory cycles, except that $\overline{DS}$ is automatically delayed by one default wait state (TWA):

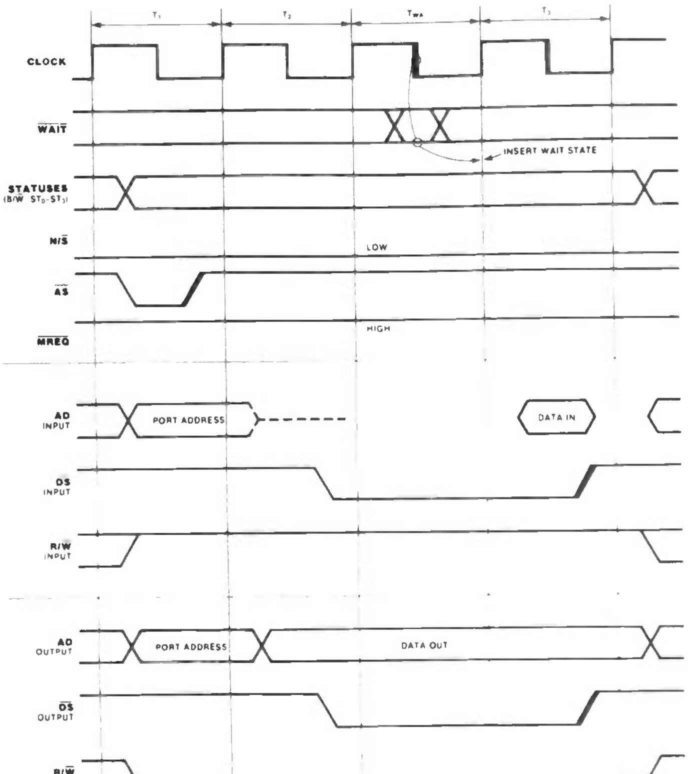


Figure 10
I/O Timing Cycle

Interrupt acknowledgement requires an extended form of I/O cycle. It, along with the general details of interrupt handling and daisy chaining, will be covered ir later lessons. The Z8000 family of peripherals will be covered in a separate course.

INSTRUCTION TIMING

The design of the Z8000 is *modular*, from the standpoint of instruction timing. The memory cycle we have already covered is used for instruction fetches as well as data transfers. Similarly, the I/O cycle is the same for all I/O instructions. In addition to memory and I/O cycles, there exist two additional cycles, *internal* and *refresh*, that may occur during the execution of an instruction.

Memory Fetch Overlap

When an instruction is fetched from memory to the Z8000, the standard memory cycle is used to gather the first (and perhaps only) word needed. At this time, instruction decoding and execution begins within the Z8000. If more words are needed to complete the instruction, they are fetched with additional standard memory cycles. At least the first of these additional fetches is overlapped entirely with the decoding of the first word fetched. Furthermore, additional execution time is *overlapped* with subsequent memory cycles when they occur. This includes the final execution period within the current instruction and the memory cycle for fetching the first word of the *next* instruction.

The Z8000, therefore, minimizes the apparent length of instruction-execution time by efficient use of its internal busses. A register-to-register load, for instance, takes no more time than the instruction fetch itself requires: three clock cycles. The encoding of Z8000 instructions is the result of extensive research on the execution frequency of various instructions in typical programs. Consequently, bus utilization (average instruction time divided by average memory cycle time) is very high (> 80%) as compared with the Z80 (> 65%). For this reason the Z8000 employs a technique other than pipelining in order to improve processor efficiency without requiring pipeline flushing when branching occurs.

Frequently-used instructions in the Z8000, therefore, consist of one word (plus, perhaps, operand/address words) and use overlapped execution and memory cycles. The LOAD instruction (LD) and JUMP instruction (JP) illustrate the conciseness of encoding when registers contain operands or addresses:

mode	1	0	0	0	0	W/B	src	dst	LD R0, R1
mode	0	1	1	1	1	0	dst	cc	JP NZ, @R1

Figure 11
Load and Jump Instruction
OP-Codes

This format can simply be extended by adding words for segmented or nonsegmented addresses if, for example, direct-addressing (DA) mode were used. Immediate values also become attached to instructions and byte mode allows concise encoding again:

LDB R0, #255	1	1	0	0	dst	src

Figure 12
Load Byte Instruction
OP-Code

In these examples, the destination register (or condition code) follows the instruction mnemonic, which is suffixed with "B" for byte operations. Any source is mentioned after the destination. "@" means IR addressing and "#" means immediate. The condition code "NZ" used with JP is one of many that represent flag combinations in FCW.

There is one exception to the basic three-clock-cycle memory access. In the Z8001 running in segmented mode, the fetch of a short-segmented address to be used in the next memory cycle must be followed by one extra clock cycle. This allows the segment number just fetched to be emitted early in relation to the following memory cycle.

Internal Cycles

Normal instruction execution thus begins with a word fetch (ST3:0 = IF1), followed by execution and, possibly, other memory cycles (ST3:0 = IFn, etc.). During execution, when no memory or I/O cycles occur, the Z8000 enters a special internal cycle.

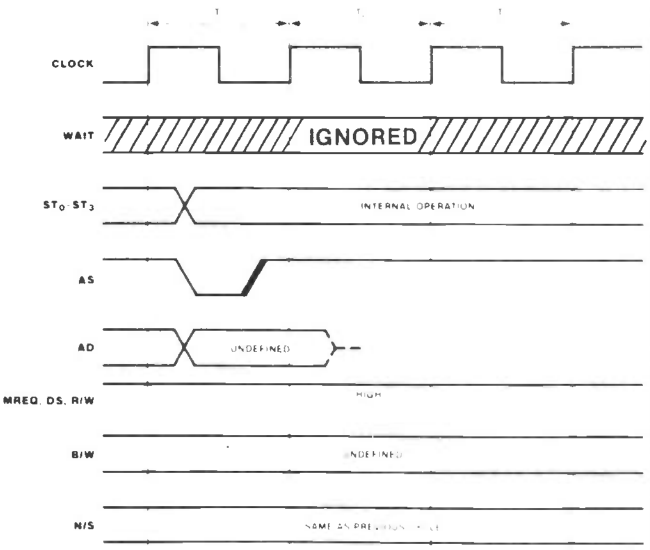


Figure 13
Internal Cycle Timing

In a lengthy execution, such as a division, much time might be spent in such a cycle. In fact, the Z8000 limits the length of internal operations to a maximum of 10 clock cycles and a minimum of three. There are two reasons for a maximum of 10 clock cycles. First, any CPU capable of bus sharing should respond promptly to bus requests (via $\overline{\text{BUSRQ}}$). The Z8000 will honor bus requests at the end of T3 in any *machine cycle* within any instruction. Thus, limiting internal cycles to 10 clock periods guarantees speedy bus yielding. Second, if dynamic memory is used, the Z8000 will usually have refresh-enabled and so must attend to this task as frequently as the rate portion of the refresh register is decremented to zero.

Internal and Refresh Cycle Timing

In the Z8000, internal cycles can be thought of as potential refresh cycles, so their frequent recurrence provides frequent opportunities for *memory refresh*. This is always a three-clock-period event: **(see Fig. 14)**

Internal-operation and memory-refresh cycles can occur at definite times during instruction execution. When the overlap of execution and memory cycles is not adequate to complete execution, internal operations

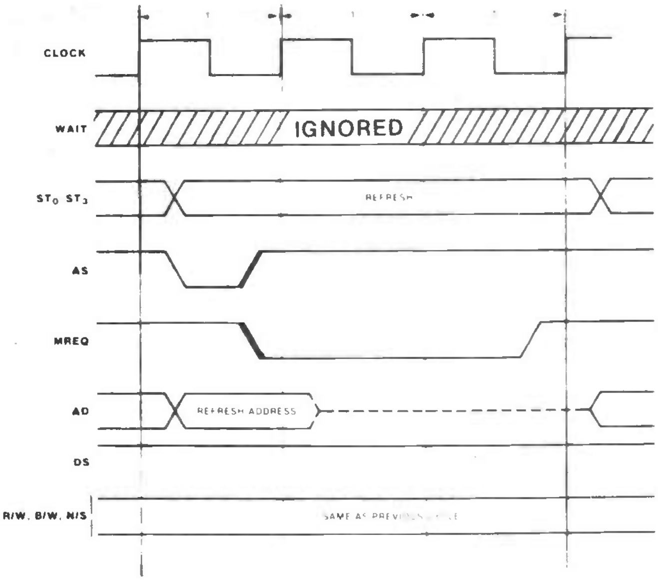


Figure 14
Refresh Cycle Timing

will occur. When the refresh rate counter (decremented every fourth clock cycle) reaches zero, the Z8000 will reload its initial six-bit value and await the next appropriate instant at which a refresh cycle can occur. Obviously one such point will be when the next internal cycle begins. Two additional times are: right after the first word-fetch of an instruction (IF1), and at each data transfer in block move and other repeating instructions. As soon as a pending refresh cycle begins, the row-counter portion of refresh is emitted on AD8:1 (A0 = 0). Then the counter is incremented (in T3) and ready to address the next row.

Basic Instruction Timing

Refresh, internal, I/O, and memory cycles comprise the basic set of *four building blocks* for constructing the basic timing of all instructions. Note that the shortest complete Z8000 cycle contains T1, T2, and T3, which should always be considered names for distinct time periods, not just clock cycles. Furthermore, all four basic timing cycles produce address strobes even though the internal operation produces no valid address. There are two reasons for this: first, $\overline{AS}$ going high is the normal point at which status lines as well as addresses should be sampled by asynchronous hardware; and second, frequent generation of address strobes allows design with memory devices that refresh themselves automatically if tickled appropriately. If such a design is used, refresh can be disabled.

Just as execution and subsequent memory cycles are intentionally overlapped for efficiency, execution and refresh effectively overlap to make refresh virtually transparent. However, refresh always takes exactly three clock periods and so may extend apparent execution time very slightly in some cases. Because refresh occurs on an estimated demand, however, it is infrequent, and so this semi-transparency is insignificant.

Segmented Addresses

An important design feature is that the Z8001 allows segmented addresses as two words (often incorporated into instructions) rather than providing dedicated segment registers within the machine itself. Requiring two words rather than one in each instance of DA or X mode addressing may appear to expand unnecessarily both the space required by instructions using those modes and the time needed to fetch their parts. However, just as Z8000 instruction coding has been optimized, this addressing scheme is also the result of careful thought.

Machines with dedicated base or segment registers obviously require reloading of these registers whenever another segment is to be accessed. The overhead for this is usually considerable; setup instructions often exhaust much space and time reloading segment registers.

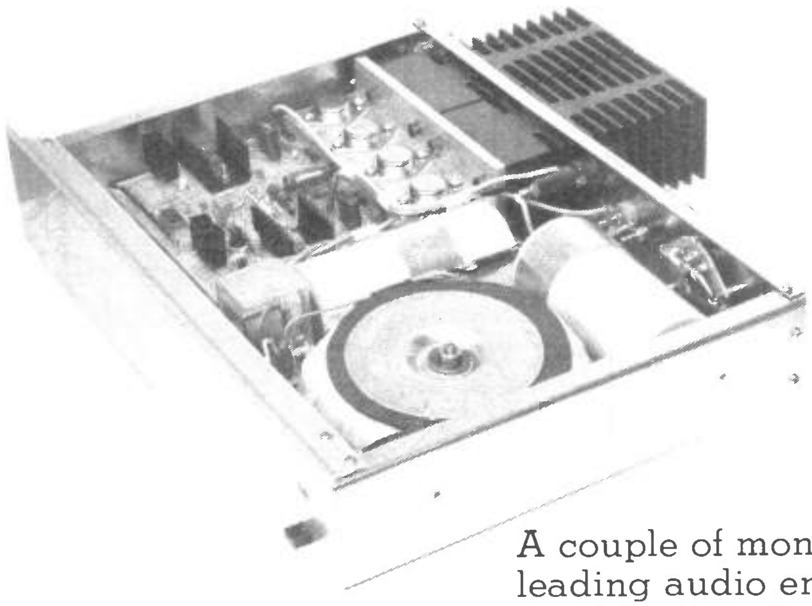
The Zilog Z8000 course continues next month with 'hardware design considerations'. The quiz for this month's section has also been held over until next month.

EVENTS: MOBILE RALLIES APRIL '83

March 9th	Lincoln Short Wave Club,	City Engineers B	
March 9th	Lincoln Short Wave Club, Satellites Lecture	City Engineers Club, Lincoln.	G4CUO, G5FZ
March 22nd-24th	Nortest - 83	Wythenshawe Forum, Manchester.	
March 22nd-24th	Sensors & Systems 83	Trident International Exhibitions, Manchester.	(0822) 4671
March 27th	BRES 144MHz Contest	Barking Radio & Electronics Society, Barking	G3XBF, G8XBF 01–550–2902 (Weekends Only)
April 13th	Lincoln SW Club, Contest Preparation	City Engineers Club, Lincoln.	G8ZHP, G6COL
April 19th-21st	All-Electronics/ ECIF Show	Barbican Exhibition Centre.	Samantha Clarke, (0799) 22612

WHAT TO LOOK FOR IN OUR MAY ISSUE

100 W HI-FI AMPLIFIER



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Next month we present the fruits of their labours.
Following current trends the amplifiers are mono designs meaning that there's no possibility of any interaction between two of these beauties used in a stereo pair.

Articles mentioned here are scheduled for the May issue but circumstances may dictate alterations to the final content of the issue.

IR Volume Control

A useful gadget for those of you with a video recorder with IR remote control and a TV without. The unit accepts the audio output of the video and feeds it via an electronic attenuator to your Hi-Fi amplifier. A bit of cunning **R&EW** design then allows you to adjust the volume of the TV sound with the *same* remote control unit that you use for the recorder.

With a project like the amplifier we doubt if you'll need much persuasion to purchase the May issue, but for those of you who are incredibly hard to please we'll also throw in the usual mix of news, views, data and features including

- **RF filter design**
- **A superb audio limiter**
- **Part 3 of our Z8000 course**
- **A handy transistor tester**

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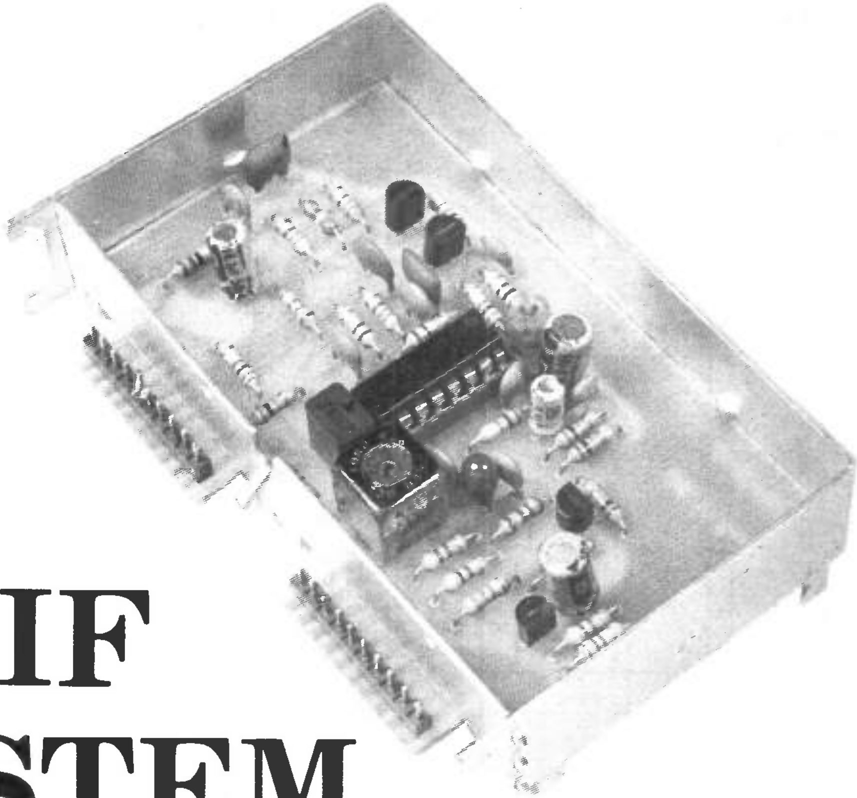


WB FM-IF SUBSYSTEM

A versatile wideband FM IF strip with muting, AFC and meter drivers. Development by Keith Collins & William Poel.

RCA couldn't have foreseen the progress of events following their launch of the CA3089 FM IF subsystem, some 8 years ago. Probably the world's most 'developed' specific function linear IC, it's almost certainly amongst the top three consumer linears of all time.

Basically a radio device, its application has been shrouded in all sorts of mystery — RF is a curious and irrational substance where minute changes in the position of a decoupling capacitor can make the difference between a system that works beautifully, and one that doesn't want to know — and thus it has become the subject of much confusion. We suggest the best policy is to forget everything you've ever heard and start again here:

Where Are We Now ?

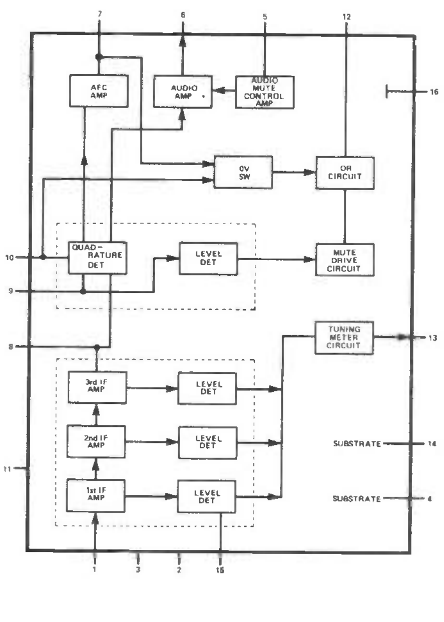
At the last count, there were around 20 copies and derivatives of the original CA3089E. Just about everyone in the big league of semiconductor manufacturing has had a go. It says much for the original device that in spite of all this, the basic operational parameters of the device have remained little changed.

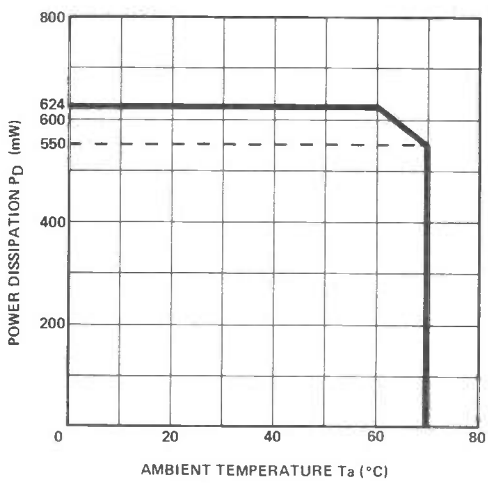
The first major innovation was the Hitachi HA1137W, which cured the major failing of the original CA3089E by providing deviation muting to suppress the huge side responses of modern high

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	16	V
Power Dissipation	P_r	624*	W
Operating Temperature	T_{opr}	−20 to + 70	°C
Storage Temperature	T_{stg}	−55 to +125	°C

* at Ta = 60° C

Figure 1: Physical characteristics of the CA3089 (above), with power derating curve (bottom right).





◀ Figure 2: Block diagram of the IC.

▶

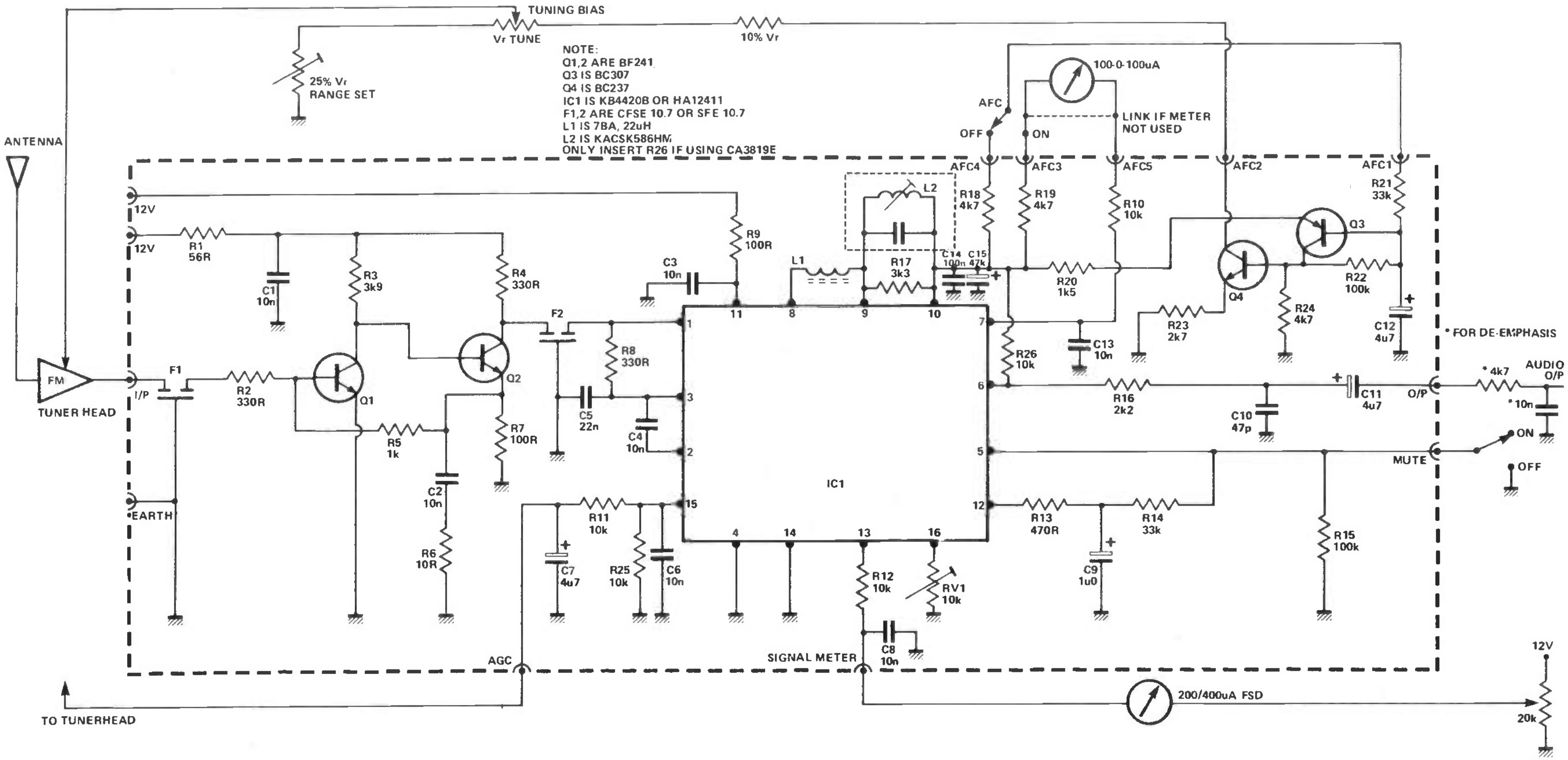


Table of small signal parameters (below) and full circuit diagram (above)

A.C. CHARACTERISTICS

Item	Symbol	Test Conditions	min.	typ.	max.	Unit
Operating Current	Icc	Vin = 100dBμ, Mute ON	–	32	39	mA
Limiting Sensitivity	Vin(lim)	at –3dB	–	31	37	dBμ
Recovered Output	Vo(AF)	Vin = 100dBμ	230	300	390	mVrms
Total Harmonic Distortion	T.H.D.	Vin = 100dBμ	–	0.06	0.3	%
Signal-to-Noise Ratio	S/N	Vin = 100dBμ	67	75	–	dB
AM Rejection	AMR	Vin = 100dBμ, Fm(AM) = 1kHz, 30% mod.	45	55	–	dB
Muting Attenuation	Mute(ATT)	Vin = 100dBμ, Vs = 2V	68	75	–	dB
Muting Band Width	BW(Mute)	Detuned frequency under 1.4V of Pin = 12 voltage, Vin = 100dBμ	–	100	–	kHz
Muting Sensitivity	Vin(Mute)	Vin under 1.4V of Pin-12 voltage	–	35	–	dBμ
Analogue Control Voltage	V 13-0	Pin-13 voltage under Vin = 0dBμ	–	0.2	–	V
	V13-60	Pin-13 voltage under Vin = 60dBμ	–	1.65	–	V
	V 13-100	Pin-13 voltage under Vin = 100dBμ	–	4.7	–	V
AGC Control Voltage	V15	Pin-15 voltage under Vin = 86dBμ	–	3.7	–	V

Circuit Description

The output from the tunerhead is boosted by a two stage amplifier circuit that more than makes up for losses from the pair of two-pole ceramic filters. These filters are used for tunerhead coupling and bandwidth selection.

The IC block diagram shows the input is passed to a 3-stage amplifier/limiter and on to a 3-stage detector. This is to drive a signal strength meter and delayed AGC control. The quadrature detector circuit is internal and feeds the audio amplifier and AFC amplifier, which in turn provides the tuning meter reading.

When the AFC control circuit is switched on (AFC1 connected to AFC3). Q3 and Q4 amplify the deviation signal, feeding it back through the tuning circuit. This adjusts the frequency, continually trying to minimise the deviation from centre zero.

Muting is derived from two sources; a standard muting drive circuit, which activates when the signal level reaches a minimum value, and an AFC circuit through a '0 volt switch'. This works by monitoring the 'S curve' voltage and muting the signal outside the specified bandwidth (set by R10).

These sources are selected by the 'OR circuit' and passed to the audio mute control amplifier via a switch. On transmission, the treble frequencies are pre-emphasised to improve signal-to-noise figures. The audio output must then be de-emphasised, which can be done before (for mono) or after the decoder.

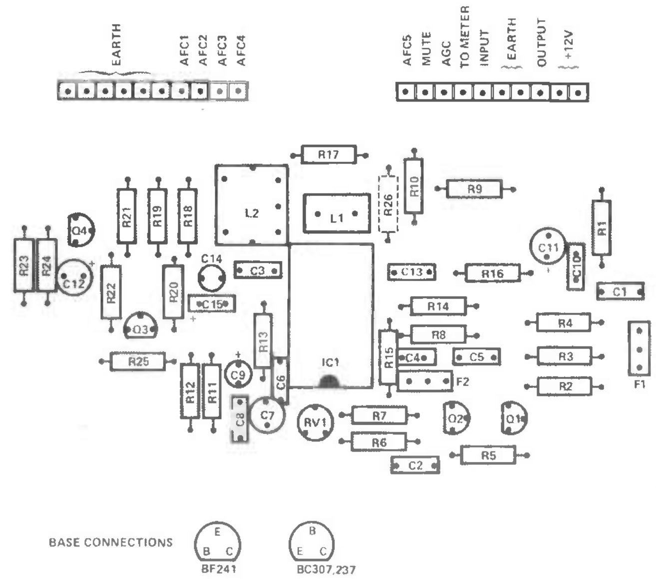


Figure 3: Component overlay for the Wideband FM-IF strip.

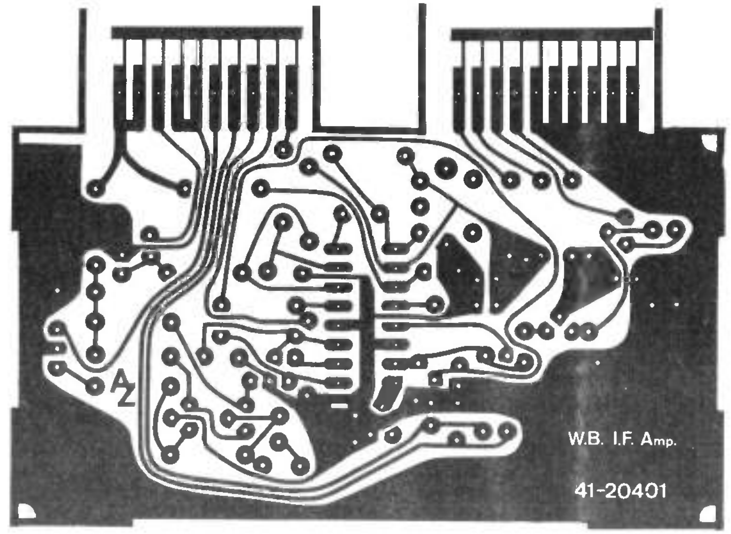


Figure 4: PCB foil pattern for the FM-IF strip. Note that the six elongated pads in the top right hand corner are connected to earth.

PARTS LIST

Resistors

R1	56R
R2,4,8	330R
R3	3k9
R5	1k
R6	10R
R7,9	100R
R10,11,12	10k
R13	470R
R14,21	33k
R15,22	100k
R16	2k2
R17	3k3
R18,19,24	4k7
R20	1k5
R23	2k7

Capacitors

C1,2,3,4,6,8,13	10n
C5	22n
C7,11,12	4u7
C9	1uF
C10	47p

Inductors

L1	7BA2220K(E)
L2	KACS586HM
F1,2	CFSE10.7/SFE10.7

Semiconductors

Tr1,2	BF241
Tr3	BC307
Tr4	BC237
IC1	HA12411/KB4420B

Miscellaneous

1off 16 pin DIL IC socket, 1off PCB.

selectivity IF filters (***Fig. 1***). The mechanism was there all the time — put the AFC and reference voltage into a comparator and set the 'window' limits which allow the signal to pass through. Depending on the 'Q' of the detector, the AFC voltage bears a very predictable relationship to the frequency offset (deviation).

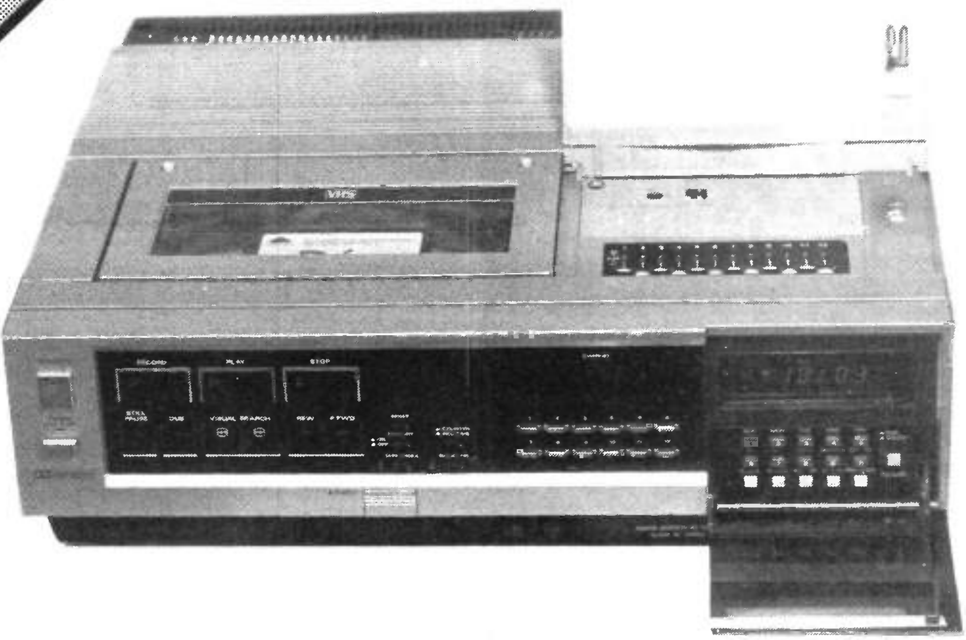
The HA12411 and KB4420B are pin compatible with (and supersede) earlier devices, where the supply voltages needed to be 12V to avoid clipping in the audio output stage. The newer devices allow a large supply voltage range, 7V to 15V, and are therefore ideal for use from a stabilised car-battery supply.

Construction

The circuit diagram shows which components comprise the PCB. All linking tracks go to the edge connector, which means there's the advantage of facilitating pin connections.

The board is designed to fit neatly into a screened box, which can then be treated as a completely self-contained IF amplifier — small enough to be board mounting in itself! (along with a tunerhead and suitable *audio* amplifier). The output of the IF stage is about 100mV and with the addition of a stereo decoder, a sophisticated FM tuner with AFC, muting and meter drives can be put together for very little cost. ■ R&EW

VIDEO NEWS



Peter Luke with some comments about review models of video recorders and a mini review of the Hitachi 9700.

As part of this magazine's aim is to collect material from all fields of electronics endeavour, we have for some time now carried regular reviews of video recorders. You may also have noticed that the makes of machines given the **R&EW** treatment are, in the main, from the better known Japanese companies. The reason for this is simple, they not only have the most efficient manufacturing operations but also fairly well organised PR departments to support the sales operation.

R&EW suffers slightly in that it is not a magazine solely devoted to matters video and thus, when it comes to obtaining the very latest machines, we are often told that there is a long waiting list — "phone back in four weeks time".

With some companies this follow up phone call is met with a similar message and its only the four or five **R&EW** regulars that manage to respond to our dogged attempts to secure a machine for review.

The other day I had occasion to phone a couple of companies whose products we have not had a chance to evaluate. The line I used was to ask if **R&EW** could review some of their products that had been around for some time. It's these machines that are often available at considerable discounts in the high street and thus might be of considerable interest to would be purchasers.

To my amazement, the same companies that seem unable to provide us with any of their new machines were also unable to supply any of these older recorders.

It seems that we at **R&EW** are either two early or too late. We'll keep on trying of course, but in the meantime while we'd like to review British in the hope that you might buy British, it's simply not possible.

Tape A-Z

The blank video tape survey featured in this issue is the first of, what we hope to be, a series of collaborative ventures with the magazine Video A-Z. The next venture, which will probably be published in our June issue, is a comprehensive look at tape head cleaners.

It seems that Video A-Z are doing a very comprehensive job judging by a conversation I had with the magazine's Editor the other day.

He was telling me that as part of the test, Video A-Z had attached thermocouples to the various head assemblies and monitored the temperature rise as the head cleaners were used. This, of course, gives a good guide as to the amount of head to tape friction and thus just how much use of cleaning tapes contributes to head wear.

Normal tape apparently caused only 0.25°C or so of temperature rise while most cleaning tapes prompted a rise of about 3 or 4°C. Some tapes however caused a 7°C rise with a consequent increase in head wear. So before using a cleaning tape — stay tuned for our June issue.

9700 In Brief

The Hitachi 9700 is top of the Company's range of video recorders and as such one might expect it to provide the facility to record stereo sound. The first surprise for some will then be, that despite its flagship status, the 9700 is a mono machine. In all other respects though the recorder offers a good all round performance and a comprehensive range of features.

In styling, the recorder is very much in keeping with the 9300 and 9500 that complete Hitachi's range of mains recorders. Unlike these other machines though, the 9700 owes far more to its predecessor, the 8700, retaining much the same timer and controls rather than presenting a completely redesigned machine.

The 9700, naturally enough features solenoid control of its transport functions, the major of these, including visual search and still frame, being available via the front panel controls.

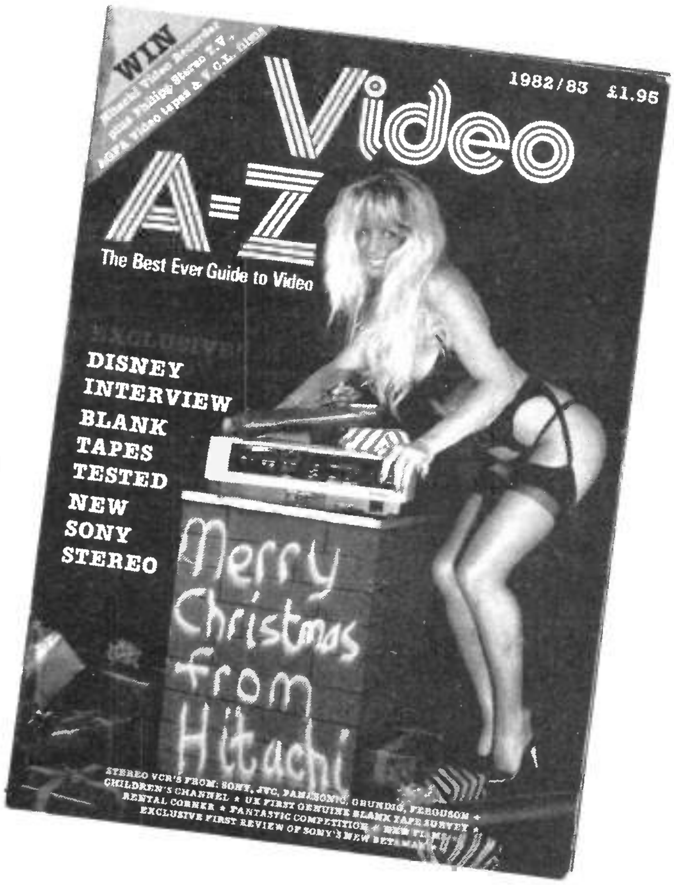
The X2 forward facility, the slow speed and frame advance are, however, only selectable from the recorder's companion IR remote unit.

To the left of the motion controls is a four digit tape counter that also doubles as an elapsed time indicator. This indicator provides a display of the amount of tape used during record or playback in units of minutes and tens of seconds. It's useful for checking the amount of tape left on a cassette but suffers from the disadvantage that it only operates during record or playback modes — not changing if the machine is rewound. A front panel switch selects either the counter or elapsed time indicator and, in the counter position the memory rewind facility of the recorder can be used. This will stop the tape at 0000 when the recorder is in the rewind mode.

The other switches below the indicator control the tape indexing system of the recorder and the Dolby audio circuitry. The tape indexing system is of particular use if a number of different recordings are made on the same tape. The control pulses recorded at the start of each section enable the different recordings to be quickly located. This facility is not found on the other recorders in Hitachi's range and is perhaps the option that is most missed from these machines. The Dolby function needs no further explanation except to say that it is Dolby B only — the option of the C format that has appeared on some machines recently, is not offered.

Both the index and Dolby switches have LEDs associated with them to provide an 'at-a-glance' indication of the machine's status.

The channel indicator and the 12 associated channel select buttons are to the right of the counter display with the clock display at the right hand end of the 9700.



The Christmas 82 edition of Video A-Z revealed rather more than the clean lines of Hitachi's 8500 recorder.

Setting Up

The 9700 is readily set up with the aid of its in-built test signal generator, the manual giving explicit and comprehensive instructions.

The 12 stations are tuned in via a set of manual presets which again are beginning to be replaced by an electronic system on top price recorders but are still preferred by many people.

The quality of the recordings made by the 9700 was excellent with all the 'trick' functions turning in a credible performance. The still frame gave a few initial problems with picture judder but a control is provided to alleviate any such troubles.

The slow picture did not produce a smooth continuous picture but rather a rapid pulsing of a still frame producing a rather jerky display and producing quite a lot of mechanical noise.

The timer section of the recorder is, as stated above, very much as that of the 8000 series. Of an 8 event 21 day specification the timer is comprehensive but takes rather a long time to set up. For each event separate start and stop times must be entered, a process that is losing supporters today, the current vogue being start time followed by duration.

Showing Its Age

The Hitachi 9700 is rather dated in some respects, particularly for a top of the range machine and one suspects that Hitachi have a new model just around the corner.

The machine's performance is however excellent and the machine can be bought at prices that make it extremely good value for money.

9700 SPECIFICATION

Recording:	Rotary Two Head Helical Scan Azimuth Recording	
Tape Speed:	23.39 mm/sec.	
Aerial Input:	UHF channels 21 — 69	
RF Output:	UHF channels 37 (30 — 39 adjustable) (system I)	
Video Input:	0.5 to 2.0V p-p 75 ohm Unbalanced	
Video Output:	1V p-p 75 ohm Unbalanced	
S/N Ratio (Video):	43 dB	
S/N Ratio (Audio):	50 dB (Dolby NR switch "ON")	
	43 dB (Dolby NR switch "OFF")	
Horizontal Resolution:	Colour	240 lines
Audio Input:	−20 dBm	50 kohm
Audio Output:	−6 dBm	10 kohm
Mic Input:	−69 dBm	10 kohm
Audio Frequency Range:	70 Hz to 12 kHz	

This month, we compare the string handling facilities of BASIC and a specialised language — SNOBOL4.

There are two major problems relating to the translation of constructs and programs emanating from AI research. One is the limited memory implicit to microcomputers, and the other concerns the lack of string handling functions in BASIC.

```
10   INPUTLINE SENT$

20   FOR I%=1 TO LEN(SENT$)

30   CH1$=FNcaps(MID$(SENT$,I%,1))

40   CH2$=FNcaps(MID$(SENT$,I%+1,1))

50   IF ASC(CH1$)>90 OR ASC(CH1$)<65 THEN CH1$=" "

60   IF CH1$=" " AND (ASC(CH2$)> 90 OR ASC(CH2$)<65)
      THEN CH1$=""

70   NST$=NST$+CH1$

80   NEXT I%

90   PRINT NST$

100  END

110  DEF FNcaps(CH$)

120  IF ASC(CH$)>96 AND ASC(CH$) <123 THEN CH$=CHR$
     (ASC(CH$)-32)

130  =CH$
```

A solution to the first problem might *appear* simple — hang a few kilobytes of dynamic RAM on the back of your micro. However, while this approach is plausible (albeit expensive), it surely defeats the object of using small machines in the first place. What's more, since most of the projects under discussion can hardly be said to possess ultra-fast 'run-times', increasing the size of your home computer's memory is not worth the effort. It's better to compromise in favour of working with individual systems' constraints.

The second problem is of a more tangible nature and best illustrated by comparing the built-in string functions of BASIC with a specialised string oriented language; SNOBOL4.

Is BASIC Too Basic?

As a general purpose 'first' programming language, BASIC fulfils its role quite adequately. Despite several attempts to oust its position as first choice for resident micro software, BASIC is by far the most widely used by home computer enthusiasts. Now, all this is fine until it becomes necessary to extract a particular subset of functions for some specific job; in our case, the functions which allow complex string processing to be performed. Looking at the essential lines of last month's 'text cleaning' routine (***Fig. 1***), if we compare these with an equivalent routine written in SNOBOL4 (***Fig. 2***), some idea of the advantages of specialist languages becomes apparent. Even without any knowledge of the structural elements contained in the second listing, it should be obvious that SNOBOL4 encompasses a far richer functional base for string manipulation.

For example, two extremely useful functions are BREAK and SPAN. The first of these matches a pattern up to, but not including, the first character in the subject string which is contained in the function's argument. The second matches a 'span' of consecutive characters contained in its argument. ***Figure 3*** shows how these elementary functions can be used to match different string formats. By combining these and other 'pattern functions' hierarchically, complex character strings can be matched — the building blocks for parsing syntactic structures in natural language.

Figure 1. Essential program lines from last months text processing routine. All output formatting and error loops have been removed.

Figure 2. An equivalent text processor coded in SNOBOL4 (again, no formatting or error checking are included). The difference in clarity and length, compared to the BASIC program is quite staggering.

```
          UC = 'ABCDEFGHIJKLMNOPQRSTUVWXYZ'

          LC = 'abcdefghijklmnopqrstuvwxyz'

          SENT = TRIM(INPUT)

          UCSENT = REPLACE(SENT,LC,UC)

TAKE      UCSENT = SPAN(UC) . WORD = :F(PRINT)

          OUTSENT = OUTSENT ' ' WORD :(TAKE)

PRINT     OUTPUT = OUTSENT
```

Typical mainframe computer installation.

Despite the advantages of SNOBOL4 over BASIC in these respects, however, we will direct our attention to the latter (how many micros have you seen with a SNOBOL4 interpreter?), due to its widespread appeal.

Making The Most Of It

The BBC micro is probably one of the better equipped machines as regards string handling functions within BASIC. ***Table 1*** gives a summary of these 'built-in' functions (owners of other micros will probably find similar ones with different names). Though hardly exhaustive, they do permit a degree of flexibility when coding string processing routines. Certain limitations can be circumnavigated with a little ingenuity: firstly, by converting characters into their ASCII equivalents, whole portions of the computer's character set can be manipulated. The translation of lower into upper case letters, for instance, can be performed by numerical subtraction. *And* there's a complementary function (CHR$ on the BBC) to change the code back into a character.

Another useful trio are concerned with substringing from sections of the subject string. LEFT$, MID$ and RIGHT$ require numerical start/finish 'markers', whose positions might be determined using the INSTR function. It's probably worth spending a few hours checking their operation to gain an insight into the possibilities. Certainly there do exist some parsing routines which rely on simple rules to identify syntactic relations (eg, the words 'a' and 'the' are followed by a noun/adjective+noun sequence).

Table 1. String functions on the BBC micro.

ASC	**returns the ASCII code for character argument**
CHR$	**returns the character with given ASCII code**
INSTR	**gives position of first character**
LEN	**length of string**
LEFT$	**substring at position counted from left**
MID$	**substring between two given positions**
RIGHT$	**substring at position counted from right**
STR$	**Converts number to string eg, 6.7 — "6.7"**
STRING$	**duplicates strings**

It's impossible, in the space available, to provide a comprehensive course on 'working with strings' in BASIC. The main criterion is to achieve some understanding of the optimum way of employing particular functions to perform a set task. Don't worry about the vagaries of structured programming until you fully appreciate the action of each command.

Figure 3.

```
        1  The A.I. File

        2  The A.I. File

BOTH OF THE ABOVE STRINGS CAN BE MATCHED USING 'SPAN' AND 'BREAK'

BREAK(letters) SPAN(letters '.') BREAK(letters) SPAN(letters)

SUCH PATTERNS CAN THEN BE ASSIGNED TO A VARIABLE.

AIPAT = BREAK(letters) SPAN(letters)

WHICH CAN BE USED FOR FURTHER PATTERN MATCHING:

SENTENCE AIPAT . FIRSTMATCH =

HERE, THE PATTERN IS ASSIGNED TO THE VARIABLE 'FIRSTMATCH' AND
DELETED FROM THE STRING
```

Lists Of Languages

One of the most popular languages used by AI researchers is LISP. At first sight, its profusion of parentheses and alien keywords makes the thought of learning how to program with it rather unattractive. However, a cursory familiarisation with the basic structures reveals a very powerful language, particularly suited to problems in artificial intelligence. Rather than the customary statement-by-statement approach, a LISP program evolves as an expanding function, with arguments, conditions, decisions and outcomes. The programmer will tend to work from the core of a problem outwards and, by adding other 'functional centres', produce a highly representative model of the task.

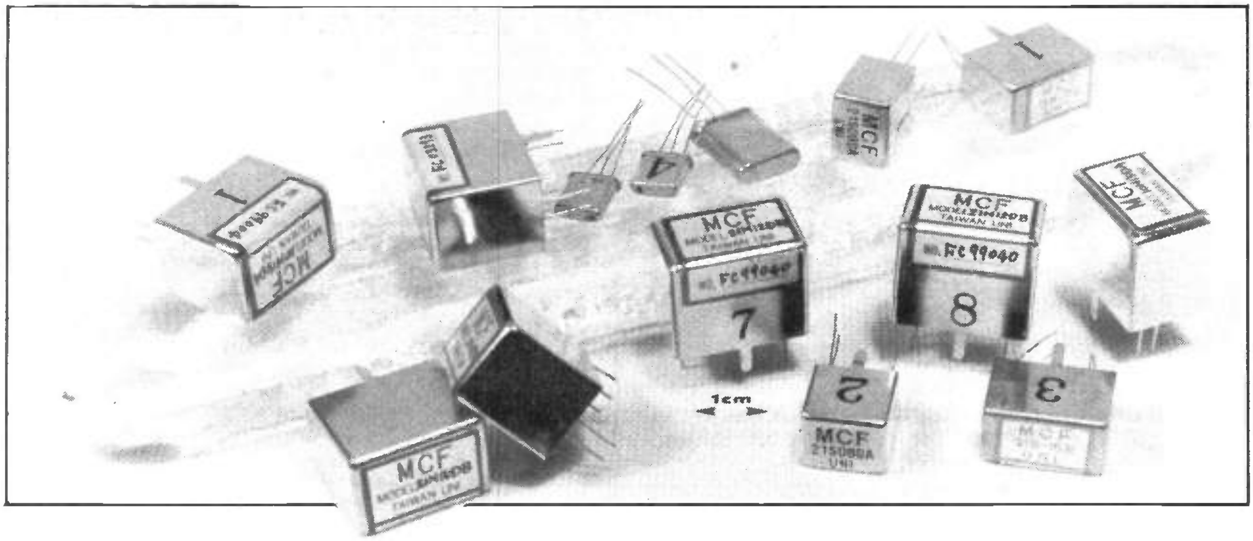
Other languages — and there are dozens of them — you may encounter include SAIL, POP-2, PLANNER and JOVIAL; though some of the famous projects, such as 'ELIZA', were written in more familiar languages (FORTRAN in this instance). It is not essential (nor practicable) to know all these languages, just to have a basic idea of their underlying actions. In subsequent months we'll attempt to outline some of these — next month, though, the subject is pseudorandom sequences and language production.

Bits And Pieces

Short and sweet this month. Rather than a source listing; the following coordinates (on the BBC micro) map out a familiar accronym.

■ R&EW

Start at: (400,768) then (480,768), (592,384), (512,384), (480,480), (400,480), (368,384), (288,384), (400,768).
Restart at: (688,768) then (880,768), (880,704), (816,704), (816,448), (880,448), (880,384), (688,384), (688,448), (752,448), (752,704), (688,704), (688,768).



CRYSTAL FILTER DESIGN

Crystal filters are still the most obvious choice when it comes to selecting specific signals from the RF spectrum. A.J. Rogers looks at the characteristics of these devices and delves into design considerations.

IN SPITE of the ever increasing advances in semiconductor technologies alternative methods of selecting specific signals from a broad RF spectrum has not yet ousted the crystal filter. Its superiority in its range of centre frequency c, bandwidth, selectivity and loss will guarantee its future in radio communications for some time to come.

Basically the reason why crystal filters can achieve better performance than other technologies is its ability to exploit the piezo-electric effect combined with the low loss associated with mechanically vibrating structures. Most crystal filters use quantity as its piezo-electric material which has an intrinsic Q of several million and even when using quartz at a common frequency of 10MHz a practical device has an actual Q > 50,000. This fact allows filters to be practically manufactured with a passband width as low as 2kHz with a centre frequency of 10MHz.

If one looks around the Industry it becomes quickly obvious that the crystal filter manufacturers are themselves also crystal manufacturers. The reason for this has evolved with the growth of crystal filters from the early telephone transmission days as a desirable situation because of the close cooperation needed between the crystal and filter designers. For the technician who requires a one off special to enable him to improve the performance of his equipment he should first see whether one of the industry standards (eg at centre frequencies of 1.4,10.7 or 21.4MHz) cannot be used. Failing that he could contact a manufacturer for a special design but unless he owned an oil well would find the best solution to design it himself and just purchase the crystals.

This article intends to show just how this can be done. You will need no more than a scientific calculator, a sweep generator, suitable detector and frequency counter.

Filter Specification

The method of specifying crystal filters is normally identical to specifying any electrical filter network. However because of the narrow band nature of crystal filters, the bandwidths are usually specified having arithmetic symmetry about its centre or reference frequency. ***Fig. 1*** defines the parameters which need to be specified, the specification limits are represented by a template.

The insertion lcss is defined as the ratio of the power delivered to the load measured at a specific freqency, normally at the filter's lowest loss point (maximum transmission) to the maximum power available to the load with the filter removed and the source matched for maximum power transfer.

There is often a tendency for the end user to over specify his requirements and this often leads to over complex designs so

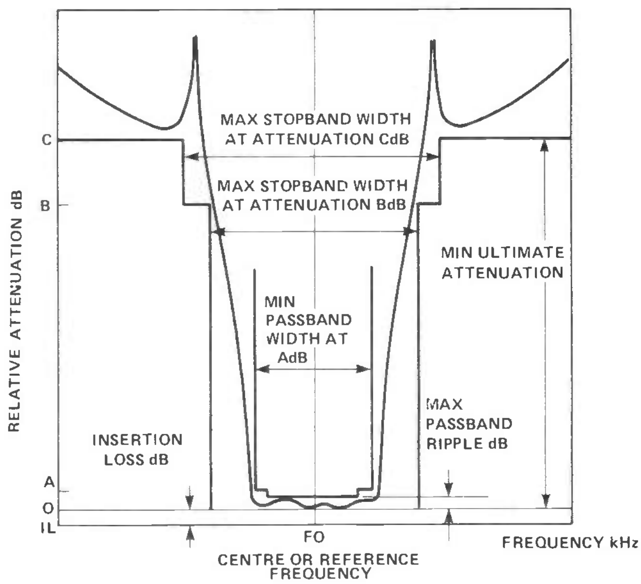


Figure 1: Explanation of the filter specification.

when specifying your requirements consider carefully whether you do really need a 90dB stopband or a 2:1 shape factor. In broad terms the higher the stopband requirement the more complex the circuit has to be and the steeper the shape factor the more crystals are needed.

Specification Limitations

Crystals are manufactured from around 1kHz to 200MHz and filters can be made from any of these frequencies. However the high cost of the very low and very high frequencies will generally limit the range to 100kHz to 100MHz and again because of cost and alternative technologies 90% of all crystal filters manufactured are between 1.4 and 21.4MHz.

To obtain this wide frequency range from a mechanically vibrating structure without having the same range in size, the quartz is orientated in many different directions so that the dimensions which control the frequency are optimised for practical values. Each of these different orientations is called the crystal cut and each has a frequency constant which relates frequency to the frequency controlling dimensions. For example the 1kHz crystal operates in what is called the X-Y flexure mode the frequency controlling length of which is approximately 60mm and at 200MHz the vibration is a seventh overtone AT operating in a thickness shear mode the frequency controlling thickness of which is only 60 microns.

The consequence of having this variety of cuts is, as would be expected, that the equivalent circuit parameters are vastly different and it is these parameters which limit the total range of crystal filters.

Figure 2 illustrates the practical limits of crystal filters classified by centre frequency and bandwidth. The discontinuities of the boundary conditions occur at the frequencies where crystals change from one type of cut to another.

Compared with other electronic components, the temperature coefficients of crystals are of course extremely low (typically 0.55ppm/°C) but this factor and the maximum Q factor is what dictates the minimum bandwidth.

Crystal filters with bandwidth ratios greater than 1% require the use of very high Q coils and which are the limiting factor on the performance of the filter. Generally speaking conventional LC filters become practical above this point in any case and often there is no benefit to be gained from using crystals. Ceramic filters however often fill a useful gap in this area as they overlap the crystal filter availability diagram over part of the frequency range.

Figure 2 also indicates the region in which monolithic filters can be obtained. Monolithic filters are a special type of crystal filter in which the equivalent of two or more crystals are manufactured on a single piece of quartz. Whereas a normal crystal has a pair of electrodes to apply the signal to the quartz, a monolithic filter has a number of pairs (usually only two) of electrodes. The signal is applied to the first pair causing the quartz to vibrate, the vibration acoustically couples to next pair inducing a signal in it which is either taken to the output for a monolithic dual or couples into the next pair. Because the design of monolithlic filters involves precise dimensioning of the electrodes which in turn involve considerable tooling costs their design is not considered in this article.

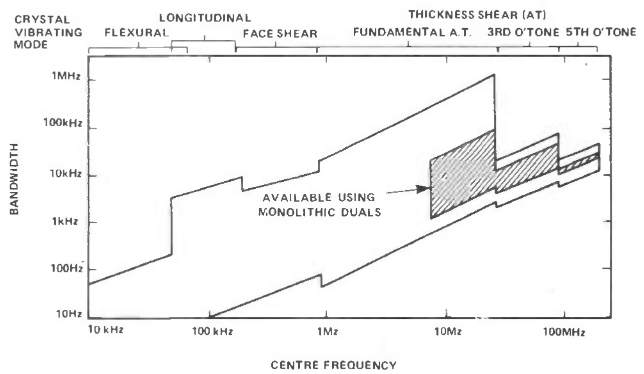


Figure 2: Availability of crystal filters.

Crystal Parameters

Crystal filters are often designed by applying conventional network transformations to the well established LC filter design techniques. As these designs are specified in terms of inductances and capacitances it is therefore necessary to have the equivalent circuit of the crystal in the same reactive components. ***Fig. 3*** shows the equivalent circuit of a crystal, this same circuit is used for all frequency ranges just the component values changing. It is made up of a series resonant circuit of L1,C1 and R1 called the notional inductances, the notional capacitance and the equivalent series resistors (ESR) respectively and in parallel with this series resonant circuit is a shunt capacitance Co called the static capacitance. As can be seen from the circuit the Co is simply the total capacitance between the two component leads when measured at a frequency well away from the resonant frequency of the series arm. For all practical purposes a measurement made on a universal bridge (at 1.0 or 1.592 kHz) is sufficient. In critical applications especially wide band filters, the Co must be split into a 3 terminal network separating the capacitance between the terminals and the capacitance between each terminal and its case (in metal canned crystals).

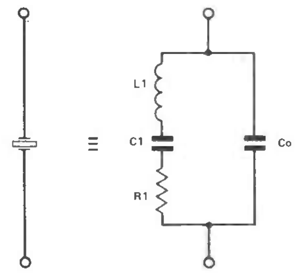


Figure 3: Equivalent circuit of a crystal.

The notional parameters are related by the following expressions.

Low frequency crystals (below 1MHz) are more often measured in a parallel resonance mode which instead of measuring the frequency of minimum impedance measures the condition of maximum impedance. To do this, the measurement circuit introduces a load capacitance (usually 30pf or 100 pf) in parallel across the crystal. The frequency and Quality Factor is then given by.

$$\text{Frequency (parallel resonance): } f_p = \frac{1}{2\pi\sqrt{\dfrac{L_1 C_1 (C_o + C_L)}{C_1 + C_o + C_L}}}$$

where C_L is the added load capacitance.

$$\text{Quality factor: } Q = \frac{1}{2\pi f_s R_p (C_o + C_L)^2}$$

where R_p is the equivalent parallel resistance (EPR)

If the inductance (L1) of a crystal is unknown then a convenient method of measurement is to make a two frequency measurement, one at series resonance and the other at the frequency to which the crystal is pulled by the addition of an accurately known capacitor (usually 30pf) in series with the crystal.

The inductance is then calculated from the following expression:

$$L_1 = \frac{1}{8\pi^2\ f_s\ (f_s - f_L)\ (C_o + C_L)}$$

where C_L is the added capacitance
and f_L is the series resonant frequency with C_L in circuit.

Similarly if the crystal measurements have been made at parallel resonance then changing the load capacitance will give a second frequency. Substituting the known quantities in the frequency F_P expression will give two simultaneous equations which can be solved for L1 and C1.

The Filter Characteristic

Present day filter designs are based on what is known as 'Modern Insertion Loss Theory' as opposed to the old 'Image Parameter' methods. The most commonly used response is the Chebyshev which is characterised by an equal ripple passband and a monotonically increasing stopband attenuation. The Butterworth response is a special case Chebyshev response of zero ripple giving a maximally flat passband shape.

To obtain maximum selectivity for a given 'order' or number of crystals the Cauer characteristic is used. This has the same passband characteristic as the Chebyshev response but also has peaks of attenuations close to the transition band. ***Fig. 4*** compares some examples.

To design crystal filters using the Cauer method involves more precise control of the crystal and other component parameters and therefore it will not be considered further for the purposes of this article.

So far the characteristics mentioned are used in applications where a good selectivity is important. A disadvantage of high selectivity is a high group delay variation. With the increasing need to transmit data through normal speech channel systems crystal filters are becoming available with linear phase characteristics. Such filters of course are less selective for the same number of components and a number of characteristic types are available providing varying degrees of selectivity versus group delay performance. The main types are Gaussion, Bessel, Legendre and a Linear Phase type which in fact has an equal ripple group delay characteristic.

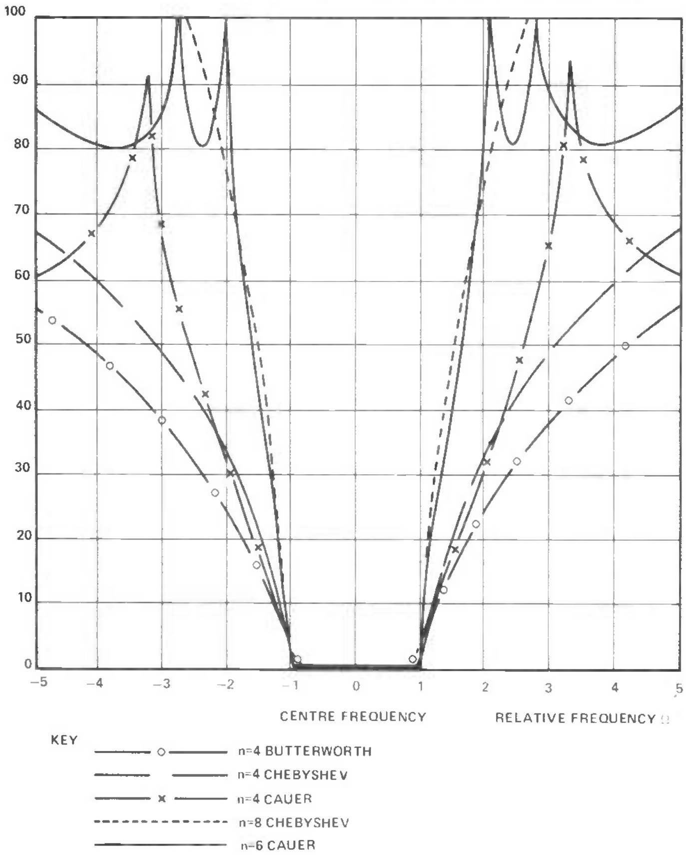


Figure 4: Examples of types of responses.

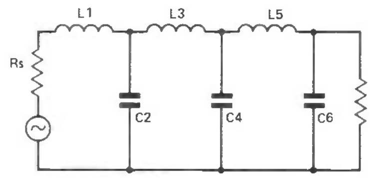
The Filter Circuit

The filter characteristics mentioned above all have an Insertion Loss Function defined as the voltage ratio of the output of filter to the output with the filter removed. This function is a polynomial whose degree is by definition the order of the filter and more commonly referred to as the number of poles. The greater the degree of the polynomial (number of poles) the greater the selectivity of the filter. Tabulated data is readily available for the commonly used response characteristics for various orders providing design data for a normalised low pass filter shape. The 3dB bandwidth point and the load impedance are the parameters which are normalised to 1 radian/sec and 1 ohm respectively.

To convert the low pass prototype as it is called into a filter in which crystals can be used requires a number of simple network transformations to be applied. The transformations are described in the sequence in which they are carried out and the expressions arrived at after the transformations have been performed are given.

1. The starting point is the circuit of the low pass prototype assigning the element values circuit symbols rather than their actual values. ***Figure 5*** gives a sixth order example.

Figure 5: N = 6 lowpass prototype



2. Transform all reactive elements to put all six reactances into the series arms of the ladder using five Impedance Invertors (Nanton Transformation). Because of the impedance invertor all six series reactances will be inductive.
3. Set the transformation ratio to X_n for each invertor so that all series arm element values are the same.
4. Denormalise all reactive elements by the bandwidth in radians/sec ie $2\pi B$.
5. To convert a low pass filter into a bandpass filter each reactive element is resonated at centre frequency. In this instance all reactive elements are inductive and equal so inserting a capacitance in series with end inductance of value is required.
6. Replace each impedance invertor with its equivalent T circuit with the shunt arm set at a capacitance of value $\frac{1}{WX}$ and the series arms a capacitance of $-\frac{1}{WX}$
7. Combine these negative capacitances with the positive capacitances (using the capacitance in series formulae) and the network now looks like a conventional ladder circuit with series tuned circuits in the series arms and capacitance in the shunt arms.
8. Denormalise the impedance level of the network by setting the level of each inductance to that of the crystal inductance (L) to be used. This converts the terminating impedance from 1ohm to $2\pi BL$.
9. The network is divided into T sections (the number will be half the order of the filter) and Bartlett's Bisection Theorem used to convert each T section into a full lattice section. The element values of each series arm need to be equal, therefore the excess capacitance which appears is left outside the T section.

10. Any capacitance remaining in the series arms will normally be at the input and output and this is transformed from a series RC network to a parallel RC network. This transformation is only valid at a single frequency. However because of the narrow band nature of the crystal filter negligible deterioration of performance occurs except on the widest of filters.

11. Subtract from each shunt capacitance the value Co and replace across each lattice arm (2 Co needs to be removed from the centre capacitances). The network now has its lattice arms in the form of a crystal equivalent circuit.

12. Each full lattice is transformed into the half lattice section by the addition of a balanced (hybrid) transformer.

13. The transformer to be practical is made to have an inductance as high as is consistent with providing tuning to permit its adjustment as a parallel tuned circuit at centre frequency and of sufficient Q that its loss is high compared with the terminating resistance.

14. The transformations are now complete and the final circuit is shown in ***Fig. 6***.

There are many variations on the method of realisation of crystal filters but the one described here is the most common. Different configurations can be arranged when all the crystals appear in a single lattice, transformers are used in the centre rather than at the terminations and the availability of different crystal inductances provides for simpler tranformations.

The Design Process

The specification required will give the centre frequency Fo, the total passband width B (normally defined at 3dB), the passband ripple level r and the stopband requirement usually as a bandwidth at some specified attenuation level.

Depending upon the application of the filter, design margins need to be taken into account which will depend upon parameters like the temperature range, the ruggedness of the application and the manufacturing tolerance of the crystals to be used. As a first approximation however if 10% of the bandwidth and 100% of the ripple is used these margins will be sufficient to cover most eventualities.

Design data is provided for Butterworth and Chelyshev responses covering ripple levels of 0.1dB, 0.5dB and 1.0dB and orders of 2,4,6 and 8. The design data used is tabulated in the form of K and 9 values as opposed to the low pass prototype elements because data for other filter types are usually published in this form.

Using the curves and tables provided proceed as follows.

1. Set the design bandwidth B at the 3dB level including the design margin (10%). Divide the stopband width by B to obtain the shape factor Ω.

2. Decide the ripple level you wish to use, say half your maximum limit or select the zero ripple case (Butterworth response).

3. Referring to the appropriate attenuation characteristic in ***Fig. 7*** plot the point for the required shape factor Ω against the stopband attenuation. The required order or number of poles will be given by the next curve above the point.

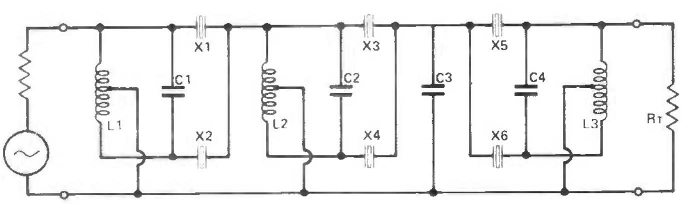


Figure 6: n = 6 crystal filter.

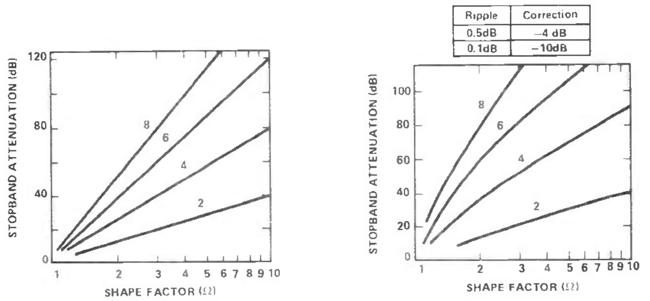


Figure 7: Attenuation Characteristics.

4. Refer to ***Fig. 8*** to obtain the appropriate K and 9 values.

5. Substitute these values, together with Fo, B, L and Co into the formulae given in ***Fig. 9*** from which all the component values will be calculated. Often at this point the values of L and Co are unknown as the design parameters of the crystals are not available. Fortunately, however, as you can see from the calculations to obtain the crystal frequencies L and Co are not required. Once the crystals are available and their inductance and static capacitance known the calculations can be completed and the circuits built as shown in ***Fig. 10*** and tested.

If in the design any of the shunt capacitances between the half lattices turn out negative in value, this is the case where the filter is in a category called an intermediate bandwidth type and an inductance has to be added to provide sufficient positive capacitance to tune out the negative capacitance.

Matching the design impedance R_T of the filter into the circuit in which it is to be used is an essential part of the design procedure. The design described here achieves its terminating impedance primarily as a function of the bandwidth, crystal inductance and number of poles and is therefore unlikely to equal the required impedance. To obtain the correct impedance therefore it is necessary to incorporate some form of impedance transformer. Two convenient methods can be used namely an additional winding on the balanced transformer or a series matching capacitance or in fact a combination of both.

For wideband filters the transformer will usually give the best results because the higher impedance obtained is more sensitive to error and the transformer, as a wideband device, is valid over the whole frequency range. A series matching

n=2

RIPPLE	q	k_{12}
1.0dB	2.21	0.739
0.5dB	1.95	0.723
0.1dB	1.64	0.711
OdB	1.414	0.707

n=4

RIPPLE	q	k_{12}	k_{23}
1.0dB	2.21	0.638	0.546
0.5dB	1.83	0.648	0.545
0.1dB	1.35	0.685	0.542
OdB	0.765	0.841	0.541

n=6

RIPPLE	q	k_{12}	k_{23}	k_{34}
1.0dB	2.21	0.631	0.531	0.520
0.5dB	1.80	0.655	0.533	0.519
0.1dB	1.28	0.715	0.539	0.518
OdB	0.518	1.169	0.605	0.518

n=8

RIPPLE	q	k_{12}	k_{23}	k_{34}	k_{45}
1.0dB	2.20	0.633	0.530	0.514	0.511
0.5dB	1.79	0.658	0.533	0.516	0.511
0.1dB	1.25	0.728	0.545	0.516	0.510
OdB	0.390	1.519	0.738	0.558	0.510

Figure 8: Design coefficients (k and q values) for crystal filters.

n=2

$$F_1 = F_0 - \frac{B}{2}k_{12}$$

$$F_2 = F_0 + \frac{B}{2}k_{12}$$

$$R_T = \frac{\pi BL}{q}$$

$$C_1 = \frac{1}{4\pi^2 F_0^2 L_1} - \frac{C_0}{2}$$

$$C_2 = \frac{1}{4\pi^2 F_0^2 L_1} - 2C_0$$

$$L_1 = L_2 = \frac{R_T}{\pi F_0}$$

n=4

$$F_1 = F_3 = F_0 - \frac{B}{2}(k_{12} + k_{23})$$

$$F_2 = F_4 = F_0 + \frac{B}{2}(k_{12} - k_{23})$$

$$R_T = \frac{\pi BL}{q}(1 + q^2 k_{23}^2)$$

$$C_2 = \frac{1}{2\pi^2 F_0 BLk_{23}} - 4C_0$$

$$C_1 = C_3 = \frac{1}{4\pi^2 F_0^2 L_1} + \frac{q^2 k_{23}}{8\pi^2 F_0 BL(1 + q^2 k_{23}^2)} - \frac{C_0}{2}$$

$$L_1 = L_2 = \frac{R_T}{\pi F_0}$$

n=6

$$F_1 = F_5 = F_0 - \frac{B}{2}(k_{12} + k_{23})$$

$$F_2 = F_6 = F_0 + \frac{B}{2}(k_{12} - k_{23})$$

$$F_3 = F_0 - \frac{B}{2}(k_{34} + k_{23})$$

$$R_T = \frac{\pi BL}{q}(1 + q^2 k_{23}^2)$$

$$C_3 = \frac{1}{2\pi^2 F_0 BLk_{23}} - 4C_0$$

$$C_2 = \frac{1}{4\pi F_0^2 L_1} + \frac{q^2 k_{23}}{8\pi^2 F_0 BL(1 + q^2 k_{23}^2)} - \frac{C_0}{2}$$

$$C_1 = C_4 = \frac{1}{4\pi^2 F_0^2 L_1} + \frac{q^2 k_{23}}{8\pi^2 F_0 BL(1 + q^2 k_{23}^2)} - \frac{C_0}{2}$$

$$L_1 = L_2 = L_3 = \frac{R_T}{\pi F_0}$$

n=8

$$F_1 = F_7 = F_0 - \frac{B}{2}\left(k_{12} + \frac{k_{23}^2}{k_{45}}\right)$$

$$F_2 = F_8 = F_0 + \frac{B}{2}\left(k_{12} - \frac{k_{23}^2}{k_{45}}\right)$$

$$F_3 = F_5 = F_0 - \frac{B}{2}(k_{34} + k_{45})$$

$$F_4 = F_6 = F_0 + \frac{B}{2}(k_{34} - k_{45})$$

$$R_T = \frac{\pi BL}{q}\left(1 + q^2 \frac{k_{23}^2}{k_{45}^2}\right)$$

$$C_2 = C_4 = \frac{k_{45}}{2\pi^2 F_0 BLk_{23}^2} - 4C_0$$

$$C_3 = \frac{1}{4\pi^2 F_0^2 L_1} + \frac{k_{45}}{8\pi^2 F_0 BLk_{23}^2} - C_0$$

$$C_1 = C_5 = \frac{1}{4\pi^2 F_0^2 L_1} + \frac{q^2 k_{23}^2 k_{45}}{8\pi^2 F_0 BL(q^2 k_{23}^4 + k_{45}^2)} - \frac{C_0}{2}$$

$$L_1 = L_2 = L_3 = \frac{R_T}{\pi F_0}$$

$$L_B = L\frac{k_{23}^2}{k_{45}^2}$$

Figure 9: Design formulae for crystal filters.

capacitance is convenient and is calculated as a straight forward parallel RC to series RC impedance transformation. In practice it is necessary to add the termination stray capacitance as shown in ***Fig. 10***.

The expressions to calculate the series capacitance are as follows.

Series matching capacitance: $$C_x = \frac{1 + 4\pi^2 f_o^2 C_s^2 R_s^2}{4\pi^2 f_o^2 R_s (C_T R_T - C_s R_s)}$$

$$C_T^2 = \frac{R_T - R_s}{4\pi^2 f_o^2 R_T^2 R_s} + C_s^2 \frac{R_s}{R_T}$$

where R_s and C_s are the required terminating impedance, R_T the filter design impedance and C_T the extra capacitance needed in the transformation which appears across R_T. In the circuit shown in ***Fig. 6***, the values of C_1 and C_4 would have to be reduced by $C_T/4$ to obtain a correctly matched termination using a series capacitance.

Practical Considerations

The design method described is suitable for all frequencies of crystal filters and all bandwidths except the widest and the narrowest. The limitations of the design method are easily discovered by two simple calculations.

The minimum bandwidth is dictated by the frequency tolerance of the crystals because in a lattice configuration the crystal frequency spacing must remain substantially constant. Therefore a safe minimum bandwidth is fixed by 5 times the crystal frequency tolerance.

Filters which are required narrower than this limit are designed as ladder filters the effect of the crystal Co being ignored as the distortion caused by it is sufficiently remote from the passband.

The maximum bandwidth is determined by the Q's of the balanced transformers used and a safe limit without excessive passband distortion is reached when the following condition is met!

$5R > 2\pi\ f_o\ Q_C\ L_C$ where R is the terminating impedance and Q_C and L_C the Q and Inductance of the balanced transformer.

Crystals can be made with a relatively wide range of inductances and as a general rule crystals used in filter applications have a higher inductance than those used in oscillator applications because it is easier to control the spurious responses that are inevitable with mechanically vibrating systems.

A further constraint is that the maximum bandwidth attainable is a function of the crystal inductances and therefore, for wideband crystal filters at least, a conflict exists between obtaining a crystal inductance sufficiently high to suppress spurious responses and yet low enough to ensure that the filter can be realised practically. Such cases need to be carefully considered before the purchase of the crystals.

The major cause of problems with crystal filters is impedance mismatching. As with all reactive networks used in a transmission system it is essential to correctly terminate the filter. The impedance looking into the filter in the passband is essentially resistive and equal to its terminating impedance and for maximum power transfer the source impedance should equal it. The same applies at the load. In the stopband the filter is totally reactive with most of the incident power being reflected and it is still best to maintain a resistive terminating impedance as this matches the conditions under which the filter was tested.

Any capacitance specified in parallel with the termination (usually to take up the strays in the external circuit) must be correct because this value is part of the filter design as can be seen from the calculations.

Another problem encountered with crystal filters is lack of ultimate stopband attenuation (100dB is easily achievable at 20MHz with just 3 sections) due to common impedance paths and stray capacitances between input and output terminations. A good earth plane solves the first point to which all earth connections including crystal cans are made and careful positioning of the printed circuit layout or additional earthed screening solves the second point.

An Example

The specification for the example is as follows:

Centre Frequency	15MHz
Minimum 3dB Bandwidth	± 4.5kHz
Maximum Passband Ripple	1dB
Maximum 60dB Bandwidth	± 12.5kHz
Terminating Impedance	50 Ω

To allow for design and operational margins add 10% to the minimum pass bandwidth making B = 9.9 kHz. Set the design ripple level r = 0.5dB and calculate the shape factor Ω = 2.53.

Refer to ***Fig. 7*** setting the stopband attenuation plus the ripple correction to 64dB. The point corresponding to Ω = 2.53 shows that the curve n=6 will adequately provide the selectivity required.

Obtain the K and 9 values for n=6 and r=0.5dB from ***Fig. 8***. Substitute these values in the formulae given in ***Fig. 9***.

The following component values are obtained.

The required terminating impedance is 50R and to avoid making special transformers a series matching capacitances would be suitable. Substituting R_T into the formulae given, the series capacitance requires to be 106.4pF and the input and

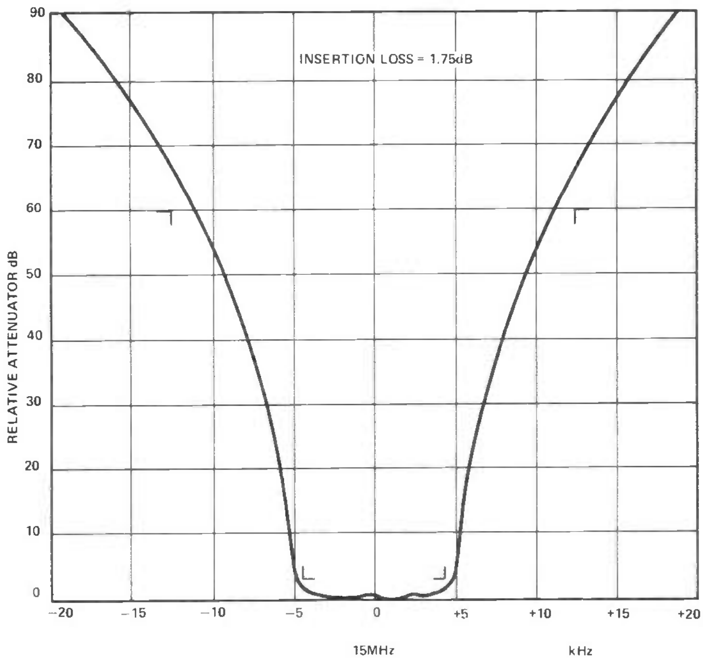


Figure 11: Computed response for n = 6 Chebyshev.

Component	Parameter Values		
$X_1 = X_5$	f = 14994.119kHz	L = 7.5mH	C_o = 2.6pF
$X_2 = X_6$	f = 15000.603kHz	L = 7.5mH	C_o = 2.6pF
X_3	f = 14994.792kHz	L = 7.5mH	C_o = 2.6pF
X_4	f = 14999.930kHz	L = 7.5mH	C_o = 2.6pF
R_T	R = 248.9Ω		
$L_1 = L_2 = L_3$	L ~ 5.28μH say 5μH		
$C_1 = C_4$	C = 31.4pF		
C_2	C = 41.3pF		
C_3	C = 74.9pF		

output capacitances to be reduced by $C_{T/4}$ = 21.25pf making $C_1 = C_4$ = 10.15pF.

Assembly of the above circuit components allowing for adjustment of the three coils or their tuning capacitances over about 10% of their value will allow the filter to be optimally adjusted. Fixed value components excluding the crystals should be selected to within 2% of the design value. To carry out the adjustment connect the filter into a 50R correctly matched line and feed a signal of about 10mV into the filter sweeping the frequency through the passband at a sweep speed of not more than 2Hz. Observing the output characteristic on an oscilloscope will permit adjustment of the tuned circuits to give optimum shape usually corresponding with minimum ripple. If a sweep generator is not available then adjusting the tuned circuits to maximum output voltage with the frequency set to 15.0047 MHz will give an adequate response. Fine adjustment can then be made by manual measurement of the passband response.

The above design as calculated was analysed on a computer and the theoretical response shown in ***Fig. 11***. To provide a realistic example the normal component losses are included in the theoretical calculation. In this case crystal ESRs of 15R and coil Qs of 50 were used.

■ R&EW

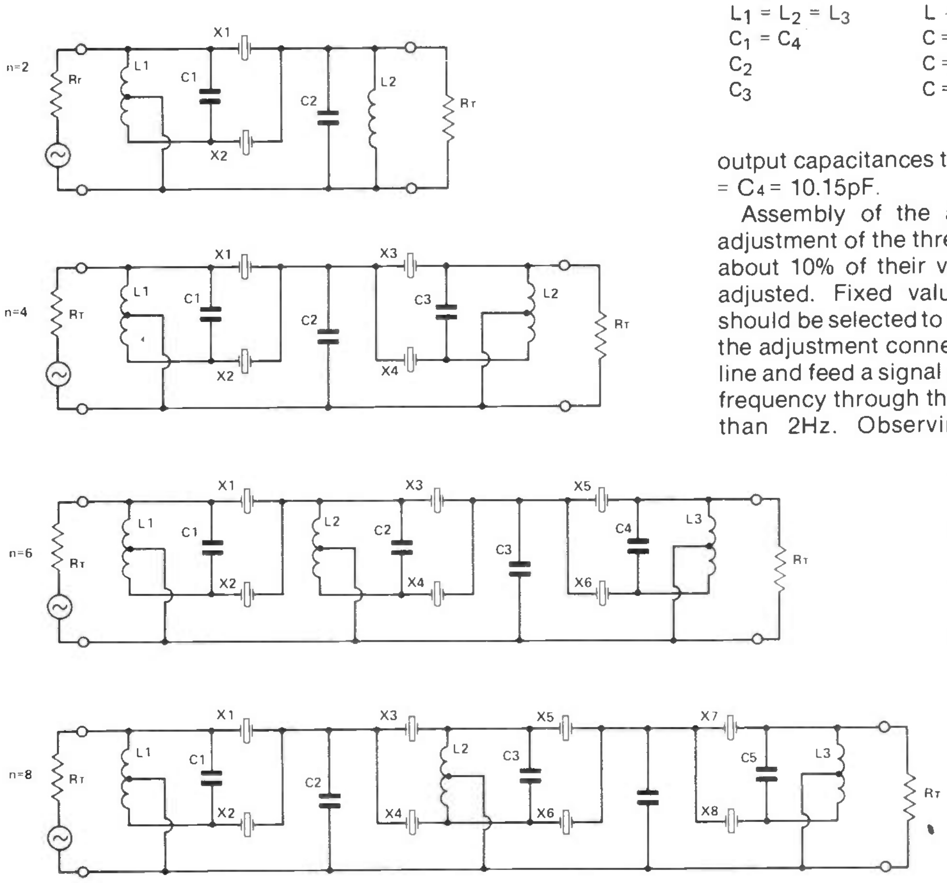


Figure 10: Circuit diagrams for crystal filters.

DVM MODULES

AND THEIR APPLICATION

Ray Marston presents, if not a million and one, a wide and varied series of circuits with the popular M176 DVM module as their central feature.

Modern digital volt meter (DVM) modules can be used to replace moving coil meters in virtually all important 'analogue' measuring applications. Most of these modules combine an Intersil ICL7026, 7126 or 7136 A-to-D converter chip and a 3½ digit liquid crystal display, together with a bandgap voltage reference and a few other components, into a compact module that consumes less than 1 mA from a 9 volt supply and costs little more than a good quality moving coil meter.

Usually, these modules have a full-scale sensitivity of ±199.9mV, with 100uV (2000-count) resolution and a typical calibrated accuracy of 0.1% ± 1 digit, but can be used to read any desired current or voltage range by connecting suitable shunts or potential dividers to the input terminals. When connected to suitable external circuitry, the modules can be made to indicate AC voltage or current, resistance, capacitance, frequency, temperature, or any other parameter that can be converted into a linear analogue voltage or resistance.

Several companies manufacture 3± digit LCD DVM modules. Generally, these modules (including the PCIM 176, DPM 200 and PCIM 220) differ only in details of their internal circuitry and displays, and in the number and notations of their user-available terminals. The M 176 (also known as the DPM 176) module manufactured by Printed Circuits International Ltd is probably the best known and most widely available model, and is very typical of the genre, so we'll refer to this specific device throughout the rest of this article. ***Fig. 1*** shows the physical details and terminal notations of the most recent (rev G) version of this device.

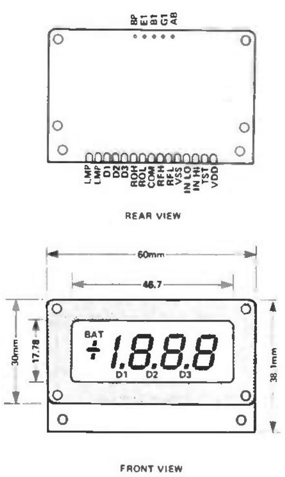


Figure 1: M176 Physical details.

M 176 Basics

Figure 2 shows the block diagram 'user view' of the M176, which is normally powered from a 9 volt battery connected between the VDD and VSS terminals. The heart of this particular unit is an ICL7026 chip which is a complete dual-slope analogue-to-digital converter and LCD driver. In essence, this chip automatically compares the relative values (ratios) of Vref and Vin and produces an LCD display of 1000⅟₁₅ Vin/Vref, updating the display about 2½ times per second.

Thus, if Vref is 100mV and decimal point D3 is activated, the display reads 10.0 with an input of 10.0mV, or 199.9 with an input of 199.9mV. The module automatically displays the polarity of the input signal, gives automatic zero adjustment, and gives over-range indication by blanking the three least significant digits of the display. The three decimal points of the LCD are externally available at the D1 to D3 terminals, and can be turned on by pulling the appropriate terminal to VDD. The module also houses a 'low battery' detector, which turns on a LCD indicator when the battery voltage falls below 7V2.

It is important to note that the DVM module displays the relative *ratios* of the input and reference voltages. To give maximum versatility each of the voltages is applied to the module via a *pair* of terminals (RFH and RFL for the reference, IN HI and IN LO for the input), and the integrator chip responds to the differential values of these inputs. In use, these terminals must be tied (either directly or indirectly) to within 500mV of the COM terminal. When correctly used, the terminals have typical input impedances of about 5000 Megohms, and pass typical leakage currents of only a few picoamps. The IN HI terminal incorporates an integrating ripple-reduction filter.

The module has two built-in reference-voltage sources. The voltage between the COM and VDD terminals is zener-regulated at 2V8 and has a typical temperature coefficient of 80ppm/°C, so any reference voltage below this value can be obtained by wiring a potential divider between these terminals. The module also houses a precision bandgap reference and when ROL is tied to COM a stable 100 mV is generated between ROH and ROL and has a typical temperature coefficient of 50ppm/°C.

Precision Digital Thermometer

Intersil make a special 2-terminal IC for use as a temperature sensor in digital thermometers. The device is the AD590, and gives an output current of 1uA/°K which, when fed through a 1k0 resistor, gives a voltage of 1mV/°K. Uncalibrated accuracy of the device varies from 0.5°C to 10°C, and linearity error from 0.3°C to 1.5°C, depending on the grade of the device (indicated by a suffix number).

The AD590 needs a supply voltage of at least 4VO, and this is obtained by wiring the IC between VDD and TEST (which is internally biased at about 5VO below VDD) via D1. The COM terminal is biased about 600mV above TEST via D1. R1 is wired in series with the AD590, and generates approximately 1mV/°K (= 273.2mV at 0°C, 373.2mV at 100°C), and this voltage is fed to the IN HI terminal. Bandgap reference IC2 generates a temperature — stable 1V2 via R2, and this voltage is divided down via R3-RV1-R4 to give a 'SET 0°C' offset voltage of 273.2mV nominal at IN LO. The bandgap reference voltage is also divided down by R5-RV2-R6 to provide a 'SET 100°C' scaling voltage of 100mV nominal at RFH. The circuit must be calibrated in the way already described for the thermometer circuits.

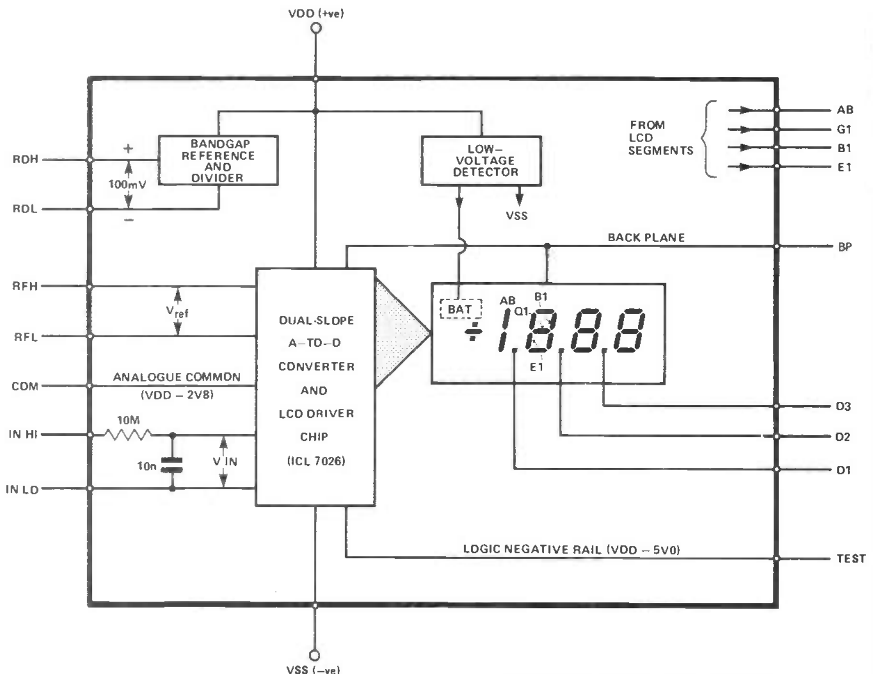
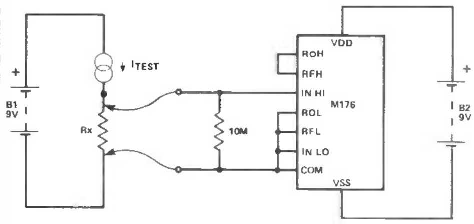


Figure 2: M176 'User View'.

Milli-Ohmmeter

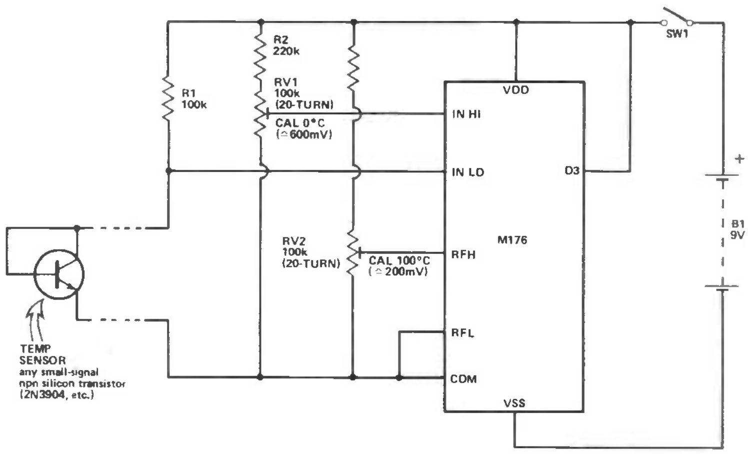
When measuring low values of resistance, care must be taken in circuit design to ensure that the resistive effects of range switches, fuses, and terminals, etc., are excluded from the measurement results. The only way of achieving this is to use the 4-terminal measurement technique shown above, in which two independent circuits are used. Here, the unknown resistor is connected between the Rx terminals and fed with a constant current from B1, and the volt drop DIRECTLY ACROSS Rx is measured via a 199.9 mV full-scale DC voltmeter powered from B2. Thus, when 10 mA is passed through Rx, the voltmeter indicates 19.99 ohms at full scale.

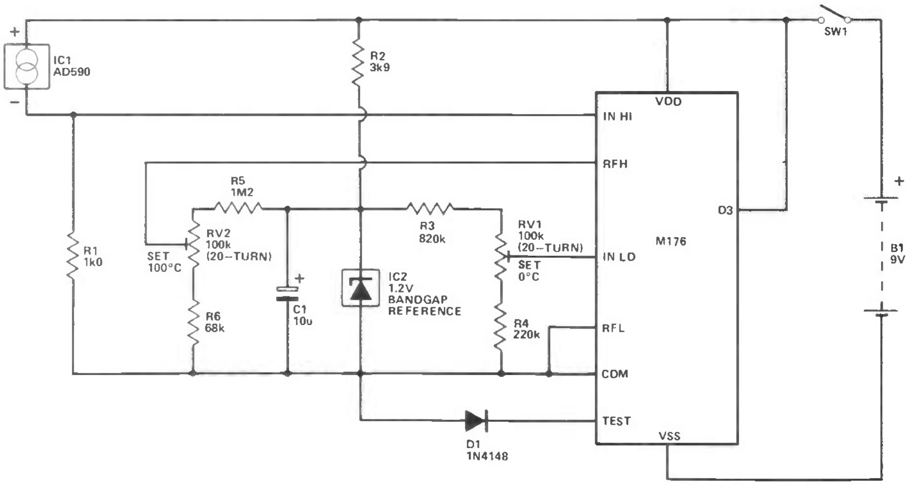
I_{TEST}	Rx fsd
1mA	199.9Ω
10mA	19.99Ω
100mA	1.999Ω



Digital Thermometer

The circuit has a typical linear accuracy of 1.5°C over the 0°C to 100°C temperature range. A stable 2V8 is generated between VDD and COM of the DVM module, so R1 drives the sensor with a current of about 22uA at 0°C, rising to about 24uA at 100°C. This current variation, combined with the basic linear error of the transistor, causes the 1.5°C linear error of the circuit. The 'CAL 0°C' voltage feeding IN HI is variable from zero to 875 mV via RV1, and the 'CAL 100°C' voltage feeding RFH is variable from zero to 255mV via RV2; these two controls are used to calibrate the meter using the technique described shortly.



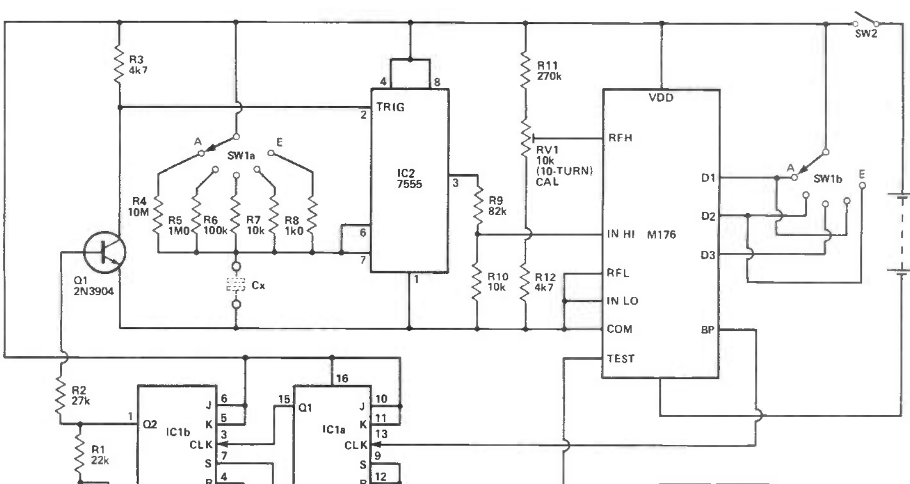


Calibration Procedure

The procedure for calibrating the thermometer circuit is as follows. First, solder the base and collector leads of the sensor transistor together, solder the sensor to a pair of flexible leads, and connect to the meter circuit. Paint all visible transistor leads and solder joints with insulating varnish (Humbrol clear varnish, No. 35, is excellent). Next, set RV1 and RV2 at mid value, mix a quantity of crushed ice and cold water in a tumbler (to act as a '0°C' standard), and immerse the sensor in the tumbler. Now adjust RV1 to give a reading of '00.0' on the meter. Finally, remove the sensor from the tumbler and immerse it in gently boiling water (to act as a '100°C' standard), then adjust RV2 to give a meter reading of '100.0'. Basic calibration is then complete.

If the meter is to be used mainly around some mid-scale value, such as 25°C, etc., RV1 can (after initial calibration) be used to set the meter 'spot on' at that value by immersing the probe and a standard thermometer in a liquid that is raised to the desired temperature.

Capacitance Meter.



RANGE	f.s.d
A	1.999n
B	19.99n
C	199.9n
D	1.999u
E	19.99u

The design uses a 7555 timer IC (a CMOS version of the 555 timer) as the precision monostable element, and uses decade values (1k0 to 10M) of Rx for range selection. The 7555 monostable generates a pulse with a width of 1.1$^1/_{15}$ C$^1/_{15}$ R, thus giving a full-scale pulse width (at '1999' on the DVM module) of 22mS with C and R values of 1999p and 10M, or 19.99u and 1k0, etc. To give the 7555 adequate recovery time between pulses, the clock period must be at least 50% longer than the maximum pulse width, and must thus have a period of at least 33mS.

The 7555 mono is triggered by pulling pin-2 of the IC low, but if the pin is not returned high again by the time the output pulse ends naturally, the trigger pulse extends the output pulse artificially. The trigger pulse must thus be shorter than the minimum output pulse. In our application, the shortest pulse width that can be indicated by the DVM module is 22mS/2000 = 11 uS. In our circuits it is a design requirement that the 7555 must be triggered by negative-going pulses with widths less than 11 uS and periods greater than 33mS. In this case these requirements are met as follows.

In the DVM modules, the TEST terminal is internally biased at about 5VO below VDD, and the BP (backplane) terminal switches between TEST and VDD at about 50Hz (= clock frequency divided by 800), giving a period of 20mS. In the first circuit, IC1 is powered via the TEST terminal, and the BP signal is divided-by-2 by flip-flop IC1a. The resulting 25Hz (40mS) signal is used to clock IC1b, which is configured as a monostable and generates positive-going output pulses with widths of 2uS via R1 and C1. These pulses are level-shifted and inverted via R2-Q1-R3, to produce negative-going 2uS trigger pulses with periods of 40mS on the pin-2 TRIG terminal of IC2, the 7555 monostable generator.

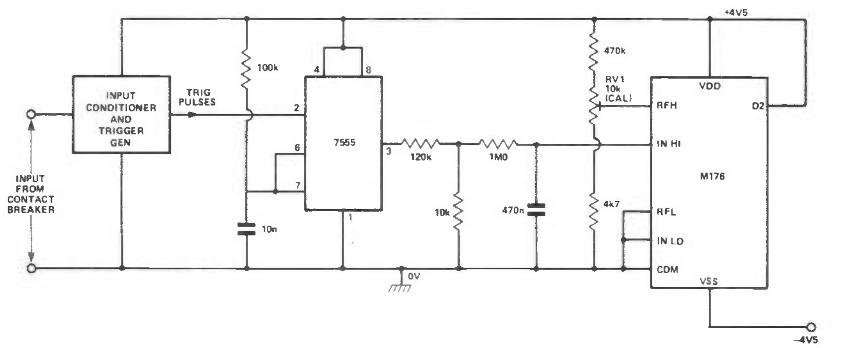
The pulse width of the 7555 is controlled by Cx and precision range resistors R4 to R8. The 7555's output is attenuated by R9-R10 to give a mean value of about 100mV at the midscale ('1000') setting of the DVM module, and the resulting signal is fed to the module's IN HI terminal, where it is integrated by the internal 10M — 10n filter. Divider R11-RV1-R12 feeds 100mV nominal to the RFH terminal of the module, and RV1 is used to adjust the precise calibration of the Capacitance Meter.

Accuracy of the first meter is determined mainly by the precision of the R4 to R8 range resistors, which should be 1% or better hi-stab types. To calibrate the meter, simply connect a precision capacitor (say 100n) in place as Cx, switch to the appropriate range, and adjust RV1 to give the appropriate meter reading. Calibration is then valid on all ranges.

This circuit has two minor defects. First, the clock signals of the 7555 are derived (via BP) from the clock signals of the DVM module. These signals are not highly frequency-stable, and the calibration of the circuit may thus shift by up to 0.5% or so over the normal range of operating temperatures and supply voltages. If precise accuracy is needed, calibration should be checked before use.

The second snag is that the circuit reads ALL capacitance, including residuals, appearing between the Cx terminals. These residuals include stray capacitance and the internal capacitance of IC2 between pins 6/7 and 1, and typically total 32p. With no external capacitance connected, the meter thus gives a typical reading of '.032' on range A, and '0.03' on range B: These residuals are too small to give readings on the remaining ranges of the meter, but must be subtracted from all readings obtained on ranges A and B.

The precision design shows how the circuit can be modified so that residual capacitance is effectively cancelled and the meter gives a zero reading on all ranges when no external capacitance is connected to the Cx terminals.



RPM Meter

DVM modules can be used to indicate the value of any parameter that can be converted into a predictable (linear or log) voltage, current, or resistance. Linear transducers are readily available for measuring values of pH, light intensity, and radiation, etc.

Cyclic parameters such as RPM and heart-beat rate, etc., can be measured by adapting the Frequency Meter technique already described. The RPM of a petrol engine, for example, is directly proportional to contact-breaker (CB) frequency, f. On a 4-stroke engine, f = N$^1/_{15}$ RPM/120, where N is the number of cylinders. Thus, on a single-cylinder engine 10 000 RPM gives a CB frequency of 83.3 Hz, and on a 4-cylinder engine a frequency of 333.3 Hz. The circuit shows the basic circuit of a digital RPM meter, designed to read 19 990 RPM full scale (10 000 RPM at mid scale) on a 4-cylinder 4-stroke engine. The 7555 monostable gives an output pulse width of about 1mS.

Precision AC/DC Converter

The gain of the converter can be set to precisely 2.2 via RV1, to give a DC output voltage that is equal to the rms value of a sine wave input. The converter is powered from the supply rails of the module, and is designed around an LF355 op-amp, which can operate quite happily from the 2V8 between VDD and COM.

5-Range Ohmmeter

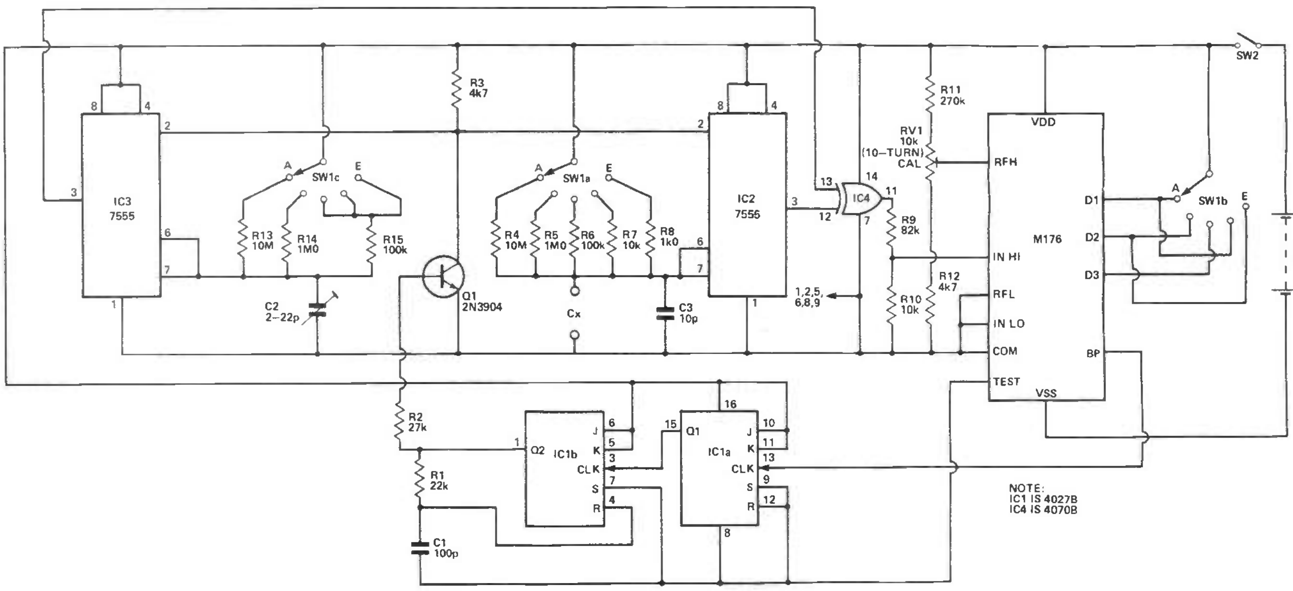
The easiest way to use a DVM module as a resistance (ohm) meter is to use it in a ratiometric configuration. This technique has two major advantages — it is very stable and inherently self-calibrating.

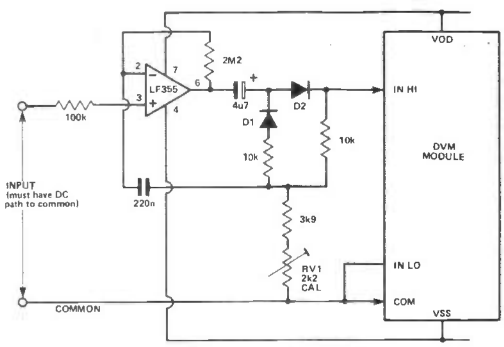
The second advantage is that very low test voltages are generated across Rx, the maximum voltage being two thirds of the energising voltage (typically 100 to 300 mV) at full scale.

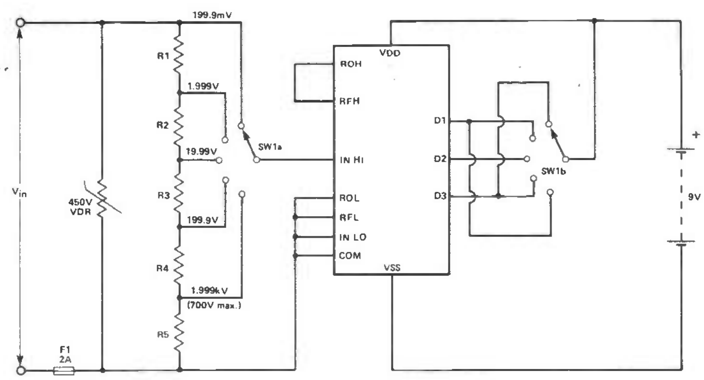
Precision Capacitance Meter

In this case the BP-derived signal is used to synchronously trigger TWO 7555 monostables, and their outputs are EX-ORed via IC4 to give a pulse with a width equal to the DIFFERENCE between the pulse widths (and thus the residual capacitances) of the two monostables, and this pulse is fed to the IN HI terminal of the DVM module via R9-R10. Thus, if the monostables have identical residuals, the EX-OR pulse width is zero and the meter gives a zero reading with zero external Cx applied.

The monostable IC2 is connected to the Cx terminals and functions in the same way as in the basic circuit except that an additional 10p is permanently wired across the terminals. The IC3 monostable, however, has a 'fixed' capacitance wired across its input terminals, and the value of this can be adjusted via C2 to equal (and thus cancel) the residuals of IC2. IC3 is range-switched in parallel with IC2 via SW1c; precise ganging is provided on ranges A, B and C only; on all other ranges the residuals are too small to influence the meter readings.

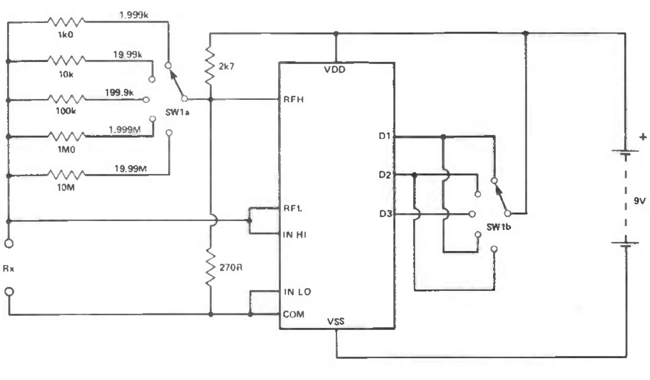






R1	R2	R3	R4	R5	INPUT Z
9M0	900k	90k	9k0	1k0	10M
10M	1M0	100k	10k	1110R	11.11M

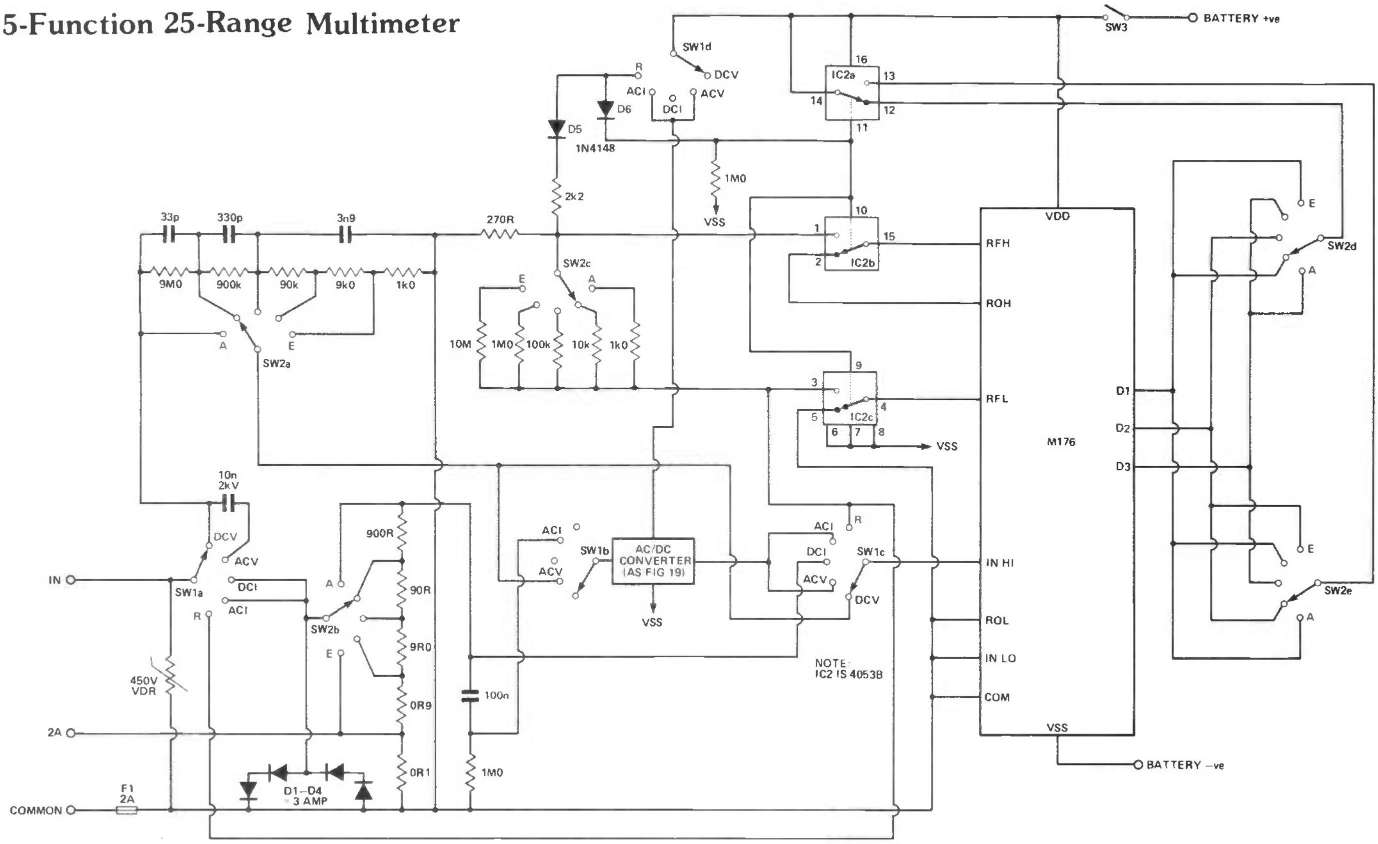
ALTERNATIVE ATTENUATOR VALUES



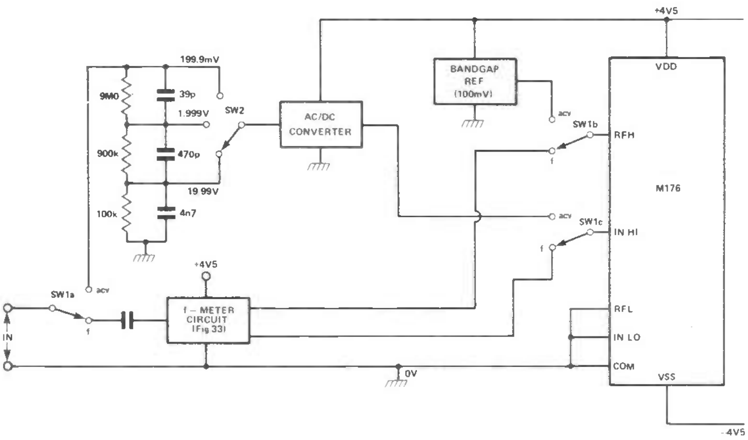
5-range DC volt Meter

The table shows alternative potential-divider component values to give input impedances of 10M or 11.11M. Precision '9'-decade (9MO, 900k etc) resistors are used in most multimeters and are available from several component suppliers. Note that in multi-range applications the circuit should be provided with some form of overload protection, and in the diagram this is given by fuse F1 and by a voltage-dependent resistor (VDR) or 'transient suppressor' across the divider. Also note that on the '1.999kV' range the maximum input is limited to 700V by the VDR.

5-Function 25-Range Multimeter



The reader should have little difficulty in following the circuit. Functions are selected by SW1, ranges by SW2. SW1a connects the inputs to the voltage, current or resistance measuring networks, and SW1d activates the AC/DC converter or energises the 'ohms' circuitry when necessary. Voltage ranges are selected by SW2a, current ranges by SW2b, and resistance ranges by SW2c. SW2d and SW2e control the decimal point positions on each range, the appropriate switch being selected automatically by IC2a. IC2b and IC2c control the basic configurations of the DVM module. IC2 (a triple 2-way analogue switch) is activated via SW1d.

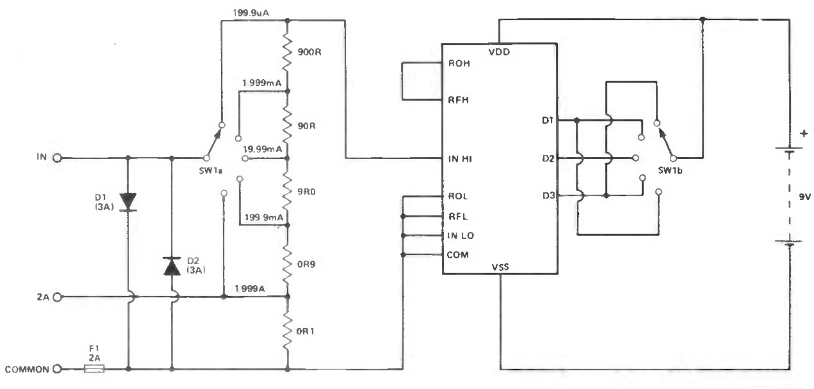


Combined Frequency/AC Voltmeter

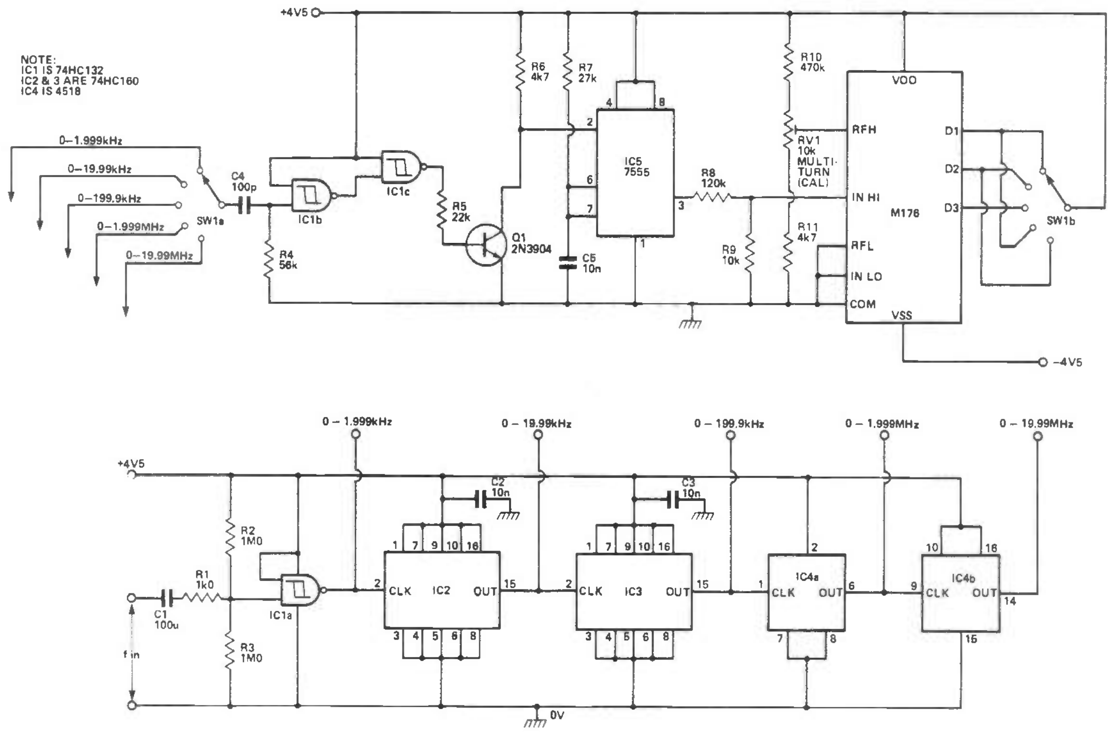
The circuit above shows, in basic form, how the DVM module can be used to read both frequency and AC volts (or any other desired parameter). With SW1 switched to 'f', the input is switched to the input of the f-meter circuit, and IN HI and RFH of the module are switched to the outputs of the circuit. When SW1 is switched to 'acv', the input is switched to the input of the frequency-compensated attenuator, which has its output fed to IN HI via SW2 and a precision AC/DC converter and RFH is switched to a 100 mV standard voltage derived from a bandgap reference.

5-range DC Current Meter

Note here that the generated voltages of the shunts are directly monitored by the DVM module, and that variations in the switch resistance of SW1a have no effect on the accuracy of measurement; a separate input terminal is used for the '2 Amp' measurement. The circuit is protected against positive and negative overloads by diodes D1-D2 and fuse F1.



Digital Frequency Meter



This circuit is of a practical DVM-based Digital Frequency Meter that reads up to 19.99MHz full-scale in five decade ranges. The circuit accepts input signals in the range 200mV to 5VO RMS, and operates as follows.

Input signals are fed, via C1-R1, directly to the input of IC1a, a very fast Schmitt trigger, which is biased as half-supply volts via R2-R3. The Schmitt output is used to ripple-clock four decade-divider stages. CMOS dividers typically operate at maximum speeds of only 800kHz or so when powered from 4V5 supplies, so, to give the required fast operating speeds, the very latest 'HC' types of silicon-gate CMOS counters are used in the first two (IC2 and IC3) counter positions. On the prototype unit, these clock at frequencies up to about 18MHz.

The output of the IC1a Schmitt and of the four divider stages are fed to range-selector switch SW1a, and the output of SW1a is fed to 4uS trigger-pulse generator C4-R4-IC1b-IC1c, which triggers the 7555 monostable via Q1. The output of the 7555 is fed to IN HI of the module via R8-R9, and a calibration 'reference' voltage is fed to RFH via RV1. The circuit is calibrated by feeding in a signal of known frequency, switching to the appropriate range, and trimming RV1 for the appropriate reading on the DVM module.

Once RV1 has been initially calibrated, calibration is influenced only by variations in the pulse width of the 7555, and these may be caused by thermal variations in the values of R7 and C5. For optimum calibration stability, R7 should be a metal-glaze resistor, and C5 should be a polycarbonate capacitor.

Footnote

The PCIM 176 module is also marketed under the device number OEM-2 by Anders.

POLARFOIL

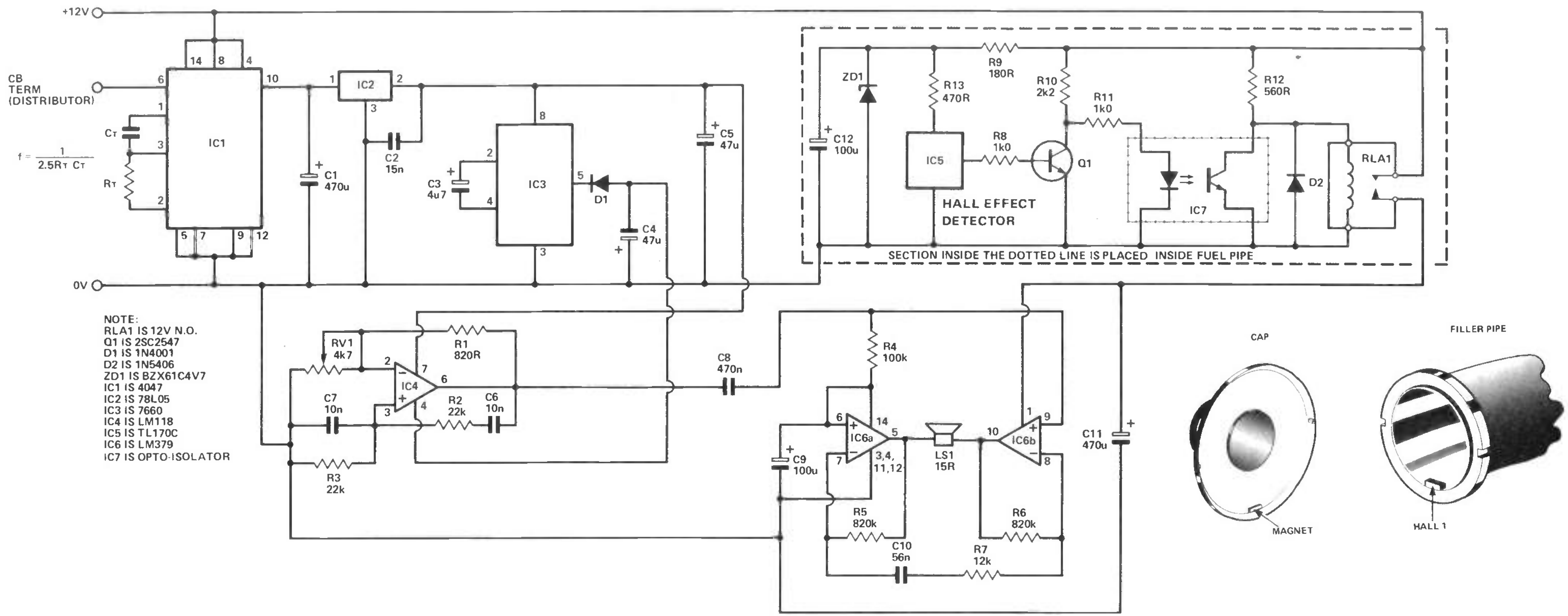
Boris Bartok BSc and Stig Svenson MSc.

The polarfoil was conceived to provide a sophisticated yet *fool-proof* alarm system, for the motorist who really wants to put the wind up 'would-be' thieves. As the name suggests ('POLAR') the trigger circuit is based on the detection of a changing magnetic field (provided by a common bar magnet). This change activates a Hall Effect detector, which in turn switches a relay supplying power to the alarm — a *very* powerful bridge amplifier.

The alarm signal is produced by a single op-amp oscillator, biased with the aid of a specialised negative voltage generator chip, connected to a long period monostable.

Construction of the polarfoil alarm system should be performed in two sections. The tone generator, supply and amplifier are built first and housed near to the distributor in the car's engine. Secure the speaker (preferably a 10-12" high efficiency type) as close to the front grille as possible. Next, wire the supply rails to the distributor and battery as indicated in the circuit diagram. This dual connection prevents the alarm being easily de-activated (remember, the monostable will go low after a fixed period, so there's no need for an 'enable/disable' switch) once the car is locked.

The detection board is then assembled. Carefully secrete it inside the fuel pipe, with the bar magnet attached to the filler cap. The ingenious design of the power supplies ensures that this arrangement will not trigger during the course of normal filling operations.



Circuit Description

The circuit may be broken down into four distinct sections. Two of these are logic 'switching' blocks, that control the operation of the analogue circuitry, consisting of an audio oscillator and a bridge type power amplifier.

The monostable is triggered on the positive edge of the pulse train that appears on the CB terminal of the vehicle's distributor, whilst the engine is running. The output of IC1 thus goes high while the engine is running, returning to the low state as the engine is switched off.

The output of IC1 switches between the 0V and +12V rails and must be smoothed and regulated before it can be applied to IC3 — a specialised IC that provides the Polarfoil's negative rail. This smoothing and regulation is performed by IC2 and associated components.

The 5V output of IC2 forms the positive rail of IC4's supply, while IC3 generates the negative side of the supply — the capacitor (C4) and diode (D1) form a 'charge pump', essential to IC3's operation.

IC4 and its associated components form a Wien network oscillator. R2, R3, C6 and C7 comprise the network, while R1 and RV1 provide the gain control element.

The Wien bridge's output is capacitively coupled (via C8) to the fairly standard bridge amplifier formed by the two sections of IC6.

The supply to the power amplifier is switched by RLA1 which is energised when the magnet, usually in close proximity to IC5, is removed. The relay's state is controlled by the transistor that forms one half of the opto-coupler IC7 — it is energised when the transistor is 'off'. This semiconductor is turned off when the LED (also part of the opto-coupler) is extinguished this being accomplished by turning on Q1.

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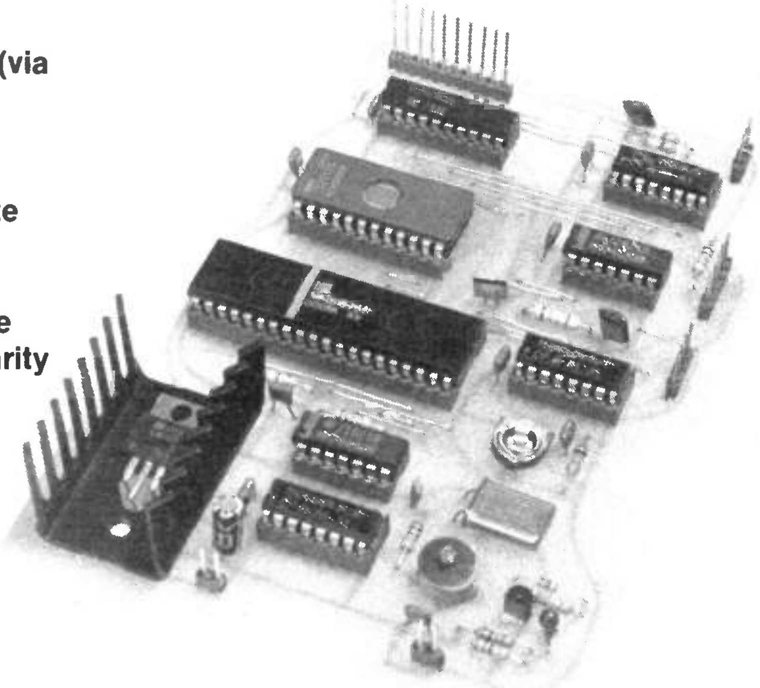
REWBICHRON 2



* Drives any 4- or 6-digit numeric display (via suitable decoder/drivers)
* Pre-multiplexed display output
* Simultaneous parallel interface output
* 12 or 24 hour display, time only or alternate time and date
* Continues running if MSF fails
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An uncommitted MSF clock module developed from the "Rewbichron" design featured in April 1982 R&EW.

Design by John Robinson, MA (Cantab), G4AZX.

The REWBICHRON (Mk 1), featured in last April's edition, uses a Z80 CPU to decode the logic signal from a 60kHz MSF receiver, and displays the time and date on an alphanumeric display module (PCIM200). Comments received since the original project have generally been favourable, with two qualifications;

1) The display module is rather expensive (and small)

2) An output to drive an external system (eg, a computer) would be useful.

The Mk 2 version sets out to remedy these problems, while retaining the useful features of the Mk 1. In particular, since many constructors already have the necessary components for a numeric display, a general-purpose multiplexed data output is provided to drive any type of display (LED, LCD, Fluorescent, etc). A suitable design for a large-format LED display is described in this article, and will be available in kit form.

MSF Recap

MSF is a standard frequency transmitter located at Rugby. It radiates an accurate 60kHz carrier, which is keyed with pulses whose widths signal the time and date, in serial BCD form. The time reference is the Caesium Beam Standard at the National Physical Laboratory.

Data is sent at the rate of 1 bit per second (the so-called Slow Code, which is now transmitted as an alternative to the Fast Code pulses sent every minute). Every second the carrier is interrupted

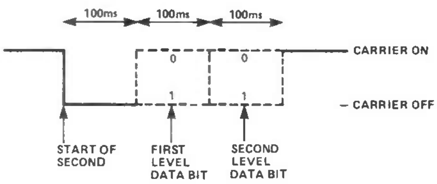


Figure 1: Certain 'seconds' pulses are modified to carry two bits.

for 100msec (binary 0) or 200msec (binary 1). In this way, the complete time and date are transmitted during each minute, defining the approaching minute. This means that a receiver can detect and check the data at a leisurely pace (ideal for a micro) ready to update a display at the start of the next minute.

In addition to the complete time and date (which even includes the day-of-week), MSF sends the difference between British Time and Universal Time, and four parity bits which assist in the detection of errors due to noise etc. Since all the information requires more than 60 bits, certain 'seconds' pulses are modified to carry 2 bits as in ***Fig. 1***. The two bits are known as First and Second Level data.

Fig. 2 summarises the position of all the Slow Code data within the minute. Each quantity (Hour, Minute etc) is sent in Binary Coded Decimal (BCD) form, to simplify the task of decoding and displaying it. The range of each decimal digit, and therefore the number of bits

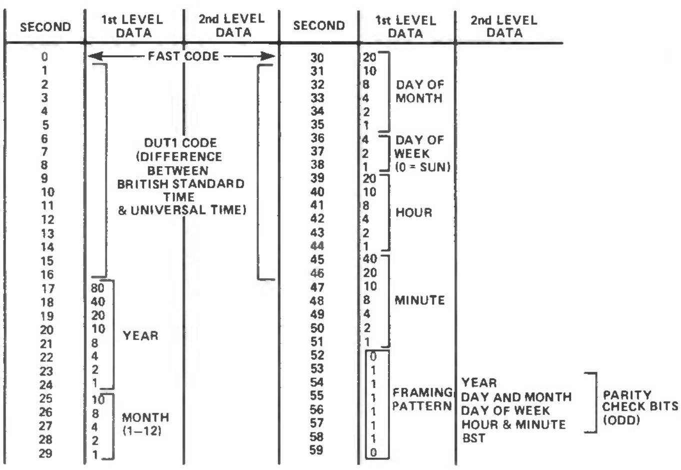


Figure 2: The position of slow code data within each minute.

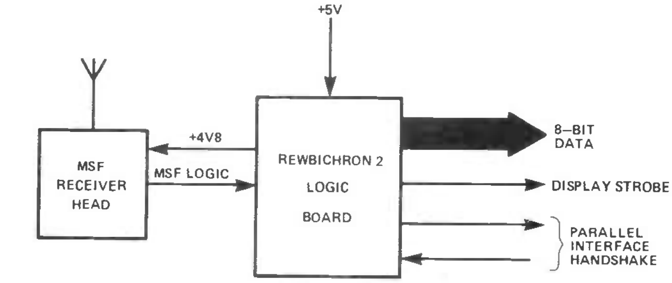


Figure 3: Block diagram of the main logic board.

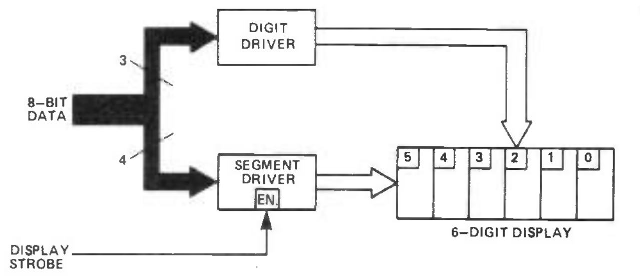


Figure 4: The general form of a multiplexed display suitable for the Rewbichron design.

allocated in the data, varies with the quantity; for instance the top 'Hours' digit cannot be greater than 2 (2 bits used) whereas the top 'Year' digit can go up to 9 (4 bits used).

The Framing Pattern is a set of 8 bits of fixed value, which can never be sent in 8 consecutive bits elsewhere in the sequence, by virtue of the 'rules' of BCD. It can therefore be spotted easily in the incoming data, and used by clock to lock its data recovery sequence.

The Parity Bits are given values which ensure that the total number of binary '1's in each parity bit and its protected data field together is odd. Thus if the clock adds up the number of '1's and gets an even number, then one bit (or an odd number of bits) has not been received correctly. If any of the parity checks fails in this way, the REWBICHRON 2 will flag all the data for the current minute as invalid. This will also happen if any received data does not 'make sense'; in particular:

1) If data is outside the permitted range (eg, 31 November)

2) If a digit is non-BCD (eg, the '2D'th November!)

The REWBICHRON 2 is quite intelligent about all this, and even knows about leap years.

Hardware Overview

A block diagram of the main logic board is shown in ***Fig. 3***. Any receiver head may be used, provided the logic sense is 0 for carrier ON. The design produced for the Mk 1 REWBICHRON is of course suitable.

The logic board will drive EITHER a multiplexed display OR an external data receiver (or other types of display) OR BOTH. This is possible because the single 8-bit output bus carries both display data and interface data at different times, which are indicated by two separate strobe outputs; one of these should be used to enable the display driver, and the other as part of the interface handshake, if needed.

The multiplexed display should take the form of ***Fig. 4***. The multiplexing sequence and timing are fixed under software control. ***Fig. 5*** shows the display data format, which applies whenever the Display Strobe signal is 'True' (Both logic polarities are available). The digits are normally scanned from left to right (sequence 5,4,3,2,1,0) 100 times per second. Once per second, the display scan ceases for 10msec, during which time data is made available for parallel interface transfer as described later. The visible effect, a very slight 'blink' of the display, is hardly noticed. At times when the CPU wants to blank a digit or the entire display, it simply omits the relevant digit(s) from the scanning sequence; there is therefore no need for the display drivers to respond to any particular blanking code. The strobe pulse may be used to enable the segment driver (as shown), or the digit driver as convenient.

Display Formats

The REWBICHRON 2 differs from the Mk1 in that it decodes and can display the year. However, the day-of-week is not displayed (although it is available via the parallel interface).

When the unit is first powered, no time data has been received. The display is used at this time to indicate the logic signal arriving from the receiver head (digit 5 displays '0' or digit 4 displays '1') for a visual check the MSF is in fact being received.

Once the main display starts, two format options can be selected by means of switch inputs;

1) Time/Time+Date. In the first case the time alone is displayed continuously, in the form:
HH.MM.SS.

The alternative format displays the following sequence:

Time	(11 seconds)
Blank	(1 second)
Date	(2 seconds)
Blank	(1 second)

This sequence starts at HH.MM.55, HH.MM.10, HH.MM.25 and HH.MM.40.

The date format is DD.MM.YY.

2 12/24 Hour. Controls the format of HH.

Leading zeroes are blanked in DD,MM, and in HH in 12-hour format. Also if the MSF data received during any minute was invalid, the seconds display SS will be blanked during second 00 of the next minute.

Parallel Interface

Once per second after the first successful data capture from MSF, the display scanning data is replaced by a 7-byte sequence of parallel interface data, accompanied by Data Strobe pulses. ***Fig. 6*** shows the data sequence. The first byte is unique in having a binary '1' in all 4 high bits, a fact that can be used by the receiving device to ensure that it has

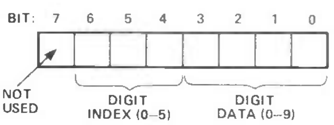
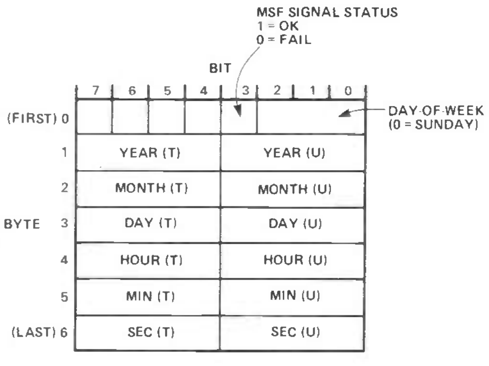


Figure 5: The display data format.



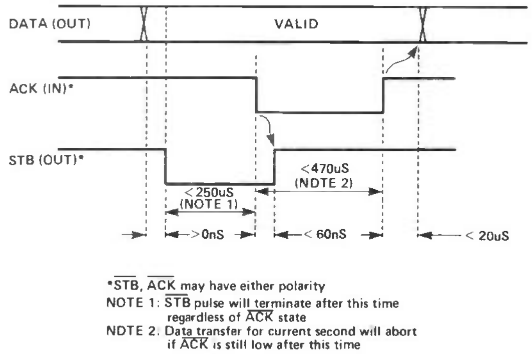
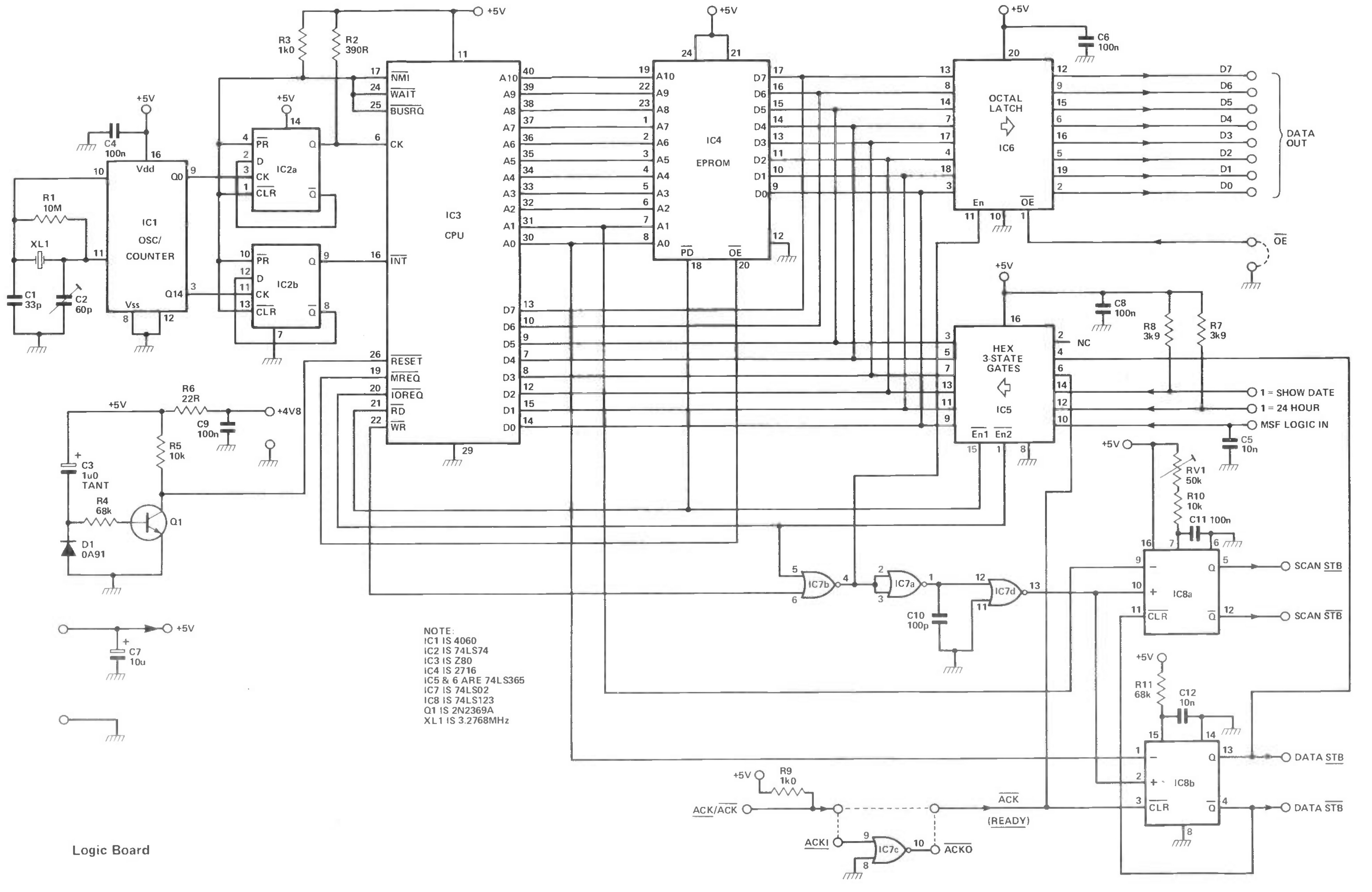
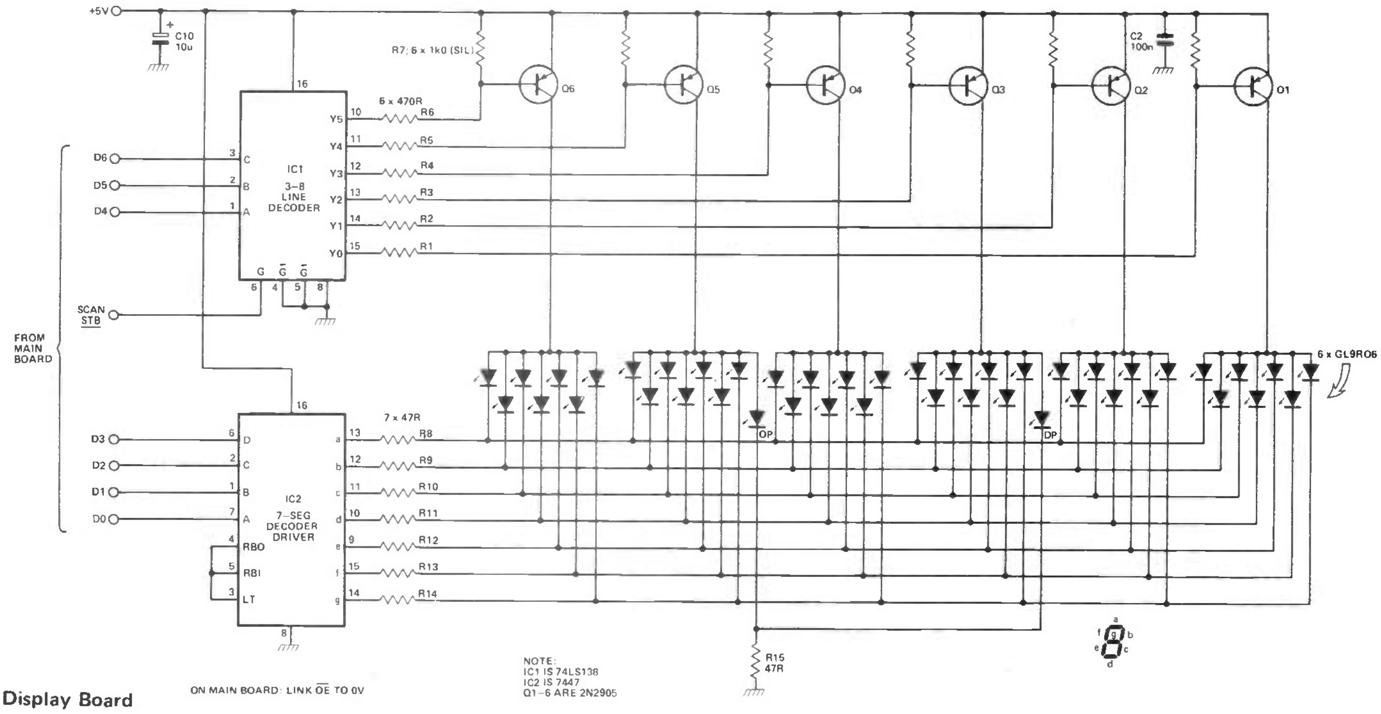


Figure 6: The data sequence of the parallel interface. Figure 7: Details of the Rewbichron's handshaking. ▶


+5V
R3 1k0
R2 390R
IC3 CPU
IC4 EPROM
OCTAL LATCH IC6
DATA OUT
D7
D6
D5
D4
D3
D2
D1
D0
OE
C6 100n
C4 100n
IC1 OSC/ COUNTER
R1 10M
XL1
C1 33p
C2 60p
IC2a
IC2b
NMI
WAIT
BUSRQ
CK
INT
RESET
MREQ
IOREQ
RD
WR
HEX 3-STATE GATES IC5
C8 100n
R8 3k9
R7 3k9
NC
1 = SHOW DATE
1 = 24 HOUR
MSF LOGIC IN
C5 10n
R6 22R
+4V8
C9 100n
R5 10k
C3 1u0 TANT
R4 68k
Q1
D1 0A91
C7 10u
RV1 50k
R10 10k
C11 100n
IC8a
SCAN STB
SCAN STB
IC7b
IC7a
IC7d
C10 100p
R11 68k
C12 10n
IC8b
DATA STB
DATA STB
R9 1k0
ACK/ACK
ACK
(READY)
ACKI
IC7c
ACKO
NOTE:
IC1 IS 4060
IC2 IS 74LS74
IC3 IS Z80
IC4 IS 2716
IC5 & 6 ARE 74LS365
IC7 IS 74LS02
IC8 IS 74LS123
Q1 IS 2N2369A
XL1 IS 3.2768MHz

Logic Board



Display Board

Circuit Description- Display Option

The circuit shown provides a large display of adequate brightness for most purposes. The incoming scan data contains a 3-bit address and 4-bit digit data (as ***Fig. 5***). The former is decoded by IC1, which, when the Scan Strobe is 'true', causes one of the digit drivers Tr1-6 to apply +5V to the common anode of the selected digit. Simultaneously, IC2 decodes the digit data and supplies segment drive current via R8-14 to the correct cathodes. R15 causes decimal point separators to be scanned whenever digits 3 and 5 are scanned, to give a pleasing 3-part display (it is a good idea to group the display digits as 3 pairs, with small gaps between pairs).

For those on a really tight budget, digits 1 and 0 could be omitted, at the expense of seconds and years displays.

Circuit Description — Logic Board

The CPU circuit is based on that of the Mk1, and retains the minimum-hardware approach. No external RAM is used, the Z80 registers being adequate for all temporary data storage.

IC1 and IC2 provide the Z80 with a medium-speed (1.638MHz) clock and accurate 100Hz interrupt pulses. R2 pulls the logic '1' clock level to +5V. Although the INT input to the Z80 is not strictly edge-triggered, some software tricks are used to ensure that only falling edges of the 100Hz squarewave can trigger the timing program.

IC4 contains the program (about 1K bytes) and is read by the CPU whenever MREQ and RD are simultaneously low. A power-up reset pulse from C3,R4,Tr1 and R5 ensures that program execution starts at address 0.

IC5 provides a single input port which the CPU reads whenever IORQ and RD are simultaneously low. The individual bits carry the following signals:

bit 7 — Not available
6 — Not available
5 — Not used
4 — STB monitor point
3 — ACK from external logic
2 — Display sequence control (0=Time Only/1=Time+Date)
1 — Time format control (0=12-Hour/1=24-Hour)
0 — MSF Carrier logic.

The software outputs to two ports (addresses 1 and 2) corresponding to display data and computer data. In both cases IORQ and WR go low, the output byte is latched by IC6 and appears on the output bus. (OE should normally be strapped to Ov). IC8 generates either a display strobe or an interface strobe pulse; both halves receive a positive pulse at their 'B' inputs from IC7, but only the one with a low level at its 'A' input is triggered. Since the two 'A' inputs are driven by the bottom two address bus lines, on which the output port address appears, addresses 1 and 2 will enable the appropriate halves of IC8.

The parallel interface, involving IC8b, has already been described. The time constant of IC8a, which generates scan strobe pulses, should be set so that six distinct pulses (ie, non-overlapping) are generated within each 10ms display scanning cycle. Subject to this condition, RV1 can be used to set the display duty cycle and therefore brightness.

With most types of displays, RV1 may be left at maximum for the greatest possible brightness; however, this may cause slight visibility of unlit segments, particularly with fluorescent displays. If so, reduce RV1 until a clear display is achieved. Note that the scan strobe monostable IC8a is important to prevent overdriving a display digit during periods when the data bus output is 'frozen', such as during power-up or CPU failure.

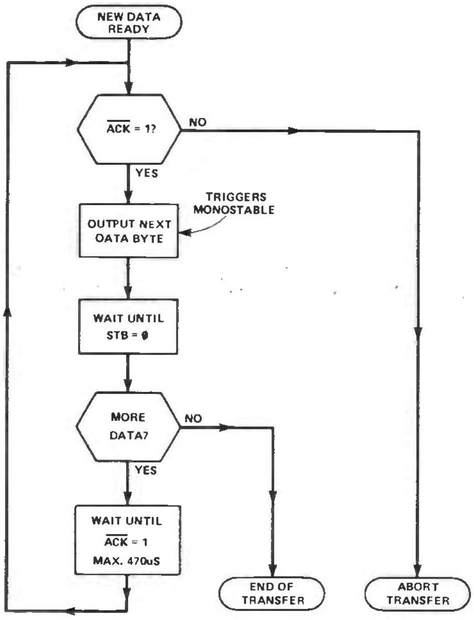
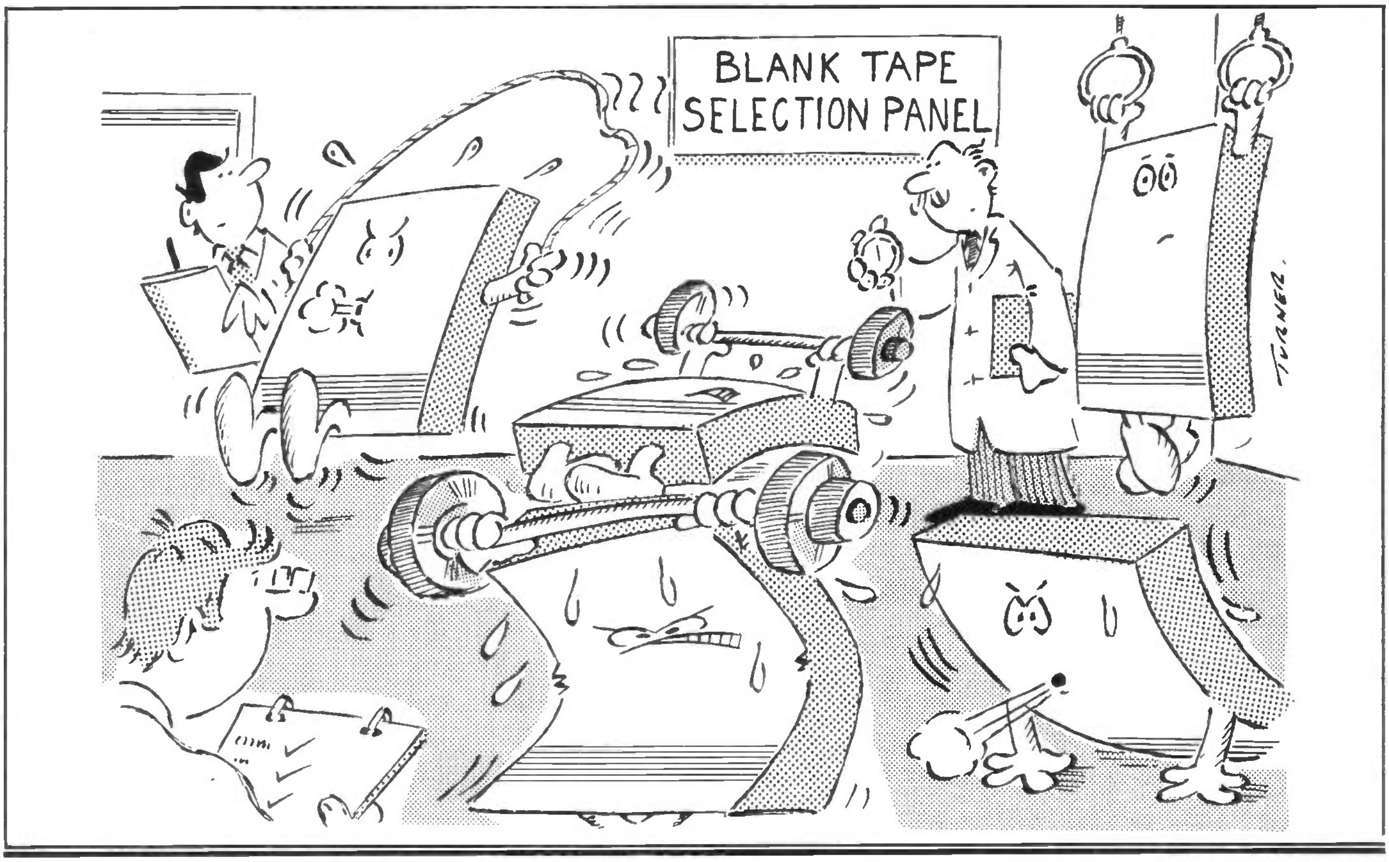


Figure 8: Section of the handshaking software that is executed every second.

caught the beginning of the data. A two-way handshake is available, to allow the data receiver to synchronise with the REWBICHRON 2 for higher transfer speed. If this is not necessary, ACK should be tied high, and each byte of data will remain valid for about 270us (strobe pulse 250us). If the handshake is used, ***Fig. 7*** should be consulted for timing requirements.

Since timing diagrams are notorious for misleading people (although I hope this one won't), ***Fig. 8*** is provided to show in detail the software which provides the parallel interface.

Continued next month. ■ R&EW



VIDEO TAPE SURVEY

Dr. Mark Sawicki has produced an unbiased blank tape test report. Over 41 tapes from some 18 distributors are included. This survery first appeared in the magazine Video A-Z of which Dr. Sawicki is Editor.

None of the tapes tested in the survey have been selected specially and therefore represent, a typical cassette that you might buy in the shops or from a mail order outlet. As a consequence, all the results reflect the quality and performance of the individual sample tested, therefore some slight variation in performance might be detected in other cassettes. In order to ensure a totally unbiased judgement all markings, labels, and stickers were removed from each cassette, so that they really were incognito, clothed only in individual plastic bags for protection against temperature/dirt/humidity, each cassette was then numbered, with the number that related to each distributor being in the sole knowledge of myself. This ensured that all testing by personnel would provide unbiased results.

The Laboratory Tests

A few of the tests require a bit more explanation — The Mechanical Noise Test, where there is no universal standard available, adopts the following guideline — video cassettes with a mechanical noise greater than 75 dBa would be considered as very noisy; between 70-75 dBa — noisy; 65-70 dBa — reasonable; 60-65 dBa — quiet; and finally 50-60 dBa — very quiet. This particular test gives a reasonable approximation of the mechanical quality of the cassette assembly, its moving parts etc., and was carried out in both 'Fast Forward' and 'Rewind' modes. It is also a useful indication as to the life expectancy of individual cassettes tested.

The Video Drop-out results say it all, with a superb performance from Sony in the BETA group and some rather shocking results from some tapes, who suffer from severe quality and design problems. The Electromagnetic tests include accurate measurements of Luminance and Chrominance Signal/Noise ratios corresponding to B/W or Colour performance. Here the higher the figure, the better the overall picture quality. The lower S/N ratio on Chroma will affect both the Hue and the Saturation, and on Luminance will cause the famous 'Snowy' effect.

On the Still Frame Test the majority of tapes performed very well, even when this was extended, the increased drop-out levels were not that significant and this test coupled with the Subjective Visual Assessment gave an even fuller picture of the recording/playback results. One or two cases proved that even with only an average reading on the Electromagnetic performance and Drop-out tests, the tape could still produce a decent picture. This only goes to prove that statistics don't necessarily mean everything. As regards Audio Sensitivity, this was measured at frequencies of 333Hz,1kHz and 7kHz and the audio signal level was adjusted for 'Normal' recording levels.

Tape Prices And Star Ratings

Prices quoted are only guideline prices and can vary enormously on factors such as supply and demand, competition etc, but on average a general idea can be built up of what one could expect to pay for good tape and cheap tape. The Star Rating gives a good overview of all the tested cassettes and the overall rating includes all the results. One noticeable point is that there is more consistency in quality in the BETA/V2000 formats than in the VHS camp, possibly due to the number of newcomers, and the problem VHS has had with substandard imitators. Two companies were absent from the results, these include intermagnetics who couldn't get a tape to us and Olympus who were only just starting up in this field. We welcome their products for future tests.

Test Conditions and Details

Test Equipment

Electromagnetic Performance

RF drive characteristics were checked on one sample from each brand to assess compatability.

A sample from each brand or type of cassette was tested in accordance with the operation of the ShibaSoku noise meter, briefly -

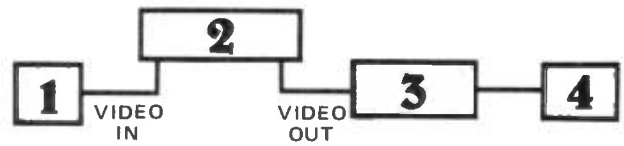
Luminance Noise

White level signal was recorded on tape sample and noise level measured through appropriate filters.

Chrominance Noise

Monochrome signal with colour burst was recorded and replayed through appropriate filters.

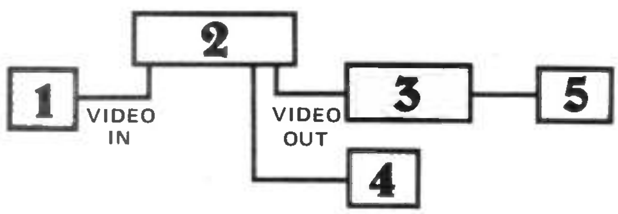
ShibaSoku 925D/2 PAL Colour Video Noise Meter.
Accuracy ±0.5dB at -20dB to -60dB
±1.0dB at -60dB to -70dB
Philips PM-5519 video signal generator
Hewlett Packard HP-400EL A.C. voltmeter
Accuracy ±1% at 40Hz to 2MHz
±1.5% at 2MHz to 4MHz
±2.5% at 4MHz to 10MHz
JVC HR-7200 EK video recorder
Sony C7E video recorder
Philips VR-2020 video recorder



1: VIDEO SIGNAL SOURCE 2: VIDEO RECORDER
3: PAL COLOUR NOISE METER 4: OSCILLOSCOPE

Drop-Out Performance

Each sample was tested over the first 10 minutes of tape, particular note being made of the first minute count.



JVC model VD-3E Drop-out counter set at -20dB/15u sec
CP-90 F7 Digital printer, with sequence controller SCY-P1
Philips PM-5519 video signal generator
JVC HR-7200 EK video recorder
Sony C7E video recorder
Philips VR-2020 video Recorder

1: VIDEO SIGNAL NOISE 2: VIDEO RECORDER
3: DROP-OUT COUNTER 4: BARCO TV MONITOR
5: SEQUENCE CONTROLLER & PRINTER

Still Frame

Still frame failure is defined as the point at which visual drop-out activity increases to an unacceptable level.

The VCR's used in this test were modified to allow still frames to be displayed for longer than the maximum of five minutes or so that is permitted with an unmodified machine.

Panasonic NV-8610 video recorder
Sony C7E video recorder
Philips VR-2022 video recorder

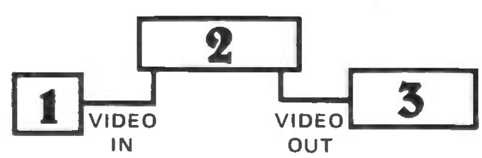
Subjective Visual Assessment

Each sample was recorded with a section of:
- Colour Bar test signal
- Multi-frequency black-and-white signal.
- Programme material (same on all cassettes)

A panel of people, representing a cross-section of technical and non-technical viewing experience viewed the recorded cassettes, replayed in a random order and graded on a five-point subjective quality scale.

1: AUDIO SIGNAL SOURCE 2: VIDEO RECORDER
3: OCTAVE SPECTROMETER & LEVEL RECORDER

JVC HR-7200 EK video recorder.
Sony C7E video recorder.
Grundig 2$\frac{1}{15}$ 4 SUPER video recorder.
Philips PM-5519 video signal generator.
Ampex VPR2 for programme source.



Audio Performance

Basic sensitivity and frequency response performance at 333Hz, 1kHz and 7kHz was measured on a sample from each brand or cassette type.

Audio output uniformity was tested on at least one sample from each brand supplied over a short section.

B&K Octave spectrometer type 2114
B&K Beat frequency oscillator type 1022
B&K Level recorder type 2305
JVC VR-3660 video recorder
Sony C7E video recorder
Philips VR-2020 video recorder

Test conditions and details

Mechanical performance

The mechanical noise emanating from each sample in 'Fast Forward' and 'Rewind' modes was measured.

Tensile strength measurements:
- strength of tape
- strength of splice

Test Equipment

Noise

B&K level recorder type 2305 with condenser microphone
JVC VR-3300 video recorder
Sony C7E video recorder
Philips VR-2020 video recorder

Strength

Anstron tensilometer

General

All tests were performed in a controlled environment at 21°C±3°C and 50±5% RH. Mechanical noise tests were performed in a 'quiet' room.

Hewlett-Packard HP-400 EL AC voltmeters as required.
Barco CRM-2032 receiver/monitors for all viewing
Hewlett-Packard HP-1742A Oscilloscope
Other video recorders as required.

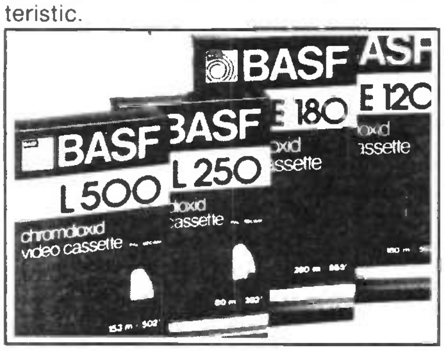
The final verdict

Agfa-Gevaert

Both VHS samples tested performed well and with a high degree of consistent quality. Although a relatively new addition to the UK video tape market, AGFA are one of the largest and most experienced magnetic tape manufacturers. A very good product at a reasonable price. Although only one BETA tape was tested it performed fairly well.

BASF

A goodish tape that is overpriced. Out of the two VHS tapes tested, the 2 hour one scored markedly higher marks than the 3 hour one. It had significantly lower drop-out levels and better results in the subjective visual tests. Their BETA tape performed well, the L-750 had a relatively low drop-out nicely combined with a flat audio sensitivity characteristic.



Fuji

One of the best tapes around. The best VHS sample we had with a 5 star rating, as it had very low drop-outs, gave an excellent picture quality and good audio. Its BETA sister fitted into the 4 star category with a good range of results. The tape was nicely packaged and irrespective of format is HIGHLY RECOMMENDED.

Bib

One of the latest additions to the market, both VHS and BETA tapes are manufactured in Japan. The BETA sample gave good performance and could be, in effect, of relabelled Sony origin — with very few drop-outs. Both VHS and BETA tapes are of a high standard marred by the less than inspiring packaging.

C.ITOH

Marketed in the UK in 1982, this is another tape manufactured in Japan. Out of the two VHS tapes tested one had a high level of drop-outs despite some good marks on a visual assessment, which is why it finally scored only two stars. The BETA sample was better with a good overall performance and good audio characteristics.

Ferguson

Unfortunately we could only test on 1 hr tape here and this scored 4 stars. A good quality tape with low drop-outs good picture quality and pleasant audio. Again packaging could and should be improved. Manufactured in Japan, probably by JVC it performed well on the practical visual assessment.

Grundig

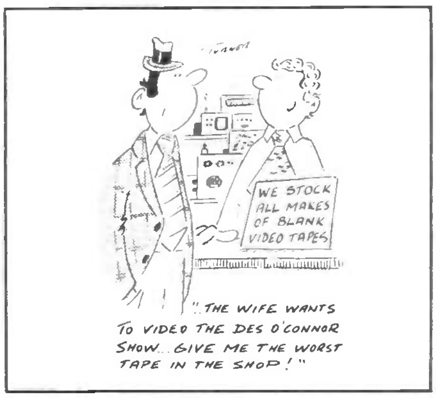
This was only one of the Grundig's V2000 format tapes tested and came out with the highest star rating. Their VCC-240 cassette featured ultra-low drop-outs, low mechanical noise and an acceptable picture. The recommended tape for any V2000 format VCR.

Hitachi

The only 4 hour VHS sample tested. The three hour VHS sample scored better marks on the visual assessment probably because the four hour tape is much thinner and constructed in a different way physically. Rather on the expensive side, (circa £14.95) but if you find it cheaper then this is a tape worth buying.

JVC

Video tape from the inventors of the VHS format must get a five star rating and they did. Their E-120 had very good picture quality with the minimum of drop-outs and proved very good in the visual assessment, one of the best tapes on the market and HIGHLY RECOMMENDED, despite the fact that the 3 hour tape scored slightly less in the final assessment.



TAPE SURVEY

BLANK VIDEO TAPE SURVEY VHS FORMAT

Manufacturer	Tape Length	Country of Origin	Typical Selling Price £	Electromagnetic Test: Luminance S/N ratio (dB)	Electromagnetic Test: Chrominance S/N ratio (dB)	Average Drop-Outs/Min.: First Minute	Average Drop-Outs/Min.: Mins. 2-10	Still Frame Test	Subjective Visual Assessment	Audio Sensitivity (dB): 333 Hz	Audio Sensitivity (dB): 1.0 kHz	Audio Sensitivity (dB): 7.0 kHz	Mechanical Noise Test F.FWD. (dBa): Max.	Mechanical Noise Test F.FWD. (dBa): Range	Mechanical Noise Test REW (dBa): Max	Mechanical Noise Test REW (dBa): Range	Quality of Packaging	A-Z Overall STAR RATING
AGFA	E 120	W. Germany	6.95	44.7	37.6	455	59	OK	Good	-0.7	-0.8	+0.4	65	12	64	9	Very Good	★★★★
AGFA	E 180	W. Germany	7.99	44.8	36.9	138	60	OK	Good	-1.1	-1.0	+0.1	62	7	61	5	Very Good	★★★★
BASF	E 120	W. Germany	10.43	45.6	37.7	145	35	OK	Very Good	+1.0	+1.1	+2.4	60	8	52	1	Good	★★★★
BASF	E 180	W. Germany	11.93	46.5	37.8	493	59	OK	Good	+1.0	+1.0	+2.4	60	8	52	1	Good	★★★
BIB	E 180	UK/Japan	8.27	42.8	38.3	207	44	OK	Good	-1.0	0.9	0.0	63	12	53	1	Average	★★★★
C. ITOH	E 120	Japan	7.50	42.4	37.8	163	152	OK	Good	-0.1	-0.1	-0.1	63	12	53	1	Very Good	★★
C. ITOH	E 180	Japan	8.50	45.1	37.4	315	62	OK	Very Good	0.0	+0.1	+0.1	63	12	53	1	Very Good	★★★★
FERGUSON	E 60	UK/Japan	6.00	41.7	37.4	97	23	OK	Good	+0.7	+0.7	+0.2	64	12	57	4	Average	★★★★
FUJI	E 180	Japan	6.90	44.8	37.3	113	17	OK	Excellent	+1.2	+1.1	+0.4	64	11	55	1	Very Good	★★★★★
HITACHI	E 180	Japan	8.75	44.9	37.3	366	43	OK	Good	+0.7	+0.6	+0.5	64	12	55	3	Good	★★★★
HITACHI	E 240	Japan	14.95	43.0	37.0	127	28	OK	Acceptable	+0.5	+0.5	+0.4	64	11	55	2	Good	★★★★
JVC	E 120	Japan	6.99	43.5	37.8	75	16	OK	Good	-1.0	+1.0	+0.5	64	12	57	5	Very Good	★★★★★
JVC	E 180	Japan	8.99	43.2	37.3	418	47	OK	Good	+0.9	+0.9	+0.4	64	12	57	5	Very Good	★★★★
MAXELL	E 120	Japan	6.90	45.2	37.7	82	20	OK	Good	+0.7	+0.7	+0.6	63	11	54	3	Good	★★★★
MAXELL	E 180	Japan	7.93	43.0	37.6	134	10	OK	Good	+0.6	+0.5	+0.5	64	12	54	3	Good	★★★★★
MEMOREX	E 180	USA/Japan	9.50	41.2	37.7	118	18	OK	Good	+1.6	+1.5	+0.1	65	13	55	1	Excellent	★★★★★
MULTITECH	E 180	Hong Kong	5.75	41.8	35.5	3000+	3000+	–	Very Poor	-2.7	-2.4	0.6	66	10	61	6	Poor	NIL
PANASONIC	E 120	Japan	7.00	42.4	37.4	50	14	OK	Very Good	+1.1	+1.1	-1.0	62	10	53	1	Very Good	★★★★★
REVIEW	E 120	Hong Kong	5.40	36.3	34.5	977	264	–	Poor	-2.5	-2.2	-0.8	60	8	53	1	Poor	★
SCOTCH 3M	E 120	UK	6.99	46.2	37.8	28	11	OK	Good	+0.2	+0.1	-0.4	60	7	54	1	Good	★★★★★
TDK	E 120	Japan	6.29	43.5	37.9	38	7	OK	Good	+1.5	+1.5	+0.1	65	12	56	2	Very Good	★★★★★
TDK	E 180	Japan	7.29	44.6	38.8	271	10	OK	Good	+1.5	+1.5	+0.2	65	12	56	2	Very Good	★★★★★
VICA	E 180	Hong Kong	5.75	35.2	36.5	380	84	OK	Very Poor	+0.2	+0.1	-2.1	64	12	54	1	Poor	★

BLANK VIDEO TAPE SURVEY BETA FORMAT

Manufacturer	Tape Length	Country of Origin	Typical Selling Price £	Electromagnetic Test: Luminance S/N ratio (dB)	Electromagnetic Test: Chrominance S/N ratio (dB)	Average Drop-Outs/Min.: First Minute	Average Drop-Outs/Min.: Mins. 2-10	Still Frame Test	Subjective Visual Assessment	Audio Sensitivity (dB): 333 Hz	Audio Sensitivity (dB): 1.0 kHz	Audio Sensitivity (dB): 7.0 kHz	Mechanical Noise Test F.FWD. (dBa): Max.	Mechanical Noise Test F.FWD. (dBa): Range	Mechanical Noise Test REW (dBa): Max.	Mechanical Noise Test REW (dBa): Range	Quality of Packaging	A-Z Overall STAR RATING
AGFA	L 500	W.Germany	6.25	47.5	37.0	38	27	OK	Good	-0.6	-0.5	-0.9	70	7	68	5	Very Good	★★★★
BASF	L 500	W.Germany	8.69	48.5	38.0	32	29	OK	Good	+1.4	+1.4	+1.2	69	6	65	6	Good	★★★
BASF	L 750	W.Germany	9.30	48.6	37.6	17	9	OK	Very Good	+1.4	+1.4	+1.2	68	10	65	5	Good	★★★★
BIB	L 750	UK/Japan	7.95	45.5	37.5	10	6	OK	Very Good	-1.2	1.0	1.3	65	7	64	7	Average	★★★★
C.ITOH	L 500	Japan	6.50	49.5	37.8	14	25	OK	Good	+0.8	+0.6	+0.8	65	8	63	5	Very Good	★★★
FUJI	L-500	Japan	5.25	48.5	37.7	17	16	OK	Good	-0.6	-0.5	+0.1	65	7	63	5	Very Good	★★★★
MAXELL	L-500	Japan	6.10	48.3	37.7	17	16	OK	Good	+0.5	+0.7	+0.5	66	7	63	4	Good	★★★
MAXELL	L 750	Japan	8.37	47.5	37.7	23	9	OK	Good	+0.6	+0.8	+0.2	72	10	65	6	Good	★★★★
MEMOREX	L-500	Japan	8.25	46.9	37.2	87	25	OK	Good	+0.8	+1.0	+4.6	70	8	68	8	Excellent	★★★★
SANYO	L 500	Japan	6.95	47.7	37.7	7	8	OK	Very Good	-0.8	-0.7	0.0	66	7	63	5	Good	★★★★
SANYO	L 750	Japan	8.95	46.2	37.4	21	3	OK	Acceptable	-1.1	-1.2	-1.4	65	7	65	8	Good	★★★
SCOTCH-3M	L500	UK	6.99	49.2	38.1	4	5	OK	Very Good	-1.2	-1.0	-1.4	67	10	61	6	Good	★★★★
SCOTCH-3M	L-750	UK	7.20	48.5	37.4	16	7	OK	Very Good	-0.5	-0.6	-1.4	68	8	64	6	Good	★★★★
SONY	L-500	Japan	7.50	46.5	37.5	4	5	OK	Good	-1.1	-1.0	+0.6	72	8	70	8	Very Good	★★★★
SONY	L 750HG	USA/Japan	11.00	48.6	38.6	NONE	2	OK	Excellent	+0.8	+0.7	-1.4	67	8	64	6	Very Good	★★★★★
SONY	L-70	USA/Japan	9.00	47.6	37.7	7	6	OK	Very Good	–1.0	–1.1	+0.4	66	8	63	8	Very Good	★★★★★

BLANK VIDEO TAPE SURVEY VIDEO 2000 FORMAT

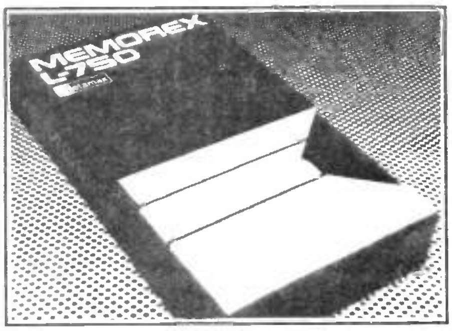
GRUNDIG	VCC 240	W.Germany	9.47	45.8	35.6	5	9	OK	Acceptable	-0.3	-0.2	+2.0	51	1	50	1	Good	★★★★
PHILIPS	VCC 240	Netherlands	9.15	44.0	36.3	60	36	OK	Acceptable	-0.7	-0.7	-2.2	50	1	50	1	Good	★★★
SCOTCH-3M	VCC 360	UK	14.95	46.2	36.1	40	23	OK	Acceptable	+1.0	+0.8	+0.1	51	1	50	1	Good	★★★

Multitech

SUPER **junk**-with over **3000** drop-outs per minute irrespective of part selected and in every respect its performance is outside the range of anything that could be called acceptable. DEFINITELY NOT RECOMMENDED and if you have bought it because of its cheap price, you have been conned! No Stars!

Maxell

One of the lowest drop-outs recorded in the VHS group for the E-180 and the BETA (L-750). Good results were also achieved in the visual assessment and this tape comes well packaged. The L-500 was a slight disappointment with only a 3 star rating but their L-750 did better at 4 stars. It seems their better tapes are in the VHS format.



Memorex

With a score of 4 stars for the L-500 and 5 stars for the E-180, they did well in the face of tough competition and in fact their tapes performed better than their own quality control standard!

For example, except for the first two minutes at the beginning of the tape, the rest of the tape according to Memorex should have less than a maximum of 50 drop-outs per minute — they scored 18. Good overall performance with the BEST packaging.

Panasonic

Another 5 star product and a nice change to our previous competitor. Ultra low drop-outs with very good picture quality and a reasonably 'flat' audio sensitivity curve. Both its Luminance and Chrominance readings are just right and the packaging was good too. HIGHLY RECOMMENDED.

Philips

Another V2000 cassette from the co-inventors of this format. These tapes except for their drop-out figures, compare well with other V2000 tapes such as those from Scotch-3M. On the subjective Visual assessment it gave acceptable results.

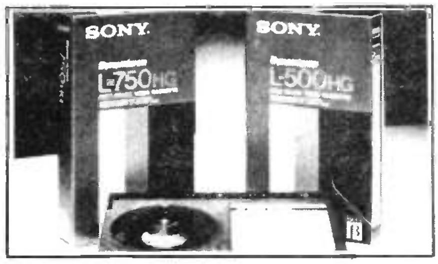
Review

Another Hong-Kong effort and not a good one at that, despite a cheap price can only be classed as a one star product. Plenty of drop-outs, poor results on the subjective visual tests, one of the worst tapes tested and only marginally better than Multitech. CANNOT BE RECOMMENDED.

Sanyo

These two BETA tapes had a very low drop-out performance but proved a bit strange on the visual assessment. The L-500 gave very good results, while the L-750 was only just acceptable. Other results were fairly similar. Very good and fair tapes from SANYO MARUBENI.

"FOR THE LAST TIME, IT ISN'T A 'SNOWY EFFECT'... WE'RE WATCHING 'ICE STATION ZEBRA'!"



Sony

HERE IS THE WINNER! Undoubtedly the SONY's L-750 HG DYNAMICRON is the best tape we saw with NO DROP-OUTS over the first minute and just two in minutes 2-10. Excellent picture and superb audio. For all this you have to pay an extra couple of pounds but it is worth it in the long run. HIGHLY RECOMMENDED.

Tests on the Standard Dynamicron tape gave good results, not quite matching the HIGH GRADE tape.

Scotch-3M

The Scotch-3M is now producing a consistently good product. Their VHS drop-outs were amongst the lowest we had and the BETA tapes performed quite well too. 3M also produce a good quality V-2000 tape. Their L-500 BETA tape had one of the highest Signal/Noise ratios on the Luminance test and VHS samples were also very good. VERY GOOD.

TDK

Two VHS tapes and two 5 star ratings for Super Avilyn products. Ultra low drop-outs combined with a good picture and decent S/N ratio whilst on Electro-magnetics. Very well packaged and naturally RECOMMENDED.

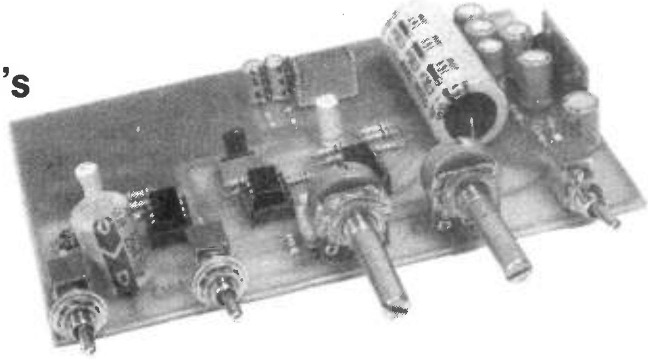
Vica

Cheap Hong-Kong Product with one of the lowest prices around, with only £5.75 for an E-180. High drop-outs and bad picture. The maximum rating for this tape is one star only because it is slightly better than Multitech and Review.

■ R&EW

PUBLIC ADDRESS AMPLIFIER

Get your message across with R&EW's small, but powerful, amplifier. Ken Alexander and Adrian Barnes handled the design.



If you are lucky enough to possess a voice like Donald Sinden's it's unlikely that you'll need the service of a PA amplifier. For those of you with less strident voices however addressing your public without any artifical aid will probably mean that your words are unintelligible to even the keenest listener.

Specific Design

During the design of the PA amp, the specific needs of this type of work were borne in mind — hence the inclusion of switchable low and high pass filters, two mic inputs of differing sensitivity and a line level input.

The two filters will, in most cases, be switched in as the frequency content of the human voice lies in the band defined by the filters. This ensures that maximum speech energy is transferred to the loudspeaker. Switching the filters in also ensures that any interference (hum or HF noise) will be suppressed.

Both the mic and line levels are adjustable via two pots and the mixing stage has been designed to ensure that there will be no interaction between the two sources.

The amplifier is designed to work into a nominal load of 8R and obviously, the more efficient the speaker, the more noise you'll be able to make.

Construction

The photograph of the prototype shows that construction is relatively straightforward if our PCB is used. For those of you using other forms of construction, pay careful attention to the earthing of the power amp IC as slight alterations in this area can lead to instability.

Having completed construction, carefully check the board against our overlay and if all is well connect up a microphone, speaker, power supply, then switch on, take a deep breath and say your piece.

PARTS LIST

Resistors

(All ¼ watt 5% carbon)

R1	2k2
R2	22k
R3,4,13,12	27k
R5,15	100k
R6	12k
R7,8	180k
R9,10,11	1k8
R14,16	10k
R17	560R
R18,19	2R2

Potentiometers

RV1	10k log
RV2	100k log

Capacitors

C1,2,11	2u2 10V radial
C3,9	10u 10V radial
C4	6n8
C5	47n
C6	22n
C7	47n
C8	3n3
C10	4u7 10V radial
C12	1u0 10V radial
C13,14,17,18,19	100u 10V radial
C15	4700u 16 V axial
C16	47u 10V radial
C20,21	100n
C22	2u2 polycarbonate

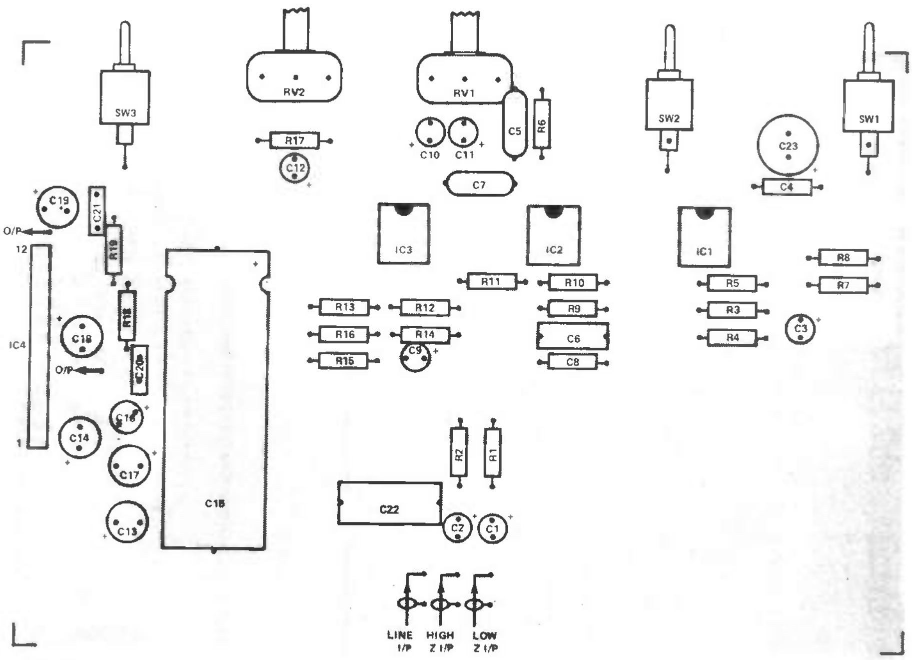
Semiconductors

IC1	LF351N
IC2	741C
IC3	MC1458
IC4	HA1388

Miscellaneous

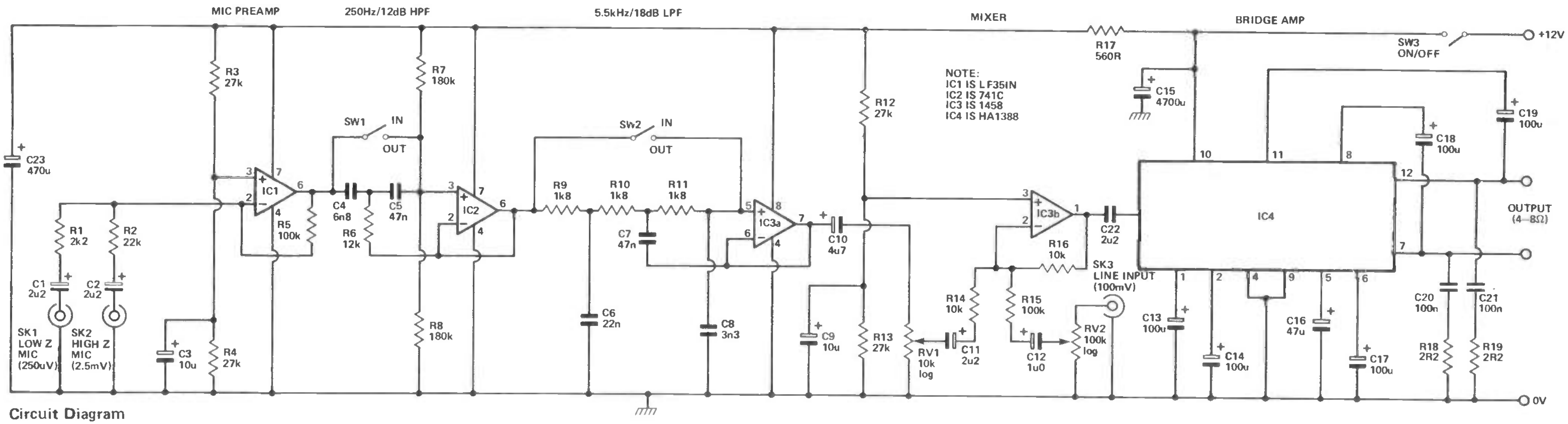
SW1,2,3 SPDT min. toggle

Heatsink, P.C.B., 16 p.c. half pins., (3 off) 8 pin I.C. sockets.

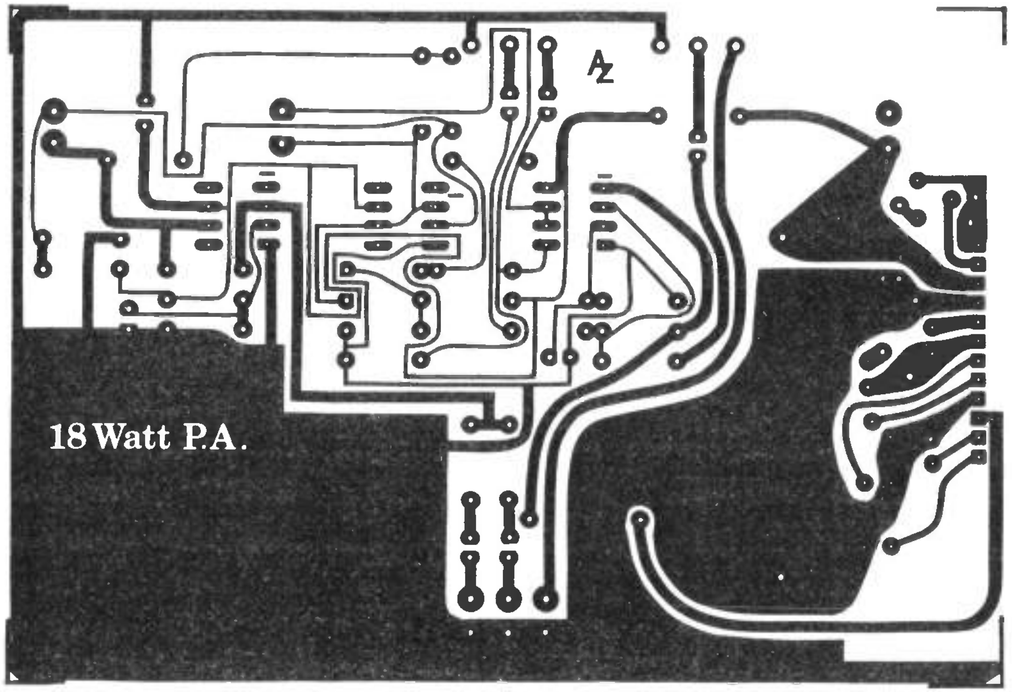


PCB Overlay

PUBLIC ADDRESS AMPLIFIER



Circuit Diagram



PCB Foil

Circuit Description

The PA amplifier provides two microphone inputs, the impedance of these being determined by either R1 or R2. Their sensitivity is established by the ratio of either resistor to R5, in the feedback path of IC1 — a low noise operational amplifier. R3 and R4 bias the non-inverting input of IC1 to mid-rail, with C3 providing supply decoupling.

The amplified microphone signal, at a level of approximately 10mV, is fed to a 12dB/octave high pass filter with 250 Hz break-point. This is formed by IC2 and its associated components. With SW1 switched to 'in', C4, C5 and R6 determine the filter's characteristics — with SW1 switched to 'out', the stage forms a unity gain, non-inverting amplifier.

IC3a, one half of a dual op-amp forms a 18dB/octave low pass filter, with roll off beginning at 5.5kHz. With SW2 switched 'out', this stage once again forms a unity gain voltage follower. The microphone signal is now fed via DC isolating capacitor C10 to level control RV1.

IC3b forms a virtual earth mixer, combining the microphone inputs with the line level input from RV2. IC3b provides unity gain for the microphone channel, R14 and R16 of equal value, whilst the line signal (nominally 100mV) is attenuated by a factor of 10. The output at IC3b is taken via C22 to the bridge tape power amplifier, IC4. This IC features Automatic Safe Area Operation (also), thermal shutdown, and comprehensive surge protection circuitry. Capacitors C13 and C17 provide an AC signal path — effectively blocking DC — inverting terminals of the two internal bridge amplifiers, to ground. C14 gives ripple rejection, while C16 determines the ASO. C19 and C18 are bootstrap capacitors, with R18, R19, C20 and C21 forming a Zobel network that contributes to the stability of the output stage.

■ R&EW

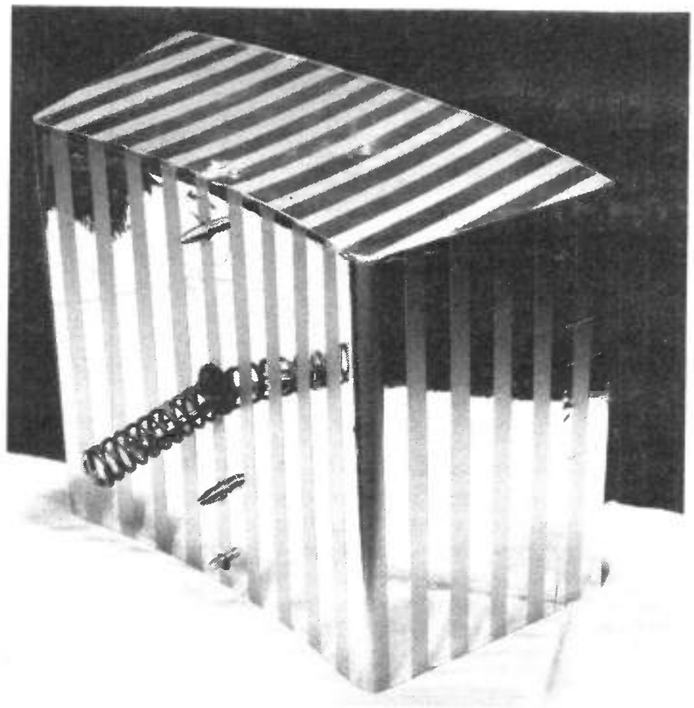
AMATEUR RADIO SATELLITES

Getting started on the amateur radio satellites.

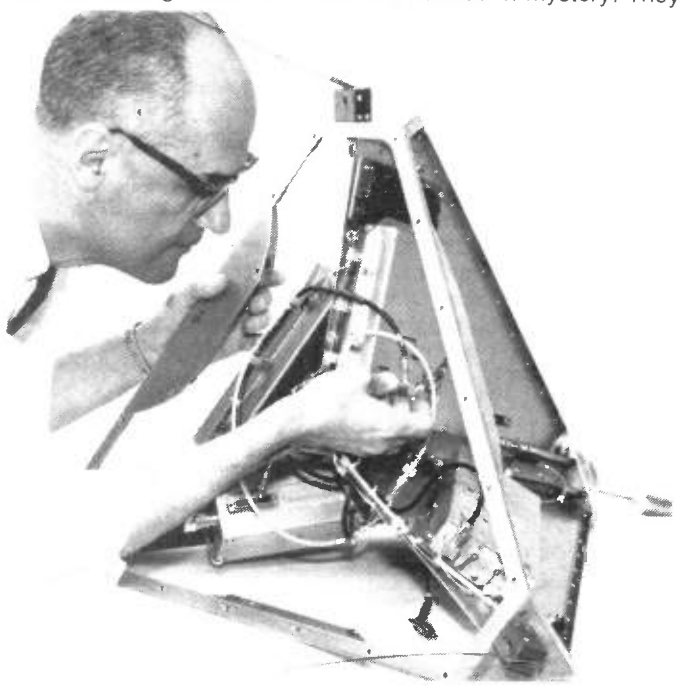
Arthur C. Gee. G2UK.

There are now a sufficient number of amateur radio satellites in orbit, to enable one to say with some confidence, that this mode of amateur radio communication is here to stay. Up to now amateur radio satellites have been somewhat experimental in nature and those who have participated in this facet of amateur radio have been in the main, those whose interests are more in the realm of experimentation than communication. Enough experience has now been acquired of amateur radio satellites, to know pretty well what can be expected in the purely communication field and it is obvious that there is much to appeal to the "dx-er" and to those who are satisfied with more "local" QSOs. It now seems pretty certain too, that there will be enough satellites in orbit in the future, to ensure continuity of this mode. What with OSCAR 8, which is still going strong, the series of Russian satellites which will undoubtedly be continued and the imminent launching of AMSAT's Phase III B satellite, to be followed in due course by another similar one, viz. Phase III C; there should be amateur radio satellites in orbit for quite a long time ahead. Quite long enough to satisfy those who so far have held back from getting into this mode for fear that they would spend a lot of time and money on getting set-up for this new technique only to find that sooner rather than later, there were no satellites in orbit to use.

The technique of amateur radio satellite communication is very different from routine amateur radio usage. This too, has made quite a number of would-be participants hesitate at getting going in this mode. Even now, with all that has been written and said about OSCAR usage, many are uncertain just what is involved and what is the commitment for launching out into something which for them is shrouded in mystery! They may well have visited a satellite orientated amateur radio friend's establishment and seen elaborate rotary beam aerial systems, charts and prediction calendars in the shack together with an array of expensive looking gear and come away thinking, "is it really worth all that?". In this article, and one to follow, the writer hopes to show how it is possible with quite simple gear to get well-worthwhile results, which at least will get the newcomer "into satellites".



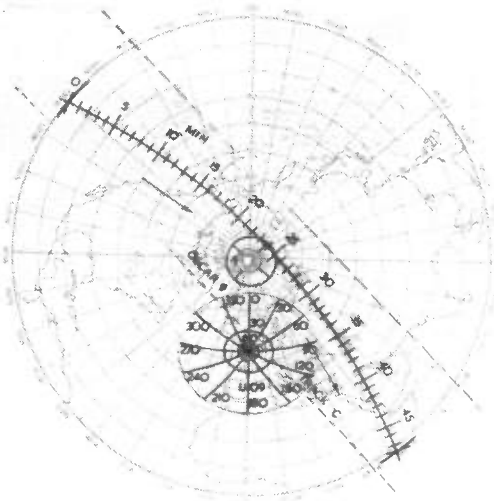
Oscar 4



Oscar 1. Oscar 2 was identical in construction to Oscar 1.

The Early Days

It is of considerable interest to take a look at how this facet of amateur radio started. The idea of an amateur radio satellite began to take shape quite early in the USA professional satellite programme. A group of West Coast radio amateurs of whom some were professional space engineers, designed and built a series of amateur satellites and succeeded in persuading the right people to launch them into space for them. When a professional satellite was launched, there was occasionally some "spare weight" to be made up and the early amateur radio satellites helped to make up this weight! The first was called OSCAR 1, — Orbital Satellite Carrying Amateur Radio. It is shown in the first of our illustrations, and as can be seen, it was so shaped as to fit snugly into the circular side of the USAF Discoverer 36 launching rocket, by which it was launched on December 12th, 1961. It had aboard, a small transmitter sending "Hi-Hi" in morse code, on 145 MHz. This it did until 30th December, when its batteries ran down. It weighed 10lbs, completed 312 orbits and reports of its signal were received from over 500 amateur radio stations in 28 countries. A second similar satellite was launched in June 1962. Designated OSCAR 2, it transmitted data on its temperature; speeding or slowing its keying rate, according to its temperature, it lasted 18 days. OSCAR 3 was the first true communications satellite for amateur use. It was put into a 570 mile high orbit on March 10th 1965. It carried a receiver, tuned to one end of the 145 MHz amateur band and a transmitter at the other end of the band. ▶



AMSAT-UK polar protection map & plotting sheets.

Signals sent up from the ground were retransmitted back to earth successfully, some 176 two-way contacts being made. A further OSCAR — "4" — had a very short life due to a failure in the launch vehicle — a fate suffered again by a later Oscar. OSCAR 5 continued the success story, being launched successfully in January 1970. This was the first to be launched by AMSAT, a Washington, USA, based organisation — The Radio Amateur Satellite Corporation. It was a scientific and educational satellite, transmitting signals in the 2 metre and 10 metre amateur bands, thus permitting study of the ionosphere near the peak of the solar sunspot cycle. OSCAR 6 and OSCAR 7 followed, being launched in October 1972 and November 1974 respectively. They were a great technical advance on the previous ones. they were the first of the "second generation" of amateur spacecraft. They were powered from solar panels which charged batteries. Data on many of the operating parameters were sent by telemetry to control stations which could switch the satellites on and off at will so that the batteries could be conserved as required. They also had 'transponders' by which two-way communications could be effected. Both these satellites have now ceased to function, after exceeding their expected life span by many months.

The place of these early satellites has been taken by OSCAR 8, launched in March 1978 and a number of similar satellites launched in December 1981 by the Russians. A further series of satellites is planned by AMSAT of an even more sophisticated type, the first of which was launched by the European Space Agency on the second of their Ariene test firings in May 1980, which unfortunately failed, and what should have been AMSAT-OSCAR 9 ended up in the sea! However, a replacement has been completed, its launch being awaited with keen anticipation by all amateur spacecraft enthusiasts.

So much for the satellites. What is needed on the ground to make use of them? How do we hear them?

On The Ground

The first thing of course that is required is a radio receiver, which will tune over the frequencies being transmitted by the satellites. This means a short wave receiver which will cover the 10 metre band and which can be used with a converter to cover the 2 metre amateur band. OSCAR 8 also operates in the 435 MHz band, as does UOSAT and as will OSCAR Phase IIIB. However we will ignore these frequencies in these articles, as the technology required for these higher frequencies demands more 'know-how' than the lower frequency operation — known as "Mode A". These articles are intended to get you going. You can spread your wings to the higher frequencies once you have got acquainted with the easier techniques.

The frequencies used by the satellites are bunched up into a narrow band within the amateur bands concerned. These amateur satellite band allocations have been agreed by International Agreements and should be respected by all users of these bands. In the case of the 10 metre band it is from 29.3 MHz to 29.5 MHz. For the 2 metre band, it is 145.8 MHz to 146.0 MHz. In the case of existing satellites, the 2 metre signal is the one on which one transmits up to the satellite — called the "up-link" signal, and the 10 metre signal is the one on which the satellite transmits back to earth — the "down-link" signal. From this we see that our radio receiver must be able to tune over quite small sections of the 10 metre band adequately, ie, it must have good bandspread and if you want to listen to satellites which are using the 2 metre allocation for their down-link — such as UOSAT — you must have a receiver in which the tuning mechanism is good enough to tune over this small section of the 2 metre band. All this adds up to the need for a proper short wave communications type receiver. A broadcast type receiver with short wave ranges really is not suitable, because the tuning dial arrangements will not spread out the signals enough to enable you to tune over these small sections of the bands. So if you have a proper short wave receiver covering the 10 metre band, either separate or as part of an amateur bands transceiver, you have got the first requirement. However — a snag! Most short wave receivers are not very sensitive when you get down to their 10 metre range. So you may require a preamplifier tuned to cover the 29.4 to 29.5 MHz range, which goes in circuit between your aerial and the aerial input socket of your receiver.

2m Reception

Turning to the reception of the 2 metre satellite band, here one needs either one's short wave receiver, used with a 2 metre converter or if you don't mind the expense, a separate tunable 2 metre receiver. Note — a "tunable" 2 metre receiver. Most of the 2 metre black-boxes used by the 2 metre fraternity these days are 2 metre FM transceivers on switched channels. These are no good for satellite working. You need a receiver which can be tuned over the band and which will receive CW and SSB, ie, it must have a beat frequency oscillator. Probably, most newcomers to the satellite scene will opt for a converter used in front of their existing short wave receiver. This converter

Sat 29 Jan OSCAR9 Mode EX			Sun 30 Jan OSCAR9 Mode EX			Mon 31 Jan OSCAR9 Mode EX		
ORBIT	EQX-GMT	DEGS.W.	ORBIT	EQX-GMT	DEGS.W.	ORBIT	EQX-GMT	DEGS.W.
7262	00:28:14	140 <	7277	00:09:05	136 <	7293	01:24:38	155 <•
7263	02:02:57	164 <•	7278	01:43:49	159 <•	7294	02:59:21	178 <• ←
7264	03:37:41	188 <•	7279	03:18:32	183 <•	7295	04:34:05	202 <•
7265	05:12:24	212 <•	7280	04:53:15	207 <•	7296	06:08:48	226 <•
7266	06:47:08	235 <•	7281	06:27:59	230 <•	7297	07:43:31	249 <
7267	08:21:51	259 <	7282	08:02:42	254 <	7298	09:13:14	273 >
7268	09:56:35	283 >	7283	09:37:25	278 >	7299	10:52:57	297 >•
7269	11:31:18	306 >•	7284	11:12:09	301 >•	7300	12:27:41	320 >•
7270	13:06:02	330 >•	7285	12:46:52	325 >•	7301	14:02:24	344 >• ←
7271	14:40:45	354 >•	7286	14:21:35	349 >•	7302	15:37:07	8 >•
7272	16:15:28	17 >•	7287	15:56:19	12 >•	7303	17:11:50	31 >
7273	17:50:12	41 >	7288	17:31:02	36 >	7304	18:46:33	55 >
7274	19:24:55	65 >	7289	19:05:45	60 >	7305	20:21:17	79 >
7275	20:59:39	88 >	7290	20:40:28	84 >	7306	21:56:00	102 <
7276	22:34:22	112 <	7291	22:15:12	107 <	7307	23:30:43	126 <
			7292	23:49:55	131 <			

Oscar 9 entry for 31st January 1982 0259 hrs GMT 178 degrees W.

A more convenient pass "overhead" at 1402 hrs, 344 degrees W.

Table 1: Extract from AMSAT-UK orbital calendar relating to UOSAT, showing entry for 31st January, 1982.

receives the 2 metre signals from the satellite and converts them into, usually, a 28 MHz signal which is then fed into the short wave receiver switched to the 10 metre range. Tuning then takes place over the 10 metre dial readings. Suitable 28 MHz preamplifiers and 2 metre converters can be easily purchased and are not too difficult to build up oneself if preferred. Circuits, kits, etc., are frequently written up in most of the current radio journals. AMSAT-UK, the organisation which looks after the interests of the satellite users in this country, can supply much information on these units. Write to the Hon. Sec. G3AAJ, AMSAT-UK, 94 Herongate Road, Wanstead Park, London, E12 5EQ, enclosing SAE for reply.

We will discuss the question of what sort of aerial to use with your receiving setup in the second of these two articles. For the present, the next most important thing to consider is how does the satellite encircle the earth and what are the characteristics of its orbit? In other words, how do we know when to listen for it?

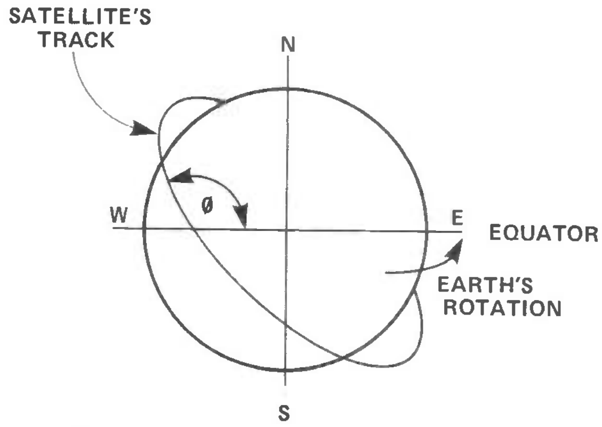


Figure 1: The track of satellite's orbit around the earth. 0 = angle of inclination. Remember the earth rotates from west to east, whereas the track of the satellite stays the same in space.

Orbital Calculations

To understand this, lets have a look at the accompanying diagram, ***Fig. 1***. The circle represents the outline of the earth's globe. The horizontal line represents the equator, the vertical line is the north-south line. The eliptical line represents the track of the satellite. Imagine the satellite is travelling from south to north. Now, after launch, the satellite being free in space, continues to travel along its orbital path until such time as its velocity falls off and it falls back into the earth's atmosphere and is burnt up. We need not go into the details of what determines the characteristics of the orbit at this stage. We will assume it is in a simple one. Let's also assume the satellite is travelling from the equator, up over the north pole, down towards the south pole and back over the Antarctic regions to the equator again. The time taken to do this is called the "orbit time" of the satellite or its "Period". That part of the orbit in which the satellite is travelling from south to north is called the "ascending node"; the part from north to south the "descending node". The Period for OSCAR 8 is approximately 103 minutes. For UOSAT it is 95 minutes. For the Russian satellites it is around 90 minutes. Note also that the angle between the orbital path and the equator is known as the angle of inclination.

To be continued ■ R&EW

EPSON HX-20

Epson's show stopper portable computer: An amazing advance in truly personal computing, but with no visible means of support — yet? William Poel reports.

As the personal/home computing scene evolves, the one thing that becomes more and more apparent is the need for self-contained computing facilities that don't involve fiddling about with the TV antenna lead, don't need a maze of mains leads, and don't have keyboards designed by occasional one-finger typists.

In this context, the much promoted EPSON HX20 is just what the doctor ordered, for this reviewer at least. In fact, it's a bit like the elixir of life compared to some of the cough-drop offerings of the established personal computer manufacturers. Have the Japanese done it again and hit the market nail squarely on the head? The answer looks like yes.

When Mrs Thatcher gave the Japanese PM a Sinclair Spectrum during her last visit, it was very decent of him not to spoil Mrs. T's day by reciprocating with one of these marvels.

The bit the Japanese seem to have grasped is the importance of CMOS to allow for true portability in their designs. There is far more activity in CMOS MPUs in Japan than anywhere else, and this experience is expertly applied to the HX20. Maybe the promised CMOS version of Z80 will be worth waiting for, but it's a perilously long time coming. What price a CMOS Spectrum with LCD — and a keyboard that hasn't been supplied to satisfy rubber fetishists, Uncle Clive?

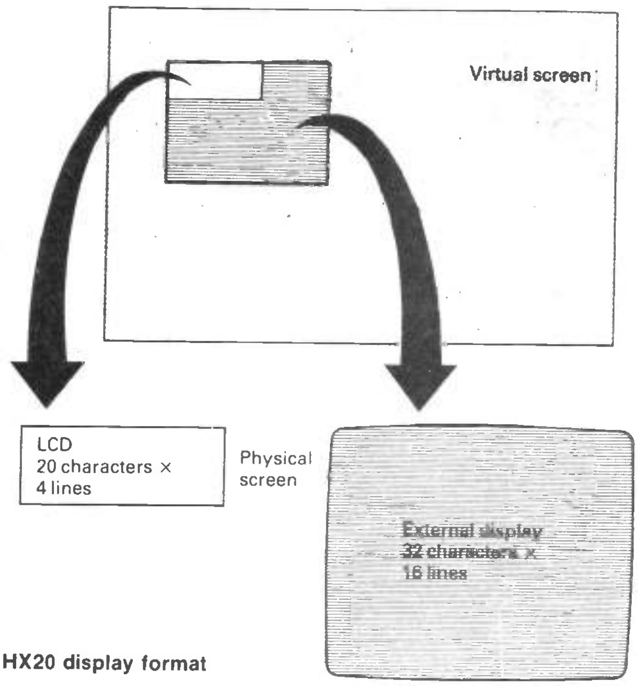


Figure 1: the HX20 display format

Battery life

Time between charges is stated as an average of 50 hours, and the handbook goes into alarming detail to point out exactly how to calculate consumption and recharge periods. The handbook contains various dire warnings about overcharging and the potential for doing harm to the battery: the machine prompts you with a "CHARGE BATTERY" warning in good time to prevent memory loss, so there's no excuse for crashing the thing. In view of the complexity of the charge instructions and warnings, it would seem appropriate that Epson should supply a program and A/D to work out exactly how to recharge the thing with the Mk II.

Figure four illustrates where the juice dribbles away.

Battery changing is reasonably simple, but it might have been nice to have a separate memory retainer battery so that RAM wasn't wiped when the ▶

*OPEN"COMO:"

FORMAT OPEN "<mode>", [#]<file number>, "COMO:[(<BLPSC>)]"
PURPOSE To specify the interface conditions for the RS-232C port and execute OPEN.
EXAMPLE OPEN "0", #1,"COMO:68N2B)"

REMARKS This command is essentially the same as the normal OPEN command except that it specifies the interface conditions of the RS-232C port. <BLSPC> consists of 5 characters each specifying one of the interface conditions of the RS-232C port as follows.
B (Bit rate)
Numerics 0 to 6 are used to specify the bit rate (data transfer rate).

Figure 2: Epson's spot the "0" contest

NiCad stack is changed. It might also have been useful to provide a disposable battery cartridge (like some of the amateur radio handy-talkies), but I shall probably feel more strongly about this when I discover the battery is run down just before I want to go walkabout with the HX20, and have no immediate prospect of charging the thing.

It's all very well making the unit rechargable over 8 hours, but these things have a habit of running out just when you're ten miles from the nearest 240V AC outlet. I may be tempted to make a 12V charger lead — or try plugging in the Kyocera solar battery pack if the sun is around.

When is a 0 not a O ?

The answer — when it's printed in the EPSON HX20 handbook.

The handbook is a generally nice piece of work. I'm not sure why they adopted an A5 size format, since according to Epson they produced the manuals in two volumes for reasons of the unacceptable bulk if it had been consolidated in one volume. Is there a good reason why they should not have been produced in A4 format (like the computer itself) and thus been able to present more information without page-turning. As followers of instruction manuals will appreciate, the more you can see at a glance, the better.

Maybe this is part of the process to soften up users for the relatively small display? There is no facility in the very nice carrying case for stowing the handbooks.

But the biggest howler is the fact that the entire manual has been printed using the plain 'O' convention for zero, rather than the computer-universal slashed zero: 'Ø'. Not only that, but on the communications interface instruction page, this practice has even got Epson's knickers in a twist. (See abstract).

When posed with this criticism, Epson's UK marketing Manager (ex-Geni supremo at Lowe Electronics), Bob Stead held up Dick Pountain's eulogy in his defence. Dick, you never tried the serial interface configuration programme, did you?

Hurry up with the petrol

Having an HX20 without the starter software, such as the word processor package ('The Correspondent' — companies are running out of names for new WP packages), is like having a Ferrari with an empty tank. You can always program using the versatile BASIC, but that's not really the point of a machine like this which aims to sell to the 'first time' executive user who is using the HX20 as a time saver. Despite the finger crossing, the HX20 landed on the market minus any visible means of support. Oops! Much flustering at Epson, no doubt, but there was no one prepared to make any promises when pressed on availability.

Here's a cracker: Epson are recommending customers who want an acoustic modem to buy a device at around £150, since (more egg on face?) the acoustic coupler is going to be a little late arriving. We wouldn't be so cruel as to suggest that they overlooked the different US and Euro standards, or even the different sized handsets, would we? And under no circumstances should you mention the VDU/screen adaptor if you want to endear yourself to the people at Epson.

Now all this may sound like sniping, but it's really more an expression of exasperation that such a superb product should stutter out onto the starting grid, firing on two of its twelve cylinders.

The Screen, the printer and the tape

To a user of the 'standard' 80x24 format VDU, the move to a 20x4 screen takes a little time. However, this is actually more accurately described as a 'window' than a screen, since the virtual screen can be defined by a WIDTH command. (*Fig. 1*)

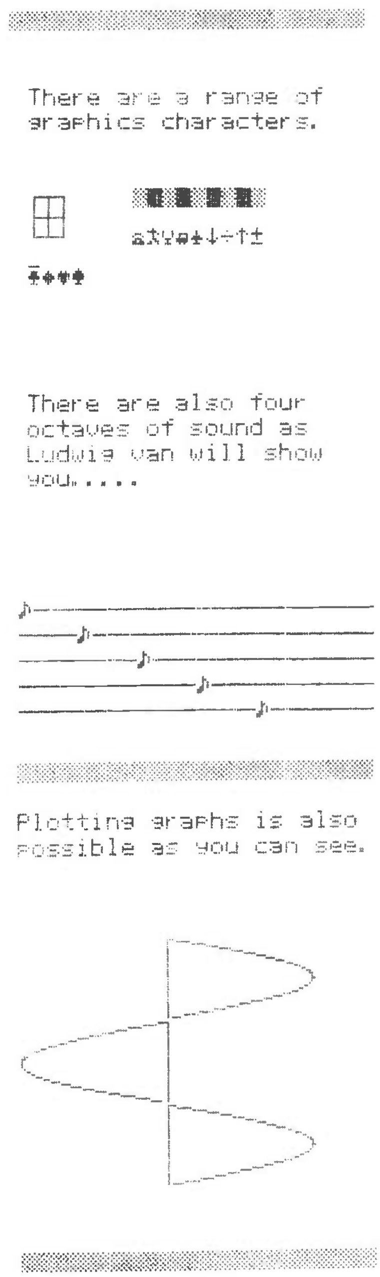


Figure 3: Some of the party-trick print-outs

The virtual screen can occupy up to 255x255 — although this then restricts available user RAM. One of the niggles comes to light at this point, because the manual doesn't say how much RAM the virtual display uses (relentless enquiry on your behalf reveals that it's about 10 bytes per character on the virtual screen) nor could we find the capacity of the microcassette described anywhere. It's an act of faith buying one — it could be 10K for all you or I know.

Epson suggest a rather conservative 25K per 15 minutes of tape (one side of the standard 30 mins Sony format microcassette, which isn't the same as the Philips microcassette...), although recording at the stated 1300 baud,

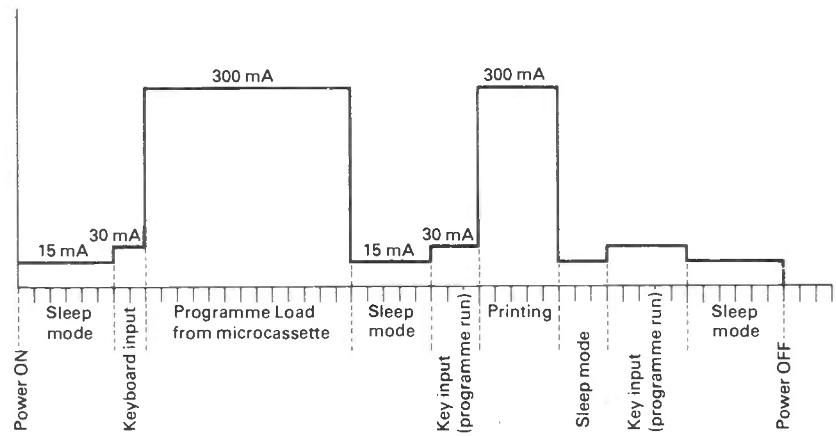


Figure 4: Current consumption over a typical minute

someone worked out that it should be about 75K per side. Watch this space for the official pronouncement.

There is an excellent software tape counter system, and various painless "WIND" commands that fly it to predetermined sections of the tape. I wouldn't go as far as to put this on a par with floppy disk convenience, but on a scale of 0 to 10 where 0 is conventional cassette handling, and 10 is floppy disk, this rates about a 3.

The screen system is very clever indeed — but you will need to spend the extra £80 for the 16K CMOS RAM pack if you want to use all its facilities. It's a bit of a shame that the extra couldn't be fitted internally, since the appendage thus provided turns the unit into something that is just a shade too big to fit in an average briefcase.

The printer grinds away with a very jaunty rythmic throb, and despite sounding more like a mincer than a graphics printer, turns out print that is streets ahead of its various rivals that operate with costly and obscure non-plain papers.

All in all, a very useful package, and one that should have the Adnams flowing like rivers as the Fenland computing fraternity set out to drown their sorrows.

Where is it now ?

Sony's Typecorder (previewed in this magazine last year) was never marketed in the UK, and we wondered why, aloud, and even gave the office products manager a hard time when we tried very hard to buy one. Well, thanks — obviously Sony had some idea that their £700 typecorder was about to be blasted away by the Epson machine, which contains many more features at half the price.

The HX20 uses a very "big" version (32K ROM) of Microsoft BASIC, with 16K CMOS user RAM, extendable with a further 16K cassette add-on. The machine makes great use of Epson's other main lines, with a very natty built-in printer and a 4x20 alpha numeric LCD with a cunning feature that adjusts the display angle to suit the user. Nice stuff — but I wonder what Epson's customers for LCDs are going to think when their products are being overshadowed in such a way.

Some Japanese component manufacturers go to great lengths not to associate themselves with finished products, so that they do not upset their customers for components. Epson does not appear to give a furry primate's...

The paper roll accepted by the printer is on the small side, and thus quickly consumed — but that's about the only major criticism of the hardware.

The manuals that were given such glowing and prosaic praise by Dick Pountain in *PCW* are not quite so wizard as DP would have us all believe — and the software was a figment of the imagination when the machine was launched — but the biggest raspberry of all goes to the marketing man who has the nerve to charge intelligent human beings £15 for a 5 pin DIN/DIN patch lead. You are being done if you pay more than £3 for such an item, so beware the accessory costs.

Epson's Ins And Outs

The "workhorse" feature that makes the HX20 for me is the liberal dose of IO. A software configurable RS232 port (up to 4800 baud) allows communication with anything from REWTEL to standard printers, host computers and the like. The high speed (38,400 baud) serial port is primarily intended for use with the floppy disk and the display controller system, which weren't available at the time of writing.

The HX20 can interface to most RS232 systems quite simply, and the manual

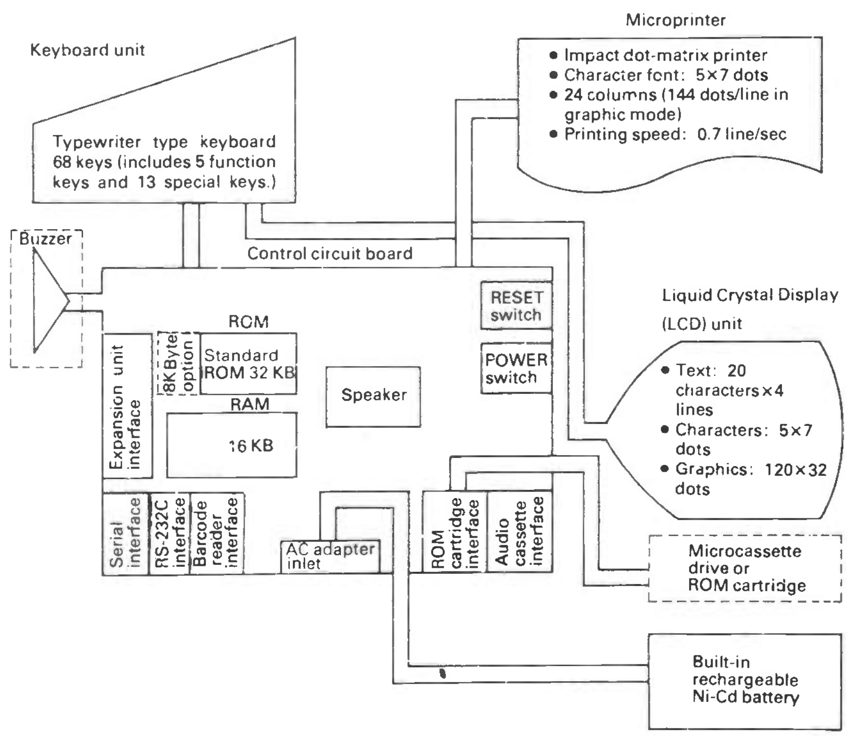


Figure 5. The HX20's Topography.

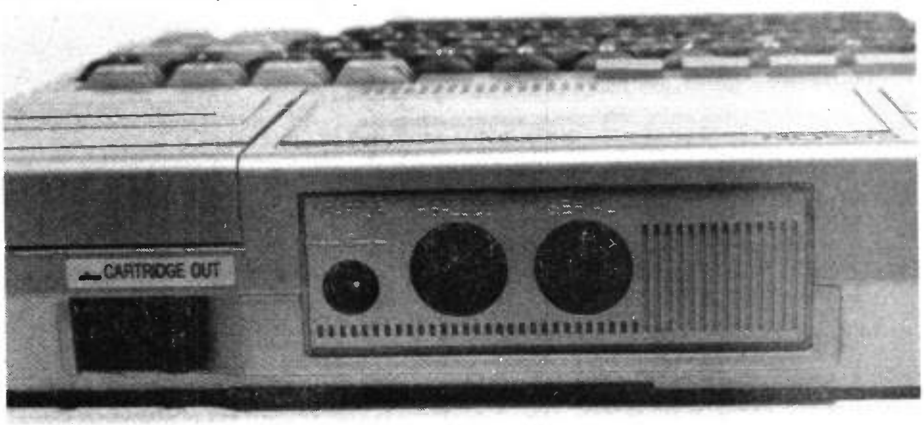
Specifications

CPU and Memory	
Main CPU	CMOS 8-bit microprocessor 6301, 614 KHz clockrate
Slave CPU	CMOS 8-bit microprocessor 6301, 614 KHz clockrate
RAM	16KB (standard) expandable to 32KB with expansion unit
ROM	32KB (standard) expandable to 40KB internally; to 72KB with expansion unit
Built-in Peripherals	
Display	Liquid crystal screen; 120 x 32 dot matrix; 20 x 4 character display; 5 x 7 font; virtual addressable area 255 columns by 255 lines (if sufficient memory is available)
Printer	24-column dot matrix impact microprinter; print rate: 42 lines per minute; bit addressable graphics; full ASCII upper and lower case character set; cartridge ribbon
Clock	Time and calender, built in CMOS battery backup
Music Generator	Programmable pulse drive, four octaves with half-tones
Communications	
RS-232C	Full/half duplex, 110 to 4800 b.p.s. 8-pin DIN connector
Serial	Full/half duplex, 38.4K b.p.s. RS-232C level, 5-pin DIN connector
Peripheral Interfaces	
Bar Code Reader	Special connector
External Cassette	Standard audio cassette interface
System Bus	16-bit address bus; 8-bit data bus and control lines, 40 pin connector.
ROM Cartridge/ Microcassette Interface	I/O port with 3 input, 6 output lines
Switches, internal	
4-bit DIP	3 bits for international character set selection; 1 bit programmable
Switches, external	
Main Power Printer On/off Reset	

Power Supply	NiCd batteries, internal, Sub C type, 1200 mA/H capacity; 40-hour capacity running BASIC (less depending on use of RS-232C port, printer or optional microcassette)
Recharge	Full charge within 8 hours
Keyboard and Character Set	
Type	Standard
Function	Interruptable
Total Number of Keys	68
Function Keys	5
Special Keys	13
Ten-key Pad	Function locked in by (NUM) key
Graphic Shift	32 special graphic characters
International Character Set	Selectable by DIP switch
Environmental	
Temperatures	
Operating	5-35°C (41-95°F)
Charge	5-35°C (41-95°F)
Storage	−20-60°C (−5-140°F)
Data Storage	−5-40°C (22-104°F)
Humidity	
Operating/Non-operating	10-80% non-condensing
Physical Characteristics	
Size	29.0 x 21.5 x 4.4 cm (11.4" x 8.5" x 1.7")
Weight	Approx. 1.7 kg (3 lbs. 13 oz.)
Options	
Expansion Unit	8KB RAM plus 24KB ROM or 16KB RAM plus 16KB ROM. Total expansion is 32KB
Microcassette	Uses standard microcassette tapes
ROM Cartridge	Uses 8, 16 or 32KB ROM to load program into RAM
CX-20 Acoustic Coupler	
Communications	Full/half duplex, selectable
Operation Mode	ORIG/ANS mode, selectable
Signalling Speed	Up to 300 b.p.s.
Interface	Standard RS-232C
Power Supply	4 NiCd batteries; AC adaptor (115V ±10%, 60 Hz), Floating charge with AC adaptor

goes to some lengths to describe the RS232 concept. To the unwary, "RS232" sounds like the universal missing link that matches anything with an RS232 port, to anything else with an RS232 port. It's far too sweeping a statement — a bit like suggesting that because a car has wheels, all tyres are compatible.

The basic configuration of the HX20 (as shown in the manual) is one of the best 'at a glance' summaries of the machine as currently available in the UK.



It's obviously part of a carefully conceived system, and I hope Epson UK will forgive me for giving them a hard time compared to some of the other reviewers of the HX20. After all, we did actually buy our model, and thus can claim to have a more objective user viewpoint: which basically boils down to frustration at what's being tantalizingly kept at bay until Epson are good and ready.

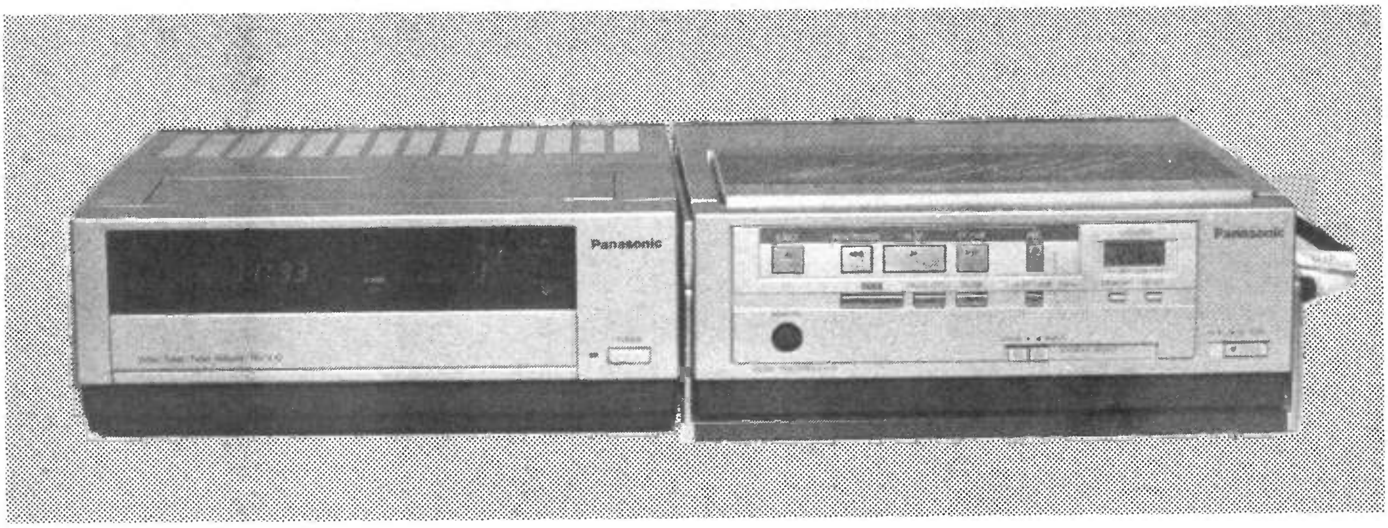
Finally...

I am obliged to Epson for the light relief provided by their glossy 8 page HX20 brochure. There are some delightful pictures therein, amongst them a photo of some young lad joyously fingering his HX20 whilst watching the Bugs Bunny show no doubt (he can't be using the TV with the HX20, can he??)

And the priceless photographs featuring some high powered executive-person with a phone stuck to his ear, gazing longingly at his secretary's knees. The caption says it all. Essential equipment ,eh? I'll say! We might as well have a laugh at the expense of the Japanese before they completely wipe out all industrial development in the West.

The "Printed in Japan" brochure includes pictures of those elusive peripherals (TV controller and disk drive) that have been strategically omitted from the UK advertising campaign.

■ R&EW



PANASONIC NV100

VHS's answer to the F1? In Peter Luke's opinion the answer's yes.

The advent of 'half size' VHS-C recorders means that standard format machines that aim to compete in the portable market must provide something extra in the way of performance. The ensemble from Panasonic reviewed here meets this requirement offering a good all round performance both as a portable and as a mains based recorder.

In addition to the new NV-100 recorder and its companion NV-V10 tuner/timer we had a chance to assess the recently launched WVP-50E auto focus camera.

Home Base

As even a portable system will spend most of its time in the home we'll start with a look at the recorder's performance in this role.

The recorder and tuner/timer are linked by two cables, one a multiway power and signal lead, the other an RF lead. With these connections made the two units offer all the facilities one would expect from a top of the range mains recorder.

The recorder's functions are all solenoid controlled — including the eject. The controls for the major functions, play, rewind and fast forward, are quite large and easy to operate. Other controls are smaller, the stop button being of just about adequate size but the pause and slow buttons being very tricky to use. These latter controls are not however in much demand and their small size is thus not too much of an inconvenience. The record button is also very small but this is a plus as it provides a measure of safety.

The other control within this group is the audio dub button.

The display at the right hand side of the recorder's front panel is an LCD panel that provides a variety of messages. Its main functions are those of a tape counter — unfortunate that there's no elapsed time facility — and a battery condition indicator. It also alerts the user if the moisture detection circuit

The recorder separated from its tuner and wrapped in its carrying case

The NV-100 features a comprehensive range of input/output connectors.

The rather stylish lines of the auto focus camera.

of the recorder becomes active and displays a prominent M if the memory rewind facility is engaged.

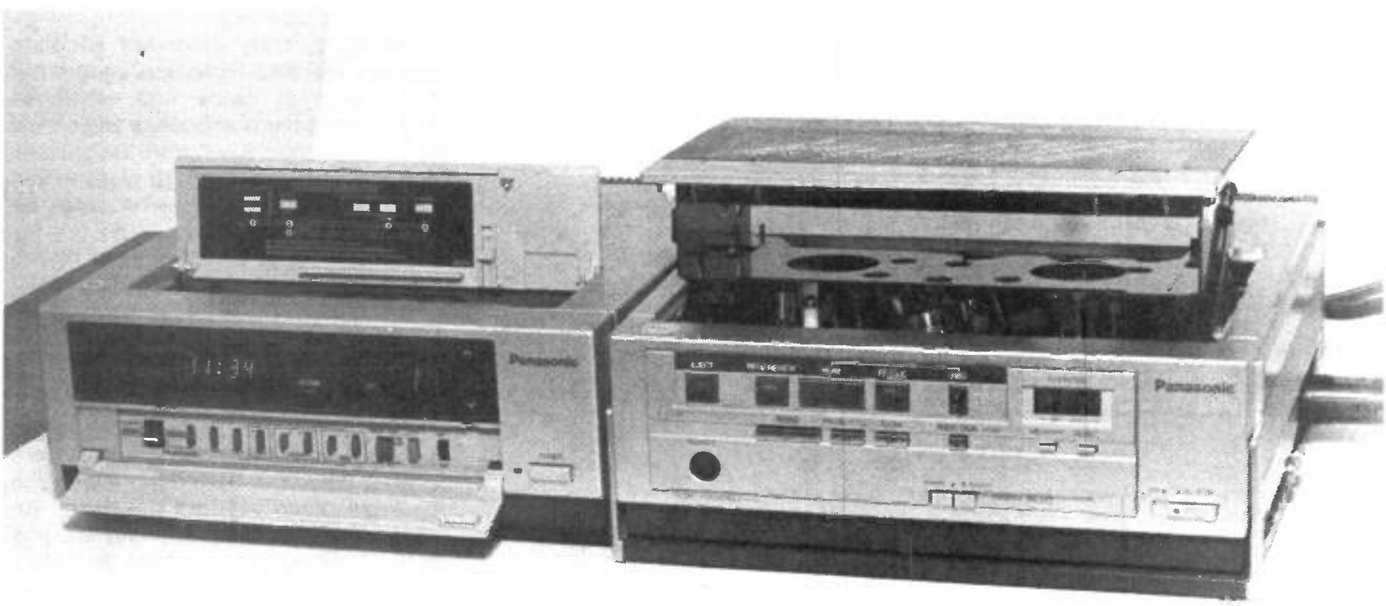
The memory rewind is the familiar system that will stop the tape when the counter reaches 0000 in the rewind mode. The memory function is controlled by one of the buttons below the counter display, the other being the counter reset. One minor irritation is that on switching the machine on, memory rewind is inactive irrespective of its state when the recorder was switched off.

The recorder's power on/off switch is at the lower right hand side while the remaining front panel switch, the camera/remote selector, is at the centre.

The NV100 features an insert edit capability that is now standard on most portable machines. This allows recordings to be inserted in existing material without any picture breakup at the beginning or end of the insert. Although the picture quality of the insert may not be as good as a 'normal' recording it's still adequate and this facility is a useful post-production tool.

Moving across to the tuner we have a unit that provides a multitude of facilities that complement the recorder's. In use, with both the NV-V10's flap's down, the tuner presents very clean lines with only the power on/off switch and the channel up/down buttons exposed.

The flap on the top of the tuner reveals the controls for the 16 station tuner. This is an automatic system, rather than manual, that is straightforward to use in contrast to the complexity of some other



The tuning and timer controls of the tuner can be seen in this shot.

tuners of this type. The tuner locked onto signals perfectly and, in our case there was no need to use the fine tuning facility offered on the machine.

The test signal on/off switch is also housed in this flap.

The lower front panel flap conceals the timer controls. The timer is a 4 event 14 day type that follows the entry format established by the mains recorders in Panasonic's range. This requires that start and stop times are entered for each event. Quite straightforward to use with each entry capable of speedy confirmation.

The NV-V10 also features Panasonic's OTR (One Touch Recording) facility. This allows recordings of 30, 60, 90 or 120 minutes to be instigated with just one button. A useful feature that is still unique to Panasonic.

The tuner and recorder combination is capable of full I/R remote control although the controller was not available for review.

Up To Spec

The two units worked well together offering good quality picture and sound recording one minor criticism was the rather high level of mechanical noise produced by the transport mechanism.

Out And About

Panasonic have managed to reduce the size and weight of the NV-100 and with its carrying pack, it provides a portable that does not weigh one down even after an extended 'filming' session.

The WVP-50E was also a delight to use. It's connected to the recorder via a 10 pin, locking connector and with the recorder's camera select switch in the appropriate position, control of recording is transferred to the camera.

The ultra sonic ranging sounder is a dominant feature of the camera.

The camera's pistol grip is cleverly integrated into the design - folding up for storage and clicking into the conventional position in use.

Two features, though, make the camera a 'cut above' many others on the market.

The first of these is the auto white balance circuit. At the start of a recording session the camera is focused on a white surface and the auto balance circuit engaged. After a couple of seconds the camera is aligned — as simple as that.

One minor point that could be made here is to do with the lens cap. At present most camera's come with a black lens cap yet one major brand of cameras use a white lens cap. This is translucent and thus when setting up white balance, instead of hunting around for some white surface, it's only necessary to point the camera at a source of light. Simple, elegant and something that others should adopt.

The second outstanding feature of the camera is its auto focusing system. Based on an ultra-sonic system, the transducer being very evident to the right of the lens assembly, the operation was almost faultless.

During a fairly extended shooting session, the auto focus was caught out only once or twice and on these occasions the lens was at the end of its 6 to 1 zoom range. Apart from the obvious fact that focusing through glass would cause problems, the focus can safely be left to the camera.

The quality of results offered by the camera, both in terms of vision and sound quality was up to the standard set by the recorder.

A Winner

Overall the equipment performed as well as any portable that has come **R&EW's** way to date. The only thing letting the package down was the quality of the instruction manuals — but as the controls were soon mastered, this minor irritation should not affect the enjoyment of an excellent product.

■ **R&EW**

Detail of the auto focus control's and the power zoom rocker switch.

Equalisation explained — a detailed discussion of the signal processing requirements for disc and tape reproduction.

The maximum modulation that can be applied to a gramophone record is not only determined by the groove pitch — how much room exists between adjacent walls — but also the stylus's ability to accurately follow the wavering nature of the groove. If the stylus is subjected to extremely fast changes in direction, distortion can occur, or worse still, the stylus may leave the groove altogether. Indeed, the researchers that developed the gramophone-record, taken for granted today, had a number of physical conflicts to come to terms with — their solution was 'Equalization'.

In The Groove

Consider the section of groove shown in ***Fig. 1***. The frequency that's reproduced from it is determined by the wavelength, and the amplitude by the amount of side-to-side movement. The stylus must track the groove accurately if no distortion is to result. However, the stylus is subjected to a great deal of acceleration and deceleration. At the top or bottom of the wave the stylus has zero velocity, but between these two extremes the velocity increases, until at halfway it is at maximum before deceleration begins to the next peak or trough. The demands made upon the stylus are not consistent, because as the frequency increases so the wavelength decreases. So, since there is less time between each change, the velocity of the stylus must *also* increase. That's not the end of it though, because as the amplitude increases so does the velocity.

A problem: the velocity is proportional to frequency and amplitude, and the ranges required for a practical system are such that without equalization, a record would be totally non-reproducible.

There are two solutions worth exploring. One is to record the disc at constant amplitude. Here, though the velocity changes are low at low frequencies, they could be excessive at high frequencies to the point of being impractical. Now you could restrict the amplitude and get the velocity down, but this only produces practical results at high frequencies; at low frequencies poor signal-to-noise ratios result.

A second solution is to restrict the velocity by keeping it constant across all frequencies. However, since the amplitude would then be inversely proportional to frequency, amplitude would be excessive at low frequencies.

The final answer is a compromise between constant amplitude and constant velocity. The Radio Industry Association of America (RIAA) standard shown in ***Fig. 2***, requires approximately constant amplitude from 20-1000 Hz, with varying velocity proportional to frequency. At around 0 dB constant velocity, amplitude varying inversely proportionate to frequency is used. Above 0 dB, it returns to constant amplitude recording. The kink in the curve allows both velocity and amplitude criteria to be met without compromising signal-to-noise ratio.

Some compensation is required in the preamplifier for a magnetic cartridge, but not for a crystal cartridge — the reason being the way the two cartridges generate their EMFs. The crystal cartridge's output is proportional to amplitude, and since the recording is made under approximately constant amplitude conditions, no correction is required. However the output of the magnetic cartridge *is* proportional to velocity and a network generating the inverse of the RIAA curve is required.

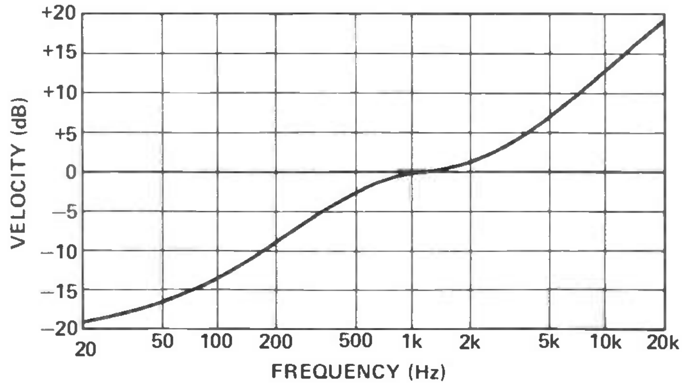


Figure 2: The RIAA characteristic for 'recording' equalisation.

Equalising On Tape

The 70us and 120us buttons appearing on mode tape decks are part of the overall frequency shaping facility. To explain their operation, it's best we go back to first principles.

Normally, when a tape carries no signal it may be considered as having millions of tiny, randomly orientated, magnets placed along its length (***Fig. 3a***). As recording takes place, each of these magnets becomes orientated according to the polarity of the head as they pass by (***Fig. 3b***).

As the tape travels past the replay head, an EMF is induced by the passage and orientation of the 'tiny magnets'. The induced EMF is proportional to the rate of change of North/South orientation — rate of change is proportional to frequency.

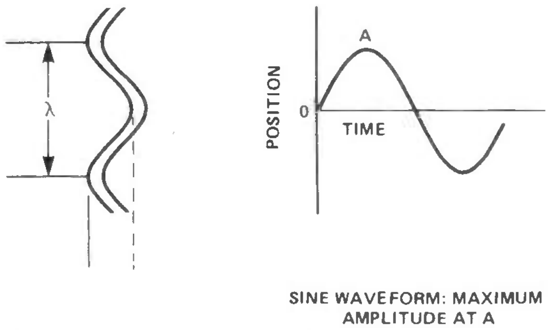


Figure 1: Sinewave represented in the form of a groove on a record.

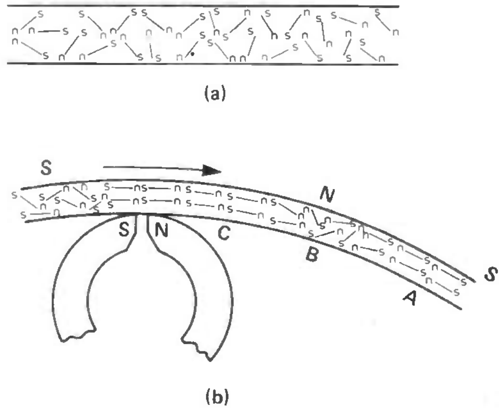


Figure 3: Organisation of 'bar magnets' on a tape (a) before and (b) after contact with the recording head (long wavelengths).

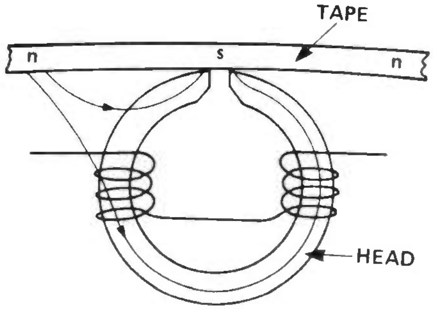


Figure 4: Effect on tape magnetisation when wavelength is long compared to head dimensions.

However, the output does not go on rising indefinitely, there is a point when it takes a steep dive and disappears altogether. This is called the Extinction Frequency and occurs when the wavelength of the signal is the same or less than the head gap. At this frequency, the two poles on the tape are equal sign ('NN') and hence no EMF is induced. At low frequencies there is also a loss, which occurs because the wavelength is so long that the pole pieces of the head are no longer linked by flux lines (***Fig. 4***).

Figure 5 shows how the output rises proportionately with increased frequency (6dB/octave), and then falls rapidly to the extinction frequency. It is clear that some compensation is required during replay, and this would be made less severe by bass and treble boost during recording. However, there is a limit to the equalisation that can be applied during recording due to overload and distortion considerations.

Standards Of Reproduction

To allow tape interchange between machines of various manufacture, a method of defining recording and replay characteristics is required. Since all that matters is the tape, this is *only considered in the specification: a perfect replay head is assumed in perfect contact with the tape. The British Standard says effectively, "...the tape should be recorded in such a way that the frequency characteristic should have a certain shape" (see **Fig. 6**)*. The shape of the curve is defined in terms of that derived from simple RC networks — at high frequencies, parallel, and at low frequencies series circuits (***Fig. 7***). The time constant has nothing to do with the *actual* component values chosen in a particular equalization network. They are chosen to match the recording characteristic defined by the curve. A lot depends upon the head design, but in order to achieve the standard curves a recording amplifier may have top and bottom boost as in ***Fig. 8***.

Finally, to complete the story, the replay system must generate a flat response from the tape, and so the inverse of the standard tape curve is needed. The precise network is *also* a function of the tape head characteristics. ■ R&EW

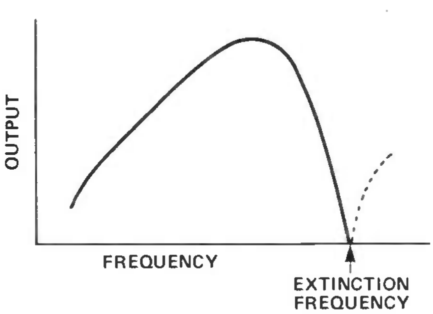


Figure 5: Typical tape head replay characteristics.

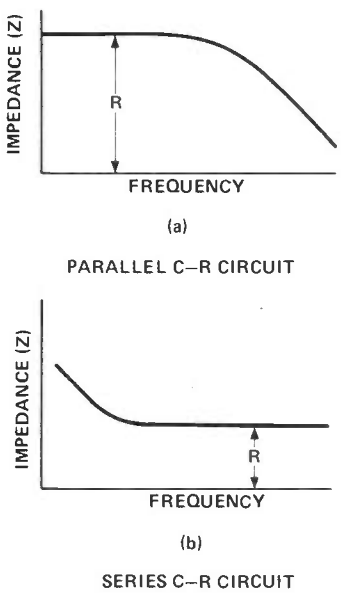
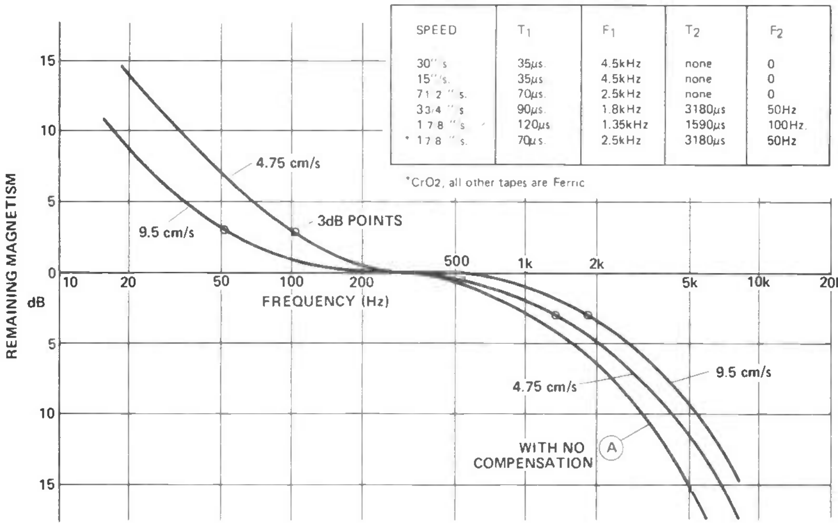


Figure 7: Parallel (above) and series (below) CR circuit curve.



SPEED	T_1	F_1	T_2	F_2
30"/s	35µs.	4.5kHz	none	0
15"/s.	35µs	4.5kHz	none	0
7 1/2"/s.	70µs.	2.5kHz	none	0
3 3/4"/s	90µs.	1.8kHz	3180µs	50Hz
1 7/8"/s	120µs	1.35kHz	1590µs	100Hz.
* 1 7/8"/s.	70µs.	2.5kHz	3180µs	50Hz

Figure 6: Equalisation standards for tape recording at different tape speeds.

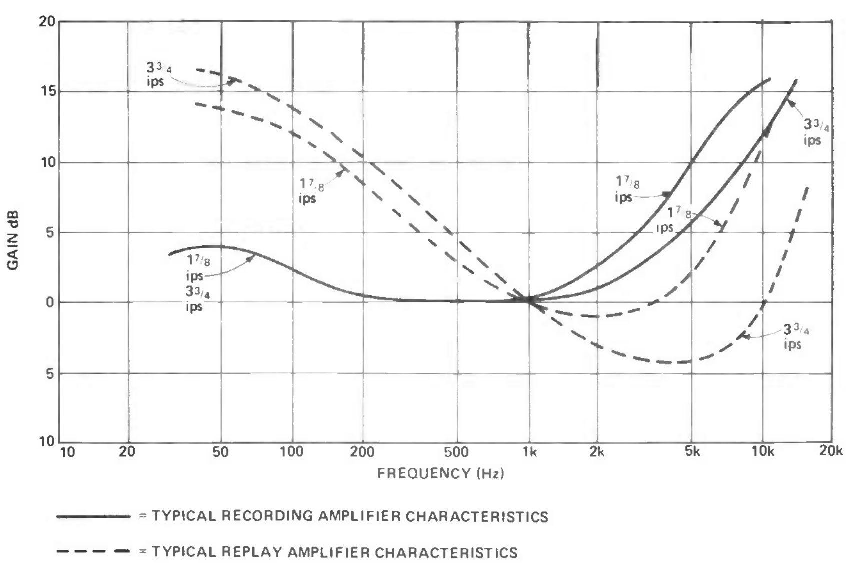


Figure 8: Tape replay equalisation on a typical amplifier (with speed adjustment).

COMPUTING NEWS

Gary Evans has been looking through just some of the ever growing number of books dealing with all aspects of computing.

Granada publishing, a long established company, are strengthening their representation in the area of computing with four recently released titles. Two are written by Ian Sinclair, a name that will be familiar to many people, Ian having written for many electronics and computing magazines for a number of years.

The first of Mr. Sinclair's books deals with the Lynx Computer and provides a comprehensive guide to the machine's operation and the potential that may be realised by this widely available machine in both business and personal applications.

The subject of the second book is the ORIC-1, the machine that is giving Sinclair's Spectrum a run for it's (or your) money. Ian Sinclair's book dealing with the said Spectrum is in its third printing since publication last October, and the ORIC title follows the same successful formula established by the earlier work.

Contents include setting up and using the cassette recorder, inputs and outputs, number and string handling, data files, planned programming,colour and graphics, sound plus a comprehensive set of appendices.

An extremly valuable adjunct to the ORIC's manual — every ORIC owner should have, or at least, read one.

Another title from the Granada stable deals with the Dragon computer that is also a very popular, low cost machine. S.M. Gee's the author this time and his Dragon Programmer is one of the first books dealing with this machine. Mr. Gee is again a well known contributor to magazines in the computing field and the work follows the style established by Ian Sinclair. Again a useful work for those wanting to get the most from their Dragon.

The last book from Granada aims to take some of the pot-luck out of choosing a microcomputer. Written by Francis Smith of Micro Decision the book aims to help the reader first identify his/her needs and then to select a system that best meets those needs at a reasonable cost.

All titles are to be published in the near future and all will retail for £5.95.

Watch out for them in your local bookshop or computer store or, in case of difficulty, contact Granada at:-
P.O. Box 9,
St. Albans,
AL2 2NF.

Budget Tape

One of the criticisms associated with Epson's HX-20 is that, to date, there has been a shortage of software available for this machine. Kuma Computers are aiming to rectify this situation with a comprehensive range of software planned for the computer.

The first of these, released on a HX-20 format microcassette, is Home Budget. This allows the user to keep track of mortgage payments, rates, credit cards, rentals, heating/lighting charges, and just about everything else.

Having just paid a visit to my bank manager to explain why I'm forever losing track of my account, the Kuma system looks ideal for me. The only trouble is that I doubt he'll (the bank manager) lend me the money to buy an HX-20.
11 York Road,
Maidenhead,
BERKS.
The budget tape retails at £17.35 plus VAT.

Aiming High

Rockwell's popular 6500 development system can now be converted for use with the new 6809 MPU.

By replacing the 6502 processor with the MACH-9 board, the AIM65 becomes a 6809 System providing facilities including text editor, two pass symbolic assembler, disassembler and program run step and trace.

Existing cassette, TTY, I/O and expansion features are retained while the monitor facilities have been enhanced.

The MACH-9 unit provides an additional 2K Bytes of RAM for stack and system variables so that all the AIM65's on board RAM is available to the user. Memory and I/O can be expanded using the RM65 module family.

Costing just over two hundred pounds, MACH-9 with AIM65 provides a very low cost development or teaching system for 6809 users. More information on the MACH-9 board can be obtained from:-
R.C.S. Microsystems Ltd.,
Gresham House,
Twickenham Road,
Feltham,
Middlesex,
TW13 6HA.

NOTES FROM THE PAST

Recessions are nothing new as Centre Tap's column from the late fifties demonstrates.

This column's interest in stereophonic sound brings to light an anecdote told by W. E. Thompson (G3MQT). The name might not at first ring a bell as strongly as some of the others associated with *The Radio Constructor*, so perhaps it would be helpful if I reminded you that he does the Book Reviews.

At the time of the slump in the early 'thirties he was "axed" under an economy drive, from the technical development section of Standard Telephones and Cables, so he went to help out his mother who had recently acquired a business near Southend. The shop carried a fair stock of gramophone records and a few quite-good-for-their-period cabinet gramophones.

Surrounded by such a galaxy of material it wasn't long before Bill hit on the idea of playing two discs of the same recording simultaneously in an endeavour to obtain a stereophonic effect. His experiments along these lines were as a matter of personal interest rather than with any idea of exploiting it commercially. Naturally he had fun and games keeping the clockwork motors in step and getting the discs to start off exactly together. Even when he acquired the knack it required so much attention to operate, that little or no time was left for listening to the resultant distribution of sound. Improving on the idea, he swapped the micadiaphragmed sound-boxes for electric pickups. Incidentally, the early pick-ups were often heavier than the sound-boxes they were intended to replace. Generally they were used in conjunction with the old-fashioned tone arm. Combined, they acted on the record surface rather like a miniature drill, penetrating deep in the grooves. The facetious types used to swear they threw their records away because after a few playings they alleged the loud passages from the other side would start breaking through! Nevertheless, record wear had to be sacrificed to the slightly wider frequency range and the possibility of having effective forms of tone and volume controls.

Bill, of course, being progressive, soon added pick-ups and separate amplifiers using LS6A triodes plus mains-energised speakers mounted on 3ft square baffles. In the early 'thirties, anything less than nine square feet of baffle was distinctly non-U. To simplify synchronisation he mounted two turntables and pick-ups, one mounted above the other; the turntables were coupled by means of a keyway on the spindle to keep them in step, and one of the pick-ups was adjustable through a small arc. It was then only necessary to locate the records so that the run-in grooves came in roughly the same place. Adjustment of the upper pick-up arm forwards or backwards enabled perfect synchronisation or stereophonic reproduction to be obtained at a touch.

Bill used this scheme for a long time and it created a great deal of customer interest. When the discs were timed to be slightly out of step, the variation in the stereophonic effect was most marked — the source of sound appearing to shift from one speaker to the other, or it could be made to sound as if coming from the space between the two. This scheme was, of course, a complete basis of the latest innovation in stereo-gramophone reproduction except that Bill was using two discs instead of a dual recording on one — nearly thirty years before its commericalisation.

Perhaps the ironic part of this little story is that he wrote up a description of it and sent it to one of the radio magazines of the period. They did not even reply, let alone publish it! This was by no means a unique experience with certain periodicals of that era, due possibly to a form of prejudice by "professionals" disdaining the work of mere amateurs. Or, maybe, the idea of anybody wanting to wear out their records two at a time, even for the sake of stereo, was too much for some unimaginative editorial assistant.

By the way, Bill mentions two of the old type wax double-sided twelve-inchers which showed up on his coupled-turntable stereo to advantage. They were recordings of "Finlandia" (Tone Poem) and "Petite Suite de Concert" (two 12in discs). How about these titles for our Aberdonian friend's quest for an ideal Test-cum-pleasure record? No one has mentioned them yet.

Double Decker

While on the subject of "E.P. Test" records, a further letter covering several interesting points comes from our old friend J.G. of Rickmansworth who, it will be remembered, sent along a couple of useful suggestions.

J.G. is once again able to be helpful in the matter of keeping garden workshops dry, and he expresses surprise that the mailbag was so light on a subject that must be something of a problem to many enthusiasts. His den is an underground brick-built air raid shelter with a concrete roof, situated half-way down the garden. It offers the obvious advantages that one can hammer and saw, making as much noise as one likes, without inconveniencing anyone. Before he got to work on it, the dampness and condensation made it uncomfortable to stay in and anything left in it was ruined within a few days. He overcame the problem by making alcoves in each of the end walls and installing burner paraffin lamps (cottage lighting type) in each, with a vent slightly to to the side and about 18in above the lamps. Three-inch metal tubing runs from above the lamps to the vents. It is now beautifully dry and cosy. The floor was concreted and the ceiling and walls were lined with roofing felt and distempered, and light and power laid on. It is fitted with a lathe, workbench and a couple of old chests of drawers strengthened and adapted for storage.

Brotherhood

In recent weeks threats of war, racial hatreds and political tyranny have dominated the news. It is thus doubly nice to feel that despite the evil-doing of violent minorities the world is still largely populated by peaceful and kindly people. Perhaps it is through one's hobbies that one can most easily get to know and understand the other fellow better, and radio serves us well in this respect. Following my recent illness I was deeply touched by friendly letters from readers, many of whom said I was not to trouble to reply. If only statesmen had more time for hobbies, what a friendly place the world would become.

The mention of readers' letters reminds me that once again I am in a sorry mess with postal replies, but I would most earnestly assure the writers that their letters were greatly appreciated. The Old Timers' Brigade were well to the fore. Is it that they are mostly retired and have more time to spare, or do radiomen become more sentimental with advancing years?

Once or twice suggestions have been made that an Old Timers' Club should be formed, and I have recently begun to wonder if they ought not to have a distinguishing mark. Possibly the chap sitting opposite to you in the train is an Old Timer too, and neither of you realises that you have so much in common. What a wasted opportunity when no doubt you would both have enjoyed swapping yarns, news and views.

Ray Marston explores the mysteries of the LM3900 quad Norton amplifier, and describes a multitude of ways to use this versatile op- amp.

Data File

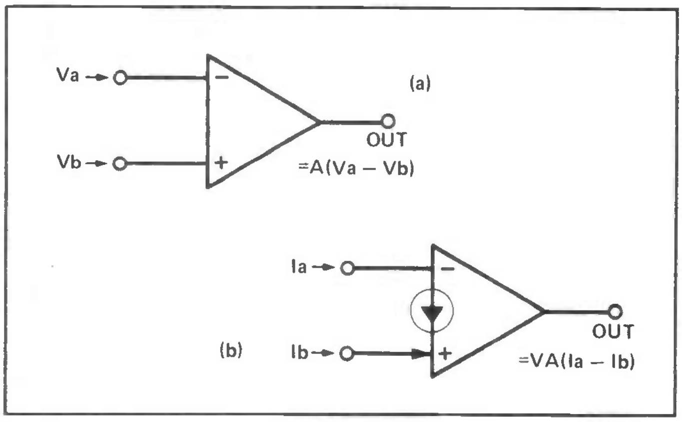


Figure 1: A conventional op-amp (a) is a voltage-differencing amplifier, but a Norton op-amp (b) is a current-differencing device.

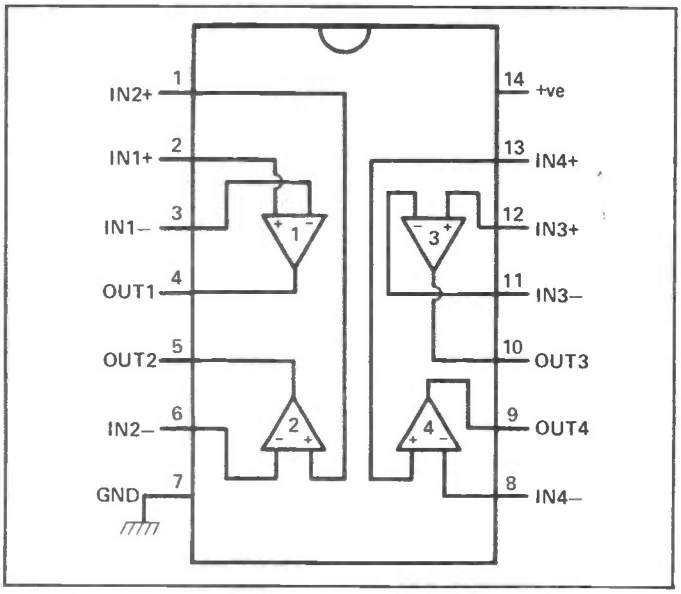


Figure 2: Connections of the LM3900 quad Norton op-amp.

Most popular operational amplifiers, such as the 741 CA3140, LF351, etc., are voltage-differencing devices. (***Figure 1a***). They give an output that is proportional to the difference between the voltages applied to two input terminals, and can thus be referred to as voltage-differencing amplifiers or VDA's. There is, however, an alternative type of op-amp, which gives an output that is proportional to the difference between the CURRENTS applied to the two input terminals, and is known as a current-differencing amplifier or CDA. ***Fig. 1b*** shows the standard symbol of a CDA, which is also known as a 'Norton' op-amp.

The best known example of the CDA is the LM3900 quad Norton op-amp, which contains four identical and independently accessible op-amps. ***Fig. 2*** shows the pin connections of this IC, which is housed in a 14-pin dil package. The LM3900 was first introduced in the early '70s, and was specifically designed as a low-cost, medium-performance, quad op-amp that would operate off a single-ended power supply and provide a large output voltage swing. The device can operate from any DC supply in the range 4 to 36 volts, and each op-amp has a unity-gain bandwidth of 2.5 MHz and an open-loop gain of 70dB.

The LM3900 operates in a drastically different way to conventional op-amps, and requires the use of special biasing techniques. Its performance, in terms of gain-stability and bandwidth, is not as good as some modern voltage-differencing op-amps, but the device is still very useful in DC and low-frequency applications where several op-amp stages are needed in a single-ended supply circuit. In the next few pages we show how the device works and how to use it in a variety of practical applications.

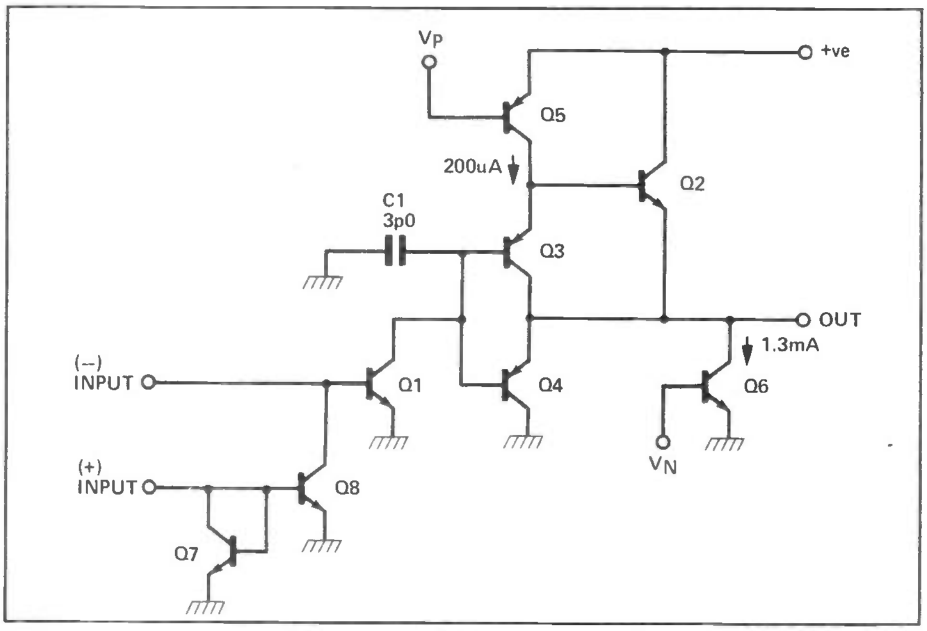


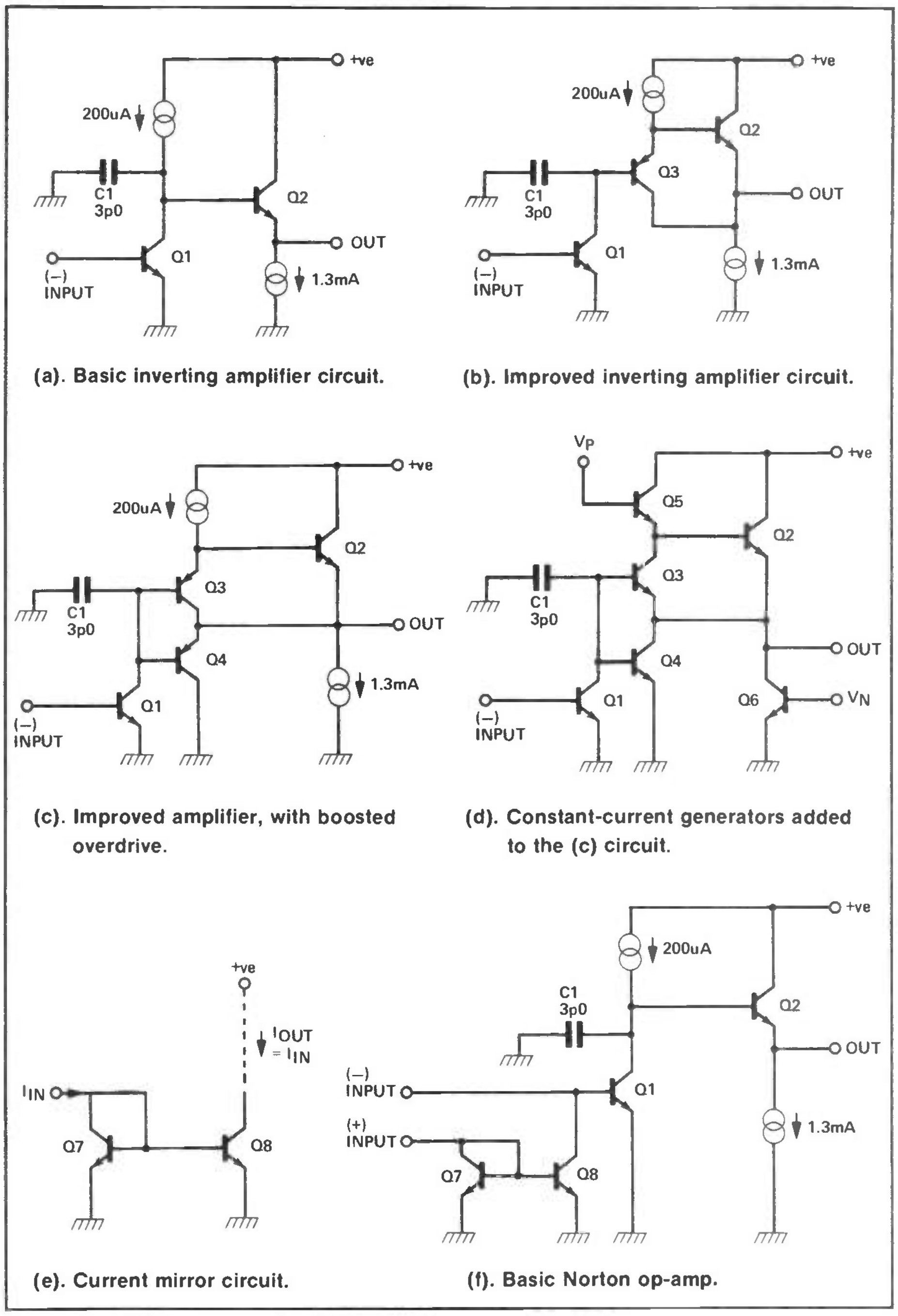
Figure 3: Circuit of each of the four identical op-amp stages of the LM3900.

Basic Principles

The LM3900 incorporates four identical current-differencing op-amps, each having the circuit shown in ***Fig 3***. To facilitate the understanding of the complete circuit, ***Fig. 4*** shows six simple stages in the development of the final ***Fig. 3*** design.

Look first at ***Fig. 4a***, which shows the basic inverting amplifier circuit. Q1 is a common emitter amplifier with a constant-current collector load, and thus gives a high-gain inverting action, and Q2 is a non-inverting emitter follower output buffer with a constant-current emitter load. The upper frequency response of the resulting high-gain non-inverting amplifier is rolled off by C1, to enhance circuit stability. Note that the output of this circuit can swing to within a few hundred mV of zero and the supply rail voltage.

The current gain of the ***Fig. 4a*** circuit is limited to the product of the two individual transistor current gains. ***Fig. 4b***



(a). Basic inverting amplifier circuit.

(b). Improved inverting amplifier circuit.

(c). Improved amplifier, with boosted overdrive.

(d). Constant-current generators added to the (c) circuit.

(e). Current mirror circuit.

(f). Basic Norton op-amp.

Figure 4: Stages in the development of the Fig. 3 circuit.

product of the two individual transistor current gains. ***Fig. 4b*** shows how the current gain can be further increased, with little reduction in the available output voltage swing, by adding pnp transistor Q3.

The output of the ***Fig. 4b***circuit can typically source up to 10mA, but can sink only 1.3 mA (via the constant-current generator of Q2). ***Fig. 4c*** shows how the sink current can be increased under over-drive conditions, by connecting Q4 so that it gives class-B operation under the over-drive condition. ***Fig. 4d*** shows the appearance of the ***Fig. 4c*** circuit when transistors Q5 and Q6 are used to act as constant-current generators: these two generators are biased via a network that is built into the LM3900 IC.

The ***Fig. 4d*** circuit forms the basis of each of the LM3900 amplifier stages, but gives an inverting action only. The non-inverting action of the LM3900 is provided with the assistance of the current mirror circuit of ***Fig. 4e***, which is made up of two identically matched integrated transistors and simply draws an output current that is almost identical to the input drive current. The circuit operates as follows.

The input current of the ***Fig. 4e*** circuit is applied to the bases of both transistors. Suppose that both transistors have current gains of 100, and that both transistors are drawing identical base currents of 5 uA. In this case the collectors of both transistors will draw 500 uA. Note however that the Q7 collector current is drawn from the circuit's input current, which thus equal 500 uA plus (2 x 5 uA), or 510 uA, and that the Q8 collector current is the output or 'mirror' current of the circuit. The input and output currents of the circuit are thus almost identical (within a few percent), irrespective of the magnitude of the input current.

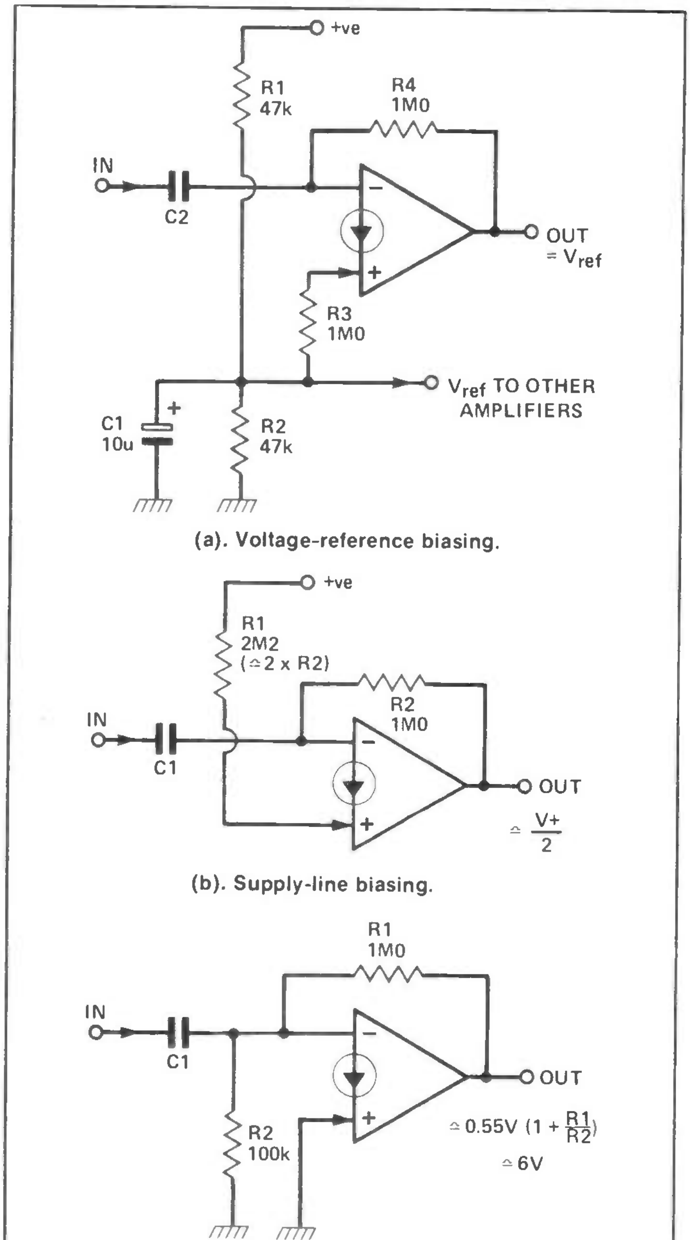
Finally, ***Fig 4f*** shows how the current mirror circuit can be connected to the basic ***Fig. 4a*** circuit to give the current-differencing action of the Norton amplifier. Here, the mirror circuit is driven via the non-inverting input terminal, and the mirror current is drawn from the inverting input terminal, which is also connected directly to the base of the Q1 amplifier stage. Consequently, the base current of Q1 is equal to (I-) — (I+), and is thus equal to the difference between the two input currents. The complete amplifier (***Fig. 3***) thus gives the current-differencing op-amp action already mentioned.

Note that, since both input terminals of the op-amp are connected to transistor base-emitter junctions, both inputs act (in voltage terms) as virtual-ground points. Consequently, these CDA circuits can be made to act like conventional voltage-differencing op-amps by wiring high-value resistors in series with the input terminals, so that the input currents are directly proportional to the input-voltage/resistor values: when this technique is used, there is no upper limit to the available input common-mode voltage range of the LM3900 op-amp.

Biasing Techniques

The basic amplifier stages of the LM3900 have high current gains, and the output of the amplifier starts to swing down through the half-supply point when the input bias current of Q1 starts to rise above 30 nA or so. This input current is normally equal to the difference between the two input-terminal currents, and these currents should normally be restricted to the range 0.5 uA to 500 uA (ideally about 10 ua).

In linear applications, an op-amp is normally biased so that its output takes up a quiescent value of half-supply volts, to accommodate maximum undistorted signal swings, and ***Fig. 5a*** shows how the LM3900 can be biased to meet this condition. R1-R2-C1 generate a decoupled half-supply reference voltage, which applies a reference current to the non-inverting terminal via R3, and a negative-feedback current is applied from the op-



(a). Voltage-reference biasing.

(b). Supply-line biasing.

(c). N$\frac{1}{15}$ V_{be} biasing.

Figure 5: Methods of biasing LM3900 op-amps for linear operation.

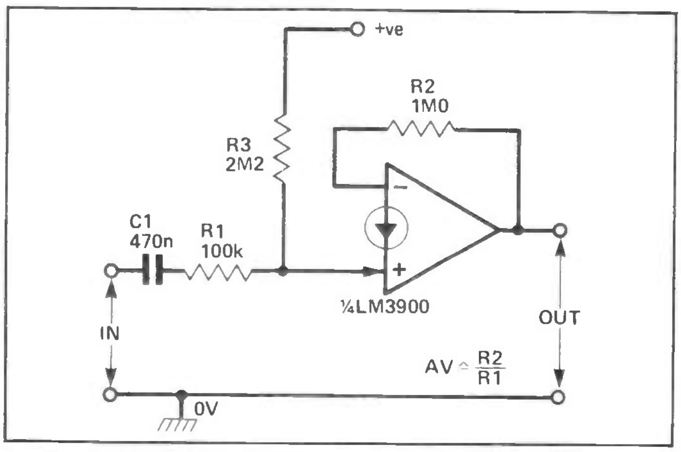


Figure 6: Inverting ac amplifier with supply-line biasing.

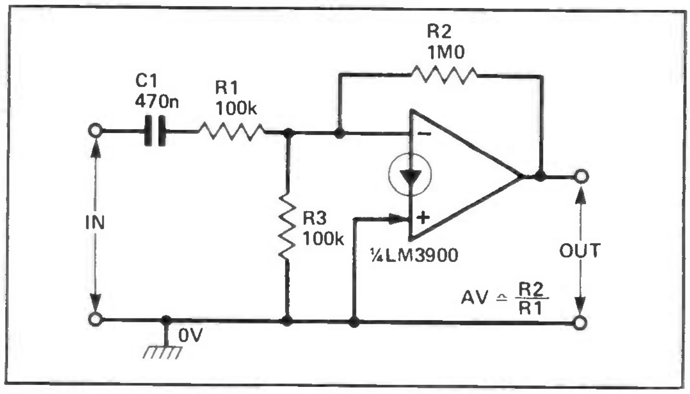


Figure 7: Inverting ac amplifier with N$\frac{1}{15}$ V_{be} biasing.

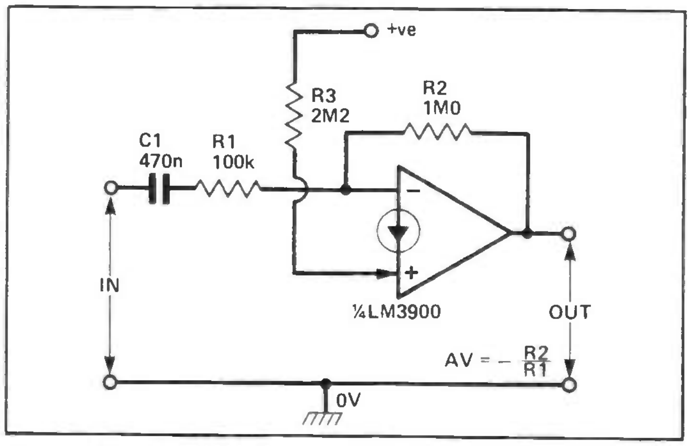


Figure 8: Non-inverting amplifier.

amp output to the inverting terminal via R4. The basic action is such that the op-amp output automatically adjusts to such a value that the two input currents equalise and hence reduce the internal Q1 base current to near-zero (about 30 nA), and in the case of ***Fig. 5a*** this situation occurs when V_{out} equals V_{ref}. In practice, the single reference voltage source can be used to apply biasing to several op-amp stages.

A variation of this biasing system is shown in ***Fig. 5b***. In this case the non-inverting terminal is biased from the positive supply rail via R1, which has a value approximately double that of R2, causing the output to bias at a quiescent value of half-supply volts. A minor defect of this biasing technique is that it allows supply-line ripple to break through to the output, with a 'gain' of 0.5.

Note in the ***Fig. 5a*** and ***5b*** circuits that the input signal is shown connected to the inverting terminal of the amplifier, but that in practice the signal can alternatively be connected to the non-inverting input.

Finally, ***Fig. 5c*** shows an alternative biasing technique that can be used when the op-amp is to be used only as an inverting amplifier. In this case the non-inverting terminal is disabled, and feedback potential divider R1-R2 is applied between the output and the inverting terminal. Consequently, since the inverting terminal acts as a transistor base-emitter junction (with a V_{be} value of about 0.55 volts), the output automatically takes up a quiescent value of V_{be} x (1 + R1/R2), or about 6 volts with the component values shown.

Linear Amplifier Circuits.

Figures 6 to ***11*** show half a dozen ways of using LM3900 op-amps as linear amplifiers. In the ***Fig. 6*** circuit R2 and R3 bias the output to a quiescent half-supply value, using the technique shown in ***Fig. 5b***. The input signal is applied to the inverting terminal via R1, and the voltage gain is determined by the R1-R2

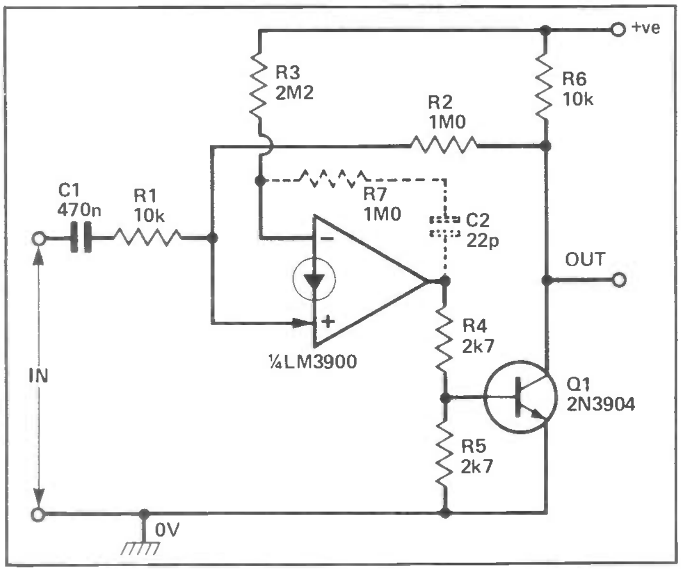


Figure 9: Wideband (200 kHz) high-gain (x100) amplifier.

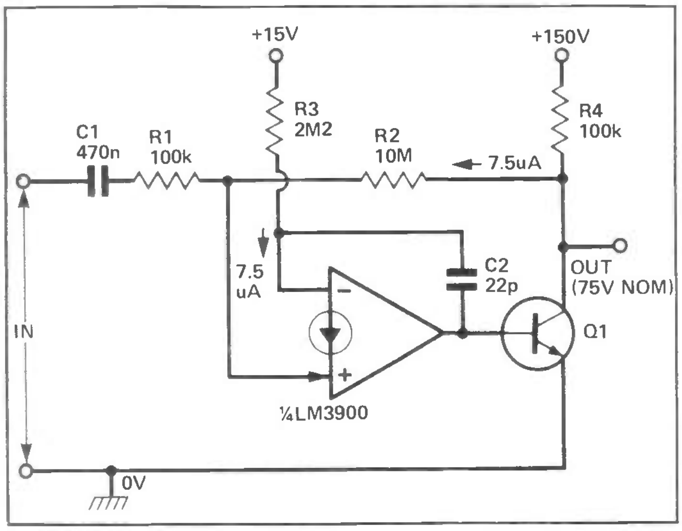


Figure 10: High-voltage amplifier with$^{1}/_{15}$100 gain.

ratio, so this design acts as a$^{1}/_{15}$10 inverting amplifier. ***Fig. 7*** shows an alternative version of the$^{1}/_{15}$10 inverting amplifier, in which N$^{1}/_{15}$ V_{be} biasing is used and the gain is determined by the R1-R2 ratio.

Figure 8 shows the connections for making a non-inverting amplifier with a gain of approximately ten. Supply-rail biasing is again used, but the input signal is applied to the non-inverting pin via R1.

The op-amps of the LM3900 are not very fast devices. They have slew rates of only 0.5V/uS, and thus have very restricted useful bandwidths. ***Fig. 9*** shows how the useful bandwidth can be increased by connecting an external common emitter transistor to the output and transposing the input connections of the standard amplifier circuit, to make a$^{1}/_{15}$100 inverting amplifier with a 200 kHz bandwidth. Because of its very high overall gain, this circuit may be unstable if care is not taken in layout; R7 and C2 can be used to slightly reduce the bandwidth and improve circuit stability, if required.

Figure 10 shows how the above circuit can be modified to give a peak-to-peak output voltage swing of 150 volts (or whatever voltage is used to power Q1). Note that the output voltage of this circuit has a quiescent value of 75 volts, causing 7.5 uA to be fed to the non-inverting terminal of the op-amp via R2, so, to give correct biasing, R3 (powered from the 15 volt

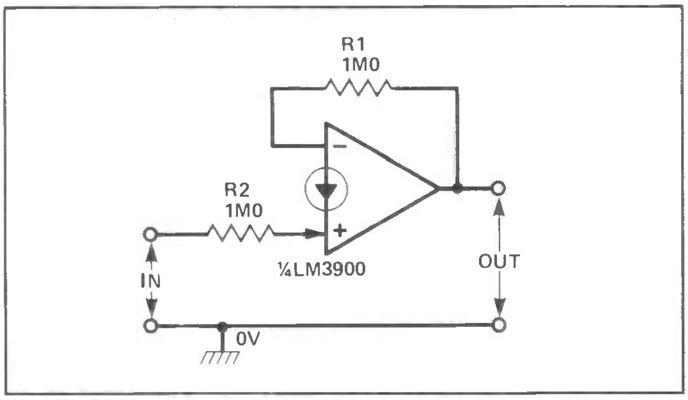


Figure 11: DC voltage-following buffer.

supply rail of the op-amp) must also apply 7.5 uA to the inverting pin of the op-amp, as shown.

Finally, ***Fig. 11*** shows how to connect an LM3900 op-amp as a unity-gain non-inverting amplifier or voltage-following buffer. The input is connected to the non-inverting terminal via R1, thus giving the non-inverting action, and R1 and R2 have equal values, thus giving unity gain. Note that the circuit would give a gain of$^{1}/_{15}$2 if R1 were given half the value of R2.

Comparators and Schmitt Circuits.

The LM3900 op-amp can be made to act as a voltage comparator by simply wiring equal-value current-limiting resistors in series with each input, and then using one resistor as the input point of the voltage reference and the other as the sample input point, as shown in the circuits of ***Fig.s 12*** to ***14***.

To be continued. ■ R&EW

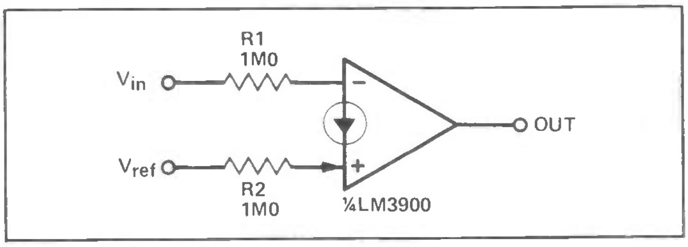


Figure 12: Inverting voltage comparator.

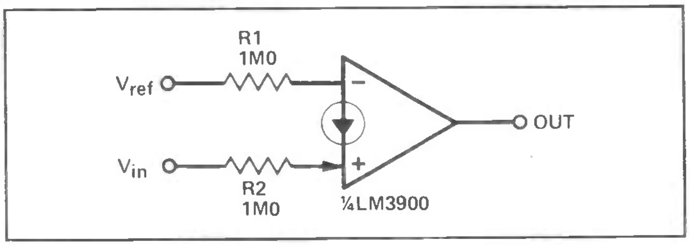


Figure 13: Non-inverting voltage comparator.

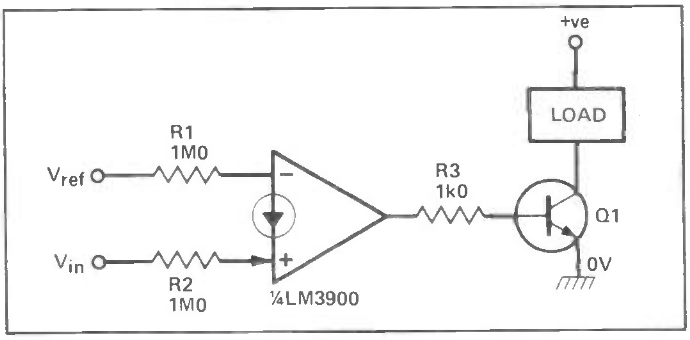


Figure 14: Non-inverting power comparator.

Reception Reports

Compiled by
Keith Hamer & Garry Smith

December 1982 was a tough month for the long-distance television enthusiast with Meteor Shower (MS) activity being the dominant feature. Two minor tropospheric lifts at the beginning and at the end of the month provided reception of European television in Band III and at UHF, but great patience was certainly required for the intervening period. Fortunately, much of the MS activity produced short bursts of test cards or captions to enable positive signal identification. A typical log for December is as follows:-

1/12/82 NOS(Netherlands) channels E4,E6,E27,39,45,47; RTE(Eire) IJ,IH; DDR:F (East Germany) E11 (all via improved trop conditions).

2/12/82 RTE IJ(Trop); DR(Denmark) E3(via MS).

8/12/82 SR(Sweden) E3.

9/12/82 Unidentified FuBK test card on E2.

10/12/82 Unidentified FuBK on E2.

11/12/82 Unidentified programmes on E4 with MS activity very good throughout the day.

12/12/82 RTB:F (Belgium) E3(MS).

13/12/82 NOS E4; SR E4; DR E4; unidentified prog on E3.

21/12/82 SR E2.

23/12/82 TVP(Poland) R1.

24/12/82 NOS E4.

25/12/82 NOS E4 with test card and progs; unidentified progs on R1.

26/12/82 NOS E4.

27/12/82 CST (Czechoslovakia) R1; TVP R1.

28/12/82 Unidentified progs on R1; unidentified FuBK on E2; SR E3. Excellent MS activity noted on channel R1 from 1900 onwards.

29/12/82 Unidentified FuBK on E4; CST R1; ORF(Austria) test card on E2a.

30/12/82 ORF E2a; RTB:F (Belgian French-language network) E8;BRT (Belgian Flemish-language network) E10; NOS E27 and E29 with the EBU Bar and seasonal identification "PTT-NL HAPPY-83".

31/12/82 ORF E2a.

Interference Problems

Since the end of 1980, many DX-TV enthusiasts have had to endure an ever increasing amount of interference on the DX channels caused by the operation of illegal equipment such as CB,49MHz walkie-talkies and cordless telephone systems using 49MHz. At precisely 1005 on December 25th, channel R1 video (49.75MHz) became jammed with interference from those cheap and nasty 49MHz walkie-talkie sets bought as Christmas presents from equally cheap and nasty suppliers. The problem of cordless 'phones also manifested itself at around the same time although only during the holiday period. By careful monitoring of the two-way telephone conversation, the problem of interference could usually be stopped once the offenders had been traced. The difficulties arising from interference shouldn't even exist since the equipment is illegal to use in the UK. Over a year ago, Timothy Raison, then Minister of State at the Home Office, put forward proposals to make it an offence to sell equipment that cannot be used legally. So far, nothing has happened . . .

The Home Office have now announced the use of 47MHz for cordless telephone systems. This should ease the problem since it falls outside the band of frequencies reserved for television broadcasting within Europe. Unfortunately, many suppliers are still selling the 49MHz variety simply because there is a lack of incentive to be legal.

The use of a notch filter possessing a very deep notch may appear to be the answer to the above interference problems. However, the closeness of the interfering signal (49.60 — 40.90MHz) to the R1 vision frequency on 49.75MHz means that the wanted signal would suffer undue attenuation. In practice, a notch filter is more effective where the interfering signal is at least 500kHz away from the one required. Attempts to use a notch filter in the vision IF also fail for the same reason but does anyone know whether this would be possible in the video amplifier stage? If anyone has any practical suggestions, please write.

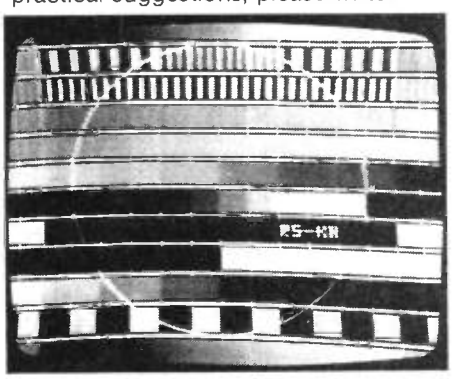


Figure 1: The Czechoslovakian "EZO" test pattern.

Beating The Pirates

More European television services are now superimposing identification on all radiated programme material in an effort to combat illegal copying. Italy was the first service to adopt this method several years ago when privately-owned television systems began to flourish in every major city. They recorded programmes originated by the state-owned service (RAI) for re-broadcast on their own illegal systems. Soon the private/pirate services began to superimpose identification to prevent other pirates from copying their illegal material! Transmissions from the state-owned service now have the initials "RAI" (Radio Televisione Italiana) superimposed in one of the corners of the screen, the position changing throughout the programme. More recently, services in Belgium (BRT), West Germany (ARD and ZDF) and Switzerland (TSI — the Italian — language network) have adopted similar measures. For the DX-er this means positive identification of the signal but it must be very irritating for viewers in the countries concerned.

Aerials & Accessories

South West Aerial Systems (10, Old Boundary Road, Shaftesbury, Dorset) have sent us a copy of their completely revised and expanded catalogue for 1983 (price 55p). They cater mainly for the TV/FM DX enthusiast and anyone else requiring specialised systems. They can supply a range of imported aerials plus all the necessary hardware and accessories such as brackets, rotators, filters, etc. They also manufacture a range of wideband Band I arrays which are essential for serious reception work. For enthusiasts with limited space there is a crossed dipole assembly available having omni-directional characteristics. There is also a stock of DX-TV publications such as "Long Distance Television Reception for the Enthusiast" and the famous "Guide To World-Wide Television Test Cards — Edition 2" which features dozens of test cards and captions of all countries likely to be encountered in the UK. The latter publication is priced at £2.95.

Figure 2: The Muppets as seen on Dutch television.

Service Information

Eire:
Radio Telefis Eireann have brought the following stations into service:
Holywell Hill(RTE-1) on channel 23 with 20kW ERP;
Holywell Hill(RTE-2) on channel 26 with 20kW ERP;
Clermont Carn(RTE-1) on channel 52 with 250kW ERP;
Clermont Carn(RTE-2) on channel 56 with 250kW ERP;

UAE: The United Arab Emirates are to expand their television network in the seven states which comprise the UAE. An additional colour television channel is to be established and there is to be an increase in the capacity of the link between Abu Dhabi and the Jebel Ali satellite earth station.

Our thanks to GEC (Coventry) and the EBU (Belgium) for supplying this information.

EBU Station List

We have been advised that subscriptions are now due for the List of European Television Stations No. 27 which is published by the EBU. This very impressive publication (it contains more than 300 pages) lists virtually all television transmitters operating within the European Broadcasting Area (which includes Northern Africa, the Middle East, Western Russia and, of course, Europe) and there are six bi-monthly supplements. The list, which is highly recommended to all DX-TV enthusiasts, is available price 750 Belgian francs from the European Broadcasting Union, Technical Centre, Avenue Albert Lancaster 32, B-1180 Brussels, Belgium

Reception Reports

Ray Davies (Happisburgh, Norfolk) has obviously raided the piggy-bank for he has purchased a new Grundig colour receiver from his local Comet branch. The set is an up-market type with frequency synthesised tuning — the European "E" channels are already stored in its memory. Ray plans to obtain a dual-standard sound IF unit which will enable it to automatically resolve 6.OMHz or 5.5MHz sound, depending on the incoming signal. We understand that

Figure 3: ATC Channel 7 identification caption. Photo by courtesy of Anselmo Roccaforte.

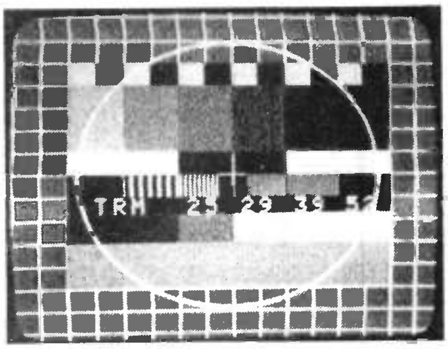


Figure 4: A typical Italian "pirate" station's test card. Photo by courtesy of Anthony Briffa, Malta.

there is a French/UK IF unit available for use in the Channel Islands. Incidentally, the less expensive Grundig colour receivers currently available, such as the 20-inch 6010, also have a multi-band tuner fitted for Bands I and III reception. Tuning is by means of a conventional 8-position press-button assembly.

Juergen Klassen has written from West Berlin. He has updated his aerial amplifiers to improve DX reception and a new PAL/SECAM video recorder has been added to his array of equipment. Juergen writes for a German DX magazine call 'Tele-audiovision' and he will be sending us photographs of reception which we hope to feature shortly. In passing, he mentions that the BBC's Nine O'Clock News is now shown live over the BFBS (British Forces Broadcasting Service) network.

While on the subject of new equipment, Simon Hamer (Presteigne, Powys) is experimenting with a Triax set-back amplifier which has a gain of 27dB with 4dB noise over the range 470-860 MHz. Channel 4 (Channel 54) from the Mendip transmitter is now received at good strength-not bad for a UHF signal at 75 miles over hilly terrain. But as Simon says, the amplifier has better uses than reception of Channel 4!

A letter has arrived from Per Lindholm, a Swedish DX-TV enthusiast living at Oernskeoldsvik on the east coast about 380 miles north of Stockholm. Per used to DX on the Medium waveband until he discovered FM and TV DX about three years ago. Nothing more than a standard aerial connected to the domestic receiver has been used which has brought in signals from many countries including Yugoslavia (JRT), Hungary (MTV), Denmark (DR), West Germany (ARD and ZDF), Iceland (RUV), the USSR (TSS) and Finland (YLE). Following the installation of a 43-element UHF aerial and a pre-amp with 20dB gain, Finnish television is received on a regular basis with signals being present daily during the summer. After visiting the UK and noticing how close we are to the Continent, Per wonders why viewers in the south and south-east don't receive European television stations to supplement their viewing diet. The main reason has been the non-availability of receivers suitable for the

Figure 5: The Toolcraft Goodwood electronics test card as used by Telecasters North Queensland Limited, Australia. Photo by courtesy of Robert Copeman.

differing television standards found on both sides of the Channel.

The Sporadic-E season in the Southern Hemisphere (November to March) is getting off to a slow start according to Robert Copeman (Mount Waverley, Victoria, Australia). He has had to rely on tropospheric DX for much of December to fill his log. Owing to the relative isolation and size of Australia, most Sporadic-E signals are of the indigenous variety although New Zealand is received occasionally. Such reception has happened seven times during the month.

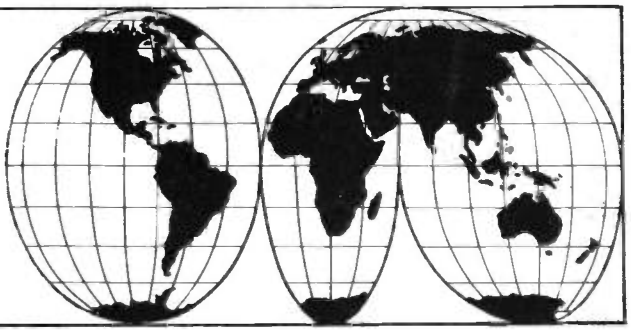
Our Argentinian DX correspondent Anselmo Roccaforte has sent a few photographs taken from his local television network. There were plans for the expansion of radio and television services throughout the country but little progress is being made as Argentina is experiencing economic and political chaos following the Falklands conflict. There are many DX-TV enthusiasts, particularly in the Buenos Aires region, and Anselmo is offering useful advice to newcomers on various matters connected with the hobby.

While on the subject of Argentinian television, we have received negatives of satellite reception in the South of England by Hugh Cocks (Robertsbridge, East Sussex) of ATC-7. Hugh is very experienced in satellite technology and we hope to give details of other successes in due course.

A lunchtime F2 opening produced Russian television signals on channel R1 for Clive Athowe (Blofield, Norwich) on the 31st. Sporadic-E successes throughout the month included RTVE (Spain) on channel E2 with programmes on the 9th and colour bars with identification on the 14th. Spanish programmes were seen again on the 30th on channels E2 and E4 while to the north-east, the Norwegian test card (PM5544) was noted displaying details of the transmitter location, namely "MELHUS". On the 11th, channel R1 was active with Russian programmes appearing via Sporadic-E propagation. Finally, on a musical note, we are informed that there is a rock group in the Norwich are called 'Test Card F'.

■ R&EW

SHORT WAVE NEWS FOR DX LISTENERS



Frank A. Baldwin

All times in GMT, **bold figures** indicate the frequency in kHz.

Having drawn readers attention to some of the Far Eastern stations that may be logged on the 60 metre band (**4750** to **5060**kHz) in the last few issues of **R&EW**, I deal finally with some of the more difficult to hear transmitters based in this region of the world.

Proceedings commence with some more Chinese local transmitters, the first being located on **4785** and sited at Hangzhou, this one opening at 2100 and closing at 2320 only to re-open at 0100 to 0515 and from 0845 to 1500. Zhejiang PBS is usually logged here during the opening session. On **4915** Guangxi PBS in Nanning opens at 2105 with the Guangxi 1 programme in Chinese, it finally closes at 1600 when relaying the Bijing (Peking) 1 service, identifying as "Kuangshi Jen Min Kwang Po Tien Tai".

Tuning to **4940**, you could make out signals from Qinghai PBS, Xining, initially opening at 2140 and finally closing at 1515. Qinghai radiates both local programmes and relays the Home Service 1. There is an English language lesson at 2300 and also at 1400, each lasting for half an hour.

A difficult one to log is Nei Monggol PBS, Xilinhot operating on **4951** from 2000 to 0200 and from 0910 to 1400 with the Home Service programmes. Lastly, on **4960** may be found Beijing (Peking) with the Foreign Service in Japanese from 2130 to 2155 and from 0930 through to 1525.

Should you be interested in logging signals from Sri Lanka (formerly Ceylon) then I suggest you try the following channels.

Flip the dial to **4940** where, from the initial opening at 0025 until final close at 1730, you may find SLBC (Sri Lanka Broadcasting Corporation) Colombo radiating the Home Service 2 in English. Not so often reported is the **4968** channel of SLBC Colombo, scheduled with the Home Service 1 in Tamil from 0000 to 0300 or you could try **5020** for Colombo with the same language service, only this time the Home Service 2, from 1000 to 1745.

A couple of Malaysians not so far mentioned in this series are those on **4895** and **4970**. The first mentioned channel is that of Radio Malaysia, Kuching in Sarawak operating in local vernaculars from 2200 to 2300 and from 1000 to 1500. The second frequency is occupied by Radio Malaysia, Kota Kinabalu, Sabah using both English and Malay languages it is scheduled from 2130 to 2400, from 0200 to 0700 and from 0900 to 1600. Listen for the first session and from about 1530 onwards for the best chance of reception here in the UK.

These reviews of Far Eastern stations on the 60 metre band which have been featured over the past few issues are not in themselves complete, there are other stations which have not been mentioned although I have in mind a review of the same area both applicable to the much more difficult 90 metre band.

Around The Dial

Spain

Madrid on **9765** at 1905, YL (Yound Lady) with a talk all about the latest internal events in the English programme for Europe scheduled from 1900 to 2000 and then repeated from 2000 to 2100. If you are interested in the land of blood and sand then this is the programme to hear.

Austria

Vienna on **21615** at 1230, OM (Old Man) with station identification followed by a newscast in the English transmission to Europe, North America, South East Asia and Australasia, scheduled from 1230 to 1300.

Belgium

Brussels on **21810** at 1234, interval signal, YL with station identification and then the Dutch programme for Africa and the Far East timed from 1235 to 1300. Mainly for seamen and missionaries.

Brussels on **21460** at 1624, YL with a news review during the French programme for Europe and Africa which is on the air from 1600 to 1645 daily, except Sunday.

Sweden

Stockholm on **21555** at 1610, OM with a talk in Swedish in a relay of the Domestic Programme 1 for Swedes abroad, timed on this frequency from 0900 to 1700. Switch the receiver to SSB for this one.

Switzerland

Berne on **21570** at 1614, OM with the French programme to Europe, Near and Middle East, South America and Africa, scheduled from 1600 to 1630.

West Germany

Cologne on **21490** at 1618, YL with a world news presentation during the Romanian transmission for Europe, scheduled from 1610 to 1630. This was a relay from Sines in Portugal.

Cologne on **21500** at 1119, OM with a talk in the Arabic programme for the Middle East and North Africa and timed from 1100 to 1150.

East Germany

Berlin on **21465** at 0650, OM with a newscast in the English programme for the Pacific area and scheduled from 0645 to 0715.

Berlin on **21540** at 0730, interval signal then YL with station identification at the commencement of the Hindi transmission for South East Asia, scheduled from 0730 to 0815. Also logged in parallel on the **21465** channel.

France

Paris on **21580** at 1630, OM with announcements in the announced "Paris Calling Africa" programme which is in English from 1600 to 1700. Also logged in parallel on **21620**.

Norway

"Radio Norway", Oslo on **21700** at 1044, OM with station identification in English at the end of the "Norway Today" feature which is in English on Sunday from 1000 to 1030.

Oslo on **26030** at 1125, OM and YL with announcements in the Norwegian programme for Europe and South America, scheduled on this channel from 1100 to 1145. Also logged in parallel on **25615** and **21700**.

Vatican

Vatican City on **21485** at 1059, interval signal, OM with station identification followed by a YL with the French programme to Africa, timed daily from 1000 to 1115 on this channel.

Finland

Helsinki on **21465** at 0958, OM with station identification at the end of the English transmission to Europe, the Far East and the Pacific Area, timed from 0930 to 1000.

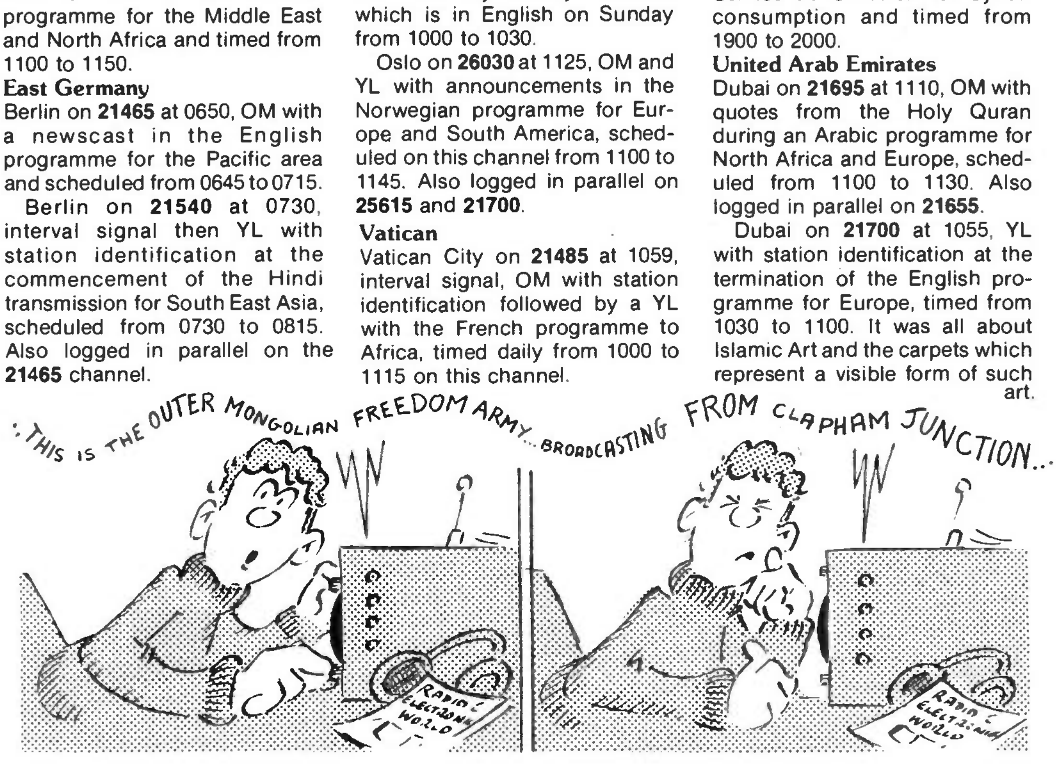
Iraq

Baghdad on **3367** at 1930, OM with a rousing speech in an Arabic dialect in a Foreign Service transmission for Syrian consumption and timed from 1900 to 2000.

United Arab Emirates

Dubai on **21695** at 1110, OM with quotes from the Holy Quran during an Arabic programme for North Africa and Europe, scheduled from 1100 to 1130. Also logged in parallel on **21655**.

Dubai on **21700** at 1055, YL with station identification at the termination of the English programme for Europe, timed from 1030 to 1100. It was all about Islamic Art and the carpets which represent a visible form of such art.



Rwanda
Kigali with a relay of Deutsche Welle, Cologne on **21600** at 1824, OM with a talk during the German programme for Europe and Africa, scheduled from 1800 to 2000.

Madagascar
Radio Nederlands Relay on **21480** at 1336, OM with a newscast in the Dutch programme for South East Asia, timed from 1330 to 1425.

Zaire
Radio Candip, Bunia on a measured **5067** at 0347, local-style music, OM with announcements in vernacular and French. This is La Voix de Education et Development which is listed as operating from Monday to Friday 0400 to 0730, 1500 to 1900 (Thursday and Friday to a variable 1830 closing time). Saturday from 0400 to 0730, 1230 to 1730. Sunday from 0400 to 0700 and from 1230 to 1835. The power is 1kW and it identifies as "Radio Candip". From the logging it is obvious that all times are variable!

Pakistan
Radio Pakistan, Karachi on a measured **21802** at 0750, OM with a cricket match commentary during the Urdu programme in the World Service to the U.K., scheduled from 0715 to 1100. An English newscast is featured from 1005 to 1010.

Karachi on a measured **21756** at 1043, OM with announcements and station identification at the end of the Indonesian programme, scheduled from 1000 to 1045. Choral National Anthem and off at 1045.

India
AIR (All India Radio) Delhi on **17875** at 1020, YL slowly detailing an Indian food recipe during the English transmission to North East Asia and Australia, on this channel from 1000 to 1100.

Japan
Tokyo on **15195** at 0758, tinkling chimes interval signal, OM station identification then YL with the Japanese programme for the Far East, the Americas and Europe in the General Service, scheduled from 0800 to 0830.

Tokyo on **21610** at 0825, YL and OM alternate with the English transmission for Europe, timed from 0800 to 0830.

Vietnam
Hanoi on **10010** at 1420, YL with the Chinese programme for the Far East, scheduled on this channel from 1400 to 1430.

North Korea
Pyongyang on **15245** at 0800, organ music interval signal then YL with station identification at the commencement of the English transmission for South East Asia, scheduled from 0800 to 0950.

Australia
Melbourne on **9760** at 0808, OM with announcements, country and western music in the English programme for the Pacific area and Papua/New Guinea, timed from 0700 to 0845.

ABC (Australian Broadcasting Commission) Brisbane on **9660** at 1202, OM with a newscast of local events, in English of course.

Clandestine
"Voice of Democratic Kampuchea" on **11685** at 1225, OM with songs, music in the local-style during the Cambodian programme, YL with a talk. In Cambodian from 1200 to 1300. The transmitter is thought to be located in China.

"Voice of the Libyan People" on **11460** at 1555, OM with a tirade in Arabic. Also logged on **11365** at 2113, OM with frequencies and times of the various transmissions then OM with quotations from the Holy Quran; on **11977** at 1520, OM and YL in Arabic (as are all these programmes), marching songs and exhortations in the usual rousing manner. This one is anti-Qadhafi (westernised as Gadhafi).

"Voice of the Sudanese Popular Revolution" on **17940** at 1610, OM with a rousing speech in Arabic. This one is hostile to the Sudanese government and the transmitter is thought to be located in Libya.

China
Nei Monggol PBS' (People's Broadcasting Station) Xilinhot on **7300** at 1501, YL with local songs and music after a programme of Chinese theatre.

Sichuan PBS, Ghengdu on **6059** at 1432, OM and YL as principals in a Chinese drama.

Radio Peking on **9630** at 1520, OM with a song in Chinese, YL with announcements and station identification.

Radio Peking on **11600** at 0929, interval signal, OM with station identification to the start of the English transmission to Australia and New Zealand, scheduled from 0930 to 1030.

Radio Peking on **11695** at 1233, Chinese music in the Cambodian programme, timed from 1200 to 1300 on this frequency.

Radio Peking on **15600** at 0918, YL with a talk during the Indonesian programme, scheduled from 0830 to 0930.

Radio Peking on **15165** at 0921, OM with announcements in the Chinese programme for South East Asia, timed from 0900 to 1000.

Radio Peking on **15435** at 0912, OM and YL with the English transmission for Australia and New Zealand, scheduled from 0830 to 1030. It was all about Chinese rivers and mountains — very informative.

Radio Peking on **15330** OM with a talk during the Cantonese programme for South East Asia, timed from 1100 to 1200.

Radio Peking on **15599** at 1034, YL with announcements during the Indonesian programme, scheduled from 1030 to 1100.

Guam
KTWR Agana on **11840** at 0825, religious programme in English complete with a childrens choir, OM with station identification at 0830 "This is the Voice of Trans World Radio, Pacific, Agana, Guam, KTWR".

Saipan
KYOI announcing as "Super Rock Radio" on **11900** at 1500, OM with announcements in English, identification frequencies etc. Heard with some difficulty under Radio Moscow, KYOI is a new one as far as I am concerned. Saipan on short waves now — life is full of surprises at times.

Chile
Santiago on **15150** at 2240, OM with a sports commentary in the Italian programme for Europe, scheduled from 2230 to 2300.

Brazil
Radio Nacional do Amazonia, Brasilia on **15445** at 2200, OM with station identification and announcements in Portuguese.

Radio Clube do Para, Belem on **4885** at 0238, OM with a talk about internal affairs — in Portuguese of course. This one is on the air from 0800 to 0300 and the power is 10kW.

Radio Clube Ribeirao Preto on **15415** at 2120, OM with a newscast in Portuguese.

Mexico
La Voz de America Latina, Mexico City on **15160** at 2135, OM with announcements and a talk in Spanish.

Venezuela
La Voz de Carabobo on **4780** at 0234, OM in Spanish announcing the pop record that followed. LV de Carabobo operates from 0855 to 0400 (Sundays from 1000 to 0300) and the power is 1kW.

Now Hear This

Guyana
GBC Georgetown on **5950** at 0740, Indian-type music, YL with a song in Hindi followed by OM with announcements in English and a time-check at 0758 as "two minutes to four" then station identification. The OM has a bass voice somewhat deep-toned so you may need to tape the identification for later confirmation.

Belize
Belmopan on **3285** at 0456, YL with a pop song, OM with announcements in English followed by an orchestral version of the National Anthem and sign-off at 0504. The schedule of this 1kW transmitter is from 1100 (Sunday from 1200) to 0510.

Greece
Radio Station Macedonia on **9900** at 2150, local-style orchestral music, OM with songs. This one is on channel from 1800 to 2200 and easier to receive than the two mentioned above — I just thought I would sugar the pill!

■ R&EW

NEW PRODUCTS

Sound Burger

The highest quality sound comes from records rather than cassettes. Now high-fidelity record listening is made *truly* portable with the uniquely styled AT 727 Sound Burger from Audio-Technica, the world's largest maker of pick-up cartridges. Whether played on its own, added to a cassette-based system or used as 'second' turntable in a domestic hi-fi set-up, Sound Burger extends the listening enjoyment of all music lovers.

Features of this novel system are:

- Direct listening, with volume control for two sets of mini-phones.
- Line outputs for playing through amplifier of hi-fi system.
- Battery power with optional mains adaptor offering 'Play Anywhere' ability.
- Choice of red, yellow or silver finish.

The complete package is available from audio/hi-fi shops and major electrical retailers, at a recommended price of £89.95 all inclusive.

'B', 'C' And dbx

Technics is expanding its range of cassette decks, with more than one noise reduction system, to include the RS-M235X. Offering Technics quality at a realistic price, the new cassette deck features Dolby B, C and dbx noise reduction, making it compatible with any type of recording and offering excellent sound reproduction.

The most powerful noise reduction system on the market, dbx, yields a signal-to-noise ratio of 92dB with 100dB dynamic range — more than enough to record any live performance, even a jet engine at take off! Greater reliability, as well as a low wow-and-flutter, are the result of a two-motor tape transport system. One high torque motor drives the reels, while a precision DC servo-motor controls the capstan. For easy operation, an auto-tape selector chooses the correct bias and equalisation for the type of tape being used.

A new system of level and balance control features are to be found in the RS-M235X. A single master level slider adjusts both channels, while a separate control balances left and right channels when necessary, permitting smooth fade-in/fade-out effects. Colour-coded, soft touch controls aid operation, and wide range FL meters indicate signal response.

Slim in style, the RS-M235X is available in silver or black, and retails for £176.95.

Discriminating Sound-Switch

The Sound Switch, from Triangle Digital Services, was developed as an aid for the severely handicapped to allow control of various electrical devices. It plugs into the mains supply (240V 50Hz or 115V 60Hz) and appliances such as lights, television, radio, tape-recorder etc plug into ten sockets on the back panel. A user can control the power to these by whistling certain notes to activate different sockets.

In the normal condition, ten lamps show the state of each of the 10 controlled channels. They are bi-coloured; red means 'ON' and green means 'OFF'. The state of each channel can be reversed in either of two ways; by a whistling sequence as shown below, or by the corresponding front panel switch. The whistle and the switch are equivalent. Either may turn a device on, either may turn it off.

To control an appliance via whistles, the procedure is: whistle the musical note C, D, E, F or G. These are two octaves above Middle C. Each corresponds with a pair of channels. The note C is for channels 1 and 6, the note D for 2 and 7 etc. The whistle should be steady, as intense as possible, and of duration at least half a second. On identification of a whistle the Sound Switch causes two red lamps to blink on the corresponding pair of channels. If neither of these is the desired channel, re-try with a different pitch until the correct lamp is blinking. Now, whistle the musical note C or E in the octave above that used for the first whistle. This will confirm the selection of either the lower or upper of the two blinking channels respectively. For example: to select Channel 3 the first whistle E will cause 3 and 8 to blink. The second whistle of the C above will confirm channel 3. (an E would have confirmed channel 8).

When the second whistle is accepted the red lights stop blinking and the channel changes from OFF to ON or vice-versa. The lamp display reverts to showing the ON/OFF state of all the channels.

If no second whistle is detected within 15-30 seconds of the first one, the blinking stops and no switch action is taken. It will then be necessary to do a first whistle again.

The Sound Switch contains a TDS900 computer, programmed in the high level language FORTH, which three-times-a-second monitors the sounds in the room and attempts to identify a whistle. The criterion is that it should be *on*, or close to, the specified musical note, and be steady. It should also be louder than the ambient noise level in the room. Almost all sounds, such as normal speech, are therefore rejected. The calculations used by the computer are borrowed from speech recognition techniques, but working on a whistle makes the device usable across a noisy room.

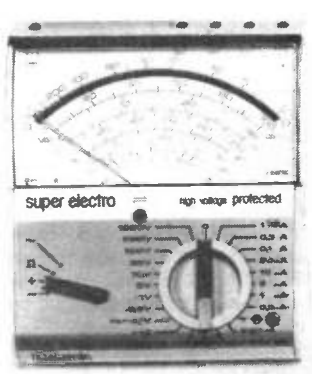
Triangle Digital Services Ltd.,
23 Campus Road,
LONDON, E17 8PG.

Stylish Analogue

The 'Super Electro' Analogue Multimeter, from Elemic of Italy, offers superb styling and presentation combined with wide-ranging specifications — 57 ranges and 50,000V protection on all of them.

With voltage measurements to 1000V (DC and AC), current to 30A (DC and AC), and resistance and capacitance ranges, the 'Super Electro' out-performs most competitors. In addition it provides phase sequence detection for tri-phasic systems and a mains and insulation tester.

Based on a high precision, moving coil microammeter, the 'Super Electro' has coloured scales and an anti-parallax mirror. It is complete with high quality lined protective case, fused test leads and a years guarantee. With 20kΩ/V sensitivity and DC accuracy of 1.5% FSD, the 'Super Electro' offers exceptional specifications for just £39.95 (+ VAT).



Further details from the exclusive importer:
Black Star Ltd.,
8a Crown Street,
St. Ives,
HUNTINGDON,
Cambs PE17 4EB.

NEW PRODUCTS

Tube News

A new display tube is being incorporated in the Philips low-cost 15 MHz PM 3207 oscilloscope, achieving much improved performance. The new tube produces a brighter and sharper picture, yet is simpler in design and more reliable.

The PM 3207 provides a wide range of features not normally found in this class of lightweight, compact oscilloscopes. In addition to high (5 mV) sensitivity, these include a full 8 x 10 cm screen, a choice of display modes and automatic triggering. Double insulation between line and instrument avoids ground-loop problems during measurements.

The specially-designed display tube, which is the main feature of the new PM 3207, reflects Philips' wide colour television experience. Simple internally-mounted permanent magnets are employed to manipulate the electron beam, rather than the more complicated conventional electrostatic systems. Two permanently-magnetised wire rings are fitted in the electron gun, resulting in greater and better calibrated deflection sensitivity, stigmatic focussing and superior deflection orthogonality. A higher acceleration voltage is possible than in other instruments of this class, ensuring a much higher light output.

The wide choice of display modes includes the possibility of A+B vertical channel display, with separate B channel inversion — in the X-Y display mode, X deflection is through the A vertical input channel for maximum input sensitivity. Automatic triggering is standard; a separate peak-level control ensures there is always a stable picture. The integral TV triggering facility provides automatic changeover from line to frame.

Pye Unicam Ltd.,
York Street,
CAMBRIDGE CB1 2PX.

Filter Your Bricks

A new Brickwall filter, the model 753A from Wavetek Electronics, is both programmable and wide ranging, with near ideal pass-band and stop-band characteristics. An independent programme of low-pass and high-pass cut-offs allow centre frequency and bandwidth selection anywhere in the 1Hz-100kHz band.

The passband is exceptionally flat for all but very closely-spaced cut-off frequencies. Roll-off is better than 115dB per octave, both above and below the selected cut-off frequencies.

The Wavetek 753A filter provides independent high-pass and low-pass channels, with each channel permitting 40 dB of pre-filter gain. It is especially effective for signal processing applications — the spectrum of interest is considerably narrower than the total spectrum over which measurement is possible. By setting the cut-off frequency appropriately, it is possible to isolate signals in the spectrum of interest — effectively attenuating all other frequency components.

The filter's high resolution and steep roll-off Brickwall make it possible to discriminate between desired and unwanted frequency components with great precision. Very sharp band-reject filters notch out any unwanted high-level signals while retaining low-level data. The programming of high and low cut-off frequencies and pre-filter gain is provided locally by front panel controls or by digital programming through a BCD or IEEE (488) GPIB interface.

Wavetek Elctronics Ltd.,
Tag Lane,
Hare Hatch,
Nr TWYFORD,
Berkshire, RG10 9LT.

Mini And Mobile

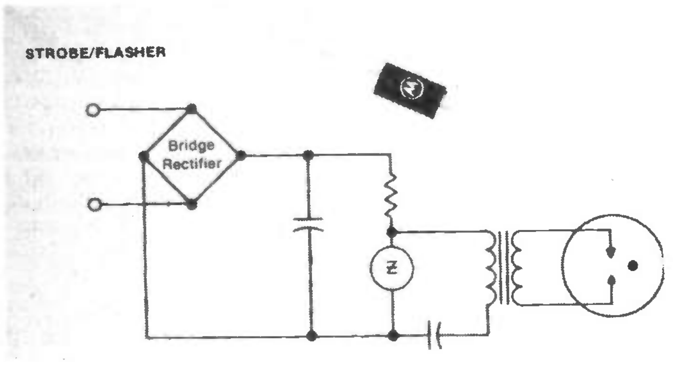
Frank Cody Electronics Limited are pleased to announce the addition of the Stentor FC205 hand-held portable VHF radio-telephone, to their growing range of private mobile communications equipment.

The pocket-sized Mini Starcom is the smallest and most compact VHF high band portable available on the market today, measuring only 70 by 140 by 26mm and weighing just under 200 grams. Due to its compact size and low power consumption (the Stentor uses only 500 mW) it can be operated by four single cell 'AAA' batteries and is thus suitable for intermittent or stand-by operation. The unit can also be used with a re-chargeable Ni-Cad battery pack.

The Stentor FC205 has a frequency range of 150-174 MHz and can be fitted with two channels. It is easy to operate and has a simple 'push-to-talk' button. Ideally suited for 'on-site' short range communications direct, or via a repeater, the Stentor can provide an effective two-way system for use just about anywhere. Approved to the Home Office specification (MPT 1301), the Stentor comes complete with helical aerial, re-chargeable batteries and a plug-in 'calculator style' battery charger.

This remarkably low-cost unit retails for only £200 (exc VAT) and is manufactured exclusively for Frank Cody Electronics. A marine version of the Stentor — the FC204 — will be available shortly, fitted with frequencies for the VHF marine band.

Frank Cody Electronics Ltd.,
Star House,
Gresham Road,
STAINES,
Middlesex TW18 2AN.



SIDAC — HV Trigger

A series of semiconductor devices for high voltage bilateral trigger applications has been introduced by Motorola. Known as SIDACs, the devices combine the high-voltage bilateral trigger capabilities of triacs with the simplicity and low cost of two-terminal diac triggers. The result is a line of products capable of competing with less reliable devices, such as neon bulbs, for applications including:

- Line-voltage transient protection
- Fluorescent lighting
- Strobes and flashers
- High voltage power supplies

The new line includes three devices with breakdown voltages ranging from 104 to 135 volts.

They are designed for direct interface with the AC power line. Upon reaching the breakdown voltage in each direction, the device switches from a blocking state to a low voltage on-state. Conduction will continue like a triac until the main terminal current drops below the holding current. The axial lead package provides high pulse current capability at low cost.

CLASSIFIED ADS

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YAESU FT290R, eight months old, listen on input and brighter audio mods. £200. Also Mufax D900/D/S/A facsimile receiver with box paper, p.s.u., complete, £50. Phone: 08893-3937.

SMALL QUANTITY integrated 30 + 30W stereo amplifiers at £75 each to your door. ILP HY6-6 HY60 full specification, completely packaged 11 x 8 x 2.5". Send s.a.e. for details to: Martin Welsh, Glassel Lodge, Banchory, Kincardineshire, AB3 4DD.

VALVES, VALVES. Offers for the following valves: QQV06-40, 6CH6, 5B254M, TT21. Phone: Fareham (0329) 287969.

SALCOM each to build HF CW equipment. 10W CW Tx £20, 10W transceiver £35,CW Memory keyer £20. Send s.a.e. for more details. Box No. REW 31.

LIST-A-RIG. A service offered by G3RCQ Electronics to introduce buyers and sellers of used amateur equipment. Buying? It's free, just send an s.a.e. Selling/wanted? Send s.a.e. for details on how to join the fast-growing list. List-a-rig is sent and updated daily; no waiting, no deadlines. LIST-A-RIG (REW), 65 Cecil Avenue, Hornchurch, Essex, RM11 2NA.

DIGITAL WATCH REPLACEMENT PARTS, batteries, displays, backlights, etc. Also reports, publications, charts. S.A.E. for full list. Profords, Copners Drive, Holmer Green, Bucks., HP15 6SGF.

£12 OSCILLOSCOPE. Yes, approx, £12 of readily available standard components, plus my circuit and plans makes an easy built unit which plugs into aerial socket of any TV and converts it to large screen oscilloscope. Circuit & plans £3 J. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

YAESU 290R 2M Multimode, P.S.U., magnet whip, "230. Yaesu FT101ZFM nine band, £500. Ring 0632 462606.

RESISTORS 100 £1.70, 400 £6.00, Mic, curly leads six core £2.00. Component packs, s.a.e. for list, Cooper Communications, 256 Highbury Grove, Cosham, Portsmouth PO6 2RX.

BOOKS ALWAYS WANTED. All types good antiquarian and secondhand books bought. Any quantity. Harold Groves (G3UYM), 36 Grange Close, Hitchin, Herts., SG4 9HD. Phone: Hitchin 33878 anytime.

AVO ELECTRONIC MULTIMETER EM272, carrying case and leads. Cost £77.40 three months ago. Bargain at £45.00. Guardian Security Group, telephone: 0272-669281.

YAESU FT290R with case, ni-cads, charger and mobile mount. Also Hansen FS-302M swr/power meter. Complete for £250. Telephone: Leeds (0532) 860091.

CLASSIFIED ADVERTISEMENTS

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Gary Evans with . . .

Last year's unpleasantness in the South Atlantic is still a thorny subject and is likely to have a high media profile for some time to come. I was reminded of the conflict the other day when a Press Release from Wavetek landed on my desk. While not attempting to detract from the pride that any British company must feel if they in some way contributed to the eventual British victory, I must confess that a wry smile crossed my face as I read the following.

"Signal generators supplied by Wavetek Electronics helped Britain win the Falklands war as the campaign switched from the sea to land in its final stages.

The 520 MHz signal generators virtually circumnavigated the world on their journey from Indianapolis to the UK and onward to the Falklands task force via Ascension Island - in a five-day race against time.

The instruments were then used throughout the battle, at sea and on land and, according to the Ministry of Defence, performed extremely well under arduous conditions."

Closets At The Cottage

This year, for the first time, **R&EW** paid a visit to the Audio show held each year at the Swiss Cottage Holiday Inn. Audio '83 is, in the main, an upmarket event with the quality end of the "Hi-Fi" market well represented. As befits this rather prestigeous event, the organisers have adopted a rather different approach to that of the more run-of-the-mill exhibitions.

Rather than dump all the exhibitors into one large open space, each company is alloted one or more of the Inn's bedrooms in which to set up shop. The beds are of course bannished to some storage area leaving only the slightly incongrous headboards dotted around the walls.

Walking around the show rather early in the morning on one of the Press days was rather an intimidating experience. With so few people about and so many exhibitors keen to demonstrate their goods meant that strolling down any of the main corridors was akin to walking down a street in a red light district when the Fleet was at sea.

A 'different' show that was however well worth the visit with one of the most unusual products being the 'Sound Burger' (typesetter — please get this one right) as previewed in this month's new products pages.

Cereal Wars

This page is being written as the early morning static of shut down TV stations is being replaced by the snap, crakle and pop of highly paid TV pundits endeavouring to liven up your early morning routine.

Before TV-AM came on air, a spokesman for their management was said to be concerned by the fact that many remote controlled TV sets automatically tune to channel 1 when switched on. The fear was the sleepy British workers would not be sufficently aware of their surroundings first thing in the morning and thus the BBC would win the rating war by default.

An interesting point but judging from efforts of both programmes during the first few days, good old auntie is on to a winner with or without the added edge that technology may or may not be giving her.

THE LAST WORD.

Advertisers' Index

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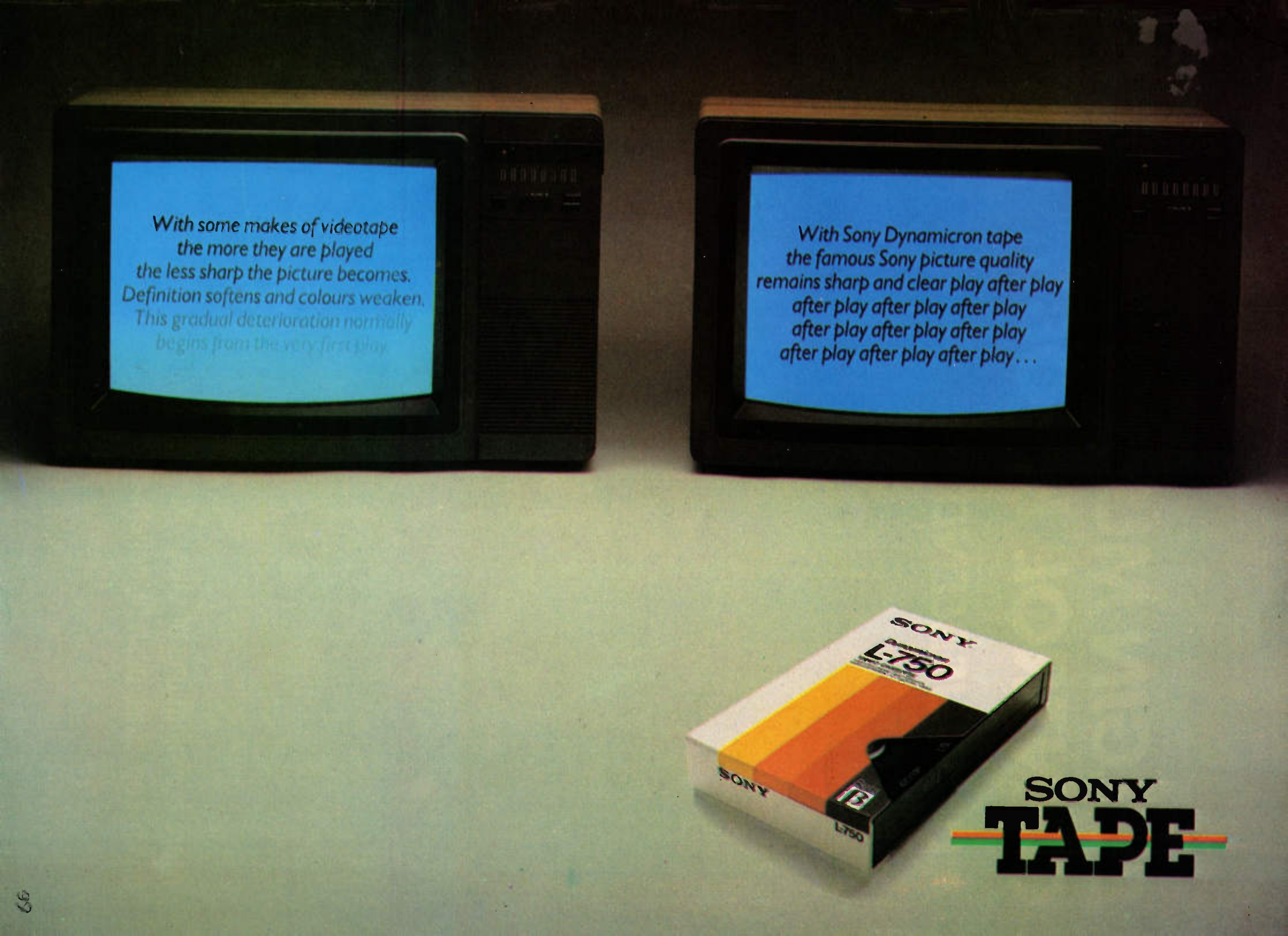

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