OCTOBER 1984

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TELEVISION

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TELEVISION

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CORRESPONDENCE
All correspondence regarding advertisements should be addressed to the Advertisement Manager, "Television", King's Reach Tower, Stamford Street, London SE1 9LS. Editorial correspondence should be addressed to "Television", IPC Magazines Ltd., King's Reach Tower, Stamford Street, London SE1 9LS.

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this month

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Rank drive cams	15
GEC 2110 tuner neons	14
Thorn 3500 A1 beam	70
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147 mm	2.10
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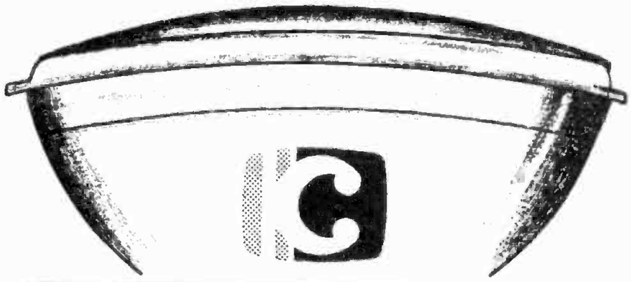

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AN5431	2.76
AN6332	6.97
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AN7115	2.37
AN7120	2.43
AN7140	2.10
AN7145	3.25
AN7150	2.89
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HA1144	2.39
HA1151	1.97
HA1156	1.97
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HA1199	2.30
HA1202	1.75
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HA1306	2.97
HA1319	2.99
HA1322	2.10
HA1325	2.30
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HA1368	2.20
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HA1377	3.80
HA1388	4.20
HA1397	4.15
HA11211	2.43
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LA1365	2.25
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LA4422	2.75
LA4430	1.93
LA4460	2.95
LA4461	2.95
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MB3713	2.25
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TA7227	4.65
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TBA120U	1.00
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STK0039	6.45
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TYPE	PRICE (£)
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STK011	7.35
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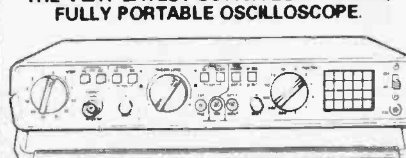

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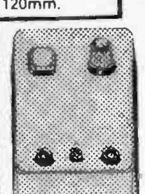

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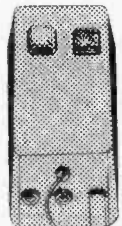

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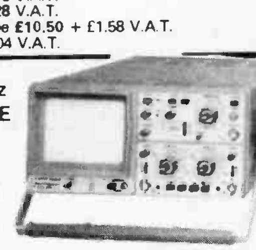

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Same old story

Two recently published reports draw attention to shortcomings in education and industrial training in the UK. The first, entitled Competence and Competition, was produced by the Institute of Manpower Studies for the National Economic Development Office and the Manpower Services Commission. It's the first report to have made a detailed comparison between education and training in the UK and its leading industrial competitors, the USA, W. Germany and Japan. The second, Crisis Facing UK Information Technology, has been published by the Economic Development Committee for the industry. It's scope is wider, covering research and development, investment policies and the availability of finance, but when it touches on labour it highlights the "acute national shortage of people with IT-related skills".

The reaction of many will probably be that there's nothing new about this. Reports published over the years have drawn attention to the same failings and have met with varying responses. Yet the Institute of Manpower Studies' report is particularly disturbing in that it relates education and training to economic and industrial performance. This is something that's not possible of precise analysis however. You can't say that if the UK had had X number of extra scientists/engineers it would have benefitted by a measurable amount, or that because Japan has say X number of extra engineers in a particular industry that industry has done measurably better. It all depends on what you do with trained manpower for a start, and the policies and priorities of those who control investment and industry. Nevertheless an adequate supply of trained manpower is a basic essential, and one's heard growing complaints from the UK electronics industry in particular in recent years about the lack of graduates with engineering qualifications. There's a deeper and more worrying problem here. A marked improvement can't be achieved until graduates have acquired industrial experience and had a chance to permeate management and influence policy and investment decisions. To merely double the output of engineering graduates will have no lasting effect until it's possible to make full use of them. An increase is an essential first step however. The long-term problem is whether we might already have left it too late. Will the UK, as the IT report seems to suggest, have declined to "Third World status" before anything can be done? Have we already reached the point of "industrial no return"?

The problem is not only one of a shortage of graduates of course. Skills of all kinds are required if modern, technologically-orientated industry is to operate effectively. It's profoundly disturbing that the efforts of so many over a very long time to produce relevant courses, training and qualifications seem to have had so little impact. We have excellent institutions concerned with training and setting standards for engineers and technicians, yet the system has failed to deliver the goods.

The IMS study makes one feel that there may be a deeper problem. After all we're not Japanese or Germans. Maybe as a nation we are less disciplined, less motivated, less work orientated? Perhaps we place a greater value on freedom and doing our own thing in our own way? This can be beneficial. The UK has not lacked inventiveness and, when the crunch comes, we very often manage to get things done. Be that as it may the problem remains, and is starkly brought out in both these reports, that our main competitors have a great lead in training and industrial strategy, a fact that has very worrying implications for the future.

It's sometimes argued that there is no great advantage in duplicating the efforts of others. Why not buy in technology as required? There are two problems with this approach. First, if industry fails to develop new goods and technology it loses the benefits of experience and know-how. You could, over a number of years, reach a position where goods whose design and operation are not understood are merely being screwed together in the UK. This danger is known, but the question is whether the scale of the effort to overcome it is anywhere near sufficient. The second problem is that production engineering is not a UK strong-point, so that a future as an assembler of goods designed elsewhere doesn't hold out much hope.

There are several related issues. For example, who is to pay for increased expenditure on training? Firms understandably don't like spending a lot on training people who promptly go off elsewhere. The answer to that one is possibly in motivation and providing interesting jobs and career structures. All of which is easier said than done, especially when industry is strapped for funds as it often is. Perhaps there should be increased training levies? This again raises difficulties – it means that some firms are in effect being asked to subsidise the training requirements of others. All this is quite likely to lead to a situation where government blames industry for its failure to take the initiative while industry blames the government for exactly the same thing. Oh yes, and we all blame the educational system.

At least the reports mentioned have drawn attention to the real and long-term problems. The usual UK reaction is that it'll be all right on the day and that somehow we'll muddle through. There's reason to doubt whether our luck will hold this time. Nor is education and training the only aspect of the matter. There's also the problem of flexibility in work practice and employee deployment. This is a field where union restrictions and worker/management attitudes come in. In the short term, making the maximum use of the skill resources we've got is the only solution open to us.

CORRECTION – VIDEO INFO CARD 1

The audio output pins with a 5-pin DIN socket wired for mono operation are 3 and 5, not 3 and 4 as printed in this month's data card.

BUMPER ISSUE

The November issue will again have extra pages – and Video Info Card 2.

FRONT COVER

Our thanks to Crow of Reading Ltd. who kindly supplied the photograph of the Barco CTVM3 series monitor reproduced on this month's front cover.

System A Modulator

David Looser

With the impending close down of the 405-line transmitter network those of us with collections of early TV sets are having to make new arrangements to supply them with suitable signals. Typical of such initiatives is the method of recording 405-line video signals on tape described by Gareth Foster in the October 1983 issue. Whatever the scheme used, some method of converting baseband audio and video into a form suitable for feeding into the set's aerial socket is required.

The modulator described in this article was designed to perform this task with little degradation of the signal. Separate carrier generators and modulators are used for the sound and vision for best possible sound-on-vision and vision-on-sound performance. Crystal control of the oscillators was chosen to ensure stability and reduce alignment problems. The choice of Channel 1 (41·5MHz sound, 45MHz vision) was made because the vast majority of 405-line TV sets, including all pre-war models, can operate on this channel. Those with one of the few Ch. 4 "Birmingham" models of the late 40s should be able to modify the design for 58·25MHz sound and 61·75MHz vision without much difficulty.

Circuit Operation

Fig. 1 shows the vision modulator circuit. The 1V peak-to-peak video input is first amplified by Tr1/2 and then fed via the emitter-follower Tr3 to the d.c. restorer Tr4. The potentiometer in Tr4's base circuit varies the modulator bias and is adjusted so that the carrier is just extinguished on the sync pulse tips. Tr5 is connected in a Butler oscillator circuit operating at 45MHz. The output from the modulator chip is transformer coupled to the output socket via a 10dB pad and a 6dB combining network. The 10dB pads in this and the sound modulator circuit act as isolators to protect each modulator from the other's r.f. output.

The sound modulator circuit (see Fig. 2) is similar, with IC2 driving the modulator chip in push-pull to reduce distortion to a minimum. The audio sensitivity of 1V r.m.s. = 100 per cent modulation is set by the value of R1, which can be varied if desired. For example, with R1 at 100kΩ 100 per cent modulation is achieved with a 200mV r.m.s. input; with R1 at 1MΩ 2V r.m.s. equals 100 per cent modulation. The quiescent carrier level is set by the two biasing networks connected to the audio input pins 1 and 4 of the MC1496.

Both modulators generate 800mV of r.f. across the secondary windings of the output transformers T2 and T4 under maximum modulation conditions (peak white for video and the positive peak of a 1V sinewave for audio). Each modulator thus produces about 130mV of r.f. at the output socket, so about 20dB of extra attenuation will be needed when this is connected directly to the aerial socket of a set. This allows several sets to be driven via a passive splitter network if required.

It will be noticed from the above that the peak vision to average sound power ratio is 6dB (4:1) rather than the correct 7dB (5:1). This has never caused problems with any set I've used, but purists may if they wish increase the loss in the sound modulator's output pad from 10dB to 11dB.

Construction

The prototype was constructed on a single Veroboard Eurocard with a "colander" ground plane. This is available from Verospeed (stock no. 10-2845H) but is fairly expensive (£5·60 trade). An alternative would be to use "solid construction" on a piece of plain copperclad board about 4 × 6in., preferably glassfibre. Start by fixing the coil formers to the copper side of the board, then glue the MC1496s to the board upside down. All the wire-ended components can then be soldered directly to the appropriate i.c. pins. A small soldering iron and a steady hand are essential. The video amplifier/d.c. restorer and the audio amplifier can be built on a small piece of Veroboard which is then mounted on the main board.

The transistor types are not critical. I used those specified because they were to hand. Any r.f. types should be suitable for the oscillators and any small-signal silicon general-purpose types for the video section. The non-electrolytic capacitors are all miniature ceramic types and the polarised capacitors bead tantalum or low-leakage electrolytics. The resistors are 0·25W, 5 per cent carbon or metal film types and the crystals were made to order by IQD Electronics – they cost about £6 each.

The transformers are constructed as follows. T1 and T3 have a primary consisting of 15 turns of 26 s.w.g. wire close wound on a 6mm former with a dust core. The secondaries consist of two turns of 26 s.w.g. wound over the "cold" end of the primary. T2 and T4 have primaries consisting of 12 turns of 26 s.w.g. close wound on a 6mm former with a dust core and a centre tap. The secondaries consist of three turns wound over the centre of the coil.

Alignment

Three alignment methods are possible depending on the equipment available.

The first method requires a video source (preferably a line repetitive waveform covering the full grey scale, such as a wedge or step-wedge pattern), an audio signal generator with an output adjustable over the range 0-1V, and an oscilloscope with a bandwidth of at least 50MHz. Connect the scope across the secondary of T2 and apply 12V d.c. to the vision modulator only. Adjust T1 and T2 for maximum r.f. output. These adjustments are very broad and not difficult to make. If the maximum signal is reached with the cores fully in or out it may be worth trying a different value for the tuning capacitor C1 or varying the number of turns.

Connect the video pattern generator to the video input and synchronise the scope's timebase to this input. Adjust the video bias control so that the r.f. output drops to zero, or as close to zero as possible, during the sync pulses. The scope should now display the modulated r.f. envelope shown in Fig. 3.

Transfer the scope to the secondary of T4 and the 12V supply to the sound modulator. Adjust T3 and T4 for

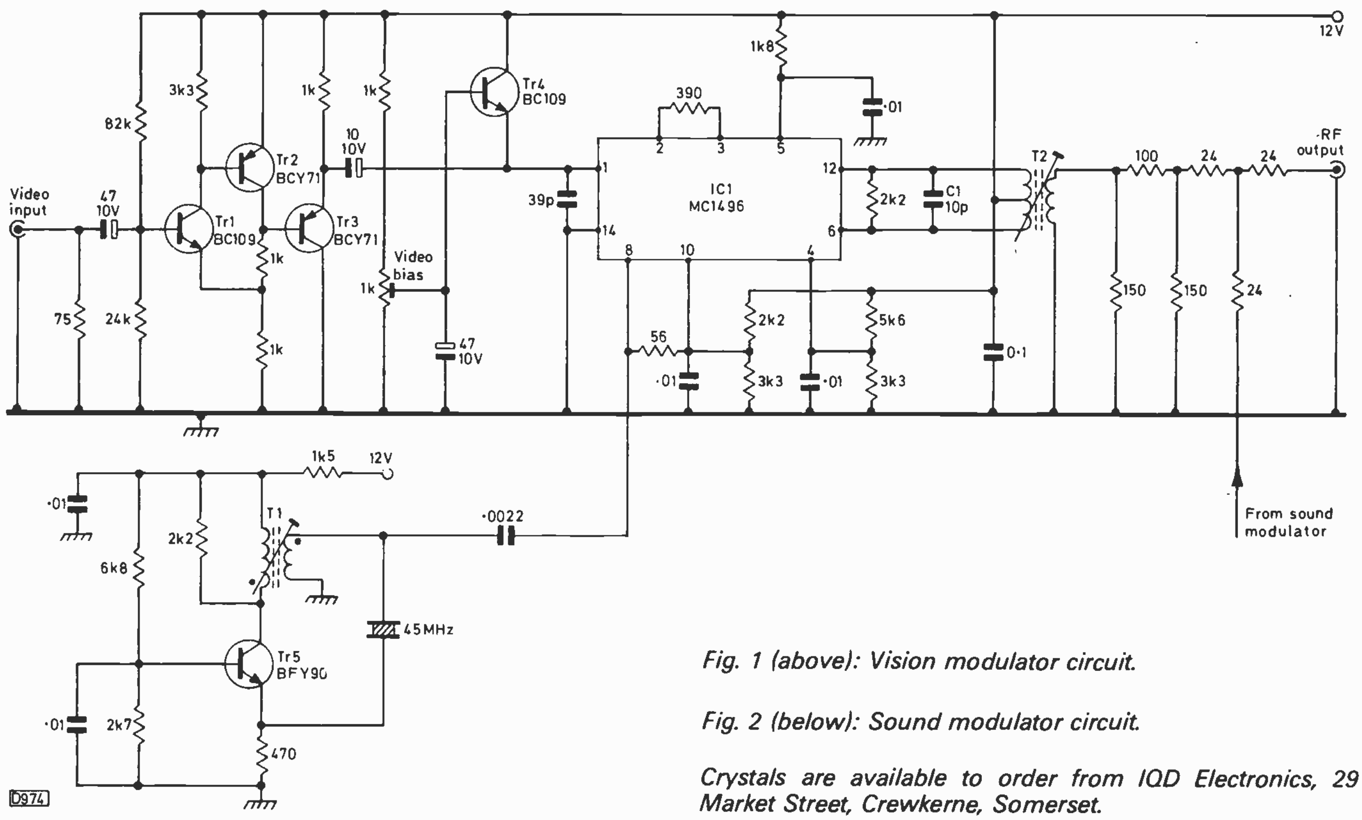
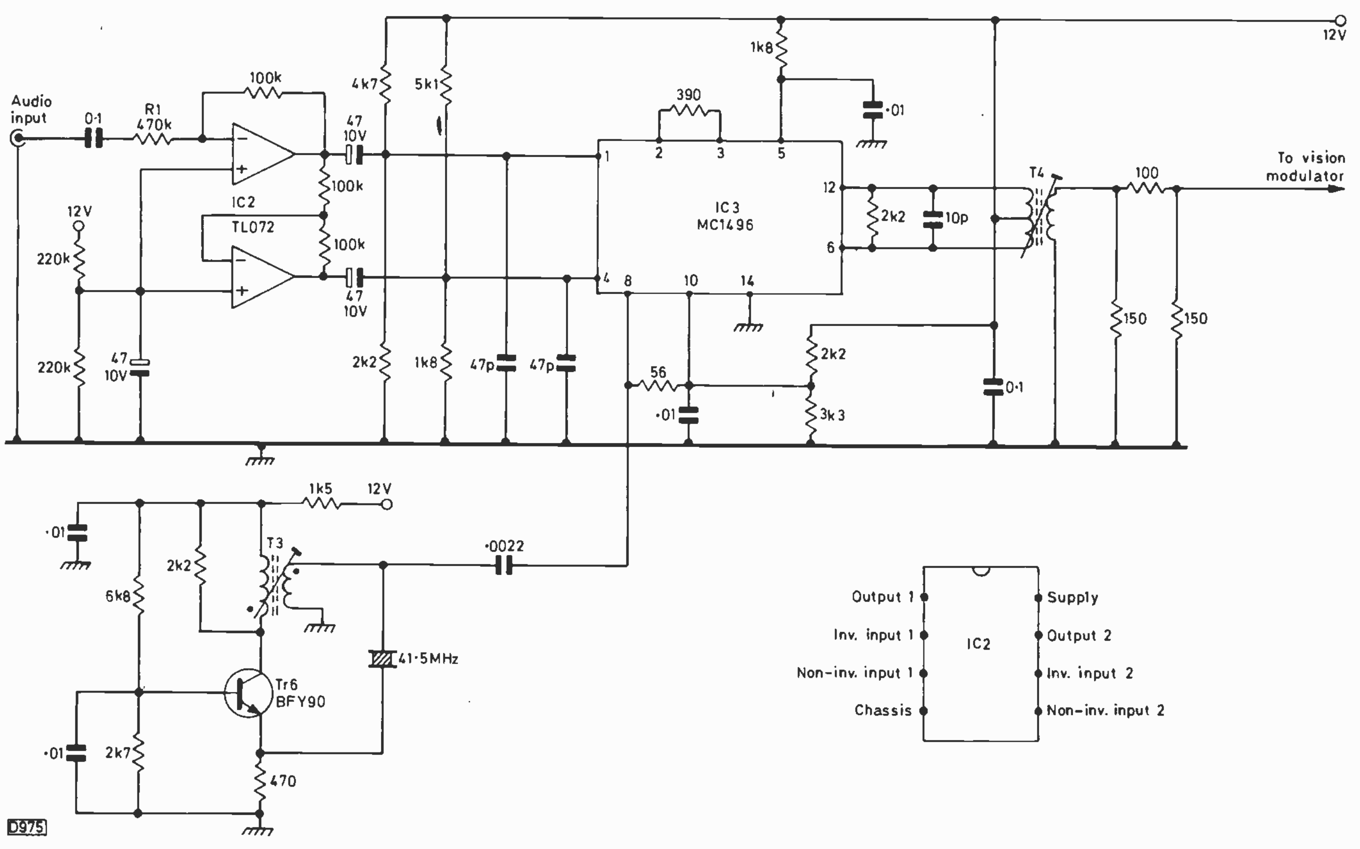


Fig. 1 (above): Vision modulator circuit.

Fig. 2 (below): Sound modulator circuit.

Crystals are available to order from IQD Electronics, 29 Market Street, Crewkerne, Somerset.



maximum r.f. output as above. Connect the audio signal generator to the audio input: with about 1V r.m.s. of input drive it should be possible to produce an envelope display as shown in Fig. 4.

The second method requires a video pattern generator as above, a scope with a limited bandwidth (say 5MHz), and a good working TV set that can be tuned to Ch. 1. This set should preferably have manual r.f. gain control, i.e. no a.g.c., and a chassis isolated from the mains. Connect the modulator's r.f. output to the TV set via an attenuator of about 20dB and the scope across the set's vision detector load resistor. Apply 12V to the modulator. Tune the TV set for maximum d.c. across the load resistor, then peak T1 and T2. Apply the pattern to the modulator and synchronise the scope with the generator. The pattern should be visible on the scope: adjust the video bias so

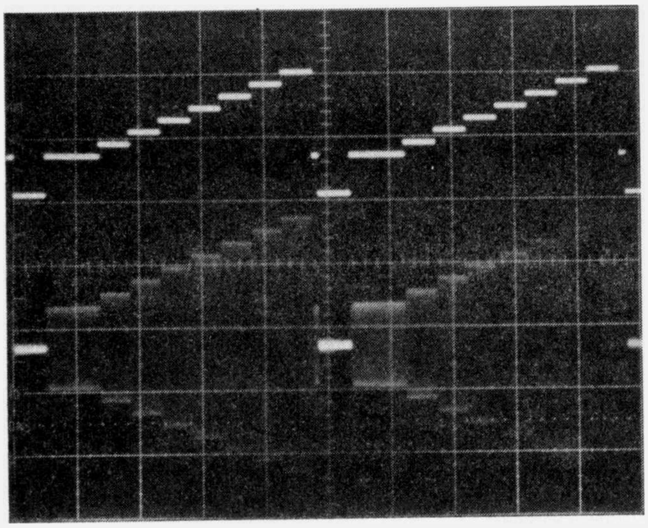


Fig. 3: Alignment traces: upper, video input, 0·5V/cm; lower, r.f. envelope, 200mV/cm.

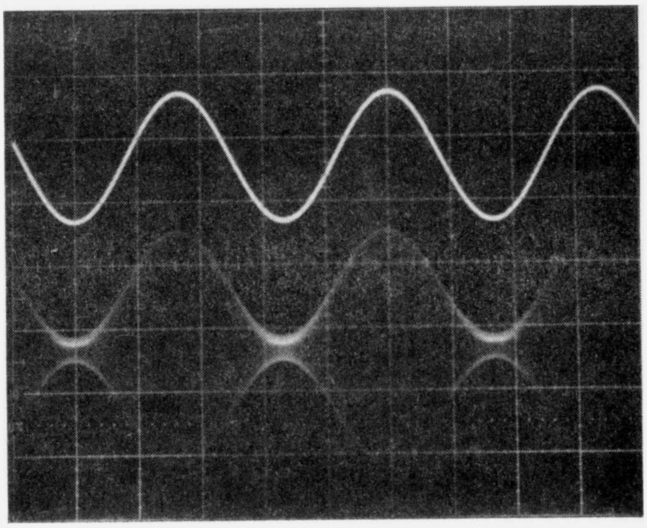


Fig. 4: Alignment traces: upper, sound sinewave input, 0·5V/cm; lower, r.f. envelope, 200mV/cm.

that the sync pulses crush, then back off the adjustment until the pulses regain their maximum amplitude. Check that the whites are not compressed – if necessary reduce the TV set's r.f. gain to ensure that this does not happen.

Connect an audio tone to the modulator's audio input socket. This tone should be heard from the speaker. Tune T3 and T4 for maximum output.

The third method requires a source of 405-line video, e.g. a pattern generator or tape, and a working 405-line TV set. Connect the modulator to the video source and to the TV set (via a 20dB pad). Apply 12V to the modulator and tune it in on the TV set. Peak T1 and T2 for maximum contrast and adjust the video bias control for best grey-scale reproduction consistent with reliable synchronisation. It may be necessary to adjust the set's contrast control to make this possible. Connect an audio source, preferably a tone, to the modulator and adjust T3 and T4 for maximum volume.

Renovating the Philips N1700

Freddie Archer

Because the Philips N1700 is now obsolete, these machines can be obtained very cheaply, especially non-workers. I've renovated a number of them and would like to pass on the following tips on repairing these old but high-performance (when working!) VCRs.

A stock fault is a faulty head drum motor. They tend to develop tight bearings with age, something that can be aggravated by lack of lubrication of the head's own bearing. If the machine is working, check the voltage across the motor with the VCR switched to play but no tape inserted. The voltage should be 16V ± 1·5V. If it's more than 20V you'll soon have problems.

The next thing that happens is that the upper drum motor drive transistor TS201 (BD437) goes short-circuit collector-to-emitter due to overloading, thus placing the full 33V supply across the motor. When the BD437 goes short-circuit it usually does some damage to the U219 drum servo control module – typically cooked resistors, the partnering BD436 drive transistor going open-circuit and occasionally the 741 chip faulty. All this is repairable with care and replacements are available from Philips.

Now to the motor itself. Due to the tightness it may be unable to rotate the head drum at the correct speed. Before condemning it and buying a new one from Philips at around £30, try swapping over the drum and capstan motors! Crazy though this may sound, it usually works – the capstan motor leads an easier life and the two motors are identical. The pulley on the head drum motor can be a pig to remove. Once you've done all this and everything works, clean and oil all that should be cleaned and oiled and you'll have little mechanical trouble in future use.

I've found that the signals sections are all very reliable. A problem that can occur is vertical lines appearing on heavily saturated primary colour scenes. The effect can be reduced by adjusting the chroma record current control R710. A compromise may be required due to chroma dropout.

The speed reduction modification described by Mike Phelan (*Television* April 1983) works quite well but is very dependent on 100 per cent good mechanics, which is not very likely on a four-six year old VCR.

Several problems can occur on the power supply/system control panel. Bad connections on IC101 (μA723CA) in the 12V regulator circuit can cause picture disturbance, a blank screen or over-saturated colour, all usually intermittent. Dry-joints on the electrolytics and bridge rectifiers can cause hum bars or a totally dead machine.

Bandpass video input and output are useful modifications to include. Articles on these appeared in the November 1979 and March 1981 issues of *Television*.

I hope these notes will help others to keep going what is probably the best luminance quality VCR that's been sold for domestic use. No other machine can achieve a 3MHz bandwidth without heavy peaking, which produces so much noise and ragged edges that in my opinion it's not worthwhile. Maybe I'm old-fashioned, but I'd rather see one hour of good quality vision than six or eight hours of muzzy, noisy pictures!

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AC142K	38	BC183L	12	BD115	49	BF185	30	BFT43	30	R2008B	1.40
AC153	39	BC184L	13	BD131	30	BF194	16	BFX38	40	R2010B	1.10
AC176	33	BC187	24	BD132	46	BF195	16	BFY50	30	R2030	70
AC176K/		BC204	15	BD133	59	BF196	16	BFY51	34	R2265	1.30
AC128K	93	BC208	9	BD139	36	BF197	15	BFY52	34	R2305	80
AC188	38	BC212L	9	BD140	38	BF198	19	BRC116	1.50	R2322	50
AD142	1.18	BC213L	12	BD144	1.70	BF199	15	BRC1693	1.43	R2443	25
AD143	1.08	BC237	12	BD150	50	BF223	18	BU105	1.00	RCA16446	30
AD149	98	BC238B	8	BD163	98	BF224	19	BU126	1.10	RCA16599	1.25
AD161	32	BC238L	8	BD201	74	BF238	20	BU207	1.05	RCA16600	1.40
AD162	32	BC250A	15	BD203	78	BF240	9	BU208	1.15	RCA16799	1.13
AD263	1.05	BC251	8	BD204	99	BF241	21	BU208A	1.15	RCA16800	1.42
AF127	45	BC252A	20	BD222	48	BF255	10	BU326A	1.30	RCA16802	1.38
AF139	38	BC294	37	BD225	52	BF256S	20	BU407	1.70	S1299	2.25
AF239	41	BC301	32	BD232	50	BF257	28	BU408	2.76	S28000	1.25
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BC115	16	BC309	14	BD238	65	BF337	29	C1129	9	T9003V	1.25
BC117	21	BC327	18	BD241	59	BF338	34	C1172B	9	T9010V	1.45
BC125	26	BC328	18	BD244	85	BF355	40	E5386	54	T9053V	1.30
BC126	23	BC337	17	BD278A	81	BF362	50	E9003	28	T9054V	1.00
BC139	27	BC338	17	BD386	68	BF391	21	E9005	25	T9039V	1.10
BC141	34	BC347	8	BD433	71	BF394	16	ME0404	10	TIC45X	50
BC142	30	BC394	8	BD437	83	BF422	47	ME0412	10	TIC46	48
BC143	31	BC454	8	BD592	1.20	BF423	53	ME6002	10	TIC106C	40
BC147	12	BC455	8	BD589	1.20	BF450	43	MJ2501	2.36	TIP29	42
BC148	12	BC456	10	BD677G	1.35	BF453	53	MJ3001	2.21	TIP30	42
BC149	12	BC460	40	BD707	95	BF458	37	MJE182	47	TIP31	35
BC153	16	BC463	22	BD708	95	BF459	40	MJE340	50	TIP32	43
BC1540R	16	BC546	8	BDX10	93	BF461	59	MJE520	50	TIP33	61
BC154YL	16	BC547	12	BDY20	1.09	BF556B	35	MJE2955	1.40	TIP41	42
BC157	12	BC548	12	BDY82	99	BF596	15	MJE3055	1.50	TIP42	45
BC158	12	BC549	8	BF137	20	BF694	16	NKT241W	8	TIP110	61
BC159	15	BC557	10	BF153	20	BF757	62	NKT241G	8	TIS91	25
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100+50+150	350V	58p
400+400	200V	72p
32+32+16	350V	52p
200+32+300+100	350V	70p
225+25	350V	50p
200+200+100	350V	70p
200+100	325V	65p
200+100+100+50	350V	60p
200+200+100	350V	55p
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50+50+8	300V	55p
100+50+100	350V	55p
100+150+50	350V	55p
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1250MF 50V	50p
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2000MF 30V	50p
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2500MF 35V	65p
2500MF 40V	65p
3000MF 30V	65p
3300MF 16V	50p
3300MF 25V	60p
4700MF 16V	72p
4700MF 40V	75p

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ITT CVC8 On/Off Switch	65p
ITT CVC9 On/Off Switch + Relay	90p
Philips G8 On/Off Switch	75p
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BT116	1.00	IN5400	12p
BT119	2.56	IN5401	12p
BT120	2.82	IN5402	14p
BT151 650	1.00	IN5404	12p
BY127	12p	IN5406	16p
BY188	16p	IN5408	16p
BY204	26p	IS025	8p
BY206	16p	IS131	8p
BY207	16p	IS1658	8p
BY208/800	38p	MR854	35p
BY223	95p	SKE1/02	20p
BY225	1.20	MCR106/1	1.00
BY227	28p	MCR406	35p
BY298	22p	2N4444	1.50
BYX22/400	30p	Y827	80p
BYX55/600	30p	Y969	75p
BYX71/350	80p	ZX150	12p
BZV15 C12R	1.16	OA91	5p
BZV15 C24R	1.16	MCR106/7	1.00
IN60	8p	MCR106/8	1.50
IN2070	8p	TO3F800H	2.80
IN4001	4p	TD3F800R	3.00
IN4002	4p	BY255	30p

A Look at Monitors

Part 1

Eugene Trundle

There was a time when a TV was a telly and a monitor was regarded as being something to do with broadcasters and professional TV users – like cameras, mixing consoles, effects generators and so on. The emergence of home video changed this to some extent, now that Tom, Dick and Harry can generate, manipulate, record and playback their own TV pictures and programmes. Another factor contributing to the change has been the proliferation of home computers. The "high-density" data produced by many computers calls for a display system with higher than normal resolution capability.

A growing awareness of the shortcomings of present TV systems involving a PAL codec (coder/decoder), and of the definition limitations imposed by domestic VCR formats, has been brought about by the sight of crisp, sharp displays of teletext and Prestel data. Those who've seen demonstrations of digital, high-definition and high-quality CCTV pictures will appreciate this. Displays of non-coded images from such sources come as a revelation to those used to the average domestic TV picture, regardless of its source. We don't wish to denigrate the broadcasters and VCR manufacturers, who do a magnificent job within the constraints imposed upon them. These consist mainly of (a) the available system bandwidth and (b) the need for compatible operation, i.e. band sharing between the luminance and chrominance signals. The conventional set up is quite adequate for off-air, VCR- and disc-derived pictures, with the currently popular screen sizes (50-56cm average) and viewing distances (about 3m): in this context a high-definition picture tube and better circuitry would be largely wasted.

What is a Monitor?

Traditionally, a monitor has been a TV set shorn of its tuner and i.f. strip. This remains true of the simplest and cheapest monitors, which use conventional timebase, video and power supply circuitry as found in domestic TV sets and an ordinary picture tube. Mains isolation is the major additional requirement, though this is increasingly a feature of domestic TV sets. Many TV set/monitor conversions have been carried out, with mains isolation by means of a chopper transformer, or a 50Hz double-wound transformer with 1:1 turns ratio (when internally fitted, toroidal winding is usually required to prevent stray magnetic fields from upsetting the operation of the picture tube), or fast optocouplers to provide isolation at the video input terminals.

Purpose-designed Monitors

Purpose designed monitors vary tremendously in price. The more expensive ones have improved specifications compared to domestic sets in most possible respects. They can be expected to offer enhanced performance and extra facilities in the following areas.

(1) Video bandwidth. Depending on the intended application, monitor video channels may have bandwidths from 10 to 50MHz.

(2) Scanning geometry. Field and line scan linearity is typically ±2 per cent of picture height, 0·5 per cent with very expensive models. Also important are absence of ripple (i.e. 50 or 100Hz mains hum) on the raster and full correction of raster distortion (scan-error and pincushion effects).

(3) Breathing. Raster size should be virtually independent of beam current. This calls for very good e.h.t. regulation. Domestic TV sets have improved greatly in this respect in recent years but a good monitor will do better, with perhaps a maximum variation of 1·5mm in picture size from cut off to full rated beam current. More on this later.

(4) Black-level clamping. A driven clamp is better than a d.c. restorer. Any clamping carried out during the back porch of a composite, chroma-encoded signal needs a clamp softener in the form of a reactive or resonant circuit between the clamp and signal to prevent crunching of the colour burst.

(5) Tube resolution. Most monitors use high-definition tubes.

(6) Convergence tolerance. This depends on type of tube but can be better than a standard production tube by a factor of up to five.

(7) Stability. Drift of important electrical characteristics with time and temperature is minimised by careful design. A strict maintenance and recalibration timetable may be specified.

(8) Input facilities and interfacing. A general-purpose monitor will be able to accept a choice of input levels and types.

(9) Scan frequencies. As you go up the price scale you find instruments with 625/525-50/60 switching and automatic height compensation; field rates between say 38 and 80Hz, interlaced or not; and line scan rates up to 38kHz. These very high scanning frequencies are relevant only to wideband monitors with very high resolution tubes.

(10) Switchable scan amplitudes. An underscan mode will facilitate inspection of the extreme borders of the picture since they will be within the visible raster area. A 1:1 aspect ratio may be provided. See Fig. 1.

(11) Pulse cross facility. A useful feature of some professional and broadcast-standard monitors is their ability to display the line and field blanking periods and the signals these contain. This is done by switching delay monostables (about 10msec for the field, 20μsec for the line) into the sync pulse paths. This mode of operation shows sync dropouts, the burst, blanking, vertical interval test signals (VITS), reference and other test signals.

Other similar features on high-specification monitors include split screen, where the upper half of the display is in monochrome so that the effect of colour on a

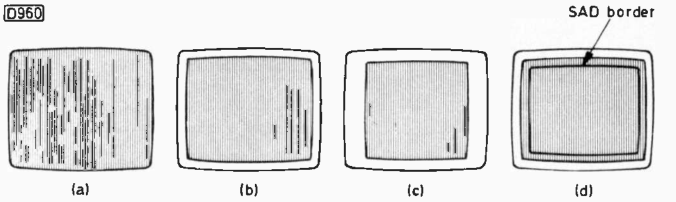


Fig. 1: Rasters. (a) Normal. (b) Underscanned. (c) With 1:1 aspect ratio. (d) SAD border on underscanned raster.

Table 1: Comparison of TV/monitor characteristics.

Characteristic	*Domestic TV set*	*High-grade monitor*
−3dB video bandwidth	5MHz	10–20MHz
CRT spot size	450µ*	260µ
Triads per picture width	400	860
Maximum convergence error	2·2mm	0·7mm
Breathing size variation	4mm	<1mm
Maximum geometrical error	3·5mm	<2mm
Scan linearity	±5%	±0·5%

*Greater at high brightness levels.

monochrome display can be evaluated; built-in generators of crosshatch, step-wedge and full-white displays for alignment; and vertical collapse, in which the height is reduced to about ten per cent of normal for quick cut-off adjustment.

(12) SAD – Safe Area Display – in which an internally generated box/frame is added to the display, see Fig. 1(d). The idea is that scene elements can be positioned for safe transmission even when the monitor is operating in the underscan mode.

(13) Scan failure protection. Beam extinction in the event of failure of either timebase in order to protect the tube. A lamp may provide indication that the protection circuit is operating.

Monitors usually have a minimum of external knobs, though a contrast control at least needs to be accessible to compensate for varying ambient light conditions in the viewing area. Some of the best monitors have calibrated brightness and contrast controls. Typical accessories include light hoods, anti-glare screens and polarizing filters. Some monitors are rack mounted, 51cm being the largest tube size that can be accommodated in a standard 19in. rack: others may be mounted on special plinths and finished to match the equipment (e.g. a computer) with which they are intended for use.

Table 1 compares some domestic TV/monitor characteristics.

Monitors are generally designed for either picture reproduction or data display, the main difference between these two categories lying in their video amplifiers. In both cases good bandwidth and fast rise times are required, but those intended solely for data display very often have "triggered" video or RGB amplifiers, i.e. there are only two states, either on or off. An in-between class is the TTL-linear type, where the computer can control the brightness which is typically confined to two levels – we'll return to this. Some monitors have amplifiers that cater for all these requirements, being able to handle analogue signals and those with just two or three levels.

Uses

The traditional uses of monitors are in studio and OB work, for editing VCR material and in CCTV installations. A growing field is that of advertising, mainly at point-of-sale – there's one each in my local bank, Post Office, Woolworths and Debenhams. Other roles are as "information boards" at travel termini; for Prestel services (particularly in travel agents); as computer VDUs, both personal and professional; for interactive learning; in CAD (computer aided design); for industrial process control, TV games displays in public places, and scores of others. High-definition TV, both monochrome and colour, needs a special display system.

Receiver-monitors

There's a growing trend amongst TV setmakers to adapt or design their chassis so that they can accept baseband video signals directly, either in RGB or CVBS (composite video, blanking and syncs) form. The receiver-monitor is a versatile device – the excellent design and performance of current TV chassis make them suitable for

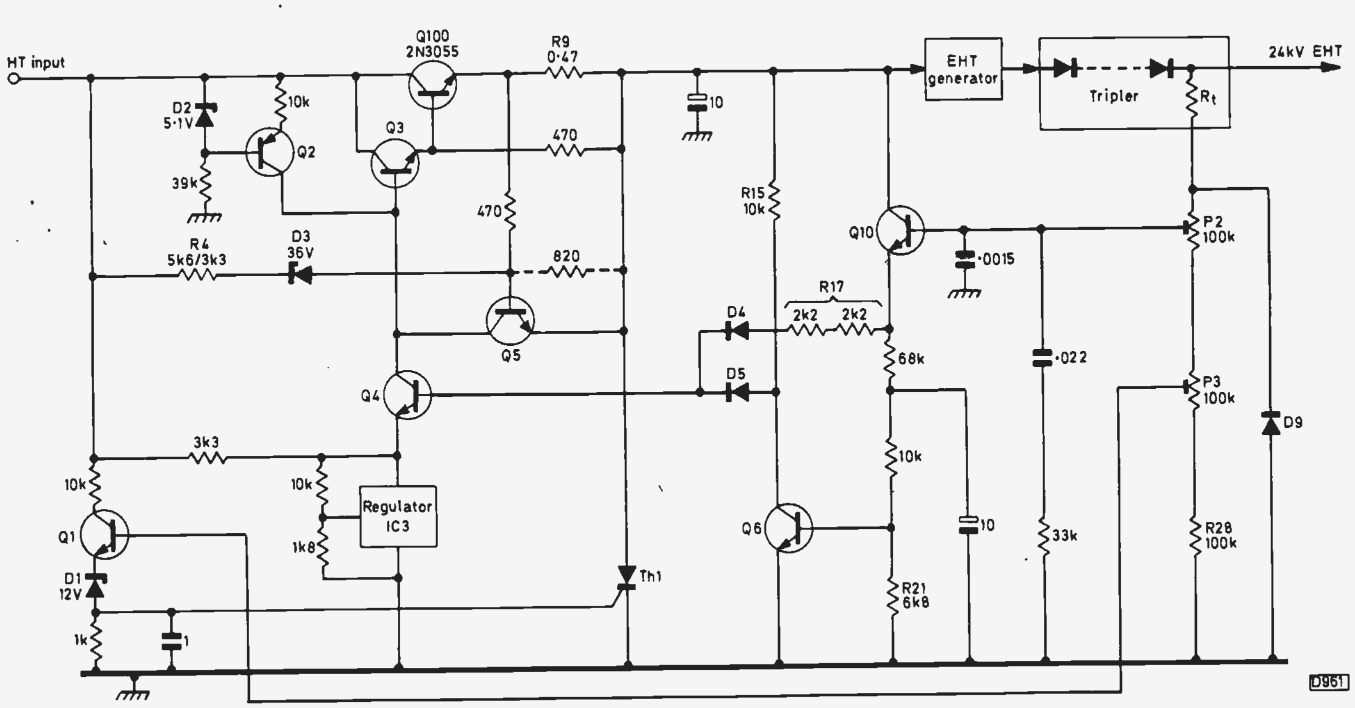


Fig. 2: E.H.T. regulation and protection system used in the Barco CTVM3 series monitor.

this use. At present there's no standard form of video connection, though the SCART socket (also known as the Euroconnector or peritelevision plug/socket) is being increasingly used. Details are given in the data card that accompanies this issue of *Television*. Some monitors have BNC connectors, some DIN, others a plug/socket type exclusive to the manufacturer.

EHT Regulation

Many very good monitors derive their e.h.t. supply from the line output stage in the conventional manner. Given careful design, this arrangement can provide excellent results, especially with an anti-breathing circuit that measures the beam current (typically via the tube's Aquadag return line) and applies a compensating bias to the width and height circuits to maintain constant picture size despite varying brightness levels. For consummate performance, a separate e.h.t. generator with a feedback stabilising loop can be used. One such circuit (from the Barco CTVM3 series) is shown in Fig. 2.

The e.h.t. voltage is measured at source via the potential divider Rt/P2/P3/R28, the sample thus obtained being applied to the base of the emitter-follower buffer transistor Q10. The output from this is passed via R17 and D4 to the base of comparator transistor Q4, whose emitter voltage is held constant by stabiliser IC3. Thus Q4's conduction depends on the e.h.t. voltage. To assist in stabilising the action, Q2 and D2 provide a constant-current supply. Q4 controls the base of Q3 which in turn drives the series regulator transistor Q100. This completes the stabilising loop, whose operating point is established by the setting of P2.

At switch-on the e.h.t. voltage will be zero and Q10 will be without base bias, i.e. it will be cut off. So a start-up system is required. Q4's base is then biased via R15 and D5. Once Q10 turns on and the voltage across R21 rises to 700mV Q6 conducts, reverse biasing D5.

There are several protective features built into the circuit. D9 provides flashover protection at the sampling point. In the event of excessive e.h.t., for example due to Q100 going short-circuit, Q1 will conduct, firing the crowbar thyristor Thl as a result of which an h.t. fuse blows. In the event of excessive e.h.t. current the voltage across R9 will rise so that Q5 conducts, reducing the drive to Q3 and in turn Q100. To prevent a pumping action, Q5 is latched on by R4 and the 36V zener diode D3 until reset by switching the monitor on and off again.

Resolution

The ultimate aim with a TV display system is to reproduce very fine detail, the virtue of a monitor being largely judged on this basis. Ultimate resolution depends on many factors: we'll discuss the main ones briefly, starting with conventional 625/50 standard pictures.

The TV image consists of a mosaic of tiny dots of light, coloured or white as the case may be. The 625-line picture is made up of two interlaced fields, each consisting of 287·5 lines – the rest are taken up by the field blanking interval. Thus a total of 575 lines is available for the picture pattern, less a few lost at the top and bottom of the screen due to the overscan that's usual in most TV sets. The number of lines determines the absolute limit of the vertical definition but there are other limitations. Any detail fine enough to occupy only one scanning line will have a high degree of flicker, because its refresh rate will

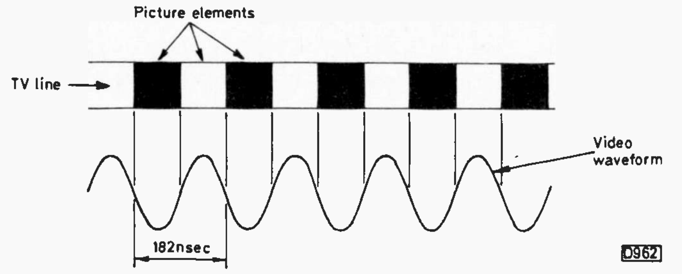


Fig. 3: TV scanning line with maximum detail, with the corresponding video waveform shown below.

be at frame frequency, i.e. 25Hz. Flickerless reproduction will occur only with vertical detail that occupies an even number of adjacent scanning lines. The interlace performance of the field timebase is also relevant: in the worst case (zero interlace, with the lines of each pair of fields superimposed), the effective vertical definition will be halved and a very coarse line structure will be seen.

There's a third factor to be considered before we go on to horizontal definition. This is the Kell factor. If the TV system is fault-free and correctly adjusted throughout, it's perhaps reasonable to expect that we should see 287 eqi-spaced white lines drawn on a blackboard at which a camera is pointed. This would represent the maximum possible vertical definition – 575 alternate black and white lines across the screen from top to bottom. We wouldn't see them however! Because the lines on the blackboard are unlikely to be exactly aligned with the scanning lines, and because at normal viewing distances the picture's line structure is not discernible, the practically realisable vertical definition is reduced by 25–30 per cent, leaving us with about 430 lines worth of effective vertical definition. This is relevant only to optically generated pictures: data displays are electronically generated on individual and precisely defined lines, and provided the viewer is close enough to the screen to see the individual scanning lines the Kell factor is irrelevant.

Horizontal Definition and Bandwidth

There's little point (in analogue TV pictures anyway) in having unequal vertical and horizontal resolutions, so optimum horizontal resolution equals the vertical resolving power. Theoretically, each picture element (pixel) will then be square. With the standard aspect ratio of 4:3, we should aim for $430 \times (4/3) = 573$ individual dots per scanning line.

Now the line blanking period is 12μsec, which leaves 52μsec out of the total 64μsec line cycle as active picture time. Assuming the worst case (see Fig. 3), where the pixels along a scanning line are alternately black and white, this would mean changing the video signal from zero to white, then to black and finally back to zero in the space of two pixels. With 573 pixels per 52μsec, one cycle of video signal must take place in $(52 \times 2)/573 = 0{\cdot}182\mu$sec. This determines the video bandwidth required. One cycle in 182nsec equals 10^9/182Hz, i.e. 5·5MHz, which is the bandwidth allotted to the luminance signal in broadcast television. If the video system can pass a sinewave at this frequency, we shall have somewhat rounded leading and trailing edges to each pixel. This is what happens with a conventional TV set. If the video channel can accommodate a 5·5MHz squarewave, our pixels will be truly square! The greater the monitor's video bandwidth, the sharper each pixel's "attack" and "decay"

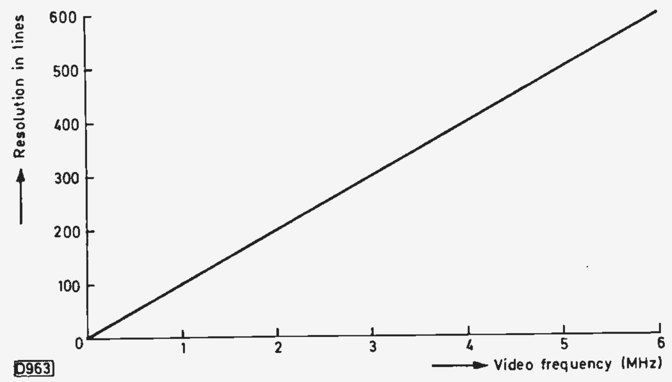


Fig. 4: Video signal frequency plotted against resolution in lines for the standard 625/50 system.

will be: provided the rest of the signal chain lives up to this, sharper edges will be seen. The broadcast channel can only just manage a 5·5MHz sinewave, so extra bandwidth is relevant only to video sources such as computers, text displays and so on. VCRs, video disc players and domestic cameras all have bandwidth restrictions and PAL coding systems, so high-quality display systems are wasted on them.

Next we need to relate bandwidth to rise time. Rise time is the time it takes for a system's output signal to get from ten to ninety per cent of its final level when the system is presented with a true step-waveform input. The formula is $t = 1/(2f\text{max})$ where t is the rise time in μsec and $f$max is the upper limit of the system's passband in MHz. Thus an amplifier whose -3dB limit is 5MHz will have a rise time of $1/(2 \times 5) = 0{\cdot}1\mu$sec or 100nsec. To convert the other way, $f\text{max} = 1/2t$, i.e. an amplifier with a rise time of 20nsec can be expected to handle sinewaves with frequencies up to 25MHz.

The horizontal resolution capability of items like cameras, VCRs and picture tubes is very often quoted in terms of lines, and it's useful to relate this to video frequencies. Fig. 4 compares line resolution with video frequency, and shows for example that a VCR with a horizontal resolution of 270 lines will easily resolve the 2·5MHz test card gratings while a monochrome camera rated at 400 lines should pick up the 4MHz gratings when viewing a test card. Sometimes a vertical definition figure is quoted, usually approximating to the horizontal figure. It will generally be less that the theoretically possible 575 lines (Kell corrected, 430 lines) due this time not to bandwidth limitations but to vidicon spot size, optical constraints in cameras and the use of identical field or line averaging techniques in other equipment.

Video Output Stages

In a class A video output stage – see Fig. 5 (a) – the bandwidth is limited by the considerable stray capacitance in the load. Stray capacitance is contributed by the transistor's body and its heatsink, the land area of the PCB, the wiring to and the construction of the tube pin and socket and associated spark gap, and the capacitance of the tube's cathode to adjacent electrodes, principally the heater and control grid cylinder. This lot can add up to 10pF or more, which has a reactance of less than 3kΩ at 5·5MHz. It's not difficult to see the advantage of mounting the video output stages on the tube's base panel. The frequency at which the response falls to -3dB is given by $1/(2\pi CR)$, where C is the stray capacitance and R the load resistor, so for a 5·5MHz response the value of the load resistor would need to be less than 3kΩ, which would make for very high dissipation in the video output transistor. In practice a higher value load resistor is often used, the resultant h.f. fall-off being compensated for my means of an inductive element in the collector load circuit or a low-value emitter decoupling capacitor – C1 in Fig. 5 (a) – to give frequency-selective negative feedback.

More significant though is the effect of stray capacitance on signal rise and fall times, which become unequal in a circuit of this type. Assuming c.r.t. cathode drive, the video output voltage is low for white, high for black. On the leading edge of a white picture feature Tr2 is being driven on, its low collector-emitter resistance quickly discharging the stray capacitance to give a fast fall time (attack) and a sharp leading edge to the object displayed. On a transition from white to black the tube's cathode voltage must rise sharply, and Tr2 is turned off to achieve this. The stray capacitance must charge to the new, higher voltage, and its only charging path is via R4. This *RC* combination forms a time-constant that permits only a relatively slow rise time and recovery to black. The result is a smeared trailing (right-hand) edge to white objects. This is acceptable in low-cost and small-screen TV sets and for low-definition graphics, but it's a non-starter for a self-respecting monitor.

The problem is overcome by using a "balanced" video output stage, of which there are two main types. One employs a complementary pair of npn/pnp high-voltage output transistors in a class B circuit. The more common circuit is the so-called class AB one in which an emitter-follower is added as an active load to a common-emitter transistor. A typical arrangement is shown in Fig. 5 (b): it's used by Microvitec in their range of monitors to provide an 18MHz bandwidth. This results in excellent analogue pictures and data displays.

Trl is a basic class A amplifier whose gain is set by the ratio of R6 to R1/2. R3/4/5 set the d.c. conditions. Trl's load resistor R7 is effectively shunted by Tr2 on white-to-black transitions, providing a low-impedance path so that the load capacitance charges rapidly. As Trl turns off, D2 becomes reverse biased so that Tr2's emitter voltage rises quickly under the influence of the base bias provided by R7. Signal h.f. compensation at the input is provided by

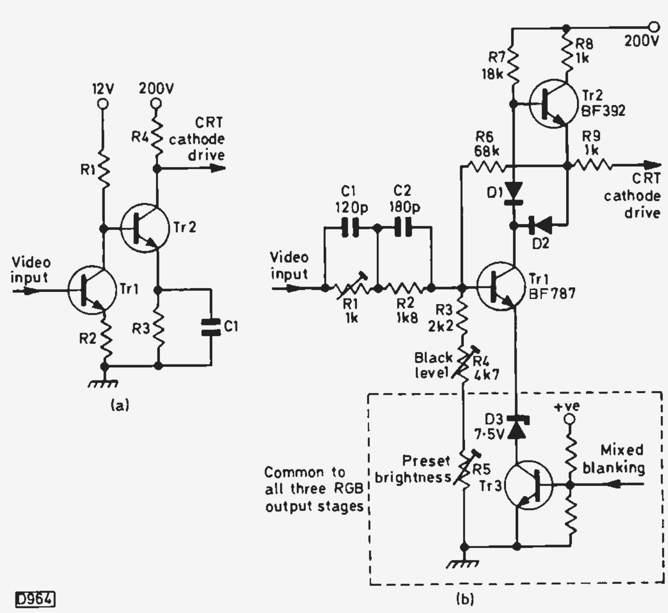
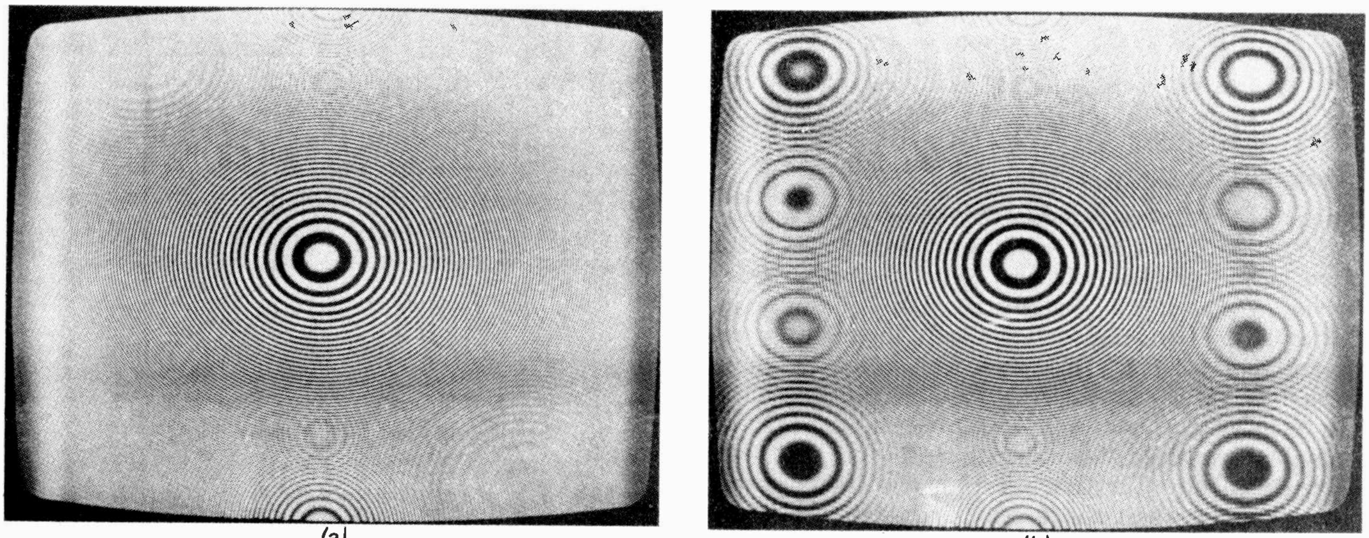


Fig. 5: Video output stages. (a) Simple class A circuit with driver. (b) Class AB circuit as used by Microvitec.



(a) *(b)*

Fig. 6: Off-screen photos of a green zone-plate image. (a) Monitor display. (b) Display after passing through a PAL codec.

C1 and C2. Tr1's emitter is held steady at 7·5V by zener diode D3, whose ground connection is interrupted during the field and line blanking periods by switching off Tr3.

Colour Codec

The three colour coding systems in use (NTSC, PAL and SECAM) were all designed for compatibility with existing monochrome TV systems, and achieve this by means of a band-sharing arrangement in which the luminance and chrominance components are interleaved. What price do we pay for this bandwidth economy? The main visible effect is a degree of cross-colour on fine detail, be it test-card gratings or picture features like striped suits and distant railings. The effect of cross-colour is brought out in Fig. 6, where (a) shows a studio picture of a zone plate consisting of concentric and graded rings of primary green and (b) shows the result of passing the zone plate signal through a PAL codec. The cross-colour effect adds spurious patterns (in blue/yellow and red/green) centred on luminance frequencies corresponding to the colour subcarrier frequency. Also present in encoded pictures are more subtle effects like cross-luminance, a moving luminance dot pattern adjacent to chrominance transients.

The main problem with an encoding system such as PAL is the inherent definition limitation however. The chroma signal bandwidth is little more than 1MHz, permitting a maximum horizontal colour definition of about 100 lines. The vertical colour resolution is much better than this because of the 575 active line scan structure, though the signal averaging process carried out in the delay line circuit considerably reduces this. Even so, for colour we have unequal vertical and horizontal resolution, resulting in such effects as the half-coloured letter T, where the vertical bar is virtually colourless while the horizontal bar is coloured. This sort of thing is particularly noticeable in titles (and other small picture features) where there is no marked change in luminance between letter and background. Another characteristic of PAL and similar systems is the barely adequate chroma signal-to-noise ratio (most obtrusive on large coloured areas).

The presence of the 4·43MHz (for PAL) colour subcarrier means that a notch filter centred on this frequency has to be included in the luminance channel to remove the worst effects of dot-patterning in coloured areas of the picture. This inevitably knocks out fine luminance detail as well, which is the second and less obvious definition penalty with shared-channel encoding.

What a catalogue of woes to lay at the door of the PAL system! With a normal moving picture however the original concept of PAL (and NTSC before it) works very well by coarsely brushing in colour over a relatively high-definition monochrome picture. Subjectively judged by those more interested in the programme material than in picking holes in the system it's quite adequate. There are special decoding systems that can remove cross-colour effects and offer higher luminance definition – by the use of sophisticated comb-filter techniques in both the chroma and luminance channels. These techniques are used in the better monitors, but they're expensive and the subjective improvement they offer is not sufficient to justify their use in domestic TV sets.

The main PAL defects come to light (literally!) where the chroma signal has no luminance back-up: where the picture consists mainly of coloured areas (a good example is computer graphics) the horizontal definition is effectively reduced by a factor of five. You can demonstrate this on an ordinary TV set by removing the luminance signal so that chroma only is displayed on the screen – the picture is very hazy and woolly. For a more graphic demonstration of the combined deficiencies of PAL encoding and VCR bandwidth limitation try recording data and graphics from a text adaptor, TV game or home computer on a VCR and play back the result – coloured areas resemble wobbly jellies full of maggots.

Modulation

The PAL and similar systems were conceived for broadcast use. Why do we go to all the trouble of PAL encoding a signal, modulating to u.h.f., then tuning, demodulating and decoding with two pieces of equipment less than a metre away, suffering all the above constraints in the process? Very simply, because the only signal access to the average TV set is via the aerial socket – and the live-chassis technique so widely used means that other forms of connection are dangerous. Now that the live-chassis era is disappearing we can look forward to much higher quality pictures where these are there to be had – if only we could standardise on connector types, signal exchange levels and similar interfacing details.

VCR Clinic

Reports from Derek Snelling, M. S. Barakat, Steve Beeching, T. Eng. (C.E.I.), John Coombes, Les Harris and Ian Hutton.

Fuses and Clocks

Further to the fuse blowing in the Toshiba V31B mentioned in the July Clinic, Toshiba report that they are aware of the problem which is caused by spiky mains supplies. They suggest changing the value of the mains filter capacitor from 0·1μF to 0·0047μF. Whether this cures the problem remains to be seen. I've since had three Sanyo VTC5150s and two Ferguson 3V35/36s that blew their mains fuses either for no apparent reason or because two-way mains adaptors were being used.

Thanks to Peter Clark for an explanation of the teletext clock problem, which we've seen once more. The difference was between local and national ITV magazines. **D.S.**

Hitachi VT19

Now to a few faults with the Hitachi VT19. A common problem is sound instability due to the audio switching relay contacts. Modified relays are now fitted and are supplied as spares. The following modification can also be made. Change resistors R462L and R462R from 2·2kΩ to 680Ω and add diodes (type 1S2076 or 1SS133) between these resistors (IC405 end) and the bases of Q415L and Q415R, with the cathodes of the diodes to the bases of the transistors. These modifications may give further improvement or make it unnecessary to change the relay. Another fault is the timer microcomputer resetting due to the 10V regulator transistor Q1795 overheating and going open-circuit. Change the transistor to a 2SD468 or 2SD882. Also replace wire link K1788 (between pin 5 of RC1795 and the 10V line) with a diode (type 1S2076, 1S2473 or 1SS133), anode to pin 5, and decouple pin 5 with an 0·22μF capacitor (add between pins 4 and 5 of RC1795).

The final fault was with one of these machines that recorded perfectly: in playback however if the long/standard-play switch was in the long-play position and a standard-play cassette was inserted the machine wouldn't always switch to standard play. Now the position of this switch should affect only record: playback switching should be automatic. The switching in record and playback is controlled by IC908 (HA11768): during playback the off-tape control pulses are used to check at which speed the tape was recorded, either pin 15 or pin 16 of the i.c. going high to tell the machine to go into the LP or SP mode. A check showed that the control pulses at pin 7 were correct during the fault condition but the relevant pin wasn't going high. Replacing the i.c. cured the fault **D.S.**

Sanyo VTC9300

Failure to record was the fault with a Sanyo VTC9300. Playback and E-E were perfect but no picture at all was evident on record. A scope check quickly showed that the fault was on board W1 (the one on the left). Much fruitless time was then spent trying to trace the fault with the wrong circuit. The board fitted in this machine was the one used in the later VTC9300PN rather than the VTC9300P. Once the correct circuit was obtained it was a simple matter to trace the signal as far as Q4 which was open-circuit base-to-emitter. It was an obscure 2SA type so an equivalent with a different pin layout was used. I checked the connections twice before fitting the transistor then put it in the wong way round, causing myself a lot of unnecessary worry when the fault still seemed to be there. **D.S.**

Hitachi VT8500

An Hitachi VT8500 came in off rental. I was checking it over and had it on final test when I noticed that pause didn't operate on record though it was perfect on playback. On playback pause merely stops the capstan motor after shunting the noise bar off the screen. On record the tape is rewound slightly, the loading motor operating until the loading switch switches off – this is sufficient to disengage the pinch roller, the capstan motor being left running. In this machine however the loading motor wasn't running long enough to disengage the pinch wheel. The loading switch was operating correctly, but no matter how it was positioned it operated too soon.

The search for the cause of the problem was a long one, but after removal of the upper and lower cylinders, the capstan motor, the pinch roller, the tension band, various levers and the subchassis the machine was finally stripped down to the point where the fault was found – a small metal spring which controls the position of the arm that operates the loading switch was incorrectly fitted (probably during manufacture). A fault that had probably been on the machine for two years without being noticed, caused by a spring being about ⅛in. out of position, had taken at least four hours to fix. If the machine had been sent out with the fault it would have been odds on that the customer who took it would have been the one in a hundred who uses pause on record! **D.S.**

Fuse Blowing

I've had the same problem as Derek Snelling with the Toshiba V31B – fuse blowing. The capacitor change mentioned above provides the cure. You get the same problem with Sanyo VTC5000s and Toshiba V9600s. **S.B.**

Mitsubishi HS302

Intermittent timer operation and a tendency to shut down during play was traced to the take-up motor. If you have to change it note the height of the turntable before you remove this – so that it can be replaced at the same level after changing the motor! **S.B.**

Toshiba V8600

This Toshiba V8600 had a colour fault. It played back a prerecorded tape with no problem, which should have been the first clue. Replay of its own recordings was reasonable except for a bit of colour reversal – a flashing effect which could be removed by adjusting the a.c.c. control. The main fault could easily have been missed, no colour in still picture. Regular readers will have notes on the still-picture circuits of this machine pinned up all over the workshop as we've reported a few brain teasers in this area in past issues. The signal levels around IC204, Q228 and the delay line X204 were checked to no avail, so the record a.c.c. level was monitored. Guess what – no pilot burst! The fault was due to the CX130 switching i.c. (IC202) which is used to insert the pilot burst. Funny how the machine managed to replay its own recordings in colour – normally the colour-killer operates when the pilot burst is absent. **S.B.**

Toshiba V5470

This machine was one of our rental stock. I'd just fitted new heads, belts, etc. when I noticed that it was not recording video. As new heads had just been fitted, maybe they were intermittent or something . . . anyway, to get to the point there was little or no f.m. reaching the record amplifier, which is on the audio board, from the video board. So checks were made on the video board. There was f.m. at the modulator (pin 30, IC401) but no output from the two transistors that follow this (Q404/5). The coupling capacitor C419 (0·022μF) turned out to be leaky, upsetting the bias conditions at the base of Q404. **S.B.**

Hitachi VT9500

Failure to record was the fault on this machine so checks were made around IC201. The signal level at the input to the record amplifier (pin 28) was only a few hundred millivolts and the output at pin 25 was not much better. The i.c. was replaced, with some difficulty, after which we had 4V peak-to-peak at pin 25. Much better. **S.B.**

JVC HR7700

No nothing was the problem and there was a cassette in the machine. The fact that there was no eject drive was not surprising as the 23V unregulated motor supply line was missing. Fuse F5 had blown and a replacement did the same thing. The reservoir capacitor C36 was short-circuit – or at least very leaky. **S.B.**

Sharp VC9700

The problem with this one was no line sync in both forward and reverse visual search. A check was made on the drum servo frequency-to-voltage converter i.c. It was working correctly but the off-tape control pulses were unstable in frequency – all over the place they were! The visual search presets couldn't be set of course: the fault was due to the reel motor. A replacement restored stability once everything was set up. I replaced the idler pulley while I was about it. **S.B.**

Hitachi VT8000

The fault with this machine was failure to record. On test we found that there were no E-to-E signals. A further check showed that the "not playback 12V" supply was missing – this supplies the tuner, the i.f. panel and the presetter board, and comes from regulator transistor Q066 on the system control panel. The cause of the problem was that R069 (1·5kΩ, $\frac{1}{2}$W) which feeds the reference zener diode in the regulator circuit had gone open-circuit. Replacing this restored all functions to normal. **M.S.B.**

Panasonic NV777

If there's lack of line lock, check whether the drum PG pulse is present at TP2006. If not, replace the drum. If the PG pulse is present, check whether the switching pulse is present at TP2011. If not, suspect IC2003 (AN6346N). If the switching pulse is all right, check the squarewave output at pin 27 of IC2001 (MN6168VIA). If this is missing, replace IC2001. If it's present, check IC2010 (AN6677) by replacement. **J.C.**

Sanyo VTC5000

For no results, check the mains fuse F5201 (315mAT). If this is open-circuit and a replacement blows, check the switch-mode power supply chip IC5101 (STK7216) by replacement. **J.C.**

Blaupunkt RTV211

Smoking was the reported complaint. This was found to be due to a loose screw, as a result of which diode D1007 had gone short-circuit. After replacing several components the machine still didn't work, due to no output from the STR1096 9V regulator i.c. There's a Blaupunkt depot just down the road, so I called in for a replacement. One of the technicians there said it couldn't be the i.c. as it never goes faulty. Well, if you're reading this Gordon – it *was* the i.c.! **L.H.**

Sharp VC9300

The fault was no rewind. Fast forward was all right but when the rewind button was pressed the machine continued in fast forward. The system control board was released, and on trying again the machine started off in fast forward then went into rewind. The culprit turned out to be relay R7751 which changes the polarity across the reel motor – it's energised in rewind and was sticking. **L.H.**

Sony C9

The tuner produced no signals and there was no clock and no programme numbers. As a start, the control voltage to the tuner was checked and found to be missing. It comes from the collector of transistor Q101 on panel TU24. Finding no voltage here either, I checked back to the 38V source on the power supply panel (board D). The source is pin 3 of a d.c.-to-d.c. converter circuit which is a sealed unit. Again there was no voltage, and although I managed to open the unit it was difficult to carry out any tests. A replacement converter module cleared all the faults on the machine. **I.H.**

Sony C5

The head drum motor on this machine had stopped. I could get it to start by pressing fast forward or rewind then going straight into the play mode, or by pressing play and then spinning the drum by hand. The machine would then work all right until stopped.

There's a head drum motor start-up circuit on servo panel AS-6. When the machine is switched on, pin 18 of IC1 (CX186) should initially be at 10·8V, dropping to 7·2V when the drum rotates. In fact there was no voltage at pin 18. The start-up circuit is connected to pin 21 of the i.c. and consists of an *RC* network and a link via D1 to the drum rotation detection circuit. The voltage at pin 21 was only 0·8V at switch on instead of 10·4V – it drops to 1·8V when the drum starts to rotate. A check on the components connected to pin 21 revealed that the diode was short-circuit. **I.H.**

Letters

CHOPPER SUBSTITUTE

The BDX32 seems to be a suitable alternative to the 2SC1942 as the chopper transistor in the Hitachi NP6C chassis (Service Bureau, July). I've used it in a number of these sets with no callbacks. In the event of intermittent power supply operation caused by suspected dry-joints the only cure seems to be to clean all the joints on the power supply section of the board and resolder them. Note that connections G1 and G3 on the power supply/deflection board go to the signals board and not to "CPT board T" as shown on page 22 of the manual (no. 338) for Model CWP132.
Paul Hardy,
Reading, Berks.

VINTAGE HI-FI

Our antiquarian Chas E. Miller's article "A Vintage Hi-Fi TV Sound Unit" with its impedance matching problem took me back to the mid-fifties when I worked in the McMichael research and development department. I remember building a push-pull amplifier to evaluate the performance of a pair of ECL80 valves: Mullard claimed 3W undistorted output into a 12kΩ anode-to-anode load with 200V h.t. My efforts at producing this output failed however. I was stuck at 2·5W until, in desperation, a 15kΩ transformer was tried. Then, eureka, we had the 3W. This information was passed on to Mullard who sent us an amended specification, so Chas's "rule of thumb" is spot on.

Incidentally, McMichael were in the forefront of radio receiver design, producing dual-speaker sets in the early thirties – anyone remember the "Twin Supervox"? Having found that twin speakers improved sound quality I've always used them, both for radio and TV, just one pair, the siting not affecting the illusion of sound coming from the screen. In mono days I used an RS matching transformer with three isolated windings for interfacing. Nowadays with stereo I use a simple system that may interest readers as it entails only a changeover relay, see Fig. 1. Most stereo equipment has 8Ω outputs with one lead being common, so the normally closed relay contacts parallel the speakers for TV use. When the stereo amplifier is switched on the relay coil is energised and the contacts connect the speakers to the stereo outputs. I use a 240V mains relay, e.g. RS 348-762. The problem of TV sets with direct output can be overcome by the use of a suitable transformer for isolation – RS supply one that's useful up to 15Ω. This system will not give bass response from TV equal to stereo but is an improvement on the TV speaker.
William Harrison,
Windsor, Berks.

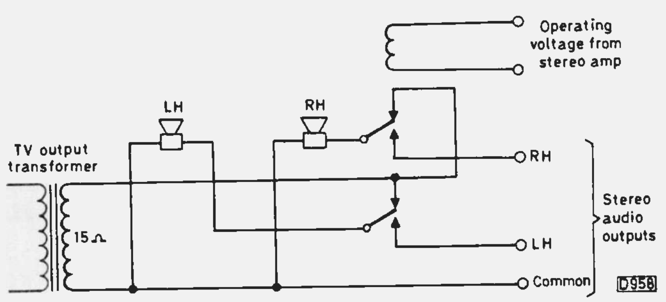


Fig. 1: Relay-operated dual-speaker system for mono/stereo operation.

COMPONENT TESTER MODIFICATION

I've built the component tester described in the June issue and am using it with a Telequipment D61 oscilloscope. The tester's X output was far too great for this scope on external trigger, also the × 5 X amplifier does not operate on external trigger. I've therefore modified the tester as shown in Fig. 2. This seems to work all right and it's useful to have the extra X amplitude with high-value capacitors. Perhaps there are better ways of doing things?
Dr. J. Rankin,
Harpenden, Herts.

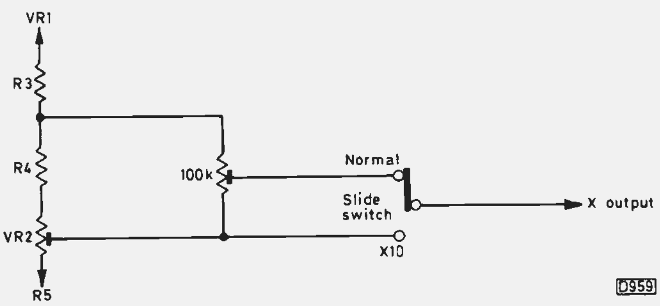


Fig. 2: Modification to the scope component test unit.

BASEBAND LINKS

I agree with Eugene Trundle (letters, August) that the loss of picture quality as a result of feeding PAL coded signals from a VCR etc. via a u.h.f. link rather than at baseband is small, even negligible. I believe however that there are good reasons for adopting the baseband approach. If one wishes to connect two or three VCRs or other video sources, e.g. a disc player, to one TV set simultaneously there's often insufficient range of modulator tuning adjustment for each double-sideband output to be given a clear piece of spectrum. This is particularly true when, as occurs in this area, the local TV transmissions are in this part of the band. In addition, whereas a baseband connection can just be plugged in and used, a u.h.f. output needs to be tuned in, which can be time consuming – especially with an unfamiliar search-tune system.

There's also the question of sound. For many years now I've listened to TV sound via an external hi-fi amplifier and speakers, so I'm perhaps more critical than most of TV receiver sound quality. In my experience the modulator-demodulator link is responsible for a significant part of the loss of sound quality when using a VCR. Problems include poor frequency response due to inaccurate pre-emphasis, video buzz – particularly when using still frame, shuttle search etc. – and background whistles.

There should be no need for tangles of wires. A combined audio/video connecting lead is easily arranged and results in only one extra connection between the VCR and the TV set. The problem of sound leakage can only be due to the well-known reluctance of TV set manufacturers to spend any money on the audio side of their products. A properly engineered audio switch within the TV set should cause no problems and will, I believe, result in noticeable improvement in sound quality.

I use a modified Philips Model 1250 (K30 chassis) which accepts baseband signals from a Grundig 2 × 4 Super and a modified Philips N1700. Video and audio switching is performed within the TV set, the selected video signal being fed to the PAL decoder and the selected audio signal to a socket at the back. The audio is then connected to the auxiliary input of my Quad 44 preamplifier. The internal audio amplifier in the TV set is not connected, as the volume control used with the TBA120 is not available for external inputs. I haven't bothered to make alternative arrangements for this because I wouldn't use them anyway.

David Looser,
Ipswich

On being fooled

Les Lawry-Johns

Just when you think you've completely mastered a particular chassis and feel that it can't hold any more heartache for you, one comes in and grabs you by the short and curlies. I'm sure it's done to deflate one's ego – if it ever gets a chance to inflate.

The T20

A Rank T20 sat on the bench and looked at me. I looked back and sneered. "I'll have you done and working in five minutes" I told it. The sheet said no results. Well, what else would it say?

I whipped the back cover off, plugged it in and waited to see if the tube's heaters glowed. They didn't. I applied the meter to the body of the BU208A line output transistor, expecting to find an unenergetic 200V. The reading was low. This suggested that the BU208A was short-circuit: removing the collector screw and checking with the ohmmeter showed that it was. So I fitted another and disconnected the tripler, just in case. I switched on and the heaters glowed. A nice rushing noise came from the speaker. I advanced the lead to the tripler input. The tube's heater went out and the sound died.

I removed the lead and the set remained quite dead. So I switched it off and on again. Still nothing and the reading across the new BU208A was low. I stamped my foot in anger and the cat ran out through the kitchen window. Another BU208A up the spout. I fitted a second one and a new tripler. All was ready. Switch on, buzz, nothing. The voltage at the collector of the BU208A was this time 200V. So I went through the usual routine: check the resistors, the low-value one over on this side and the high one over on that; check the EW modulator diodes; check the line driver transistor and its supplies. I disconnected the new tripler just in case. The sound boomed out and the heaters lit. After checking a few capacitors I connected the tripler again. Set dead but the BU208A lived on.

Think. If the new tripler is at fault why isn't it hurting the BU208A? It must be passing a high current through the protection circuit. Fit another tripler. Just the same. Think again. Something connected with the tripler has happened, probably as a result of the original faulty one. This means removing the panel yet again to check through the small items on the protection subpanel. I felt angry and wished the cat was around so that I could kick it.

I shouted out to Honey Bunch "bring the bloody cat in".

"Oh no, not for you to kick it" bawled back H.B. "She's your little pet and the only time you want to kick her is when you can't do your job properly. Kick yourself instead."

I did and it hurt. So I took the panel out and carefully checked the small items on the subpanel. 5D5 was leaky (read both ways). "It's all right dearest, call Spock in, it wasn't her fault it was 5D5."

"Heaven protect us from him" mumbled H.B.

Thought: if a faulty tripler can murder a hefty BU208A it can certainly do in a 1N4148 diode.

The G11

Ah well, a dear old Philips G11 won't be any trouble at all. Probably a short-circuit BU208A, defective 470μF h.t. reservoir capacitor, possibly a short-circuit BY223 EW modulator diode and maybe a faulty BD238 EW modulator driver transistor over on the other side. No bother, nice after the agony of the T20.

Take the back off and note that the two 3·15A mains fuses have shattered. Simple, just check the bridge rectifier diodes. Two short-circuit. In went a couple of BY127s and two 3·15A fuses. Bob's your uncle.

Bob's not my uncle and never was. Bang went the two fuses. Check more thoroughly. A short-circuit OT121 thyristor. Well I never. Fit a new one and check carefully for shorts with the degaussing plug out. No shorts found. Fit two new fuses and switch on. Bang.

"Bring that bloody cat in here. She's spoilt rotten and I'm going to let her know who's who around here. This shouldn't happen to a dog. And where is the dog anyway? Never around when he's wanted."

"Ben can't help you dear. The cat can't and neither can I. Besides that the cat's busy eating the dog's toast.

"Why doesn't she eat her own food?"

"She has."

Bloody rotten cat. Everyone's spoilt in this place. Even H.B. It's only me who's not spoilt, flogging myself to death to keep that lot happy. It's not fair.

"It's probably a dry-joint" said H.B. as she went upstairs to talk to the bird. Oh yes, the bird's spoilt as well.

I looked at the G11 again. It looked back out of the corner of its tube and laughed. I'd a spare power panel and was sorely tempted to fit it and forget the whole thing. But no, too easy. Taking the easy way out is not on. At least not till the going gets really rough. I had time. All I needed was patience.

Check the h.t. fuse to ensure it's the right value. I once found a piece of wire across the fuseholder, reflecting the load back to the mains fuses. Not so this time. It was 1A and there were no shorts up top. So we were still on the power panel. Something was shorting on load and didn't live too far from the mains input. Recheck the diodes, recheck the thyristors. I'd replaced one, why not the other? I did and the fuses still went bang. I went through that board with a fine toothcomb, disconnecting this, that and the other, until my attention was caught by a fairly low reading that should have been high with the other components out of circuit. Then I saw it. A black mark on one of the VDRs. It was reading 15Ω when it shouldn't. So that was it. Voltage dependent be buggered. The battle was over and we were short of 3·15A fuses. "Come on then nice pussy, there's a pretty girl."

Tinker Tim

A truck pulled up outside. On the back were a load of bits of metal and a couple of old fridges. I groaned to myself. Tim had been over the tip and had no doubt found a discarded TV set he thought I would make as good as new for next to nothing. In he came with a Decca CTV – 18in. Bradford chassis.

"This belongs to my next door neighbour. Asked me to run it down to the best bloke I know."

"You mean the cheapest cheapskate in town Tim."

"Oh no Lawry. We all know you're a fair bloke who's got to make a living."

So I looked at it. It didn't have a plug on the end of the lead, so I proceeded with caution. The meter recorded a dead short across the mains. I took the back off and slid out the chassis. A light shone on the on/off switch showed the brown and blue leads connected together on one tag. Charming.

"Well I'll leave it with you Lawry and call back later."

I shone a light on the volume control again and noted that it was of completely the wrong type: 50kΩ linear instead of 500kΩ logarithmic. Oh well. Out it came and a new control was fitted, wiring the leads to the volume control as found (not to the switch of course). Back went the panel and after a few precautionary checks I switched the set on. Turn up the volume but there's no sound. Turn it down and the sound comes up loud and clear. How can anyone do this sort of thing? I took it out again and reversed the outer contact leads. The sound was now o.k.

Only the height and linearity needed adjustment, despite a distinct crack around the glass base of the PL508 field output valve. We've seen this before however and know that the vacuum's not impaired despite the appearance. I wrote out what I considered to be a very moderate bill (daft really). When Tim returned he threw up his hands in horror. "The old boy'll never pay nearly a tenner for it. He only wanted you to look at it."

I won't tell you how the conversation went after that, but I shan't have the pleasure of Tim's company again. There was no old boy, don't worry about that!

Teletopics

VCR NEWS

VCR deliveries in the UK showed a further slight fall in the first quarter of 1984. As mentioned in the June Teletopics, deliveries in the final quarter of 1983 fell by 40 per cent in comparison with the same quarter in 1982. The reduction in the first quarter of 1984 was 44 per cent. It seems that the entire W. European market is experiencing a downturn: European Commission figures show a decline of just over 20 per cent in deliveries during the first five months of the year compared to 1983. The Japanese Ministry of International Trade and Industry, which is responsible for overseeing the EEC-Japanese agreement on VCR deliveries, has as a result authorised Japanese VCR manufacturers to lower prices by 5-7 per cent. In contrast, the UK TV market during the first quarter was buoyant, with CTV deliveries up 15·8 per cent (55 per cent in the case of small-screen colour sets).

The point at which the VCR market reaches saturation in the UK is open to speculation. A recent Key Note report suggests that saturation will occur when 60 per cent of households have a VCR, and that this level will not be reached until the next decade.

New releases include the first VHS machines from Pye and Toshiba. The Pye 65VR20 is a front loader with wired remote control and a suggested price of around £420. The Toshiba machines, Model V55B with manual control and V57B with remote control, are being assembled at Toshiba's Plymouth plant from JVC kits. The suggested prices are £450 and £490 respectively. Sony's SLHF100UB Beta hi-fi model, which was first shown at Cetex earlier this year, is now in the shops with a price tag of just under £600. The helical-track sound recording system is similar to that used in VHS hi-fi machines.

Alps Electric, a leading Japanese manufacturer of parts for VCRs, is considering establishing a factory in the UK. Discussions on grants and financial assistance are taking place between the firm and the Department of Trade and Industry.

The subject of VCR protection was mentioned in this column last July (Videotek's "cassette" which can be locked and loaded into a machine). AVF Ltd. of Dixon Street, Wolverhampton WV2 2BX have now introduced the Videoguard, a lockable, wall-mounted bracket which can be adjusted to suit most VCRs. The price is around £30. Grundig's new VHS model comes with a built-in lock, and it's understood that other manufacturers are likely to follow suit. Some lock designs permit the machine to make timed recordings despite being locked.

Dealers who stock prerecorded tapes and are unsure which of these might be "video nasties" can obtain a list of some 62 titles from the Metropolitan Police, A3(1) Branch, New Scotland Yard, Broadway, London SW1H 0BG. The list has been prepared by the Director of Public Prosecutions and is periodically updated.

TV SETS

An old TV brand name, Philco, will shortly reappear in the UK. In the fifties Philco TV sets were produced at Chigwell, Essex. When the plant was closed in 1962 Thorn acquired the brand name and marketed Philco sets for a couple of years before dropping it. Recent Philco colour sets have been produced at Milan in a factory acquired by the Italian Philco company from Telefunken two years ago. Philco claim to have 12·5 per cent of the Italian CTV market at present. 22in. Philco sets are to be imported and distributed to independent dealers by CIH. If the move is successful the complete range of models, with tube sizes from 14 to 27in., will be made available in the UK.

Sinclair's 2in. monochrome TV sets, which have previously been available only via mail order, are now being supplied to retail outlets. The suggested price has been increased by £20 to £99·95. Akai is planning to enter the TV field. Sony has introduced in Japan a set whose picture can be reversed from left to right via remote control – it's intended for use in barbers' shops etc. where viewers may be watching programmes via a mirror.

The SGS-Ates 250V RGB output chip (see Teletopics, March) has now gone into production. The type number is TDA8150.

ITT have issued a safety warning concerning models CB502, CB602, CB702, CB0506, CB0606, CB9504 and

CB9604 fitted with control panel types CMC50, CMC54, CMC63 and CMC67. The problem is due to the soldering of the on/off switch. All sets should be modified as follows whenever servicing is carried out. (1) Disconnect from the mains and remove the back. (2) Withdraw the control assembly (four screws). (3) On the CMC50 and CMC54, remove the push-button assembly from the control panel (two screws). (4) Solder four wires (two brown and two blue, approximately 12cm long) to the unused connections on top of the on/off switch, ensuring that the brown leads connect to the live and the blue leads to the neutral terminals. (5) Route these four wires the shortest distance around the PCB to the solder side. (6) Solder to corresponding live and neutal connections at PC lands farthest from the on/off switch solder joints. (7) Strap each positive and negative cable pair together, using a cable tie as close to the soldered connections as possible. (8) Reassemble and test.

CABLE AUTHORITY CHIEF

The government has appointed Richard H. Burton, until last year chairman of Gillette Industries, to be chairman of the Cable Authority which is to license new cable TV companies and supervise services. A second batch of cable licences is expected to be issued during the autumn. A deputy chairman, chief executive and five other authority members are still to be appointed.

Of the eleven originally licensed cable operators, only four have plans to start services soon.

INTERFERENCE

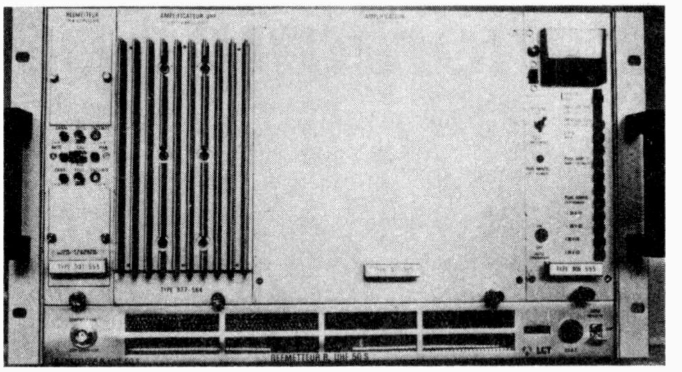
The Department of Trade and Industry has taken over from British Telecom control of the Radio Interference Service, which has been renamed the Radio Investigation Service to reflect its activities more accurately. The RIS at present has some 260 field investigators who check on interference to authorised broadcasting, land mobile radio and emergency services. From now on the RIS will form part of the DTI's Radio Regulatory Division.

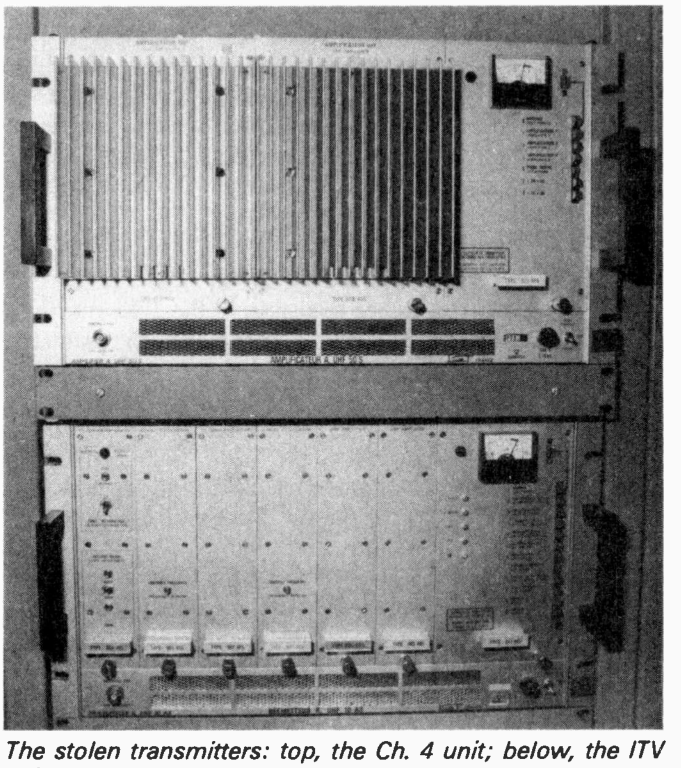
The Home Office plans to abolish licensing for various low-power radio devices that include garage-door openers, radio-microphones, radio aids for the deaf and some types of anti-shoplifting tags. Stringent controls on type approval for such devices would remain in force, and manufacturers/importers would have to prove compliance before licence-free appliances could be sold. The DTI has issued a green paper to interested parties for comment. The present licensing regulations will continue until an exemption order is made.

SATELLITE TV

The five firms selected by the government to form a "third force", along with the BBC and the ITV companies, in setting up a UK satellite TV service are Thorn EMI, Granada TV Rentals, S. Pearson, the Virgin Group and Consolidated Satellite Broadcasting. The various parties involved in the proposed UK DBS service have already held meetings at the BBC and have set up working groups to consider various aspects of the project – one of these groups is considering the technical standards to adopt. The Home Secretary has called for a report on the progress of negotiations between the parties by the end of September. Latest estimates put the capital investment required at around £580 million. It seems that the commercial "third force" would prefer a larger stake in the project than initially proposed.

Peter Gray, managing director of Satellite TV Antenna Systems, says that his firm will be able to supply a complete domestic satellite TV installation – dish, downconverter and receiver – for about £250 when the service starts. He feels that the cost will fall below £100 once demand has developed. Interesting to compare this with the £320 suggested by Luxor recently. There's a large element of guesswork in this sort of thing at present of course.





The stolen transmitters: top, the Ch. 4 unit; below, the ITV units.

TRANSMITTER THEFT

Two transmitters have been stolen from the Ivybridge relay station near Ermington, Devon. These were used for ITV and Ch. 4 broadcasts – the older BBC transmitters were left. The Ch. 4 transposer is of LGT (French) make, serial no. 92, receives on ch. 32 and transmits on ch. 49 at 50W. The ITV transmitter consists of two units, both of LGT make: low-power transposer serial no. 9 which receives on ch. 25 and transmits on ch. 42, and amplifier serial number 238. Both sets of equipment were removed by unscrewing from drawer/cabinet frames, with connectors unscrewed and left behind. The equipment is understood to be worth £20,000 and could be used for pirate TV operation. Anyone with any information on this equipment should contact Detective Inspector John Alford, Devon and Cornwall Constabulary, Police Station, Plympton, Plymouth PL7 3AJ (telephone Plymouth 336 471).

Panoramic Spectrum Display

Denis G. Mott

Occasionally in my line of work quantities of multiband varicap tuners have to be repaired and tested. Unless sophisticated test equipment is available, laborious manual realignment is required after transistors and/or varicap diodes have been replaced.

To simplify matters I devised the spectrum display system described in the following article. It's applicable to ATV and DX-TV as well as to tuner alignment. A commercial 1GHz spectrum analyser would cost many hundreds of pounds. The unit described below can be constructed for a fraction of this outlay. A block diagram of unit is shown in Fig. 1.

Description

Many varicap tuners are available in the UK, but there are few Band I/III/u.h.f. types. For the DX-TV enthusiast however a multiband analyser is of greatest use. Fortunately Grundig's European tuners are available, e.g. type 29500-027-07. This incorporates a pin diode attenuator with a control range of 0 to −16dB. The voltage required to tune from ch. 21 to ch. 68 is 0-30V; the tuner requires a 15V supply for Band selection, and 0-12V to operate the attenuator.

As a Grundig tuner was selected for the project it was common sense to partner this with a Grundig i.f. module which will be correctly matched. I.F. module type 29301-022-44 was adopted. Various SAW filters are available for different bandwidths: some to note are OFW431 (4·5MHz), OFW361 (5·5MHz) and OFW362 (6MHz). By earthing pin 7 of the i.c. and taking the output from pin 12, the i.f. amplifier is used as a peak detector, i.e. the a.g.c. system is altered to peak-level detection.

A scope with a Y bandwidth of d.c. to 10MHz is more than adequate. An Hitachi V212 was used, but many similar scopes could be adapted. The drawback with most modern scopes is that a sweep output socket is not provided. In the V212 the sawtooth sweep can be taken from the junction of R551/IC550 pin 15. Unfortunately it's an a.c. waveform (see Fig. 2), so modification is necessary before it can be used to provide the 0-30V tuning voltage swing for the tuner. This is done by using capacitive coupling, a d.c. restorer, and an operational amplifier to produce the ramp shown in Fig. 3. The circuit is shown in Fig. 4. Depending on the type of scope used, ramps of various amplitudes will be encountered. If it's necessary to alter the amplifier's gain, change the value of the feedback resistor RG.

Use

The flat bottom at the start of the ramp (wait period) is important. This ensures that the varicap diodes are completely discharged (the tuning circuit is of high impedance, with some small stray capacitance in the circuit). If the diodes are not allowed to discharge, the lower end of the band will be missed. The d.c. level preset can be adjusted to alter the wait period – its effect on the display is to shift this to the left or right depending on the length of the wait. The scope's timebase sweep should be about 10msec/cm for minimum display flicker while allowing the varicap diodes time to discharge fully. If a faster sweep is used the diodes will not recover and the start of the sweep will be chopped off.

Fig. 5 shows the spectrum of an internal cable signal distribution system we use. Peak 1 is ch. 37, peak 2 ch. 44, peak 3 ch. 47, peak 4 ch. 55 and peak 5 ch. 68. The signal input level at the aerial socket is 1mV except for ch. 47.

The equipment described consists at present of a group of modules forming part of another piece of equipment that's used for aligning tuners. The more adventurous enthusiast could add a frequency marker and a more elaborate attenuator, thus achieving a more definitive signal measuring set.

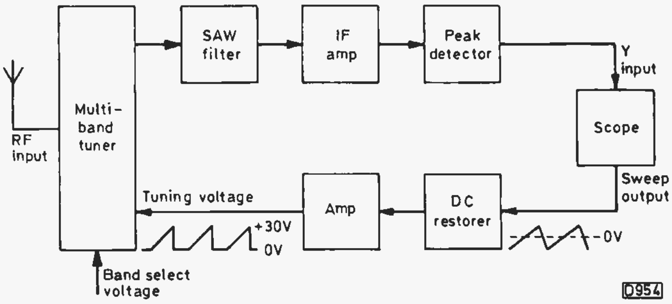


Fig. 1: Block diagram of the unit.

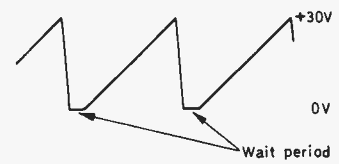


Fig. 2 (left): A.C. sawtooth waveform.
Fig. 3 (right): Waveform obtained after processing.

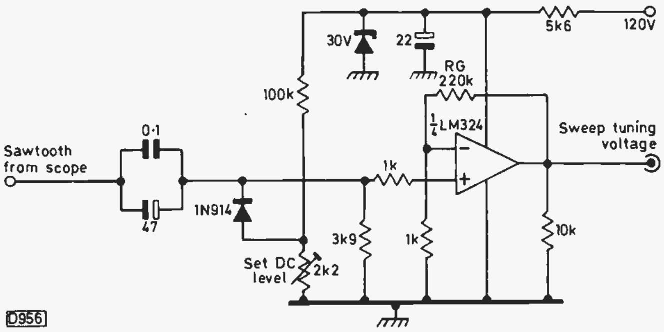


Fig. 4: D.C. restorer and amplifier circuit.

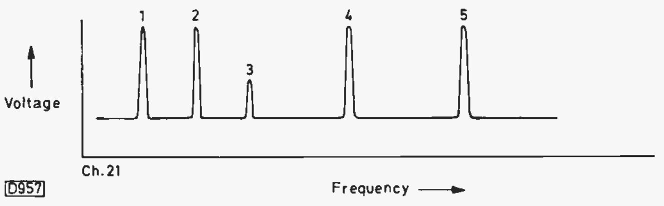


Fig. 5: Spectrum display of a cable signal distribution system – see text.

Pre-War Television

Harold Peters

"As I was saying before we were interrupted . . ." Leslie Mitchell's opening words when 405-line television recommenced after the 1939-45 war began an era of technology and discovery that this magazine has covered faithfully, from the conversion of VCR97 radar c.r.t.s to TV use at the beginning to the current offerings of ECS-1. But what of those three years of TV before the war, when the technical features of TV broadcasting were being established? My boyhood days were spent in SE London, which gave a me a view of those eventful years . . .

Crystal Palace

It was 1936. "The Crystal Palace is on fire!" Pausing only to finish scorching my gym shorts for tomorrow's PE I rushed to join neighbours at the local vantage point, a railway footbridge from which we used to get a free view of the celebrated "Brocks Benefit" firework displays. I was witnessing the ultimate in bonfires, the destruction of Crystal Palace itself.

As the hot ash from three miles away rained down upon us we queried how something built entirely of iron and glass could catch fire so readily. We didn't know then about the spontaneous combustion of decades of rubbish that had been swept through the gaps in the Palace's wooden floorboards, so we laid the blame fairly and squarely on "that Mr. Baird" who had been carrying out television experiments in part of the building close to the South Tower. We were not the only ones to do so apparently, as the papers next day put great stress on the fact that Baird's experimental work had suffered little damage in the conflagration.

Low-definition TV

Baird wasn't exactly Top of the Pops in the early thirties. For several evenings we were deprived of our wireless entertainment while the BBC allowed him to transmit his experimental 30-line low-definition TV broadcasts. These took up prime listening time, with the vision content radiated (it sounded like bagpipes warming up) on the National programme while the accompanying sound (meaningless to anyone without a Nipkow disc set) hogged the alternative Regional programme.

Even if you had a Nipkow disc set only one eye at a time could watch the tiny 2 × 2in. picture, while the rest of the family stood in mortal danger of being impaled by the flying disc as it spun loose from its spindle, loosened by progressive attempts at controlling the motor speed to obtain a stationary picture.

Alternative Systems

Rumour had it that Baird's work at Crystal Palace involved a much higher definition picture, including colour. However true it was, the real breakthroughs were taking place in the EMI laboratories at Hayes. In addition to developing the 405-line TV system we are only just dismantling today, the EMI team had discovered a way of detecting approaching aircraft. They called this Radiolocation (later Americanised to Radar), and with Hitler's sabre rattling the full import of their work was not wasted on the military of the time. So secrecy became a problem, especially with factories making high-frequency equipment.

EMI's development of the 405-line system embraced the whole package – cameras, transmitters, receivers, outside broadcast units and the tubes and circuitry required. It's incredible to reflect that the whole lot, which still forms the basis of the world's TV systems as we know them today, was developed in the comparatively short time span of eighteen months.

Getting the BBC to adopt the EMI system was not a straightforward business however. The BBC has a history of backing the wrong horses (405 lines postwar, NTSC colour in the early sixties, EMI Percival stereo radio and lately Extended-PAL for satellite TV), and they owed a certain allegiance to Baird who'd promised them a high-definition system. A Royal Commission had failed to make a decision between the two systems, so when the BBC's TV service started in November 1936 it was on a trial basis, one week with the Baird 202-line system, the next week with the EMI 405-line system, and so on. Many of the first TV sets produced to receive the service were switchable, 202/405 dual standard receivers.

There was soon little doubt as to what the outcome of this trial operation would be. The problem that Baird had was that he could offer TV only via an intermediate film process. The studio, in darkness, was scanned by a flying spot of light, its reflected output being recorded on 35mm cine film. This film was rapidly processed and passed through a telecine machine whilst still wet, with a delay of about a minute – at the end of a programme the artists could nip round the back to see the last few seconds of their performance as it went out. It followed too that the sound quality was reduced, to the same order as current cinema sound, since it had to be delayed to synchronise with the vision. The equipment was clumsy and immobile. By comparison the EMI system offered a choice of viewpoints from three mobile cameras mounted on rubber tyred dollies or a standard Vinten film studio crane, with mixing facilities similar to those used for sound broadcasting. The cameras operated satisfactorily in natural (cloudy) daylight and with stage lighting, and under studio conditions with lighting as used by the film industry they could be stopped down to give a very good depth of focus.

The 405-line Specification

Even looked at fifty years on, the original 405-line specification is impressive. The number of lines was chosen so that it would be easy to divide down from the line scan rate of 10,125Hz (c/s in those days) to a field rate of 25Hz. Interlacing was used to reduce flicker, and blanking periods were provided so that the scanning spot would be blacked out during the line and field flyback times. For a 1V peak-to-peak signal, white was 1V, black 0·3V and anything "blacker than black" was used for synchronisation. Gamma correction of the grey scale was provided to compensate for the Ia/Vg characteristics of valves and c.r.t.s. The transmitters at Alexandra Palace were amplitude modulated with positive video (i.e. white represented 100 per cent modulation), using a 45MHz carrier and double-sideband operation. The sound also used a.m., with a 41·5MHz carrier. I seem to remember that the transmitter and its twin stacked arrays of wire dipoles managed about 16kW e.r.p. of vision. It soon became clear that the initial "line of sight" reception predictions were wholly wrong – good results were obtained in the Bromley/Beckenham area which was in shadow from the transmitter by virtue of the Upper Norwood ridge.

Alexandra Palace

There were two studios and a telecine suite at Ally Pally. Both studios were tiny by today's standards, and each control room ran three cameras. Both studios could be linked for major productions, and to make this possible the multicore cables that connected the cameras to the control rooms and thence to the master sync pulse generator were made identical in length to avoid phase errors in mixing. In the original Emitron and Super-Emitron camera tubes the gun was mounted at an angle to the target, instead of the gun/target/photocathode being in line as in the later orthicon type tubes. This meant that unless corrected the image would be trapezoidal in shape and darker at one end than the other. This fact accounted for the gentle and intimate production techniques that were used. Every shot had to be corrected by the operator on the "racks" (one operator per producer, sitting in front of the producer). He corrected for "tilt and bend" distortion by introducing variable sawtooth waveforms as the scene changed.

As now, the cameraman sitting on the dolly merely composed the picture and carried out optical focusing, looking at the scene upside down in an optical viewfinder coupled to the lens. This arrangement permitted a degree of "overscan" so that he could see the other cameras approaching his field of view before they got into his picture. To chop from one camera to another was impractical. Slow dissolves of between five-ten seconds were made, during which the rack operator had time to correct the distortions without perceptibly disturbing the viewer. This quiet method of presentation became so well established that when the orthicon type tube (the first was the CPS Emitron) came on the scene in the early fifties almost all the critics accused the producers of "restless editing". Though most film was shot at 24 f.p.s., telecine ran at 25 f.p.s.: the change in sound pitch was regarded as being acceptable.

Outside Broadcasts

One of the first big TV events was the Coronation of King George VI. For this, two OB units were commissioned. One of them, MCR1, was ready by the day. Each unit was housed in three single-decker bus shells, one a control van for the three cameras and sound, another as an equipment tender and the third a generator van to provide the current. A coaxial cable had already been laid through central London, to be within reach of theatreland and the Olympia exhibition building. This cable conveyed the video signal from the events happening close to its route via Broadcasting House to Ally Pally.

Events off the cable route called for the services of a fourth van, the vision transmitter, which provided an off-air link on what is now Ch. 2 to a reception point on Highgate Hill where it was demodulated and piped as video via coaxial cable to Ally Pally – image rejection techniques were not good enough at the time to allow a pickup receiver to be co-sited on the A.P. mast. The OB unit's transmitting aerial was a horizontally-polarised H type mounted atop a standard Merryweather fire escape ladder.

The Programmes

What of the programmes we watched in the pre-war era? It didn't take long for a pattern to emerge. Up to two hours of general interest programmes in the afternoon, with evening transmissions from 7-10p.m. Saturday night was variety night and because of the intimate nature of the medium Cabaret Cruise became quite popular. Commander A.B. Cambell (later of the Brains' Trust) hosted the show on the deck of a cruise ship with music provided by the BBC Television Orchestra. Plays were performed twice, on Sundays and Thursdays, to justify the settings. They had intervals between acts and a warning bell, as in a theatre bar, to tell of their resumption – a habit carried on almost to the coming of ITV in the fifties.

C.H. Middleton planted vegetables in a patch dug out of the lawn in the A.P. grounds, becoming the forerunner of Gardeners' World, and the three presenters were Leslie Mitchell, whose voice was already familiar from Movietone News, blonde Jasmine Bligh who would go anywhere and try anything, and Elizabeth Cowell who added dignity to any occasion. They would always walk on in evening dress, approaching the camera from a full length view and stopping well before their waists went off the bottom of the screen. Strangely, this three-quarter length view is currently use by the Russians seen via Gorizont!

The precursor of Tonight and Nationwide was Picture Page: Joan Miller operated a dummy video switchboard to introduce celebrities who happened to be in town. Corny? Well, it seemed all right at the time!

The two classic OBs were Wimbledon, which hasn't changed a bit, and the Boat Race. The two OB units were used for the latter event, one at Putney for the start and the other at Mortlake on the finishing line. In between, while the boats were out of sight from either end, we were taken back to the studio where we were shown the progress of the race with a pointer and map whilst listening to John Snagge's radio commentary.

Jasmine Bligh's visits to London Zoo were popular, as were excerpts from West End shows. Even then the entertainment profession was canny about letting you see the whole thing. The pantomime from the Grand Theatre, Croydon, became an annual event at Christmas. It ended in disaster one year when MCR1 suffered a major equipment fire and MCR2 overheated and failed. Another major event was Radiolympia, the early autumn radio show where the latest sets were on show to the public.

The Sets

The pre-war sets had screen sizes of 5-12in. with prices ranging from £28 to £100 – much the same as today, but with the spending power of the pound thirty times as great. Even with wages averaging around £3 a week, 20,000 homes had TV by the summer of 1939.

Flyback e.h.t. had not come into use, the mains derived (lethal) e.h.t. supply being of some 5-8kV. Subdued room lighting was needed, but it was not as dark as at the flicks. Most valves were octal based though some sets had the old, large 7-pin types. Both t.r.f. and superhet circuits were used, with the i.f.s going no higher than 10MHz. Blocking oscillator or thyratron timebase generators were employed and magnetic deflection was the rule, though one or two electrostatic tubes were used. Philips nearly gave the radar game away by offering a set with a green screen! Radiogram cabinets were often adapted, with a mirror in the lid and the tube mounted vertically with the field coils reversed.

Being "Saturday boy" at a local dealer, most of my viewing was done on our demonstration model – a 5in. Cossor with no sound! To get sound you had to connect the audio output to the pick-up socket of your radio receiver. Many cheap sets did it this way. At the other end of the range, Baird had linked with Scophony to market a rear projection set with a ground glass screen measuring about 2ft 6in. × 2ft. The modulated light beam scanned the screen via a rotating mirror drum and you had to turn the sound up to cover the motor's noise!

Test Cards

I cannot remember seeing a test card as such. There was the tuning signal which was transmitted on film five minutes before the start of programmes. This had a mid-grey background, two small grey scales and a central circle which contained vertical focusing bars. I doubt if the edge was castellated. At times a mixed programme of documentary films was put out in the mornings for demonstration purposes. An electronic pattern consisting of a black cross on white, known to the BBC as "art bars", was available from the master pulse generator by taking suitable squarewaves from the counting chain.

At the end of evening programmes the radio symphony concerts would sometimes be radiated in sound only to take advantage of the full bandwidth v.h.f. transmissions. I was never up late enough to see what, if anything, was transmitted on the vision channel at the same time.

Radiolympia 1939

As previously mentioned, the various models available were shown annually at Radiolympia, which was more of a public affair than a trade show. Extended television hours permitted demonstrations throughout most of the show's opening time and as the years progressed things got more sophisticated. In 1939 a closed-circuit TV network and a huge theatrical set gave us the thrill of being in on a live broadcast. Even programmes for radio listeners, such as the Kentucky Minstrels, were televised within the exhibition. Lionel Gamlin, the first announcer to introduce humour to the work and survive the wrath of Lord Reith, acted as the anchor man.

Close Down

The queues were missing however. The antics of Mickey Mouse on the huge Scophony Baird screen attracted no attention. People gathered around the few battery portables that could pick up outside news bulletins despite Olympia's screening. It was Saturday, September 2nd.

Next day Chamberlain made his famous speech, the sirens sounded their first warning wails, and one very frightened youth ran indoors to find his gas-mask case. The world's first public television service had come to a halt.

Servicing the Grundig 2×4 Super

Part 4

Mike Phelan

The motor connection board behind the tape deck is probably the most awkward of the modules to work on – there are plugs and sockets connected to both the top and bottom edges. The best that can be done is to pull the board up as far as it will go, to the extent of the leads.

A couple of important points here. The insulating sheet must always be replaced, otherwise the "tea-tray" will short out any long leads on the print side of the panel. Also make sure that the plugs are correctly fitted – there's one spare edge connector at the bottom, next to plug L6. Fortunately most machines have plug connection diagrams on the tea-tray and on the head preamplifier cover below the deck.

Various troubles can be encountered on this board – autostop failures come high on the list. As the cassette is of the turnover type, the two sensors are stacked one above the other – the roles are reversed when the cassette is turned over. They operate by sensing the difference in reflection between the normal tape and the stop foils.

Two operational-amplifiers are wired as a type of comparator, with the two optosensors connected to opposite sense inputs of each. The other two inputs are connected to a potential divider. The outputs close electronic switches in the key/switch scans to the microcomputer. See Fig. 7.

Failure of either autostop will result in the end of the tape being pulled out of the reel. This can be repaired quite easily. Grundig cassettes use adhesive tape to attach the ends, Philips cassettes use a small plastic peg – don't lose it.

For autostop testing and adjustment a useful tool consists of a strip of Paxolin or similar material with a piece of tape and stop foil glued to each end – see Fig. 8 (a). With a cassette inserted, first check that the voltage at test point MA1 (top of panel) is about 2·5V. Remove the cassette, lower the carriage by operating the switch on the front flap, engage fast forward or rewind and use the foil on the gadget to reflect on to the stop sensor. The voltage at MA1 should rise to about 4V or drop to about 1·2V depending on which sensor is energised: one sensor only will cause the machine to stop, depending of whether fast forward or rewind was selected. Problems are usually due to wires broken off a sensor, adjustment of the preset BEA or, less frequently, failure of the operational amplifier IC1210 (LM324). The gadget prevents pulling the ends out of your entire tape collection – the speed at which this machine winds doesn't give you much time to find the stop key if test point MA1 doesn't do its stuff! Another cause of problems here, sometimes intermittent, is a hairline crack across edge connector L3 due to rough handling.

The other half of IC1210, together with transistors T1248 and T1251 (BD616 or BD898), drive the two reel motors. Two control voltages come from the microcomputer. In the event of failure of either transistor replace them both, together with IC1210, and before switching on check R1211/R1232 (both 2·7Ω) for being open-circuit.

The two reel tacho signals are amplified and converted to fixed width pulses on this panel – if either is absent or low in amplitude the autostop will be slow to operate and the "P-time" indication may give strange readings or display "cass" even with a tape inserted. Low reel motor torque on playback is usually the result of the 12V supply being low – see Part 1, July. For APF and fast wind, T1254 switches the supply to 20V.

The loading motor is driven from IC1230 (L293B) which occasionally goes short-circuit, causing the power supply to trip – check by disconnecting plug CP3.

Up to now we've not had any problems with the head motor drive circuit, though the motor itself sometimes develops an intermittent fault, refusing to start and locking up. This is caused by a shorted turn in one of the stator windings. Two different motors (Siemens and Papst) have been fitted: the stators are of different diameters but are interchangeable provided the rotor is also changed.

The Deck

The tape deck is very robust. The lower drum and all tape guides are mounted on a massive casting which also provides screening for the head preamplifier. The DTF will try to compensate for any tape path errors, so it's not much use looking at the shape of the f.m. envelope – the only way to check the tape path is to look at the DTF waveforms on the two slipring brushes, using a double-beam scope. The active period should be as nearly flat as possible (see Fig. 9).

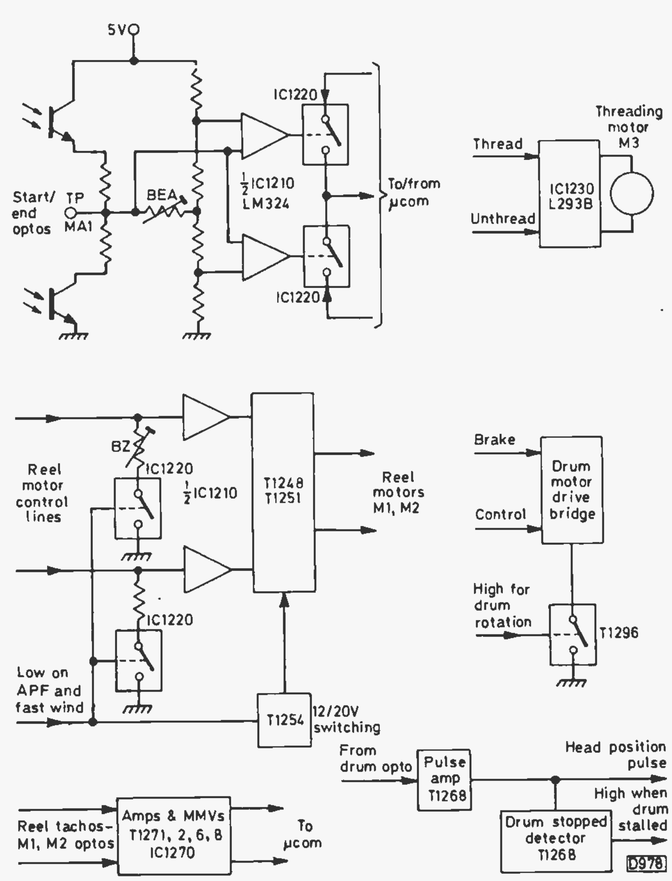


Fig. 7: Motor connection board block diagram.

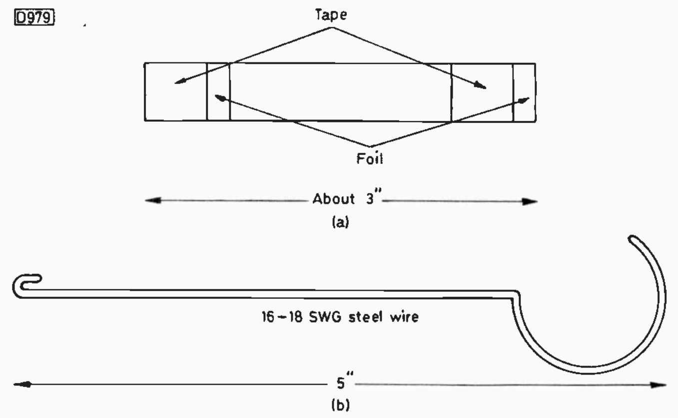


Fig. 8: Simple servicing aids.

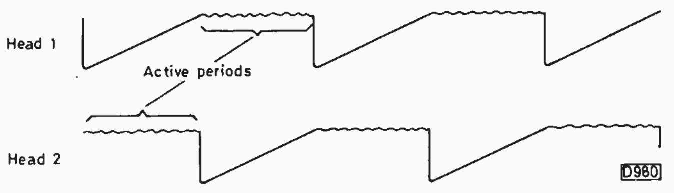


Fig. 9: DTF waveforms at slipring brushes.

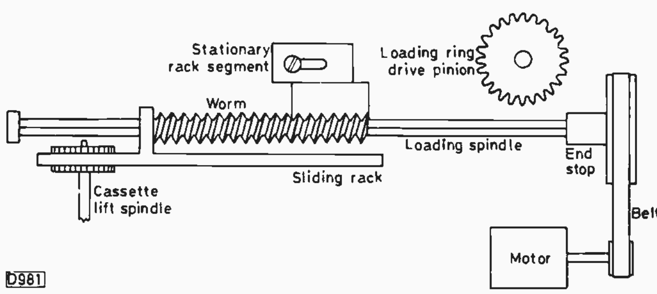


Fig. 10: The loading mechanism.

Don't be tempted to twiddle any of the tape guides: most tape path problems can be blamed on things like ridges of tape oxide on the capstan or in the lower drum groove.

There are various switches associated with the tape deck. Two of them correspond with the unload and after load switches on VHS machines, but their operation is slightly different. Conductive segments on the loading ring short out the switch contacts, which occasionally loose their tension and need bending slightly. If the unload switch doesn't close the machine won't accept a cassette and the reel motors will rotate all the time. If the other switch isn't making the only apparent effect is that the tape will unthread in record pause.

There's another switch that's operated by the end of the loading rack. Any problems here will result in the ring oscillating in stop, fast forward and rewind.

Occasionally the cassette flap fails to close completely when there's a cassette inserted. This is usually because the leads to the microswitch under the lower flap are protruding and being trapped when the carriage descends.

It's possible for the two sides of the cassette carriage to get out of step with each other – in other words the carriage is tilted. The removal method may not be obvious, making it very hard to take out and replace the cassette lift. The only special tool required is a wire hook – see Fig. 8 (b). Remove the transparent front flap, unhook the two long springs and remove them. The carriage will then lift out. When replacing it, engage the first tooth on each rack with the marked pinion tooth, then hook each spring on to the gadget after passing the latter up from below the deck in the space where the spring goes. Hook the top end of the spring on, then pull the lower end through and hook it on. Replace the flap and away you go!

While on the subject of the cassette lift, one common fault is that after ejecting a cassette the machine immediately reloads. The eject slides are smeared with a slightly sticky grease that collects dust. As a result they stick. If the cassette doesn't slide forward on ejection the microswitch recloses and the cassette is loaded again. The cure is to clean off all the grease then apply a light smear of Vaseline. With no grease at all the machine is quite capable of firing a cassette across the room!

Head replacement is simple, but follow the directions about shims on the spindle given in the manual. Too few and the head will come to a grinding halt after an hour or so as the casting expands and the two sections of the rotary transformer rub together. Be careful not to lose the aluminium collar from inside the motor, and replace the spring with its largest diameter section next to the rotor. The screw needn't be very tight, but lock it with a dab of cellulose paint. Make sure that all wiring is securely clipped in position and can't foul any rotating parts.

Loading Mechanism

This article would not be complete without a description of the loading mechanism (see Fig. 10) which combines the two tasks of loading the cassette, i.e. lowering the cassette lift, and tape threading, i.e. turning the loading ring. This is achieved with the minimum of parts. The worm is free to slide on the spindle but can't turn independently of it due to a longitudinal flat on the latter. The sliding rack operates the cassette lift by turning its spindle. The drive is shown in the rest position in Fig. 10, i.e. with no cassette inserted. When a cassette is inserted the motor runs and the worm turns, screwing itself along the stationary segment and allowing the rack to follow it under tension from the two springs that pull the cassette lift down. Once the cassette is down the worm is up against the end stop and just clear of the stationary rack segment: it's now engaged with the loading ring drive pinion. Because the worm has screwed itself along the segment, it does the same with the pinion, but the latter doesn't turn (yet). When the motor is energised again (on selecting playback etc.) the worm drives the loading ring. There's also a locking bolt (not shown), operated by the sliding rack, to retain the loading ring at its extremes of travel.

Faults here are unusual. The adjustment of the segment is critical however: it must engage the worm cleanly when the latter is just entering the pinion. If not, the end tooth of the segment and the end of the worm thread get damaged. This process is self-perpetuating, the mechanism doing machine-gun impressions on completion of loading.

In Conclusion

Finally, someone asked for further details on the recording we made for dropout adjustment (page 556, Part 2). The small piece of adhesive tape we stuck on the lower drum, about half way round, towards the top, where the tape travels, was about $\frac{1}{10}$in. square. Don't use Sellotape: masking tape is suitable. And don't forget to remove it!

That's all for now on the Grundig. Next month a little chat about cameras, in particular the Ferguson 3V06/3V17/3V20.

ECONOMIC DEVICES, PO BOX 228, TELFORD TF2 8QP

16029	1.58
16181	1.13
16182	1.13
16334	0.88
16335	0.72
16446	0.89
16600	1.25
16799	2.16
16801	0.86
16802	1.03
16803	4.81
16905	1.35
17074	6.00
17127	3.91
17376	1.43
1N4001	0.05
1N4002	0.05
1N4003	0.05
1N4004	0.06
1N4005	0.07
1N4006	0.07
1N4007	0.07
1N4148	0.03
1N4448	0.12
1N5401	0.12
1N5402	0.13
1N5403	0.14
1N5404	0.15
1N5408	0.18
1N914	0.05
1S44	0.06
1S5012A	0.73
1S921	0.09
2582	1.94
2N1302	0.24
2N1303	0.34
2N2218	0.38
2N2219A	0.29
2N2222	0.34
2N2646	0.75
2N2904	0.32
2N2905	0.39
2N2906	0.34
2N3053	0.24
2N3054	0.90
2N3055	0.55
2N3055H	0.77
2N3442	1.05
2N3702	0.12
2N3703	0.12
2N3704	0.12
2N3705	0.12
2N3706	0.12
2N3707	0.14
2N3711	0.14
2N3771	1.85
2N3772	1.55
2N3773	1.65
2N3819	0.28
2N3823	1.06
2N3904	0.56
2N3906	0.56
2N4101	1.10
2N4240	3.00
2N4443	1.35
2N4444	1.12
2N4914	0.65
2N5064	0.64
2N5293	0.45
2N5294	0.45
2N5296	0.40
2N5297	0.45
2N5298	0.55
2N5490	1.35
2N5496	0.45
2N6107	0.53
2N6109	1.43
2N6122	1.60
2N6130	0.65
2N6133	0.57
2N6178	0.66
2N6180	0.66
2N696	0.39
2N698	0.39
2N707	0.39
2SA1027	1.15
2SA1076	1.78
2SA329	0.36
2SA351	1.06
2SA489	1.06
2SA490	1.51
2SA493	0.95
2SA628	1.03
2SA637	1.32
2SA673	1.11
2SA683	1.46
2SA684	1.33
2SA748	0.88
2SA818	1.65
2SA835	2.27
2SA940	1.64
2SA951	1.23
2SA966-Y	0.54
2SB325	3.51
2SB337	1.85
2SB375	3.51
2SB400	0.36
2SB407	2.94
2SB411	3.00
2SB511	1.48
2SB54	1.26
2SB56	1.26
2SB618A	1.40
2SB681	2.44
2SB695	1.70
2SB75	0.94
2SB861	0.88
2SC1034	5.61
2SC1050	3.06
2SC1061	0.54
2SC1096	1.05
2SC1104	2.60
2SC1106	4.12
2SC1114	5.61
2SC1124	1.10
2SC1151A	4.29
2SC1152	4.25
2SC1157	4.12
2SC1162	0.95
2SC1172	1.92
2SC1195	2.83
2SC1213	0.75
2SC1226	1.32
2SC1306	0.85
2SC1307	1.35
2SC1316	3.40
2SC1364	0.49
2SC1383	1.39
2SC1398	0.51
2SC1410	2.17
2SC1413	3.88
2SC1505	0.56
2SC1578	6.67
2SC1617	3.35
2SC1670	2.84
2SC1678	1.25
2SC1810	1.40
2SC1815	0.41
2SC1829	2.01
2SC1875	4.77
2SC1891	3.35
2SC1929	2.25
2SC1942	5.70
2SC1945	4.11
2SC1953	1.75
2SC1957	0.86
2SC1959	0.36
2SC1962	1.75
2SC1969	2.92
2SC2027	2.67
2SC2028	1.91
2SC2029	1.49
2SC2057	1.07
2SC2073	1.40
2SC2078	1.25
2SC2091	0.59
2SC2122A	4.65
2SC2141	1.69
2SC2166	1.35
2SC2216	0.62
2SC2233	2.20
2SC2271	3.64
2SC2278	1.03
2SC2335-KIT	7.61
2SC2526	1.70
2SC2551	0.95
2SC2570	1.80
2SC2570A	0.95
2SC264A	4.38
2SC2671	1.99
2SC2728	0.95
2SC372	1.27
2SC373	1.05
2SC383	1.20
2SC388	0.45
2SC41	1.99
2SC458	0.55
2SC495	0.83
2SC508	3.36
2SC515A	1.28
2SC537	0.49
2SC558	3.35
2SC605L	1.05
2SC620	1.32
2SC643A	1.40
2SC673	1.11
2SC681	4.00
2SC684	1.50
2SC685A	2.62
2SC693	0.69
2SC710	0.62
2SC717	1.92
2SC734	1.30
2SC735	1.05
2SC782	2.24
2SC790	1.15
2SC806	10.26
2SC814	1.26
2SC828	0.25
2SC867A	2.49
2SC926A	1.29
2SC930	0.49
2SC935	3.75
2SC936	1.58
2SC937	3.25
2SC940	4.25
2SD1138	0.78
2SD198	3.51
2SD234	0.42
2SD235	0.54
2SD257	2.67
2SD291	2.67
2SD292	2.35
2SD313	2.59
2SD315	2.67
2SD325D	1.36
2SD350	7.03
2SD350A	2.08
2SD353	3.25
2SD389	2.19
2SD401	1.57
2SD551	2.20
2SD588A	1.25
2SD621	8.88
2SD657	2.54
2SD731	1.72
2SD811	3.86
2SD869	2.40
2SD898B	2.67
40408	0.45
40594	1.39
40595	1.39
40636	0.86
40871	1.39
40872	1.39
60857	1.10
74LS132	0.72
74LS138	0.85
74LS157	0.79
74LS161AN	1.18
74LS196	1.25
74LS20	0.25
74LS244	1.65
74LS30	0.29
74LS367	1.05
74LS373	1.55
74LS47	1.05
74LS73	0.39
74LS74	0.39
74LS75	0.52
74LS86	0.49
74LS90	0.75
74LS92	0.75
74LS93	0.75
74LS95B	0.85
7805 TO-220	0.63
7805 TO-3	1.05
7806	0.66
7808	0.54
7812 TO-3	0.54
7812 TO-220	1.05
7815	0.55
7818	0.55
7824	0.55
AC107	0.66
AC117	0.39
AC123K	0.39
AC128	0.28
AC138	0.08
AC141	0.26
AC142K	0.39
AC151	0.25
AC153	0.30
AC153K	0.36
AC176	0.17
AC176K	0.40
AC179	0.25
AC183	0.65
AC186	0.30
AC186K	0.50
AC187	0.35
AC187-01	0.40
AC187K	0.39
AC188	0.33
AC188-01	0.40
AC188K	0.39
AC193K	0.59
AC194K	0.59
AD140	0.96
AD142	0.96
AD143	0.96
AD145	1.45
AD149	0.81
AD161	0.30
AD162	0.30
AD262	0.95
AF114	2.24
AF115	0.79
AF116	0.79
AF117	0.75
AF118	0.75
AF121	0.50
AF124	0.36
AF125	0.36
AF126	0.36
AF127	0.36
AF139	0.48
AF178	0.75
AF179	0.50
AF180	0.50
AF181	0.48
AF182	0.50
AF186	0.48
AF239	0.48
AF279	0.80
AL100	3.66
AL102	1.75
AL103	2.43
AL113	1.80
AN208	3.22
AN210	2.07
AN214	2.05
AN214Q	2.05
AN231	5.56
AN234	5.02
AN235	4.84
AN236	3.02
AN238	4.98
AN239	3.95
AN240P	1.88
AN241	1.55
AN245	2.54
AN247P	2.62
AN252	2.33
AN253	2.70
AN262	1.58
AN272	5.36
AN281	5.52
AN295	5.01
AN301	3.30
AN302	3.62
AN303	3.50
AN305	8.07
AN313	3.10
AN315	2.12
AN316	5.58
AN318	4.75
AN320	4.97
AN322	4.38
AN331	2.99
AN337	3.99
AN340P	1.06
AN355	3.36
AN362	1.47
AN5111	2.34
AN5132	3.99
AN5250	3.33
AN5435	2.80
AN5610	6.75
AN5613	3.72
AN5620X	4.63
AN6320N	3.89
AN6342	1.36
AN6344	4.88
AN6363	10.20
AN6551	0.56
AN6552	0.52
AN7145	2.04
AN7150	2.22
AN7151	2.05
AN7156	2.05
AN7158	2.34
AN7218	1.49
AP58076	4.25
AS560S	1.43
AU106	1.96
AU110	1.96
AU113	2.15
AY102	2.62
AY105K	1.89
AY106	1.98
BA102	0.30
BA1310 (IC)	1.72
BA1320 (IC)	1.22
BA1330 (IC)	1.82
BA145	0.17
BA154	0.08
BA155-01	0.12
BA156	0.12
BA157	0.17
BA159	0.12
BA182	0.17
BA222 (IC)	1.26
BA284/2	0.15
BA301 (IC)	0.92
BA302	0.90
BA311 (IC)	1.06
BA312 (IC)	0.98
BA313 (IC)	1.28
BA316	0.07
BA317	0.07
BA318	0.08
BA328 (IC)	0.80
BA333 (IC)	1.24
BA401 (IC)	0.58
BA511 (IC)	1.98
BA521 (IC)	1.81
BA532 (IC)	1.88
BA536 (IC)	2.72
BA6304A (IC)	2.65
BA843 (IC)	3.60
BAV10	0.10
BAV18	0.10
BAV19	0.10
BAV20	0.10
BAV21	0.17
BAX12	0.10
BAX13	0.10
BAX16	0.10
BB105B	0.22
BB119	0.15
BC107	0.13
BC107B	0.14
BC108	0.12
BC108A	0.12
BC108B	0.15
BC109	0.11
BC109B	0.13
BC113	0.12
BC114	0.17
BC115	0.14
BC116	0.20
BC116A	0.53
BC117	0.18
BC118	0.18
BC119	0.30
BC125	0.18
BC126	0.18
BC132	0.12
BC135	0.12
BC136	0.15
BC137	0.16
BC138	0.30
BC139	0.32
BC140	0.33
BC141	0.28
BC142	0.30
BC143	0.28
BC147	0.10
BC147A	0.42
BC148	0.11
BC148B	0.11
BC148C	0.11
BC149	0.10
BC149B	0.11
BC153	0.12
BC154	0.12
BC157	0.14
BC158	0.09
BC159	0.14
BC160	0.36
BC161	0.36
BC167	0.32
BC168	0.32
BC169C	0.14
BC170	0.14
BC171	0.10
BC172	0.09
BC172B	0.24
BC173	0.15
BC174B	0.24
BC177	0.18
BC178	0.23
BC179	0.23
BC182	0.08
BC182B	0.23
BC182L	0.09
BC182LB	0.12
BC183	0.09
BC183L	0.09
BC183LB	0.23
BC184	0.09
BC184L	0.09
BC184LB	0.23
BC186	0.24
BC187	0.18
BC204	0.14
BC207	0.12
BC212	0.10
BC212B	0.13
BC212L	0.09
BC212LB	0.23
BC213	0.09
BC213L	0.09
BC213LB	0.23
BC214	0.09
BC214L	0.12
BC214LB	0.23
BC225	0.24
BC237	0.09
BC238	0.09
BC238A	0.11
BC239B	0.08
BC251A	0.15
BC252	0.12
BC258	0.22
BC261A	0.20
BC262	0.20
BC287	0.45
BC294	0.45
BC301	0.36
BC302	0.30
BC303	0.34
BC307	0.09
BC307A	0.14
BC308	0.12
BC308A	0.09
BC309	0.15
BC317A	0.11
BC323	0.92
BC327	0.15
BC328	0.10
BC337	0.08
BC338	0.10
BC360	0.30
BC368	0.23
BC440	0.99
BC441	0.40
BC454	0.32
BC455	0.32
BC460	0.38
BC461	0.42
BC462	0.27
BC463	0.58
BC464	0.50
BC465	0.58
BC477	0.25
BC478	0.29
BC479	0.29
BC532	0.25
BC546	0.15
BC547	0.09
BC548	0.09
BC549	0.09
BC550	0.36
BC556	0.12
BC557	0.09
BC558	0.09
BC559	0.09
BC560C	0.10
BC635	0.18
BC636	0.18
BC637	0.18
BC638	0.18
BC639	0.18
BC640	0.18
BC879	0.28
BC880	0.28
BCX32	0.33
BCX33	0.24
BCX34	0.36
BCX37	0.80
BCY70	0.27
BCY71	0.19
BCY72	0.18
BD115	0.29
BD116	0.63
BD124	1.19
BD124P+KIT	0.62
BD131	0.38
BD132	0.38
BD133	0.48
BD135	0.32
BD136	0.32
BD137	0.32
BD138	0.41
BD139	0.27
BD140	0.33
BD144	1.30
BD150	1.08
BD157	0.80
BD159	0.48
BD160	1.45
BD163	0.84
BD165	0.56
BD166	0.38
BD168	0.66
BD175	0.39
BD177	0.39
BD179	0.44
BD181	0.90
BD182	0.90
BD183	0.90
BD184	1.10
BD187	0.48
BD189	0.35
BD190	0.59
BD201	0.54
BD202	0.54
BD203	0.54
BD204	0.54
BD207	1.00
BD208	1.00
BD222	0.44
BD225	0.44
BD228	0.57
BD229	0.63
BD231	0.45
BD232	0.44
BD234	0.38
BD235	0.43
BD236	0.45
BD237	0.38
BD238	0.29
BD239	0.44
BD240	0.36
BD240D	0.47
BD241	0.45
BD242	0.45
BD243	0.44
BD243A	0.50
BD244	0.44
BD244A	0.77
BD245C	0.80
BD246C	0.74
BD253	0.95
BD278A	0.60
BD317	1.96
BD318	2.00
BD375	0.30
BD377	0.23
BD379	0.69
BD380	0.69
BD410	0.44
BD412	5.70
BD418	0.76
BD433	0.33
BD434	0.39
BD435	0.42
BD436	0.42
BD437	0.41
BD438	0.44
BD441	1.29
BD442	0.56
BD507	0.54
BD508	0.54
BD509	1.29
BD510	0.45
BD518	1.36
BD519	1.36
BD529	0.38
BD530	0.60
BD533	0.60
BD534	0.36
BD535	0.44
BD536	0.55
BD537	0.60
BD538	0.60
BD544B	0.75
BD580	1.06
BD590	1.06
BD598	1.13
BD645	3.62
BD677	0.55
BD680	0.69
BD681	1.34
BD695	2.09
BD696	2.24
BD697	3.27
BD698	1.68
BD699	3.17
BD700	3.36
BD702	2.94
BD707	0.55
BD709	0.72
BD710	0.72
BD807	0.60
BD809	0.60
BD810	0.60
BD879	0.64
BD880	0.65
BD895	1.98
BD899	2.25
BD901	0.55
BDV64B	1.14
BDV65B	1.14
BDX32	1.50
BDX53	0.80
BDX53A	3.08
BDX54B	2.37
BDX62A	1.92
BDX63A	1.95
BDX64A	2.37
BDX65A	2.37
BDX76	0.53
BDY20	1.10
BDY62/01	4.20
BDY81	1.07
BF115	0.36
BF117	0.36
BF118	0.60
BF121	0.22
BF123	0.11
BF127	0.11
BF137	0.11
BF152	0.28
BF153	0.52
BF154	0.23
BF157	0.23
BF158	0.16
BF159	0.16
BF160	0.28
BF167	0.34
BF173	0.30
BF177	0.50
BF178	0.36
BF179	0.32
BF180	0.32
BF181	0.29
BF182	0.30
BF183	0.35
BF184	0.39
BF185	0.35
BF194	0.15
BF195	0.12
BF196	0.15
BF197	0.14
BF198	0.15
BF199	0.15
BF200	0.33
BF216	0.32
BF218	0.32
BF222	0.50
BF224	0.15
BF237	0.59
BF240	0.15
BF241	0.15
BF244	0.23
BF245A	0.33
BF255	0.18
BF256	0.25
BF256LC	0.38
BF257	0.30
BF258	0.29
BF259	0.30
BF262	0.51
BF263	0.51
BF264	0.33
BF271	0.30
BF273	0.18
BF274	0.18
BF324	0.16
BF336	0.27
BF337	0.36
BF338	0.36
BF355	0.36
BF362	0.54
BF363	0.54
BF371	0.45
BF391	0.36
BF393	0.90
BF417	1.20
BF418	1.70
BF422	0.26
BF423	0.26
BF435	0.49
BF450	0.30
BF451	0.26
BF457	0.37
BF458	0.35
BF459	0.35
BF460	0.54
BF469	0.27
BF470	0.28
BF471	0.28
BF472	0.28
BF479	0.55
BF480	0.54
BF495	0.50
BF506	0.39
BF509	0.37
BF523	0.18
BF594	0.24
BF595	0.24
BF596	0.16
BF597	0.24
BF617	0.95
BF618	0.95
BF694	0.20
BF757	0.59
BF758	0.59
BF759	0.30
BF760	0.59
BF762	0.30
BF763	0.27
BF871	0.84
BF900	0.68
BF907	1.82
BF959	0.38
BF970	0.55
BFR39	0.36
BFR52	0.45
BFR62	0.36
BFR79	0.29
BFR81	0.45
BFR86	0.98
BFR89	0.39
BFT41	0.27
BFT42	0.39
BFT43	0.39
BFT84	0.36
BFW10	0.79
BFX29	0.30
BFX30	0.59
BFX84	0.33
BFX85	0.25
BFX87	0.50
BFX88	0.30
BFX89	0.36
BFY50	0.24
BFY51	0.24
BFY52	0.24
BFY90	0.96
BLY49	2.00
BR100	0.20
BR101	0.37
BR103	0.45
BR88B	0.50
BRC-M-300	1.58
BRC116	0.60
BRC1330	1.80
BRC300	1.82
BRC4443	1.12
BRC4444	1.12
BRC5296	0.70
BRC6109	0.75
BRC82	0.98
BRC83	0.98
BRC84	0.98
BRX44	0.54
BRX49	0.45
BRY39	0.50
BRY55	0.60
BRY56	0.38
BSR59	1.17
BSS38	0.30
BSTBD1409	2.48
BSTB01405	4.37
BSTC0146	2.25
BSTC0233	2.25
BSTC0246	4.51
BSTC1233	3.91
BSTC3146	0.71
BSTCC0143	2.79
BSTC0643	3.06
BSV57B	2.66
BSW68	0.38
BSX19	0.30
BSX20	0.30
BSX21	0.45
BSY52	0.45
BSY79	0.46
BT100A	1.46
BT106	1.20
BT106	1.31
BT109	1.31
BT112	2.25
BT113	2.25
BT116	1.52
BT119	1.60
BT120	1.60
BT121	2.25
BT122	2.25
BT123	1.80
BT125	2.25
BT126	2.25
BT128	2.25
BT128P	2.79
BT129	2.25
BT151-800R	1.47
BT151 500R	1.25
BTT8018	2.20
BTT6218	2.20
BTT8024	4.02
BTT8124	4.44
BTT8214	5.44
BTT8224	2.70
BU105	1.66
BU106	2.25
BU108	1.90
BU109S	1.90
BU110	2.52
BU111Y	3.78
BU124	1.25
BU126	1.11
BU134S	4.15
BU204	1.29
BU205	0.98
BU206	1.20
BU207	1.50
BU208	0.98
BU208/02	0.98
BU208A	0.98
BU208D	1.43
BU209	1.60
BU226	2.08
BU312	2.16
BU326	0.75
BU326A	1.40
BU326S	2.25
BU406	1.35
BU407	0.74
BU407D	1.29
BU412	4.80
BU426	1.95
BU426A	1.67
BU427	2.67
BU500	1.61
BU508A	1.33
BU526	1.65
BU608D	1.42
BU806	1.29
BU806D	1.35
BU807	1.40
BU826A	2.79
BUV46	1.13
BUV84	1.12
BUW81A	3.15
BUW84	1.56
BUX84	1.47
BY126	0.11
BY127	0.11
BY133	0.11
BY164	0.50
BY176	1.38
BY179	1.42
BY182	0.95
BY184	0.42
BY187	0.70
BY189	1.20
BY198	2.38
BY201/2	1.36
BY203/20	0.18
BY206	0.17
BY207	0.22
BY210-400	0.24
BY210-600	0.27
BY210-800	0.30
BY223	0.85
BY224-400	0.90
BY225-100	0.79
BY226	0.28
BY227	0.44
BY228	0.54
BY255	0.97
BY298	0.25
BY299	0.25
BY476A	0.76
BYW56	0.30
BYX10	0.26
BYX55-350	0.48
BYX55-600	0.25
BYX71-350	0.67
BYX71-600	0.85
BYX94	0.18
BYY56	1.09
BZV15-C12	0.72
BZV15-C12R	0.72
BZV15-C24	0.72
BZV15-C24R	0.72
BZV15-C30R	0.72
BZX61 Range	0.16
BZX70-C11	0.54
BZX70-C12	0.54
BZX70-C15	0.54
BZX70-C30	0.54
BZX70-C47	0.54
BZX79 Range	0.09
BZY88 Range	0.09
BZY93-C12	0.99
BZY93-C18	0.99
BZY93-C24	0.99
BZY93-C24R	0.99
BZY93-C30	0.99
BZY93-C47	0.99
BZY93-C68	0.99
BZY93-C7V5	0.99
ZTK33	0.39
ZX18	2.47
C106D	0.46
C1129	0.52
CA1310E	2.45
CA3044	3.18
CA3046	2.23
CA3060	1.50
CA3065	1.17
CA3089	3.35
CA3089E	1.30
CA3090	1.25
CA3094	2.00
CA3131EN	2.83
CA3132EN	2.83
CAH76023N	6.00
CBF16848N-07	1.41
CD4001	0.24
CD4002	0.24
CD4008	0.96
CD4011	0.23
CD4012	0.24
CD4013	0.37
CD4016	0.37
CD4017	0.74
CD4020	0.92
CD4021	0.24
CD4023	0.25
CD4025	0.54
CD4028	0.76
CD4047	0.96
CD4049	0.52
CD4050	0.50
CD4052	0.68
CD4053	0.72
CD4069	0.23
CD4081	0.26
CD4093	0.72
CD4511	1.00
CD4517	1.06
CP5521	16.20
CV-12E	2.49
CX034	10.75
CX095D	2.85
CX104	8.49
CX108	6.92
CX109	6.92
CX121	10.75
CX130	4.90
CX131	10.75
CX134	10.75
CX136	10.75
CX137	10.75
CX139	10.75
CX157	4.40
CX158	3.44
CX170	6.92
CX177	5.99
CX506	8.48
CX507	6.92
CX758	6.92
D1893	2.35
DEC1	1.52
DEC2	1.52
E1222	0.36
E5024	0.25
E5386	0.22
E5529	0.22
E8021	1.17
E9003	0.41
E9005	0.45
ER1400	10.12
ESN310BP	3.86
ESM432C	4.18

IF YOU DON'T SEE IT LISTED ASK FOR QUOTE. GIVE MAKE MODEL LOCATION. REMEMBER TO ADD 0.60p POST & HANDLING. ADD 15% VAT TO TOTAL

ECONOMIC DEVICES, REGISTERED OFFICE: 14, BEE LANE, FORD HOUSE, WOLVERHAMPTON WV10 6LF.

ESM532C	4.18
ESM632C	4.18
ESM732C	4.18
ETT8016	2.85
ETTR6016	2.16
FND500	5.25
FT3055	1.05
GF758	0.82
GF759	1.02
GF761	0.78
GH3F	1.65
HA11211	2.30
HA11215	4.80
HA11225	3.90
HA11226	7.56
HA11229	2.51
HA11235	3.80
HA1124	4.70
HA11244	4.32
HA1125	3.90
HA11251	3.38
HA1137W	2.57
HA1138	3.56
HA11414	2.50
HA1144	6.38
HA1156	1.23
HA11580	7.80
HA1160	3.45
HA1166	3.08
HA1167	5.13
HA11711	16.13
HA11713	6.70
HA11714	7.05
HA11715	7.05
HA11718	6.79
HA11724	15.80
HA11725	16.80
HA1180	4.88
HA1203	1.56
HA1306	1.74
HA1322	1.74
HA1339	1.76
HA1342	1.80
HA1350	2.97
HA1365	3.65
HA1366WR	1.62
HA1367	3.20
HA1368	1.69
HA1368R	1.66
HA1370	2.97
HA1377	2.88
HA1389	1.62
HA1389R	1.74
HA1392	2.68
HA1397	2.97
HA1398	2.88
HA1406	1.80
HA17723	5.40
HBF4030AF	2.25
HD4480	15.60
HD44801A05	15.90
HM6231	8.50
HM6232	7.71
HM9102	2.92
HM9104	2.94
HT4207	15.80
IS689	1.87
IS751	1.87
ITT2003	0.20
K174YP	2.95
KA2101	2.65
KC581C	5.47
KC582C	3.45
KC583C	4.80
L129V	1.78
L200CV	1.88
LA1111AP	0.80
LA1201	0.90
LA1210	1.38
LA1320	1.46
LA1352	1.40
LA1357N	5.90
LA1364	2.74
LA1365J	2.79
LA1385	1.70
LA1387	4.57
LA3155	0.90
LA3300	1.40
LA3301	1.28
LA3350	1.30
LA3361	1.30
LA4030P	2.37
LA4031P	3.00
LA4032P	1.48
LA4050P	1.42
LA4051P	1.62
LA4100	1.62
LA4101	1.18
LA4102	2.55
LA4112	4.35
LA4125	2.46
LA4138	2.00
LA4140	0.80
LA4192	2.88
LA4220	1.34
LA4400	2.04
LA4420	1.56
LA4422	1.56
LA4430	1.48
LA4460	1.92
LA4461	2.00
LA5112N	1.62
LA7020	6.86
LA7025	7.31
LA7800	2.12
LA7801	3.80
LD3120	1.20
LM1011N	2.95
LM1017N	1.96

LM1303P/N	1.50
LM1310P/N	1.25
LM3065N	0.77
LM317CKC	1.30
LM339N	0.88
LM3407	1.29
LM340T5	0.75
LM340T12	0.75
LM340T5	0.75
LM342N	0.56
LM384N01	1.84
LM567CN	1.30
LM748	1.65
LM8360	2.78
LM8361	2.78
M1024	2.55
M1025	4.70
M1124	2.54
M1130	4.86
M191	5.74
M193	18.55
M51102L	4.02
M5115P	4.34
M51231P	2.79
M5124P	4.38
M5134-9341	3.75
M51394P	6.25
M5142P	4.38
M5143P	6.86
M5144P	3.42
M51513L	2.06
M51515BL	3.10
M51516L	3.40
M51517L	2.90
M5152L	1.00
M51522	4.90
M5191P	4.49
M5192	2.00
M53273P	0.92
M53274P	1.20
MA06	0.97
MA8001	0.74
MB3705	1.62
MB3712	2.65
MB3713	1.30
MB3730	2.94
MC13002	4.66
MC1303P	1.96
MC1307P	1.90
MC1310P	1.25
MC1327P	1.20
MC1330P	1.23
MC1349P	1.20
MC1350P	1.10
MC1351P	0.75
MC1352P	1.01
MC1357P	1.95
MC1358P	1.55
MC14001	7.15
MC14011	0.23
MC14013	0.37
MC14016CP	0.37
MC14025	0.54
MC14049UBC	0.52
MC1438R	0.95
MC14493P	2.56
MC14510BAL	3.15
MC14556BCP	3.15
MC1712	3.52
MC7724CP	3.17
MC7818C	1.98
MC7824CP	4.25
MC78M12	0.75
MC78M24	0.85
MCR101	0.60
MCR106/5	1.17
MCR220/7	1.34
ME0402	0.27
ME0404	0.23
ME0404/2	0.42
ME0411	0.45
ME0412	0.21
ME4102	0.45
ME545B	9.10
ME6002	0.23
ME6102	0.45
ME8001	0.26
MJ2501	4.95
MJ2955	1.34
MJ3000	2.15
MJ3001	1.30
MJ3028	2.40
MJ481	1.39
MJ802	4.95
MJE2955	1.71
MJE3055	0.78
MJE340	0.44
MJE520	0.44
ML231	2.28
ML232B	3.30
ML237B	2.28
ML238	4.02
ML741CS	0.36
ML923	2.18
ML0926	3.25
MM5314N	3.72
MM5316N	3.72
MM5318N	2.82
MM5369N	1.82
MM5387AA/N	11.50
MM5841N	5.90
MP8112	1.35
MP8113	1.35
MP8512	1.23
MPF256C	0.54
MPS6570	0.43
MPSA42	0.59
MPSA56	0.24
MPSA92	1.11

MPSU05	0.78
MPSU10	0.78
MPSU55	0.90
MPSU56	0.30
MPSU60	1.20
MR510	0.30
MR812	0.80
MR914	0.46
MSSD7002	0.65
MVS240	0.52
MVS460	0.30
MVS460-02	0.55
ME545B	2.95
ME545B	3.80
ME5534N	1.48
ME555	0.34
ME556	0.75
ME5560N	3.16
ME565N	1.20
ME645BN	3.80
ME646N	3.80
ME650N	3.94
ME645BN	3.80
MP1106	4.80
OA200	0.10
OA202	0.10
OA47	0.10
OA90	0.07
OA91	0.08
OA95	0.08
OC28	0.96
OC29	1.95
DC35	0.96
OC36	1.16
OC44	0.40
OC45	0.40
OC75	0.40
ON188	1.70
ON236	2.90
OT112	0.98
OT121	0.70
PD144	2.03
PT1017	2.43
PT2014	2.76
PT6042	1.82
R1038	1.99
R1039	1.99
R2008B	1.20
R2009	1.20
R2001B	1.20
R2029	1.20
R2030	1.20
R2257	2.16
R2265	1.95
R2305	1.07
R2306	1.23
R2322	1.26
R2323	1.23
R2348	1.82
R2354A	1.82
R2354B	1.82
R2441	1.23
R2443	0.80
R2461	2.10
R2477	0.92
R2501	1.16
R2540	1.80
R2540X	3.00
R2615	0.60
RC4195NB	1.96
RCA16029	1.82
RCA16083	4.81
RCA16334	0.92
RCA16335	1.23
RCA16600	1.25
RCA16799	2.16
RCA16801	0.86
RCA16802	0.98
RCA17028	2.25
RCA17074	6.00
RCA17376	1.43
RCA60857	4.50
RGP10	0.45
RT402	1.40
RT905A	2.00
S0280	1.94
S0281	1.94
S041P	1.26
S042P	1.46
S1299	4.30
S175	18.95
S2062D	1.88
S2800	5.25
S2800D	2.55
S2802	3.15
S3702S	4.73
S3703F	4.73
S3707	3.92
S40W	7.99
S551	4.12
S552	4.12
S6080B	2.75
S6087AR	4.45
SAA1020	4.32
SAA1021	4.32
SAA1024	2.55
SAA1025	4.70
SAA1050	3.78
SAA1051	5.30
SAA1061	3.28
SAA1075	4.41
SAA1082	8.04
SAA1121	4.32
SAA1124	2.55
SAA1130	4.86
SAA1174	5.75
SAA1250	3.78
SAA1251	5.30
SAA5000	3.65

SAA5010	4.90
SAA5012	6.50
SAA5020	5.25
SAA5030	7.50
SAA5040A	14.75
SAA5050	8.50
SAA661B	1.80
SAA700	3.00
SAB1009B	4.53
SAB1046P	3.66
SAB3011	7.34
SAB3012	5.34
SAB3013	3.28
SAB3021	7.18
SAB3022B	12.34
SAB3023B	11.18
SAB3024	4.77
SAB3209	4.75
SAB3210	2.93
SAB4209	12.75
SAF1031	2.30
SAF1032	5.60
SAF1039	11.66
SAS5010	7.62
SAS560	1.68
SAS560S	2.97
SAS560T	2.85
SAS570	1.61
SAS570S	0.00
SAS570T	2.50
SAS580	4.41
SAS5800	2.62
SAS590	4.55
SAS5900	2.32
SAS660	2.50
SAS6600	1.20
SAS6600S	1.20
SAS6610	1.20
SAS670	2.50
SAS6700	1.20
SAS670S	1.20
SAS6710	1.20
SAS6800	2.30
SAS6810	1.30
SBA550B	1.95
SBA750	1.46
SC9488P	1.90
SC9503	1.50
SC9504P	1.46
SC9511P	1.90
SCR957	1.20
SG264A	4.38
SG613	7.88
SG629	6.28
SG6533	9.37
SI-1020N	4.76
SI-1125HD	10.70
SI-1130N	6.30
SKB2/08	0.70
SKE2F 1/04	1.26
SKE2G 2/04	0.95
SKE2G 3/04	0.95
SKE4F 1/02	1.26
SKE4F 1/06	0.66
SKE4F 2/06	2.10
SKE4F 2/08	0.60
SKE4G 2/02	0.87
SKE5F 3/10	1.45
SL1310	2.85
SL1327E	1.20
SL1430	1.26
SL1430T	2.10
SL1432	2.25
SL414	3.35
SL432A	3.12
SL437	6.00
SL439	2.25
SL480	5.00
SL490	1.78
SL901B	6.08
SL917B	7.95
SL918A	5.63
SN6848	8.82
SN16861N-07	1.59
SN16862N-07	1.68
SN16880N	3.30
SN16965	8.13
SN16966N	5.49
SN29715N	5.49
SN29716N	3.32
SN29717N	6.53
SN29722	10.65
SN29723AN	6.95
SN29744N	2.08
SN29764AN	3.38
SN29767	3.61
SN29770AN	2.04
SN29771BN	4.23
SN29772BN	4.21
SN29773	2.28
SN29791	1.51
SN29798N	3.89
SN29845	2.14
SN29848	1.66
SN29861	2.08
SN29862	2.08
SN72709	0.40
SN7400N	0.24
SN7401N	0.24
SN7402N	0.59
SN7404N	0.21
SN7408N	0.24
SN7410N	0.24
SN74121	1.20
SN74122	0.95
SN7413N	0.33
SN74141	1.41
SN74151AN	1.51
SN74154N	1.15

SN74190	1.81
SN7420N	0.30
SN7430	0.28
SN7440N	0.24
SN7473	0.56
SN7474N	0.72
SN7490AN	0.93
SN75110N	0.75
SN76001ANQ	2.25
SN76003N	2.81
SN76013N	3.63
SN76013ND	2.25
SN76013NDG	8.07
SN76023N	2.35
SN76023ND	1.04
SN76033N	2.33
SN76105N	2.36
SN76110N	1.13
SN76115AN	1.46
SN76131	1.74
SN76226DN	1.20
SN76227N	0.68
SN76228N	2.97
SN76231	2.31
SN76242	4.75
SN76243	4.75
SN76322	2.51
SN76360	1.97
SN76390	2.80
SN76396	2.63
SN76510N	0.95
SN76530P	1.90
SN76532N	1.80
SN76533N	1.56
SN76540N	1.80
SN76544	1.60
SN76545	4.55
SN76546	3.15
SN76546N	3.15
SN76549	2.35
SN76550	0.30
SN76551	1.35
SN76570	2.80
SN76600	1.10
SN76611	2.35
SN76620	2.35
SN76622	1.50
SN76623	0.62
SN76630	2.31
SN76640	3.85
SN76650N	1.24
SN76651	1.35
SN76660N	2.25
SN76665N	1.35
SN76666N	0.98
SN76705	3.38
SN76705N	3.99
SN76707N	3.99
SN76709	4.65
SN76709N	4.95
SN76730	4.23
SN76810N	0.62
SN76920N	2.63
SN94041	3.45
SN94042	3.95
SP8385	0.50
STA441C	2.27
STK0029	3.42
STK0039	4.00
STK0050	4.96
STK0059	6.48
STK0080	8.32
STK011	3.86
STK013	7.04
STK014	7.14
STK015	5.12
STK016	4.82
STK022	4.77
STK025	7.20
STK040	7.09
STK043	7.09
STK054	6.48
STK070	20.28
STK077	7.00
STK078	5.52
STK082	7.54
STK086	9.90
STK2101	5.74
STK2110	6.66
STK2230	6.66
STK415	6.04
STK433	9.35
STK435	5.44
STK436	5.70
STK437	8.10
STK439	6.26
STK441	8.96
STK443	9.35
STK459	6.56
STK460	5.78
STK461	7.14
STK463	8.06
STK465	7.32
STK466	10.70
STK501	5.74
STK502	5.74
STR441	6.34
STR453	6.75
STR6020	7.20
T6007V	0.69
T6007N	0.62
T6016	0.36
T6017	0.65
T6018V	0.65
T6021	0.36
T6022V	3.56
T6026	0.89
T6027	0.73
T6028V	0.35

T6029V	4.41
T6032V	0.89
T6033V	0.73
T6035V	0.86
T6036	0.44
T6037	1.91
T6041V	0.86
T6044V	0.86
T6045	1.09
T6049	1.10
T6052V	0.76
T6058	0.46
T6059	1.05
T8001V	1.09
T9003V	0.86
T9005V	2.16
T9010V	0.87
T9011V	1.27
T9013V	5.81
T9014V	1.52
T9016	0.92
T9022N	0.39
T9034V	1.25
T9035V	1.26
T9038V	6.15
T9051	2.55
T9053V	1.03
T9054V	0.92
T9057V	0.63
T9063V	2.94
TA5814	1.35
TA7020P	4.36
TA7027	4.36
TA7050	1.58
TA7051	1.58
TA7060AP	0.80
TA7061AP	0.78
TA7069	2.84
TA7070P	1.52
TA7071	3.35
TA7072P	1.35
TA7073P	4.05
TA7074P	1.95
TA7076P	4.95
TA7089N	1.41
TA7089P	1.36
TA7092P	3.85
TA7093P	1.64
TA7102P	5.34
TA7108P	1.40
TA7109	3.37
TA7120P	0.58
TA7122B/P	0.54
TA7124P	2.00
TA7130P	1.15
TA7136AP	1.15
TA7137P	0.85
TA7141AP	3.51
TA7146P	8.04
TA7148P	1.51
TA7149P	2.10
TA7153P	4.53
TA7161P	5.66
TA7162P	4.25
TA7169	4.80
TA7171P	2.53
TA7172P	1.28
TA7176P	2.25
TA7193P	4.44
TA7201P	3.25
TA7202P	2.24
TA7203P	1.95
TA7204P	1.95
TA7205	1.25
TA7208P	1.95
TA7210P	3.25
TA7214P	2.90
TA7215P	2.09
TA7217AP	1.36
TA7222	1.95
TA7227P	1.69
TA7229P	4.10
TA7310P	1.95
TA7313AP	1.36
TA7314	5.10
TA7609	3.00
TA7611AP	3.54
TA7676P	3.05
TAA300	2.99
TAA310A	0.27
TAA320A	1.15
TAA350A	1.62
TAA435	1.65
TAA550	0.33
TAA570	1.58
TAA611B12	1.50
TAA621AX1	2.00
TAA630S	3.31
TAA640	3.85
TAA661B	1.59
TAA700	2.35
TAA840	2.27
TAA930	4.42
TAA970	2.57
TAD100	1.91
TAG232-600	0.66
TAG626-600	0.84
TBA120	0.95
TBA120A	0.95
TBA120AS	0.95
TBA120S	0.95
TBA120SB	0.95
TBA120T	0.95
TBA120U	0.95
TBA120UB	3.47
TBA1440	2.08
TBA1440G	3.40
TBA1441	1.59
TBA240A	3.42

TBA395	1.35
TBA395Q	1.00
TBA396	1.80
TBA400	2.17
TBA440P	1.55
TBA480	1.42
TBA480Q	1.67
TBA500PQ	4.95
TBA510	1.55
TBA510S	6.39
TBA520	1.67
TBA520Q	1.35
TBA530	0.86
TBA530Q	0.85
TBA540	0.98
TBA540Q	1.15
TBA550	1.95
TBA550Q	2.25
TBA560C	0.86
TBA560CQ	1.15
TBA570	1.55
TBA570A	1.55
TBA570Q	1.35
TBA625A	1.97
TBA625B	1.97
TBA625C	1.97
TBA641A12	3.75
TBA641BX1	2.07
TBA651	1.60
TBA673	2.35
TBA700Q	2.19
TBA720	2.85
TBA730	1.75
TBA750Q	1.46
TBA760	1.55
TBA780	3.00
TBA800	0.00
TBA810AS	1.46
TBA810S	1.46
TBA810T	1.46
TBA820	0.83
TBA820M	1.65
TBA890	1.85
TBA900	2.25
TBA920	1.50
TBA920Q	2.10
TBA940	1.70
TBA950	1.55
TBA970	2.08
TBA970Q	2.98
TBA990	1.65
TBA990Q	1.95
TBA231	2.33
TC4001	1.29
TC4053BP	3.94
TCA150	1.62
TCA160B	1.62
TCA270Q	1.55
TCA270S	1.95
TCA270SQ	1.65
TCA290A	2.05
TCA420A	1.90
TCA440	1.65
TCA4500A	1.95
TCA530	1.80
TCA640	2.63
TCA650	1.85
TCA660B	2.63
TCA730	3.84
TCA740	2.25
TCA750	1.75
TCA760B	2.79
TCA800	1.65
TCA800Q	2.25
TCA830S	1.94
TCA900	1.85
TCA910	1.50
TCA940E	1.88
TCE330	3.53
TCE527	1.37
TCE82	0.98
TCE83	0.98
TCE84	0.98
TCEP100	4.80
TCEP100Q	9.31
TD190	0.54
TD3F700H	6.00
TD3F800H	2.25
TD3F800R	3.21
TD3F900H	3.78
TD3F900R36	3.78
TDA1001A	2.10
TDA1003A	2.15
TDA1004A	2.15
TDA1005A	2.15
TDA1006A	2.15
TDA1010	2.43
TDA1011	2.60
TDA1028	2.22
TDA1029	4.44
TDA1034B	2.20
TDA1035T	1.83
TDA1037	1.45
TDA1041	1.96
TDA1044	1.61
TDA1047	2.14
TDA1054M	1.10
TDA1059B	0.98
TDA1060	2.01
TDA1082	2.65
TDA1104	5.95
TDA1151	0.65
TDA1170	2.15
TDA1170S	1.85
TDA1180	2.25
TDA1190	1.91
TDA1190Z	2.25
TDA1200A	1.30
TDA1220	2.25

TDA1230	2.93
TDA1235	3.52
TDA1270	2.84
TDA1327A	1.65
TDA1327B	1.65
TDA1330	1.60
TDA1365	6.35
TDA1412	0.95
TDA1420	1.48
TDA1470	2.63
TDA1512	2.20
TDA1670	3.65
TDA1770	5.56
TDA1905	1.25
TDA1908	2.95
TDA1910	2.38
TDA1940	2.54
TDA1950	2.54
TDA2002	1.20
TDA2003	1.05
TDA2004	2.52
TDA2006	1.25
TDA2010	2.79
TDA2020	2.75
TDA2030	1.65
TDA2140	1.44
TDA2150	5.63
TDA2151	1.75
TDA2160	3.64
TDA2161	1.68
TDA2190	3.11
TDA2510	1.82
TDA2520	2.15
TDA2521	2.15
TDA2522	2.81
TDA2523	2.75
TDA2524	4.50
TDA2525	2.96
TDA2530	2.19
TDA2532	2.51
TDA2533	2.09
TDA2540	1.95
TDA2541	1.95
TDA2545Q	3.16
TDA2560	1.97
TDA2571A	2.81
TDA2575A	2.95
TDA2576A	2.58
TDA2577	5.31
TDA2581	1.95
TDA2582	1.98
TDA2590	2.80
TDA2591	2.80
TDA2591Q	2.80
TDA2593	2.24
TDA2594	2.80
TDA2600	5.00
TDA2610	2.53
TDA2611A	1.25
TDA2611AQ	2.55
TDA2612Q	4.25
TDA2620	1.96
TDA2630	2.34
TDA2631	2.48
TDA2640	2.25
TDA2643	6.93
TDA2651	2.95
TDA2652	7.05
TDA2653	2.95
TDA2654	2.91
TDA2655B	3.15
TDA2660	2.24
TDA2661	2.24
TDA2670	2.50
TDA2670A	1.76
TDA2680	2.30
TDA2690A	2.40
TDA2780AQ	2.18
TDA2790Q	5.92
TDA2791	2.50
TDA2795	2.95
TDA2800	6.12
TDA3000T	2.31
TDA3030A	10.44
TDA3190	1.75
TDA3300B	7.75
TDA3500	5.95
TDA3501	10.99
TDA3506	10.12
TDA3510	5.95
TDA3520	8.82
TDA3521	12.17
TDA3560	6.87
TDA3561	7.50
TDA3571Q	2.25
TDA3571A	5.67
TDA3576	4.76
TDA3950	2.81
TDA3950B	1.40
TDA4050A	3.15
TDA4180P	1.74
TDA4260	1.40
TDA4280	6.45
TDA4290	4.06
TDA440	1.95
TDA4400	2.06
TDA4420	4.25
TDA4422	5.63
TDA4430	4.34
TDA4431	2.06
TDA4432	2.06
TDA4440	2.52
TDA4600	2.58
TDA4610	2.42
TDA4620	4.50
TDA5500	2.48
TDA5600	2.88
TDA5700	2.10
TDA9403	2.90

TDA9503	2.80
TDA9513	2.40
TE527	1.25
TE538	0.36
TE626	1.35
TEA1002	3.15
TDA1009	0.96
TEA1020SP	5.34
TEA1087	0.46
TIC106C	0.55
TIC106M	0.55
TIC116D	0.80
TIC44	0.65
TIC45	0.70
TIC47	0.70
TIP120	0.96
TIP110	0.48
TIP112	0.80
TIP117	0.86
TIP120	0.73
TIP121	1.08
TIP126	0.96
TIP127	1.30
TIP2955	0.78
TIP29A	0.41
TIP29B	0.57
TIP29C	0.40
TIP3055	0.65
TIP30A	0.41
TIP30B	0.63
TIP31B	0.35
TIP31C	0.63
TIP32B	0.35
TIP32C	0.66
TIP33C	1.25
TIP34	1.07
TIP41A	0.39
TIP41B	0.28
TIP41C	0.44
TIP42A	0.39
TIP42B	0.71
TIP42C	0.44
TIP47	0.65
TIP48	0.83
TIP49	3.28
TIS43	1.21
TIS90	0.22
TIS91	0.26
TL071CP	2.02
TMS1000NL	10.78
TMS3748NS	11.66
TMS4116	1.87
TV106	1.20
TY6010B	2.70
U05G	1.03
U143M	2.80
U3700	0.55
U37003	0.44
UA723CA	5.02
UA758PC	3.06
UA783P3C	1.07
UAA170	2.14
UAA180	2.14
ULN2165	1.35
ULN2204	7.00
ULN2216F	1.95
UPC1001H	2.50
UPC1009C	5.74
UPC1020H	2.12
UPC1025H	2.49
UPC1026C	1.24
UPC1028H	0.90
UPC1030H	2.06
UPC1031H	8.05
UPC1031H2	6.00
UPC1032H	0.94
UPC1154H	1.75
UPC1156H	1.45
UPC1181H	1.25
UPC1182H	1.82
UPC1185H	2.94
UPC1186H	0.95
UPC1212C	0.95
UPC1213C	0.95
UPC1217C	2.24
UPC1350C	1.75
UPC1351C	1.64
UPC1353	6.75
UPC1360C	4.10
UPC1362	7.95
UPC1365	5.79
UPC1366	4.23
UPC1458	7.87
UPC2002	1.48
UPC30C	2.22
UPC32C	4.49
UPC41C	3.72
UPC554C	1.88
UPC558C	3.67
UPC566H	2.78
UPC572	3.51
UPC575C2	3.72
UPC576H	2.60
UPC577H	0.64
UPC587C2	2.34
UPC592H	1.02
UPD1514C	7.56
UPD851	14.39
UPX27C	1.98
X0022CE	3.67
X0035TA	4.35
X0056CE	3.90
X0062CE	4.95
X0085CE	3.48
X0109CE	6.10
X1074AF	6.36
XC949P	1.20
Y730	0.24
Y969	0.60

IF YOU DON'T SEE IT LISTED ASK FOR QUOTE. GIVE MAKE MODEL LOCATION. REMEMBER TO ADD 0.60p POST & HANDLING. ADD 15% VAT TO TOTAL

Long-distance Television

Roger Bunney

July was quiet to start with but sporadic E activity increased towards the end and continued into early August. Unfortunately the period produced little by way of exotic reception and tropospheric propagation did little to excite or inspire. The SpE log of identified reception is as follows:

8/7/84 RAI (Italy) chs. IA, B; JRT (Yugoslavia) E3; TVE (Spain) E2.
9/7/84 RAI IA.
10/7/84 RAI IA, B.
11/7/84 RAI IA; TVE E3.
13/7/84 TVE-2 E2; RAI IA.
14/7/84 TSS (USSR) R1, 2; SR (Sweden) E2; TVE E2, TVE-2 E2.
15/7/84 TVE E2, 3, 4; TSS R1, 2.
16/7/84 CST (Czechoslovakia) R1, 2; TVP (Poland) R1; TSS R1.
17/7/84 TVE E2; SR E2.
18/7/84 RAI IA.
19/7/84 RAI IA, B; TVE E4; JRT E4; MTV (Hungary) R1; CST R1.
20/7/84 +PTT (Switzerland) E2; RAI IA, B; TVE E2, 3, 4; TSS R1, 2; NRK (Norway) E2, 3, 4; SR E2, 3, 4; TVP R1.
21/7/84 DR (Denmark) E3, 4; ARD (West Germany) E2; ORF (Austria) E2a; RAI IA, B; TVE E2, 3, TVE-2 E2; MTV R1; CST R1, 2; TSS R1, 2; TVP R1, 2; NRK E2, 3; SR E2, 3, 4.
22/7/84 RAI IA, B; TVE E2, 3, 4; CST R1; ORF E2a; ARD E2; MTV R1.
23/7/84 RAI IA; TVR (Rumania) R2; JRT E3, 4; ORF E2a; TSS R1, 2.
24/7/84 TSS R1, 2; CST R1, 2; TVP R1, 2; SR E2, 3; NRK E2, 3; YLE (Finland) E2; DR E3, 4; ORF E2a; RAI IA; TVE E2, 3, 4; +PTT E3; ARD E2, 4.
25/7/84 RAI IA, B; YLE E2; TSS R1, 2; NRK E2, 3.
26/7/84 RAI IA, B; TVE E2; ARD E2; NRK E2, 3; TSS R1; RTM (Morocco) E4; NTV (Nigeria) E3.
27/7/84 TSS R1, 2; TVE E2, 3, 4; RTP (Portugal) E3.
29/7/84 TVE E3, TSS R1, 2; ORF E2a; MTV R1.
30/7/84 CST R1; TVE E2, 3, 4.
31/7/84 RAI IA, B; TVE E2, 3, 4; JRT E3, 4; TSS R1, 2; TVP R1, 2, 3; CST R1, 2; ARD E2; DFF (East Germany) E4; JTV (Jordan) E3. Signals noted up to ch. R4.
1/8/84 TVE E2, 3, 4; RAI IA; TVR R2; ARD E2; EPT (Greece) E3.
2/8/84 RAI IA; TVE E2, 3, 4.
4/8/84 CST R1, 2; ARD E2; NRK E2; RAI IA; TVE E4.
5/8/84 +PTT E2, 3; RAI IA, B; MTV R1; TVE E3; DFF E4; SR E2; RUV (Iceland) E4; EPT E3.
6/8/84 RAI IA, B; TVP R1, 2, 3; TSS R1, 2, 3; MTV R1; CST R1, 2; ORF E2a; SR E2; NRK E2.

CST was noted on August 4th with a studio insert identification similar to the RAI corner one, the letters S and P initially then expanding to give the complete name. At 1030 BST on the same day I logged a possible exotic ch. E4 signal from the SE – a slow-fading signal going to a flag and then further programme material. The following day Cyril Willis received Middle Eastern/Indian type music on ch. E4 at 1400 but there was no accompanying picture.

The most exotic reception occurred on the 26th. Arthur Milliken (Wigan) received Morocco ch. E4 at 1857 BST onwards, the PM5544 test pattern going on to an announcer, the Koran and then cartoons. At 1900 Paul Barton (Harrogate) received dancing Africans in tribal dress on ch. E3; the signal was swamped by TVE at 1903. The African signal is most likely to have come from Sokoto, Nigeria.

There were several tropospheric lifts but few of consequence. Band III signals from Denmark and Norway were received in the eastern UK on the 19th. The 25th was more productive, with DFF ch. E6 and several ARD Band III/u.h.f. stations. High-level French u.h.f. signals were received along the south/east coasts during the weekend of the 28/29th, but the only unusual signal was a 435MHz ATV one – F3LP Le Havre. It's unfortunate that there's so little UK ATV activity during the mornings whenever there's a reasonable lift – many opportunities for DX contact are being lost.

My thanks to the following for sending in reports: Paul Barton (Harrogate), Cyril Willis (Cambridge), Arthur Milliken (Wigan), Iain Menzies (Aberdeen), Dave Shirley (Hastings), Ian Johnson (Bromsgrove), Bill Cotterill (Tipton), Simon Hamer (Powys). Too late for mention in last month's column was Tim Anderson's suspected reception at Bexhill of NTV ch. E3 – at 1851 BST on July 6th, with an African news announcer.

News In Brief

An experimental Chinese satellite is in orbit at 125°E, relaying a single TV and fifteen radio channels. Does anyone know the downlink frequencies being used? . . . Spain is to have a private TV channel by 1985 though the transmitters will be operated by a central organisation . . . ARD/ZDF (WG) are to carry data which will automatically intitiate video recording in conjuction with a suitably equipped receiver – the system is to be introduced at the 1985 Berlin Fair . . . Czechoslovakia is considering a DBS service to start later in the decade, with tests planned for 1987 . . . Insat-B is relaying AIR from Delhi at 1800-2300 local time, operating at 2·5GHz . . . The 50·05MHz RSGB beacon GB3NHQ should now be in operation at Potters Bar, Herts.

Interference

The RSGB reports that a new form of fluorescent light is causing interference due to a built-in l.f. oscillator. In some of these lights the oscillator runs all the time whilst in others it's used just at start up. The interference is wideband and can reach 80MHz.

The problem of interference generated by home computers has been mentioned in previous columns. The Department of Trade and Industry comment that they recognise the need to limit spurious signals generated by data processing equipment but an international standard will not be available for some years. Meanwhile work on a UK standard has gone ahead due to the increasing use of data equipment in offices and industry, and a draft document has been circulated – an extended British Standard (BS6527) is due shortly. The DTI doesn't say whether this will cover domestic data processing equipment and add that BS specifications are not legally binding unless referred to in statutory regulations. There's thus no recourse at present against users/manufacturers of home computers that cause interference. I nevertheless feel that if interference occurs in recognised bands action should be possible. As soon as I receive a copy of BS6527 I'll pass on any relevant information. Thanks to the DTI for their cooperation.

Quite by coincidence we received a press release the other day on a new product designed to combat interference radiated by plastic encased electronics. Decospray of Charlton, London SE7 have formulated a spray-on pure zinc metal coating for plastic surfaces to prevent radiation. Interesting to note that the product has been used on radio/radar dish reflectors. I'm awaiting further information – whether the price is such that enthusiasts will be able to afford it remains to be seen.

New Networks

France: Provisional plans for the Canal Plus service are as follows:

Channel	*Vision carrier*	*Sound carrier*	*Channel*	*Vision carrier*	*Sound carrier*
5	176MHz	182·5MHz	8	200MHz	206·5MHz
6	184MHz	190·5MHz	9	208MHz	214·5MHz
7	192MHz	198·5MHz	10	216MHz	222·5MHz

Main station channel allocations are as follows:

Ch. 5: Gex, Le Havre, Toulouse Pic du Midi.
Ch. 6: Chamrousse, Hyeres, Niort, Paris Eiffel Tower.
Ch. 7: Bayonne, Rennes.
Ch. 8: Bourges.
Ch. 9: Caen, Gap, Nancy.
Ch. 10: Limoges.

Further main stations will have frequency offsets.

At present, films are being transmitted as test material. The only Band I outlets will be in Corsica – Bastia ch. 2 and Ajaccio ch. 4.

Denmark: Gosta van der Linden provides the following provisional channel assignments for the Danish u.h.f. network.

Station	*Channels*	*E.R.P.*
Aarhus	23, 26, 54	800kW
Bornholm	56, 59	800kW
Bramminge	50, 58, 68	200kW
Fyn	22, 25, 58	800kW
Hillerod	53, 56, 67	100kW
Jyderup	48, 51, 65	800kW
Kibeek	43, 46, 66	800kW
Kobenhavn	31, 34, 60	800kW
Logumkloster	29, 32, 67	100kW
Nakskov	49, 52, 63	100kW
Salling	28, 59, 62	800kW
Sundeved	24, 27, 60	800kW
Tinghoj	29, 44, 47	500kW
Vejle	30, 33, 64	500kW
Vendsyssel	32, 35, 63	800kW
Vordingborg	39, 42, 66	800kW

The higher channels will be used initially.

From our Correspondents . . .

Tim Anderson recently moved from Stroud to Bexhill. Obviously his French TV reception increased dramatically despite using fixed aerials at the time of writing. He's bought an SX200n scanner, having also considered an AR2001. Though the AR2001 seems to be ideal for DXing, with its wide/narrow bandwidth at a.m./f.m., we've received conflicting reports on it. Comments from users would be welcome.

A "down under" DX-TV group is planned by James Cotterill of 15/246 Buffalo Road, Ryde, NSW, Australia 2112. He hopes that anyone in Australia and the Far East interested in this will get in touch with him. A monthly newsletter with reception and news information is promised. Include return postage if your write! Alan Duchatel plans to start a new French DX magazine, covering both f.m. radio and TV. Further information will be passed on when received. Incidentally Alan received two Canadian ch. A2 transmissions at his home near Bordeau between 2300-0130 French Summer Time (BST plus one hour) on June 30th, via multiple-hop SpE. One programme was in English with CBC captions, the other in French about fishing in the Japanese Sea. He used an AR2001 for the sound.

Imported TV Receivers

Many DX-TV enthusiasts use small-screen monochrome, v.h.f./u.h.f., dual-standard sound receivers such as those from Plustron, Vega, Hitachi and Panasonic. They incorporate most of what's required for simple DX reception and are inexpensive. At the other end of the scale a number of enthusiasts are using Scandinavian v.h.f./u.h.f. colour sets of Salora or Luxor manufacture. The current Salora chassis provides a wide range of options – system L SECAM, NTSC at 3·58 or 4·43MHz, 5·5/6/6·5MHz f.m. and 6·5MHz a.m sound and all forms of teletext can be included via appropriate boards. Most models are fitted with multiband tuners and the on-board microcomputer tuning system provides for a hundred preprogrammed channels. Further details can be obtained from Salora (UK) Ltd., Techno Trading Estate, Swindon, SN2 6EZ. The Luxor SX9 chassis was described in the January 1984 issue of this magazine and offers similar facilities to the Salora range. Luxor (UK) Ltd. can be contacted at 87/9 Farnham Road, Slough, Berks SL1 4UL – their receivers have an established following in UK DX-TV circles at present.

In view of the facilities that these sets offer a price of £600 or so seems reasonable, especially with arm-chair remote control! My thanks to the two companies for sending much valuable and interesting information on their current ranges. I'd be interested to hear from enthusiasts who use these multi-standard "domestic" sets.

ATV at 24cms

As previously mentioned I've succeeded with reception of f.m. video in the 1·3GHz ATV band. The results at this low microwave frequency have been less than startling to date, the farthest signal received having come from some 12 miles away, albeit with just a few watts at the transmitter end and using the normal u.h.f. aerials and head amplifiers for reception – hardly the ideal arrangement! The BATC advocate the use of f.m. in this band, though some of the repeaters use a.m. The 23/24cm band covers 1240-1325MHz with a gap at 1260-1270MHz.

Although an f.m. demodulator is best for f.m. video, slope detection with an a.m. demodulator gives pictures that should be good enough to enable sources to be identified. Various aerials are available, such as loop Yagis, though the prices seem high. I'm looking into this and hope to be able to present a simple (and cheap) solution shortly. Down conversion from 1·3GHz is the main problem for the DXer however. I've looked at three currently available solutions.

Fortop have several units available for use in this band. The TVC1300 is a GaAsfet receiver/downconverter tuning across 1240-1325MHz with very low noise and an output at 50MHz (for use with their TVIF50 f.m. video i.f. system). It requires 12V at 250mA, is completely stable and is housed in a diecast box. This provides a very high performance front end for a retail price of £79·95 plus £2·50 post and packing.

The CQ Centre, an amateur radio emporium, has available a ready built 23/24cm converter in a diecast box with BNC aerial input and Belling-Lee output sockets – output is at ch. 36 nominal. You tune the TV receiver, which acts as a tunable i.f. strip, to either side of ch. 36 to cover the band. Examination of the PCB inside shows a single r.f. stage, mixer and oscillator with an on-board voltage stabiliser – the converter accepts 12-24V d.c. and draws 24mA at 12V. This was the first converter I tried and it worked immediately. It appeared to be stable throughout the band and I consider it excellent value. An outboard preamplifier could be added to improve the noise performance. I experienced little by way of breakthrough problems from the local group A channels – the nearest here is ch. 31. Those with a strong local ch. 33 signal might experience breakthrough either via the unit or after it. Input bandpass filtering is incorporated and should attenuate all but the strongest ch. 33 signals. Apart from this minor reservation I feel that the unit can be thoroughly recommended as a starter: the price is £29·95 including postage.

The Solent Scientific 23/24cm converter kit is priced in the same range. I obtained one of these and after construction and alignment found it worked well, giving pictures two grades up on the CQ one. The kit comes with a high-quality PCB and the electronic components required and the recommendation to house it in a diecast box (RS509-939 advised as the board fits it exactly) – this and the other hardware could add £6-7 if bought new from a retailer. The main advantage, apart from the multistage r.f. amplifier, is that the output can be adjusted to lie in a locally empty section of the band, thus avoiding breakthrough etc. The alignment instructions are clear and easy to follow. There are three r.f. amplifier stages (2SC3358, NE21936, BFR91) so there's plenty of gain and a good low-noise performance. This lot is followed by a diode mixer, BFR96 oscillator and BFR91 u.h.f. amplifier. The unit takes 120mA at 12V which is supplied by a two-transistor voltage stabiliser. It's an upmarket design and certainly gives upmarket performance. Construction should take two-three hours, casing another hour and alignment perhaps half an hour. Clear instructions and a phone number for queries should ensure satisfactory results. The kit costs £34·95 plus £1 pp. It's also available assembled and aligned at £48·95 uncased or £62·95 cased and fitted with BNC sockets. A 24cm transmitter is available for alignment use.

I've tried the CQ and Solent converters on signals and they work well. I've not tried the Fortop converter but I do use their 435MHz products whose quality is first class. Addresses: Fortop Ltd., 9 Ryebrook Grove, Chell, Stoke-on-Trent, Staffs; CQ Centre, 10 Merston Park Parade, Kingston Road, London SW19; Solent Scientific, 75 Chalk Hill, West End, Southampton SO3 3BY. Include an sae with enquiries.

Solent also have available a u.h.f. video/tunable audio f.m. receiver suitable for 23/24cm and satellite reception. I hope to report on this later in the year.

Information on the BATC (British Amateur Television Club) can be obtained from 13 Church Street, Gainsborough, Lincs.

TV Fault Finding

Mick Dutton, Graham Colebourn, B.Sc., Malcolm Burrell, P. J. Bradford, Nick Lyons, M. S. Barakat, John Coombes, Robin D. Smith and Philip Blundell, Eng. Tech.

ITT CVC32 Chassis

This set led us a merry dance for several weeks. The symptom was an unstable picture on all channels except BBC-1: the set was extremely sensitive – to the point where a tap on the floor ten feet away would put it right – and as soon as the back was removed the fault had gone. We eventually solved the problem by looking at the board layout. There are link wires between the number one tuning preset and all the others – this link was dry-jointed. The exterior of the joint looked perfect, but a touch of solder provided a permanent cure.

The set came back a while later with a different fault – intermittent no results. This turned out to be due to a dead spot on the line hold control, as a result of which the line oscillator would occasionally fail to start. **M.D.**

Kingsonic R96 Monochrome Portable

The problem was intermittent field collapse. When the set was switched on it would produce a picture that was excessively high and rolling, but after a few seconds the raster would collapse to two inches in the lower half of the screen with a bright line across the centre. The field timebase voltages were correct up to the driver transistor, but in the output stage they were wavering erratically. We traced the problem to a low-gain output transistor (Q503). Replacing this provided a cure, but the customer had left the set running in the fault condition with the result that there was a burn mark on the tube. **M.D.**

Grundig CUC120 Chassis

The set would lose line sync when warm. We solved this one with the aid of a hairdryer and a can of freezer: C2711 (0·022μF) was leaky when warm. **M.D.**

Decca 130 Chassis

The customer's complaint was "lines on the picture". When we arrived at the house we took one look and loaded the set in the back of the car. The problem was excessive field scan with black lines across the centre of the screen. Diagnosis was made difficult because the raster kept blanking out due to the operation of the protection circuit in the TDA1670 field timebase i.c. We removed D301 to stop the blanking action and looked more closely at the fault. The voltages in the field timebase were about right while the height and linearity controls seemed to have some effect. Replacing the i.c. and the flyback diode D302 made no difference and we spent a long time checking this, that and the other. In the end we decided that the fault must be in the output side of the circuit. We started bridging components one by one and when C303 (0·22μF) was bridged we were rewarded with a normal picture. This capacitor is part of the scan impedance matching network. A few days later we had to replace a faulty field timebase chip in a Ferguson TX9 and noticed that the circuit is similar – this stirred a recollection that we'd reported on the same basic fault once before in the magazine. **M.D.**

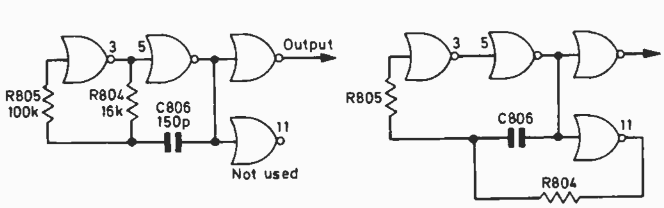


Fig. 1: CMOS gate oscillator circuits.

Grundig 7200GB

Three of these sets have been our way recently. The first came in with a very distorted keystone raster and misconvergence: the picture was narrower at the top than at the bottom. The fault was on the convergence board where the print from pin K5 to the red/blue tilt control was open-circuit.

There was no EW correction on the second set. This was traced to Tr498 (BC237), Di498 (39V zener diode) and R493 (8·2kΩ) which was burnt.

The complaint with the third set was field cramping. It also had an EW fault. The connection between the two is that both circuits are powered from the 36V line. Clearing the EW fault cured the field trouble as well. **M.B.**

Philips 20C934 (KT3 Chassis)

We had to repair one of these sets (KT3 chassis with remote control, Model 20C934) because arcing at the mains switch had killed the CMOS clock oscillator chip (IC806) on the Telco remote control decoder panel. The customer subsequently complained about unreliable operation. The set would often come on with either no colour and no sound or gaudy colour and deafening sound, normal control being restored after a minute or two. The new CD4001 oscillator was refusing to start promptly and we found that the circuit used – Fig. 1(a) – is called "less than perfect" in the National CMOS guide because it doesn't always start up properly when low-value capacitors are employed. It can easily be converted to the "sure-fire" design by lifting the end of the 16kΩ resistor (R804) nearest IC806 and wiring it to the unused pin 11 as shown in Fig. 1(b). This three-gate oscillator arrangement always starts – unless you fail to observe CMOS handling precautions when carrying out the modification! **G.C.**

ITT CVC1200 Chassis

The picture on this set was negative: the sound was normal, and both the brightness and contrast controls had some effect. We suspected a fault in the vision demodulator area within the r.f./i.f. module but replacing this made no difference. A new decoder panel cleared the fault so we refitted the original one and checked around the TDA3561 i.c. A large line pulse was found to be present, superimposed on the normal signal, at the luminance input pin 10. This caused some confusion since the pulse was not present at the emitter of the luminance delay line driver transistor T860. Changing the i.c. made no difference and the pulse was still present when the delay line was disconnected. It turned out that the luminance coupling capacitor C865 (0·047μF) had a heavy leak, as a result of which pin 10 of the i.c. was being loaded down through R865 (1·5kΩ). **M.D.**

Fidelity CTV14R

Intermittent tuning drift was the problem with this set. After a couple of hours spent taking voltages, prodding around and replacing various items we decided to consult Fidelity's Technical Department. It was suggested that we remove the control board and go over the print side with methylated spirit and a toothbrush. This worked – it appears that the problem is to do with flux on the soldered connections. **P.J.B.**

Pye 731 Chassis

A Pye set fitted with the 731 chassis wouldn't start – because it had incinerated the power supply panel output socket 876. The solution to this was simple enough, to cut away the burnt areas and hard wire in connections. With this done the set started but produced no picture, in fact no e.h.t. The h.t. fuse F971 in series with the line output stage hadn't blown but was found to be 1·25A instead of the 800mA it should have been. The AVO showed that just over 1A was flowing, a clear indication in this chassis that something is amiss, 600mA being the norm here. Disconnecting the tripler solved the problem and highlights the consequences of careless servicing. With the 1·25A fuse fitted the set would have kept running with the faulty tripler until sufficient additional damage had been done to the line output stage for even this value fuse to blow. In this chassis there's a factor of only two in the current drawn by the line output stage driving a faulty as opposed to a good tripler, so correct fuse rating is vital. In most chassis the difference is greater than this, but that shouldn't be taken as a licence to fit higher values unless recommended by the manufacturers.

A couple of days later the set was back as only the picture highlights were displayed – smeary and mainly purple. The first anode voltages had disappeared. In later versions of the chassis the first anode presets are 470kΩ instead of the 1MΩ used in earlier versions. A series resistance is included in these sets in the supply to the presets. It consists of two resistors, 390kΩ and 270kΩ, of which only the 390kΩ resistor is normally in circuit. By means of a wire link the 270kΩ resistor can be added in parallel with the 390kΩ resistor to give additional range of control. If the 390kΩ resistor has gone open-circuit, as this one had, don't expect the 270kΩ resistor (if it's in circuit) to last long – being rated at only ½W, it can't stand the load on its own. In this case I replaced both with a single 330kΩ 1W resistor. This usually gives adequate range. These are safety components, so don't stray too far from the original specification, i.e. don't use resistors rated at more than 1W or a single resistor of less than 180kΩ. **N.L.**

Philips 320 Chassis

It's unusual but you do get sets that run with faults in the line output stage. Here's a case of the dreaded Philips 320 monochrome chassis. When the set arrived it was dead from the power supply onwards. It's not often that a 320 comes in with a working power supply, but I suppose there's a first time for everything. A hole was seen in the resistor that feeds the line output stage – the cement job with the "safety pin" on it – and, surprise, surprise, it was open-circuit. The replacement got steaming hot when the set was switched on, and the line output department made a lot of noise. Despite this the set would tune, provide sound, and though there was no picture the tube's heater was brightly lit. With a set in this condition, i.e. the line output stage operating after a fashion but no picture, I always turn the brightness to minimum, wait for about ten seconds, then slowly advance the control while carefully watching for any trace of a picture.

Most sets give conclusive results with this test, enabling you to condemn the line output transformer without further ado. This one didn't! A very large, very dim picture could just be discerned. Well it's obvious I thought, the e.h.t. stick must be faulty. So I changed it and the fault remained. Attention was then turned to the transformer, whose primary winding was red hot. Replacing the transformer restored correct operation. But what of the line output transistor, a delicate violet in these sets? Surely it couldn't have survived feeding a transformer with shorted turns? Well it had, and does to this day! **N.L.**

Rank T20 Chassis

The cause of the fault on this set was a well known one, but the symptoms that arose whilst tracing it were nevertheless confusing. When switched on the set would degauss, just start to rustle up and that was it. Various checks were made in the line output stage without success, so the business of bridging the start up capacitor 4C19 in the line oscillator circuit was resorted to – use a wirewound resistor of around 6·8kΩ with a rating of say 7W. Scope checks then revealed that the oscillator was working all right but there was no drive at the base of the line driver transistor due to the over-voltage trip working.

The over-voltage subpanel was removed and the set supplied via a variac. We then found that we had almost everything except field scan, a check on the supply to the field output stage revealing that it was high at about 45V instead of 36V. Hence the operation of the trip. The high voltage was due to the light loading as a result of no timebase operation. The fact that we were still operating the line oscillator via the 6·8kΩ resistor from the h.t. rail provided the clue – no 12V supply. 4R16 in the 12V regulator circuit had struck again. **N.L.**

Some Quickies

GEC PIL/20AX Chassis: It's been said before in these pages but we've also had it from time to time: if you find the chopper transistor short-circuit, check that the driver transistor's base bias resistor R515 (150kΩ) hasn't gone high in value or the new BU126 will short in a matter of seconds.

ITT CVC20 Chassis: No 24V supply was traced to D24 (BYX71-350) in the EW modulator circuit being open-circuit – though it read all right in circuit.

ITT CVC32 Chassis: Intermittent line collapse and intermittent shut-down was traced to a dry-joint on the line driver transformer L10/11. **R.D.S.**

ITT CVC8 Chassis

An ITT set fitted with the ever poisonous PCL86 audio valve had been giving both myself and the customer the run around for a few weeks. The sound would go off for about an hour once a week, usually during the opposite end of the week to when I was trying to find the cause of the fault. In the end I just changed the valve and this cured the problem. Why on earth didn't manufacturers stick with the known and very reliable PCL82? It's too late to complain now I suppose – that technology long since sank from setmaking. **N.L.**

Pye 697 Chassis

There was a raster but no picture on this Pye hybrid colour set. Quietly dabbing about with the scope showed that no vision signal was coming from the i.f. strip, due it turned out to the 33·5MHz trap coil L10 in the detector circuit being dry-jointed. Unbelievable: all those years' service before a joint that was poor even to the eye finally gave up. I'm not grumbling though. It's seldom that I find a dry-joint so quickly. **N.L.**

Binatone 01/9909

The complaint was that the picture "goes into lines and keeps drifting". Checks and component substitutions in the line sync and oscillator circuits failed to cure the problem and we then noticed that the line output transistor overheated when the timebase was running at the wrong speed. The transistor was o.k. but the efficiency diode D503 (1N4004) was found to have a reverse leakage reading of 8MΩ. Replacing this cured the fault. **M.S.B.**

Decca DV9357 (131 Chassis)

We've had two common faults on these sets, which use the frequency synthesis tuning system 30. Channel display shows r and will not tune in: transistor QR16 leaky. Will not remember channel numbers or analogue settings: rectifier diode DE05 short-circuit (removes the −23V supply to the EAROM **P.B.**

Bush BC6004

In the event of no sound or picture, first check that the mains bridge rectifier D856 is producing 300V across its reservoir capacitor C858. If this is all right fault-finding gets more difficult – this set, which was supplied to Rank by Saba, uses a combined switch-mode power supply/line output stage known as the Wessel circuit. In a recent case we found that the 122V line output stage supply was low and the set tripping. Quite a few components turned out to be faulty. On the sync/control module R967 (680Ω) had burnt up, C967 (1μF) was leaky and D968 (BAX13) short-circuit – these items are connected between the 122V line and chassis. In the line output circuit the isolation diode D687 (SKE4F1/10) and the 122V reservoir capacitor C836 (100μF) were short-circuit. It's also worth checking the sampling resistor R836 (2·7Ω) which can go open-circuit under this sort of fault condition.

In the event of intermittent fuse blowing, check for dry-joints at the line deflection module plug/socket. **J.C.**

Decca 100 Chassis

In the event of reduced height with slight foldover, check the field output transistors by substitution then check R371 (2·2kΩ) in the second driver transistor's base biasing network – it tends to overheat and go open-circuit. Use a ½W replacement and check D309, D311 and Tr309 which can be damaged in the process. **J.C.**

VCR Servo Systems

Part 2

Eugene Trundle

We ended last month with an account of the single-motor system used in the Sony SL8000 and Sanyo VTC9300. We'll turn next to the separate-motor systems used in some of the earlier VHS machines.

Simple Two-motor System

The Hitachi VT5000 is a representative example of this type of machine. It uses separate d.c. motors to drive the capstan and drum, both belt coupled and servo controlled. The reference is provided by a 32·765kHz quartz crystal. Fig. 10 shows the system in block diagram form.

Starting with the drum servo (top), during record it's necessary to phase the head rotation to the incoming field sync pulses. These, after division by two and delay by an MMV (record head-switching adjustment), provide a narrow pulse which is used to sample a ramp initiated by the drum PG pulse. The output from the phase comparator sample-and-hold circuit is applied to the motor drive amplifier via an operational amplifier. This constitutes the phase control loop. The system is the same during playback except that the reference signal is this time derived from the crystal oscillator, after division by 1,310 (count down to 25Hz). The tracking control, via the MMV, adjusts the reference/drum phase relationship.

There's also a drum speed control system. This is a simple feedback loop which operates on the principle that increased mechanical loading on the drum motor will reduce its speed and its effective resistance. The negative-going voltage across the motor is applied to the inverting input of the operational amplifier, increasing the motor drive to compensate. The motor is thus accelerated quickly from standstill and maintained at about the correct speed.

The operation of the capstan servo on record is quite simple. All that's required is constant speed in the face of varying loads. When the capstan is running at the correct speed, the capstan FG generates a 126Hz signal. This is divided by six to give 21Hz sampling pulses. A 21Hz ramp is produced from the reference oscillator's output after division by 1,560. The error voltage produced by the phase comparator circuit is fed to the motor drive amplifier via another operational amplifier.

During playback the capstan servo has an additional task – tracking phase control. The head drum is locked to the crystal oscillator, so if phase lock between the off-tape control track pulses and the oscillator is established, correct tracking will be achieved. This time the oscillator's output is divided by 1,310, to 25Hz, and is used to trigger a ramp which is sampled by the off-tape control pulses. The situation now is that the capstan phase is determined by the off-tape control pulses and the reference signal while the drum phase is controlled by the PG pulses and the reference signal, the latter as it were becoming the common denominator. The tracking control thus achieves its purpose even though it operates via the drum servo.

Capstan speed control is the same in record and playback and is a little more elaborate than the drum speed control system, consisting of a full loop rather than simple negative feedback. The capstan FG rate is propor-

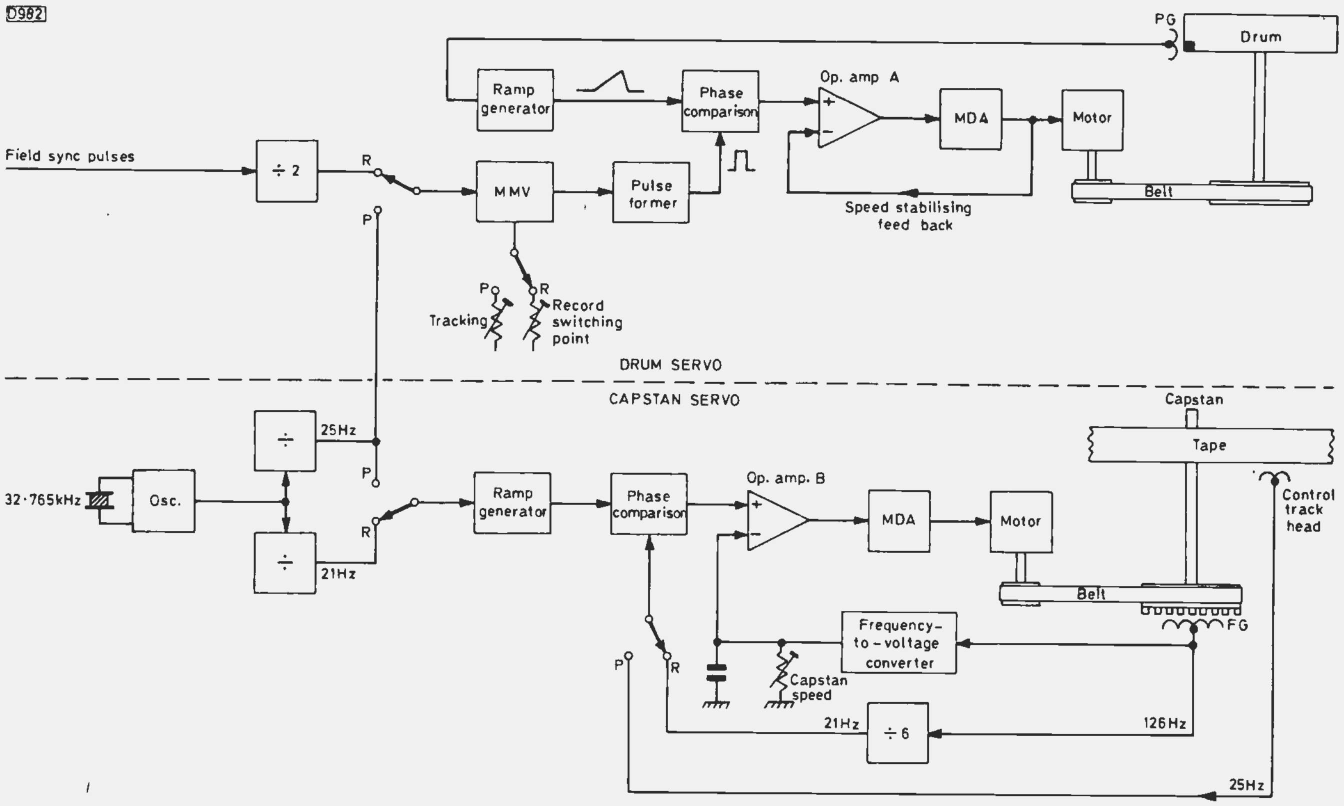


Fig. 10: Block diagram of the servo system used in the Hitachi VT5000 to control two d.c. motors.

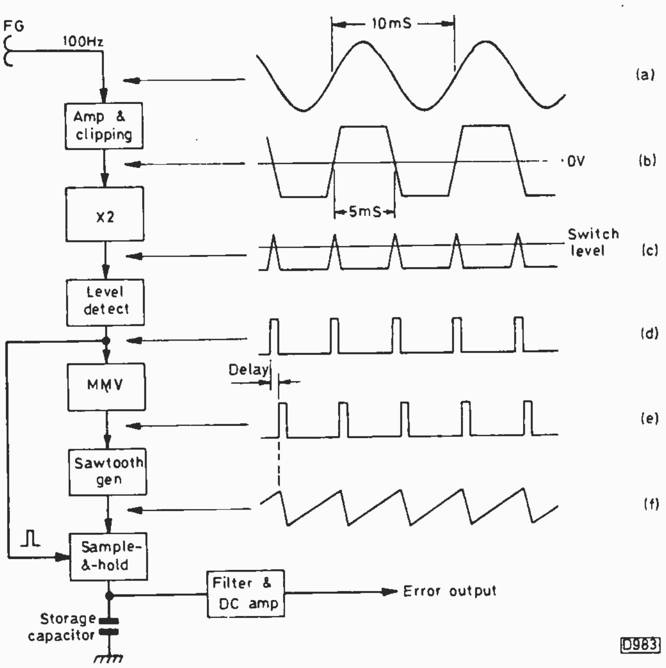


Fig. 11: Speed control system used in the Hitachi VT8000. This employs frequency-to-voltage conversion by means of a ramp and sample system. The duration of the ramp is set by the FG frequency.

tional to speed, the loop maintaining it at 126Hz. A frequency-to-voltage converter produces across the storage capacitor an error voltage which is applied to the inverting input of the operational amplifier: the speed control sets the circuit's operating point. This arrangement deals very effectively with speed changes outside the range of the phase control loop.

Four Loops

The dual-loop servo system just described has become the standard in later machines for both the capstan and drum servos. Let's examine the speed control system used in the Hitachi VT8000, see Fig. 11 – a similar arrangement is used for both servos and operates in both record and playback. We'll consider the drum servo as it's not complicated by trick-speed switching.

With the drum rotating at 1,500 r.p.m. the drum FG produces a 100Hz sinewave output – waveform (a). This is amplified and clipped to produce waveform (b). The following doubler circuit effectively inverts everything above the zero line, rather like a bridge rectifier, to produce waveform (c). The level detector then produces trigger pulses, (d), which are coincident in time with the zero crossings of the original FG waveform. Next comes a fixed-period MMV which produces a slightly delayed pulse, (e), that in turn triggers a sawtooth generator. Now the longer the ramp, (f), the higher its amplitude: if we sample its final level just before the "flyback", i.e. just before the sawtooth generator is triggered, we shall have a voltage that's proportional to the time lapse between the FG pulses, i.e. the FG frequency. Trigger pulse (d) always occurs at the top of the sawtooth waveform and is used as the sampling pulse.

This ramp and sample system is quite different from the basic sort described earlier in that both the ramp and the sampling pulse are derived from the same source – a sort of electronic incest. The key to this is that the frequency of the whole system is variable. If the drum slows down, the FG frequency will fall below 100Hz and the 5msec intervals between trigger pulses will get longer. Sawtooth (f), having a constant rate of rise, will achieve a higher voltage by the time it's sampled. Thus the error voltage will rise and, fed to the motor, will increase its speed to compensate. The process works in the same manner in reverse, so a constant motor speed is achieved.

The error output from the speed correction loop is simply added to the error output from the phase control loop, which is quite conventional, using its own sample-and-hold phase detector system (see Fig. 12). The drum PG pulses are converted to ramps and fed to a phase comparator whose other input is the divided-by-two field sync pulses during record, thus achieving head/sync pulse phasing, and the counted down output from the crystal oscillator during playback. The capstan FG is locked to the crystal reference during record. During playback the capstan phase, relative to the reference, is governed by the

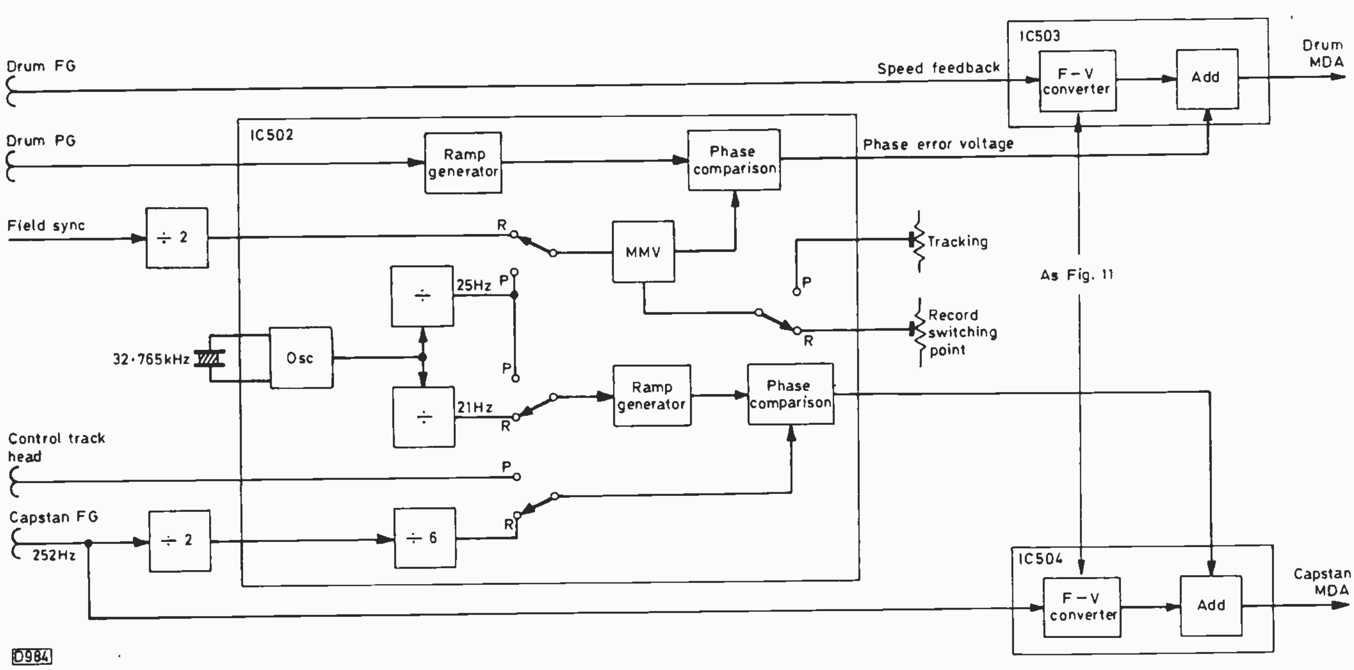


Fig. 12: Addition of the phase and speed control signals. The four-loop system used in the Hitachi VT8000.

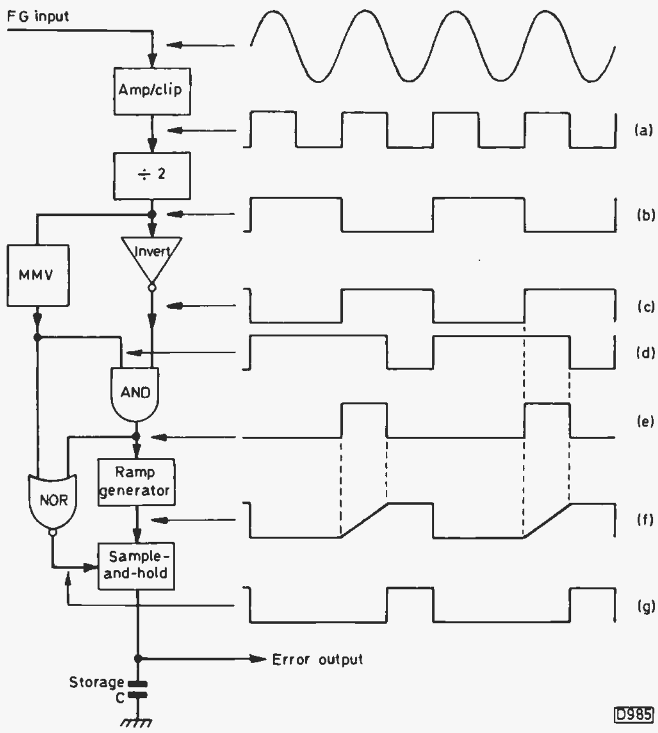


Fig. 13: Frequency-to-voltage conversion technique used in the Panasonic NV7000.

off-tape control track pulses. This arrangement is similar to that used in the VT5000.

The Panasonic NV7000

An alternative approach is used in the Panasonic NV7000, whose speed loop is shown in Fig. 13. Both the capstan and drum are fitted with FGs, which generate 504Hz and 200Hz outputs respectively at normal speeds. Taking the drum loop as our example, the FG signal is first converted to a squarewave, then halved in frequency by a bistable. The output, waveform (b), is fed to an inverter and an MMV. The outputs from these, (c) and (d), are applied to the inputs of an AND gate whose output goes high only when (c) and (d) are both high. Hence waveform (e). During the high period of waveform (e) a constant-slope ramp generator is enabled, and because the on period of the MMV – waveform (d) – is fixed, any variation in FG rate will alter the ramp duration. Thus the terminal ramp voltage is proportional to the FG rate. It remains only to sample the ramp voltage at its highest point to produce an error voltage. Sampling pulse (g) comes from a NOR gate whose inputs are (d) and (e). The storage capacitor providing the hold function charges to the peak ramp voltage, which is the speed error voltage.

In describing the NV7000's speed control loop we said that the MMV's period is fixed. This is not wholly true. It's

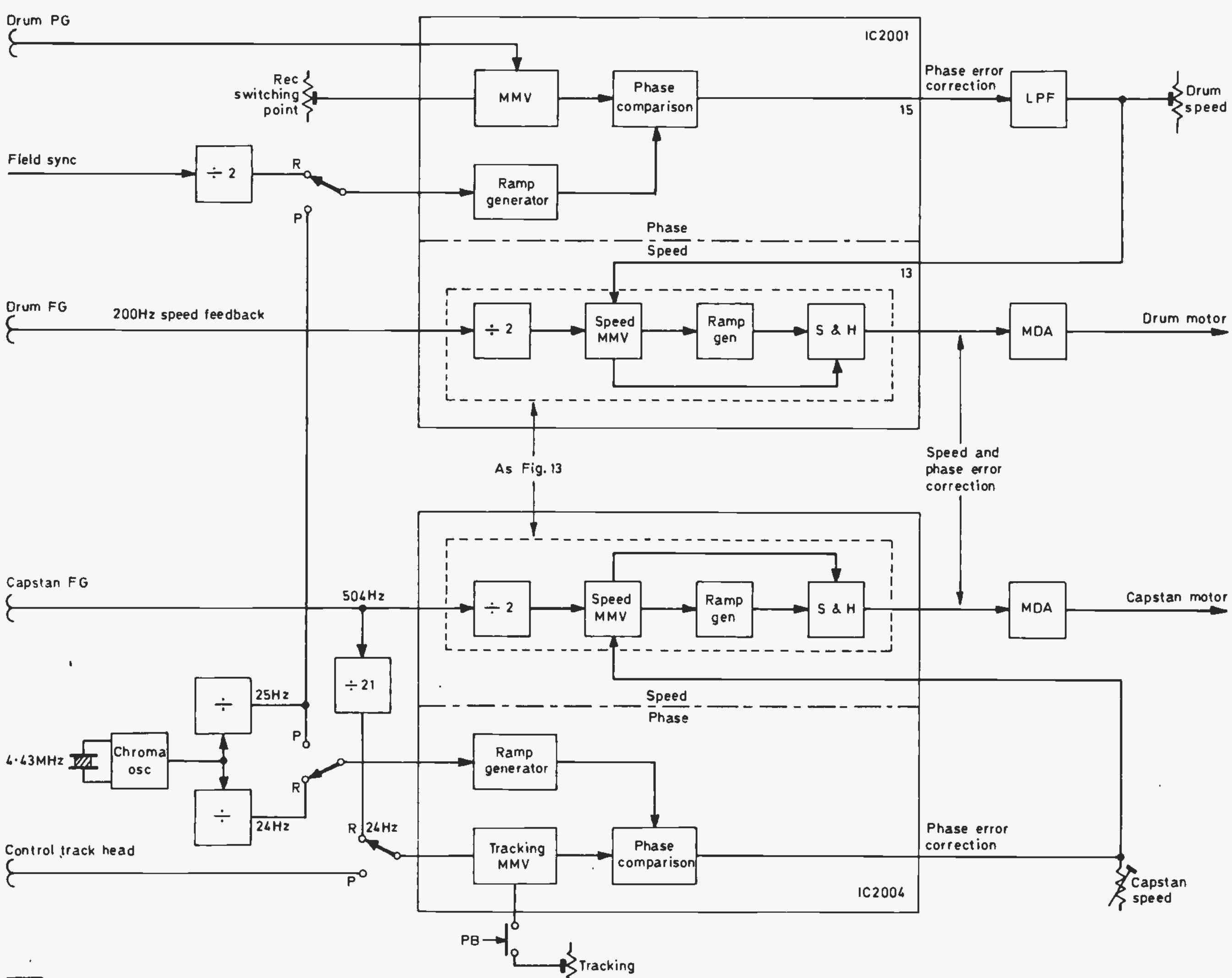


Fig. 14: Phase loops operating on the speed MMVs – Panasonic NV7000. The 4·43MHz chroma reference crystal also provides the servo reference signals.

period is governed by two influences, the free-running speed preset and the phase servo control voltage. Study of the waveforms shown in Fig. 13 will show that the motor's speed depends on the MMV's on/off period, so this is a convenient point to introduce the bias level control (free-running speed adjustment) and the control voltage for the phase correction loop. These are shown in the more detailed block diagram (Fig. 14), where the items in Fig. 13 are shown within broken outlines.

Looking at the drum servo (top), we can see that the idea is to phase the drum PG pulses with a reference, the field sync pulses during record and 25Hz reference pulses derived from the 4·43MHz chroma crystal oscillator after division during playback. The reference pulse triggers a ramp which is sampled by a PG-derived pulse whose timing is adjustable to set the record switching point. The resultant error voltage leaves the chip at pin 15 and, after filtering, is added to the adjustable speed bias voltage. This combined voltage re-enters the chip at pin 13 to vary the period of the speed MMV.

The capstan phase control works similarly. Rotation of the capstan is controlled basically by the crystal derived reference, which is used to generate a ramp. During record this is sampled by the capstan FG pulses while during playback the off-tape control track pulses do the sampling after undergoing an adjustable delay in the tracking MMV. The capstan phase error voltage is fed, along with the set-speed bias, to the capstan speed MMV. Thus as with the drum servo the output from the speed loop provides both speed and phase correction.

Dual-loop Complexities

Why go to all this trouble with the speed control loops when a simple frequency-to-voltage converter suffices in some machines? One answer is improved noise immunity, but what's more important is stability and freedom from drift. There's also the need for trick-speed modes such as multiple speed playback (fast, slow etc.). By inserting dividers into the loop the capstan speed can be set to a multiple of its normal speed while phase lock is maintained: in machines which include these features the servo circuits are arranged to facilitate this. In all cases the heart of an FG-fed speed control loop is some form of frequency-to-voltage converter while the essence of the phase loop is a phase or timing detector.

Digital Servos

There's another way of carrying out these frequency and phase measuring actions – by means of a counting system rather than an analogue ramp arrangement. The basic idea is simple enough. Fig. 15 shows the rudiments of a counting servo whose essential components comprise a couple of counters, a latch, a comparator and an SR (set/reset) bistable. The output from a servo of this type consists of a squarewave whose mark-space ratio is proportional to the error.

In the elementary system shown in Fig. 15 the reference pulse is used to enable counter 1 which will start to count clock pulses from 0000 upwards. If it's a ten-bit counter the maximum count will be 2^{10}, i.e. 1,024. At the clock rate of 1MHz the counter will take about 1msec to reach its full count. Before this happens however the sample pulse appears and activates the latch. In effect this stops the count and dumps the total into the comparator's hold register. If the sample pulse comes 500μsec after the

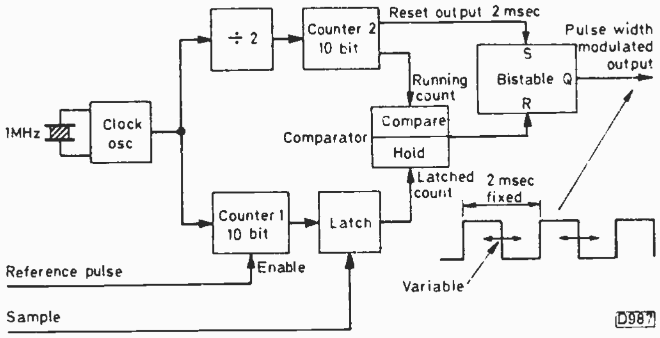


Fig. 15: Simplified outline of a digital servo used to provide phase control.

reference pulse the count will have reached about 512 (binary 1000000000). The latch operates and binary 512 is loaded into the comparator as an indication of the time lapse between the arrival of the two pulses.

Now consider the top half of Fig. 15. After emerging from the divide-by-two stage the clock pulses are at 500kHz. These are fed to a second ten-bit counter which also counts from zero to 1024, resetting itself each time it reaches the full count. This count and reset process is continuous for counter 2, and because it's counting 500kHz (2μsec period) pulses it resets at 1,024 × 2μsec = 2msec intervals. Each time it resets a trigger pulse is applied to the set input of the SR bistable, setting the bistable's output high. The continuous count going on in counter 2 is also fed to the comparator, which looks for coincidence between the number in its hold register and the running count. After 1msec counter 2 will have reached 512 so that the counts in the two halves of the comparator match. Bingo! The comparator output produces a pulse which is applied to the SR bistable's reset input, and the output from the bistable goes low. The bistable is being set and reset at 1msec intervals, producing an output with a 1:1 mark-space ratio.

Consider what happens if the motor runs slightly fast. The sample pulse will come close on the heels of the reference pulse, giving counter 1 little time to accumulate a count before the latch operates. So a low number, say 250, will be loaded into the hold register of the comparator. Counter 2, after setting the bistable high when it passed 0, will take only half a millisecond to reach 250 when the comparator detects count coincidence and resets the bistable low again, where it sits for 1·5msec before being set high again by counter 2. Thus the mark-space ratio of the output squarewave has become 1:3. It works the other way round as well, when the motor speed is slow. The rising edges of the output waveform shown in Fig. 15 always occur at 2msec intervals, when counter 2 sets the bistable, the position of the falling edges being determined by the time interval between the reference and sample pulses.

This pulse-width modulated pulse train can be converted to a d.c. voltage proportional to error by being passed through a low-pass *RC* filter. The result (see Fig. 16) is an error voltage that can be used to control the motor in the same way as in the other servos we've looked at.

Digital Speed Control

The first machines to use digital servos (examples include the Toshiba V5470 and Hitachi VT6500) used conventional feedback systems in the speed loop of one or

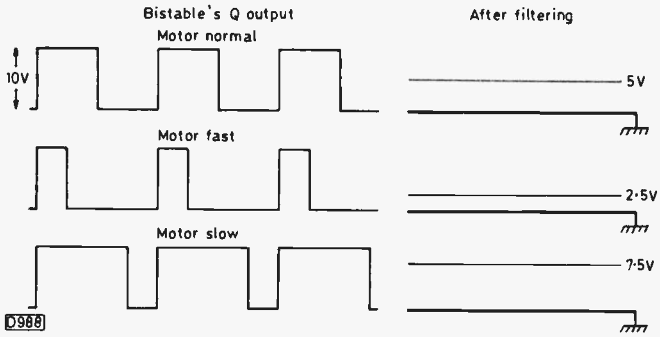


Fig. 16: Low-pass filtering (integration) produces a d.c. error voltage proportional to the mark-space ratio of the squarewave output from the SR bistable.

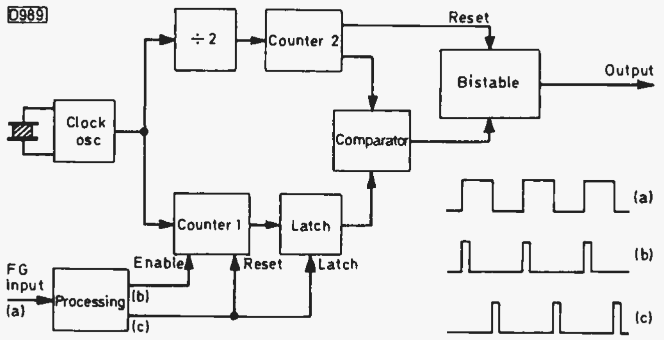


Fig. 17: Digital servo arranged for speed control. The FG pulses operate both counter 1 and the latch.

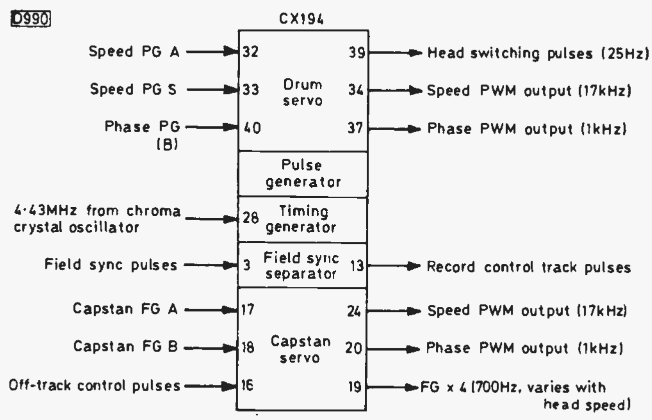


Fig. 18: LSI servo chip used in the Sony F1 and C9. These machines have no drum servo as such: regularly positioned magnets on the drum give six pulses per revolution to PGs A and S. Because the PG S coil is offset by 30° under the drum its pulse lags A by 3msec and the speed loop works to maintain this interval. PG B provides one pulse per drum revolution for phase control.

both servos: later models are fully digitalised for the speed and phase loop of both servos. The basic digital servo we've just described is suitable for use in only a phase correction loop since fundamentally it measures time. For application as a frequency-to-voltage converter in a speed control loop it can be adapted as shown in Fig. 17. Waveform (a) is the squared FG signal. Its rising edge produces waveform (b) which starts counter 1 while its falling edge produces waveform (c) which resets the counter and operates the latch. The latched count will be inversely proportional to the FG frequency and will sit in the comparator's register until counter 2 catches up with it. The rest of the action is the same as before. In practice the speed control pulse-width modulator bistable works at a higher rate (4-17kHz) than the 1kHz or so of a conventional phase control PWM. In all cases the bistable rate is set by the number of bits in the recirculating counter (counter 2 in our examples) and the clock rate, and is chosen to give an appropriate sampling rate for the loop in question.

In the Panasonic NV777 the counter bit capacities and clock rates vary with the different loop requirements, ranging from eight bits counting $fck/2^6$ in the capstan servo speed loop to ten bits counting $fck/2^4$ in the drum servo phase loop. This machine also has some ROM in the digital servo chip to hold "start count from" information. This is addressed by a mode select line. The MN6168VIA i.c. used for this purpose also has a self-oscillate arrangement in the drum phase counter circuit to maintain correct conditions should the field sync pulse momentarily disappear due to noise or interference.

Comparisons

Digital operation brings several advantages. Amongst these are: elimination of the ramp capacitor; zero drift with time and temperature; the elimination of several presets including the record switching point control and the sampling position control; a lower component count; and the opportunity to introduce programmable counting systems to cater for different modes of operation. In a digital servo the traditional ramp is replaced by a count-up circuit while a count coincidence detector in conjunction with a PWM replaces the traditional phase detector.

It's not necessary to know very much about digital circuit operation because the operations take place within an i.c. which (see Fig. 18) can be regarded as a black box. All we can do is to inspect the input and output signals. These i.c.s promise to be reliable animals and we would expect most troubles that may arise to be due to other items such as crystals and motors. Table 1 shows the servo arrangements used in a representative selection of VCRs produced over a period of several years.

Trick Servo Operation

If we define trick playback as any mode in which the tape isn't moving at the same speed as during record, we have still frame, frame advance, cue and review (search functions), slow-motion and high-speed playback on the list. The LP mode and clever-edit facilities are more the concern of the syscon than the servo department. In the trick playback modes (Sony call them jog modes) the rotating video heads are still scanning the tape but because the tape speed is not the same as during record the head scan and video track angles will diverge. This will result (apart from noise bands due to track crossing) in a change in the number of lines per field. The reason for this can be seen in Fig. 19. Now if a TV set starts to see a video signal with non-standard timing, luminance/chrominance registration will first be upset then line lock will be lost. To prevent these things happening, speed compensation is applied to the drum motor (speed up in forward trick, slow down in reverse trick) to maintain the correct line speed. This is all that's required in the drum servo and is easily arranged in the servo loop – usually by providing switched preset potentiometers, sometimes by means of a programmable divider in the reference pulse path to the drum phase loop.

So trick-speed operation mainly concerns the capstan servo. For cue or review the syscon decides the motor direction and its supply voltage is increased by a factor of

Table 1: Comparison of servo arrangements used in different VCRs.

Servo type	Philips N1500	Sanyo VTC9300	Ferguson 3V00	Sony C7	Hitachi VT5000	Hitachi VT8000	Sharp VC9500	Ferguson 3V01	Hitachi VT9500	Panasonic NV333	Toshiba V8600	Sanyo VTC5000	Ferguson 3V23	Panasonic NV777	Hitachi VT6500, VT11	Panasonic NV200	Sony F1, C9
Mains reference	X	X															
Crystal reference			X		X	X		X	X		X	X		X			
4·43MHz reference				X			X			X			X		X	X	X
Capstan PB control	X			X	X	X	X		X	X	X	X	X	X	X	X	X
Drum PB control		X	X					X									
Capstan PG	X		X				X										
Drum PG	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Capstan FG				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Drum FG						X	X	X	X	X			X	X	X	X	*
Speed and phase loops				X		X	X	X		X	X	X	X	X	X	X	X
Digital servo											X			X	X	X	X

* Drum PG for speed control – see Fig. 18.

two or three. If phase control is applied from a divided down off-tape control track pulse it will be possible to lock the noise bars and hold them steady in these modes. This is done in the Sanyo VTC5000 for example, though an alternative approach is to operate the search functions via the reel drive with the pinch roller disengaged, as in the Toshiba V8600 and Ferguson 3V29 etc. The latter uses the capstan motor to drive the reels and manages to lock mistracking bars by means of a reel servo working on the off-tape control track pulses.

During still-frame operation the capstan is stopped, and for a noise-free display the stopping point is determined by the relative positions of the noise bar in the replay f.m. envelope and the 25Hz head switching squarewave. This will put the noise into the field blanking interval, and because this will obliterate any field sync pulse present a synthetic field sync pulse is generated from the head switching or head PG pulse and is added to the video output signal. Slow motion consists of a series of still frames, with the capstan motor stepping forward at intervals under the control of the off-tape control track pulses so that a new, correctly aligned track is presented in the path of the head sweeps.

We've been able to mention trick-speed servo operation only briefly here. It's hoped to be able to present more detail on the basic principles in a later article.

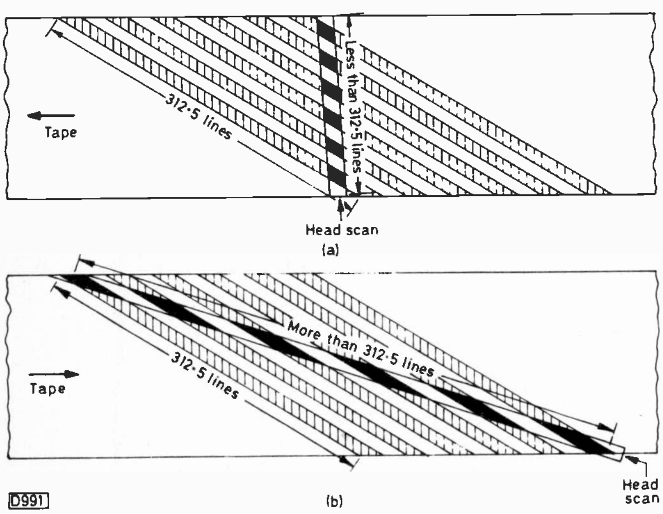


Fig. 19: Video head path with respect to the tracks in (a) cue and (b) review. It can be seen how noise bars arise, also why drum speed correction is required to maintain the correct line scanning rates in these modes.

Book Notices

The 1983-84 volume of **Radio and Television Servicing** has been published by Macdonald at £22·50. It contains over 850 pages of servicing data for current radio and TV sets and audio equipment (but not VCRs). This series of books has been going for thirty years now.

Servicing Digital Circuits in TV Receivers, by R. Fisher, has been published by Newnes at £13·95. Bob Fisher is a lecturer in digital and television electronics at Plymouth College of Further Education and has written for this magazine from time to time. The book has 270 pages and is a thorough guide to digital techniques as applied to TV receivers, including teletext, Prestel, remote control and tuning systems. There's not a lot on actual servicing – the book is rather an introduction and useful reference standby written with the needs of service personnel in mind.

Servicing Monochrome Portable Television, by G. R. Wilding, has been published by Newnes at £13·50. This book contains some 135 large pages and falls into two sections: first a practical description of the circuitry used in monochrome portable sets, with guidance on fault symptoms and causes; secondly service data, including circuit diagrams and board layouts, for a representative selection of monochrome portables.

Service Bureau

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PANASONIC TC492G

When the set is first switched on it remains dead. You have to operate the on/off switch several times to get it going.

This effect is usually caused by dry-joints around the chopper transformer T801 or the chopper transistor Q801. Some of the leads that connect to the board are of iron to inhibit heat transfer, and they don't solder well. Disconnect them and apply "Tinmans flux" or something similar before retinning and resoldering.

SONY KV1810UB

The screen is modulated from left to right, starting black on the left-hand side then changing linearly to white at the right-hand side. The video circuits have been scoped but nothing wrong can be found. The electrolytics in the brightness circuit have been changed.

The effect is not uncommon in these sets and is generally due to a dried up electrolytic in one of the line output transformer derived supply lines. Check by substitution in the following order C543 (4·7μF, 350V, 200V supply – C596 in the Mk. II version), C546 (470μF, 25V, 18V supply) and C534 (0·068μF, 1·5kV, first anode supply).

GRUNDIG 5010

After the cutout operated a check was made for shorts or anything obviously amiss. As nothing untoward could be found the trip was reset and the set switched on. This time there was a small picture, lacking an inch or so all round, with horizontal foldover in the middle. The only other clue is that R545/6 are blackened and smoked when the set was on.

R545/6 form part of the first anode supply network which is fed from the "earthy" end of the line output transformer's e.h.t. overwinding. The fact that they are burning means that a heavy ripple current is flowing in the overwinding. The e.h.t. tripler is the first suspect, then the first anode supply reservoir capacitor C521. Check the presets R547-9 for damage, also the beam limiter sensing components Di521 and R521.

SHARP 12P-26H

There's sound but no raster – just a faint raster can be seen if the brightness control is turned up slowly to a point where a loud clicking noise starts. When the brightness control is further advanced the raster disappears and the rate of the clicks increases.

The symptom suggests that the e.h.t. rectifier is breaking down under load. An alternative possibility is that the tube itself is defective. Before checking either of these items, examine the e.h.t. feed lead and the Aquadag earthing.

HITACHI CNP190

There are intermittent brightness variations accompanied by small (not more than two per cent) variations in picture size. The brightness can increase or decrease, and the variations may occur at switch on or after several hours' running. The sound is not affected.

It's likely that the h.t. voltage is varying slightly, but the cause of this may be difficult to trace. Concentrate on the series regulator circuit, checking zener diode CR40 and CR39 which is in series with it, also the potential divider network R910/1/2. Use of heat and freezer spray in this area and on the transistors should narrow the area of search.

BEOVISION 3400 CHASSIS

The fault is intermittent line drive. When the set goes off the lower PL509 in the line output stage overheats. On touching the line driver transistor's connections with the meter probe drive is restored. The transistor has been replaced, also the two silver mica capacitors in the line generator circuit. We've also checked the screened lead to the PL509.

Check thoroughly for dry-joints in the area of the line generator and driver. Then try replacing 2TR2 which drives the emitter of the driver transistor, and the driver's protection diode 2D20. Other suspects include 2D3 which could be leaky, shorting the output from the TAA790 line generator chip, the 13V zener diode 2D1 and the chip itself.

PYE 697 CHASSIS

If the mains voltage drops (indicated by the brightness of the house lights dimming) the picture slowly disappears, returning when the voltage is restored. The PL509 line output valve glows cherry red when the picture goes. The controls have been turned up fully to avoid the problem but the picture takes five-ten minutes to appear while the colour is weak for another twenty minutes or so.

This series of sets is very voltage conscious. If the mains supply regularly falls below 220V a.c., fit an autotransformer to ensure that the set receives 240V. If the mains supply is reasonable, check the heater supply, especially the VA1026 thermistor R304. If this is all right the PCF802 line oscillator could be stopping intermittently.

PHILIPS N1700

The sound is o.k. but the picture is unstable, with intermittent field roll and pulling. The instructions for servo adjustment given in the manual are not very clear.

Ensure that the ruler on the lower drum is free of tape oxide, especially at the ends under the plastic guides. Then adjust the servos as follows. (1) Adjust R9 (drum servo module) so that the picture gap (head overlap point, visible on the picture as a slight horizontal disturbance) is within three lines of the bottom of the picture. This can be done by making trial recordings and playing them back. The adjustment affects record only, and is very critical. (2) Adjust the drum servo ripple control R2 for minimum ripple (scope at test point B31). (3) Short out the control head (link A41/2), play back a known good tape and adjust R7 (balance control) in the capstan servo module until noise passes through the picture very slowly. Remove the short. (4) Adjust the capstan servo ripple control R3 for minimum ripple (scope at test point B32). (5) Adjust R38 (tracking range adjustment) in the capstan servo sync module for maximum f.m. at plug F21 – this is on panel 71, below panel 51 on the right-hand side. Carry out this adjustment with the tracking control at centre and a recording made on the machine.

TEST CASE

262

Each month we provide an interesting case of television servicing to exercise your ingenuity. These are not trick questions but are based on actual practical faults.

A lucrative and growing trade is being done by some TV and video workshops in converting foreign equipment for UK use. Products from across the Atlantic are not really practical candidates for conversion, and equipment intended for use in other parts of the world can be difficult – we had to turn away an Australian colour set a while ago because it was fitted with a v.h.f. tuner and the estimated time and expense involved in finding and fitting a u.h.f. tuner and station selector/potentiometer bank made the whole thing uneconomic. With equipment designed for use in continental Europe and the Middle East however modification can be a practical proposition. Incidentally, it's amazing how many multi-standard VCRs and TV sets can't get a grip on 6MHz sound.

Our concern this month is with a certain Sharp VCR – the W. German version of the VC3300. It's designed to work on the PAL-G standard, whose main difference from our own system I is the 5·5MHz sound-vision spacing. The conversion was required in a hurry by an itinerant civil engineer, and the job was entrusted to a small service company with little experience of this sort of thing. It seemed straightforward enough to them – once the considerable problems of physical access were overcome!

What they did was to adjust the intercarrier generator coil in the VCR's u.h.f. modulator to 6MHz, which was easily done by replaying a good tape and twiddling for best sound via a UK-type TV set. The sound receiver section of the VCR was then tackled. New 6MHz ceramic filters were fitted in the intercarrier sound take-off and the video channel 6MHz notch filter positions. The two-leg second intercarrier sound filter in the video channel was replaced with the special UK type available from Sharp spares. Finally, the quadrature coil was adjusted for best E-E sound and the r.f. modulator department was given a tweak. On test all went well on all functions, and only slight adjustment was needed to the audio E-E and audio playback level potentiometers to equalise the sound levels. The two proprietors of the service outfit were well pleased with their efforts, and returned the VCR to its owner with a flourish.

Pride comes before the fall, doesn't it? The roving customer returned a few weeks later, after sojourns in London and elsewhere. He was not very happy, and demonstrated to our startled pair recordings made since the conversion. They were marred by patterning effects and in some cases a degree of caption buzz. Thinking that the quadrature coil's alignment was perhaps not spot on they checked this on a "Ceefax in vision" daytime transmission, only to find that their original alignment was correct.

With a little help from a friend, they finally realised the source of the trouble, and in doing so had a basic lesson in TV theory! Where had they gone wrong? In their new-found wisdom they now offer full-specification conversions with a guarantee of no spurious effects. You shouldn't need the Sharp circuit to puzzle this one out: answer next month!

ANSWER TO TEST CASE 261

– page 618 last month –

A Rank colour set fitted with the T20A chassis was in the spotlight last month. After some consultation between site and workshop we'd reached the point where the line oscillator's start-up circuit had been overridden and the line driver transistor was operating normally, though the line output stage was still dormant. It will perhaps be remembered that the set had earlier "eaten" a BU208A line output transistor for reasons unknown . . .

Both these symptoms had a common cause in the BU208A's base feed resistor 5R8 (1Ω) which was found to be open-circuit and dry-jointed to boot. Whether the bad joints led to its failure or whether it overheated to crystallise the solder is open to question, but there was no doubt that its original spasms had caused overheating and the eventual failure of the previous line output transistor. There's a nice little 4W resistor in there now (it's not a BEABed component!) and we don't expect any further trouble, especially as 4C19 and the notorious 4R16 (910Ω) were replaced at the same time by way of a little preventive medicine.

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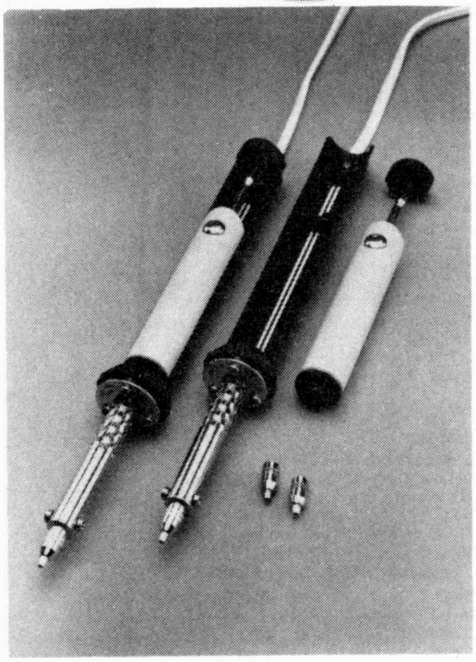

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2N.1131	28p
2N.1132	28p
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2N.2219	24p
2N.2221	23p
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2N.2369	15p

2N.2484	20p
2N.2646	38p
2N.2904	20p
2N.2905	20p
2N.2906	18p
2N.2907	18p
2N.2926	8p
2N.3019	28p
2N.3053	18p
2N.3054	35p
2N.3055	32p
2N.3055H	38p
2N.3440	58p
2N.3442	85p
2N.3702	9p
2N.3703	9p
2N.3704	9p
2N.3705	9p
2N.3706	9p
2N.3707	9p
2N.3708	9p
2N.3771	85p
2N.3772	90p
2N.3773	100p
2N.3819	29p
2N.3866	68p
2N.4031	25p
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2N.4037	25p
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BY133	8p
BY164	22p
BY176	85p
BY179	35p
BY182	32p
BY184	32p
BY187	32p
BY196	20p
BY206	11p
BY207	11p
BY208	18p
BY210	22p
BY223	72p
BY225	120p
BY226	18p
BY227	19p
BY228	32p
BY296	20p
BY298	26p
BY299	28p
BY476	90p
BYX10	15p
BYX55/350	30p
BYX55/600	30p
BYX55/800	32p
BYX70/300	29p
BYX70/500	31p
BYX70/800	36p
BYX71/600	80p
OA47	6p
OA90	4p
A091	4p
OA200	7p
OA202	7p
IN.914	2p
IN.4001	4p

IN.4002	4p
IN.4003	4p
IN.4004	4p
IN.4005	4p
IN.4006	4p
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ECC84	40p
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ECH84	52p
ECL80	57p
ECL82	59p
ECL84	57p
ECL85	57p
ECL86	49p
EF80	31p
EF85	34p
EF89	43p
EF183	45p
EF184	53p
EL34	190p
EY86	31p
EY87	31p
PC97	100p
PCC85	42p
PCF80	58p
PCF200	135p
PCF801	110p
PCF802	57p
PCF806	115p
PCH200	100p
PCL81	54p
PCL82	63p
PCL84	50p
PCL85	55p
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4009	50p
4010	50p
4011	27p
4012	27p
4013	50p
4014	60p
4015	60p
4016	45p
4017	65p
4018	60p
4019	60p
4020	75p
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4082	27p
4093	45p
4094	85p
4098	85p
4099	82p
4501	40p
4502	55p
4503	52p
4504	75p
4506	110p
4507	45p
4508	125p
4510	57p
4511	57p
4512	57p
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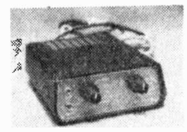

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2n2/2KV	15p
7500pf/2KV	10p
4n7/2KV	15p
8n2/2KV	15p
0.0082/2500	15p

Infra Red and Ultrasonic G11 Teletext Decoder Panel	£30
RANK & ITT Mains Remote On-Off Switch (720R)	£1.50
RANK & ITT Mains Remote Switch 2865 ohm	£1.50
RANK & ITT Remote Switch 2800 ohm	£1.50
G11 Mains Switch	50p
4 amp Mains Switch	25p
GEC Mains Switch 4 amp	30p
KT3 Mainswitch	£1.00
THORN Rotary Mains Switch	50p
G8 Mains Switch	75p
Thyristor 600/4 amp C106/2	24p
G11 Preh Red LED P/Button for C.H. Change	20p
RANK TOSHIBA Transductors TPC-2011	50p
CVC 5 Mains on/off +250K+100K+500K+50K+500K Pot on Panel	£2.00
Thorn 12 or 24 volt battery convertor for portable colour T/V	£12.00
	Post £1

150/3500	10p
1800/4KV	5p
4.7nf/5KV	10p
170/8KV	10p
180/8KV	10p
210/8KV	10p
1000/10KV	10p
210/12KV	10p
1000/12KV	10p
1200/12KV	10p

Multi-Caps

470/250 G11	10 for £15
Thorn 3500	
175/100/100/350v	£1.75
KT3/200/25/25/385v	£1.00
300+300+150+100+50MFD 350V	£2
47/220/350v	60p
150/150/100/100/100/320v	£2.00
2500/2500/63v	50p
470/470/250v	50p
150/200/200/300v	70p
400/400/200v	£1.70
300/100/100/16/275v	£1.50
100/200/325v	40p
150/150/100/375v	£1.50
300/300/100/32/32/300v	2.00
1500/2000/30v	50p
Jelly pot Thorn 00D4/013	£3
150/150/100/100/320v	£2.00
100/350 + 300/200/100/16/275v	£2.00
300+300/300	£1.00
225+25/380	70p
200/100/100/350v	£1.50
500/500/25v	50p
150/150/100/300v	75p
200/150/150/300v	1.00

ITT Panels

CVC 40/2 Chassis, new £30, complete	£20.00
CVC 820 Line O/P Panel	
CVC20 Mains Panel	£3.00
ITT 8 & 6 Push Button Unit	£1.00
CMA 10	£2.00
CMA 11	£2.00
CMA 30	£2.00
CMA 40	£1.50
CMC 10/2	£5.00
CMC 16	£4.00
CMC 38	£8.00
CMC 45	£1.50
CMC 47	£1.00
CMC 52	£15
CMC 57	£6.00
CMC 58	£8.00
CMC 59	£8.00
CMC 67	£3.75
CMC 67/2	£4.00
CMC 68	£4.00
CMD 12	£10
CMD 32	£5.00
CMD 33	£5.00
CMD 40	£5.00
CMD 41	£5.00
CMF 25	£2.00
CMF 26	£2.00
CMF 40	£2.00
CMH 10	£1.50
CMH 31	£1.00
CMK 12 (untested)	£4.00
CMK 30 (untested)	£4.00
CMN 20	£1.50
CMN 21	£1.50
CMN 40	£1.00
CMN 45	25p
CMP 10	£2.00
CMP 11	£4.00
CMP 40	£2.00
CMS 11	£2.00
CMS 40	£2.00
CMU 12	£10.00
CMU 14	£8.00
CMU 30	£7.00
CMU 45	£7.00
CMZ 30	£5.00
GMA 90	£5.00
GMC 120	£2.50
GMR 64	£5.00
TMN 2	£2.00
VCA 20	£10
VCA 21	£10.00
VMC 26	£3.00
VMC 34	£5.00
VMC 44 + 45	£4.00
VMC 51	£5.00

Hand Sets

Transducer Hand Set Insert, crystal, transducer, SAA 1124 & lead	£3.50
8 C.H. Ultrasonic GEC Full Remote C2014H/C2219H	£15.00
New Replacement for G11 Ultrasonic Full Remote	£12.00
Thorn 4000 insert with 7 buttons	£5.00
Decca RC 11	£14.00
Decca RC 12	£14.00
G11 Infra-red full teletext	£19.00
C11 Ultrasonic full teletext for G26c 674/02 and G22c 66/02	£16.00
G9 Philips R/C Transmitter	£8.00
Rank, Infra-red	£10.00
Dynatron-Full remote CTV 62, 63, 64	£19.00
Hitachi infra red handset	£18
Philips full remote KT3, 16C928/20C934; 7228/7324; K12 26C 797/1ST 66K 1826	£12.00
G11, Full remote top button assy.	£12.00
G11, Full remote repair service (exchange unit)	£12.00
Philips infra red full remote 9 channel for 60 CP2605	£6.00
Philips infra red full remote 12 channel for 60 CP2605	£12.00
KT3-30 Push Button Kit	£3.00
KT3/K30 T/Text	£15.00
KT3/K30 Full remote	£15.00
KT3 Power supply	£4.00
Hitachi 8 button unit with resistor unit. Last year mod.	£7.00
GEC infra-red 2236-2026	£4.00
GEC push pad hand set button blobs	10p each

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ELC1043/05 Mullard	£6.00
ELC1043 (Ex Panel)	£3.75
ELC1042 „	£5.00
ELC2000 „	£7.00
ELC2004	£10.00
ELC2006	£10.00
GEC Tuner V/Cap Hitachi After 1979 ET548, ET547	£10.00
U322 (UHF) „	£4.00
V314 (VHF) „	£5.00
U321	£6
U341 UHF	£7.00
U411 UHF	£7.00
U.V. 411 Tuner	£10.00
ELC1043/05 Thorn	£5.90
Small V/Cap Mitsumi	
UHF „	£4.00
VHF „	£3.00
G8 Tuner	£6.00
Portable & rotary Tuners Sanyo & Mitsumi UHF	£5.00
6003 Bush V/Cap Tuner	£10.00
NSF-UHF/VHF Varicap (old type)	£8.00
Mosfit UHF/VHF (new type)	£8.00
SONY 1400KV Tuner unit	£3.50
Thorn Tuner PANEL with 6×100K pots + cursors NO TUNER	£1.00
U321 on panel	£6.00
Tuner unit VHS Sylvania GTR Videon MTS 900	£2.50
Mullard Video Modulator. Application, video tape recorders, TV cameras, video games, closed circuit T/V, C.C.I.R. system. Data supplied.	£10.00
VT 100 Sound Tuner Kit. TV. Viosound. The latest design in low noise fitted with DNR, RF output and audio	£30.00
Sylvania UHF VHF F6013 (Fits Rank)	£6.00
Sylvania F6003	£6.00
Sylvania UHF F4720B	£6.00
Sylvania VHF 900	£6.00
Decca Bradford Tuner 5 Button	£4.00
Small Tuner DX 175-220MHz Auto Changeover	£5.00
9000 Thorn Tuner on Panel	£7.00
D.P.D.T. switch Black knob: Chassis or PCB mount	4p each or 40 for £1.00

THORN 1400 4P.B. Mech. Tuner	
THORN 1500 4P.B. Mech. Tuner	
THORN 1590 4P.B. Mech. Tuner	
THORN 3500 4P.B. Mech. Tuner	
THORN 8000 4P.B. Mech. Tuner	
THORN 8500 Mech. Tuner	£4.00 each

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DL20A **80p**	DL600 £1.00
G8 (Old Type)	£1
DL700	£1.00
UDL11	30p
KT 3 Luminence	75p
Luminance Delay Line (CVC 45)	
10×630ma fuse	25p
10×2A fuse	50p
10×3.15 fuse	50p
10×500mA	80p
10×1 amp	80p
10×1.6 amp	80p
20 3.15 AS Fuses	£1.70
Co-Ax Joint	15p
Co-Ax Belling Lee Plug	12p
Co-Ax Splitter	£1.00
UHF Modulator CCIR	£3.00
Infra Red Emitting Diode	20p
NE286H Small Neon Lamps GEC & Philips	5p
Mullard 5 Watt Amps. LP1162 New	75p

T.V. Tubes

12" A31/300 Hitachi	£10
15" A38/170W Hitachi	£8
18" Hitachi PIL tube with scan coils 470 KCB22-TC03	£25

Integrated Circuits

AC76003	£1.50
AM25LS23PC	10p
BAV40	40p

BFR39	15p
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BFR81	15p
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BTT6018/ML237B	£1.50
BTT6218	£1.50
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CA270CW	50p
CA270CE	50p
CA920AE	£1.00
CA1310	50p
CA3065Q	50p
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CA3146	£1.00
CA3189	40p
CBF16848	50p
CD4510	30p
DM7492	50p
HA1196	40p
HA1370	£2.00
HA11223	40p
HEF4001	10p
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HEF4053B	30p
M913	£2.00
M1024=SAA	£2.00
M1025=SAA	£2.00
MC476p	£1.00
MC1307	75p
MC1312	
MC1330	75p
MC1349	50p
MC1352	£1.00
MC1358	£1.00
MC14002	15p
MC14013	25p
MC14016	25p
MC14066	30p
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MEM4956	£1.00
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ML236E	£1.50
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MM5387	£1.00
MM5611	£1.00
MM5840	75p
N64100	£1.00
NE545B (Dolby)	75p
NE555P	60p
NE555	60p
IL-1	20p
OPT600	20p
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SAA611	50p
SAA661	£1.75
SAA1020	£4.00
SAA1021	£4.00
SAA1024	£2.50
SAA1025	£2.50
SAA1073	£3.00
SAA1074	£3.00
SAA1075	£3.00
SAA1124	£2.00
SAA1130	£2.50
SAA1174	£3.00
SAA1176	£3.00
SAA1250	£3.00
SAA1251	£4.00

SAA1272	£3.00
SAA1276	£3.00
SAA5000	£1.50
SAA5000A	£1.50
SAA5012A	£5.00
SAA5020	£3.50
SAA5030	£5.00
SAA5040	£3.50
SAA5040A	£4.40
SAA5050	£3.50
SAF1032p	£2.50
SAF1039	£2.00
SAS560	£2.00
SAS660	£1.00
SAS670	£1.00
SL901B	£5.00
SL918	£6.20
TA7122	£1.15
TAA320A	50p
TAA470	£1.50
TAA570	75p
TAA611B	£1.50
TAA621	£2.00
TAA661	£1.75
TAA641	£1.50
TA7117	50p
TA7120P	50p
TA7315AP	50p
TA7607AP	40p
TA7609P	50p
TBA120A	40p
TBA120AS	50p
TBA120SA	40p
TBA120B	40p
TBA120SB	40p
TBA120SQ	£1.00
TBA120U	75p
TBA120Q	30p
TBA120C	40p
TBA1441	£1.00
TBA231	75p
TBA395Q	50p
TBA396Q	£1.00
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TMS1000NL	£4.00
TMS1943 (clockchip)	£1.00
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SN76115AN	50p
SN76131	50p
SN76141N	£1.00
SN76226	£1.00
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SN76270	£1.00
SN76532N	50p
SN76544N	£2.00
SN76545	£3.50
SN76546	£1.00
SN76550	30p
SN76552	30p
SN76570	£1.00
SN76620	50p
SN76650	50p
SN76660N	40p
SN76620AN	50p
SN76666	£1.00
SN76705N	£1
SN76707N	75p
SN76708AN	75p
SN76720	£1.00
UA783P3C	40p
BT100A/02	40p
BT138/10A	70p
BT146	30p
TBA540Q	£1.50
TCA270	£1.00
TCA270Q	£1.00
TCA640	£1.00
TCA660	£1.00
TCA270S	£1.00
TCA270SQ	£1.00
TCA740	£1.00
TCA800	£2.00
TCA830	£1.00
TCEP100	£2.25
TCE120CQ	£1.00
TDA440Q	£1.00
TDA1003A	£1.00
TDA1010	£1.00
TDA1060A	£1.50
TDA1072	£1
TDA1151	30p
TDA1170	£1.00
TDA1190	£1.00
TDA1327A	£1.00
TDA1412	50p
TDA2003	80p
TDA2004	£2
TDA2010	£1.00
TDA2140	£3.50
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TDA2640	£2.00
TDA2522	£1.00
TDA2530	£1.50
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TDA2002	£1.00
TDA2640	£2.00
TDA2680	£1.00
TDA2690	£1.00
TDA2593	£1.00
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TDA3571Q	£1.50
TDA9403	£3.00
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SN16862AN	£1.00
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UA721	40p
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MPSA14	10p
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MJE3055	£1.00

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MJE2955	50p
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Sanikron Diode SKE2G2/04	30p

Transistors

A1222	15p
A1223	15p
AC106	15p
AC121	15p
AC124	15p
AC128	15p
AC137	15p
AC151	15p
AC131	15p
AC138	15p
AC152	15p
AC153K	15p
AC142K	15p
AC169	15p
AC176	15p
AC176K	15p
AC178K	15p
AC179	15p
AC186	15p
AC187K	15p
AC188	15p
AC188K	15p
ACY21	25p
AD143	50p
AD149	50p
AD161/162	pair 40p
AF139	25p
AF181	£1.00
AF239	25p
AF367	25p
AL102	£1.75
BC161	30p
BD507	50p
BD509	30p
BD510	30p
BD517	30p
BD519	30p
BD534	30p
BD535	30p
BD544D	30p
BD562	30p
BD610	40p
BD646	50p
BD676A	30p
BD678	50p
BD681	25p
BD807	20p
BD826	50p
BD948	30p
BDX75	20p
BDX32	£1.25
BF115	20p
BF121	20p
BF127	20p
BF137	20p
BF157	20p
BF160	20p
BF161	20p
BF164	60p
BF179	30p
BF180	20p
BF181	20p
BF182	20p
BF184	20p
BF194	10p
BF195	10p
BF196	10p
BF197	12p
BF198	10p
BF199	10p
BF200	20p
BF222	10p
BF224	15p
BF238	20p
BF240	16p
BF244	40p
BF245b	20p
BF256	10p
BF257	20p
BF258	25p
BF262	15p
BF263p	25p
BF264	15p
BF271	10p
BF273	10p
BF274	10p
BF324	25p
BF337	50p
BF355	30p
BF362	20p
BF363	15p
BF367	15p
BF391	15p
BF394	10p
BF419	30p
BF423	15p
BF448	30p
BF450	20p
BF458	30p
BF459	30p
BF468	30p
BF469	30p
BF470	20p
BF480	50p
BF594	10p
BF597	10p

BF694	10p	2SC2122A	£1.00	BC365	10p
BF758	30p	2SC2229	15p	BC384	10p
BF760	30p	2SC7350	15p	BC394	10p
BFT34	15p	2SD180 TO3 80v/6A	15p	BC413	10p
BFT43	10p			BC414	10p
BFT84	8p	2SD200	£2.00	BC416	10p
BFW11	20p	2SK30A	10p	BC440	30p
BFX29	30p	BC107	10p	BC454	10p
BFX84	25p	BC108	10p	BC455	10p
BFY50	15p	BC109	5p	BC456	10p
BFY52	20p	BC113	10p	BC460	25p
BFY90	25p	BC114	10p	BC462	10p
BLY49	25p	BC115	10p	BC463	10p
BPW41	25p	BC116	10p	BC478	10p
BRC116	25p	BC117	20p	BC527	10p
BRX43	15p	BC119	20p	BC532	10p
BRX48X	10p	BC125	10p	BC546	10p
BRY56	30p	BC126	10p	BC547	10p
BSS68	10p	BC139	10p	BC548	10p
BSY79	10p	BC140	30p	BC556	10p
BSY95a	10p	BC141	25p	BC557	10p
BTY80	20p	BC143	25p	BC558	10p
BSX19	17p	BC147	10p	BC559	10p
BSX20	17p	BC148	10p	BC635	10p
FT3055	30p	BC149	10p	BCX31	25p
TCE82	30p	BC153	10p	BCX32/36 Pair	75p
2N930	25p	BC154	10p	BCX32	25p
2N2221	8p	BC157a	10p	BD116	25p
2N2222	8p	BC158	10p	BD124	50p
2N2906	10p	BC159	10p	BD124 (metal)	60p
2N3055	40p	BC160/16	25p	BD130Y	25p
2N3566	10p	BC171	10p	BD131	30p
2N3702	10p	BC172	10p	BD132/238	30p
2N3711	10p	BC173	10p	BD135	25p
2N3583	50p	BC174	10p	BD136	30p
2N3904	15p	BC183	10p	BD138	30p
2N4355	10p	BC184	10p	BD176	25p
2N4442	£1.00	BC204	10p	BD182	£1.00
2N4444	£1.00	BC207	10p	BD183	70p
2N5296	40p	BC212	10p	BD202	60p
2N5983	30p	BC213	10p	BD204	60p
2N6099	40p	BC214	10p	BD221	20p
2N6109	40p	BC237	10p	BD222	30p
2N6130	50p	BC238	8p	BD228	30p
2N6133	20p	BC239	10p	BD226	30p
2N6348	20p	BC250	8p	BD233	30p
2N6399	10p	BC251	10p	BD235	30p
2X 2N6099 on heat sink	50p	BC252	10p	BD239	15p
2SA437	20p	BC262	10p	BD243c	30p
2SB407 Sanyo TO3	10p	BC263b	20p	BD244	50p
2SB474	30p	BC294	30p	BD250a	30p
2SB566	10p	BC298	10p	BD252	20p
2SC381	10p	BC300	30p	BD253B	50p
2SC458	50p	BC301	30p	BD331	20p
2SC515	10p	BC303	30p	BD332	20p
2SC732	10p	BC307	7p	BD373b	20p
2SC733	10p	BC308	7p	BD416	25p
2SC1030	£1.00	BC309	10p	BD433	25p
2SC1172A	10p	BC327	10p	BD437	25p
2SC1173	10p	BC328	10p	BD439	50p
2SC1419	20p	BC328/338 pair	15p	BD501	30p
2SC1546	20p	BC337	10p	BF761	30p
2SC1725	20p	BC338	10p	BF858	30p
2SC2068	20p	BC347	10p	BF871	30p
2SC2073	8p	BC349b	10p		
		BC350	20p		

Filters

5-5MHz	15p
6MHz	30p
BFU455K	5p

Thyristors

TD3F800	£1.50
BT106 Plastic	30p
BT106 Metal	£1.20
BT119	£1.00
BT120	£1.00
BRC4443	75p
G11 Thyristor	60p
Decca 80-100	60p
2N4444	£1.00

Thermistors

VA1104	50p
ITTP7266312	15p
PTH451 AOR	15p
PT37P Fits Pye & PT34	20p
Degausing Thermistor (fits most sets)	20p
GEC Double Thermistor	75p
G8 Degausing	35p

BLY49	50p
I.C. Heat Sink	20 for £1
20×TO5 Heat Sink	£1.00
CVC 9 power supply board	£1.50
CVC 20/2 mains panel	£2.00
ITT Mains Filter .1/250v/	
CVC 20 to 45 chassis	50p
Pots 10 k with Switch	25p
Pots 47 k with Switch	25p
Mullard Surface Wave Filter RW 153P Colour TV Filter	40p
Mullard Surface Wave Filter RW 154 Colour TV Filter	40p
G11 Line Scan P.C.B.	£1.00
G11 Power Supply P.C.B.	£2.00

TV Crystals

4MHz
4.433-619
6MHz
8.867238
Large or small **50p each**

GEC Power Panel	
TV106 Thermistor	
PT34 New	£1.00

I.C. Holders

DIL – DIL		DIL – QIL	
40 Pin × 4	£1.00	16 Pin × 10	£1.00
42 Pin × 5	£1.00	18 Pin × 10	£1.00
28 Pin × 5	80p	28 Pin × 4	£1.00
16 Pin × 10	70p	8 Pin × 10	50p
24 Pin × 5	75p	16 Pin G11	each 10p
14 Pin × 10	70p		
18 Pin × 10	80p		