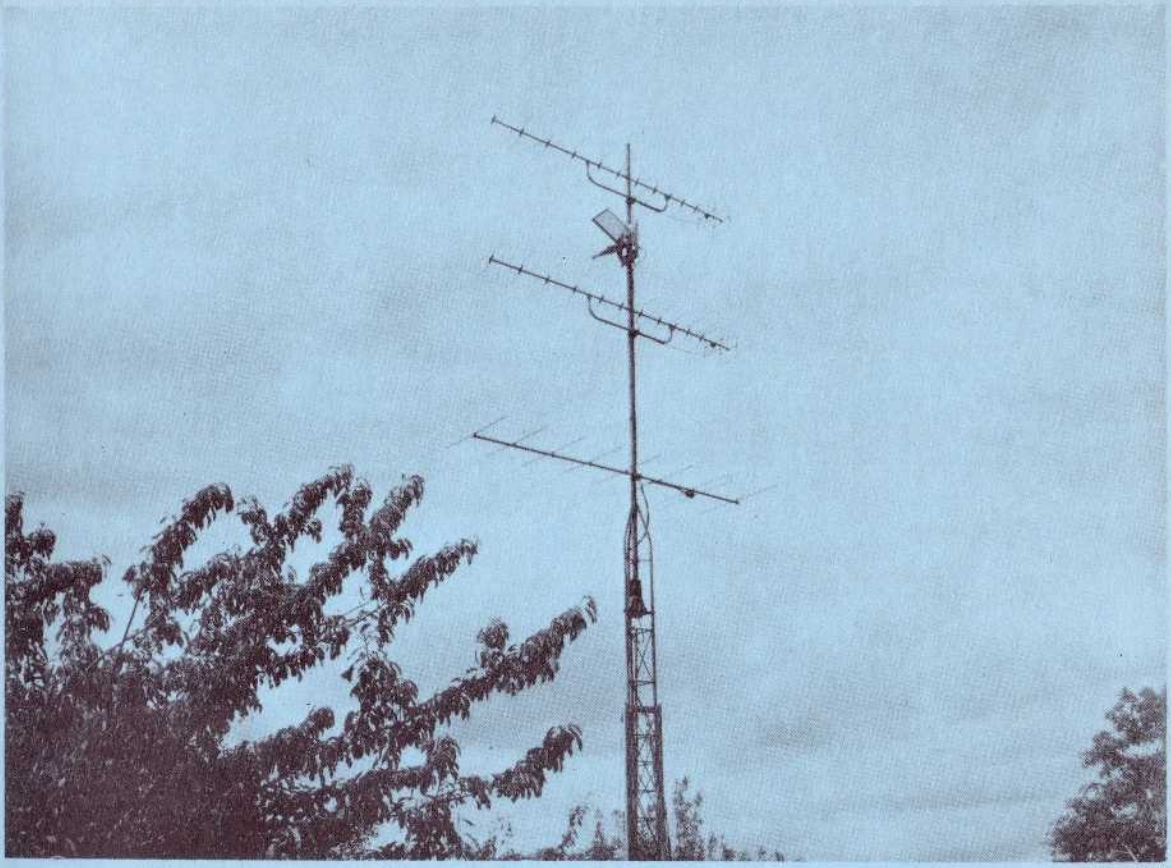

CQ·TV 83

THE BRITISH AMATEUR TELEVISION CLUB.

SEPTEMBER 1973

THE BRITISH AMATEUR TELEVISION CLUB

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C Q - T V is published quarterly by the British Amateur Television Club and is posted free to all members. Single copies are available from the Editor at 25p each; back numbers are also available to members at reduced prices.

Overseas members may have their copy of C Q - T V sent by airmail, for a surcharge depending on their country. Details are available from the Treasurer.

Members wishing to have material published in C Q - T V should send the manuscript and drawings to the Editor; articles are invited on all subjects of interest to amateurs and should be of about 1500 words, larger articles should be divided into convenient Parts for publication in consecutive issues of the journal.

Cover Photo Antennae in use at G6KQJ/T

EDITORIAL

Many B.A.T.C. members have been using "Club Sales" for years, and indeed, without it would probably never have been able to buy some components. Now we have news of a new organisation with similar aims, but a somewhat wider brief.

This is the Amateur Radio Bulk Buying Group, based in Surrey and Essex whose basic aim is to help the construction side of the amateur radio hobby. They can produce printed circuit boards (for designs published in Radio Communication) and will endeavour to obtain virtually any component. Prices are usually well below advertised prices, and from the "Surplus Section" prices are rediculously low. Some items which should be of interest to readers of C Q - T V are:

Minitron 3015F 7 segment indicator		£1.43p
Holder for above		.23p
Digital I.Cs	7490	.57p
	7447	£1.04p
	7475	.55p
	7400	.22p
	7473	.37p

These prices include VAT and there is a 5p charge for postage on orders less than £1.

If you would like some information on the group, and a copy of their current price list, write to P.L.A. Burton G3ZPB
20 Thornton Crescent,
Old Coulsdon, Surrey.
Do please include a stamped addressed envelope.

And now back to our own magazine. You must have realised by now that almost all the articles we publish are written by the same old names. And very good they are too! But don't you think that a few new names should appear to augment the old ones? Some of you members must be doing something that everyone else is just dying to hear about. Perhaps you organised a portable expedition, or have designed a new type of camera, or some new gadget which everyone should have. Then write it up! Send it to the Editor! We need your penmanship more than you realise.

THE EDITOR

CONTENTS

B.A.T.C. EQUIPMENT REGISTER

Just one year ago BATC started the Equipment Registry as a Club service designed to help co-ordinate the exchange of surplus equipment between members themselves and manufacturers etc. Since then many members have found the service to be extremely useful, both for second-hand cheap gear, and for those out of the ordinary items, and it is proposed to continue the Registry for as long as it appears to be necessary.

For the benefit of new members, or those who have not used the Registry before, this is how it works. A filing system is held by BATC, cross-referenced between two sections - "Wants" and "Surplus". Into the "Wants" section go details from the forms which members have filled in and into the "Surplus" section go similar details of all the equipment known to be available, either from members, or from manufacturers, tv companies etc. When a requirement matches an availability, the members are put in touch with each other and left to sort out the purchases themselves. Every effort is made to ensure that contacts are only made where the price asked equals the price offered and for this reason we ask you specially to fill in the "price" column in the form. If you're not sure, put e.g. "approx. £1", or give a range e.g. £25 to £35. But don't leave us in the dark, unless you want to get fed up with us for offering you a £55 camera when you only wanted a £10 one!

Where manufacturers surplus equipment is concerned, BATC may occasionally undertake to store equipment for a short time, but the Club will NOT pay carriage. Members will be expected to reimburse BATC for any costs incurred, although these will be kept to a minimum. It would also be appreciated if a stamped addressed envelope were included with each form, or at least a 2½p. stamp. The postage costs for the Registry over the last year have been phenomenal!

As soon as you have obtained the equipment you wanted, or sold your surplus gear, do please inform the Registry so that you can be removed from the file. Otherwise the system will slowly grind to a halt, and you will become annoyed with the letters which continue to flow in. Help us to help you.

Don't worry if your request seems to be for the most unlikely piece of gear; it may still be possible to find it. Perhaps from a Company, or from the fantastic hoards that some amateurs have stored away somewhere, thinking that no one will ever want their "rubbish".

This service is for surplus equipment, not for new; the Club has always operated a Club Sales section and continues to do so for new gear. Yokes, lens mounts, tubes, badges etc. are all available and are advertised in every issue of this magazine by Grant Dixon, the Club Sales Officer. Please continue to use this non-profit making service.

We shall be pleased to hear your criticsms of the new system, which we hope will fill a gap and help benefit amateur tv enthusiasts everywhere. Send your comments and suggsetions for improvements to the address below, together with your completed forms.

BATC Equpment Registry,
A.R. Watson Esq.,
"Somerby View",
Bigby,
BARNETBY,
Lincs.

Telephone messages can be taken in the evenings if you wish for an estimate, or any enquiries you may have. The number is Searby 287 (065-262-287 on the STD system).

B.A.T.C. EQUIPMENT REGISTER

PLEASE INCLUDE A S.A.E.

MEMBER'S REQUIREMENTS

Name _____ **Address** _____

Call Sign _____ _____

Tel. No _____ _____

Please insert the following requirements in the Club Equipment Register:-

Maximum price I am prepared to pay.

I agree to inform the Registry when the above requirements cease and pay 10% of the purchase price to B.A.T.C.

PLEASE INCLUDE A S.A.E.

MEMBER'S SURPLUS EQUIPMENT

Name _____ **Address** _____

Call Sign _____ _____

Tel. No _____ _____

Please insert the following equipment, which is surplus to my requirements, in the Club Equipment Registry:-

Price required

Cut here

Give details of Model No., Make, size and weight.

78-1

B.A.T.C. at the

VHF CONVENTION

The R.S.G.B. Diamond Jubilee VHF Convention was held on Saturday 7th April 1973 at the Winning Post Hotel, Whitton and as has been usual in the last few years the B.A.T.C. was represented there with a wide range of equipment display.

A total of six monitors were used on the stand, each displaying a different picture source. Five members brought along a large variety of their equipment, which was more than could be displayed on the space available. Something must be said for the use of Club standards, as all the equipment worked well together.

Arthur Critchley brought some of his latest I.C. equipment along which included an SPG measuring only a few inches square, and a character generator displaying Seven Segment numbers on a monitor screen. Malcolm Sparrow had his "off air" receiver on display, as described in C Q - T V No 81, and he showed VTR tapes of his shack and "off air" pictures recorded at CAT 70.

Dave Lawton demonstrated his call sign generator of C Q - T V No 74 and other I.C. equipment including 625 SPG, grille and P.L.U.G.E. generators. Other equipment included an I.C. patch panel by Grant Dixon, and three vidicon cameras.

Club Sales went well, with several new members being signed up and a lot of interest being shown by many people. Many thanks must go to all those who helped to make the day a success, although it was rather a disappointment to see no new faces among the ranks.

Those who helped were Mike Bues G6OPB/T, Arthur Critchley, Grant Dixon G6AEC/T, Mike Hastings G6AHO/T, Dave Lawton G6ABE/T, Ian Lever G8CPJ and Tom Mitchell G6ACP/T.

CIRCUIT NOTEBOOK No 14

J. Lawrence GW6JGA'T

To complete the series on Field Scan Generators, here is a circuit developed by the Ferranti Applications Laboratory. It is one of a number of most useful circuits published by Ferranti Ltd. in their book "E line Transistor Applications" and their permission to publish this circuit is acknowledged with thanks.

The circuit shown in Fig. 1 will provide a peak-peak scan current of 30-40mA for typical scan coils having an inductance of 40mH and resistance of 160 ohms.

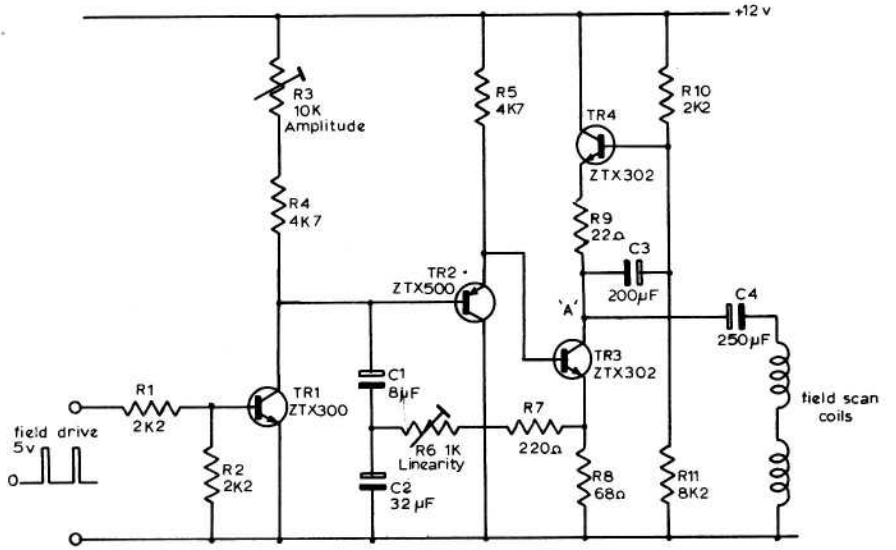


Fig. 1

CIRCUIT OPERATION

The circuit requires an input pulse of 1mS period, +5V amplitude and 20mS repetition time. Tr1 discharges the timing capacitors C1 and C2, and R3 controls the charging current and hence the amplitude of the sawtooth generated. Emitter follower Tr2 increases the input impedance of Tr3 and also compensates for its V_{be}. The emitter current of Tr2 was chosen to be about four times the peak base current required by Tr3. Tr3 and Tr4 together form a high impedance output stage. The upper transistor Tr4 is an emitter follower for d.c. conditions and allows the bias voltage at the output defined by R10 and R11. Under a.c. conditions capacitor C3 effectively shorts the base to point "A" and the current flowing in Tr4 remains constant. Tr3 is a common emitter amplifier with a large amount of local negative feedback provided by R8. This gives Tr3 good linearity and a very high output impedance, and also provides a convenient source for the parabola correction. The value of R8 was chosen to give 40mA pk-pk scan current with about 3 volts pk-pk input. A higher value would give improved linearity but would reduce the available output swing (the scan coils require 6.5V pk-pk at 40mA) and a lower value would give more output but inferior

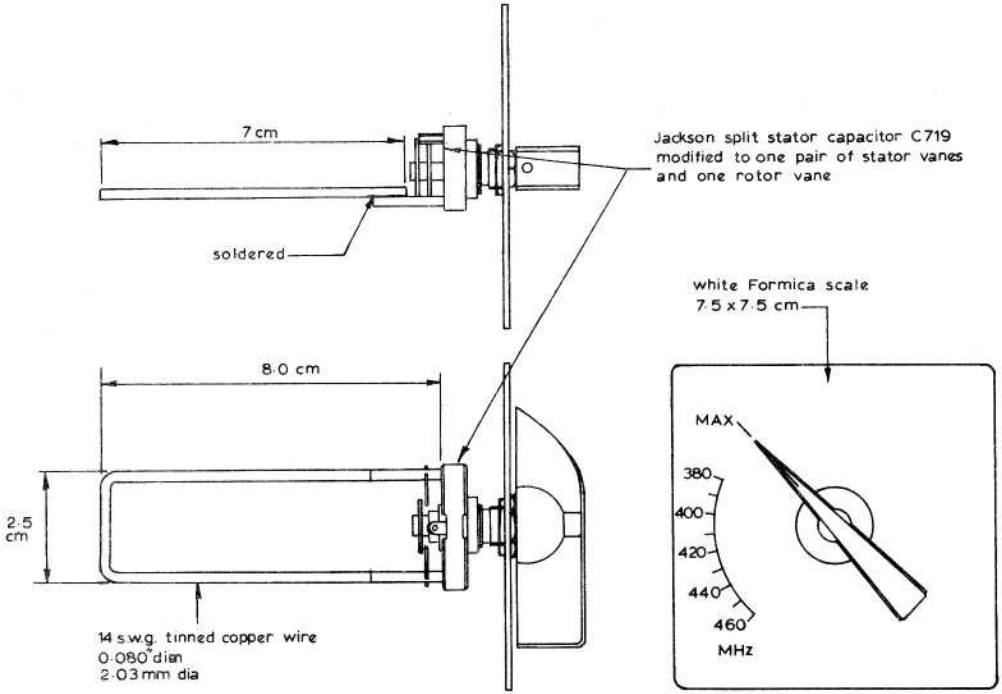


Fig 2 70 cm ABSORPTION WAVEMETER

linearity. When electrolytic capacitors are used for C1 and C2 the first part of the ramp may be non-linear so very low ramp amplitudes are undesirable.

An Absorption Wavemeter for 70cms

Fig. 2 shows a useful absorption wavemeter for checking the approximate output frequency of a 70cm transmitter.

The tuning capacitor is a Jacksons Type C719 14pF version which has had sufficient vanes removed to leave one rotor vane and one pair of stator vanes.

The wavemeter should be loosely coupled to the transmitter tank circuit and a change in the input or output power noted when the wavemeter is tuned through resonance.

For a typical QQV03/20 or 6/40 output stage sufficient coupling can be obtained at 5-8cms away from the output lines, but closer coupling would be required when checking the output from small diameter coils.

NOTICE

TO CONTRIBUTORS

Members wishing to contribute material for publication are asked to note the following details.

Whilst articles may be typed or handwritten, they should be of about 1500 words; if longer, they should be divided into separate parts for publication in consecutive issues of the magazine.

Photographs may be included, and should be sent as semi-matt EN-Prints or postcards.

Any drawings necessary should be clear enough for our draughtsman to read!

Articles are invited on all subjects, but particularly those of amateur constructional interest. Please send your material to the Editor, C Q - T V, (address on page 1) in a stout card-backed envelope. Material will only be returned in requested.

POSTBAG

Leslie Lea who lives near Sevenoaks in Kent is very interested in amateur television and is now building up a stock of equipment. He has a Pye Lynx vidicon camera, which feeds into an EMI monitor, which as Leslie says, gives very good results.

R.F.G. Thurlow G3WW in Cambridgeshire wants to know when there is going to be more SSTV activity on 40m. He knows of activity by G8DXC on 2m SSB, G3DOX who has a convertor (from the ARRL handbook) feeding pictures to his scope, GW3DZJ and G3BXI on 40m as well, of course, as himself. Some others are on their way, he hopes - but where is the news of other SSTV types on 40m?

Doug Laver VK4ZDL/T from Queensland, Australia is, in his own words, enjoying a modicum of success. He has radiated 5 watts over a path of some 20 miles, and although his pictures were rather snowy the other end, they were stable and viewable. We wish you further success in the future.

R.L. Hill of 5 Prospect Row, Gorsley, Ross on Wye, Herefordshire would like to offer help and advice to B.A.T.C. members who have problems with Pye or Philips colour receivers. He could also perhaps help in the supply of spares for either type of receiver. Thanks OM.

THE COMMITTEE have divided the work load of running the Club among themselves, as you can see from the list of jobs on page 1. (Some of the committee members have no specific title in order to leave spare effort for special projects such as exhibitions). This means that B.A.T.C. has no single address - but it should be possible to decide who to write to when you wish to contact the Club. We do ask you to address letters to the most suitable committee member as it helps so much if the first recipient does not have to forward your letter to another.

BIBLIOGRAPHY OF AMATEUR TV

J.K. Wood K611S of 17576 Pinedale Ave., Fontana, California 92335 has produced the above work and asks if the B.A.T.C. member who ordered a copy with an IRC from the Post Office at Cheapside, Birmingham would write to him again as he has unfortunately lost his address.

FOR SALE

Two Marconi Mk 111 Cameras, each comprising; Camera unit; cable; C.C.U.; P.S.U.; I.O. tube; 2 lenses; operational on 625. Offers invited.

Heavy duty tripod with wedge plate £25

2 17inch Peto Scott monitors (405 but capable of fair operation on 625) Offers.

1 Pye 14inch 405 precision monitor Offers.

1 RBM 19inch 405/625 monitor with new crt fitted £15

1 Marconi picture & waveform monitor (complete but needs attention) Offers.

1 new 17inch rimband crt CME713 £5

1 new 24inch crt CME2413 £8

M. Burrell
30 Beehive Lane,
Redbridge,
Ilford, Essex.
Tel. Brentwood 221152 (evenings)

More adverts on page 25.

A 70cm Transmitter from Germany

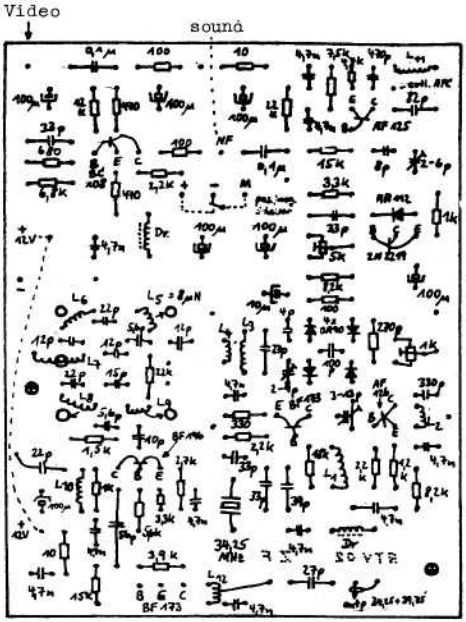
An ATV Transmitter from Germany

This transmitter was originally described in the journal of A.G.A.F., the German amateur organisation. This translation is for the benefit of those B.A.T.C. members who will not have seen the German magazine. A.G.A.F. may still be able to supply printed circuit boards ready made at a price of 10D.Marks each, plus 2D.Marks postage and their address is:

6842 Burstadt
Karl-Ulrich-Str 29
Postscheckkonto 324788
Germany.

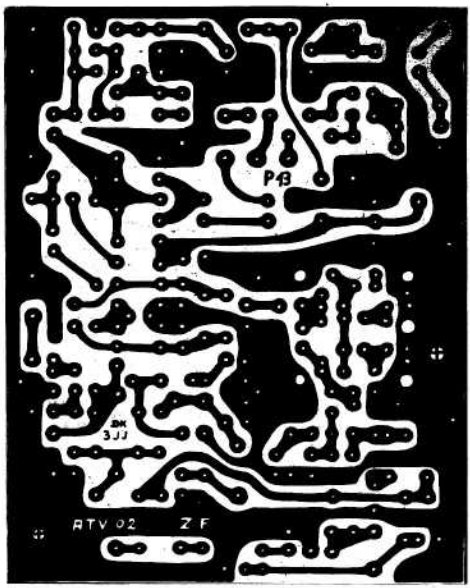
Transistor driver by DK3JJ

The video input signal is amplified in the clipper circuit and appears across the 5kohm gain control on the IF board. Here it is led to the emitter of the AF125 transistor which consists of a 5.5MHz oscillator, which is frequency modulated by means of the LF signal and led to the base of the 2N2219 through the trimmer. On this base there also appears the video signal. The mixture is now given to the ring modulator which also receives the carrier from the 34.25MHz quartz-oscillator. This is followed by a five tuned circuit filter which increasesthe upper side band. This signal is then amplified by the following transistor, BF 196, also by transistor BF 173. At the output of this unit, Z, there is a signal reaching from 34.25 to 39.75 MHz, which is passed by means of a coaxial cable to the driver board. This unit consists of a 25MHz quartz-oscillator whose frequency is quadrupled to 400MHz (T1-T3). Those circuits above 400MHz appear as etched strips on the printed circuit board. The tuned circuit and the mixing transistor base receive by means of a 2pF capacitor the 400MHz signal, and by means of a tap, the intermediate frequency signal running from 34.25 -



LF board component side

Scale $\frac{1}{2}$.



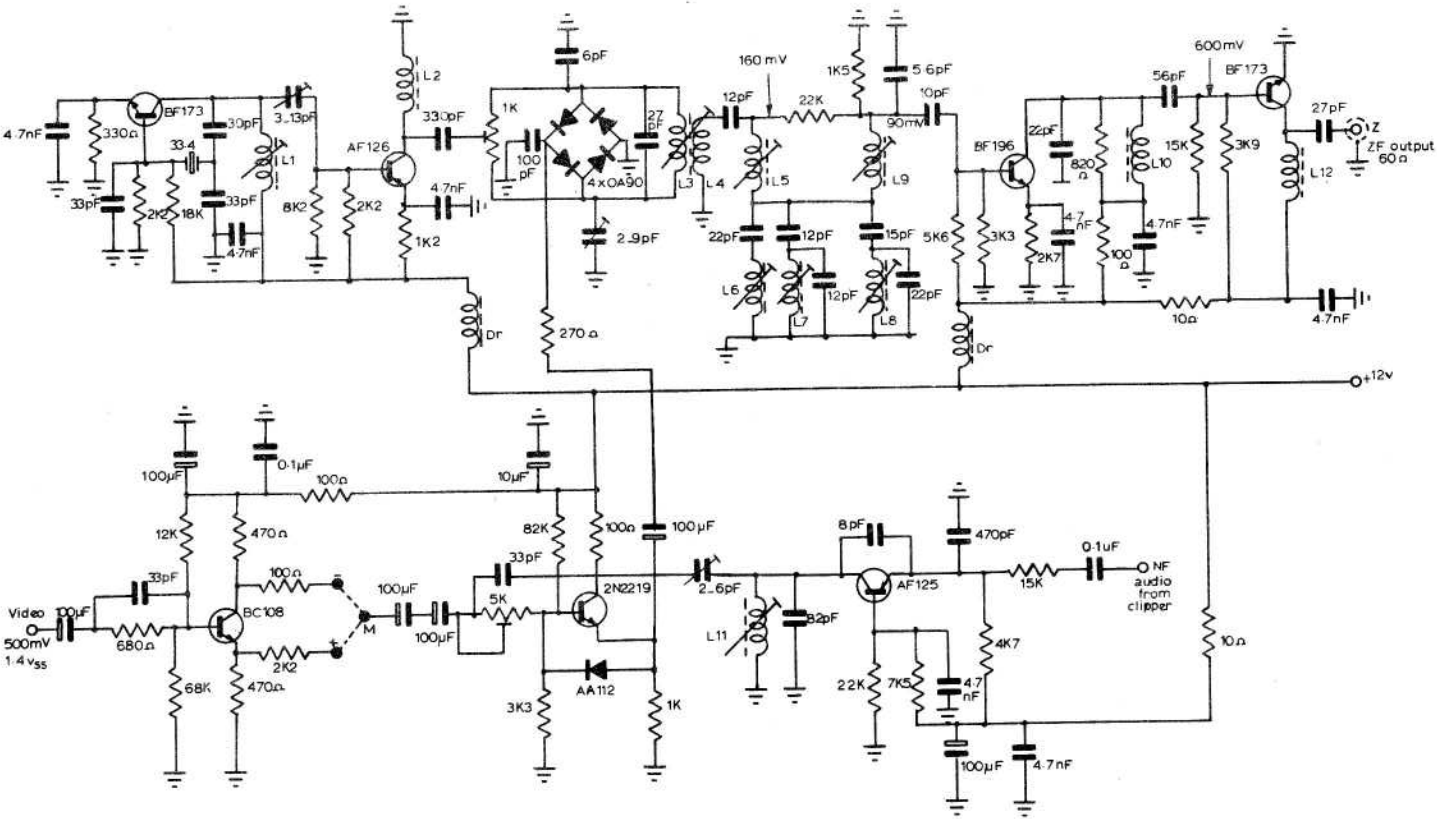
LF board copper side

39.75MHz. The output circuit of the transistors 4 and 5 will balance about 435MHz. At the output O there stands approximately a 7mW signal shich can be used to drive a linear amplifier later.

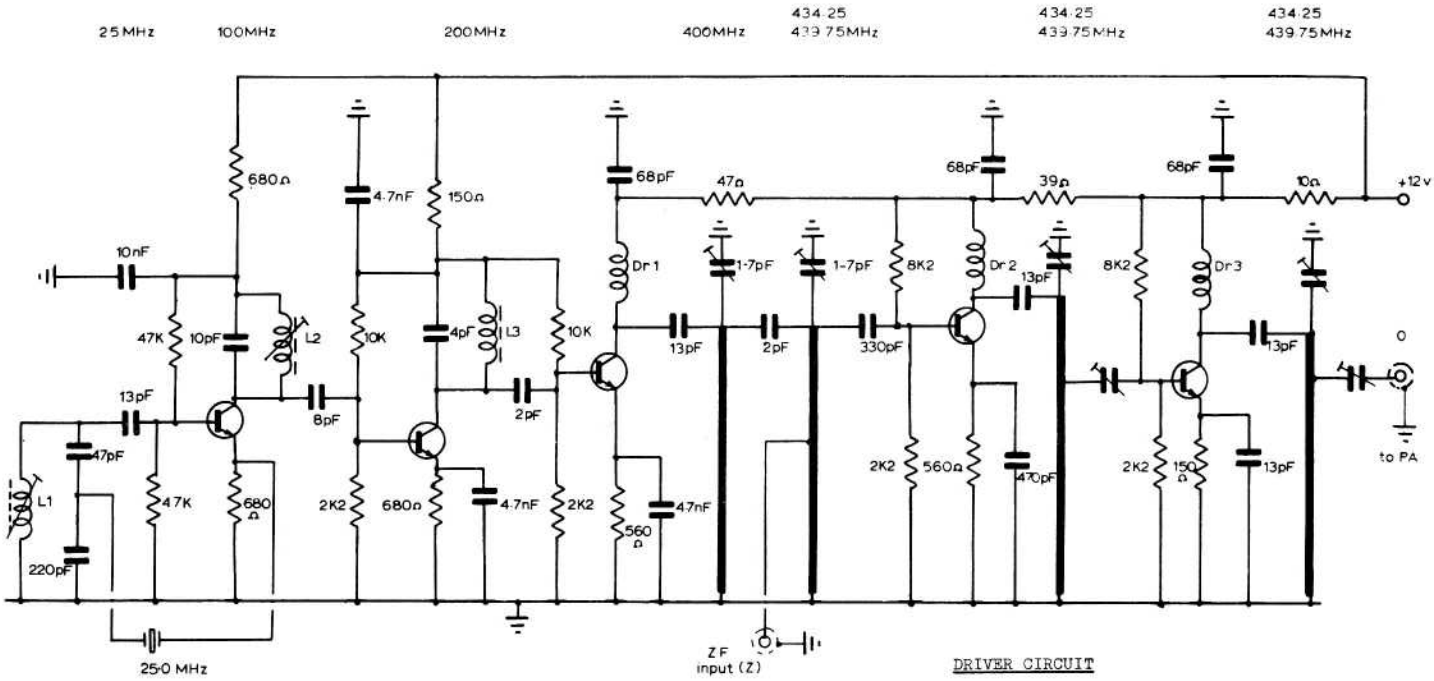
LF board coil data

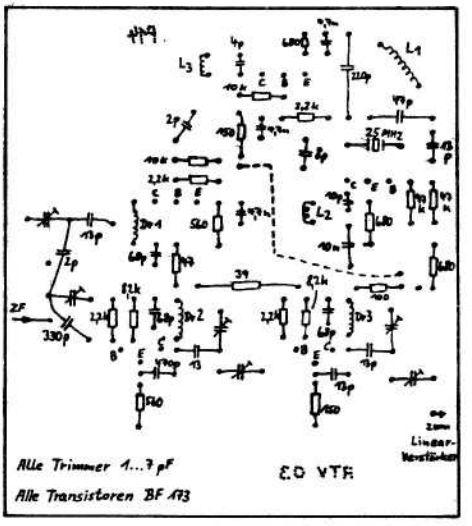
L1 12 turns 0.4mm copper wire on 5mm former
L2 13 turns 0.3mm copper wire on 5mm former with ferroxcube core
L3 10 turns 0.5mm copper wire on 5mm former
L4 3 turns 0.2mm inside L3
L11 5.5MHz
L5-L6-L8 17 turns 0.3mm copper wire on 4mm former
L7-L9 12 turns 0.3mm copper wire on 4mm former

L5 35MHz max
L6 31.9MHz min N.B. Dr is rf choke
L7 40.4MHz min
L8 33.4MHz min
L9 37.5MHz max
L10 6 turns 0.3mm copper wire on ferroxcube 5mm former
L12 12 turns 0.3mm copper wire on ferroxcube 5mm former

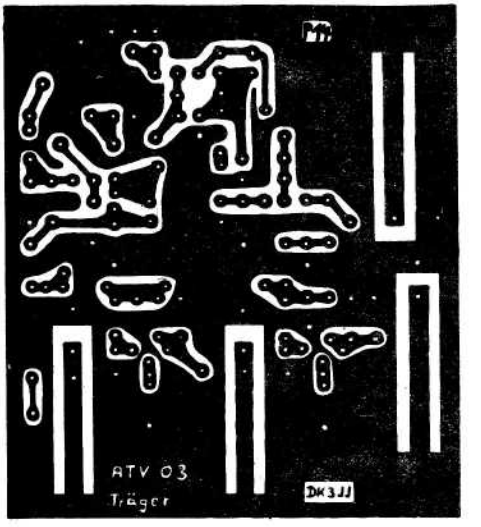


Signal Processor


25MHz
100MHz
200MHz
400MHz
434.25
439.75MHz
434.25
439.75MHz
434.25
439.75MHz
680Ω
4.7nF
150Ω
68pF
47Ω
68pF
39Ω
68pF
10Ω
+12v
10nF
47K
10pF
L2
10K
4pF
L3
10K
Dr1
1-7pF
1-7pF
8K2
Dr2
13pF
8K2
Dr3
13pF
13pF
2pF
330pF
13pF
0
8pF
2pF
47pF
13pF
L1
47K
680Ω
2K2
680Ω
4.7nF
2K2
560Ω
4.7nF
2K2
560Ω
470pF
2K2
150Ω
13pF
to PA
220pF
25·0 MHz
ZF
input (Z)
DRIVER CIRCUIT
5 x BF 173



Driver board component side



Scale ½.

Driver board copper side

Driver board coil data

L1 15 turns 0.3mm copper wire 5mm former
L2 5 turns 0.5mm copper wire 5mm former
L3 3½ turns 0.5mm copper wire 5mm former
Dr 1: 5 turns Dr 2: 4 turns Dr 3; 4½ turns

Linear PA by DCODA

If you transmit ATV it is important for contacts to receive good field strength. As you all know a broad band signal tends to get lost in the noise of the IF amplifier. In the past ATV stations have usually used high gain antennae to improve the field strength, both for transmission and reception. The signals are not always sufficient for a picture, despite all the work put in. The PA stage to be described could put an end to this evil, but the

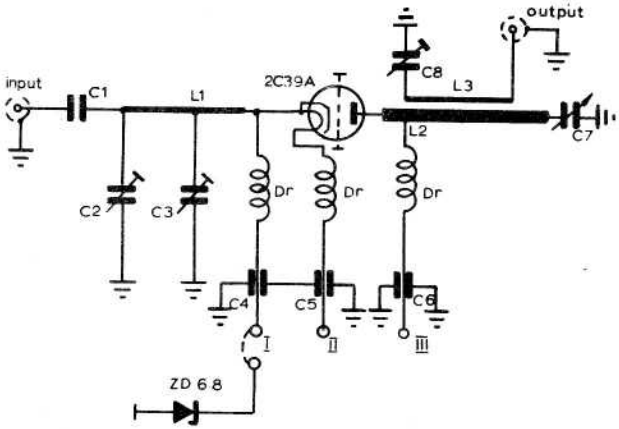


Fig. 1. 70 cm_PA.

PA stage components list

L2 copper strip 115 x 10 x 1mm
L1 copper strip 50 x 5 x 1mm
L3 copper wire 2mm diam.
Dr 15cm wire coiled 4mm diam.
C1 56pf ceramic
C4,5,6, Inf lead throughs, C6 at 2KV
C2,3,8 uhf trimmers c.10pf
C7 5pf tuning condenser see text

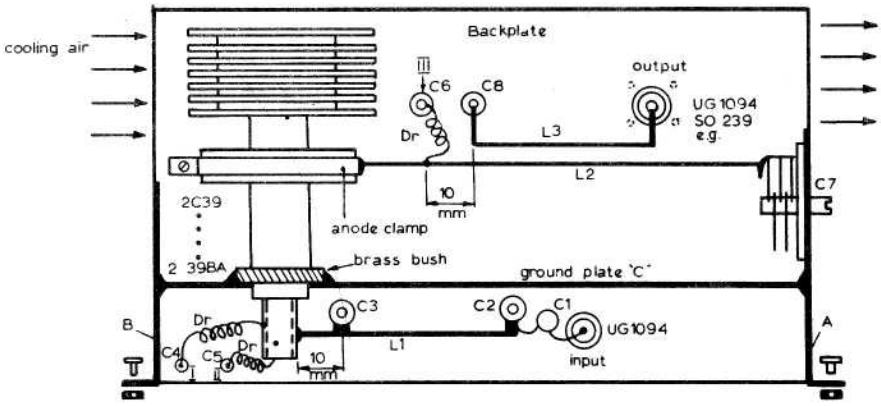
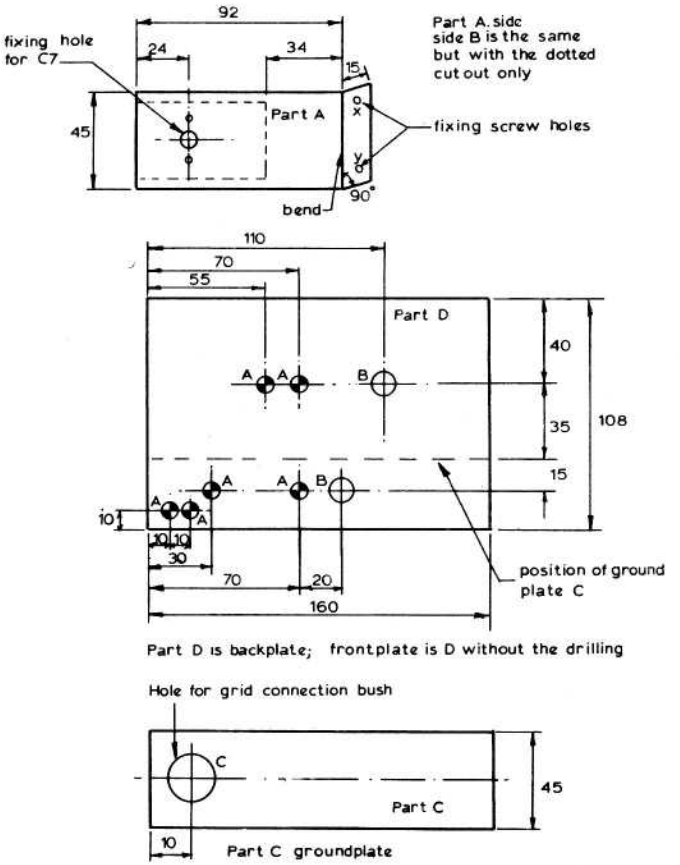


Fig.2 Construction and assembly of parts



MATL. 1mm brass sheet. HOLES: A _ 6 mm dia.
DIMS. IN mm. B _ 9 mm dia.
C _ to suit grid bush

Fig.3. Details of metalwork

valve to be preferred is not available for ATV experiments. We must restrict ourselves for ATV experiments to another somewhat obsolete valve. This naturally means that the picture quality will be a little bit poorer and with the same input one would get a much better result with a bigger valve. With this PA stage, therefore, only horizontal bars or the A3 tone signal for ATV test purposes can be sent. The valve works on the well known grounded grid circuit. A stable grid voltage can be produced by means of a zener diode. The heater voltage from points 1 and 2 must come from the earth free 6 volt winding. Construction should be made of sheet brass. Parts should be prepared in accordance with Diagram 3 and then soldered together. In connecting the anode circuit the clamp is prepared which grips the anode firmly and to which the valve circuit can be soldered. Tuning condenser C7 can be obtained from a larger capacitor by means of removing every other plate. One thus obtains a higher voltage working variable condenser with a lower capacity. The zener diode is mounted on zinc and is isolated. The supply is brought through point 3 and an anode voltage of about 1,000 volts is necessary. About 120 watts input can be obtained by means of a cathode current of about 120mA. This value should not be exceeded. Thus with a 5w drive about 50w of RF are obtained. The valve depends very much on the input, the heater voltage and the cooling. Cooling is necessary for any input more than 20w, and is done by means of a stream of air or a fan.

Collaborators on this article were DC6LR and DC6LC

Continued from page 25.

It is intended that the next issue of CQ-TV will complete the series as far as TTL ICs are concerned. It is then hoped that the material contained in this series can be redone in the form of a booklet. This will not be a straight reprint as much editing is anticipated.

Now that TTL is obsolescent (not for many years though) its successor will be introduced into this series; this is of course CMOS. Linear ICs will not be neglected though.

Acknowledgement

The author wishes to thank the Directors of EMI Sound and Vision Equipment Division for permission to publish this series of articles.

References

CQ-TV 71 to 82 for articles on digital Integrated Circuits.

CQ-TV 75 to 77 for CQ-TV SPG.

Designing with TTL Integrated Circuits - Texas Instruments Book, McGraw-Hill Publishers.

INTEGRATED CIRCUITS

PART 13

A.CRITCHLEY Dip El; C Eng; MIERE.

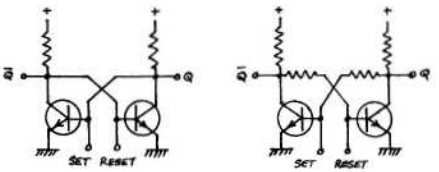
BISTABLES

A Bistable is, by definition, a device with two stable states. It is often called a Flip-flop although this name better describes a monostable device. Another common name is Bistable Multivibrator. There are also Binary, Toggle or Latch.

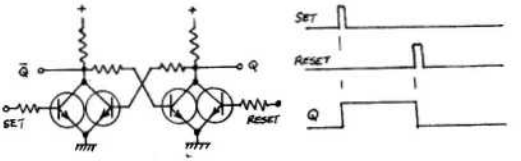
The basic bistable consists of two cross-coupled inverting amplifiers, giving a total phase-change of 360° and therefore positive feedback. Any slight change at the input of one amplifier is returned to the same input as a much bigger change until the two amplifiers settle with one hard on and the other hard off.

This basic situation can be reversed if the 'off' transistor is externally turned 'on'; the two states still remain but the previously 'off' transistor is now 'on' and the previously 'on' transistor is 'off'. This is still so when the external signal is removed.

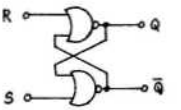
An external signal to the other half will now make the two states change back, and so on. The bistable can be considered to be a simple memory - it will remember that a pulse was applied and caused a change of state. However, repeated pulses to the same input will not cause more than the one change.



This simple circuit has a disadvantage in that the collector voltage can only change from saturation of some 0.15v to V_{be} of the other transistor which is about 0.6v - a total change of 0.45v only. This voltage can beincreased by including resistors in the base circuits. To isolate the external inputs a second pair of transistors can be used to shunt the collectors.



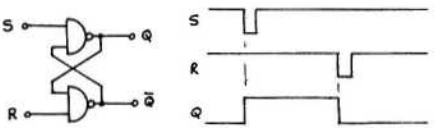
This system is now exactly that used when two RTL gates are cross-coupled and can be represented by the following diagram.



The symbols for NOR-gates are used because RTL is Positive Logic - that is, the two-input gate gives a low output when either input is taken high.(positive)

If TTL NOR-gates are used instead, the operation is identical - positive input pulses cause the change of state. The only difference is in the higher voltages.

If TTL NAND-gates are used, then, as might be expected, negative pulses are necessary.



This form of bistable is commonly known as the R-S latch and forms the basis of all TTL bistables.

Types of bistables

There are four basic types of bistable - known as

D, J-K, R-S and T. There are also three possible types of triggering - a.c., d.c., or Master-Slave.

R-S Bistable

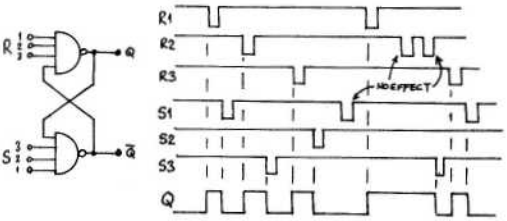
The type of bistable previously described is the R-S type (Reset-Set) because this describes the functions of the two input terminals. Set is also known as Preset and Reset as Clear. This bistable is d.c. triggered.

A truth table can be drawn for the R-S bistable. (with NAND-gates)

R	S	Q	$\bar{Q}$
0	0	Not allowed	
0	1	1	0
1	0	0	1
1	1	No Change	

This is seen to show the changes as depicted in the waveform diagram given earlier (0,1 & 1,0). It also shows the conditions when no pulses are applied (1,1). Also shown is the condition when both inputs are applied. The bistable then has both outputs high, but, the final state of the output is decided by which of the inputs is removed first. This situation is clearly not allowable as the result is not always predictable.

The R-S bistable may have several Set and Reset inputs each of which will have the desired driving effect. (This is so because the gates require negative logic pulses which, in the case of NAND-gates, gives the OR function.)

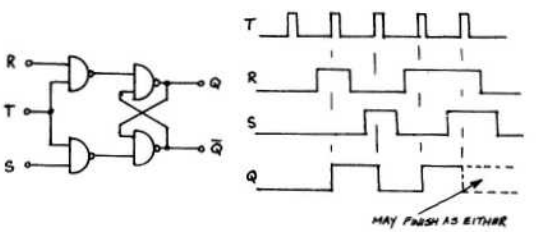


R-S bistables, or latches, are available in TTL packages in the form of the 74118 (16 pin) and the 74119 (24 pin) which both contain six latches. Both ICs have common Reset inputs but the 74119 also has some separate ones as well as having three of its latches with two Set inputs.

T - Bistable

If the R-S bistable is fed from a pair of NAND-gates with a common pulse, then the latter can be used as a clock pulse to operate the bistable - if allowed to by the A and B inputs.

Unfortunately the forbidden state can occur with both inputs on together and the final result depends on relative circuit delays so that one half will always



be 'on' after such a condition. This is because the removal of the clock pulse allows the bistable to operate properly.

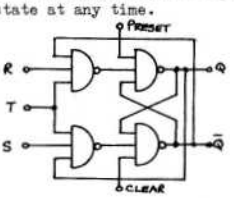
The problem can be overcome by using the bistable to steer the clock pulses to the 'live' side only, in a manner rather like that of the commutator of a d.c. motor.

The bistable will now 'toggle' with the clock pulses - that is, change state for every clock pulse, or make one cycle for every two clock pulses. However, problems arise with time delays and rapid oscillations due to the d.c. triggering and only very short pulses will give the correct operation. These can be obtained by a.c. coupling through a short time-constant differentiator.

Because of these problems the T-bistable is not in common use. Other types of bistable can do the toggling function rather better.

The truth table is very simple and shows that if T is low (0) before a clock pulse, Q_n will not change, but if T is high before a clock pulse then Q_n will become $\bar{Q}_n$. i.e. it changes state.

The Preset & Clear inputs can change the bistable state at any time.

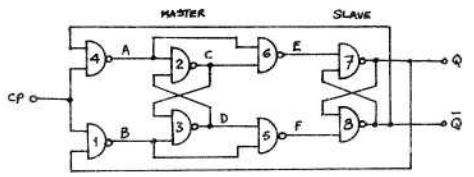


t_n	t_{n+1}
T	Q
0	Q_n
1	$\bar{Q}_n$

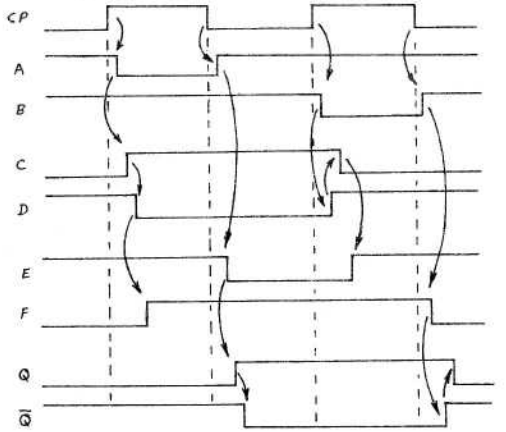
Edge-triggering (Master-Slave operation)

The problem of oscillation can be overcome if the Q and $\bar{Q}$ outputs can be made to change when the clock pulse is removed rather than when it is applied as then the AND-gates will not be active.

One way to do this is to use a.c. coupling with a very short time-constant as mentioned but a better way is to use two bistables in cascade which are triggered off the two different edges of the clock pulse. A system is shown that does this.



The waveforms for this circuit are shown in the next diagram so that gate delays are exaggerated.



The action is as follows :-

Assume that the clock pulse is low, Q is low and C is low. Then A and B will be high, as will be D and $\bar{Q}$. Therefore E is high and F low - keeping $\bar{Q}$ high and thus Q low.

When the clock pulse goes high, A goes low and so C goes High (and D low). This causes F to go high, but the removal of F does not cause any change of Q or $\bar{Q}$ and the system remains stable.

Removal of the clock pulse causes A to go high which causes E to go low (since C is high). This makes Q go high (and $\bar{Q}$ low). The latter have no effect on A and B since the clock pulse is low so the system is again stable.

The next time the clock pulse goes high B will go low and causes D to go low (and C high). E now goes high and Q and $\bar{Q}$ stay unchanged.

When the clock pulse again goes low B goes high, F goes low and Q high.

The system is therefore stable in between the pulse edges, i.e. it responds only to the edges and as far as the output is concerned, to only negative-going edges.

This use of two bistables is known as Master-Slave operation because the bistables operate from different edges of the clock pulse and thus never change together. The arrangement forms the basis of most of the available J-K bistables.

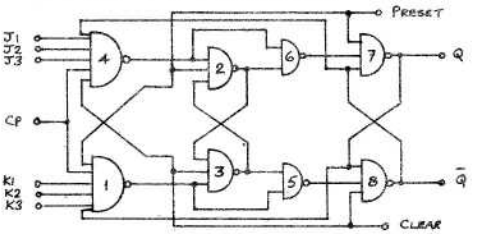
The sequence of events within the master-slave system can be simplified if a slower clocking system is considered.

1. Remove slave inputs from master inputs by means of gates 1 & 4 (the normal state)
2. Enable data inputs to master (i.e. Q & $\bar{Q}$)
3. Disable data inputs from master.
4. Transfer master data to slave (C & D to Q & $\bar{Q}$)

Note, there is a <u>minimum</u> speed for the clock pulse edges. Slower than this minimum erratic operation may occur.

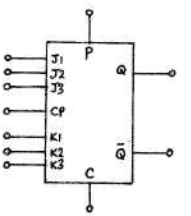
<u>J-K Bistable</u>

The master-slave system can be put to use as a gated bistable if gates 1 and 4 are expanded.

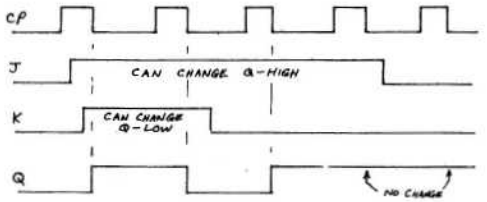


The inputs P and C over-ride the state of the bistables to set Q high or Q low, respectively. Inputs J1,J2,J3, K1,K2, and K3 can be used to interupt the toggling action.

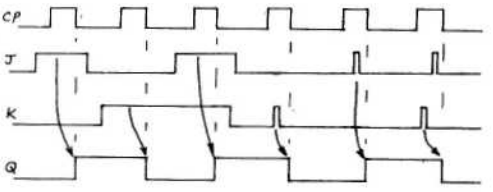
J1-3 perform the AND function on the $\bar{Q}$-steering so that unless all three J inputs are high Q cannot be <u>clocked</u> high but <u>can</u> be clocked low if <u>already</u> high. If Q is low no change occurs. Likewise, K1-3 can prevent Q being clocked low but not high. If a J and a K input are low together, then no changes will occur for any clock pulses.



t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\bar{Q}_n$



Since the J and K inputs are only inputs to NAND-gates, they cannot, by themselves, cause clocking of the bistable. This depends upon the states of the J and K combinations not only at the time of clocking, but at any time whilst the clock pulse is positive. In other words, if the J or K combination was high during the clock pulse - even for an instant - the bistable will remember that fact. This happens because the master bistable receives an input but the slave bistable does not change until the clock pulse goes low.



There is a TTL bistable available in which this is prevented from happening(74110 & 74111). The J and K inputs need be high only at the time the clock goes high. However, the problem does not normally cause any difficulty with counters and the like.

Don't Care

A feature of the J and K inputs is that if, say, the Q-output is low and the J-input high, then the state of the K-input makes no difference when the clock pulse arrives. The Q-output will go high whether the K-input is low or high - it does not care!

Similarly for the Q-output high and the J input.

This 'don't care' condition of the K or J input can be helpful in reducing the amount of logic gating required in complex systems, since, if the input state does not matter, there is no point in supplying a particular state of logic level.

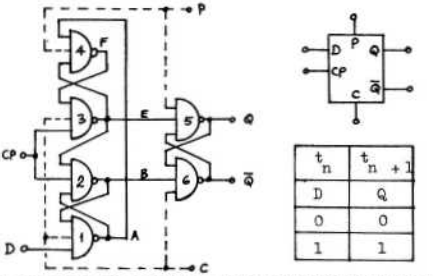
The TTL J-K bistable comes in several forms and these are listed in the following table.

Type No.	Qty	CP	type	No.J/Ks inputs	Other inputs	Speed MHz	Pins	Notes
7470	1	+	edge	3	P & C	35	14	1 J & K inv.
7472	1	-	M/S	3	P & C	20	14	
7473	2	-	M/S	1	C	20	14	
7476	2	-	M/S	1	P & C	20	16	
74104	1	+	M/S	4*	P & C	30	14	J/K slowed by int. capacity.
74105	1	+	M/S	4*	P & C	30+	14	1 J/K inv.
74107	2	-	M/S	1	C	20	14	As 7473 but pins different.
74110	1	-	M/S	3	P & C	25	14	Like 7472 but has data lockout.
74111	2	-	M/S	1	P & C	25	16	Data lockout.

* One J and K joined to form JK, also buffered clock.

The D-type Bistable

This bistable has only one data input (D) apart from the clock, preset and clear inputs. It consists basically of three interconnected R-S bistables.



t_n	t_{n+1}
D	Q
0	0
1	1

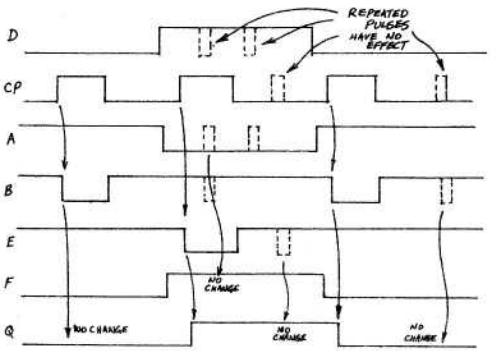
The sequence of events is quite straightforward if followed logically.

The signals at A and B depend on both the clock and D inputs - A must be high if D is low and B must be high if the clock is low. R-S bistable action occurs if either D or clock is made high. For instance, if D is high A will go low because B is high due to the clock.

Points E and F depend similarly upon the clock and point A. (The link E to gate 2 ensures that E-low gives B-high if D goes low whilst Clock pulse is high.)

Finally, B and E operate the Q-bistable where the repeated pulses have no further effects.

The total result is that Q takes up the state of the D-input at the time of the positive-going clock edge. The D-input state can be changed before or after the edge whilst the clock is high or low with no consequent effect on the output states. However, there is a short time just prior to the edge in which it should not be changed.



There is another sort of D-bistable known as a D-type Latch. Here the clocking still occurs on the positive edge but if the clock is kept high the data at the D-input is transferred to the Q-output - and any changes appear at the Q-output. When the clock is low the Q-output retains the state that was present at the D-input at the time the clock went low (actually just prior to going low).

This type of bistable is used to temporarily store data and finds a common application in holding the count for Nixie display tubes.

Types of D-bistable

Type No.	Qty	CP	type	Other Inputs	Speed MHz	Pins	Notes
7474	2	+	Edge	P & C	25	14	Clocking as 7470
7475	4	-	Latch			16	2 pairs CPs.
74100	8	-	Latch			24	2 quads CPs. Only Qs avail.

General

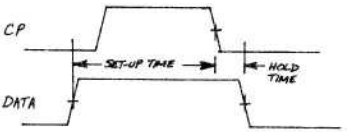
The different kinds of data inputs to the various bistables determine the type of the bistable but the different kinds of clocking inputs may be used with any bistable.

A data input which does not cause an immediate change of output state - that is, it needs another input pulse (clock) - is called a synchronous input. This is useful because the clock can be made common to many such bistables in a large system. This makes for common synchronisation and accurate timings as well as faster operation because the data inputs can be changed at convenient times rather than specific times.

Clock Skew

In a system with many clock inputs it is quite possible to have significant differences in timings between some inputs. If this difference exceeds the propagation delay of the bistable then errors in operation will occur. This is called clock skew and depends also on the maximum hold-time of the bistable. This is the amount of time that the data inputs must be kept stable after the clock pulse has dropped to some level(usually 50%). Generally for TTL this is zero and can be ignored.

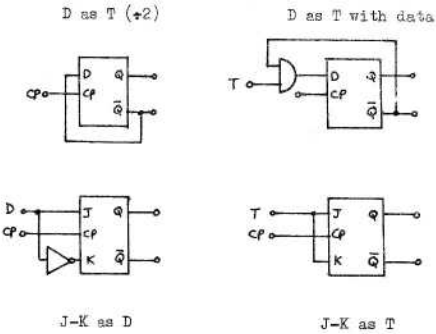
There is another factor though; the set-up time. This is the amount of time required at the data inputs during which the data must be kept stable before the clock pulse arrives. It also is due to internal propagation delays and is measured from the 50% clock level of the edge which sets up the outputs - that is, primes them so that on the opposite edge they actually change.



It is evident that for a master-slave bistable the set-up time is equalto, or greater than, the clock pulse width. This allows more time for logic systems to operate in and eases the design problems of large systems.

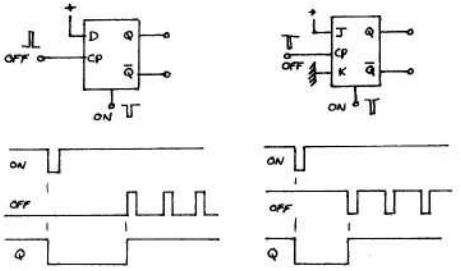
APPLICATIONS OF BISTABLES

The four types of bistable have been described in detail, but often it required to substitute one type for another. Here are some ways to do this:-

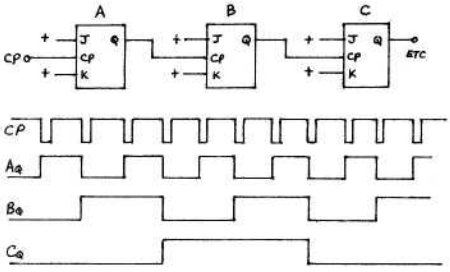


Bistables are used mainly in counters and shift-registers but there are other jobs that they can do. Some simple counters and latches have been shown in CQ-TV 73 and 75.
For instance, a latch can be made by using either a D type of a J-K type of bistable depending on whether

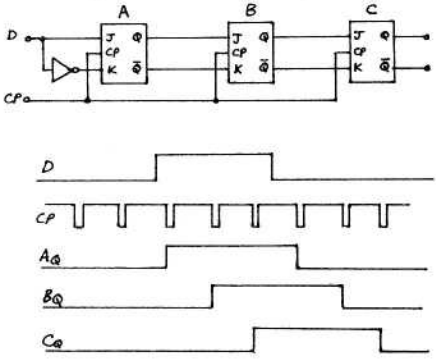
positive or negative edge action is required. In either case the bistable is cleared with a negative pulse. The clock input can of course be a continuous stream of pulses - only the first one will do the job. This circuit has been used to good effect in the CQ-TV SPG (in CQ-TV 75-77)



A binary counter is simply made by series connecting D or J-K bistables. It counts in multiples of two.



A simple shift register uses the same bistables but connected in a different manner. This moves the input data along by one bistable per clock pulse



Counters

A good use for J-K bistables is in making counters which count by non-binary numbers or which produce non-binary waveforms. For example, a count of three.

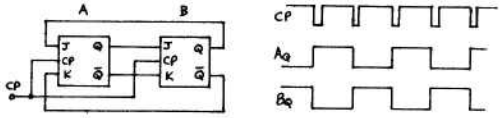
These fall into two further categories - ripple or synchronous (coherent)

In a ripple counter successive bistables are clocked by other bistables and the various propagation delays all add up. The final output may then be many such delays in duration. Whilst this is not important for many applications, parallel outputs from the bistables cannot be gated together without spikes occurring in the gate output. Such spikes can trigger any subsequent bistables. The main advantage of a ripple counter is its simplicity.

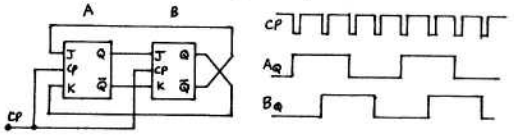
The synchronous counter is one in which all the outputs change simultaneously in accordance with a common clock pulse.

Let us see what happens when two Master-slave, J-K bistables are interconnected in various ways in a synchronous manner.

Firstly the Qs are joined to the Js and the $\overline{Q}$s to the Ks. This is a two-bit shift register with the output connected to the input. The result is that the bistable states are moved round by one bit at a time. This is a ring counter with a count of two. The initial data can be preset into the bistables by means of the preset and clear inputs.

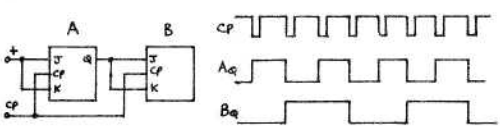


Now let us cross over the output feeds back to the inputs. Obviously the output signals will appear at the bistable outputs in inverted form after two clock pulses. After another two they will again be inverted - back to the original. The system therefore counts by four. It is known as a 'twisted ring' for obvious reasons or as a Johnson counter and gives square waves.

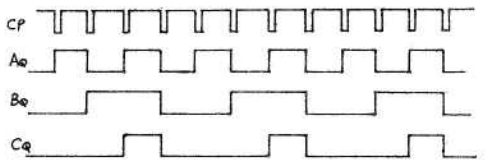


The count can be extended to more than four but then the initial states of the bistables must be preset to be all alike otherwise the count will be a nonsense. This also applies to the ring counter for counts greater than two. It is possible to correct for initial errors though.

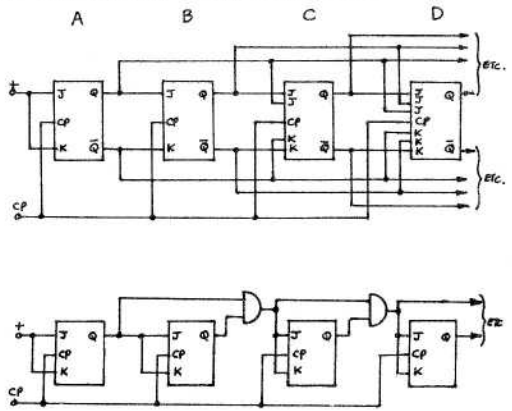
Another simple system is a binary counter. Here the bistables are used as T-bistables. With only two the count is four. Each bistable toggles when both J and K are high.



But if another bistable is added the unexpected happens - the last output is not at half the frequency of the previous one. This is because the last bistable has its J and K inputs both high for two clock pulses. It therefore toggles up and then down again. To overcome this problem the third bistable must have both previous bistable outputs fed to two Js and two Ks so that the resultant J plus K is high for only one clock pulse.

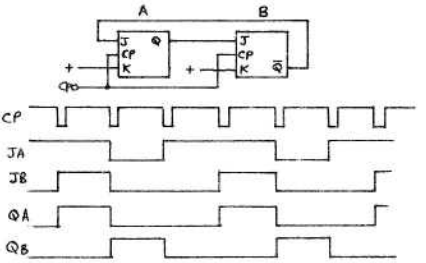


This principle has to be extended formore bistables but the process may be simplified a little.



In the next arrangement only the J-inputs are used; the K-inputs being kept high. The bistables are thus not prevented from going Q-low. But they may be stopped from going Q-high if J is low.

A sort of Ring-counter with Js to Qs will not do anything of much use but if one $\overline{Q}$ is used instead then the system will be seen to count by three.



If the Q-outputs are initially assumed to be low then J_A will be high and J_B low. So Q_A can go high whilst Q_B can not. This then happens on the first clock pulse. Now both Js are high so both bistables can toggle on the second pulse - Q_A goes low and Q_B high. At the third pulse both Js are low so the bistables cannot go Q-high, although they can go Q-low. Therefore Q_B goes low and Q_A stays low. This is the starting condition so the system has counted three pulses.

Suppose that $\overline{Q}_A$ was joined to K_B also? The K-input would have to be low to stop Q_B going low. This would be when Q_A was high. Now, when Q_A is high, Q_B is low anyway. However, when Q_B is high, K_B must be high in order that Q_B may go low. In fact, K_B is high so there is no reason for K_B to be low at any time. This is an example of the 'don't care' connection as Q_A to K_B is of no use.

The counter uses only three out of a possible four states of the two bistables. If the fourth state is obtained at switch-on (both Q-high) J_A will be low and J_B high. So Q_A cannot go high, but, since it is already high, and K_A is high, it can toggle to go low. Thus the counter will extricate itself from the unused state and continue to count correctly.

What if more than two stages are used? It will be found that the arrangement will not work in a sensible manner. There are now several possibilities to consider if a counter is to be made which will count by larger numbers than three.

1. Try another variation of inter-connection in hope.
2. Try a ready-made device such as a 7490.
3. Crib somebody else's circuit.
4. Abandon the idea.
5. Find a way to work it out.

Of these, the last one will be considered. The second one has been described in a previous issue of CQ-TV.

Since most counts can be obtained from other more complex devices in one way or another, it would seem that the only reason for wanting to use several bistables in a counter system is to generate a complex waveform. Such waveforms may be encountered in SPGs for example.

This particular problem and a way of solving it will described in the next issue of CQ-TV. The article will also describe logic, Boolean Algebra and Karnaugh Maps and how they are used to work out counter logic.

Continued on page 17

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