Amateur Television

Amateur Television Handbook

By John L. Wood, G3YQC and Trevor Brown, G8CJS

Acknowledgements

The British Amateur Television Club expresses its gratitude to the following companies, societies and individuals who have provided material and assistance for this publication.

Blean Video Systems, Canterbury, Kent

Plessey Semiconductors Ltd., Swindon, Wiltshire

Radio Ref. Paris

Radio Society of Great Britain, Doughty Street, London

Wasco Electronics, Queens Street, Leicester

C. Browabridge		D.E.Jones	GW8PBX
M.Chamley	F3YX	J.Lawrence	GW3JGA
M. Crampton	G8DLX	T. Mitchell	G3LMX
C. G. Dixon	G8CGK	R. S. Roberts	G6NR
A.Emmerson	G8PTH	R.T.Russell	G4BAU
J. Goode		N. Walker	G8AYC
A.F.Wood	G3RDC		

This special A4 sized edition edited by Ian Pawson, August 1998

Editors note: This book was originally printed A5 size. This version has the same content, but has been rearranged to A4 size. The quality of some of the diagrams and pictures is not up to our usual standard as they have been scanned in from an original paper copy.

Contents

Preface

Amateur television is a large and complicated subject and to do justice to its many facets a book of several volumes would be required.

Amateur television handbooks in the past have tried to cover as many subjects as possible and consequently, due to size limitations, each subject has been treated in rather less detail that one could have wished. The original conception of this handbook was to deal in greater depth with the more complex and in some cases less-well publicised techniques used in the modern amateur television station. You will therefore find less information on basic principles, aerials, operating techniques, licensing requirements and even transmitters, all of which are adequately covered in books and frequently found in magazines. Instead, emphasis has been placed on subjects such as modern receiving systems, electronic video sources, vision-processing techniques and of course colour television. These subjects are particularly susceptible to changes in modern techniques and innovations and therefore the designs need to be periodically up-dated.

The newcomer to ATV has not been forgotten however and a chapter explaining such things as the composition of the modern TV signal and the organisation of an amateur station has been included. There is also guidance on aerials, feeders, simple receiving equipment and colour television principles and it is hoped that this information will adequately augment the large amount of already published data in other books and periodicals.

Almost all of the projects in this volume have never before been published and indeed some were designed especially for this book. Printed circuit boards will be made available to the constructor in order that the more complex circuitry may be successfully built by less experienced constructors. The video projects are all compatible with each other and the PC boards have been made to a standard size and use standard edge connectors that enable them to be installed in a card4rame cabinet system if required. This ensures complete flexibility and permits the use of only those units that are required.

The British Amateur Television club is pleased to present this book in the hope that it will encourage and stimulate television amateurs throughout the world to strive for technical improvement and will help newcomers to enjoy this fascinating hobby.

Principles

There are several methods of picture transmission; high and low definition television, slow scan television and facsimile (FAX) for still pictures, pictures built up using radio teletype, and so on. This book is mainly concerned with high definition television and sets out to describe the equipment necessary to build a modern amateur television station.

The broad principles involved in television transmission are well known, and this brief review is intended to highlight many of the important features of a modern system which are dealt with in full detail in the following chapters.

All forms of picture transmission and reception differ from normal ‘seeing’ with a human eye in one important respect, the human eye uses about 150 million simultaneous channels of visual communication, but an electronic system uses only one channel at any instant in time, consequently a process termed ‘scanning’ has to be used whereby the visual information to be transmitted and received is explored bit by bit and translated into electrical terms for modulation of a transmitter. The received signal is demodulated and used to build up a reconstituted picture on the screen of a cathode-ray tube.

Scanning

To simplify the explanation we will consider a picture made up of only eight lines and displaying a black square in the centre of the screen.

Scanning requires, firstly, that the picture to be transmitted is framed in a field of view having an ‘aspect ratio’. The standard aspect ratio for television is 4 x 3 units, as shown in Fig 1(a). It is seen that the actual picture size is of no importance so long as the aspect ratio is correct.

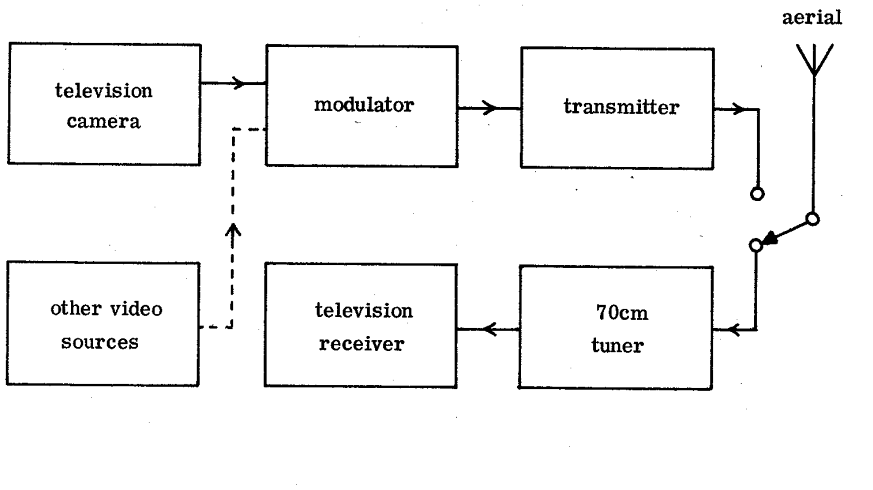


Fig 4. A simple amateur television station.

Fig 1(a) shows a scanning spot that traverses the field line by line, (similar to the manner in which we read a book page), translating the variations of light and shade (and possibly colour) into voltage variations which are used to amplitude-modulate the transmitter. The camera, with its optics and electronics carries out this operation. At the receiver, a CRT beam is swept across the face of the tube in synchronism with the camera scan, and the demodulated signal is used to modulate the beam current, thus writing a reproduction of the picture scanned at the transmitter.

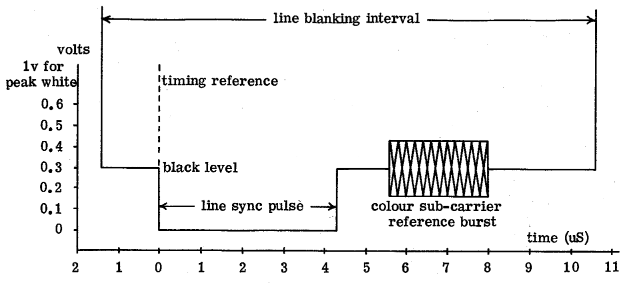


Fig. 2(d)

Fig 1(b) shows the voltage obtained by scanning (say) line four of the picture. Because electronic circuitry cannot respond instantly the changes from white to black and from black to white at the edges are not sharply defined. To improve resolution the spot is made smaller and the number of lines increased.

Television, in dealing with moving pictures, requires a complete scan of the field to be so fast that, compared with any movement taking place in the scene, each complete scan is of a virtually still picture. Standard broadcast television in the UK scans 25 pictures per second.

All broadcast television systems use a technique called ‘interlaced scanning’, this means that the screen is scanned and every other line is displayed onto the screen, during the next scan the in-between lines are displayed thus completing the picture. Referring to the eight line picture in Fig 1(a), interlaced scanning would require that the complete field would be scanned by lines 1, 3, 5 and 7 and then the gaps would be filled by re-scanning the field with lines 2,4, 6 and 8.

Television Standards

Picture quality is determined by the scanning spot size and, therefore, the number of lines required to fully scan the field. There are many reasons why amateur television should follow existing broadcast standards, not least of which is the availability of receivers. There are two UK broadcast standards, the original 405 line ‘black and white’ system A, and the later 625 line system I which includes colour. Both use an aspect ratio of 4 x 3, and both transmit 25 pictures per second. The highest modulation frequency generated during scanning in system A is about 3MHz, whilst 5 to 5.5MHz can be generated in system I.

Any TV system can include a sub-carrier with colour information, the normal 625 line system uses a colour sub-carrier frequency of 4.43MHz. A black and white system does not of course require a colour sub-carrier.

The Modulating Waveform

The scanning system output will be used to amplitude-modulate the transmitter, and it is necessary for the receiver tube beam to be in the same two-dimensional position as the scanning beam in the transmitter camera. As stated earlier, a single communication channel can only handle one bit of information at any instant of time but, in addition to the video information, it is necessary for the transmitter to send synchronising information to the receiver indicating the precise position of the scanning spot in both horizontal and vertical planes.

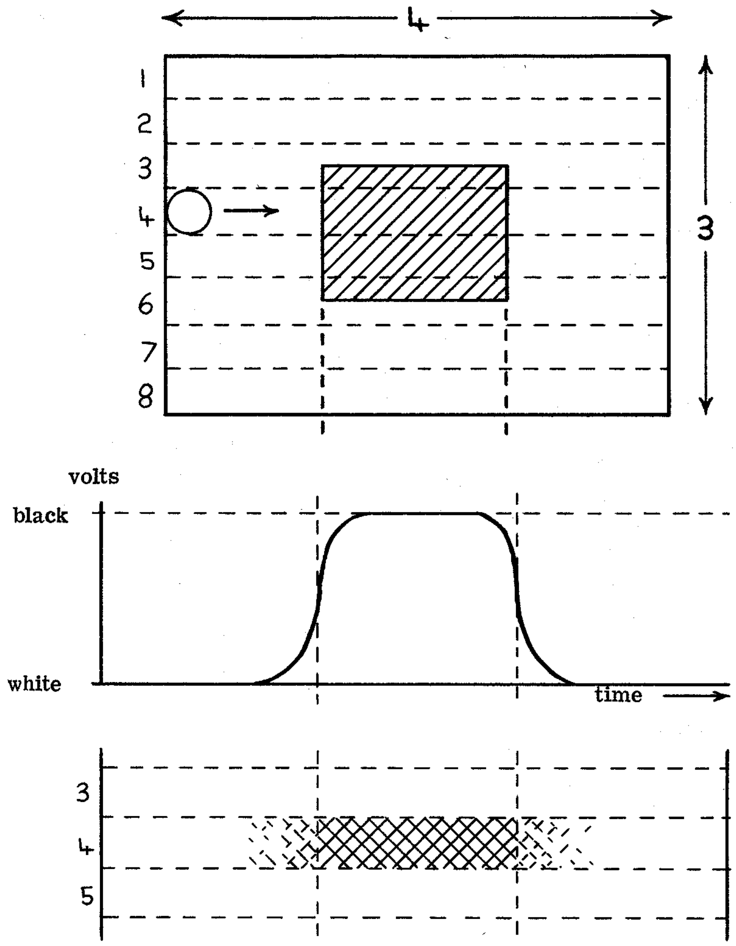


Fig. 1 (a)

Fig. 1 (b)

Fig. 1 (c)

Fig 2(a) shows the modulating waveform during a one-line scan. The video signal varies the transmitter output according to its amplitude. Time is taken from the complete video line scan by ‘blanking’ the video signal for a fraction of the total line period. During the blanking period a line-synchronising pulse is inserted which takes the transmitter output from 30% to near zero. This pulse is processed in the receiver to ‘tell’ the sweep circuits when to start the line scan across the CRT face. When the line scan reaches the bottom of the field, a field blanking pulse blanks several lines and a train of broad pulses are inserted during the blanking interval (Fig 2(b)). The receiver processes this train of pulses to return the CRT beam to the top of the display tube to retrace its vertical sweep.

Fig 2(a) shows what is termed ‘positive’ modulation as used in system A, in which peak white corresponds to maximum transmitter output. The 625-line system I uses the same principle but an inverted waveform (‘negative’ modulation) is used in which sync tips drive the transmitter to maximum output, and peak white is near zero.

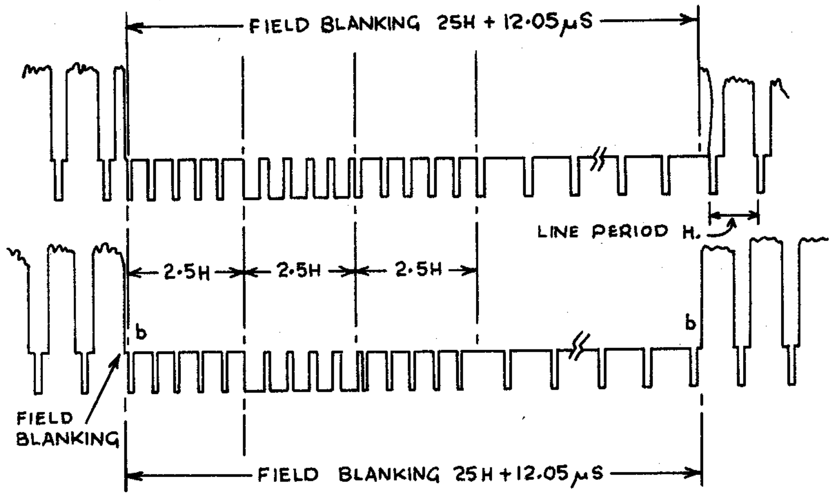
cycles) is inserted on the back porch, together with the timing associated with the line blanking pulse.

Bandwidth and Channel Space

Television is characterised by the need to handle very high video frequencies throughout the system from the camera to the receiver, and this includes the aerial system Amplitude modulation of the transmitter would produce the normal double sidebands which, for system A, would require a channel space of about 6MHz, and up to 11MHz for system I. Including a sound channel to either system would increase the channel width by about another 1MHz.

It was realised very early in the history of broadcast television that the heavy demands for channel space would limit the number of available channels, and a new system for saving channel space was evolved and called ‘vestigial sideband’ (VSB), or ‘asymmetric sideband’

FIG. 2b



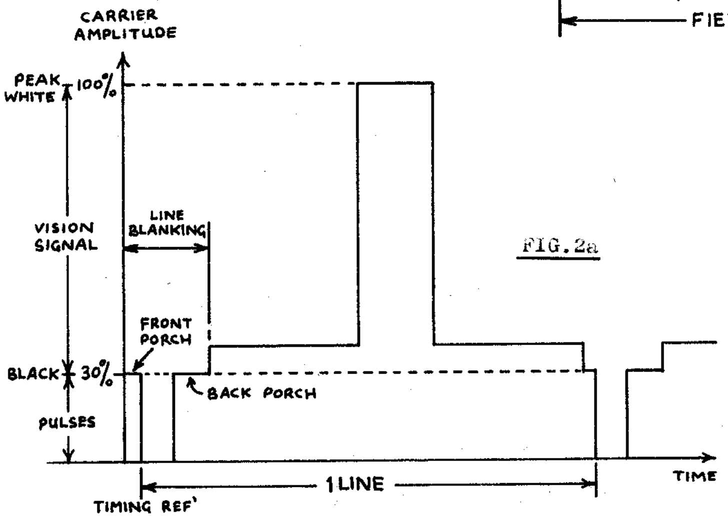


FIG. 2a

For a black and white system, a complete picture requires two cycles of video and synchronising information, as shown in Fig 2(b). Colour requires, in addition, further information in the form of a ‘burst’ of about ten cycles of sub-carrier on the back porch. This burst experiences a phase change on every line and, although interlacing is completed in two scans, the complete cycle of blanking, pulses and colour-burst phase requires four fields, as shown in Fig 2(c). Fig 2(d) shows how the burst of colour sub-carrier (about ten

(ASB). Fig 3 shows the channel spectrum for one system I channel. VSB involves filtering off a large part of the lower sideband, leaving only about 1 MHz or so, and an overall channel width (with guard bands) of 8 MHz. With suitable tuning of the receiver IF circuits distortion of the vision signal by the loss of part of a sideband can be reduced to negligible proportions.

The bandwidth required for a single system I channel is 8 MHz. The 2-meter band is thus quite unsuitable for television transmissions. The 430 MHz band can only support one channel by the use of nearly the whole of the band. Higher carrier frequencies such as 10.5GHz are much easier to modulate than are low carrier frequencies and, of course, can provide the much-needed channel space. Another reason for using a band such as 10.5GHz is that risks of interfering with other users are minimised because the aerials used at both the transmitter and the receiver are highly directional and have a narrow beamwidth.

The Station

The modern amateur television station is neat, compact, usually solid-state and by no means complicated or difficult to construct and use. Gone are the days of 6ft racks of equipment, huge valved linear amplifiers and their associated lethal power supplies and large modulators. Gone also are the large valved excommercial cameras with their boxes of control equipment which took two strong men to lift.

A modern 10-Watt vision transmitter can be housed in a small neat cabinet often smaller than a H.F. bands transceiver. The tuner can also be incorporated in the same cabinet or tucked away inside the station TV set. If a camera is used it will typically be an ex-commercial surveillance type such as those seen in supermarkets and department stores.

The block diagram of a station is shown in Fig 4 and many amateurs use no more equipment than this.

It is often possible to modify an existing FM or SSB transmitter for video service without jeopardising its intended mode of operation. Solid-state linear transverters are usually quite suitable for vision use with fairly simple modifications. Custom-built transmitters are not difficult to construct using modern techniques.

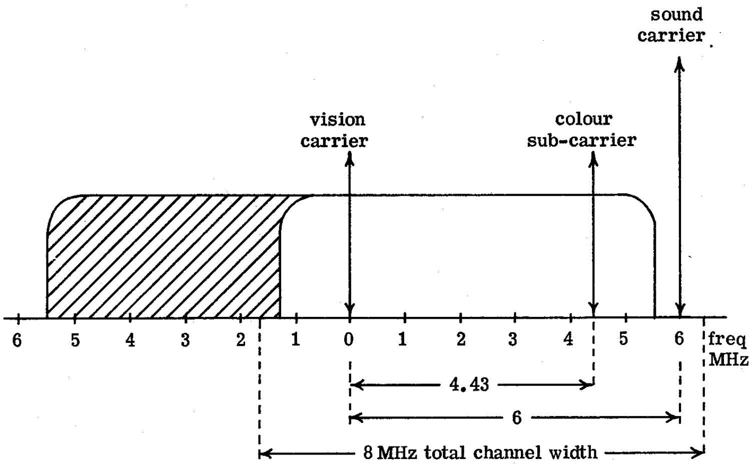


Fig.3

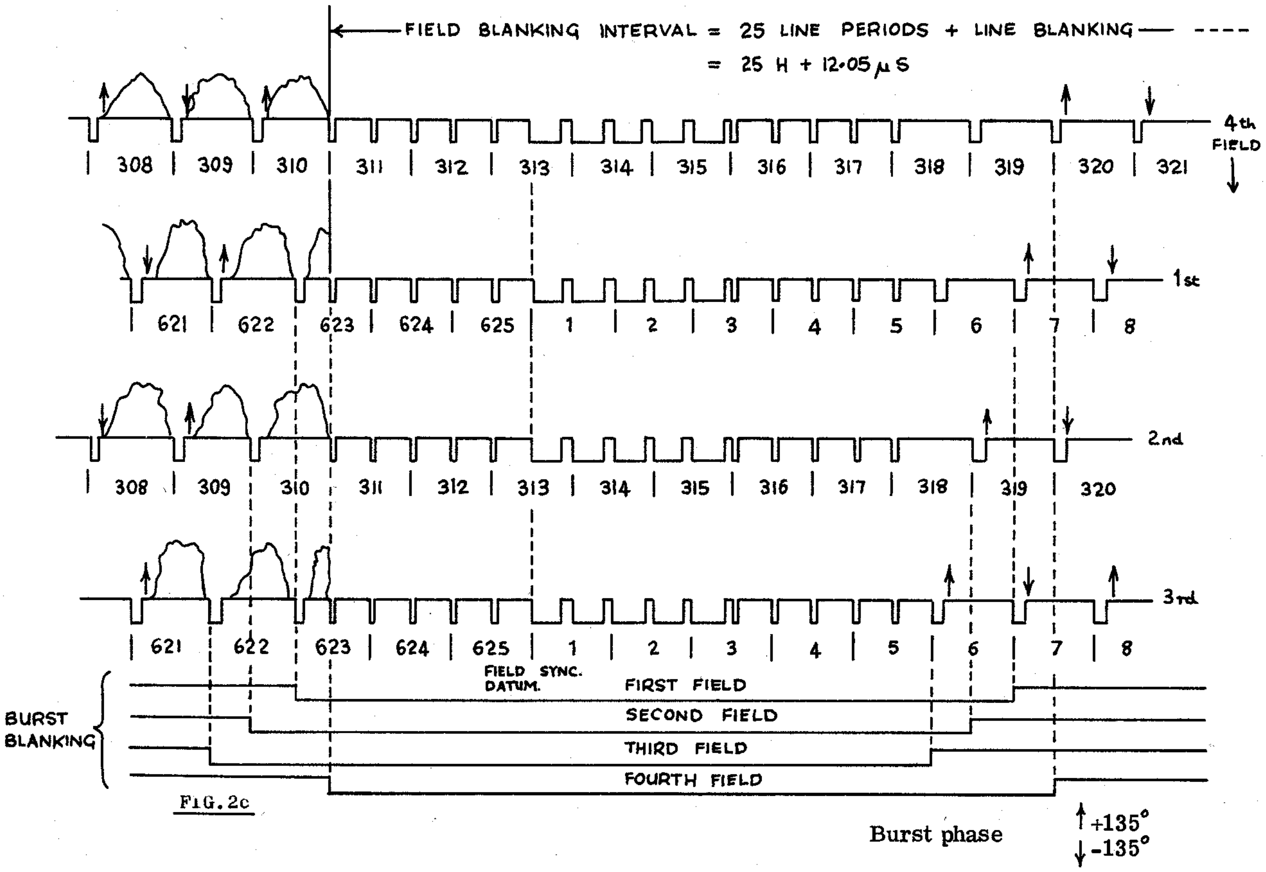


FIG. 2c

Aerials

Aerials suitable for amateur television are similar to those used for other modes of amateur radio, although the actual selection is limited by some specialised requirements. The two most important considerations in ATV work are gain and bandwidth. For anything other than local operation an aerial gain of 10dB should be considered to be the minimum requirement. Since television requires a stronger received signal for adequate results care should be taken to obtain the maximum possible ERP from the aerial system over the whole of the 70cm band. Poor aerial design will degrade or lose colour sub-carrier and may cause you to miss foreign DX at the top end of the band.

Polarisation, though technically non-critical, should be horizontal since this is the standard used throughout Western Europe. Height and location of the aerial are prime factors and should be chosen carefully to ensure the shortest possible feeder length. The aerial should clear any local obstructions-including trees which absorb RF-and should have as clear a take-off as possible. Height gain increases usefully up to 50ft or so, above this the increase in gain due to height is offset by increased feeder losses, so ultra high aerial systems are often not ideal unless special arrangements are made to reduce losses.

In practice three types of aerials are in common use in the UK. The first is the eight-over-eight skeleton slot that has good forward gain (around 12dB) and adequate bandwidth for television work. It is small and light making it easy to handle and erect.

The second is the eighteen element Parabeam which has been around for many years. This aerial, although not so popular today has a good performance in amateur television service. It exhibits high forward gala and a fairly good polar pattern together with sufficient bandwidth for modern colour transmissions.

Lastly there are the ‘X’ element types of aerial commonly known as ‘Multibeams’.

The 48 element Multibeam achieves a gain of 15. 7dB and has a beamwidth of 26 degrees. It is 1.83 metres long. There is also an 88-element version that has a gala of 18.5dB. This is a very big aerial however, almost 4 metres long, and the beamwidth is so narrow (19 degrees) that it is easy to miss signals through incorrect beam alignment. The 48 element Multibeam is therefore considered by many as an ideal compromise and is one of the most popular ATV aerials presently in use. It has been noted by a number of amateurs however that the performance of Multibeams often falls off during wet weather, presumably due to the water on the element insulators shorting out the elements since these points are at high impedance.

Feeder Systems

Feeder cable should be 50ohms coaxial and should be low loss hard-line. Uniradio 67 is probably the minimum acceptable quality, anything flimsier or thinner will only be a disappointment. In particular beware of so called ‘bargains’ in 50ohm cable.

When choosing and installing coaxial cable try to ensure that the braiding is densely woven to provide adequate screening and preferably should be made from tinned copper strands since bare copper will oxidise in time and prevent good electrical contact between the individual strands. The inner dielectric should preferably be solid rather than semi-airspaced to try to minimise the ingress of moisture over the years.

When installing the cable avoid sharp bends and undue strain or pressure on any part of the feeder run and make sure that both ends of the feeder are properly sealed to stop moisture getting under the outer sheath and corroding the braiding. Finally, ensure that all connections to aerials, plugs and sockets are properly made, scrupulously clean and adequately protected against moisture.

The subject of RF connectors in VHF and UHF amateur stations is one that is often neglected but many would be surprised at the losses incurred by using poor quality or incorrectly chosen connectors.

Ideally an RF connector will be transparent to the signal, i.e. it should appear like a continuous piece of coaxial cable.

There are many different types of connector available today and it is well worth establishing a standard throughout the station. Since large diameter coaxial cable is almost essential for effective 70cm work ‘UHF’ or ‘N’ types are to be preferred. ‘UHF’ (PL259, S0239) are adequate if correctly fitted but the ‘N’ type is undoubtedly superior and is used throughout the modern electronics industry. It is important that good quality plugs are obtained and fitted according to the manufacturers instructions, this is most important if the connector is to perform at its best.

‘N’ type and ‘UHF’ connectors however are rather bulky and it is good practice to use smaller connectors such as 50 ohm BNC and thinner cable for general purpose video and IF connections inside the shack. Do not use long runs of this coax at 70cm otherwise unacceptable losses will result.

Note that with ‘N’ type plugs and sockets 50 and 75-ohm types are NOT interchangeable because of different sized centre pins. If one decides to standardise with say 50 ohm ‘N’ type then it is strongly recommended that 75 ohm versions be completely excluded from the shack, junk box etc. to avoid costly mistakes.

The well known ‘Belling Lee’ type of plug and socket used commonly on broadcast television sets should never be used in an amateur station, the losses and un-reliability caused by these connectors make them totally unsuitable. In case you ask why, broadcast television signals are almost always very strong and therefore losses in poor quality cable and connectors are often insignificant.

Receivers

The most popular amateur television system in current use consists of a standard black and white 625 line TV, (the modern portable set sold in the high street is a popular choice) together with an external commercial tuner modified for 70cm.

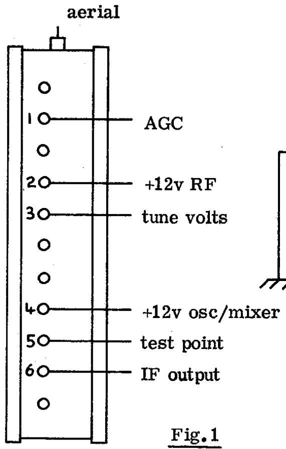


Fig.1

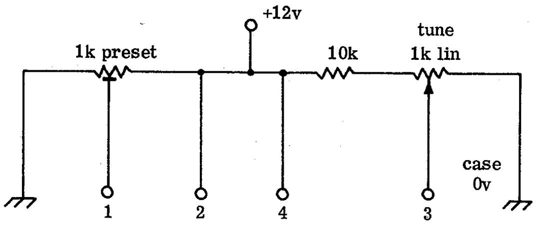


Fig.1(a)

A favourite tuner used extensively by amateurs is the Mullard ELC1043 and ELC1043/05. These are readily available and inexpensive, the later versions may not quite tune down as low as the 70cm band but by a simple modification can be made to do so. The tuners as purchased are quite sensitive and suitable for receiving local and semi-local amateur transmissions but the addition of a good pre-ainplifier improves the gain and sensitivity making the system suitable for longer distance working.

The IF output may be left tuned to the standard IF frequency and fed straight to the IF input of a domestic 625 line TV set, great care should be taken when using a mains operated set with a live chassis. If required a switch may be installed in the TV to change over from the internal to external tuner thus preser-ving the set for domestic use. Alternatively the IF may be set to channel 1 or 2 in band 1 and fed to the VHF tuner (if the set is dual standard), in this case though the timebase will need to be changed to 625 lines and the modulation sense should be correct for receiving negative modulation. The advantage of this system is that the gain of the VHF tuner is used as IF amplification giving perhaps a small advantage.

A slightly different converter makes use of the fact that only one 625 line television channel can occupy the band between 434 and 440 MHz at a time. The converter is adjusted such that it can only receive a television channel in this segment, thus there is no need for a tunable converter since this is the only place where television on 70cm is permitted.

This type of converter usually out-performs modified commercial tuners since it uses relatively high Q bandpass filters which considerably attenuates out of band signals and give a better overall noise performance. Low noise transistors are used in the RF and mixer stages and the mixer is usually more capable of handling strong interfering signals without causing intermodulation distortion.

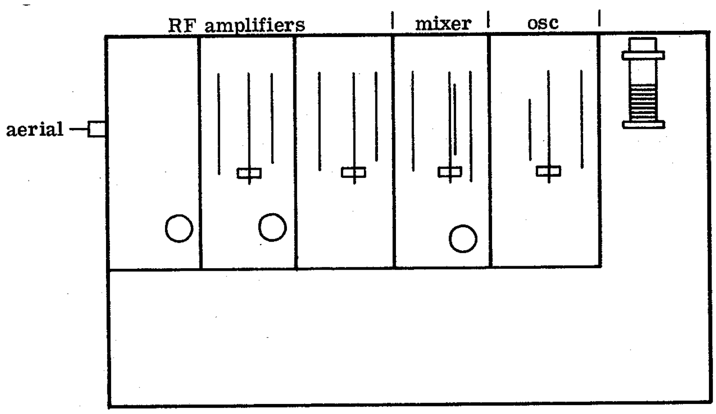


Fig.2

TOP VIEW

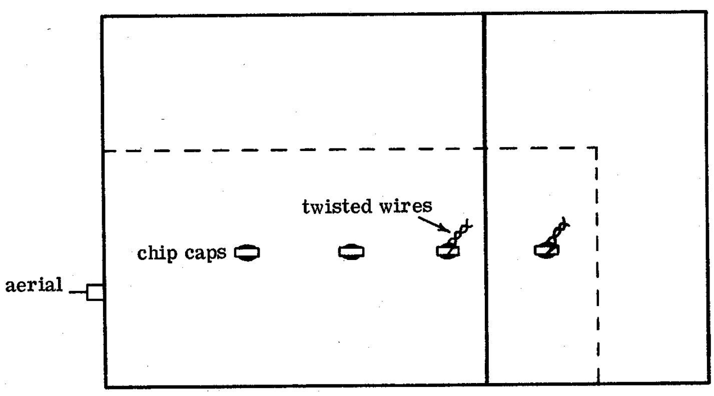


Fig.2(a)

BOTTOM VIEW

Some domestic TV receivers- particularly it seems the Japanese sets- will tune directly to 70cm without modification, in this case all that is needed is the addition of a good low noise pre-amplifier to make a suitable amateur TV receiver.

The ELC1043 Series Tuners

Fig 1 shows an ELC1043 type tuner and gives the layout and pin connections. A circuit for wiring up the tuner is given in Fig 1(a) the 1K linear potentiometer is the main tuning control that should preferably be mounted onto a 10-1 ratio reduction drive.

The later model ELC1043 and ELC1043/05 may not tune low enough to cover the 70cm band and consequently will need slight modification to enable them to do so. Two modifications are described here and either or both may be used as required.

The first and most effective is simply to lengthen the tuned lines in the mixer and oscillator compartments, this is done by unsoldering the main lines (those connected to the varactor tuning diodes) and pulling the line out of the PC board as far as it will go whilst still leaving enough line protruding through the print side to enable it to be re-soldered properly, this will effectively lengthen the line by up to an eigth of an inch overall, this should be sufficient to allow the whole of the 70cm band to be tuned. The RF amplifier lines may be lengthened in a similar manner and the tuner re-aligned.

The second modification increases the capacitor values in the oscillator and mixer tuned circuits.

Refer to Figs 2 and 2(a) and locate the ceramic chip capacitors at the ends of the oscillator and mixer tuned lines, these protrude through the print side of the board. Take two pieces of thin hookup wire about 1 inch long and solder one to each side of the oscillator and mixer chip capacitors. Set the tuning voltage on pin 3 to about 0.3 volts and with the aid of a strong local 70cm signal twist together the oscillator wires a little at a time until the signal is tuned in. In a similar manner adjust the wires on the mixer for maximum signal. It is important to use as little extra capacitance as possible since too much may stop the oscillator. The remaining tuned circuits should then be re-aligned for maximum signal.

A High Performance Wideband Tuner

This converter is a high performance unit which receives amateur television transmissions on the 70cm band. It is fixed tuned and covers the range 434 to 440 MHz and therefore needs no tuning control. The converter has a sensitivity and immunity to cross modulation which considerably exceeds that found in most commercial tuners, the performance owes much to the correct adjustment of the tuned circuits to reduce out of band signals.

This project is intended for those with access to proper test equipment but may also be successfully built by those less fortunate but who are prepared to spend time on the alignment.

The overall gain is of the order of 30dB with a supply of 14 volts. The measured noise factor of several specimen converters was measured at between 1.8 and 3dB. The bandwidth is nominally 6 MHz but can be adjusted as required, the passband ripple is better than 0. 5dB between 434 and 438. 5 MHz. Total power consumption is around 40niA at 14 volts.

Circuit Description

Two BFR9l low noise transistors provide RF amplification of the signal before it is applied to the 40673 MOSFET mixer. The local oscillator is a self-oscillating push-pull circuit.

The input signal is applied to a quarter wave line L1 which matches the impedance of the aerial system to the first RF amplifier and provides input selectivity. The first transistor is used in a common-emitter configuration with the emitter lead soldered directly to the earth plane, because of this a compensation network is provided in the collector circuit to provide bias for the transistor in the absence of an emitter resistor.

The signal is then applied to the second RF amplifier via a bandpass filter consisting of two over-coupled tuned circuits L2 and L3 and then to the mixer via L4. The IF output is fed to the transformer that has adjustable capacitive coupling. The secondary has an adjustable capacitive potential divider for correct matching to the IF unit and to control the damping on the output tuned circuit due to the output load.

The push-pull oscillator circuit uses printed inductors and has been found sufficiently stable for TV reception. Oscillator injection is applied to gate 2 of the mixer via a 9pF trimmer capacitor.

Construction

The tuner is built on a double sided printed circuit board, most of the components are mounted on the circuit side, the underside is used as an earth plane and for the point-to-point wiring of the 4.7 ohm decoupling resistors in the transistor output circuits.

The 47pF coupling capacitors must be low impedance disc ceramic or chip types, all decoupling capacitors should be good quality disc ceramics. The trimmer capacitors are not critical with the exception of that which tunes Li, this should be an air spaced type. The trimmers are placed flat on the PCB and the earth connection, where needed, is passed through the board and soldered onto the earth plane. The 4.7-ohm decoupling resistors should be mounted on small stand-

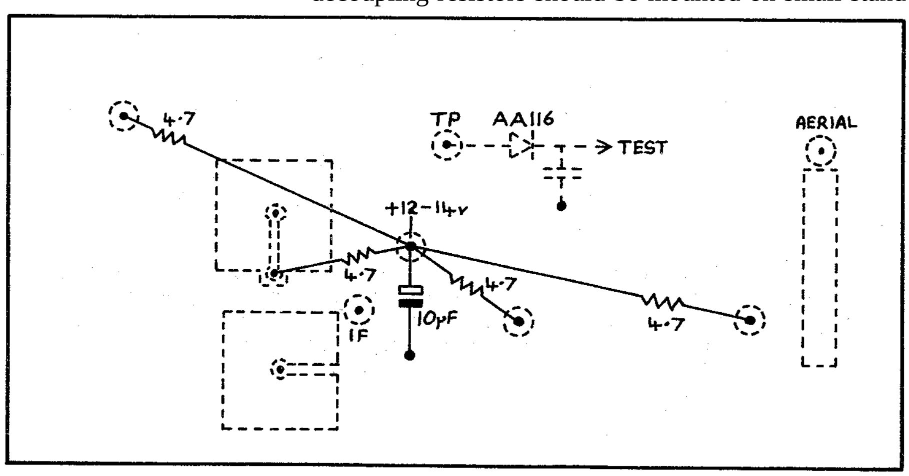


Fig. 5 EARTH PLANE SIDE.

off insulators on the earth plane side (see Fig. 5).

RF chokes CR1 and CH3 are made from 12 turns of 28swg enamelled copper wire close wound using a one eighth drill and made self supporting on SHORT leads. 0112 and CH4 have 10 turns on a 1K ~W resistor.

The transistors should be mounted last, the BFR9l's are mounted on their edges with the emitter leads passing through the board and soldered to the earth plane in such a way that they are as short as practicable. Bend the leads of the oscillator and mixer transistors about half a millimetre from the case and solder them with a small iron keeping the leads as short as possible. Special care should be taken to ensure that the iron used to

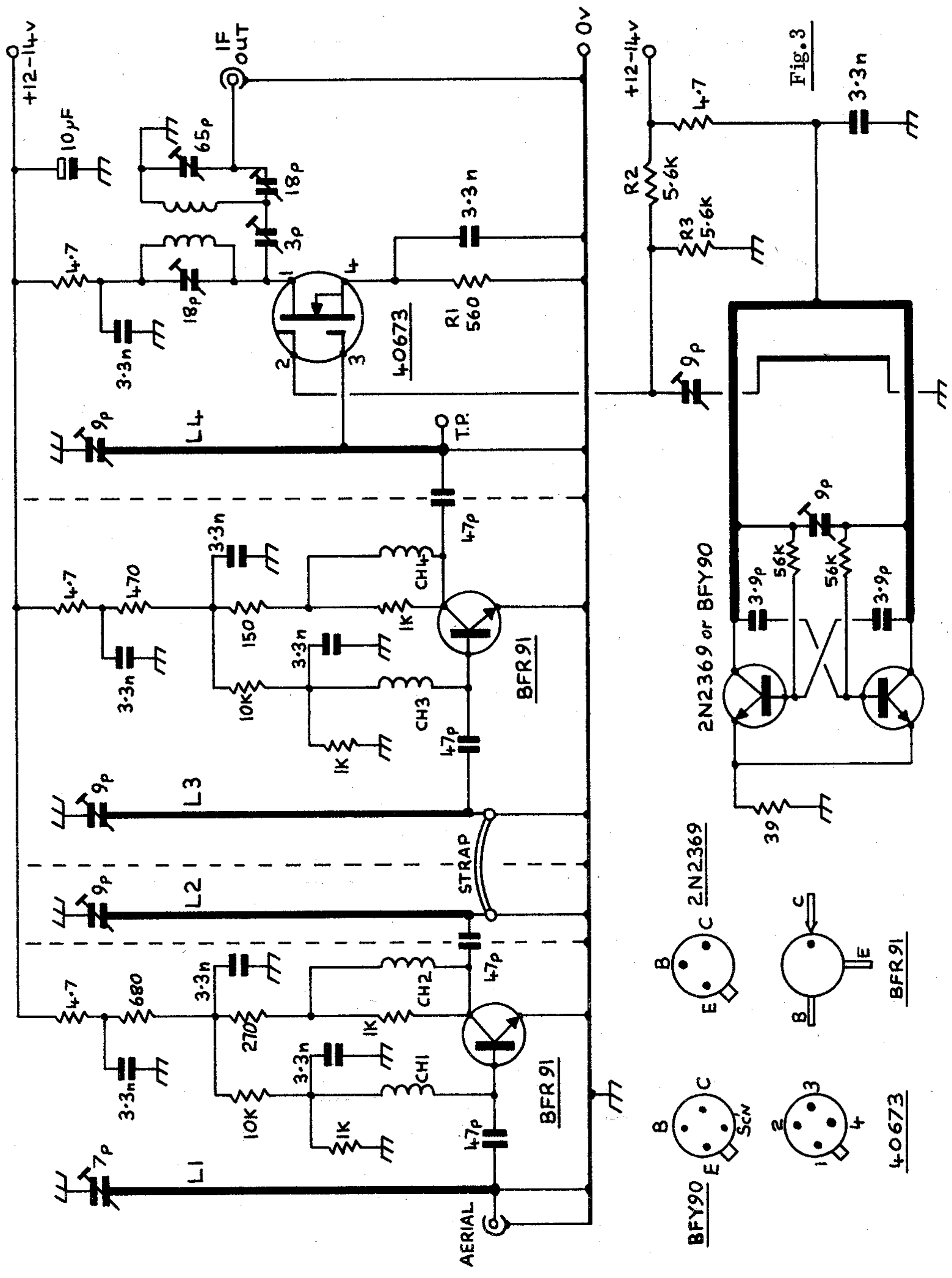


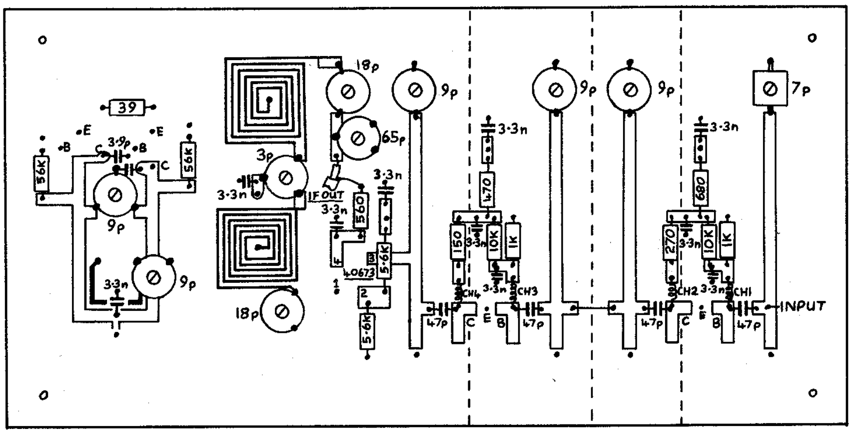
Fig.3

solder the FET is properly isolated, in practice it is wise to unplug the iron from its supply just before making the joints.

Screens are used to isolate the RF stages from each other, positioning is shown on the circuit diagram (Fig.3). The screens may be made from sheet brass, copper, tin or double-sided copper laminated board and fixed to pins pushed through the board and soldered through to the earth plane. Care should be taken to make cut-outs in the bottom of the screens to prevent fouling of components or shorting of the printed tracks. A long cut-out should be made in the screen separating the bandpass filter lines to enable the shorting link to be adjusted during alignment.

Adjustments

The converter is intended to have an IF frequency on a convenient channel in band 1 but can be modified for the standard TV IF frequency or any other suitable frequency up to about 250MHz.



COMPONENT LAYOUT.

Adjustments are best made in three stages with the aid of a sweep generator, detector and oscilloscope display (a Polyskop or similar RF analyser is ideal).

Connect the swept source to the aerial input and the detector probe to the test point on **IA.** Adjust the capacitors on L1, L2, L3 and L4 and the position of the shorting strap between L2 and L3 to obtain a passband curve having a bandwidth between 434 and 440MHz at the -1dB points.

Using a grid-dip oscillator, frequency counter or a receiver adjust the local oscillator frequency to that required for the chosen IF output.

The oscillator is positioned on the low side of the input and is calculated from:

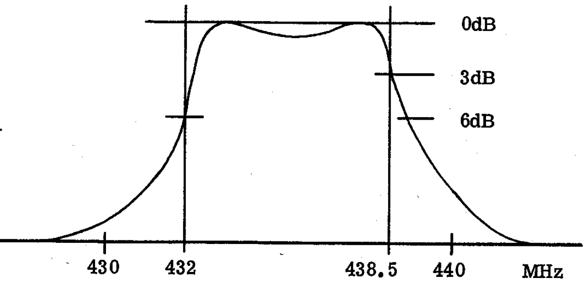
F oscillator = F input - F if.

eg. for an IF frequency of 39. 5 MHz and taking the centre of the band as 437 MHz the oscillator frequency is:

F oscillator 437MHz - 39.5MHz = 397.5MHz.

For final adjustments connect the swept source to the aerial input and the detector probe to the IF output socket. Adjust the four trimmers around the output transformer to achieve a curve similar to that shown in Fig. 6. Finally re-adjust the capacitor on L4 to peak in

Fig. 6



RESPONSE CURVE.

the middle of the band.

In the absence of proper test equipment the converter may be adjusted by trial and error using a strong local amateur TV signal. If a signal generator is available a probe can be made using a germanium diode and a decoupling capacitor the output of which is connected to a sensitive voltmeter, the probe should be connected to the points described earlier. By manually tuning the signal generator and plotting the response on a piece of graph paper it should be possible to obtain the correct curve.

If a high IF frequency is used it may be necessary to short circuit one or more turns of each output transformer winding and to increase the values of the oscillator injection and tuning capacitors.

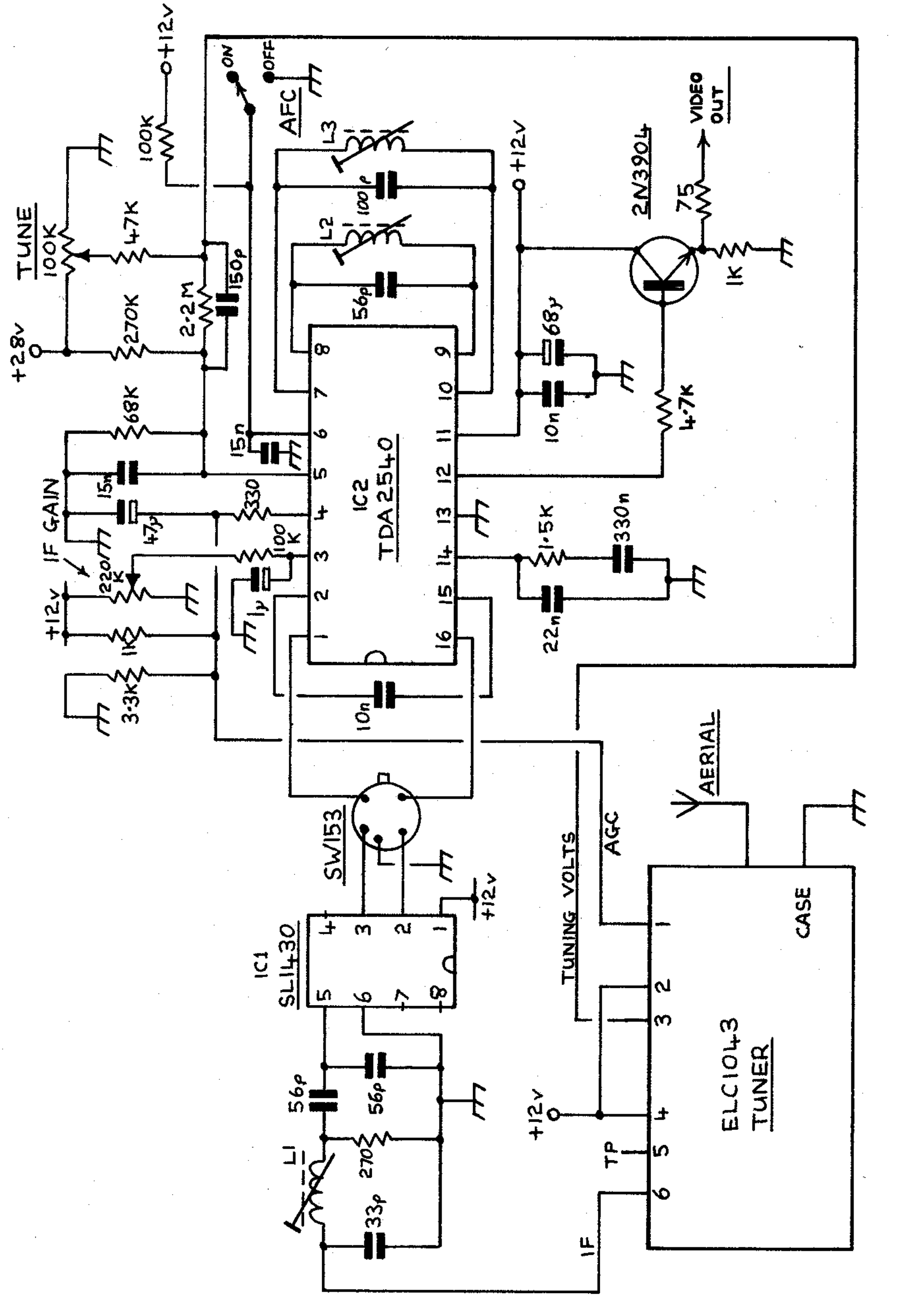
If the standard IF frequency of 39.5 MHz is chosen it will be necessary to increase the four trimmer capacitors around the output transformer to roughly twice their original values, this may best be done by selecting fixed capacitors and placing them in parallel with the existing trimmers. It may be necessary to change the 3pF coupling capacitor to around 10pF to achieve the correct response.

The completed converter should be housed in a screened box which can conveniently be made from sheet metal soldered together or from copper laminated printed circuit board.

A drilled and tinned printed circuit board is available for this converter, details of which may be found at the back of this book.

An Amateur Television Receiver

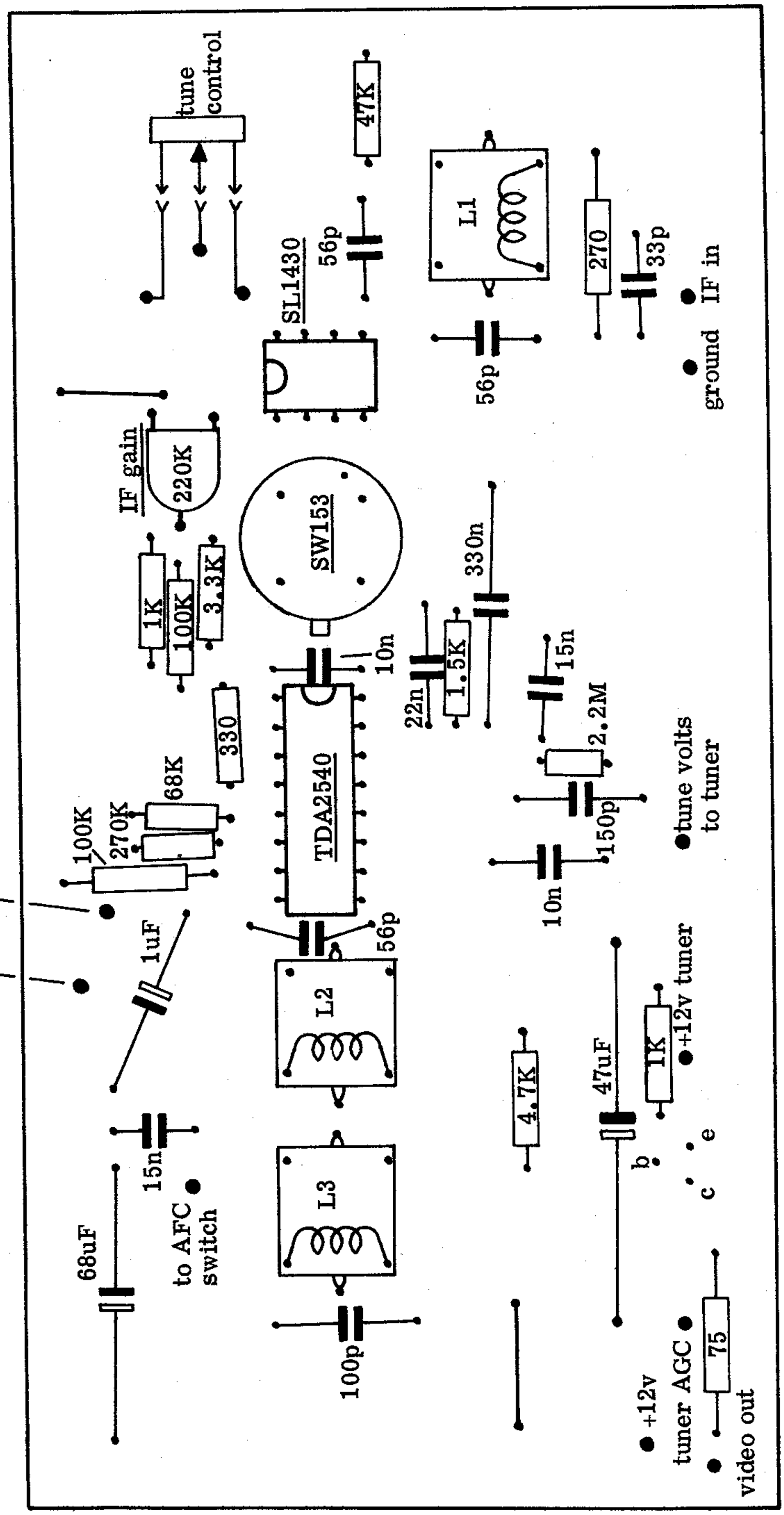
This receiver differs from the majority of systems used by television amateurs in that it includes IF selectivity, amplification, demodulation, AGO and AFC circuits and its output is 1 volt peak-to-peak video. Thus there is no need to use the RF circuits of a standard broadcast receiver, display being via a video monitor.



RECEIVER CIRCUIT DIAGRAM.

The tuner can be a modified ELClO43 commercial type, the broadband converter shown elsewhere in this chapter or any other tuner having an IF frequency of 39.5 MHz. The tuner IF output is matched to the IF pre-amplifier (IC1) with the tuned circuit L1/C1, R1 ensures correct broadband termination.

IC1 is a high gain IF amplifier and is needed to offset the large loss caused by the selectivity filter.



COMPONENT LOCATIONS.

Selectivity is achieved using a surface acoustic wave filter (SAW). This filter is specifically designed for the UK 625 line broadcast television standard and is a significant advance on the multitude of tuned circuits previously required.

The differential output from the SAW is applied to 102 which is an IF amplifier, video demodulator, AGC and AFC generator all on one integrated circuit. The tuned circuit L2/C2 is a critical part of the synchronous demodulator and must be of good quality and high Q. L3/C3 is part of the AFC generator, its adjustment is described later

The video signal from pin 12 of 102 is applied to an emitter follower which matches the output to 75 ohms suitable for feeding a video monitor.

Construction

Component layout is not particularly critical providing care is taken to preserve symmetry around 102, input and output circuits should be kept well separated and all leads should be as short as possible, particularly those on the bypass capacitors. Connections to the SAW filter should be made in such a way that the input and output leads are kept as short as possible and are kept away from each other otherwise the filter passband characteristic may be distorted.

The printed circuit board should be mounted on top of the tuner using 3/lOinch spacers. The two top corners and one of the bottom corners should be earthed to the tuner case.

If the whole of the broadcast band is not required the 28 volt tuning supply may be omitted and the 12 volt supply used instead. Band-spreading for 70cm may be obtained by fitting a series resistor between the tune control and the tuning volts rail, this resistor should be chosen to give a tuning volts range of between 0 and 1.5 volts.

A drilled and tinned printed circuit board is available for this receiver, details of which may be found at the back of this book.

Alignment

Alignment is best carried out using a strong television signal such as one of the local broadcast transmitters.

Adjust the core of L1 to about half way and the IF gain control to mid-position, switch off the AFC.

With no aerial connected measure the dc voltage between video output and ground, adjust L2 and note the voltage reading at each end of the adjustment range, adjust the core for a voltage reading exactly mid way between the two.

Connect the aerial and tune in a strong signal. Switch on the AFC and adjust L3 until the signal is brought back on tune (this adjustment is fairly critical).

If an oscilloscope is available monitor the video output waveform and adjust the ‘scope to display one or two lines of video, check the adjustment of L2 and if necessary re-adjust slightly for minimum distortion of the video waveform.

Finally adjust L1 and the tuner IF output coil for maximum signal.

Transmission

Video Modulators

Modern amateur television transmitters are usually low power and invariably have transistorised final amplifiers. It is often possible to vision modulate an existing FM or SSB “black box”. These will typically produce HF levels up to about 10 watts.

Vision modulation is quite straightforward and details are given here of two modulators suitable for transmitters up to about 2 watts or 10 watts respectively. The circuit of the low power modulator is given in Fig 4 and is very simple whilst that required for higher power is shown in Fig 5.

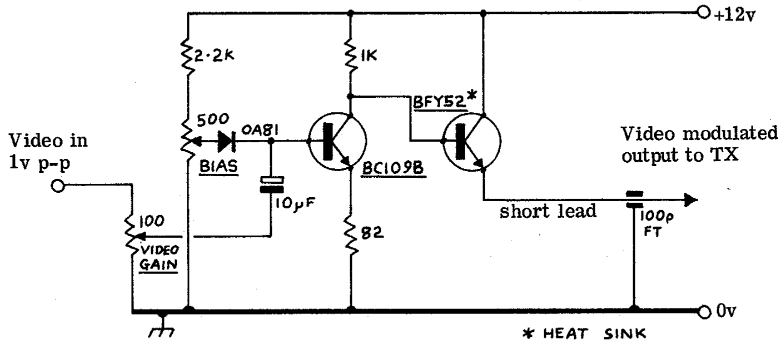
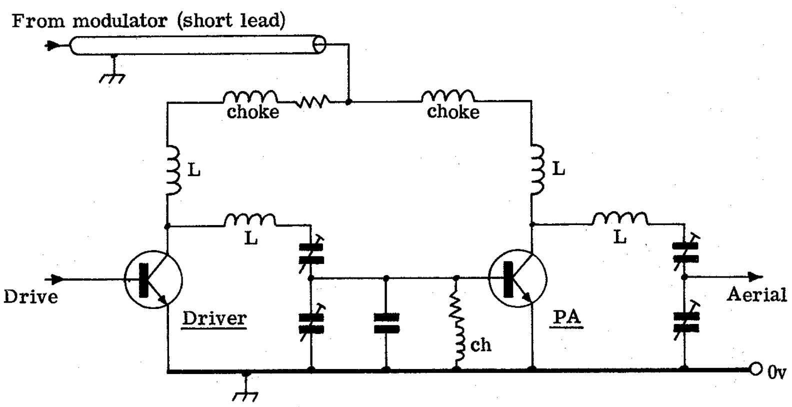


Fig 4 VIDEO MODULATOR FOR 2W TRANSMITTERS



Showing a typical driver/PA with video modulator connected.

“High level” modulation is used in both cases and on the low power version the bandwidth has been reduced to 3MHz so that the resulting signal comprising carrier and both sidebands can be contained within the limits of the 70cm band.

Both modulators are wired in series with the HT supply to the final amplifier of the transmitter. It is important that a very short lead is used and that all bypass capacitors which exist in the original transmitter HT circuit to the stages to be modulated are removed, otherwise the video information will be lost. A choke will prevent HF from entering the modulator. Bypassing may be accomplished with LOW value capacitors (100pF or less).

If possible both the final amplifier and its driver stage should be modulated to achieve a reasonable depth of modulation.

The bias control sets the black level and the video gain control sets the level of the picture signal. With the transmitter switched on and with no video input, adjust the bias control until about three-quarters of the transmitters output power is observed on a power meter, then connect a video signal when it will be seen that the power output will drop, this indicates modulation and it will be expected that the power will drop to about half which indicates a good depth of modulation. Final adjustments should be carried out by using a video HF probe and monitor or a local station receiving the signal.

The modulators should be built in well-screened boxes to exclude HF and should have adequate heat sinks for the output transistors.

A Modular Linear Amplifier

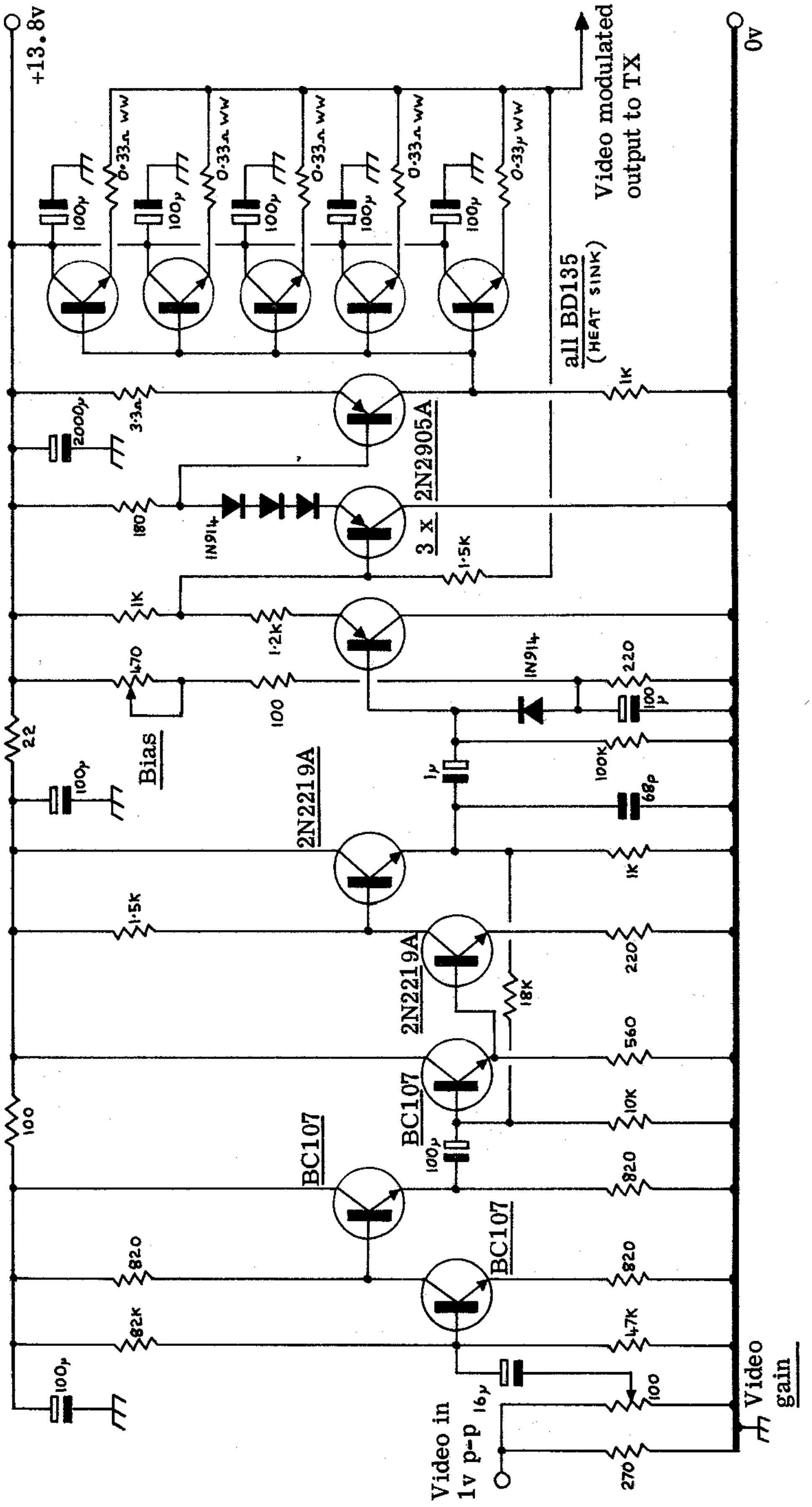
The Motorola MHW710 hybrid module an integrated circuit and transistor device which is encapsulated in blue epoxy and mounted on a heat sink flange. It was originally designed as a 15Watt class C amplifier for radio telephone use and has been used as the final amplifier in many 70cm amateur FM transmitters-principally in the US. When correctly biased and driven however it can be made to work as a linear amplifier though with reduced output power.

To achieve linear amplification suitable for television service an HF level of 80mW is sufficient to drive the output to 10Watts peak, care should be taken not to overdrive the module otherwise compression of the video and sync pulses will result. The power supply must be 13 volts plus or minus 1 volt and very well regulated, power leads should be as short as possible and certainly not longer that 18 inches. Supply levels greater than 15volts may destroy the module. The amplifier is otherwise virtually indestructible and will tolerate a high VSWR or even no load for short periods.

The following notes regarding amplifier adjustment and operation apply equally to other amplifiers used for television transmission.

Although this unit will deliver 10Watts peak to a 50 ohm load a power meter will show considerably less, typically half peak power. This is because with a negative modulation sense such as that used by most amateurs peak power will only be acheived on sync tips, black level will produce about 7Watts and the video information will drop the power towards zero thus the power meter reading is proportional to the average power developed by the complex modulating signal.

A technique of 'pre-distortion' is often used to raise the average power generated by the video information whilst ensuring that the sync pulses are not crushed. A suitable sync-stretch pre-distortion circuit is shown in

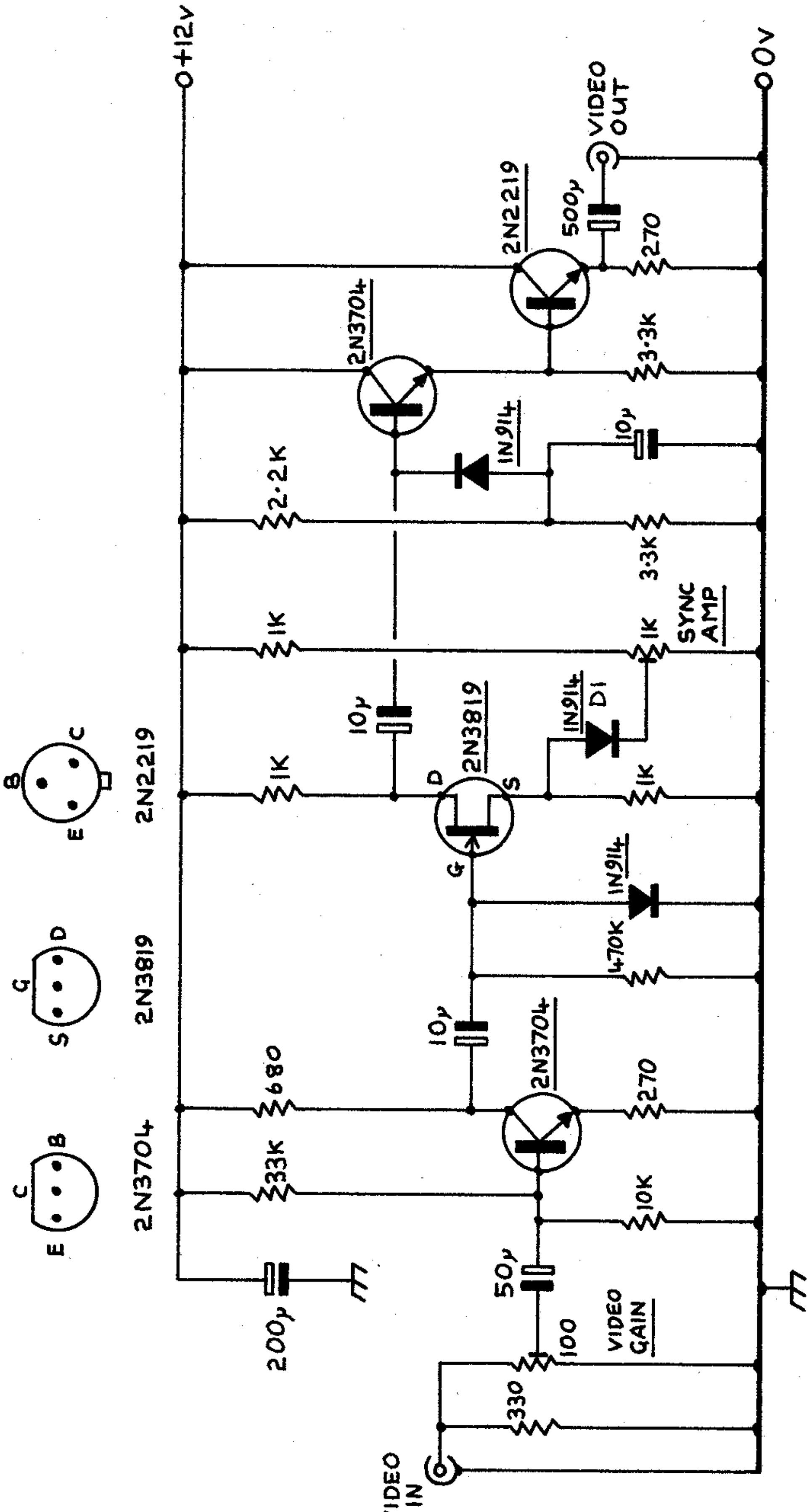


VIDEO MODULATOR FOR 10W TRANSMITTERS

Fig 5

Fig. 2. Using this circuit the power amplifier can be driven into sync compression until the syncs are reduced to their proper size.

The video signal is amplified, inverted, DC restored and applied to the gate of a FET. DC restoration is necessary so that the amount of distortion is independent of the



Sync stretch amplifier.

Fig. 2

average signal level. The gain of the FET stage is unity but during the sync period diode Dl switches on and effectively reduces the value of the source resistor thus increasing the gain. The amplitude of the syncs can be adjusted with the sync amp control. DC restoration is again applied to re-establish black level before the signal is passed to the emitter follower output stages.

The output signal of an amateur television station should always be monitored with a HF probe and an oscilloscope to check that an undistorted signal is being radiated. Fig. 3 shows a suitable probe.

A pickup wire is connected to a tuned circuit and the signal demodulated to produce a video signal which is fed to a two-stage emitter follower, the resultuig output

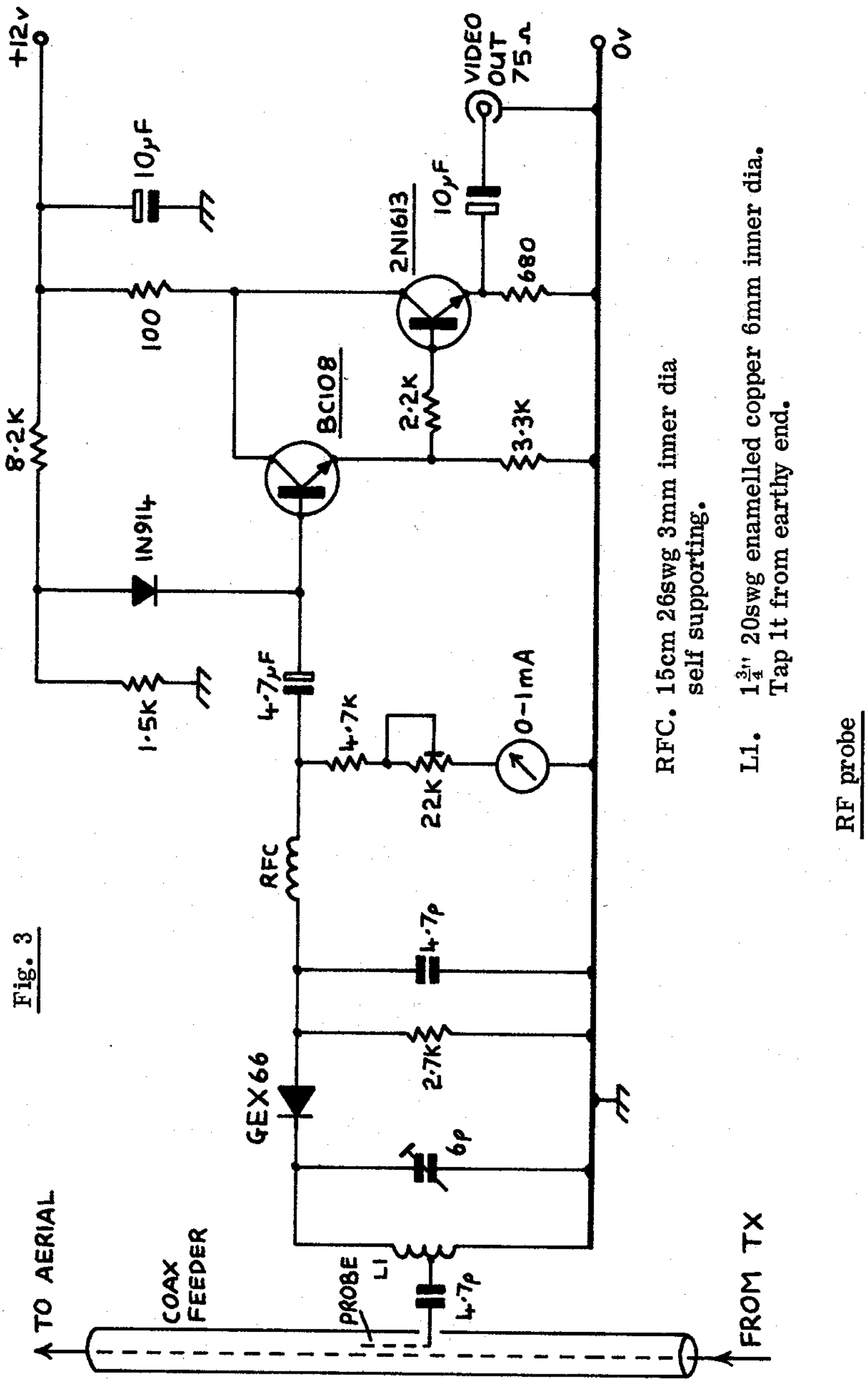


Fig. 3

RF probe

is suitable for display on a video monitor.

A 1mA meter is provided to give an indication proportional to the HF output power and is useful in tuning the transmitter since, because of the tuned circuit, it only responds to power at 70cm.

Construction.

Construction should preferably be on a printed circuit or plain copper laminate board which should be firmly secured to the aerial feeder. To insert the pickup wire cut out a small square of outer covering from the coax cable and push open the braiding, thread a thin piece of connecting wire under the braiding for a distance of about half an inch and connect the free end to the 4.7pF coupling capacitor using as short a lead as possible. The actual length of wire will vary according to the HF output power of the transmitter but will usually be between a quarter and half an inch.

Adjustment.

Connect the video output to an oscilloscope terminated with a 75 ohm resistor. Transmit a properly modulated television signal and adjust the input tuned circuit for maximum, adjust the length of the probe pickup wire until about 1 volts peak to peak is displayed on the oscilloscope. Set the meter adjustment control for a convenient reading, usually about two-thirds deflection.

The MHW710 module is available in the UK mounted on a finned heatsink and wired as shown in Fig. 1 from Blean Video Systems, 4 Mount Pleasant, Blean Common, Canterbury, Kent, CT2 9EU

Vision Sources

An Electronic Character Generator