Slow Scan Television Explained

Mike Wooding G6IQM

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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.

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Foreword

When it first became apparent that the production of a new BATC book on Slow-Scan Television was going to be required I started to shudder, not so much because I had only a few months ago completed a many month-long production of the new book ‘‘An Introduction to Amateur Television’’, but because my family would once again have a husband and father who would be hardly ever seen. What with the production of CQ-TV and my other interests, my office would become almost my home.

However, this particular project was not so daunting as a completely new book, as a lot of the material has been reproduced from our previous tome ‘‘The Slow Scan Companion’’. Whilst some of the material in that publication has become dated, a lot of it has proved to be not only of great interest to slow scanners, but also to be still of great use to newcomers to the mode.

However, the problem with using this previous material was that the earlier book was produced on equipment at least two generations older than that in present use by the editorial office. Thus, all the text was going to have to be re-typed in! Enter my new document scanner, which I decided to ‘‘lend’’ the Club for the production of this book, and all was saved!

The end result is, I hope, a book that will provide newcomers to SSTV with the basic knowledge that they will need to build and operate a station. Also, I hope that the book will provide an essential reference source for those already hooked by the mode.

Whether you decide to build a home-brew slow-scan station from designs contained herein, use a commercial converter, or operate a computerised system, this book will have something for you.

I hope that you enjoy it!

73 ... Mike G6IQM

A Moment in History

This was the first SSTV picture to be transmitted across the Atlantic Occean. It was sent by Copthorne Macdonald WA2BCW on December 20th 1959 and received in England by John Plowman G3AST.

Introducing Slow Scan Television

Introduction

SSTV is a narrow-band mode, which means that signals in this mode can be transmitted on normal voice channels. Thus, wherever you can reach by voice mode you can reach with SSTV signals, in other words on appropriate bands they are world-wide communication modes.

Slow-scan television has changed greatly since it was invented by Copthorne Macdonald and first used by radio amateurs many years ago. Nowadays, we have a plethora of systems within the mode and a variety of equipment which can be used to transmit and receive SSTV pictures. The original idea behind SSTV was to find a method by which a normal wideband television picture could have its bandwidth reduced so as to allow its transmission over a single channel voice communication system. This meant that a typical (at that time) 3MHz wide television signal had to be reduced to around 3kHz - around a 1000 to 1 reduction in bandwidth! Nowadays this reduction is even greater if a colour picture source is used as this generally has a bandwidth around 5.5MHz. Because of this severe narrowing of the bandwidth the system is only suitable for the transmission of still pictures.

Parameter	**50Hz Mains**	**60Hz Mains**
Line speed	16.6Hz (60ms)	15Hz (60ms)
Lines per Frame	120 or 128	120 or 128
Frame Speed	7.2s or 7.68s	8s or 8.53s
Aspect Ratio	1 to 1	1 to 1
Scanning direction:		
Horizontal	left to right	left to right
Vertical	top to bottom	top to bottom
Sync Pulse duration:		
Horizontal	5ms	5ms
Vertical	30ms	30ms
Subcarrier frequency:		
Syncs	1200Hz	1200Hz
Black	1500Hz	1500Hz
White	2300Hz	2300Hz
Required transmission bandwidth	1.0 to 2.5kHz	1.0 to 2.5kHz

Table 1.1: Basic Frequencies of the SSTV System.

To reduce the bandwidth of a television signal both the horizontal (line) and vertical (frame or field) scanning rates must be reduced to as low a frequency as possible. At the outset it was decided that both the line and frame frequencies could be conveniently derived from the domestic AC mains supply (50Hz in the UK). The basic frequencies and parameters of the system are shown overleaf in Table 1.1. It can be seen that the line frequency of 16.6Hz is obtained by dividing the mains frequency by three (in countries with 50Hz), and the frame frequency of 1/7.2Hz by dividing the mains frequency 50Hz by 360. In countries using a 60Hz mains supply different division ratios are used to arrive at the same standards.

The above refers to the ‘original’ SSTV concept, however, in view of the fact that SSTV is increasingly using digital techniques and computer systems, there is a tendency to increase the number of lines to 128, which is a convenient binary number (10000000). Most SSTV monitors and receivers of the ‘old’ standard will decode pictures using 128 lines with no noticeable effect other than the picture being slightly larger on the screen. A full review of all the current SSTV modes can be found in Chapter 2.

The Basics of a Slow-Scan Picture

The composition of a single SSTV picture line of the above original standard is shown in Fig.1.1. In order to separate the spectrum of the synchronisation (sync) pulse as much as possible the line sync pulse length is made 5ms. Analysis shows that such a pulse width has a base video bandwidth of 200Hz. The frame sync pulse is made much wider than the line to make it easier to separate the two pulses in an integrating circuit. The frame pulse is thus 30ms long, which is approximately the length of one horizontal line.

The aspect ratio of the picture of 1:1 is rather an inherited standard which was originally chosen to suit the ex-radar, long-persistence cathode ray tubes first utilised in SSTV display monitors. These tubes had round faces rather than the 4:3 rectangular faces of modern tubes, thus a square picture rather than a rectangular one was more appropriate.

In order to avoid phase shift and drift problems within SSTV demodulators the video information is modulated onto a subcarrier placed within the 3kHz SSTV spectrum. The subcarrier is frequency modulated by both video and synchronising signals. The basic video frequency at black level is 1500Hz, which rises to 2300Hz at peak white.

The sync frequency of 1200Hz represents 'blacker-than-black', so that the visible raster is blanked out during retrace, when the spot returns from the end of the line on the right hand side of the screen back to the beginning of the next picture line on the left hand side. At the beginning of each frame the first 5ms line sync pulse is replaced by the 30ms frame sync pulse, during which the scanning spot resets from the bottom right of the displayed picture to the top left. Once again this flyback is visually suppressed.

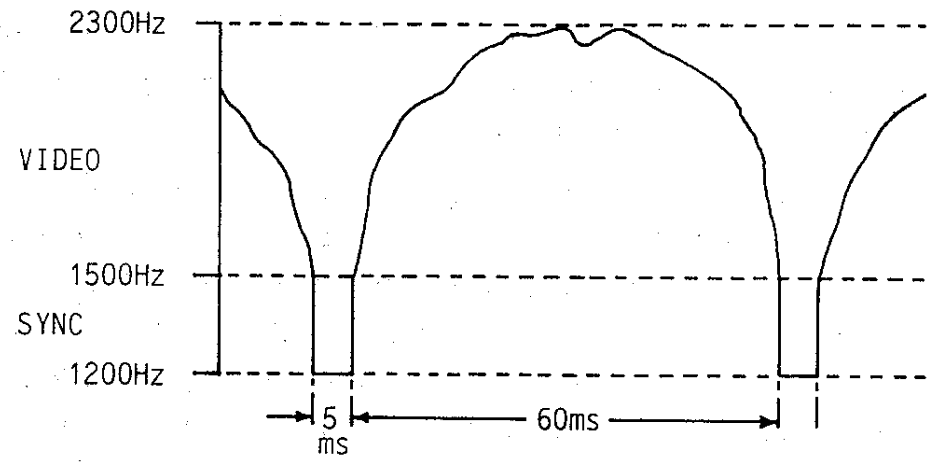

Fig.1.1: Frequency Composition of a Slow-Scan Line

The placement of the three key modulating signals is shown in Fig.1.1.

Band (MHz)	IARU recommended Freq. (MHz)	Popular Frequencies (MHz)
3.5	3.735	3.730
7	7.040	7.040
14	14.230	14.230
21	21.340	21.340
28	28.680	28.680
144	144.500	144.500

Table 1.2: SSTV Operating frequencies

Receiving Slow-Scan Television

SSTV pictures can be received using an ordinary communications receiver or transceiver covering the popular amateur bands. No modifications are required to the receiver, although the internal IF filter should be not less than 2.5kHz wide - 3kHz for preference. The SSTV signal is extracted either from an audio line output or from a headphone jack. These signals can then be either fed to the SSTV decoder or saved onto an ordinary domestic cassettes or tape recorder for decoding at a later date. Table 1.2 on page-3 shows the amateur bands used for SSTV as well as the IARU recommended working frequencies and those frequencies which are perhaps most often used. The mode of transmission may be either SSB or FM.

Equipment

Broadly speaking there are three methods by which a slow-scan picture can be displayed:

1) A conventional monitor containing an integral long-persistence cathode ray tube (CRT) together with signal processing and deflection circuits.

2) A digital scan converter, whereby the received signal is digitised and stored in a memory. The memory is then scanned at fast-scan (625 or 525-lines) rate for displaying on a conventional TV set or monitor.

3) A computer which processes the picture either directly or via a hardware interface.

The Monitor: The basic principle of all SSTV monitors is the same. The audio signal from a receiver is a frequency modulated subcarrier, therefore FM detection is required. As with conventional FM receivers a good limiter is required ahead of the discriminator to help eliminate AM noise, etc., and to present a constant amplitude to the demodulator.

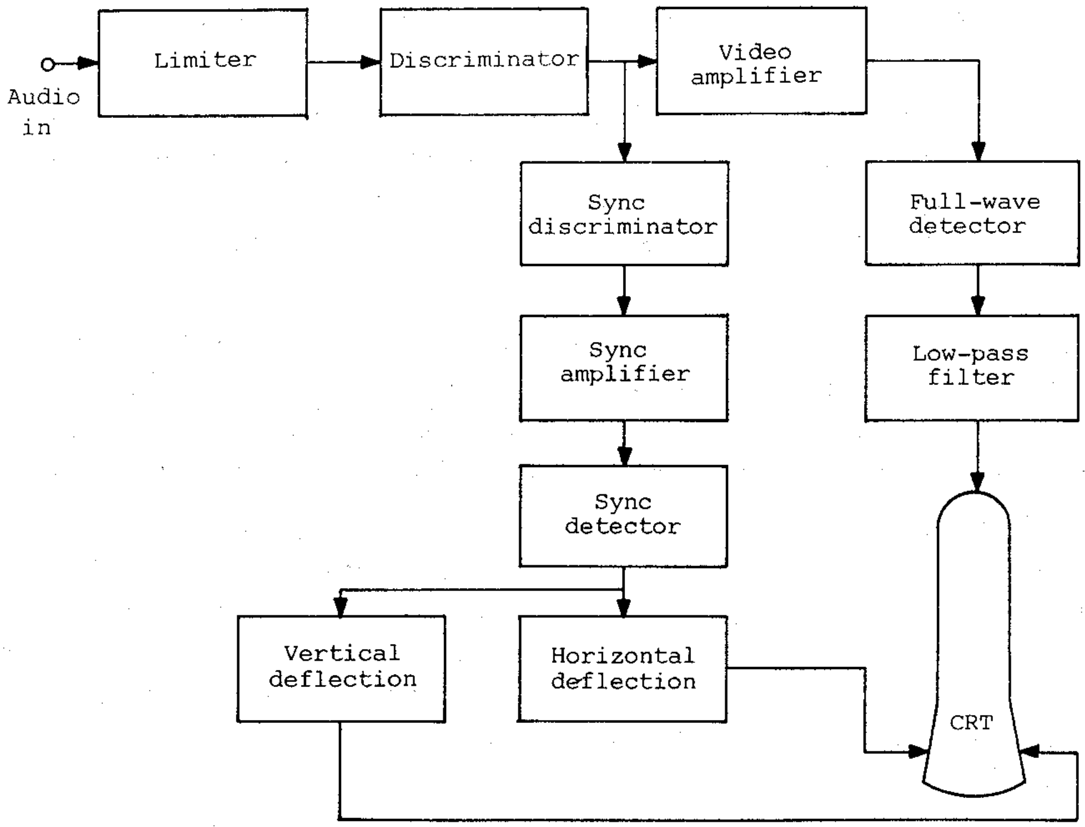

Fig.1.2: Block Diagram of a Slow-Scan TV Monitor

The discriminator changes the FM signal to an AM one, however, it is important to realise that the waveform still consists of a subcarrier centred around 1500Hz. The sync signal is recovered by using a tuned circuit sync discriminator, which can be adjusted to accentuate its amplitude in order that both vertical and horizontal pulses can be recovered by threshold detectors.

The AM subcarrier signals will need to be detected to recover the original baseband video and sync signals. Full-wave rectification is most often used because the design of the necessary post detection filter is eased.

The deflection circuits are controlled by the sync pulses, to provide a raster on the screen in the same way as a conventional TV set. However, in simpler designs no internal generator is provided to scan out a raster in the absence of received syncs. When using this type of monitor one must take care that a stationary scanning spot does not burn the CRT phosphor and, ideally, some form of spot suppression should be employed. The baseband video signal itself is filtered and used to bright up the CRT in the normal manner. A block diagram of a slow-scan monitor is shown in Fig.1.2, and a design may be found in [1].

A Digital Scan Converter: It is only in recent years that digital techniques and devices, especially memories, have come within the reach of amateurs. The main reason for adopting this technique in a receiver is to enable a domestic TV set (or monitor) to display the slow-scan pictures. The benefits will be realised by those who have experienced conventional slow-scan monitors as described in the previous section. With these the picture starts to fade at the top of the frame as it was being traced out, and because it is not possible to easily increase the overall brightness and persistence of the image, it became necessary to view pictures in subdued room lighting. Also the reception of colour transmissions is very difficult on such a monitor and necessitates several frames of each of the three primary colours, each viewed through an appropriate colour filter and recorded on film to photographically build up the full colour picture - hardly practical.

Although there are several methods of accomplishing digital frame store and scan conversion, the method described here is typical. Shift registers are now considered obsolete, Read Only Memory (RAM) is used nowadays, however, for the ease of explanation shift registers are referred to. It should be noted that dynamic RAM addressed by a clock and address lines is not equivalent to a shift register.

A block diagram of a simplified SSTV scan converter is shown above in Fig.1.3. As with a conventional monitor the incoming signal is limited to provide a constant amplitude signal. This is then passed to an

Analogue-to-Digital (A-D) converter, whose purpose is to digitise each line of information into 128 4-bit binary words. Two 512-bit shift registers act as buffer stores, the digital information for the first slow-scan line being stored in the odd-line buffer, which is controlled by a slow-speed clock. The storage operation takes 60ms, the length of a slow-scan line. The second line is stored in the even-line buffer but, whilst this is going on, the first line is being loaded into the main memory bank.

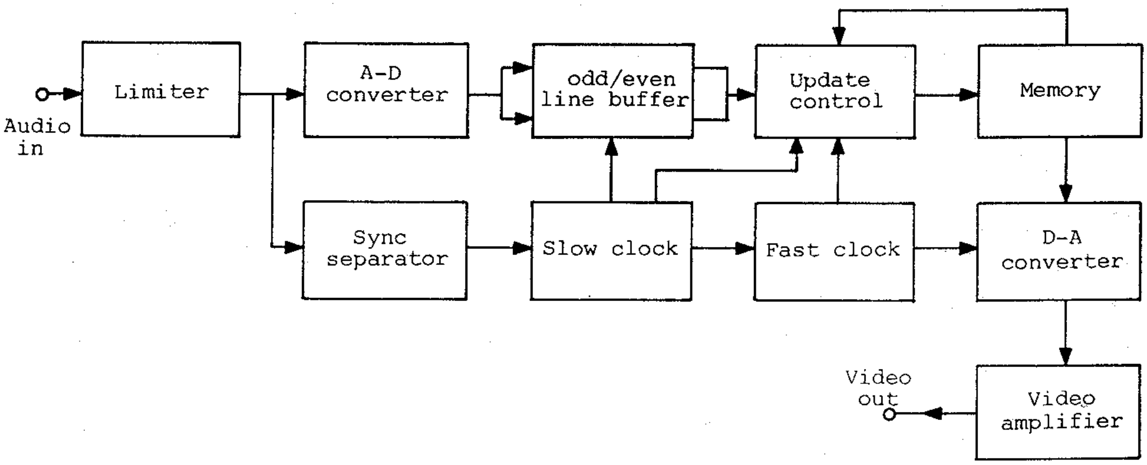

Fig.1.3: Simplified Block Diagram of an SSTV Scan Converter

The main memory consists of a set of four shift registers, each of which handles one bit of the 4-bit word. because the whole TV frame is made up of 128 lines, each containing 128 pixels, there will be a total of 16384 4-bit words, thus each shift register must have a capacity of 16k bits. The memory is continually scanned at fast-scan rate and the information passed to a Digital-to-Analogue (D-A) converter to bring it to a baseband video signal. The video is mixed with fast-scan syncs and either fed out to a monitor, or used to drive a UHF modulator so that it may be viewed on a domestic TV set. A continuous picture is displayed on the TV screen, the beauty of which is that it stays there until a new SSTV frame is received, which slowly replaces the first picture as it progresses down the screen. Of course, any picture may also be stored on the screen for a long as you wish by disabling the input to the scan converter.

Naturally, there is a difference in aspect ratio between the two TV systems; SSTV having a 1:1 ratio, whilst FSTV has a 4:3 ratio. If this were left uncorrected it would result in distortion of the displayed picture, so arrangements are made within the scan converter to blank out the first and last eighths of each fast-scan line, resulting in a square SSTV picture framed by a completely black border on either side. This does not detract from the presentation of the picture on the screen.

Designs for an SSTV receive converter appears in Chapter 5. A design can also be found in [4].

Computerised SSTV

Most personal computers, including of course the ubiquitous PC, are capable of being employed as SSTV receivers and picture generators. Most systems presently in use require some form of hardware interface between the computer and the radio receiver, apart from systems running on the Sinclair Spectrum, which are generally software only SSTV receive systems.

One of the main reasons for using a computer is to make use of the relatively large amount of memory available, as well as taking advantage of the excellent display facilities. Of course, once the information is in the computer's memory it is relatively simple to manipulate it in various ways to provide extra facilities and effects.

As just about all the computer SSTV packages are actually transceive systems, a short review of one or two of them appears in the Transmitting SSTV section following this.

Transmitting Slow-Scan Television

Sending SSTV pictures over the air is quite straightforward. an ordinary HF or VHF transmitter or transceiver can be used and the combined SSTV signal is simply fed into the microphone socket. The band in which you are operating largely dictates the mode of emission and sideband convention, although both SSB and FM are used on VHF.

No modifications to the transmitter are necessary, however, when using SSB there is one very important factor to be borne in mind: Transmitting ordinary speech using SSB means that the maximum power output is only reached at speech peaks, therefore the duty cycle for the power amplifier is fairly low, enabling it to be run harder whilst not overheating.

An SSTV signal, however, transmitted in the same way produces a 100% duty cycle, due to the presence of the subcarrier. When transmitting slow-scan via SSB therefore you must turn down the audio gain so that the transmitter output stages are operating within their recommended limits.

Picture Sources

The most popular slow-scan picture sources are: computers, electronic patter generators, keyboards, digital scan converters with fast-scan cameras, sampling cameras and flying spot scanners.

Computers: Computers can be used to generate both graphic pictures and text, which can of course be saved to disc for later use. As will be discussed later, computers can also form the basis of the SSTV system, rather than just being the picture generator.

Pattern Generators: It is quite easy to make small logic circuits to produce such patterns as grey scale, chequer board, horizontal and vertical bars, grille, etc., but in their simple form these patterns are of only limited use, because personalisation cannot easily be added to them. Such patterns nevertheless do have considerable value in providing test signals to help in aligning equipment.

Keyboards: The keyboard is an electronic typewriter, on which you can type a message which will be output as a combined slow-scan TV picture ready for transmission. These units were very popular some years ago and are still quite widely used, however, SSTV is a visual medium and it is generally considered bad form to conduct and entire QSO using keyboards. They are though an excellent way of titling and captioning within a QSO.

Digital Scan Converters: The digital scan converter for transmission is similar in principle to the one described in the earlier section dealing with receiving SSTV. The transmitting system has to accept a fast-scan picture, store it and then scan the memory at SSTV rate in order to provide a slow-scan picture. In practice only samples of the fast-scan picture are stored in memory, since to store all of it - in high resolution - would take a considerable amount of memory capacity which would be very wasteful. In use the scan converter ‘snatches’ a frame of video and stores it, then waits until the slow-scan picture has been transmitted before snatching the next frame. Construction projects for SSTV transmit converters may be found in Chapters 5 and 6, and also in [4].

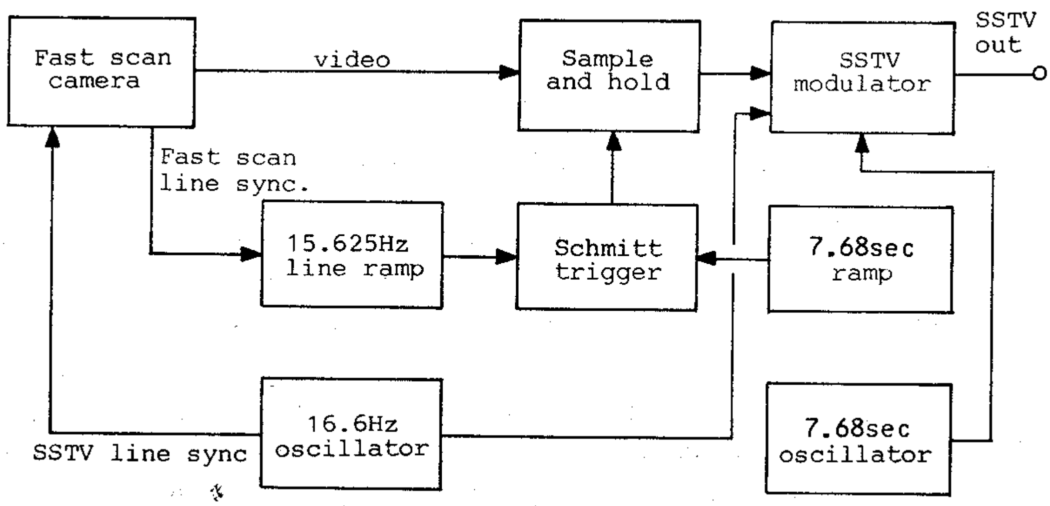

Fig.1.4: Block Diagram of a Sampling Camera System

Slow-Scan Camera: Cameras which actually scan a vidicon tube at slow-scan rates are not often used these days. The tube essentially stores a latent image, so that a mechanical shutter may be used to ‘freeze’ the action at the beginning of a scanning period, with the image being read off during the remainder of the scan.

Sampling Camera: A sampling camera is essentially a conventional vidicon camera, operating in a near-conventional manner, but having the actual video information sampled in order to produce a slow-scan picture. The normal (UK) fast-scan standards call for a line frequency of 15.625kHz and a frame speed of 50Hz. If one turns the camera on to its right side then the 50Hz scan now becomes horizontal, dividing this rate by three results in the correct slow-scan line speed. The modification required is normally to either drive the camera’s frame sync circuit with external slow-scan line syncs, or, in the case of a camera with internal synchronisation, alter the value of the timing circuit of the oscillator (usually by raising the capacitor value) to obtain the correct speed. A block diagram of a sampling camera is shown below in Fig.1.4.

The fast-scan line (now running along the vertical axis) is sampled many times during the slow-scan frame period, and the resulting video is used to produce the slow-scan image. Of course, since a part of every fast-scan frame is sampled, it follows that in order to produce a complete slow-scan picture the subject must remain stationary for the duration of the slow-scan frame. The output from such a camera is fed direct to the transmitter microphone socket.

Flying Spot Scanners: It must be said, that equipping oneself with a live slow-scan camera is neither straightforward nor cheap. There is, however, one method of generating slow-scan pictures from photographs, slides, or pictures, which may appeal to the home constructor, this is the flying spot scanner. Again, the output of this unit is fed direct to the transmitter microphone socket.

The principle of the flying spot scanner is shown in the block diagram overleaf in Fig.1.5. With the aid of slow-scan deflection circuitry a raster is produced on the face of a small magnetic or electrostatic CRT. The raster is actually a fast moving spot of light, which is used to scan the picture to be transmitted. This can be accomplished by placing a photographic transparency onto the face of the tube, allowing the light to shine through it and be picked up by a photo multiplier.

Another method is to use a lens system to focus the raster spot onto a photograph or drawing and pick up the reflected light with a photo multiplier. In both methods the brightness of the light produced fluctuates depending upon the part of the picture being scanned.

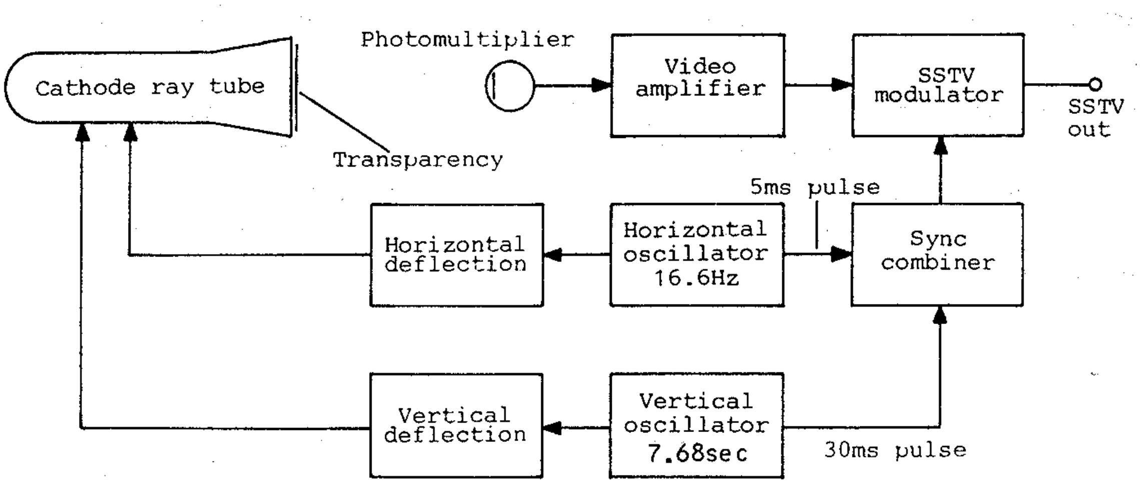

Fig.1.5: Block Diagram of a Flying Spot Scanner

A sensitive photo multiplier tube, often a 931A, is used to pick up the light and convert it to a voltage which is proportional to the amount of light falling on its sensor. A photo multiplier is generally used because it is so constructed that it provides a considerable amount of internal amplification, thus the following amplification stages are kept to a minimum. It does, however, need a rather high voltage (up to 1000V) to operate and therefore many constructors prefer to use modern solid state image sensors. A design for a flying spot scanner may be found in [5].

Commercial Systems

So far we have been discussing mainly home-brew equipment, however, there are several commercially built items of SSTV equipment that are available both new and second hand. The principal manufacturers are Robot Research Inc., Davtrend Ltd. and Wraase Elektronik, although there are one or two very new units coming onto the market as this book is being written, the most notable being the Superscan 2001 available from Jad Bashour.

Robot Research Inc. have produced many SSTV converters throughout the years and the latest version is the model 1200C colour scan converter. This is a sophisticated microprocessor based high resolution video scan converter and image processor which enables the reception and transmission of SSTV signals with a great deal of ease. The picture source may be any fast-scan unit, such as a camera, camcorder, VCR, etc., in black and white or colour. Hard copies of received pictures can be produced if a suitable printer is connected to the converter. With this unit all you need to receive and transmit SSTV is your transceiver.

There are many other models that have been produced by Robot in the past and most feature full transmit and receive capabilities, although some are only black and white models. Further details of other models produced by Robot can be found in Chapter 4.

Davtrend Ltd. produce their SSTV units under the name of DRAE. Their initial unit was called the ‘DRAE Slow Scan’ unit and was for reception of SSTV signals only. However, provision has been made on the circuit board for the installation of a transmit board. A certain amount of setting up of the internal controls has to be carried out to achieve correct results when this is done, but the manufacturer’s instructions are quite precise. The overall operation of the converter is quite acceptable and the quality of pictures received and transmitted are comparable to other units having similar facilities.

Wraase Elektronic produce a range of SSTV scan converters including the SC-1 and its later versions. This converter is a portable dual-mode unit, for SSTV and FAX. Also available as optional extras are a colour graphics keyboard, a video light pen, a printer interface and a fast-scan camera interface for ‘snatching’ pictures for transmission. Further details of this unit can be found in Chapter 4.

The Superscan 2001 from Jad Bashour has only just been released on the market as this book is being compiled. The unit is supplied in kit form and is a state-of-the-art SSTV and FAX scan converter. It is compatible with all current SSTV systems and has been designed with upgrading in mind and can accept a 1MBit EPROM, allowing compatibility with any new modes for the foreseeable future, with software updates. The video input source can be from any colour or black and white camera, etc., and the received picture can be displayed on a standard RGB analogue monitor. Further information on this unit can be found in Chapter 4.

Software Systems

Finally, in our introduction to the world of slow-scan television, we must go into a little detail of the numerous software and computer-based SSTV systems available, especially as this method of receiving and transmitting SSTV is perhaps becoming the most widely used as time goes by. Full details of the systems mentioned below, and other computerised SSTV packages, can be found in Chapter 8.

Just about every home computer ever made has a software or software/hardware SSTV receive or transceive system written and designed for it. However, during the past ten years computer makes have come and gone, leaving the stalwart few models whose pedigree has stood the test of time. The most noticeable computers for SSTV use are the Spectrum, BBC, Atari, Amiga and, rapidly coming up from behind, of course the PC and all its derivatives.

The Sinclair Spectrum, although rather limited in this application, can provide perhaps the simplest (and cheapest) SSTV station of all, especially since it may not need any hardware interfacing between the computer and the radio equipment. Technical Software produce one of the better software packages for the Spectrum called the RX-4 Multimode Receive Program. As its name implies it operates in four modes, SSTV, RTTY, Morse and Amtor and is a receive only system which operates without the need for any interface between the receiver and the computer. The system allows for the reception of black and white or colour pictures. Frame sequential colour pictures are displayed as a set of monochrome frames, whilst line sequential pictures are displayed in colour. Received pictures can be stored in memory, to disc or tape, or dumped printer. This package is also available for the BBC and Commodore CBM64 computers, for which an additional hardware interface is required.

The Atari and Amiga computer are of course in a totally different league to the Spectrum, BBC, etc. For a start they are 16-bit machines with greatly enhanced operating systems and vast (by comparison) amounts of memory available. As a consequence there are quite a few SSTV systems available for each. One of the major Atari ST packages is available from A & A Engineering and comprises a set of printed circuit boards and the software package. The system is highly versatile and allows both reception and transmission of SSTV pictures in a variety of modes. The facilities available are far too numerous to mention here, suffice it to say that if the Atari can do it, so can this package.

The Amiga computer also has some extremely good SSTV software available for it, and taking into account the superb graphics capabilities of this machine, superb results can be obtained. One such system is the AVT package. The Amiga Video Terminal is available from ICS Ltd., and claims to support all the SSTV modes, including the NewModes (M1, M2, S1 and S2 - see Chapter 2) and also 60, 120 and 240-line analogue Faximile transmissions (not office type digital Fax). The system consists of a small interface unit and the software, the interface requiring a separate 12V supply of around 150mA.

Finally, the PC and its clones are now being supported with an on-board SSTV system that may possibly sound the death knoll for many of the other systems, both computer based and other. Details of the Pasokon TV system are only just being released as this book is being compiled. However, the basic outline of the system is: send and receive all popular modes including Robot Colour and B&W, AVT, Martin, Scottie and Wraase, with speeds up to 188 seconds in some modes. The interface is an internal card which fits into a spare slot on the PC motherboard. The software reads and writes popular image formats (I assume .TIF, .GIF, .PCX, etc.) and incorporates a graphical user interface with mouse support. There is an on-screen tuning indicator, test pattern generation and image manipulation, with full VGA and SVGA screen support. At the outset this appears to be the best computer based system yet.

As mentioned earlier, further details of the above computerised SSTV systems and others can be found in Chapter 8.

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[1] ‘‘W4TB Simplified Electrostatic Monitor’’ and ‘‘W6MXV High Performance magnetic deflection SSTV monitor (5FP7 tube)’’: Slow Scan television Handbook by W9NTP and WB8DQT, *published by 73 Magazine.*

[2] ‘‘A basic solid-state slow-scan television monitor’’, by WB8DQT: *73 Magazine August 1973.*

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[5] ‘‘A simple solid-state flying spot scanner for SSTV, by WB8DQT: *73 Magazine July 1972.*

Modes and Systems

Monochrome SSTV Modes

Introduction and general comments

The mode first used to transmit pictures by Slow Scan Television (SSTV) dates back to the time when the only display storage available was the long persistence radar CRT available on the surplus market. A frame time of 7/8 seconds was chosen because it was the slowest sweep speed where the top part of the display had not complexly faded and was just visible, when the scan had reached the bottom. Thus it was possible to just see a complete frame provided a darkened room was used for viewing.

Both the 7 second and 8 second standard have been used for some time, the 7 second frame being used in Europe where the 50Hz mains frequency could be divided by three to produce a line time of 60ms, and in U.S.A. the 60Hz mains frequency was divided by four to give a 67ms line time.

This system was used because early SSTV monitors were very crude devices by comparison with a modern scan convertor but the two standards remain, although the 8 second mode is probably the most widely used today. The very first SSTV transmissions used amplitude modulation but this was soon replaced by frequency shift with 1500Hz representing black, 2300Hz for white and 1200Hz being used for line and frame sync. These frequencies are used with only slight variations for all the currently used SSTV modes.

The following is a more detailed look at the various modes in use today and in the past.

The 7/8 second monochrome mode

The 7/8 second mode still has the advantage of being the most basic of all modes and can therefore be received by any SSTV station in the world irrespective of the equipment being used, and allows getting a picture across in the shortest possible time. Because of this it is normal operating practice to send multiple frames, either the same or to produce a slide-show effect.

However, there are now many disadvantages to this crude form of SSTV, firstly, the rather poor resolution obtained with just 120/128 lines, secondly the image will be broken up if there is any interference to the sync frequency.

High resolution monochrome SSTV

The now wide-spread use of digital scan convertors, which store the SSTV image in a computer type memory, no longer have the 7/8 second time limit as the image can be stored for as long as the power is on. It is now possible to extend the transmission time to give improved vertical resolution using 256 (or more) lines and to increase the time taken for sending each line to produce a higher resolution in the horizontal direction also.

Currently the 16 second 128 line system and the 32 second 256 line systems are used, but also the 64 second 256 line mode is now also used by some SSTV stations to get super quality. The above modes are all related to the basic 8 second 128 line system by simply doubling the line transmission time, or by doubling the number of lines or both, with the 64 second the line time of the 32 second mode is doubled to give even greater horizontal resolution.

However, the situation has now become rather confused because there are also several other line speeds and number of vertical lines per frame that can be used. These other modes are spin-offs from colour modes and are thankfully rarely used, but for completeness, there are the monochrome versions of the Robot colour modes which are as follows, 12 second 120 line, 24 second 240 line and 36 second 240 line modes.

Similarly, there is a monochrome version of the AVT mode which takes 125 seconds for a 200 line picture, which gives superb quality even if the picture is rather narrow like cinemascope, the timing approaches that of fax transmissions and like fax no line sync pulses are used as the system relies on accurate line timing at both ends for fully synchronous operation. Both the Robot and AVT systems are fully described in the section dealing with colour SSTV.

The advantages of these long transmission time monochrome systems is that they give considerably improved picture quality over the original 7/8 second mode, and those modes where synchronous, or free run, operation is used are much less effected by interference especially at the 1200Hz sync frequency. Furthermore, the modes are still reasonably simple so that home built scan convertors or computers with suitable software, can be easily adapted to work with most of the currently available modes. The disadvantage is that these high resolution modes take a lot of transmission time, which could be used more effectively to produce a colour image, which is likely to convey more information than even the most detailed monochrome picture. it is for this reason that colour SSTV has become so much more wide spread.

Colour SSTV Modes

Introduction and general comments

The very first colour SSTV transmissions consisted of sending red, green and blue colour separations using the 7/8 second monochrome system. The received images were stored in three separate display memories in the colour scan convertor, and displayed simultaneously on a suitable colour monitor, or converted domestic colour TV. The results were reasonably satisfactory providing the original colour separations had been produced with the correct colour filters and under suitable lighting conditions, colour cameras being rather rare at the time when these experiments were taking place.

Because of the unreliability of amateur radio as a communications medium, due to interference and fading, etc., it was usual to transmit more than one frame of each colour, soon three frames of each, red green and blue became the standard. In practice it was often difficult to get all three colour frames received correctly and in perfect registration, leading to requests from the receiving station to retransmit one or more of the colour separations. It was because of these problems and because a colour image could only be seen when all three separations had been received, that lead to the change to line sequential colour SSTV transmission. All the currently used colour SSTV transmission modes are based to some extent or another on the line sequential system where a complete colour line is transmitted as a set of components which are sent sequentially and produce one complete colour line on the receiving stations monitor screen, before the next colour line is transmitted.

There are as many variations on this theme as there are workers in the colour SSTV scene, however the simple red, green and blue colour separated lines are most commonly used. The various modes will be described highlighting their advantages and disadvantages, but it is left to the individual operator to make his or her own choice as to which mode to use on any particular occasion, suffice it to say that all the following modes are to be currently heard on the SSTV frequencies.

Although some modes are definitely used more than others in certain areas of the world, so far there does not seem to be an absolute favourite, so it is necessary to be equipped for all these modes for complete compatibility with all colour SSTV stations.

The Wraase SC-1 line sequential system

This system is the survivor out of several almost identical line sequential systems that followed the frame sequential system. The SC-1 system uses line sequential colour separations starting with a green line after the frame sync pulse followed by the blue and red lines. It was probably intended to use the more conventional red, green and blue colour sequence, but a design fault in the hardware of the SC-1 caused the red line after the frame sync pulse to be actually swallowed up by the frame sync pulse, but the receive side seemed to have been adjusted to correct for the strange sequence. This system is very closely related to the 8 second monochrome system having a conventional line sync pulse of about 6ms between each coloured line, presumably done by simply modifying existing hardware designs. However, this is the biggest downfall of this system because if the receiver should loose (or gain) a line sync pulse due to interference of any kind, then the receiver will loose colour synchronisation causing some very peculiar coloured pictures.

As all three colour separated lines are transmitted in the same form there is a one in three chance of getting back into correct colour synchronisation. This lead to the introduction of the "Red line sync" which was added to later production SC-1 scan convertors. This consisted of a shortened line sync pulse of 5ms before a red line immediately followed by a short burst of 2300Hz for 1 to 2ms, which allowed the receiving scan convertor to regain sync after interference had caused colour sync to be lost. In practice the system works, but if interference levels are high the received picture is likely to have many coloured bands, where colour synchronisation has been lost and regained, a process which often takes some several coloured lines to achieve. The original SC-1 mode was 24 sec for a 128 line frame so the picture quality was no better than the 8 second monochrome except the colour really made a very great difference by comparison to the monochrome pictures. The mode was soon expanded into longer transmission forms by first doubling the number of lines to 256 giving a 48 second line time. Also a 48 second 128 line mode, known as "quasi 48" is also used giving improved horizontal resolution, but the 96 second 256 line "quasi 96" gives very impressive colour pictures provided no interference causes loss of colour lock.

The "Martin" Synchronous Mode

This mode, which was originally called ``New Mode'', but to avoid confusion with other new modes that have come along subsequently, has now been universally named, by it's users, after the originator Martin Emmerson G3OQD. The mode was developed to overcome the problems with the earlier line sequential colour systems like the SC-1 mode. There were two significant changes introduced, firstly, instead of transmitting a line sync pulse before each colour separated line, just one line sync pulse is sent before the green line which is then followed after a short gap by the blue line and finally after another short gap by the red line. This colour sequence was chosen as it adhered to the established standard used by the SC-1 of green, blue and red, but there is no other particular advantage in using this sequence over any other possible colour sequence.

The most important feature is the use of only one line sync pulse at the start of each colour sequence, this makes it impossible for the receiving scan convertor to get confused as to which colour line is being transmitted, as only one line sync pulse is sent for each complete colour line. The time intervals where line sync pulses are no longer transmitted are filled with reference black level at 1500Hz. However, interference near the sync frequency of 1200Hz can still cause loss of line sync and areas of the picture to become corrupted, but using this mode, sync will be regained as soon as the signal to noise ratio is sufficient for the sync pulses to be received reliably.

Although this was an immense step forward, a second improvement was made so that after initial synchronisation at the start of a frame, line sync pulses are no longer required. To allow this to be possible it has been necessary to make the line timing of the transmit and receive scan convertor extremely accurate so that fully synchronous operation could be used once the picture has started, in a rather similar fashion to a facsimile transmission. When working in the fully synchronous mode, even a complete loss of sync pulses due to interference at or near the 1200Hz sync frequency would cause no loss of colour integrity or horizontal synchronisation.

The results using this system demonstrate pictures with much sharper vertical edges, although phase distortion often found during darkness hours on the low frequency bands can still causes a degree of picture degradation, but conventional modes relying on line sync pulses are completely unusable under these conditions. This system, which was originally implemented as a modification to the Robot 1200c, has been further improved in the most recent version by further enhancing the resolution of the received image. This is achieved by receiving each line at 512 pixels which is twice the horizontal resolution of the frame store. The high resolution received line is stored temporarily in computer memory where it is processed using a software algorithm down to half the resolution, with minimum loss in quality, and then written to the display memory.

The Martin mode can operate at four different speeds, the slowest and higher quality modes use 256 lines for each frame, but the two faster modes using just 128 lines can give remarkably good quality and are useful where transmission time needs to be kept to a minimum. The line sync pulses and inter colour line gaps are the same duration for all speeds but the active line time and total number of lines for a frame, are both factor of two different between speeds giving the total combination of four. The slowest speed of about 114 seconds seems to have become the most popular, and although the line sync pulses are not normally required after the picture start they are still transmitted at the start of each line throughout the frame. This allows the picture to be re-synchronised should interference have been present when the picture started or if the receiving station should happen to tune onto the SSTV transmission some point during the frame time. This feature can be very useful when the transmission time is very long as a partial picture can reveal the transmitting stations identity and anyway part of a picture is better than no picture at all.

The ``Scottie” Mode

The Scottie was developed by E.T.J.Murphy GM3SBC and is a modification to the original SC-1 software as implemented on the Robot 1200c by G3OQD. This mode has many of the features of the Martin mode except that the line sequence is altered and the line timing and hence frame time are different. Following the frame sync pulse the first line transmitted is green followed by a gap and then blue which is followed, rather strangely, by a line sync pulse and finally red completes the line. This rather odd sequence results from adapting the SC-1 software where the sync on red has been retained, but the line sync pulses before the other coloured lines have been replaced by gaps of black level. Line sync pulses are used for reception throughout the frame and thus interference to the sync frequency can still cause picture degradation. However, a later enhancement is the "Intelligent Receive" and "Super Intelligent Receive". These systems relied on making the line transmission time more accurate, as in the Martin mode, however, unlike the Martin mode, the line sync pulse is still received and processed in software so that even a severely corrupted sync pulse is adequate to maintain sync and colour integrity. Nevertheless, a complete loss of sync for any reason will cause the receiving scan convertor to lose sync and it may take several lines to regain sync when the pulses are once again reasonably well received.

Again, the Scottie mode exists in four speeds, two with 256 lines per frame and two with 128 lines. The horizontal line timing between speeds is however not a factor of two, in fact the faster speed is slightly slower than half the slower speeds. The performance of the Scottie mode and Martin mode are extremely similar, speed for speed, especially as it is also possible to receive the Scottie mode fully synchronously or "free run mode", which is used as standard in the Martin mode. Theoretically the slowest Martin mode should be slightly better than the slowest Scottie mode as it is just slightly slower, a longer transmission giving a better received picture. In practice there is not a lot to choose between these two modes although there those who prefer one mode over the other.

The Scottie "DX mode"

This version of the Scottie mode is simply a much slower, about two and a half times, version of the standard Scottie mode described above. Only the active line time is lengthened, the line sync and gap durations remain the same. The improvement in performance is partly obtained at the receiving end, but also inherent in the fact that a longer transmission time will give improved picture quality, which is why high quality facsimile transmissions take so long.

The improvements comes about because each pixel making up the picture contains many more cycles of the tone frequency used for transmission. Thus, any corruption of some cycles will have less effect on the whole. Also, as each pixel will occupy a greater length of time, any transmission timing differences due to path length variations due to changing propagation (height of reflective layer) will represent a smaller fraction of a pixel time. This gives a much greater immunity to phase distortion at the expense of much greater transmission time of about four and a half minutes, long enough to send at least two pictures using the slowest of any other existing mode.

The longer transmission time also allows further improvements in quality by providing the necessary time to implement special receiving software algorithms similar to those used to enhance the Martin mode. The DX mode undoubtedly gives the ultimate in received picture quality provided the long transmission time is not a problem, especially on DX paths which may not always stay open long enough for one picture, let alone allowing everyone on a large net the chance of sending a picture.

The "AVT" Mode

The Amiga Video Transceiver mode was originally implemented on the Amiga computer as a mainly software system, with a special add on hardware interface. Although initially heralded as a major breakthrough in SSTV transmission systems, it has much in common with the previously described fully synchronous systems. However, it has several novel features which make it unique.

Firstly, the AVT system is a line sequential colour system using the sequence of red, green and blue, but this time with no black reference gaps between and more interestingly no sync pulses either. The interesting and unique feature, is that all the necessary synchronisation information is sent as a digital header before the picture actually starts. The digital header contains coded information in the form of a sequence of thirty two eight bit data bytes, which are each transmitted twice. Once normally and then with all bits inverted, so that the normal and inverted versions may be compared to check for errors in reception.

The total of sixteen bits of data (normal plus inverted version of the eight bits) is preceded with a start pulse which uses a frequency of 1900Hz, whereas the actual data uses 1600Hz for a zero and 2200Hz for a one, but in the narrow mode these are changed to 1700Hz for a zero and 2100Hz for one. The first three bits of the eight bits of data indicate the transmission speed and the last five bits are used for a count down to start of picture. It is these last five bits which give the essential timing information, because correctly receiving any one of the sequence of thirty two will give the exact time before the start of picture, because these five bits of data start at all ones (31) and decrement down to zero immediately before the picture starts. These data pulses use precise timing, such that once a correct code has been received it is only necessary for the receiving system to accurately time down from that point and then start receiving a perfectly synchronised picture at the end of this precisely timed period. The digital header takes five seconds to send, and as only one thirty-second part of it is required represents a fair amount of redundancy. Under all but the very poorest of conditions this five seconds can be considered wasted time, and if conditions are very poor, and not one of the thirty two digital signals are received correctly, then it will not be possible to subsequently synchronise the following picture as it contains no line sync pulses at all. So if all the header information is lost due to interference during the first five seconds of picture, then the picture section will not be received correctly, even if the interference stops when the actual picture part of the transmission is in progress.

It can reasonably be said that the AVT system puts all its eggs into the one basket, which is the first five seconds of transmission. However, in practice the AVT system does seem very reliable when there is interference present but inevitably there will be some lost pictures.

To further enhance its performance the AVT has two special variants to it normal mode of operation. Firstly, the narrow mode uses a reduced bandwidth of just 400Hz from 1500Hz to 1900Hz, and matched to a similar bandwidth receiving filter can result in a further immunity from interference, with an almost imperceptible loss in picture quality. Secondly, there is the "QRM" mode where the lines are sent alternately thus requiring two frame scans for a complete picture, this is exactly the same as the interlace system used in broadcast TV. In theory this mode should work well, but in practice, particularly on the HF bands where conditions can change rapidly, the second pass may be effected differently by phase distortion than the first pass. The effect of this is to cause "cogging" of the vertical lines, which can also occur if the two stations do not have precisely the same line timing. Under conditions of interference not accompanied by phase distortion, as might occur on the VHF bands, the QRM mode certainly does break up the interference effect and gives a subjectively better looking picture. The QRM mode may also be used in conjunction with the Narrow mode if required.

Once again the AVT system exists in four colour modes, but this time the number of lines per picture varies in a rather peculiar was as follows:-120 line 24 seconds, 240 lines 90 seconds, 200 lines 94 seconds and 400 lines 188 seconds. In summary, the AVT system gives reliable results most of the time with the picture quality of the 94 second mode being equal to the slowest of the Martin mode pictures, even if the picture is rather narrow by comparison. The five second digital header coupled with sending the VIS signal three times, is real belt-and-braces, but on the occasions it fails it is very difficult to manually re-sync the receiving scan convertor to the incoming picture.

The SC-2 Free Run Mode

This new version is implemented on the new SC-2 scan convertor from Volker Wraase in Germany, and is yet another variation on the line sequential theme.

This mode departs from the sequence of colours used by the much earlier SC-1 convertor by using the more conventional red green and blue sequence. It has now been recognised that the single line sync pulse per coloured line, as instigated in the Martin and copied in the Scottie mode, is the way to go. However, an interesting deviation from the other line sequential modes has been introduced. This is to transmit the green line at half the speed to the red and blue lines so that the green section takes the same time to transmit as does the red and blue sections together, also the gaps between colours have been omitted. Presumably the idea of transmitting the green line at half the speed of the other colours is that in an average coloured picture the green separation contains over half the total information in the picture. This situation is really only true for an actual picture and pictures generated using computer graphics may differ from this quite significantly. The system is basically rather crude by comparison to the Robot composite colour system.

Apart from this the mode also has a fundamental problem, because if the picture is not received in perfect synchronisation then the colour registration between the three frames will not be correct, causing picture degradation. The other line sequential modes will only suffer from picture shift if synchronisation is not perfect but no loss of colour registration.

The transmission speeds that seem to be available on current SC-2’s is 120 second 256 line, 60 second 256 line and 30 second 128 line per frame, and no VIS signal is transmitted on this or any the other modes available on the SC-2 or the earlier SC-1. 2.7) The Robot modes are so named as they were first implemented on the Robot 450c and on the 1200c colour scan convertors produced by Robot Research Inc. in California U.S.A. The Robot mode is unique amongst the line sequential systems as it does not transmit red green and blue colour separations directly, but encodes the three primaries into a luminance signal which gives a good monochrome version of the picture, and two colour difference signals carrying the colour information. The luminance line signal is sent first after a conventional line sync pulse of 1200Hz, this is followed by both colour difference line components in format 2. In format 1 only one colour difference is sent after the luminance line, the other colour difference line being sent on the alternate lines.

The use of only one normal sync pulse at the start of each composite line ensures colour integrity, especially as the two colour difference signals also have special sync pulses, one at 1500Hz and the other at 2300Hz. Nevertheless, the Robot system suffers loss of sync if there is any interference to the sync frequency, so has no real advantage over other systems relying on line sync pulses. A further disadvantage with the Robot mode is due to the colour encoding system which can only be decoded correctly provided the received tones are correct. Any frequency error caused by SSB stations not being exactly on the same frequency will cause the received picture to have a slight green, or pink cast. Tuning errors of this type also cause some slight degradation to the line sequential systems using simple colour separations, but in these cases it is only to the picture brightness, and not to the actual colour or hue of the picture.

The Robot modes also exist in four different speeds as follows, 12 second 120 line format 1, 24 second 120 line format 2, 36 second 240 line format 1, and 72 second 240 line format 2. The format 2 modes give superior colour reproduction and the slower speeds have the best resolution and hence picture quality.

Although the presence of the luminance component of each line should give compatibility with stations only equipped with monochrome, in practice only the 12 second colour speed has an equivalent in the currently used monochrome modes which is the original 8 second mode, and even so compatibility with 7 second European monochrome is rather unreliable, so, really full compatibility only exists with other Robot equipment.

The Vertical Interval Signal (VIS)

Robot were also the first to introduce Vertical Interval Signalling (VIS) to their equipment, although the idea had already been suggested by other workers in the SSTV field. The VIS signal is a digital code which is transmitted as part of the vertical sync pulse, and consists of a 1200Hz start tone followed by seven data bits and an eighth bit for parity. A frequency of 1300Hz represents a zero whilst 1100Hz is used for a one, and the duration of all data bits is 30ms.

Using these tone frequencies for the VIS signal will not cause any problem with equipment not being able to recognise the VIS as it will just appear as a rather long frame sync pulse.

There are a 128 possible combinations of the seven data bits forming the VIS code, and this fact has enabled other SSTV modes to use some of the spare code combinations unused by the original Robot system. All the other colour modes described above, except SC-2 at the moment, have been allocated previously unused codes.

However, due to a lack of collaboration and information exchange between some of the workers in SSTV two modes have unfortunately been allocated the same VIS code, namely the Scottie DX mode and the AVT 188 second mode. Fortunately as the DX mode takes so long to send it is not normally sent without informing the receive station that he or she is in for a long session, so in practice the SSTV fraternity have learned to live with this anomaly.

The Future

Every SSTV operator dreams of receiving perfect high resolution colour pictures, preferably with motion, under the very worst possible communications conditions. Whilst we are still a long way off from this utopia, the developments, since the original 8 second monochrome transmissions, have been very significant. SSTV is still an area of amateur radio where there is plenty of scope for future developments. It is to be hoped that many other enthusiastic and dedicated amateurs will be willing to pick up the challenge and work towards the ultimate mode, even if this does mean having many different and incompatible modes coexisting on the SSTV channels, but this is the price of progress.

Slow Scan Television Techniques

In this chapter I shall be looking at techniques used in the transmission and reception of slow-scan television, and in the generation of pictures for transmission. Taking the later aspect first, I offer no apologies for going into depth on the use of cameras and subject lighting, even though many stations are now using modern cameras, which produce high quality results under all sorts of lighting conditions without the need for any special techniques. However, there are many stations still using the techniques described below, and it may be that you are also interested in producing studio-quality pictures for transmission; either way it is useful to have an understanding at least of the techniques involved.

The SSTV Studio

The final quality of an SSTV picture should be the most important consideration in any slow-scan station, since it is by your transmissions that you are judged by others. Experienced SSTVers will no doubt have observed considerable variations in received picture quality from different stations, especially on camera shots. One of the main reasons for this is one of lighting, or the correct illumination of the subject.

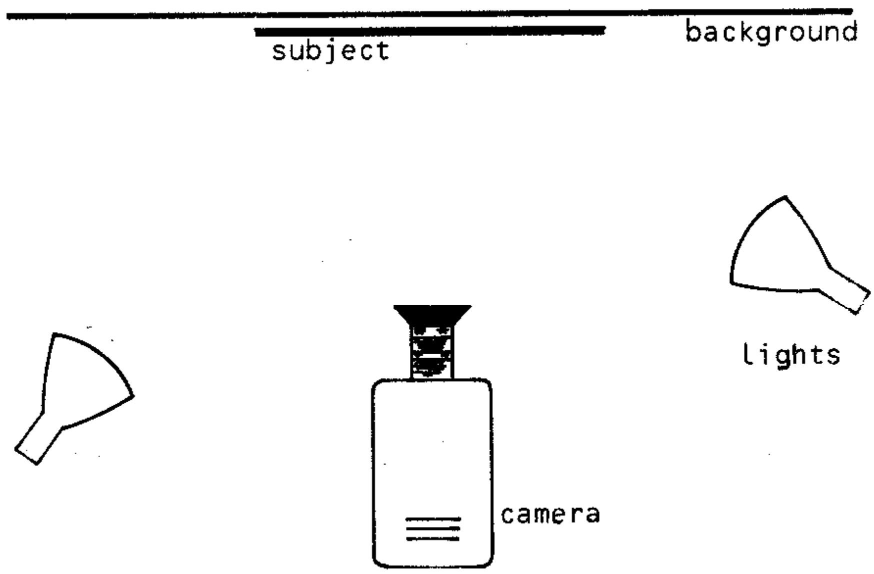


Fig.3.1: Basic Studio Lighting arrangement

A camera is normally set up and used in a ''studio''. Now this may sound very grand, but in practice a studio may be no more than a corner of the shack, or a few feet of bench space. Whatever you use as a studio it will certainly need a fixed and properly controlled lighting system.

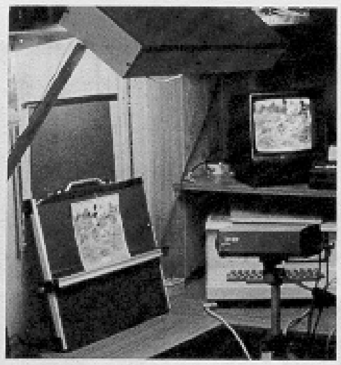
A basic studio set up is illustrated overleaf in Fig.3.1. For effective SSTV pictures a fairly bold approach to subject matter and contrast levels is required. It is perhaps best to use a matt black background, which could typically be made from a sheet of black poster card obtainable from your local stationers or art shop. The card can be about two feet square and should have some means, towards the bottom, of holding or standing caption cards and pictures. The lights are connected to a lamp dimmer (the usually household variety available from your local electrical shop) which allows for the light level to be adjusted for different subjects.

The use of a black background ensures that maximum light from the subject and not the background is returned to the camera. Having such a background also reduces the risk of light reflections feeding back to the camera. The lighting arrangement of Fig.3.1 is adequate for pictures and captions, but for three-dimensional subjects a third light can be used to good effect. This third light is often placed behind the subject, or sometimes overhead, its purpose being to provide back or top illumination to create roundness and depth, and also to produce interesting highlights. Without this third light three-dimensional subject are prone to look ''flat''.

Lighting

The amount of light required on a given subject is, of course, that which produces the best quality image in terms of contrast and detail. Generally, looking after the contrast will ensure that the detail looks after itself. If too much light is used the camera will not reproduce detail from the lighter parts of the subject, and these areas will tend to flare or ‘‘white-out’’. If too little light is used then the picture will be somewhat thin and of poor contrast.

Suitable lights for black and white SSTV can be almost any that produce a fairly white light and daylight is, of course, ideal. Photographic photoflood and spot lamps are very good, but do tend to be somewhat expensive, as well as running very hot. Also, as they age, the light tends to fall off towards the red end of the spectrum. The conventional 100W household lamps can produce good results and they are certainly a lot cheaper. Both photofloods and domestic bulbs may be controlled by a dimmer switch. Some household fluorescent tubes are satisfactory for black and white, but not for colour, although the standard fittings using ‘‘daylight’’ tubes seem very good indeed - even for colour. With any light source it should be remembered that the further away the subject is from the light source, the brighter it needs to be to produce a given picture quality. Further details on the subject of lighting for colour cameras can be found later in this chapter.

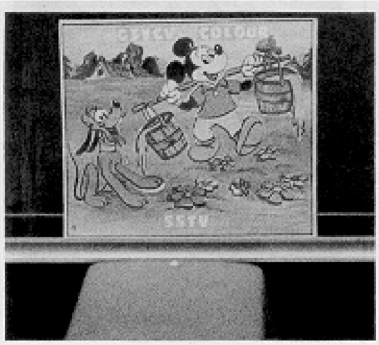


A suitable set-up for captions and printed pictures. Simple strip lighting may be used in this instance.

Setting up

Let us now go through a typical adjustment procedure for setting-up a studio for SSTV work. Firstly, you should make sure that the video camera is set according to the manufacturers’ recommendations. Since many shack cameras though are second-hand, the following general instructions may be of some assistance:

This sequence assumes that the camera is electrically correctly adjusted, that is having one volt peak-to-peak of video available at the output and that the beam current, target volts and electrical focus are correctly set. Choose a subject with some black and some white content, as well as in-between shades, and adjust the camera lens to f8. Turn on the lights and focus the lens. If a fast-scan monitor is being used its contrast control should be set for an average picture - neither fully up nor down - and the brilliance for a comfortable level. If the studio lights are turned up and down now, you should be able to adjust them for best lighting. The black parts of the picture should be truly black and the whites (you guessed it!) truly white. Once the lighting level is right, any correction needed for different subjects may be made using the aperture setting of the camera.



This caption holder has a black background and a means of supporting or fixing pictures.

A good picture shows rich blacks, brilliant whites and good in-between shades of grey.

If no fast-scan monitor is available and adjustments are being made using a slow-scan monitor, then it is important that this is previously correctly set up using a good quality recording of a 8 or 16-step greyscale, or custom-built greyscale generator such as is described in Chapter 8 of this book. When displayed on the monitor the brilliance and contrast controls should be adjusted so that there is an even graduation between white and black, and so that all of the steps of the greyscale are clearly visible.

Once the monitor has been adjusted in this way the controls **MUST NOT** be adjusted at all for any reason, as this monitor is now your standard against which everything else is set. The camera can now be set up in a similar way to that described before so that a good slow-scan picture is reproduced on the monitor.

You should now be in a position to make a number of test recordings. Use the monitor as your standard and, if the pictures look good, record them onto tape. These recordings can then be played back to confirm the quality. The various settings of lens aperture and light brilliance should be noted for later reference.

SSTV in Colour

Colour slow-scan television is a very complex subject, which is made worse by the number of different systems in use by amateurs. All these different systems have their merits and drawbacks, although the particular system used by the individual is often dictated by the equipment available. Broadly speaking, the common systems fall into ‘‘camps’’, which are usually those adopted by various SSTV equipment manufacturers. However, I shall attempt in the following section to at least give a description of the basic principles of colour SSTV.

Also, I shall be describing a system whereby a practical colour SSTV station can be set up using a black and white video camera as the picture source. Practical guidance will also be given on the use of a colour camera, in order to achieve the best results from modern digital scan converters.

Principles

Colour slow-scan television consists of breaking the colour subject down into three black and white pictures, which can be transmitted using a standard SSTV system. This process is called analysis. The three frames consist of the original colour picture viewed by the black and white camera through three filters - a red, a green and a blue one. It is a fact that three separate black and white frames, each taken through a different filter, contain all the colour information necessary to reassemble a complete colour picture at the receiving end, thus making them suitable for use with all colour SSTV systems.

The filters commonly used are the Kodak Wratten type, which are in gelatin form and should be available from most photographic shops. The filters required are :

RED - number 25, GREEN - number 58, BLUE - number 47B

Good contrast and tonal range are important in achieving the best colour pictures.

The various colour transmission systems are likely to be based on either Frame Sequential or Line Sequential techniques. However, there are other systems such as ‘‘Time Multiplexed Component Colour’’, as used in some Robot equipment, which takes advantage of the latest digital technology.

Frame Sequential Colour: This involves the use of three separate frames of the same picture, each containing red, green and blue information. These frames are transmitted in sequence and may be repeated several times to ensure that at least one good frame is received, even over a difficult transmission path.

Line Sequential Colour: Alternating red, green and blue (usually in that order) are transmitted and are synchronised by the Vertical Synchronisation Pulse.

Colour SSTV using a Black and White Camera

Making a colour picture using a black and white camera is quite straightforward. Firstly, you require a scan converter which is fitted with three memories that can be used for transmitting. The camera should be correctly adjusted as detailed previously, as should the SSTV monitor. To set the colour monitor load each of the memories with the same unfiltered grey scale and display all three memories together, adjusting contrast and brilliance for a correct display of the black and white picture (good black, good white and each step in the grey scale clearly discernable). The settings on the monitor are then left alone from this point.

Good lighting brings out some essential highlights.

Now the scan converter brilliance and contrast settings should be set to produce the best picture, after which these settings should also remain untouched. Put the scan converter memory switch to RED and place the red filter in front of the camera lens. Hold this position for two or three seconds to allow any automatic functions within the camera to settle, then load the picture into the red memory. The same procedure is adopted **WITHOUT MOVING** the camera, for the green and blue frames, after which the scan converter memory will contain the complete colour picture, but in its separated form. Now switch the scan converter to ‘‘display’’ and you should have a good colour picture on the screen.

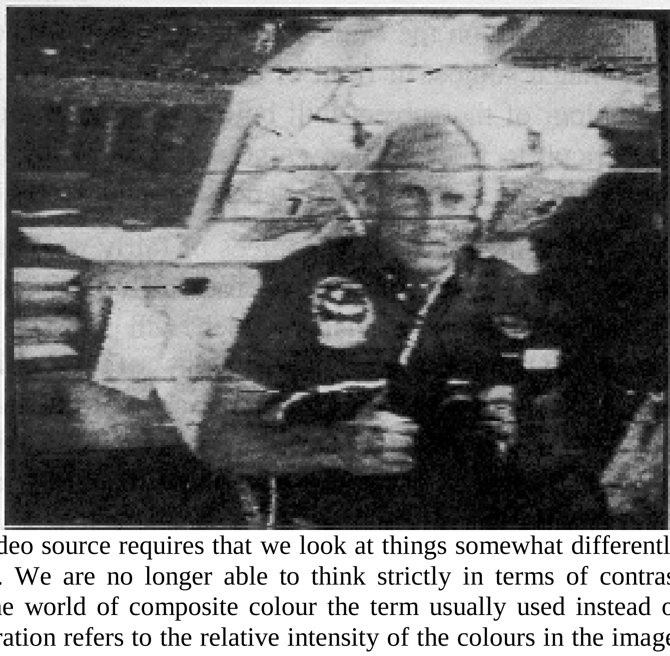
If the colours do not match the subject check the lighting and scan converter settings. After a few test pictures have been made and recorded, play them back to see how they look after being passed through the memories a few times.

Of course, once you have the colour separations in store you can transmit the pictures at will, using any of the colour systems available.

Colour SSTV using a Colour Camera

With the advent of the modern digital scan converter it is usually possible to use a colour camera directly, the converter then ‘‘snatches’’ a complete frame and automatically breaks it down into the three colour separations ready for transmission. Such a scan converter is the Robot 1200c (described in Chapter 4), and some of the information in the following section, providing guidance on the use of colour camera in this application, is reproduced from the Robot 1200c instruction manual (Appendix A) by kind permission of Robot Research Inc.

Off-screen photograph of G3NOX colour SSTV received in Scotland by GM3WOJ via meteor scatter



Off-screen photo taken direct from the Space Shuttle on 144.500MHz.

Photo G3NOX

The use of a colour television camera as a video source requires that we look at things somewhat differently than we do with a black and white camera. We are no longer able to think strictly in terms of contrast because we must now consider colour. In the world of composite colour the term usually used instead of contrast is ‘‘Colour Saturation’’. Colour saturation refers to the relative intensity of the colours in the image. An image with relatively subdues colours is said to have low colour saturation, whilst a brightly coloured image is described as having high colour saturation.

Colour intensity, or saturation, is only one aspect of colour quality. Another factor, perhaps the most important in colour work, is HUE. Also referred to as TINT or PHASE, HUE is colour itself. Thus, red, green, blue, orange, etc., are different HUES. The term is important because we need a way to describe the colour errors in a reproduced image. Such errors are called HUE errors. Green skies, blue faces and purple hair are the result of HUE errors, no matter how they are caused.

Now that colour saturation and hue have been defined, let us consider the role that light plays in determining the quality of a composite colour video image. The amount of light used to illuminate a colour image in front of a TV camera affects colour saturation in the same way that if affects contrast in a black and white system. The more light falling on the subject, that is the greater the illumination, the more saturated the colours in the video image will be. In practice, sufficient light must be provided for the camera to produce colour which is as saturated as the original. The problem of of determining how much light is required when a modern colour video camera is used is a relatively simple one to solve. This is because most manufacturers of colour cameras generally have designed very good video control circuitry into their products. Too much light is almost never a problem and, in general, the more light the better the colour reproduction. Lighting requirements vary, of course, depending on subject material and the nature of the video equipment used, but the important point is do not skimp. For a great example of how not to skimp on lighting, try to arrange a visit around a broadcast TV studio.

Having discussed the importance of providing sufficient light in colour video work we must now consider the quality of the light utilised. The character of the light falling on the subject is tied immutably to the quality of the colour image that the camera will produce, and is where hue comes into play.

Truly white light is balanced, that is it consists of equal portions of every visible colour. If this balance is disturbed the light will no longer be white, but will take on some characteristic overall colour or hue. The colour of anything which is illuminated by a source of unbalanced light will take on the same characteristic hue as the light itself. This fact applies to an illuminated subject in front of a television camera. If the light source is not balanced the colour of the subject will be biased. Now, whilst a source of perfectly white light is difficult to find, we can come close rather easily. The important point is that what the camera ‘‘sees’’ is totally dependent on the colour of the illuminating light.

In practice there are many sources of fairly well balanced light. The most common, of course, is daylight. If you are forced into operating indoors there are a number of inexpensive lamps available which will suffice. The most familiar is the ordinary household tungsten lamp, which emits a fairly white light when new. Tungsten lamps age, and as they do their light becomes more red. A more sophisticated version of this type of lamp is the ‘‘photoflood’’. generally, the light from a photoflood lamp is very close to white, but it shares the same tendency to red as it ages. Another source of light which has become rather common recently is the quartz halogen lamp. Quartz light is very well balanced and changes very little with time. Quartz lamps typically produce a great deal of light for their size, but have a somewhat shorter lifetime than tungsten lamps. Generally, good results can be obtained by utilising a sufficient amount of light from any of the lamps just described. Colour ‘‘perfectionists’’, however, may wish to use the best quality illumination available.

There is one common source of home lighting which is not really suitable for use with most cameras, and that is fluorescent lamps. The light produced by these lamps is spectrally very narrow, that is many colours are missing altogether from its light. As a result, it is very difficult to accurately reproduce colour subjects when ordinary fluorescent lamps are used for illumination.

Finally, on the subject of colour cameras. The modern state-of-the-art generation of CCD (Charge Coupled Device) cameras now readily available, including , of course, camcorders, are extremely versatile and adaptable to all sorts of lighting conditions. They usually offer quite low-light (3 to 4 Lux) capabilities and are able to automatically compensate for large variations in light level. However, the above discussion referring to the lighting hues still applies to CCD based cameras. The colour of the light falling on the subject will be reproduced as a hue over the output video image.

Scan Conversion Techniques

Fast to Slow

The first scan converters used in slow-scan television were designed to allow a normal camera to be used for generating the SSTV signal. For this purpose there were two approaches:

1) the Line Sampling Camera

2) the Line Store Converter

The Line Sampling Camera is a normal television camera, modified so that its frame timebase is scanning at the SSTV line rate (50/30Hz). The camera is put on its side so that the picture is scanned vertically with 3 x 312 lines. The grey value is sampled, using an electronic switch, for a brief period on each line and this series of samplings constitutes one SSTV line. This process is repeated at intervals down the picture, thus producing the required 128 SSTV lines. The great disadvantage with this system is the need to modify a camera and the difficulty in monitoring a fast-scan picture.

The Line Store Converter cleared up the above problems. In this system a single line of fast-scan picture id digitised in the converter and clocked into a quadruple shift register during the 60us of the line. During the next three fast-scan frames (60ms) this data is clocked out of the shift register at the slow-scan rate, thus generating the SSTV signal. The digitising process can be done with a string of 711 dual comparator ICs. Devices known as ‘‘Flash Digitisers’’, or ‘‘Flash Converters’’, are also readily available which digitise up to 64 levels (6-bits) at a rate of 15MHz. Higher resolution devices are also available, but they are generally quite expensive, dependant greatly on the resolution offered.

A string of 711 devices will digitise to 16 levels (4-bits) and this is quite adequate for most amateur requirements, the limitations only becoming apparent when large areas of the picture only have small differences in the grey level, causing the effect known as ‘‘contouring’’. This effect is less apparent where a picture has lots of detail and there are rapid transitions through several grey levels, or where the number of grey levels is much larger - 64 for example.

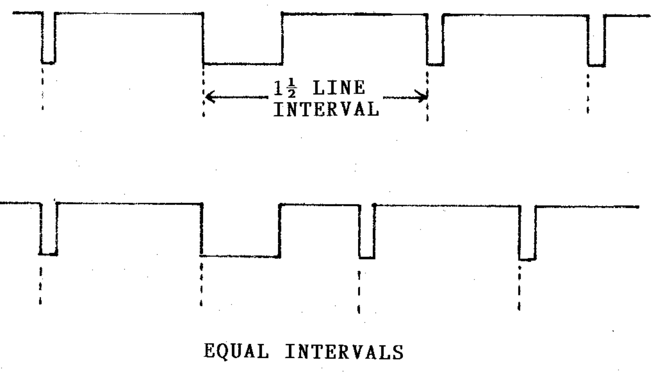


Fig.3.2a (upper) and 3.2b (lower): Sync Pulse Intervals

The mention of quadruple shift registers above ties in with the 4-bits which the 711 devices produce; one shift register is allocated to each bit. If the fast clock is made to run a little too fast, then the first part of the fast-scan picture line disappears out of the end of the shift register and is lost. This is a good thing as it enables us to adjust the left-hand edge of the SSTV picture in relation to the fast-scan screen. Similarly, if the slow clock is too slow, it fails to deliver the last bit of the line and this can be used to control the right-hand edge of the SSTV display.

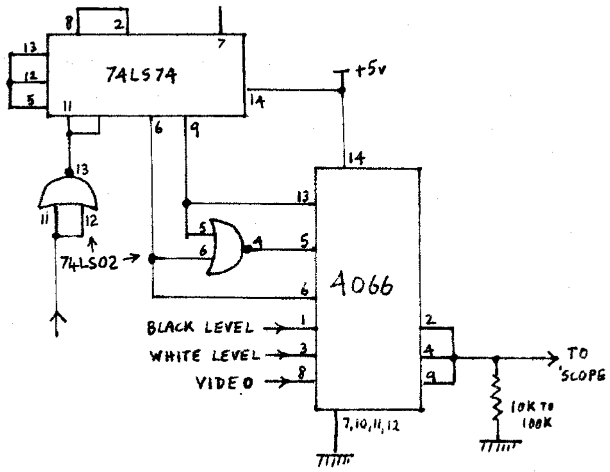


Fig.3.3: Grey Level Monitor Circuit

Shift registers are now out of fashion as a means of storage and have been replaced to a greater extent by the use of Random Access Memory (RAM). RAMs are now readily available at reasonable cost with access times of 100ns and less, which means that they can readily be clocked at frequencies of 10MHz or more. The main disadvantage with using RAM is that each device requires a large number of address lines and it is these addresses which must be clocked at the fast or slow rate. On the bonus side, however, is the fact that each picture element can be selected by using the correct address and one is not limited in the order in which they are selected.

There are two different ways of adding synchronising pulses to the SSTV video as shown in Fig's.3.2a and 3.2b. In Fig.3.2a the frame sync pulse, which is of 30ms duration, starts at the end of the last picture line and continues until the first line of the next picture. As a result of this, if the line oscillator is free running, at the start of the picture the sync pulse is half a line period out of step with the oscillator, and a ‘‘hard lock’’ circuit is required to bring it rapidly back into step.

In Fig.3.2b the frame pulse occurs during the first line and the rhythm of the line sync pulses is not interrupted. It can be seen, therefore, that the latter method of adding sync pulses is by far the more elegant, even at the expense of the first half of the first picture line.

When a fast-scan signal is digitised it is essential that some form of monitoring is used to check that all sixteen grey levels are being used in the conversion. The circuit in Fig.3.3 can easily be added to a converter which uses chains of 711 devices. The output of this circuit is fed to an oscilloscope which has the timebase set to display three fast-scan frames.

The fast-scan line sync clocks a divide-by-three circuit which closes three electronic switches in rapid succession. Thus, on the screen of the oscilloscope we see a sequence of one line of white level, one line of black level and one line of video, which is repeated across the screen. This gives the appearance of a steady line at the white level, a similar line at the black level and the varying video signal in between.

The white and black level controls on the converter are then adjusted so that the video waveform lies in between them. If the white level is too low, or the black level is too high, then clipping will occur which would be seen on the SSTV display as large areas of white or black with very little detail in them.

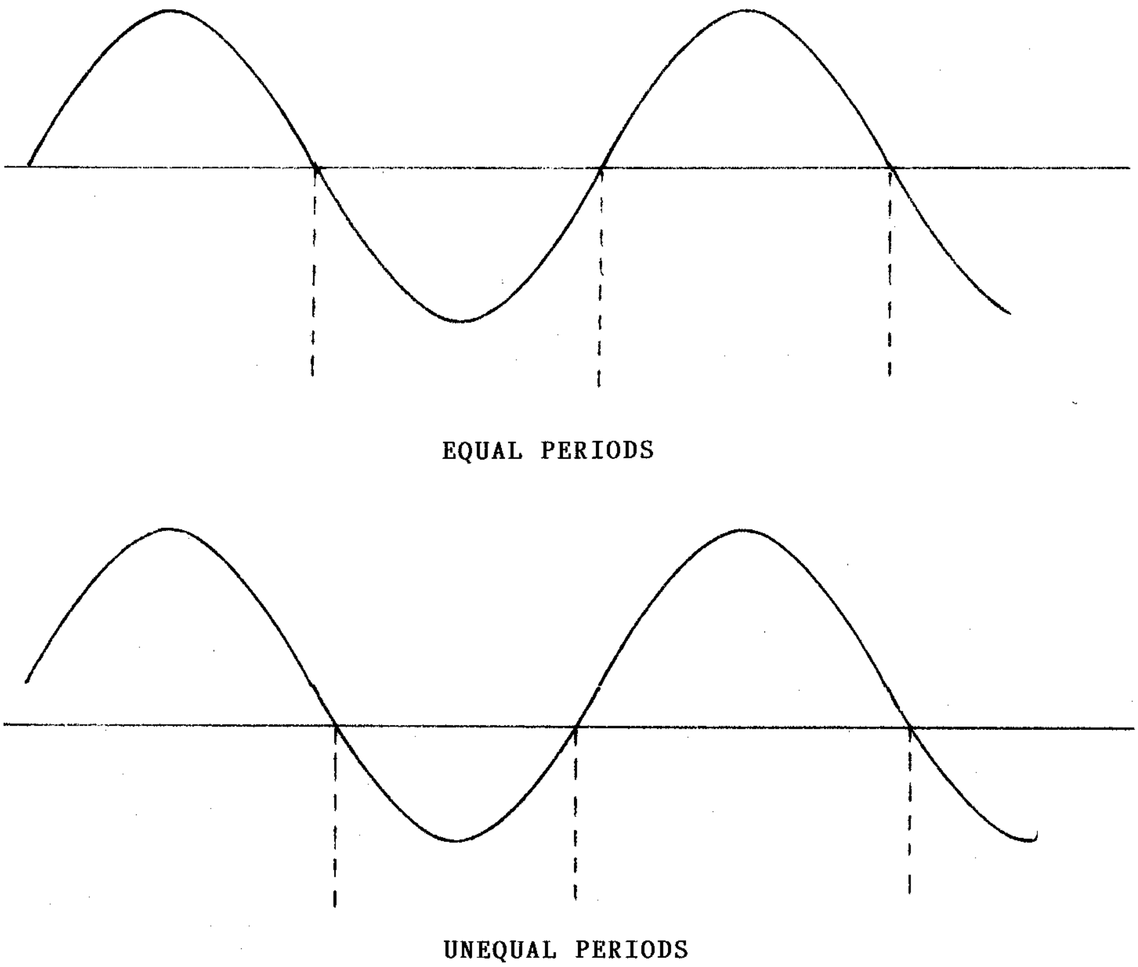


Fig.3.4: Symmetric (top) and Asymmetric (bottom) Waveforms

Note that some digitisers use ''contrast'' and ''brightness'' controls rather than the white and black level controls referred to. The principle of setting these controls remains the same.

Whilst on the subject of picture quality, it is worth conducting some trials with a series of different pictures, as it appears that some pictures are more suitable than others for the SSTV system. Experiment with a critical eye on the SSTV screen and you will soon find out the type of picture the system likes best.

Slow to Fast

When we come to consider the use of a fast-scan monitor to display SSTV, it is easily seen that the required memory must be large enough to store a complete picture, as the fast-scan display must repeat its display many times in the course of a single SSTV frame. In computer terms we need 128 x 128 x 4 = 64kbits, or 8kbytes. As there are 8-bits in one byte we can store two 4-bit pixels (i.e: 2 nybbles) in one byte. This is convenient, as RAMs are readily available configured as 16k x 1-bit (4116) or 16k x 4-bit (4416).

It is worth noting here that dynamic RAM can quite happily be used in this system without the need for the complex refreshing circuitry required for these devices, as we are using the memory in a rapid read-out cyclical manner, thus automatically refreshing the data in the devices.

One of the earliest slow-to-fast converters, which was designed by WB9LVI, used four massive recirculating shift registers, with some clever circuitry involving a line buffer store, which was switched into the path of the recirculating data to give a ''load-on-the-fly'' arrangement. The advantage of having RAM for memory is that a complete picture can be loaded into memory in the fast-scan frame time of 20ms, which is within the SSTV frame sync pulse. Thus, we can display successive frames of SSTV, taken as snapshots approximately

7.68 seconds apart. With the use of a line store the subject must remain still in front of the camera for the full 7.68 seconds - as for a Victorian photograph!

The resolution of a converted slow-to-fast picture using these methods leaves a little to be desired. At any given period of time during the picture the frequency determines the level of grey. Thus, the period of half a cycle is the smallest ‘‘information packet’’ which is being transmitted, and one can only make use of this half cycle if the waveform is symmetrical about the axis, as shown in the upper diagram in Fig.3.3. When the waveform is asymmetric with respect to the axis, as shown in the lower diagram in Fig.3.4, then the two periods between the crossing points are different and would be interpreted as two different shades of grey.

From this we can see that the usual 128 x 128 pixel converter is not using the full potential of the system. What we need is a scan converter with a 128 x 256 memory, which would give better resolution in the horizontal direction.

References

1)SSTV to FSTV Converter.*QST March/May/August 1975*

Commercial SSTV Equipment

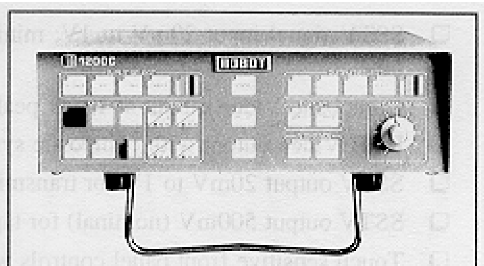
A great deal of our discussion so far in this book has been to do with home-brew equipment and some of the techniques involved with picture production. However, there are of course many commercially built items of slow-scan equipment available to the amateur. In this chapter then we shall take a look, not only at currently available equipment, but also at some of the earlier models, so that you may be aware of what to look out for on the second-hand market.

The principal manufacturers of SSTV equipment until now have been: Robot Research Inc., Davtrend Ltd. and Wraase Elektronik. A relative newcomers to the scene is Jad Bashour. Whilst Davtrend and Wraase equipment is quite popular in the UK and Europe, Robot products are used almost exclusively in the USA and the rest of the world, and are fast catching up over here as far as hardware driven SSTV systems are concerned. Robot have been manufacturing SSTV equipment for the amateur market for many years and as a consequence have the largest range of models, therefore I shall start this chapter with a look at their equipment. All specifications have been taken from the manufacturer's original publications.

Robot Research Inc. Model 1200C

The most recent Robot model is the model 1200C Colour Scan Converter. This is a sophisticated microprocessor based high resolution colour video scan converter and image processor. The features displayed by this converter are very advanced, using state-of-the-art techniques such as ‘‘Time Multiplexed Component Colour’’. (An explanation of this technique is not within the scope of this book, but suffice it to say that the results obtained can be more accurate end efficient than with other SSTV modes). The converter is compatible with existing scan converters with a choice of four transmission formats. This choice, for black and white and colour operation, allows the operator to obtain the best pictures, optimising between speed and noise immunity.

A problem that can often be a source of irritation is the constant need to fine-tune some signals when receiving pictures, especially when tuning in SSB. This problem is alleviated with the 1200C due to the software system developed for the microprocessor. This system automatically detects mistuning within +/- 150Hz and compensates accordingly. Hard copies of received colour pictures can be produced in colour if a suitable printer (e.g: Seikosha GP-700A) is attached. When the converter is being used to transceive pictures with another Robot converter, an automatic mode of operation may be selected.



Robot 1200C

The fast-scan picture for transmission can be ‘‘snatched’’ from either a colour camera or black and white camera equipped with colour filters (see Chapter 3). Alternatively, a previously stored picture can be recalled from one of six memories for transmission. There is also a built-in colour bar generator, which is useful as a test pattern for receiver adjustment. For ease of transmission the converter is equipped with a full width screen cursor indicating the line being transmitted.

Another feature of this unit is the provision of two input/output ports for connection to a suitable computer. This facility allows for full remote operation of the 1200C from the computer via the parallel port or an RS-232 serial port.

It can be seen therefore that this converter, utilising as it does the most modern ideas and circuitry, is a very sophisticated piece of equipment and will provide the user with state-of-the-art results.

Specifications for the 1200C include the following:

Transmit speeds selectable from: B&W - 120 lines @ 8 or 12 seconds, 240 lines @ 24 or 36 seconds, Colour - 120 lines @ 12 or 24 seconds, 240 lines @ 36 or 72 seconds.

Automatic speed following on receive to any of the standard SSTV formats.

Video display composed of 61440 pixels in a 256 pixel by 240 line array when in memory page 1 or 2 mode. An 18-bit digital ‘‘word’’ for each picture element giving a possible 262144 colours.

Standard camera input, 1 volt peak-to-peak into 75 ohms.

SSTV signal input 20mV to 1V; minimum signal-to-noise ratio for clear picture 6dB

Composite Video output at 1 volt peak-to-peak into 75 ohms.

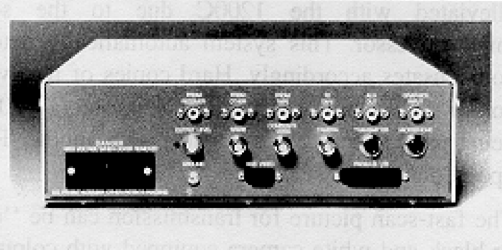
RGB Video output with composite sync on each. Separate syncs available.

SSTV output 20mV to 1V for transmitter, adjustable by rear panel control.

SSTV output 500mV (nominal) for tape recorder.

Touch sensitive front panel controls with LED status indicators.

Other models previously manufactured by Robot include the 450C, 400, 300 and the 70. many of these models, as well as their accessories, become available on the second-hand market from time-to-time. Of course, the facilities available with each model vary according to the technology available at the time of their design. However, any of them will provide the operator with an SSTV station capable of receiving and transmitting excellent slow-scan pictures.



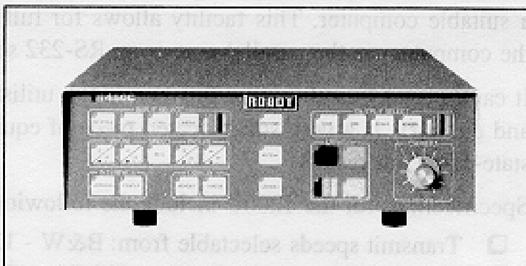
Rear view of Robot 1200C

Robot 450C

The 450C is basically the same as the 1200C, but with less memory and as a consequence restricted operational modes.

The main differences between the two models lie in their relative display capabilities and possible colour combinations.

The 450C has a 128 pixel by 120 line display, producing 15360 pixels, but still remains compatible with 240 line reception, and 4096 possible colour combinations. Apart from these differences the specifications and operation of the 1200C and the 450C remain much the same.



Robot 450C

Robot 400

The first of the Robot models to incorporate digital techniques and sold-state memories, the 400 represented a major step forward at the time of its introduction and was possibly their most successful model.

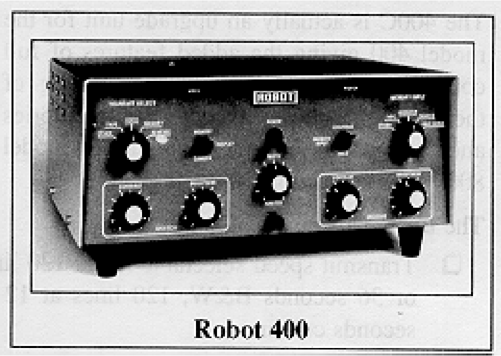
The most noticeable difference between using digital memories to the previously used display method of phosphor or silicon storage tubes, is the permanent retention of the received picture in the memory without fading after a few minutes (whilst the power remains switched on of course). Flicker-free received pictures with the slow downward scan of the replacing frame, and the ability to preview transmit pictures on the fast-scan receiver/monitor were also new experiences.

The features exhibited by the model 400 are generally the expected norm for modern scan converters:

- Standard 8 second 128 line by 128 pixel transmit and receive, black and white only with a 16 level grey scale.
- Fast-scan video input 1 volt peak-to-peak into 75 ohms.;
- Fast-scan video output 1.4 volt peak-to-peak into 75 ohms.
- SSTV input 20mV to 1V into 10k. Signal-to-Noise ratio for noise free picture 6dB.
- SSTV output 2V peak-to-peak maximum into 1k, adjustable by rear panel control.
- Snatch controls for brightness and contrast to enable picture level to be set prior to transmission or storage.
- Receive controls for adjusting contrast and brightness whilst viewing picture, or prior to memory storage.
- ‘‘Hold’’ facility to allow retention of a received frame without it being updated by further incoming SSTV.
- Width control to allow reception of pictures from countries using 50 or 60Hz supplies.
- Internal grey scale generator for receiver adjustment or transmission.

Robot 400C

The 400C is actually an upgrade unit for the model 400 giving the added features of full colour transceive, automatic fine tuning of the received picture, three picture memories and the capability of interfacing to the model 800 for colour graphics.


Robot 400

The upgraded specifications are:

Transmit speed selectable from: 120 lines at 8 or 12 seconds, or 240 lines at 24 or 36 seconds B&W, 120 lines at 12 or 24 seconds, or 240 lines at 36 or 72 seconds colour.

Automatic speed tracking of the received picture, allowing reception of the standard SSTV formats without independent selection.

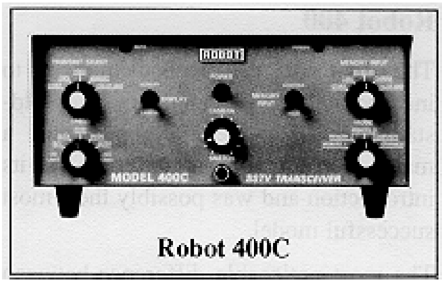
Automatic fine tuning within the range +/- 150Hz.

Three independently selectable memories for storing received or snatched pictures. The memories can be simultaneously selected to give a composite picture of all three.

Robot 300

This model was produced using storage tube techniques and is believed to have been the first commercially available scan converter. Another first for this model was the ability to view the received picture on a fast-scan monitor.

The incoming SSTV picture is processed and stored on a silicon target storage tube, it is then electrically read out and reprocessed into a fast-scan picture for viewing on a monitor. The transmit picture is snatched from a fast-scan source, processed and stored in the tube, from where it is again electrically read and processed into a slow-scan picture for transmission.

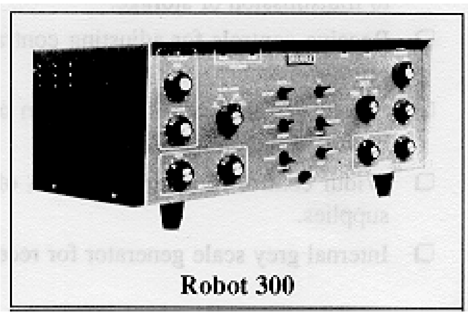


Robot 400C

The facilities available with this unit are comparable with today's generation of converters, the only real differences being black and white working only and no internal picture storage. Storage is achieved by recording on magnetic tape or by photographing the screen. Once an SSTV picture is stored on tape it can be read back into the converter for transmission. It is worth remembering that the same applies to most of the digital converters available, their memories only store pictures whilst the power is switched on, permanent storage must be on tape.

As previously mentioned, any picture that is stored in the silicon tube will eventually fade out, and after a few minutes will have to be refreshed or replaced. Also, even when new, these tubes, by nature of their manufacturing process, exhibit small blemishes on the target which are sometimes seen on the picture.

The specifications for the model 300 include:


Robot 300

Transmit and receive speeds: 128 lines at 2, 4 or 8 seconds. 256 lines at 4. 8. 17 or 34 seconds - black and white only.

Video input 1 volt peak-to-peak into 75 ohms.

Video output 1.4 volts peak-to-peak into 75 ohms.

SSTV input 20mV to 1V into 10k. Minimum Signal-to-Noise ratio for clear picture is 6dB.

Transmit FM deviation controls set degree of FM swing and centre value of SSTV picture. Indicators show when limits of swing are reaches (i.e: 1200Hz for sync and 2300Hz for white).

Snatch controls to set the required depth of modulation of the picture from the camera or video source.

Normal or inverted video transmitted picture.

Tuning indicator activated by incoming SSTV sync pulses when correctly tuned.

Horizontal hold control to allow reception of pictures from countries using 50Hz or 60Hz supplies.

Span and balance controls to set depth of modulation and centre value of swing of incoming pictures.

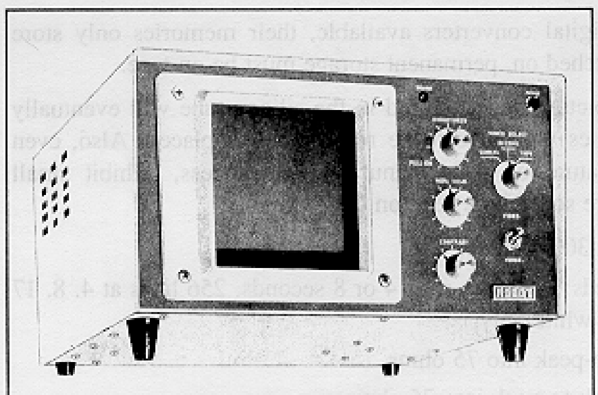
‘‘Hold’’ facility to freeze an incoming picture on the screen without updating, to allow viewing or storage.

Transmit mode can be switched between SSTV mode and voice mode, the microphone being plugged into a socket on the rear panel.

Robot 70

The model 70 monitor was the first commercially available slow scan unit in the world. The final version, the 70D, was quite sophisticated for a unit built around a P7 phosphor cathode ray tube. The 70 series are receive only monitors, but include in their circuitry Power feeds for the 80 series slow-scan cameras to enable the operator to transmit as Model 70A monitor well.

The received SSTV signal is processed and then fed to the CRT. The CRT is scanned by free-running timebases thus producing a raster at all times whether or not a picture is being received.



Robot 70A Monitor

Due to the persistence of the P7 phosphor tube (similar to those used in early radar equipment) the displayed picture remains on the screen for approximately 8 seconds, after which time it has to be refreshed because it fades out. The picture is best viewed in a darkened room, or by using a viewing hood to reduce the level of ambient light failing on the screen.

The models 70C and 70D were the last produced in this series and the facilities they offered make them useful even in today’s shack. The specifications for these two models include:

Reception of 128 lines @ 8 seconds or 256 lines @ 34 seconds. Will also accept 2 and 4 second transmissions, the resulting pictures being quarter and half screen respectively.

Automatic sync threshold circuit accepts line sync pulses from 3 to 10ms and frame sync pulses from 30 to 90ms duration. This permits the monitor to receive pictures originating from tape storage, where the tape speed may vary causing frequency shift.

SSTV input 40mV to 10V into 1k. S/N ratio for a clear picture is 6dB. SSTV output suitable for cassette tape recorder.

Horizontal hold control to allow reception of pictures from countries using 50 or 60 Hz supplies.

Contrast control to vary the amplitude of the SSTV applied to the CRT. Model 70D only.

Robot 70D only:

Oscillator mode enabling accurate fine tuning of the incoming SSTV or for setting-up a slow-scan camera.

Viewfinder mode allowing the monitor to be used to preview the picture from the slow-scan camera, enabling rapid set-up of pictures for transmission.

(The 80 series slow-scan cameras have a fast-scan output for feeding into the monitor for this purpose).

It is also worth noting that, not without some patience, 256 line 32 second pictures could be received on this unit. Although the picture will have started to fade by the time the scan is completed, enough remains on the screen to be viewed.

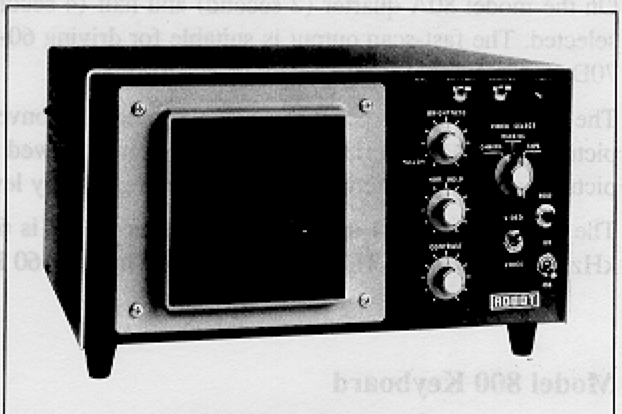
Model 61 Viewfinder on top of a model 70A Monitor

Robot 70 Accessories

There are two main accessories used with 70 series monitors; a slow-scan camera for transmit and a viewfinder. As previously noted the model 70D monitor has a built-in viewfinder, so only a camera is required to transmit ‘‘live’’ pictures.

The models 80 and 80A slow-scan cameras are powered from a 70 series monitor and they operate as sampling cameras, the picture initially being fast-scan generated from a standard vidicon tube. This fast-scan Picture is sampled within the camera at slow-scan rates thus producing an SSTV picture. Both pictures are fed to their appropriate output sockets on the camera. The slow-scan picture produced is in the standard format of 8 second/128 lines. The audio FM output is variable to 2.5V P/P maximum into 1k. There are contrast and brightness controls to set the picture to the desired level and a beam control for optimum sharpness.

On the model 80A quarter (2 second) and half (4 second) frame durations can also be selected. The fast-scan output is suitable for driving 60-series viewfinders or the model 70D monitor direct



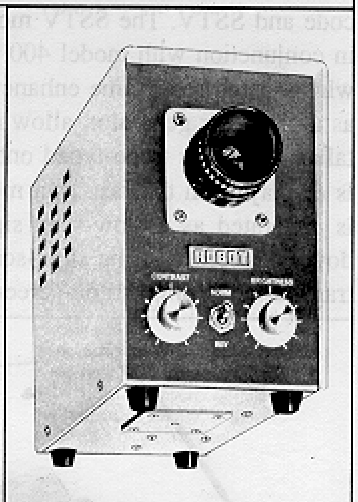
Robot 70C/D Monitor

The models 60 and 61 viewfinders provide a convenient fast-scan display of the picture from the 80 series cameras. The picture viewed is an exact replica of the SSTV picture transmitted, therefore accurate setting of grey level, etc., is possible.

The model 60 has a 4 inch display whereas the 61 is 6.5 inch. The fast-scan rate of 3 kHz used produces a 180 line display (200 lines @ 60 Hz).

Model 800 Keyboard

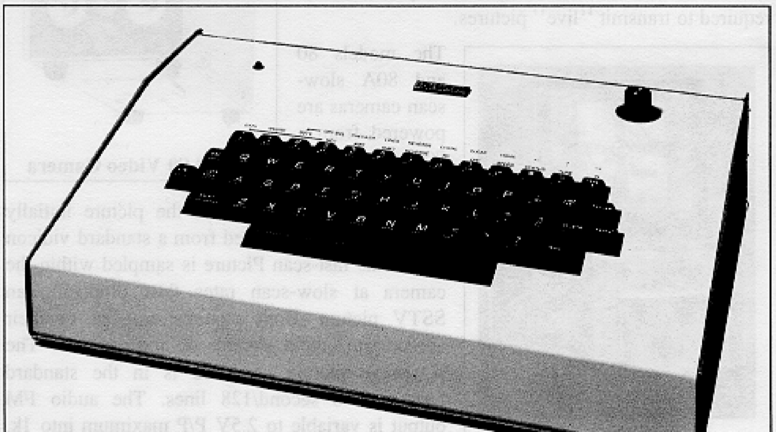
The Robot 80 is a multimode keyboard terminal unit combining baudot, ASCII, Morse code and SSTV. The SSTV mode is transmit only and the unit is intended to be used in conjunction with model 400 and all later models to complete the transceive station, whilst at the same time enhancing the transmit features of the 400. The unit operates as a character generator, allowing 6 lines of 6 alphanumeric characters, or 3 lines of 6 taller characters to be typed onto an SSTV format screen. The message being typed in is displayed on the fast-scan monitor connected to the unit, whilst at the same time it is generated as a slow-scan signal and sent to the transmitter. A line cursor moves down the screen at the slow-scan rate indicating which portion of the display is being transmitted. Complete on-screen cursor controls allow the operator to change any part of the text easily and immediately, there are also carriage return/line feed, delete character and clear screen commands. Further commands give the ability to transmit only certain lines of the text instead of the whole screen and also to reverse the display from the default mode of black characters on a white background to white on black. Also built into the terminal are a standard 6-bar grey-scale and a chequer-board pattern to assist in setting up equipment or for transmission.



Model 80 Video Camera

Robot 800C

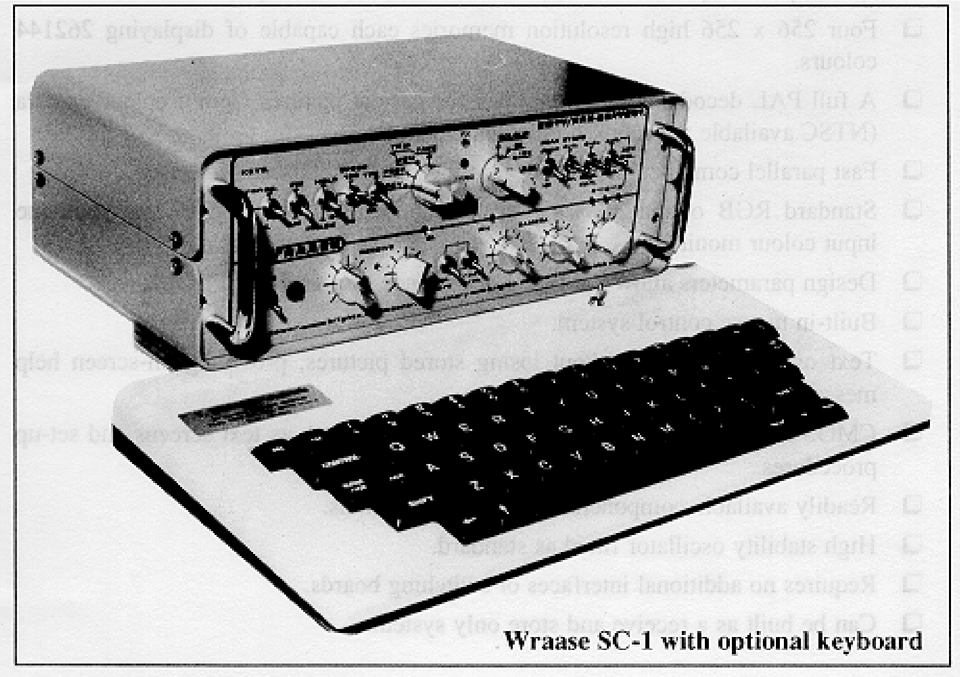
The model 800C is basically the same as the 800 but has some expanded features. The display becomes 6 lines of 8 or 3 lines of 8 characters allowing more text on the screen. A serial output is provided for colour graphics and special effects with Robot colour scan converters, with eight graphic memories and battery back-up.



Model 800 SSTV Keyboard

This completes our look at the Robot range of equipment. They have been producing SSTV equipment since 1970 and as a result have made available more models in the U.K. than any other supplier, therefore it is more likely that any second-hand equipment found will be of their manufacture. Should any problems arise with any Robot equipment it is comforting to know that the company are only too willing to offer advice and assistance.

Robot (U.K.) Ltd, Building 33, East Midlands Airport, Castle Donington, Derby, DE7 2SA. Telephone: 0332 812446.



Wraase SC-1 with optional keyboard

Davtrend Ltd. Model DRAE SSTV Television Transceiver.

A more recent entry into the SSTV field by the U.K. company Davtrend has resulted in the manufacture of this SSTV scan converter. The unit was designed initially as a receive only converter, but provision has been made on the main circuit board for the installation of a transmit board. A certain amount of setting-up of the internal pre-set controls has to be carried out to achieve correct results, but the manufacturers point out clearly in their documentation which controls to adjust and which not to touch. The overall operation of the converter is quite acceptable and the quality of pictures received and transmitted are comparable with other units having similar facilities.

The manufacturer’s specifications for the Drae SSTV receiver are:

Receive and transmit 128 lines @ 8.5 seconds with 128 pixels per line.

16 level grey scale.

SSTV input 100mV to 2V.

Video input fast-scan 625 lines 1V peak-to-peak into 75 ohms.

SSTV output FM modulation 1500 Hz to 23 Hz. Sync pulse 1200 Hz.

Video output 1V peak-to-peak into 75 ohms.

UHF output on channel 35 into 75 ohms.

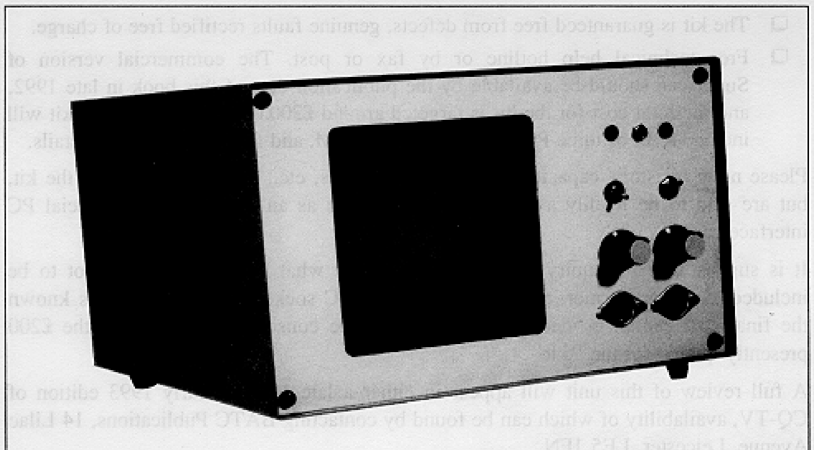
Davtrend SSTV Receiver

The converter also carries a microphone socket on the front panel which allows for phone operation without having to disconnect the unit from the transmitter. The input to the converter is switchable between the radio receiver, a tape recorder or a fast-scan camera to allow setting up focus etc. prior to transmission. The only transmit picture source input is for a fast-scan camera (or video recorder), from which the unit snatches a frame during each slow-scan frame pulse and transmits it as SSTV. A ‘‘freeze frame’’ facility is also available which allows the received picture to be displayed on the screen without being overwritten by incoming video.

Davtrend Ltd, Sanderson Centre, Lees Lane, Gosport, Hampshire, P012 3UL. Telephone: 0705 520141.

Wraase Elektronik Model SC-1

The SC-1 is the latest model Wraase converter to be described here. It is a portable dual-mode unit for SSTV and FAX. Also available as optional extras are a colour graphics keyboard, a video light pen, a computer printer interface and a colour camera interface to allow the ‘‘snatching’’ of colour pictures from fast-scan. Later versions of the SC-1 (serial numbers above 1000) are equipped with a new line sequential colour sync system. A 1ms long 2300 Hz pulse at the beginning of each RED line is used to synchronise the colour sequence, thus, even under strong received interference, the colour will not change during reception of a colour frame.


Spacemark SSM-1 Monitor

These later versions have a ‘‘high resolution’’ colour mode in which both memory banks are switched together for 256 lines colour. Transmission or reception of one high-resolution colour frame takes 48-seconds.

Colour SSTV Standards:

Frame-sequential colour: RED, GREEN, BLUE manually switched 1, 2 or 3 frames each depending on propagation conditions.

Line-sequential colour: RED, GREEN and BLUE lines alternating, synchronised by the vertical sync pulse, starting with red. Sequence: R-G-B.

Manufacturer's Specifications:

SC-1 SSTV/FAX Standards

SSTV/FAX FM-Modulation Subcarrier Frequencies

Sync: 1200 Hz Black: 1500 Hz White: 2300 Hz Horizontal Sync: 5ms Vertical Sync: 50ms

SSTV 8sSSTV 16s SSTV 32s Colour SSTV FAX

Scanning lines 128 128 256 256 256Picture elements /line 128 256 256 256 256Line rate (lines/sec.) 16 8 8 16 4 Scan time /frame (secs) 8 16 32 2464/128 Picture format 1 : 1 1 : 1 1 : 1 1 : 1 1 : 1

The U.K. agent for Wraase equipment is: Mr.A.Corker, 59 Foljambe Road, Eastwood, Rotherham, South Yorkshire, S65 2UA. Telephone: 0709 68098.

There have been one or two other notable SSTV products in the past which, although no longer made, may still be available on the second-hand market so it is worth taking a brief look at them here.

Spacemark SSM-1

This monitor is built around the 5FP7 long persistence phosphor CRT, giving a yellow or green picture which remains viewable for about 8 seconds before it fades. In this model the line and frame timebases are NOT free running, so nothing at all appears on the screen until a correctly locked SSTV signal is received.

There is a built-in tuning indicator in the form of a LED that flashes in sympathy with the received SSTV signal. When the signal is correctly tuned the LED flashes at its most rapid and brightest, with long flashes indicating the frame pulses.

Once correct tuning has been achieved the frame reset button is operated and the picture appears on the screen. Further tuning may then be necessary to obtain the best picture resolution.

This monitor is of the ‘‘old school’’ type, being designed before the widespread use of digital techniques revolutionised slow-scan TV. The monitor was sold in kit form.

The specifications for the SSM-1 include:

Reception of 120 line/8 second format only.

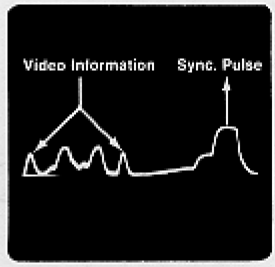
SSTV input 10mV to 20V into 3k.

LED tuning indicator.

Brilliance and contrast controls.

Four position input selector.

Although very basic in its capabilities this monitor could still provide a cheap entry into SSTV and would no doubt be of interest to SSTV ‘‘old timers’’ as well.



"Accu-Sync" Display

Venus SS2

Venus were very proud of the fact that they produced the high voltage power supplies used in the television cameras on the Apollo space missions. To quote their original brochure ‘‘Your Slo-Scan may not have to work on the moon ... but it is reassuring to know that the same quality and reliability has been designed into it’’. It is still possible to find the occasional Venus monitor on the second-hand market and they are worth looking out for.

Venus SS2 Monitor

Again the monitor is only capable of receiving 120 line 8 second SSTV, but to be fair that was the only standard in use at the time of it’s introduction. The display utilises a square P7 phosphor tube (not an ex-RADAR device), with the provision of a film camera adaptor on the facia to accommodate a Polaroid camera for directly photographing off-screen. This model features an oscilloscope mode which allows the operator, by selecting the ‘‘Accu-Sync’’ function, to accurately tune-in the incoming signal by watching the sync pulses appear on the display.

Features included are:

Receive only 120 lines at 8 seconds.

SSTV input 40mV to 10V into 1k.

Oscilloscope mode tuning.

Contrast and brightness controls.

Four position input selector.

This concludes our look at the world of commercial hardware-based slow-scan converters and receivers. However, in Chapter 8 we shall be looking at the various commercial computer based slow-scan systems.

The G3WCY Digital Scan Converter

Principles

The concept of digital conversion for reception of SSTV is to change the incoming slow-scan signal, which is in analogue form, into a digital signal. This digital signal is then synchronised, recognised and stored in a dynamic random-access memory, to be released and refreshed at the required fast-scan rate, to enable a simulated picture to be displayed on a normal 625-line television.

The actual picture is only 128 picture-elements (pixels) wide, with four bits or digits to a pixel, by 128 lines high. As the scanning rate is so slow all movement is lost, but considering that 128 lines are now spread into the space of 625 lines, the clarity and resolution is quite amazing.

Operation of the Analogue-To-Digital Board

The circuit shown in Fig.1 comprises an audio op-amp IC1 protected by limiting diodes D101 and D102. SSTV demodulators and filters are catered for by IC2, IC3, IC4 and the bridge networks formed by diodes D103 to D110. The output from IC4 is connected to the digital conversion circuitry IC5, IC6, LED bar drivers type LM3914 each containing 10 comparators, 10 of which are used to give the video levels fed to the inputs of IC7 and IC8, which are eight-line priority encoders. The outputs from IC7 and IC8 are interfaced to IC18, giving an overall 16-to-4 bit code conversion presenting a four level Gray code in data form to the memory devices IC37 to IC40 (see Fig.3). A bandpass filter is formed by the configuration of IC9 and IC10 which extracts the sync pulses from the SSTV signal coming from IC3. These sync pulses are amplified and split by transistors TR101 to TR103 giving the required horizontal and vertical SSTV sync pulses at the outputs of IC11 (TP3 and TP4 respectively).

The circuit shown in Fig.2 provides fast-scan sync pulses which are derived from an adjustable oscillator, utilising the famous NE555 timer IC12, set to run at 31.250 kHz. This output at pin-3 of IC12 is fed to a series of 7490 decade counters,IC13 to IC16. The second half of IC13 is used in the divide-by-two mode, producing an output of 15.625 kHz for the fast-scan horizontal sync pulses, the remaining 7490 ICs are connected in the divide-by-five mode, providing division down to 50 Hz for the fast-scan vertical sync pulses.

Operation of the Digital Memory Board

The circuit of the board is shown in Fig.3. The memory section, IC37 to IC40, uses 16K RAM type 4116 selected to have an access time of 250nS or less, otherwise errors may occur in the write mode. The seven address lines A0 to A6 are driven by IC23 and IC31 which act as row and column address counters respectively. The write and read counters used are ordinary binary counters type 74LS393, IC27 is the Read-Row counter and IC28 is the Read-Column counter. The Write-Row and Write-Column counters are IC29 and IC30 respectively, whilst Write-Enable for the memories is fed from pin-I of IC32. The alternate row and column counters are multiplexed from four 74LS153 dual 4-to-1 line multiplexers, IC33 to IC36.

The position of the horizontal picture is determined by IC24 which sets IC20. When this occurs oscillator IC19 starts up and IC27 then begins to count to 256 upon which IC20 resets and IC27 stops counting and waits for the next horizontal sync pulse. Parts b and c of IC21 produce a blanking pulse, the length of which is determined by R210 and C210. Vertical timing is achieved in a similar manner, the clock for the vertical counter is fed from the fast vertical sync pulse at the base of TR202.

To stop the write function the horizontal slow sync is halted by connecting pins 2 and 12 of IC29 to the +5V rail, with the effect of producing a freeze-frame function. This facility is very useful for picture study and storage, hence a small toggle-switch (S202) is brought to the front panel for convenience.

The digital video signal from data output of the 4116 memories (pin-14) is converted by IC41 (74LS175) into a binary code with the aid of the common R, 2R 4R, 8R method using resistors R214 to R217 (use good quality 2% types here). Horizontal and vertical fast sync is re-introduced at this point by means of TR203 and TR204. At this stage video is ready for display at either of the output terminals (a) and (b). These two points give alternate outputs: (a) is for connecting to d normal TV via d suitable modulator, as used in computers or TV games; (b) goes via TR205, an emitter-follower, to provide the correct 75ohm output impedance for a monitor.

Feeding the video via a modulator to a TV is not recommended as rather poor picture quality and resolution is obtained. If a video monitor cannot be obtained a normal TV set can be easily modified to suit the purpose and act as a monitor, with no harm or change to the receiver’s normal operation (not forgetting to observe the necessary safety precautions when opening a TV set).

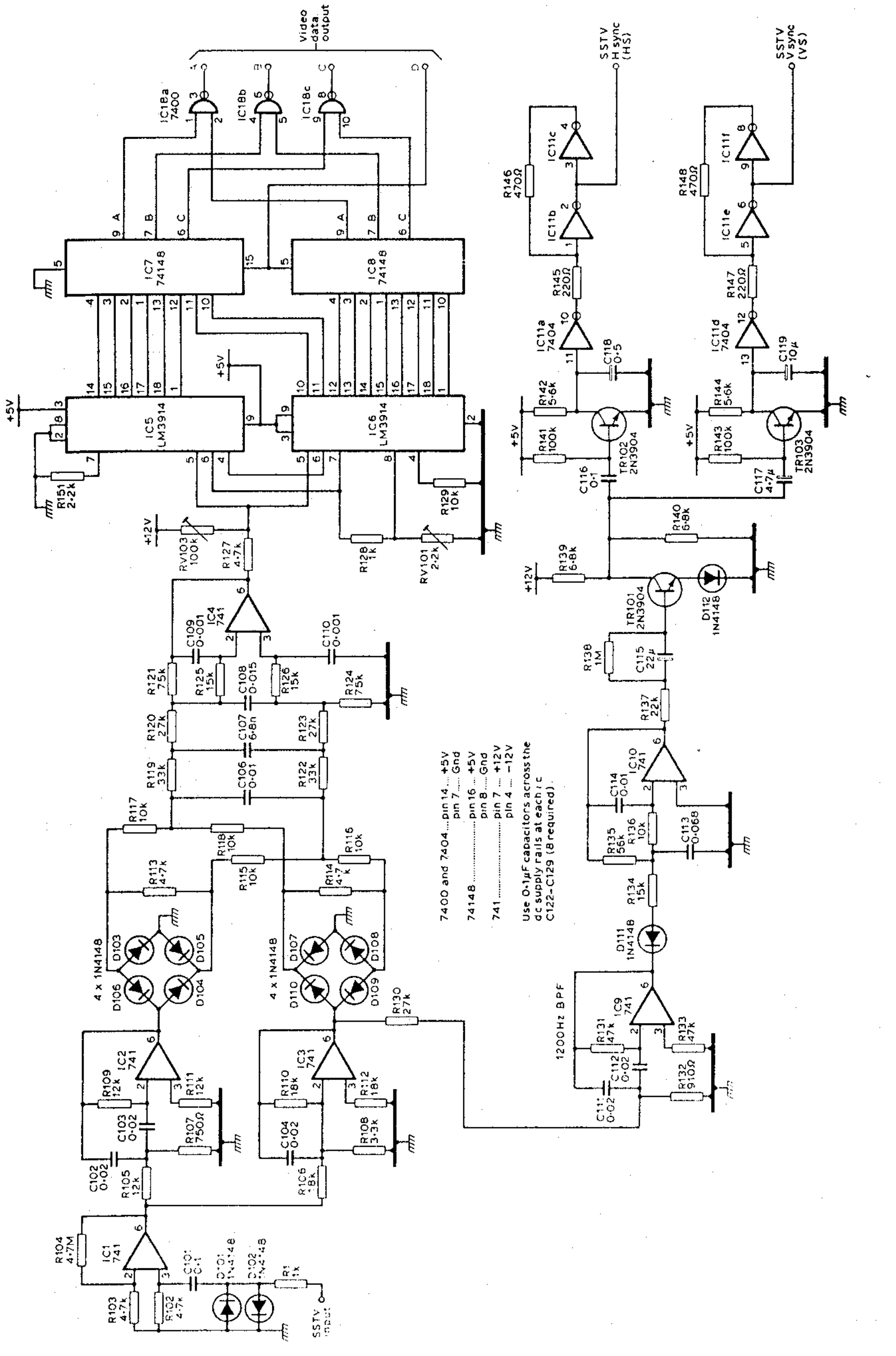


Fig.1: Circuit Diagram of the Analogue Board

The first essential is to obtain the circuit diagram or manual of the TV set in question. With this locate the cathode of the CRT and trace back to the video driver stages, which in modern sets comprises two transistors in a series configuration. Cut the track at the base input of the first of the driver transistors and bring a pair of miniature 75ohm coaxial leads from either side of the cut track to a convenient point on the case. These leads (as short as possible) should be connected to a switch and socket arrangement, where the switch is wired to open and close the cut PCB track, thus restoring normal TV operation when required. When the switch is in the open position the coaxial socket will be connected to the base of the driver transistor, therefore the SSTV video output from the converter can be plugged into this socket giving good quality and resolution. The ideal screen size for the SSTV format is 12-inches, any larger than this results in the pixels making up the picture appearing as large squares and the viewer would have to be 5ft or more from the screen to make the picture recognisable. **NOTE:** When using a converted TV set in this manner an isolation transformer must be used if none exists in the television already.

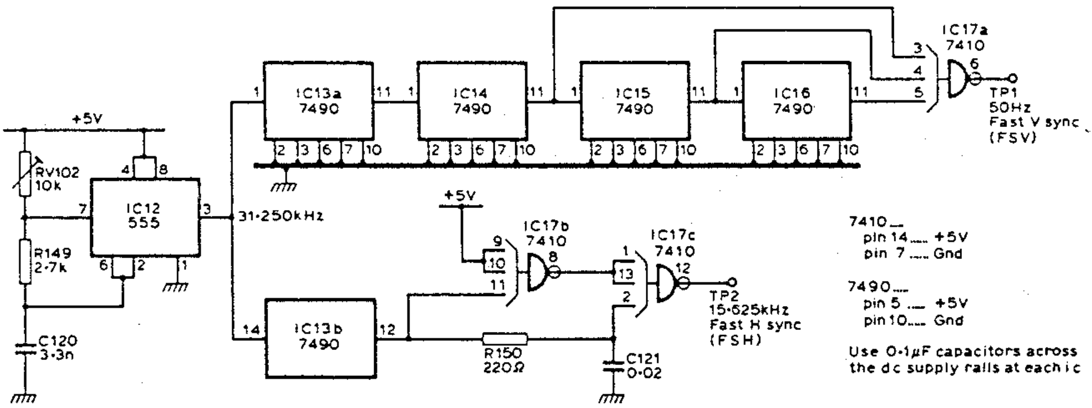


Fig.2: Fast-Scan Sync Generator (part of Analogue Board)

Power Supply

The power supply may be of any design or as that shown in Fig.4. In this a single 30VA transformer with two 15V secondaries is used for convenience, with the usual regulator configuration to provide plus and minus 12 and 5V. Current requirements are +5V @ 500mA, -5V @ 1mA, +12V @ 80mA and -12V @ 15mA; thus in most cases a common zener output could be used to cut costs. If a 7805 regulator is used for the +5V rail a good heat sink must be incorporated, a 78H05 (6A regulator) would of course allow plenty of scope for future memory expansion, say for colour where three memory boards are used. It may be found that these DC supply rails are noisy so it is advisable to fit a I00uF capacitor across all four even though bypass capacitors are fitted at almost all the ICs.

Construction

As stated earlier construction is quite straightforward using the set of printed circuit boards available from BATC Members' Services, with no difficult components to find, but a word of warning, this is not a junk box project. Use good quality components, 5% resistors (unless otherwise stated) and at least 10% tolerance capacitors. Use Mylar, metallised polyester or monolithic ceramic capacitors, particularly in the analogue filter circuitry. It is suggested that IC socket strip or Soldercon sockets be used instead of conventional bases for the ICs, as there are a lot of links that run under the IC areas. When wiring the memory board fit the socket strips first and then the links, noting that there are six long links using insulated wire labelled LK1 to 6. All resistors are 0.25W types to keep size to a minimum, the only pre-set, RV201, is a miniature vertical type. Printed circuit boards for this converter may be obtained from BATC Members' Services. Whatever type of cabinet or chassis is used provide plenty of ventilation to keep the temperature to a minimum.

Setting-Up And Calibration

No special equipment is required just a good multimeter (or DVM) and an oscilloscope. The only difficulty is an SSTV source, which is essential, but this can be overcome by either asking a transmitting station to record a transmission on cassette for you, or by recording an off-air transmission yourself (making sure that the receiver is tuned-in correctly). A grey-scale pattern is an ideal source for setting up the converter. Before connecting the source SSTV signal some preliminary adjustments have to be made, it is also advisable not to plug the ICs in yet. First check that the power supply is functioning correctly and verify that the correct voltages appear at the appropriate IC pins, switch off and plug in the ICs and again check the voltages.

Initially the analogue board is set up on it's own without the memory board connected. Set all three potentiometers to mid-position and, with the aid of the oscilloscope, adjust RV102 to give a squarewave output at pin-3 of IC12 at a frequency of 31.250 kHz, thus giving a corresponding output at TP1 (FSV) of 50 Hz and at TP2 (FSH) of 15.625 kHz.

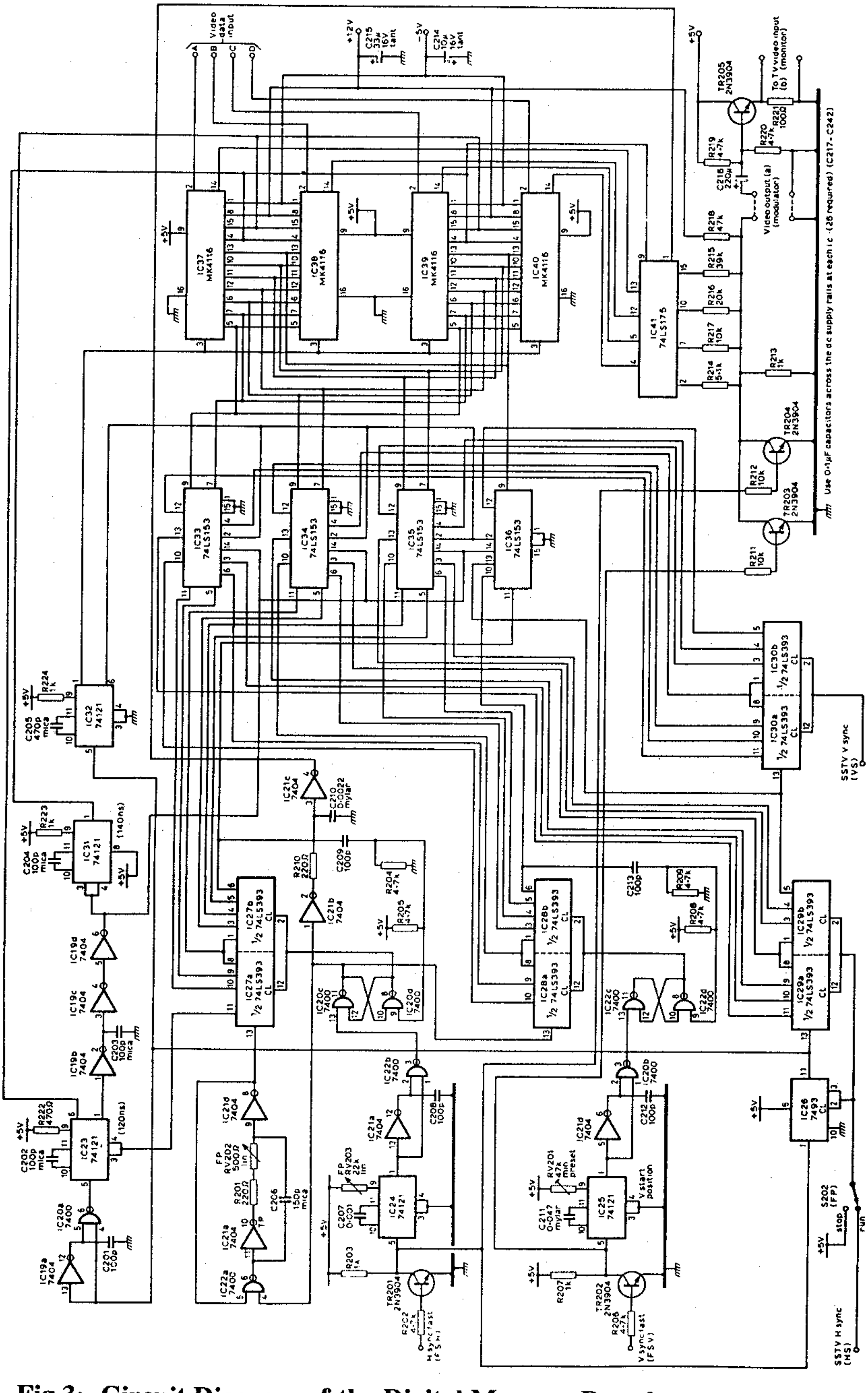


Fig.3: Circuit Diagram of the Digital Memory Board

The following adjustments are carried out with a SSTV source connected to the input. Connect the oscilloscope to TP3 (HS) and observe narrow pulses approximately 5.8cm apart at a timebase speed of 10ms; likewise at TP4 (VS), pulses should be observed every 8 seconds, note however that these pulses appear very quickly and are not permanently present as are the HS pulses. As a reassuring check at TP3 and TP4, stop and start the cassette recorder, or connect and disconnect the SSTV source if not coming from tape, whilst monitoring the oscilloscope and the pulses should start and stop accordingly. Now connect the oscilloscope to the video data outputs A, B, C and D in turn (IC18), again with the SSTV source connected. Varying width data pulses should be seen which verify that analogue-to-digital conversion is taking place. Leave RV101 and RV103 undisturbed for the time being.

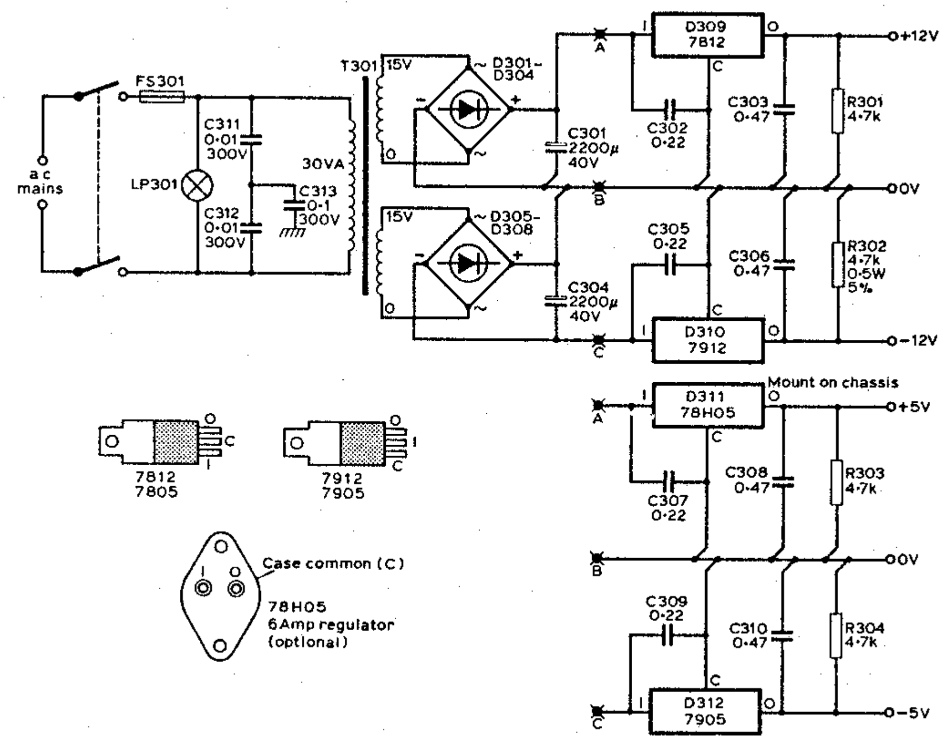


Fig.4: Power Supply Circuit

Connect the digital memory board to the analogue board not forgetting the two front panel potentiometers, RV202 and RV203, both of which should be set to mid-position. Leave the connection of S202 until later. Connect the output of the memory board to a video monitor, or TV if using a modulator, and with no SSTV input to the analogue board alternate black and white bands that move from top to bottom in approximately 8 seconds should be observed. Adjust RV202 and RV203 to produce a square and centralised format on the screen, with gaps at either side; this is normal for SSTV. Connect the SSTV source to the analogue board and a picture should appear, although it may not as yet be discernable. Adjust RV101 and RV103 on the analogue board for the best shading and resolution, this is where a grey-scale source is advisable, there will be some interaction between the two potentiometers but patience will get it right. Potentiometer RV201 on the digital board is adjusted to centralise the picture vertically on the screen. Finally connect S202 to the memory board and check the freeze-frame action when it is operated. Once all the adjustments have been completed all that remains to be done is to install the complete converter into the cabinet.

It may be found that some SSTV signals are more critical to tune-in than others. This is mainly because some stations use cassette tape-recorders for transmission of prerecorded pictures which often results in poor sync pulses as these recordings become worn. Also, of course, the other problem that can arise from using tape-recorders is the variation of speed that can occur. It will be noticed that the best resolution and definition is observed in the grey areas of the pictures, not at the extremes of black and white.

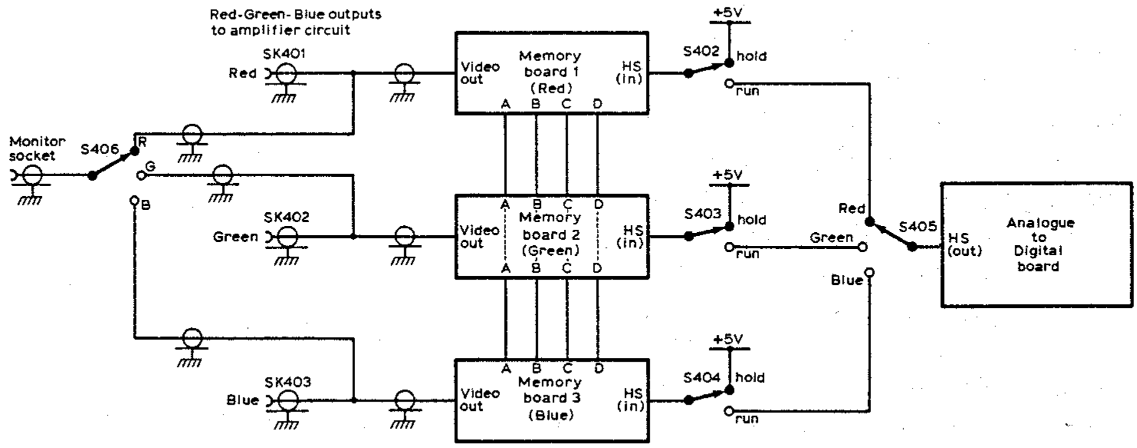
If noise is experienced on the received picture, usually line jitter, then an additional link from the earthy end of C120 direct to the circuit board 0 volt connection will improve the frequency stability of IC12, the cause of the problem.

Colour SSTV Reception

To use this converter system to receive colour pictures it is only necessary to add two extra memories to the digital circuits. This is achieved by ‘‘piggy-backing’’ two extra memory boards over the top of the digital board, circuit boards and all instructions for this are available from BATC Members’ Services. This system with one memory for each colour (Red, Green and Blue) produces a perfectly registered, clear, picture on the screen.

Colour Amplifier

There are three methods of getting your colour picture onto the screen: The first is to use a RGB colour monitor such as those used for home computers, the second is to use a colour modulator with a standard TV set, again with the Ioss of definition, the other is to build the colour amplifier described and feed the CRT of the colour TV or monitor directly.



Colour Memory Switching

The colour amplifier consists of three separate amplifiers, one for each colour, to drive the guns in the CRT, with the various controls for brightness, contrast and colour. It will also be necessary to feed mixed horizontal and vertical sync pulses from the converter, but minus the video information.

The circuit shown in Fig.5 is the sync mixer, the inputs to TR401 and TR402 are taken from the collectors of TR201 and TR202 on any of the memory boards. Using a common load resistor for TR401 and TR402 gives the required mixed sync which should be fed to the sync line of the TV. Components C401 and R405 ensure sufficient isolation when the TV is being used normally without the need to disconnect the external sync feed.

A suggested colour amplifier circuit is shown in Fig.6. This is very straightforward and can be built on a small piece of Vero-board and easily incorporated inside most TV sets. A small control panel can be made to house potentiometers RV401 to RV404, S401, BNC sockets for the colour inputs and a Phono socket for the sync (Fig.7). This control panel may then be mounted conveniently on the rear or side of the TV set. Alternatively build the unit into an external box with only the need to fit sockets 401 to 404 and the DC feeds from the TV to the rear panel of the set.

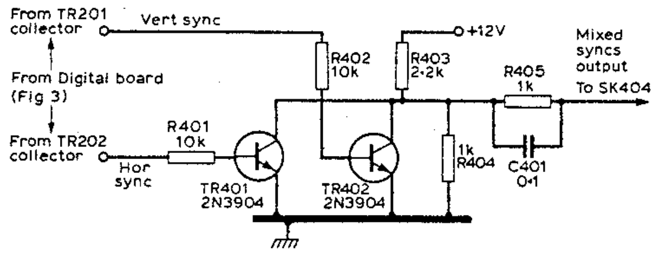


Fig.5: Sync Mixer Circuit

The 115V and 12V DC supply lines should already be available within the TV on it's own video amplifier panel.

The purpose of S401, a rotary 4pole/2way, is to switch from monitor position (1) to normal operation (2). The only real modification to the set on the video amplifier board is to break the red, blue and green tracks, or leads, to guns of the CRT and re-route via S401. A very important point to note is that this modification MUST NOT be carried out if the TV set does not have an isolating transformer. If the set is not isolated in this manner then a suitable transformer 1000VA) may be used externally.

Setting up the colour amplifier board requires a grey-scale picture source to achieve perfect results. Load each memory with the grey-scale and as each is transferred to the TV the picture is observed for pure black and white with no colour tinges. This balance is determined by the parameters of the colour tube and the colour amplifier circuit. If colour tinges do occur change resistors R410, R411 and R412 to 4.7k presets and adjust in turn to obtain a pure black and white picture. In the initial construction of the colour amplifier it may be convenient to mount resistors R410 to R412 on Vero-pins to facilitate easy conversion to presets if necessary. Also selection of close-matched transistors for TR403, TR404 and TR405 will help overcome this coloration.

Modifications and Additions

Since the original publication of the G3WCY converter system, several components have been found whose value and configuration required changing. These changes have been incorporated in the diagrams and explanations already given, however, there have also been other units built which complement the system, and these are described below.

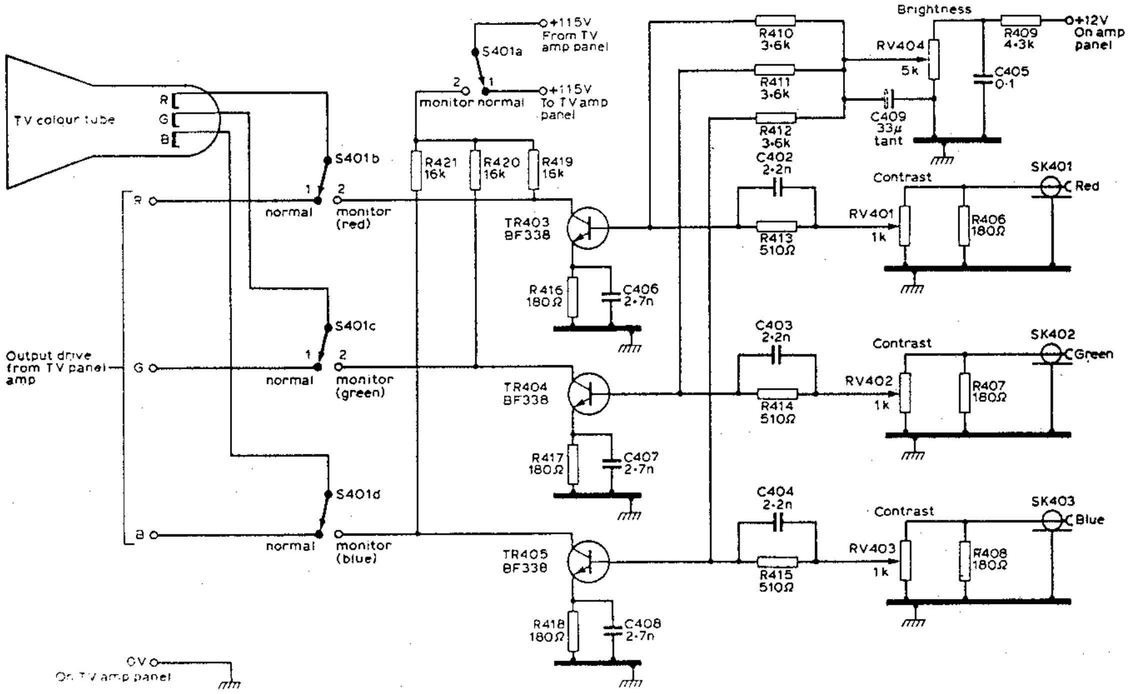


Fig.6: SSTV Colour Amplifier Circuit

Any modifications to the converter when it is used in conjunction with the transmit system are detailed in Chapter 6.

A simple tuning indicator is shown overleaf in Fig.8; this circuit can be built on a small piece of board and mounted directly onto switch S202, the LED is added to the front panel. As an SSTV signal is tuned in the LED lashes in sympathy with the received Line syncs, thus giving a guide to the correct tuning point at which the received picture should be taken, tune for best flicker.

Many stations have the facility to clear the screen, which is easily achieved by adding a switch in the input line from the radio receiver. On opening this switch the screen will be cleared as the slow-scan progresses. This switch could in fact be a multi-position one giving a choice of inputs as well as the clearing facility.

The circuit in Fig.9 can be incorporated to overcome the stripes displayed at the top and bottom of the slow-scan frame. These stripes are due to the short periods when the column counter is not working. Upon reaching 128 the counter resets, thus displaying the top line of the picture as stripes. The ‘‘clear’’ signal to IC28 (pin-12) is used to blank the display during the waiting periods created by the fast scan timing signals. The 470 ohm variable resistor controls the blanking voltage and must be set to the black level. The easiest method is to use an oscilloscope to monitor the video output signal whilst making the adjustment. If too low a blanking voltage is applied, then there will be sync problems.

Fig.10 overleaf shows another method of stripe blanking. This method involves a small modification to the Digital Memory Board; the connection to pin-1 of IC21 is broken, joining the cut tracks together with a wire link, leaving pin-1 isolated. The two diodes and the resistor may be easily wired to the back of the board.

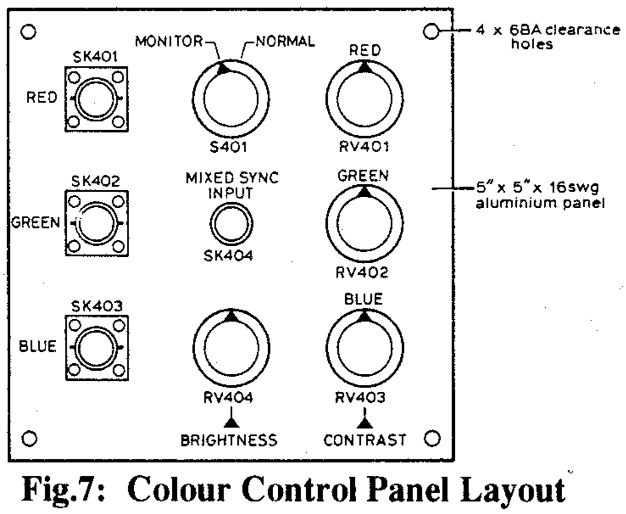


Fig.7: Colour Control Panel Layout

The width control modification shown in Fig.11 permits the full memory map to be used when receiving, as the existing design only utilises the complete memory when receiving 60 Hz generated pictures.

Line-sequential-colour is advantageous in a colour receive system as it allows for normal (normal for SSTV that is) colour reception. The circuit shown in Fig.12 selects each of the three memories in turn and loads the respective colour into it's memory, thereby taking 21 seconds to write the frame on the screen of the RGB monitor or TV conversion. A printed circuit board incorporating this modification and the width control is available from BATC Members' Services with full instructions.

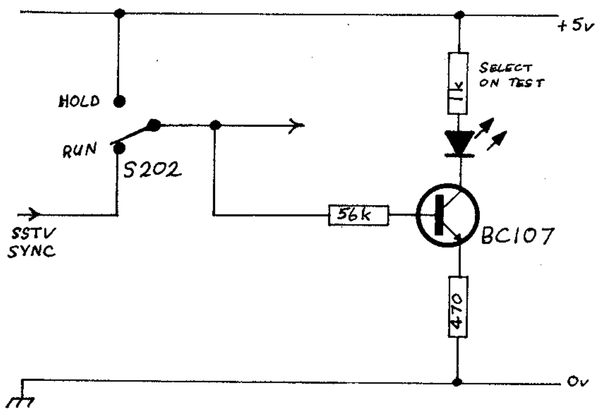


Fig.8: SSTV Tuning Indicator

Due to the design of the frequency-to-voltage conversion stage in the system, blurring of the picture has to be traded for ripple for a noise-free grey level be realised. The circuit shown overleaf in Fig.13 is a suggested way of overcoming this. IC1a is a 3-pole filter which removes unwanted noise above 2.3 kHz. IC1b limits the sine-wave and, through TR1, generates the timing signal for the analogue switches (IC2). During the first half cycle of the incoming frequency, the voltage on Ca ramps up until the timing signal changes the state of the analogue switches. The voltage reached is stored, buffered to IC1c and fed to the output amplifier IC1d. During the next half cycle the process is repeated for Cb. Potentiometer RV1 adjusts the constant current charge to Ca and Cb and is set to give zero ripple for a steady input frequency, it is best set when receiving at 1.5 kHz. The printed circuit board and instructions available from Members Services for this modification does not, however, incorporate the circuit in Fig.14, which is recommended for use at the input of this frequency-to-voltage unit in order to obtain a standard drive voltage for a varying input level. Also it is very important that the incoming signal is not distorted at all, due to overdriving the audio stages in the radio receiver, as any such asymmetrical distortion will cause an error in the period of the half cycle times and a resultant patterning effect on the screen.

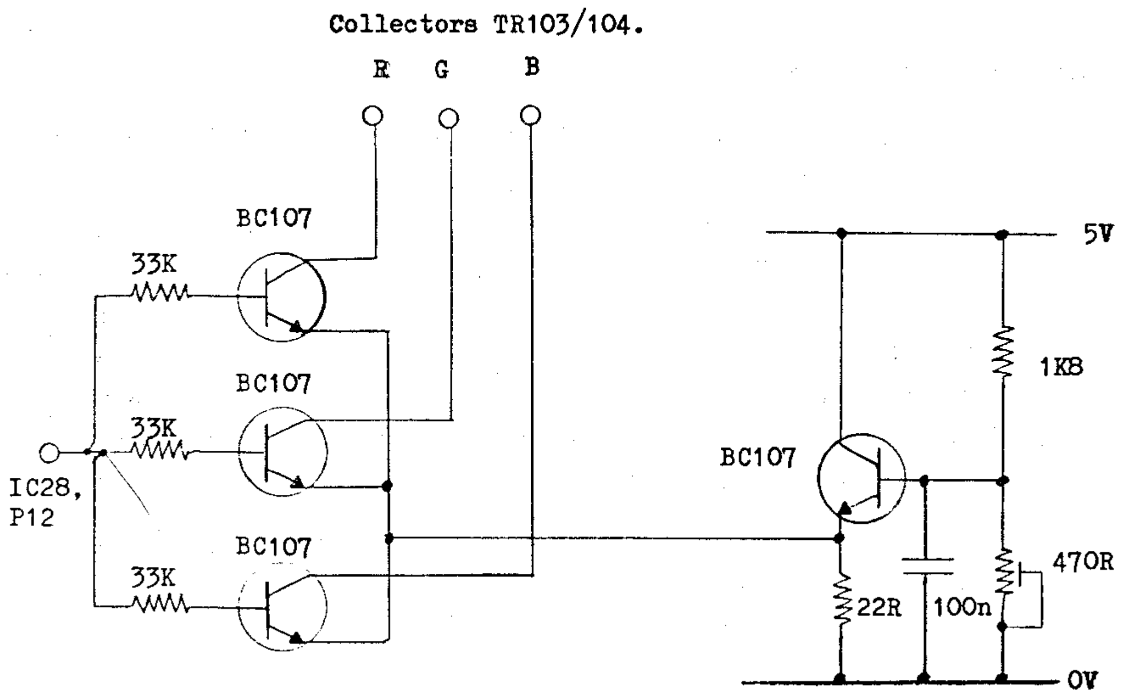


Fig.9: Stripe Blanking Circuit (G4ENA)

The Transmit converter described in this section has been designed by G4ENA to be compatible with the G3WCY receive converter described in Chapter 5 and a set of printed circuit boards is available from BATC Members' Services.

The facilities offered by this design are:

Auto picture snatch of Fast-scan pictures.

''Look through'' memory for fast camera adjustment.

Receive digital board memory used to store transmit pictures - allows re-transmission of a received picture.

Positive and negative video control.

Width control and Line-sequential colour receive for the G3WCY converter, (as already described in that section).

21-second Line-sequential colour Transmission, (3 memories required).

Audio output for direct connection to a microphone socket.

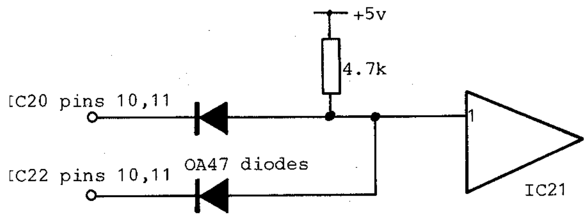


Fig.10: Stripe Blanking Circuit (G8KZG)

Circuit Description

Reference should be made to the circuit diagram, Fig.1, and the switching/interconnection diagram, Fig.2.

The video signal selected by S13 is converted to a 4-bit grey code by the eight dual-comparators, IC1 to IC8. The video is latched by IC5 before each of the 128 pixels that make up a line are loaded into the memory. IC5 performs a gray-code to binary conversion and the video is then stored as a 4-bit binary picture in the receive converter memory. Selection of either fast-scan digital video, or slow-scan receive video, is carried out by IC7.

Selection of the fast-scan sync pulses is by S14. Transistors Tr1, 2 and 3 form a sync separator circuit which extracts the external pulses for the memory board. If an independent sync source is used, rather than the composite video, then the thin piece of track connecting pins "A" and "B" should be cut.

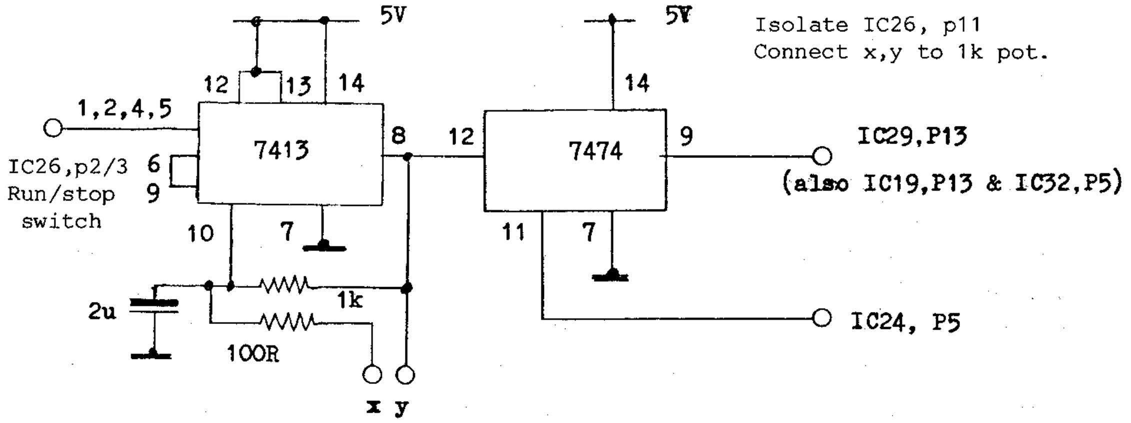


Fig.11: Width Control

The video information to be transmitted is selected by S1 which controls the tristate buffers IC13 and IC14, a logic "low" enables the buffers. The video is latched at the slow-scan rate by IC12, before conversion to a scaled, 16-level analogue voltage by resistors R23, 24, 32 and 33. Potentiometers RV1 and RV3 set the black and white span of the picture.

The SSTV FM audio is generated by IC16 and to this is added the line and field sync pulses, by IC17c switching in the voltage from RV2. Any unwanted high frequency components of the FM audio are removed by IC15, which is configured as a 2-pole low-pass filter. Potentiometer RV4 adjusts the level of audio drive to the transmitter microphone input.

The dual monostable IC24 produces slow-scan line and field sync pulses from timing information derived from the receive converter memory board address counters. The slow-scan line oscillator IC23 is gated off during sync pulses which permits the maximum use of available memory for SSTV pictures. Width control potentiometer RV5 adjusts the oscillator frequency to cater for both 50 Hz and 60 Hz formats.

Line-sequential colour timing is controlled by ICs 18, 19 and 20. The link from "b" to "c" can be connected to "a" and "b" This will load a 14-second, 256 line picture into the red and green memories.

Typical signals found at various points in the circuit are shown in the waveform diagrams of Fig.3.

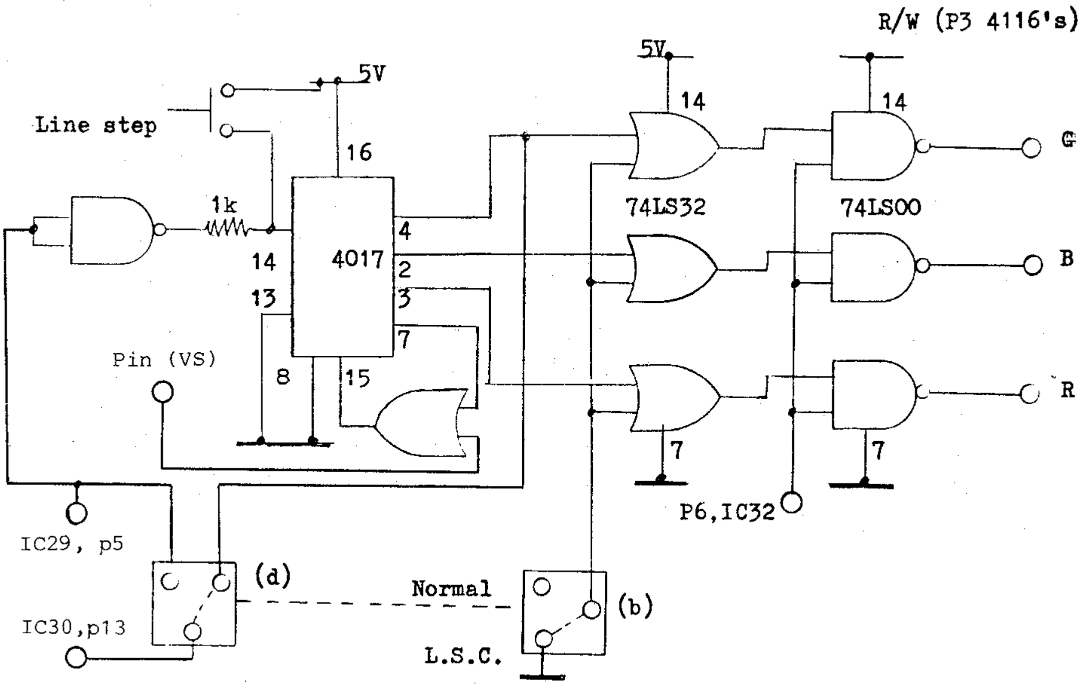


Fig.12: Line Sequential Colour

Construction

It is recommended that the printed circuit boards are housed in a metal instrument case, with removable side panels allowing easy access for wiring. Full information for a suitable front panel layout may be found in Fig.4.

The transmit board uses the IC pins to connect top and bottom tracks, therefore it is not possible to use conventional IC sockets, however "Molex" or "Soldercon" socket strips may be used. It is advisable to solder the CMOS components in last.

Careful checks should be made for shorts, solder splashes or IC pins only soldered on one side, where they should be soldered on both. When all visual checks prove satisfactory the boards may be installed and connected up, using screened cable for all video and audio signals.

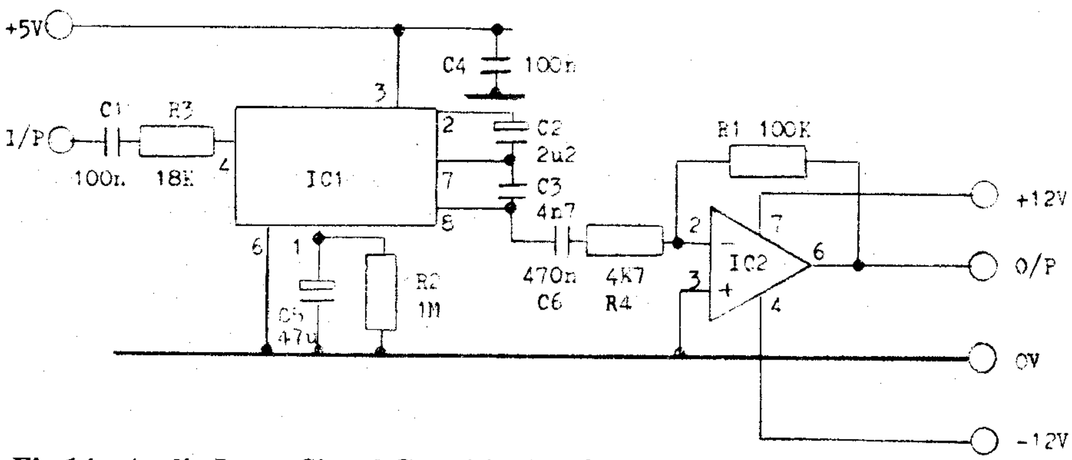


Fig.14: Audio Input Signal Conditioning Circuit

Calibration

The width oscillator is set using an oscilloscope to monitor the waveform at ''W2'' (see waveform 8, Fig.3 overleaf), whilst selecting a value for R50 (in the region of 20k) and adjust RV5 until the correct waveform is observed. To set the sync frequency, connect TP1 to +5v and, whilst monitoring the audio frequency output, adjust RV2 for a frequency of 1200 Hz. The simplest way to set the black and white levels is to load a black and white picture into the memory and feed "AF" back into the receive input, adjusting potentiometers RV1 and RV3 until peak black and white are achieved.

It is most important that the receive converter has been correctly calibrated first if this method is used to set the black and white levels. An alternative method of setting black and white is to connect "W2" to 0v, which will inhibit the line oscillator and prevent the generation of sync pulses. With a peak white video signal (adjust "Brill" control) and S5 set to CONTinuous, adjust RV3 for a frequency of 2300 Hz (measuring at "AF"). Operate S10 (video invert switch) and adjust RV1 for a frequency of 1500 Hz. Repeat until both black and white frequencies are correct.

Modifications To The G3WCY Converter

Analogue board: It is necessary to invert the polarity of the sync pulse "VS". To do this the printed circuit track from pins 6 and 9 of IC11 to the "VS" output pin must be cut, ensuring that pins-6 and 9 remain connected. The "VS" output is then taken from pin-8 of IC11.

Digital board: IC32 must time out before IC31 to enable the SSTV picture to be sampled for transmission. This is effected by replacing C205 with a 220pF, or a select-on-test value close to this to achieve correct timing. As the memory’s read/write lines are now controlled from the transmit board by switches S2 to SB, the track connecting IC32 pin-1 to pin-3’s of IC37-40 must be cut on each memory board (ensure that the pin-3’s of IC37-40 remain connected together).

If the G4ENA memory boards have been fitted to the converter, then the CAS lines (pin-15 of the memory IC’s), which are at present switched, must be reconnected to IC31 pin-1. Only the read/write lines (pin-3’s) of each memory IC are independently controlled.

A small modification to the "VS" circuitry also has to be carried out on the memory board. Cut the track from IC26 pin-11 to IC29 pin-13. Cut the track from IC29b pin-5 to IC30 pin-13. Connect "VS" from the memory board to "X" on the transmit board.

Constructors should note that if you have already built the line-sequential colour and width control circuits as additions to the G3WCY Converter, they are accommodated on the transmit converter board supplied from BATC Members’ Services.

Operation

To receive a picture into a memory, e.g: RED, the switches are set in the following manner; S2 to RX, S6 to Write, S15 to F.S.C. and S14 to INT. Either INT or EXT syncs can be used if a camera is connected. Adjustment of RV5 will load the whole picture into memory.

To transmit a picture from a memory, e.g: BLUE, the switches are set as follows: S4 to TX, S8 to Write, S10 to +, S5 to CONT and S14 to EXT. Adjust CONTRAST and BRILL to produce a picture which spans all the grey levels from peak white to peak black. To store the picture in memory set S8 to HOLD. To transmit the picture set S1 to B.

To receive a line-sequential picture all three memories must be enabled and S15 set to L.S.C. If a field sync pulse is missed and the wrong colour is being loaded into the wrong memory, then correction is possible using the STEP push-button S11. Re-transmission of the received colour is achieved by setting S1 to L.S.C. The 21-second mode of line-sequential colour could also be used to transmit three separate black and white pictures at a time.

It has been found on some units that unreliable "VS" may cause some problems. If this is the case, then connect a 1M resistor from the junction of C20 and D8 to the +5v rail, likewise connect a 1M resistor from the junction of C19 and D7 to +5v.

Transmit Auxiliaries

A transmit auxiliary board is available from Members Services which has been designed to complement the transmit converter. On this board are three separate circuits (Fig.5):

Cursor

Colour picture snatch

Three video buffers and sync combiner.

1) Cursor (IC1)

A 4-bit magnitude comparator compares the binary value of the fast-scan and slow-scan counters (IC's 28 and 30) and, when both are equal, the A = B output (pin-6) pulses high. This pulse appears as a bright strip and moves down the screen as the SSTV picture is transmitted. Tr2, controlled by TX/RX, clamps the pulse when receiving as tuning is difficult when it is present. (A cursor is unnecessary on receive). Pin Cl connects to any one input of the video buffers.

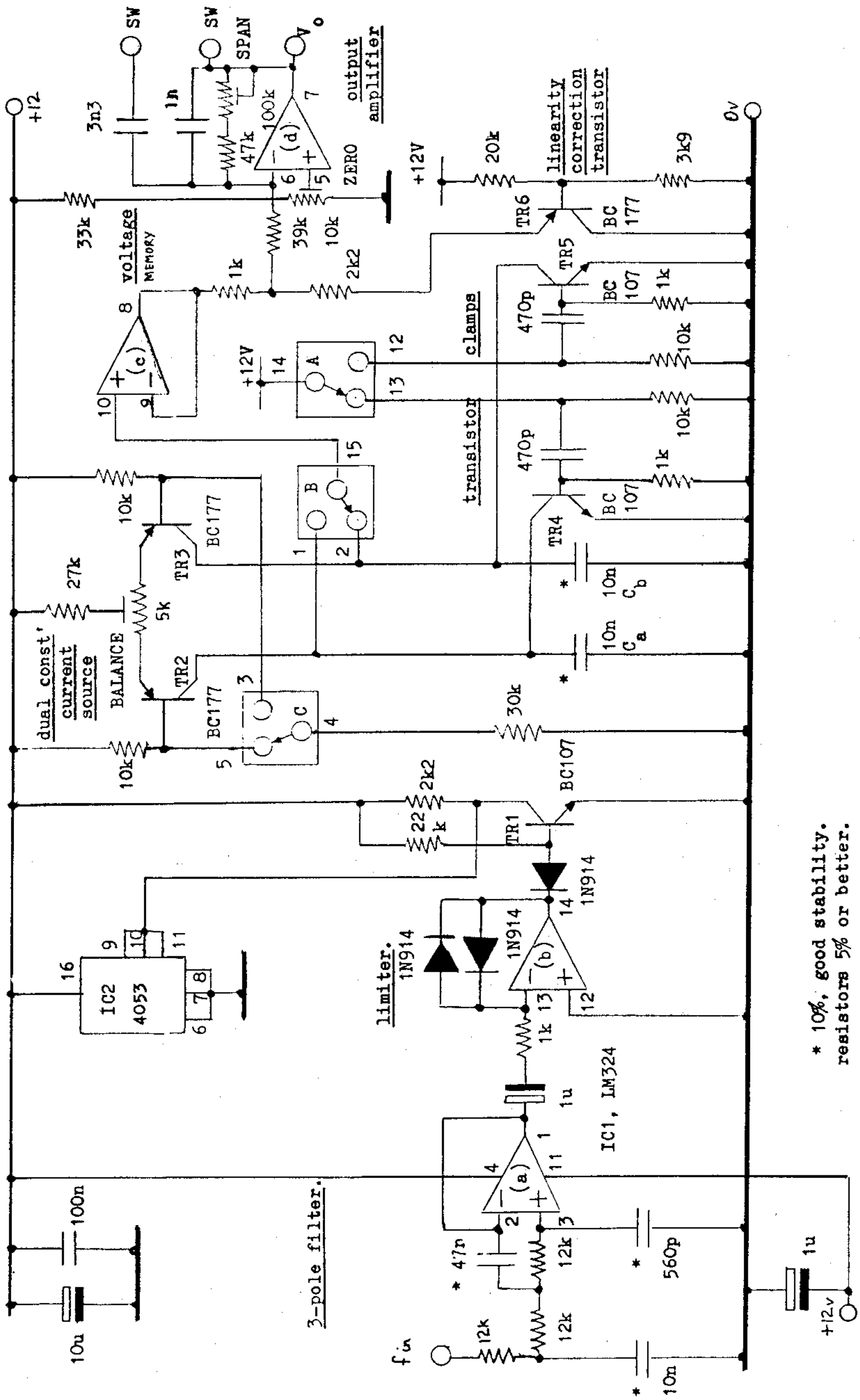


Fig.13: Frequency to Voltage Converter Circuit

2) Colour Picture Snatch

This facility allows the separate R,G and B frames of a colour picture to be loaded into memory during the SSTV frame pulse. This frame pulse has to be extended to at least 80ms to ensure that three complete frames can be sampled. To ensure that this pulse length is correct, change R46 on the transmit board to 750k. When in receive IC2 connects R2 (Auxiliary board) across R46 (TX board) to shorten the pulse length again.

When IC3 is enabled it closes the R,G and B video switches in turn (IC4) and, at the same time, writes the respective video information into memory by electronically operating the write/hold switches (S6-S8).

S11 is a three-position switch (DPDT, ON-OFF-momentary ON). With S11 in the OFF (centre) position, S5 controls CONTinuous and SNATCH sampling of the fast-scan colour video. CONT allows setting of the contrast and brilliance controls and SNATCH takes a new picture after the transmission of the existing one in memory.

S11 up-locks the colour picture in memory and SNATCH (step RX) instantly resets the frame, loads the next picture and commences transmission. This is the momentary switch position. Colour snatch is only possible when S9 is set to L.S.C. R17 provides a high impedance DC path to ensure that C8 is correctly charged before RGB sampling takes place.

No extra holes need be drilled in the front panel as the additional switching is achieved by increasing the poles of S5 and S11.

3) Video Buffers and Sync Combiner

It will be necessary to drive a colour monitor from the RGB memory outputs. Three buffers, the same as on the memory board, can be used for this purpose. Also mixed syncs are available from TR5.

The switching of video signals will vary according to individual requirements but an example is given below for guidance (Fig.6). It caters for two B/W cameras and one RGB source.

The G4ENA Transmit Converter

The Transmit converter described in this section has been designed by G4ENA to be compatible with the G3WCY receive converter described in Chapter 5 and a set of printed circuit boards is available from BATC Members' Services.

- The facilities offered by this design are:
- Auto picture snatch of Fast-scan pictures.
- ''Look through'' memory for fast camera adjustment.
- Receive digital board memory used to store transmit pictures - allows re-transmission of a received picture.
- Positive and negative video control.
- Width control and Line-sequential colour receive for the G3WCY converter, (as already described in that section).
- 21-second Line-sequential colour Transmission, (3 memories required).
- Audio output for direct connection to a microphone socket.

Circuit Description

Reference should be made to the circuit diagram, Fig.1, and the switching/interconnection diagram, Fig.2.

The video signal selected by S13 is converted to a 4-bit grey code by the eight dual-comparators, IC1 to IC8. The video is latched by IC5 before each of the 128 pixels that make up a line are loaded into the memory. IC5 performs a gray-code to binary conversion and the video is then stored as a 4-bit binary picture in the receive converter memory. Selection of either fast-scan digital video, or slow-scan receive video, is carried out by IC7.

Selection of the fast-scan sync pulses is by S14. Transistors Tr1, 2 and 3 form a sync separator circuit which extracts the external pulses for the memory board. If an independent sync source is used, rather than the composite video, then the thin piece of track connecting pins "A" and "B" should be cut.

The video information to be transmitted is selected by S1 which controls the tristate buffers IC13 and IC14, a logic "low" enables the buffers. The video is latched at the slow-scan rate by IC12, before conversion to a scaled, 16-level analogue voltage by resistors R23, 24, 32 and 33. Potentiometers RV1 and RV3 set the black and white span of the picture.

The SSTV FM audio is generated by IC16 and to this is added the line and field sync pulses, by IC17c switching in the voltage from RV2. Any unwanted high frequency components of the FM audio are removed by IC15, which is configured as a 2-pole low-pass filter. Potentiometer RV4 adjusts the level of audio drive to the transmitter microphone input.

The dual monostable IC24 produces slow-scan line and field sync pulses from timing information derived from the receive converter memory board address counters. The slow-scan line oscillator IC23 is gated off during sync pulses which permits the maximum use of available memory for SSTV pictures. Width control potentiometer RV5 adjusts the oscillator frequency to cater for both 50 Hz and 60 Hz formats.

Line-sequential colour timing is controlled by ICs 18, 19 and 20. The link from "b" to "c" can be connected to "a" and "b" This will load a 14-second, 256 line picture into the red and green memories.

Typical signals found at various points in the circuit are shown in the waveform diagrams of Fig.3.

Construction

It is recommended that the printed circuit boards are housed in a metal instrument case, with removable side panels allowing easy access for wiring. Full information for a suitable front panel layout may be found in Fig.4.

The transmit board uses the IC pins to connect top and bottom tracks, therefore it is not possible to use conventional IC sockets, however "Molex" or "Soldercon" socket strips may be used. It is advisable to solder the CMOS components in last.

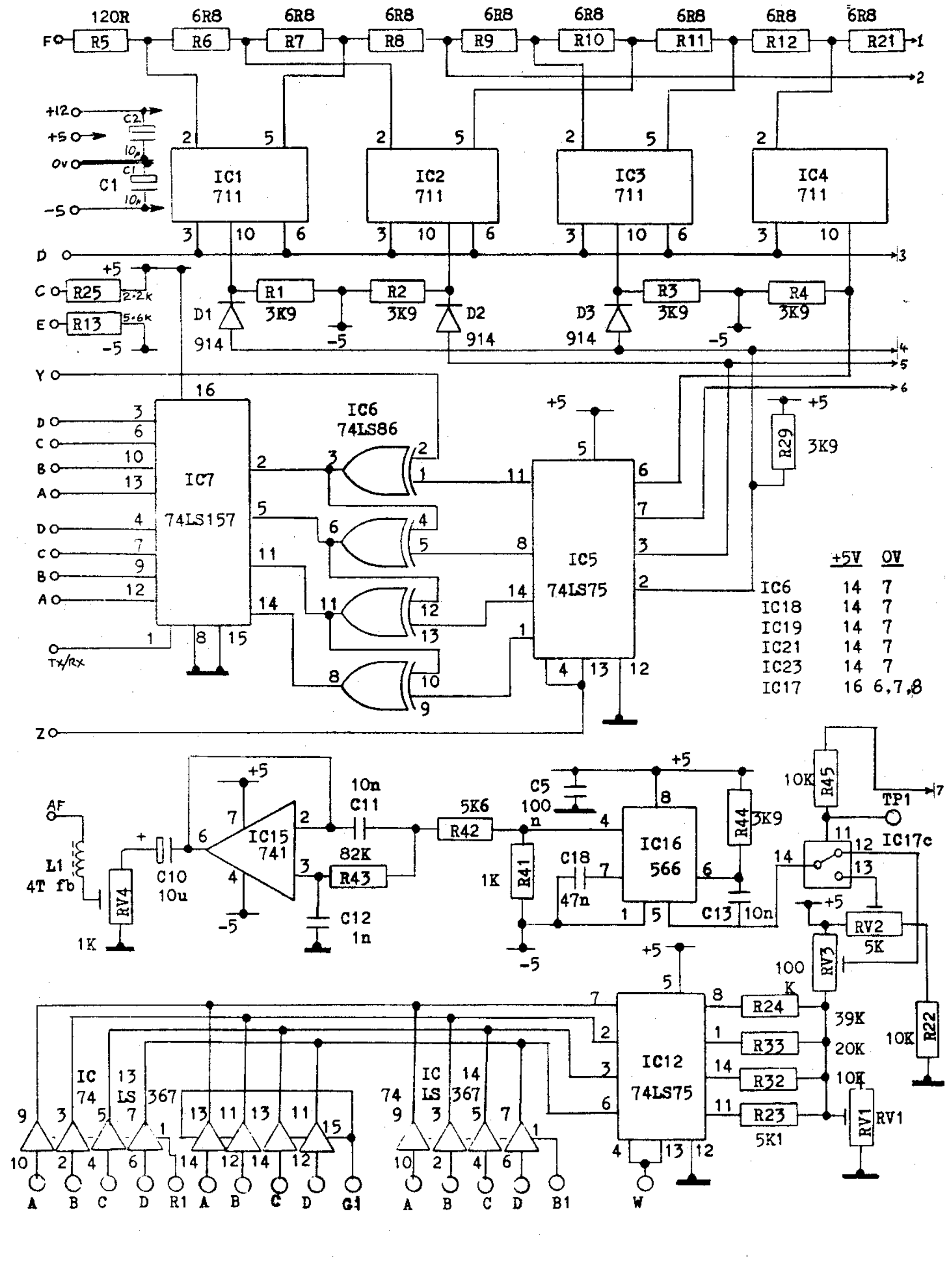
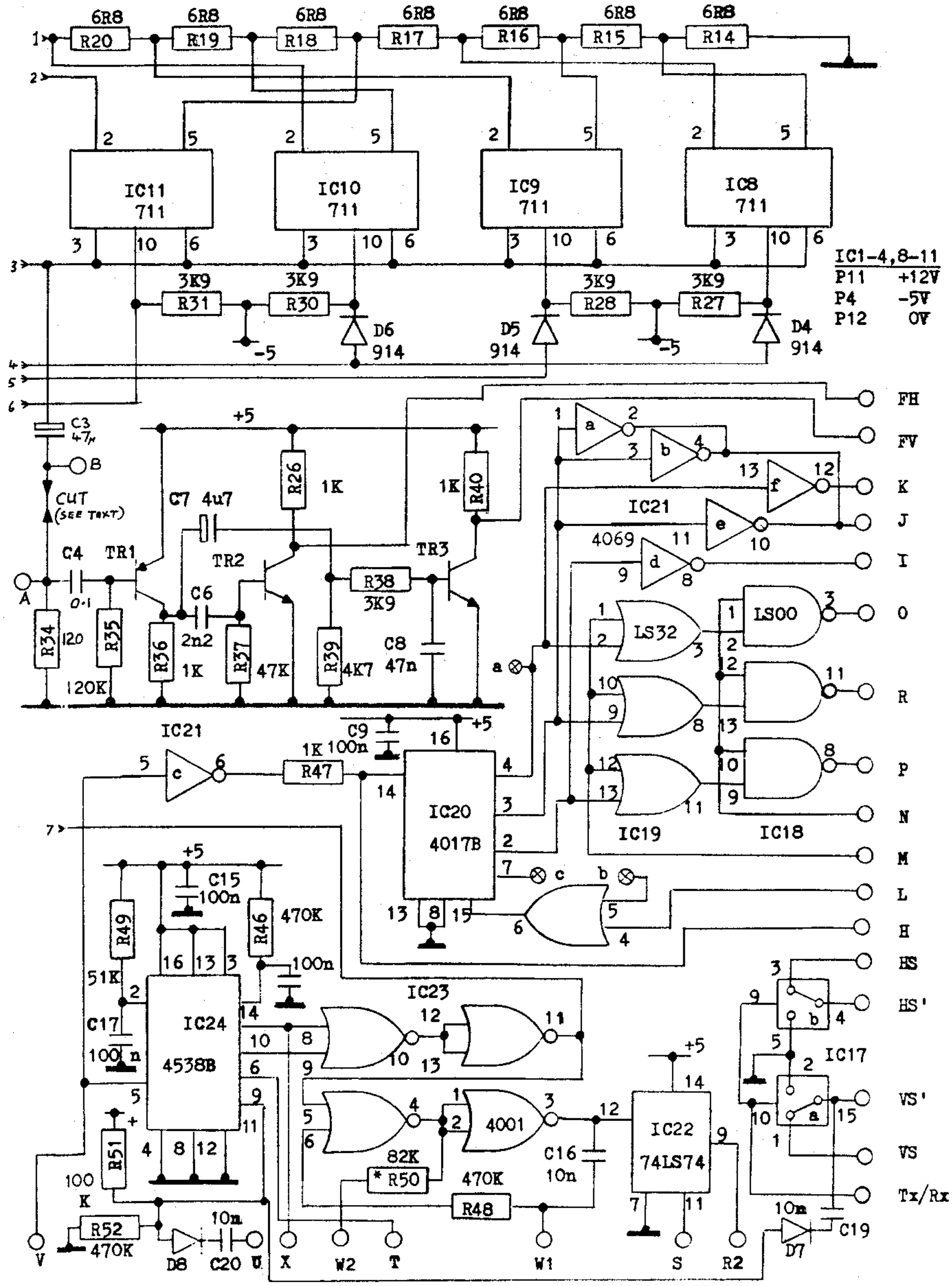


Fig.1: Circuit Diagram of the Transmit Converter

Careful checks should be made for shorts, solder splashes or IC pins only soldered on one side, where they should be soldered on both. When all visual checks prove satisfactory the boards may be installed and connected up, using screened cable for all video and audio signals.

Calibration

The width oscillator is set using an oscilloscope to monitor the waveform at ‘‘W2’’ (see waveform 8, Fig.3 overleaf), whilst selecting a value for R50 (in the region of 20k) and adjust RV5 until the correct waveform is observed. To set the sync frequency, connect TP1 to +5v and, whilst monitoring the audio frequency output, adjust RV2 for a frequency of 1200 Hz. The simplest way to set the black and white levels is to load a black and white picture into the memory and feed "AF" back into the receive input, adjusting potentiometers RV1 and RV3 until peak black and white are achieved.



It is most important that the receive converter has been correctly calibrated first if this method is used to set the black and white levels. An alternative method of setting black and white is to connect "W2" to 0v, which will inhibit the line oscillator and prevent the generation of sync pulses. With a peak white video signal (adjust "Brill" control) and S5 set to CONTinuous, adjust RV3 for a frequency of 2300 Hz (measuring at "AF"). Operate S10 (video invert switch) and adjust RV1 for a frequency of 1500 Hz. Repeat until both black and white frequencies are correct.

Modifications to the G3WCY Converter

Analogue board: It is necessary to invert the polarity of the sync pulse "VS". To do this the printed circuit track from pins 6 and 9 of IC11 to the "VS" output pin must be cut, ensuring that pins-6 and 9 remain connected. The "VS" output is then taken from pin-8 of IC11.

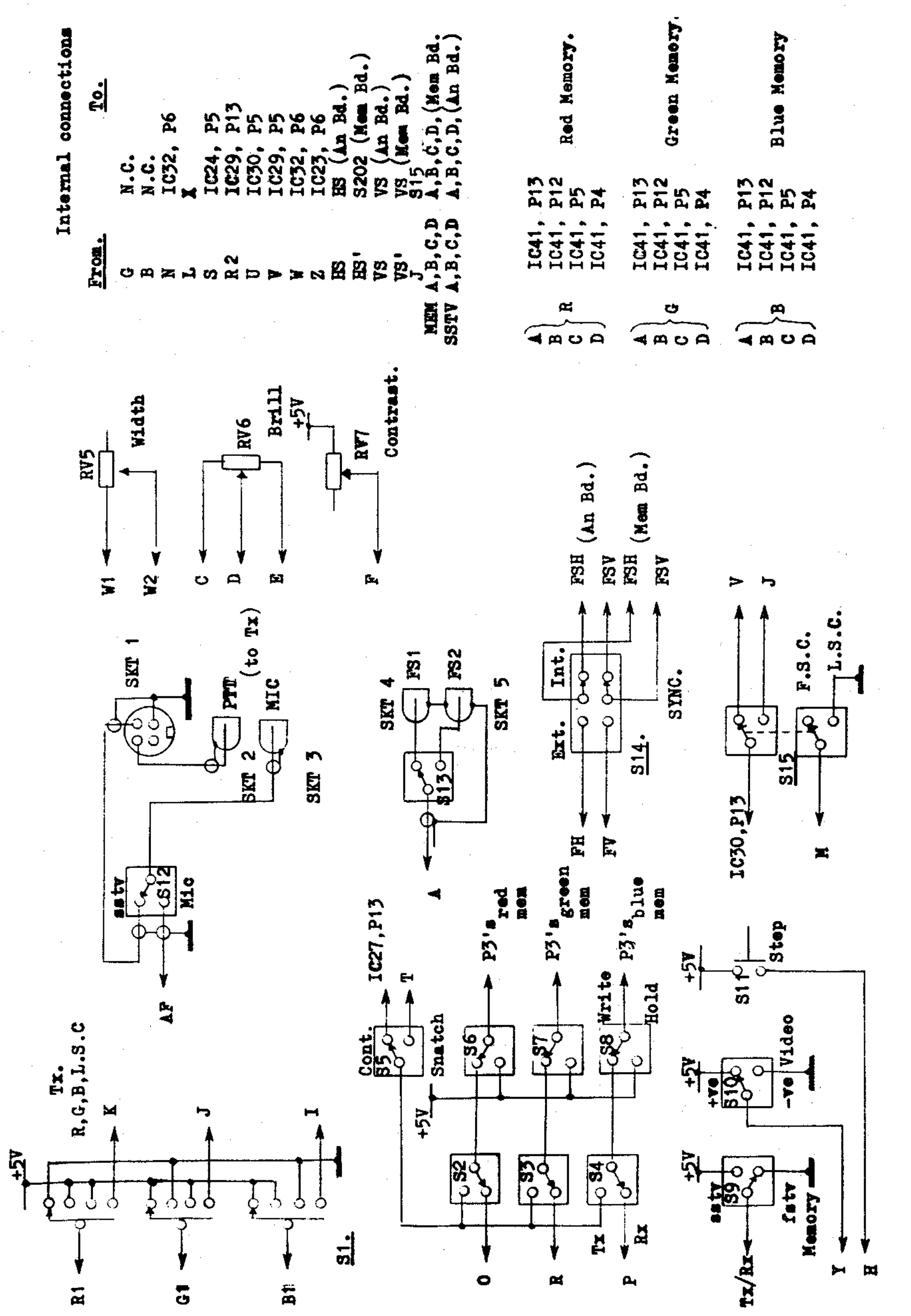


Fig.2: Switching and Interconnection Diagrams

Digital board: IC32 must time out before IC31 to enable the SSTV picture to be sampled for transmission. This is effected by replacing C205 with a 220pF, or a select-on-test value close to this to achieve correct timing. As the memory's read/write lines are now controlled from the transmit board by switches S2 to SB, the track connecting IC32 pin-1 to pin-3's of IC37-40 must be cut on each memory board (ensure that the pin-3's of IC37-40 remain connected together).

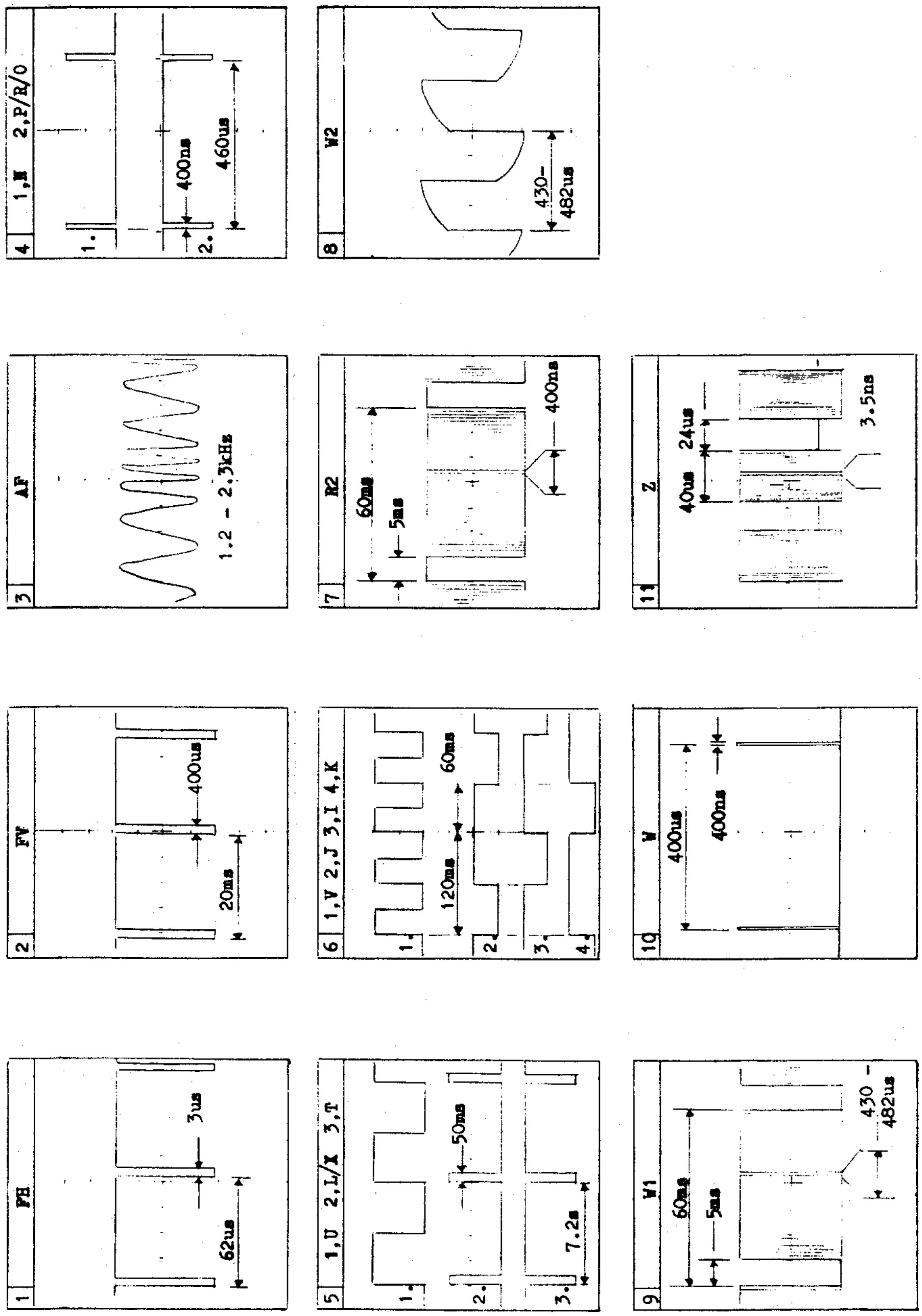


Fig.3: Waveform Diagrams

If the G4ENA memory boards have been fitted to the converter, then the CAS lines (pin-15 of the memory IC's), which are at present switched, must be reconnected to IC31 pin-1. Only the read/write lines (pin-3's) of each memory IC are independently controlled.

A small modification to the "VS" circuitry also has to be carried out on the memory board. Cut the track from IC26 pin-11 to IC29 pin-13. Cut the track from IC29b pin-5 to IC30 pin-13. Connect "VS" from the memory board to "X" on the transmit board.

Constructors should note that if you have already built the line-sequential colour and width control circuits as additions to the G3WCY Converter, they are accommodated on the transmit converter board supplied from BATC Members' Services.

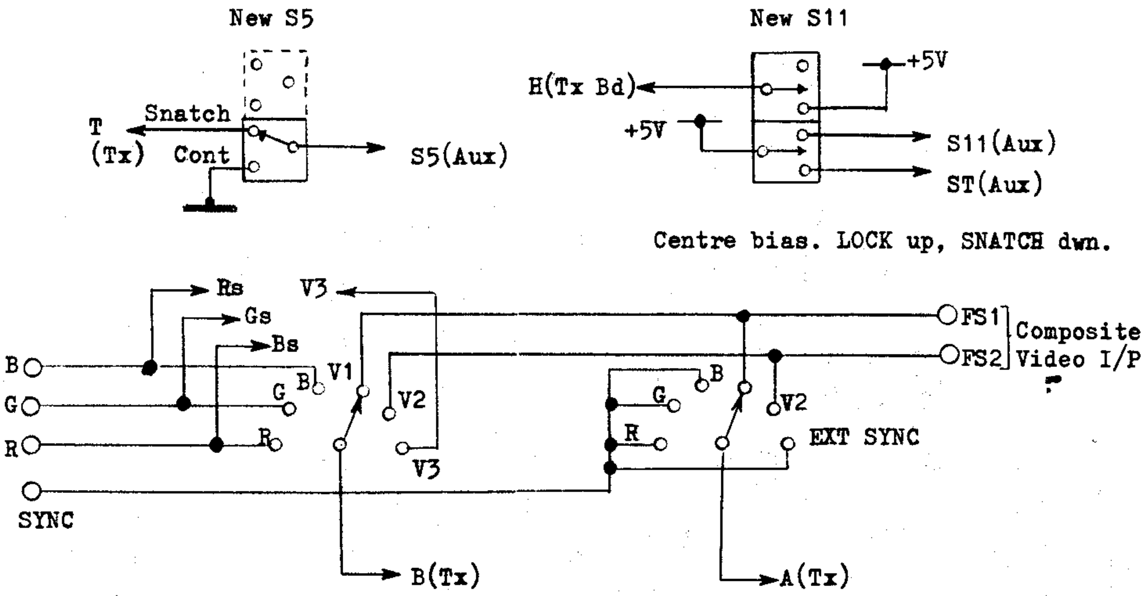


Fig.6: Suggested Switching Arrangement

Operation

To receive a picture into a memory, e.g: RED, the switches are set in the following manner; S2 to RX, S6 to Write, S15 to F.S.C. and S14 to INT. Either INT or EXT syncs can be used if a camera is connected. Adjustment of RV5 will load the whole picture into memory.

To transmit a picture from a memory, e.g: BLUE, the switches are set as follows: S4 to TX, S8 to Write, S10 to +, S5 to CONT and S14 to EXT. Adjust CONTRAST and BRILL to produce a picture which spans all the grey levels from peak white to peak black. To store the picture in memory set S8 to HOLD. To transmit the picture set S1 to B.

To receive a line-sequential picture all three memories must be enabled and S15 set to L.S.C. If a field sync pulse is missed and the wrong colour is being loaded into the wrong memory, then correction is possible using the STEP push-button S11. Re-transmission of the received colour is achieved by setting S1 to L.S.C. The 21-second mode of line-sequential colour could also be used to transmit three separate black and white pictures at a time.

It has been found on some units that unreliable "VS" may cause some problems. If this is the case, then connect a 1M resistor from the junction of C20 and D8 to the +5v rail, likewise connect a 1M resistor from the junction of C19 and D7 to +5v.

Transmit Auxiliaries

A transmit auxiliary board is available from Members Services which has been designed to complement the transmit converter. On this board are three separate circuits (Fig.5):

1. Cursor
2. Colour picture snatch
3. Three video buffers and sync combiner.

1) Cursor (IC1)

A 4-bit magnitude comparator compares the binary value of the fast-scan and slow-scan counters (IC's 28 and 30) and, when both are equal, the A = B output (pin-6) pulses high. This pulse appears as a bright strip and moves down the screen as the SSTV picture is transmitted. Tr2, controlled by TX/RX, clamps the pulse when receiving as tuning is difficult when it is present. (A cursor is unnecessary on receive). Pin Cl connects to any one input of the video buffers.

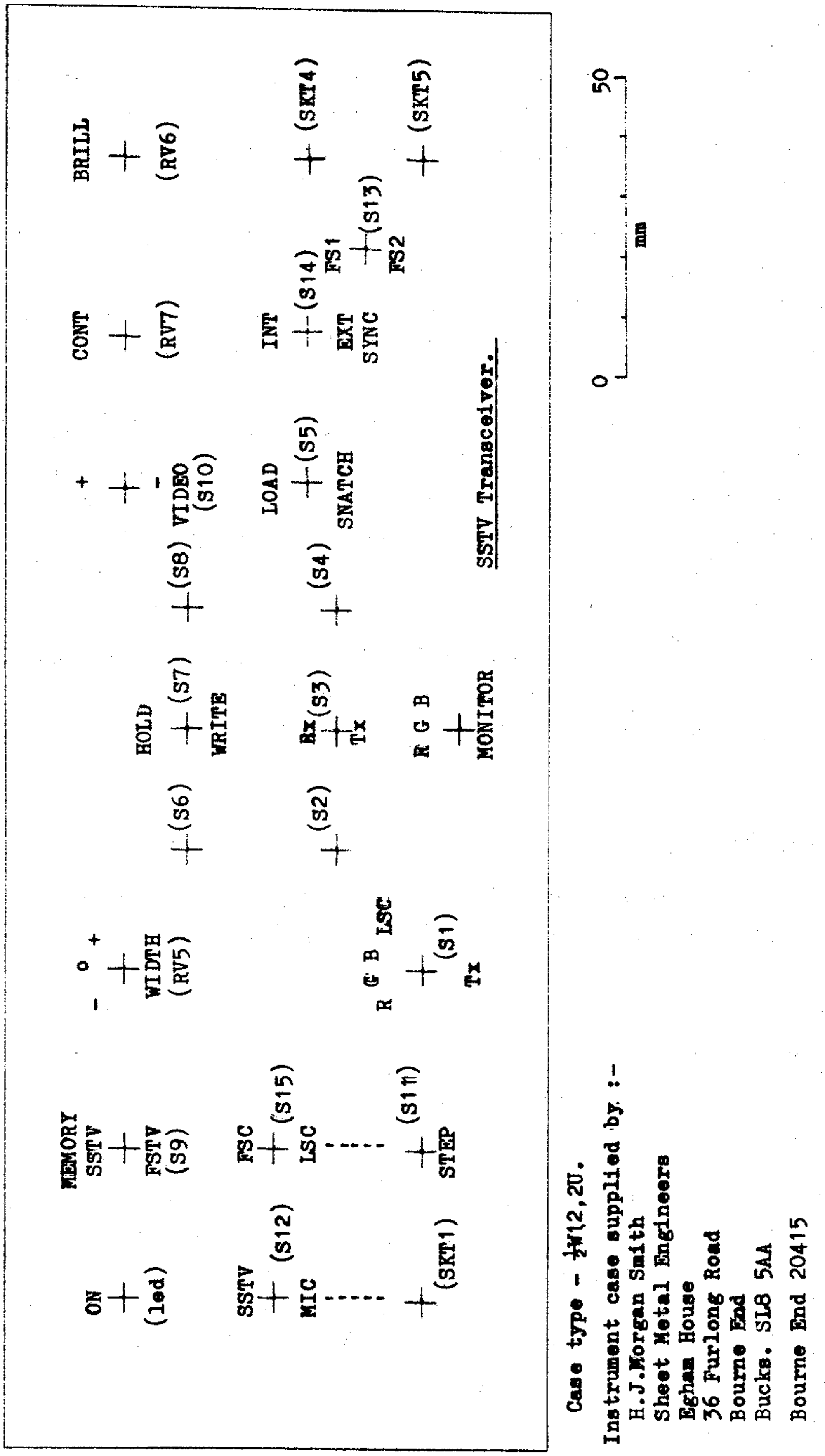


Fig.4: Front Panel Layout

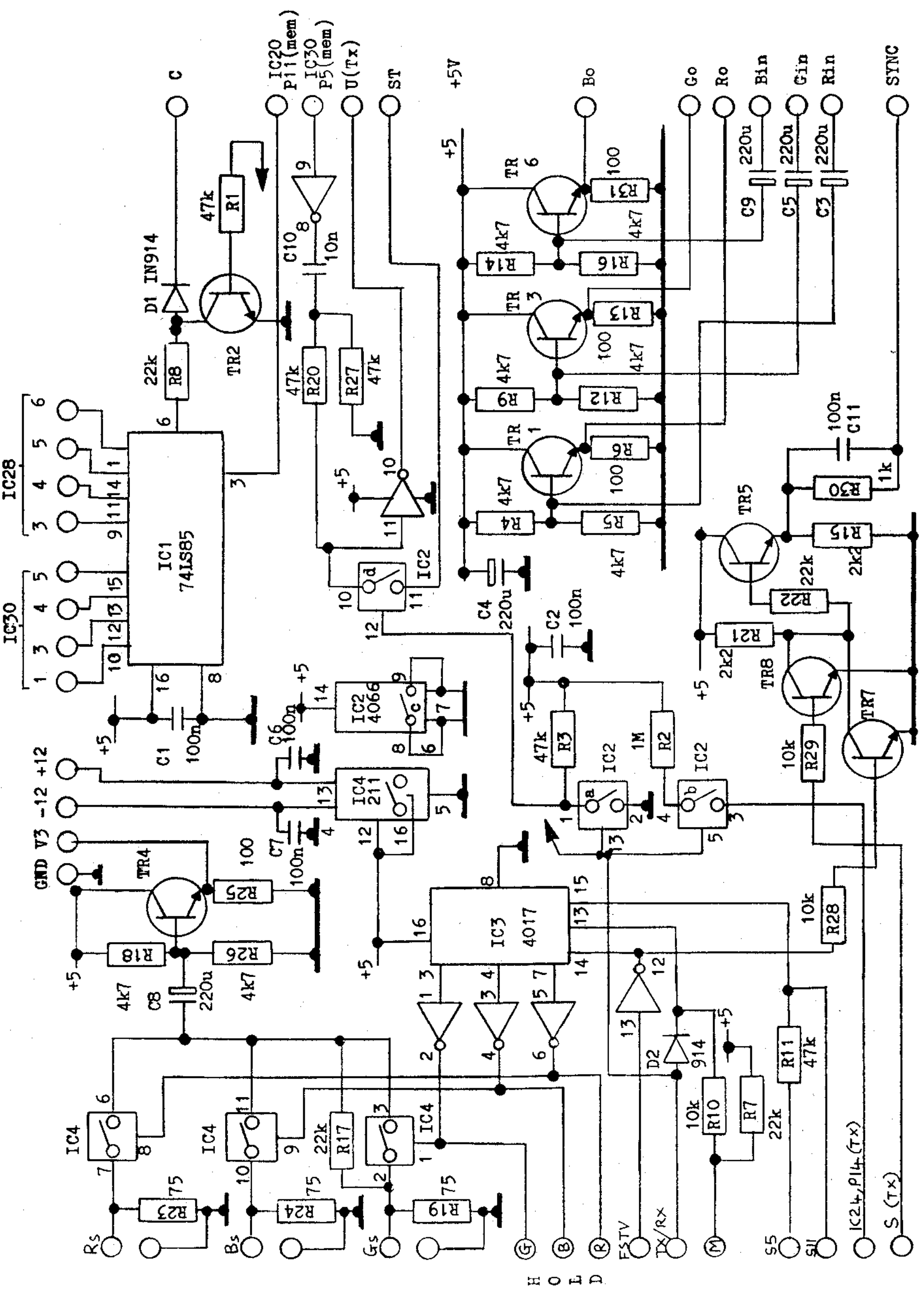


Fig.5: Colour Snatch and Cursor Circuitry

2) Colour Picture Snatch

This facility allows the separate R,G and B frames of a colour picture to be loaded into memory during the SSTV frame pulse. This frame pulse has to be extended to at least 80ms to ensure that three complete frames can be sampled. To ensure that this pulse length is correct, change R46 on the transmit board to 750k. When in receive IC2 connects R2 (Auxiliary board) across R46 (TX board) to shorten the pulse length again.

When IC3 is enabled it closes the R,G and B video switches in turn (IC4) and, at the same time, writes the respective video information into memory by electronically operating the write/hold switches (S6-S8).

S11 is a three-position switch (DPDT, ON-OFF-momentary ON). With S11 in the OFF (centre) position, S5 controls CONTinuous and SNATCH sampling of the fast-scan colour video. CONT allows setting of the contrast and brilliance controls and SNATCH takes a new picture after the transmission of the existing one in memory.

S11 up-locks the colour picture in memory and SNATCH (step RX) instantly resets the frame, loads the next picture and commences transmission. This is the momentary switch position. Colour snatch is only possible when S9 is set to L.S.C. R17 provides a high impedance DC path to ensure that C8 is correctly charged before RGB sampling takes place.

No extra holes need be drilled in the front panel as the additional switching is achieved by increasing the poles of S5 and S11.

3) Video Buffers and Sync Combiner

It will be necessary to drive a colour monitor from the RGB memory outputs. Three buffers, the same as on the memory board, can be used for this purpose. Also mixed syncs are available from TR5.

The switching of video signals will vary according to individual requirements but an example is given below for guidance (Fig.6). It caters for two B/W cameras and one RGB source.

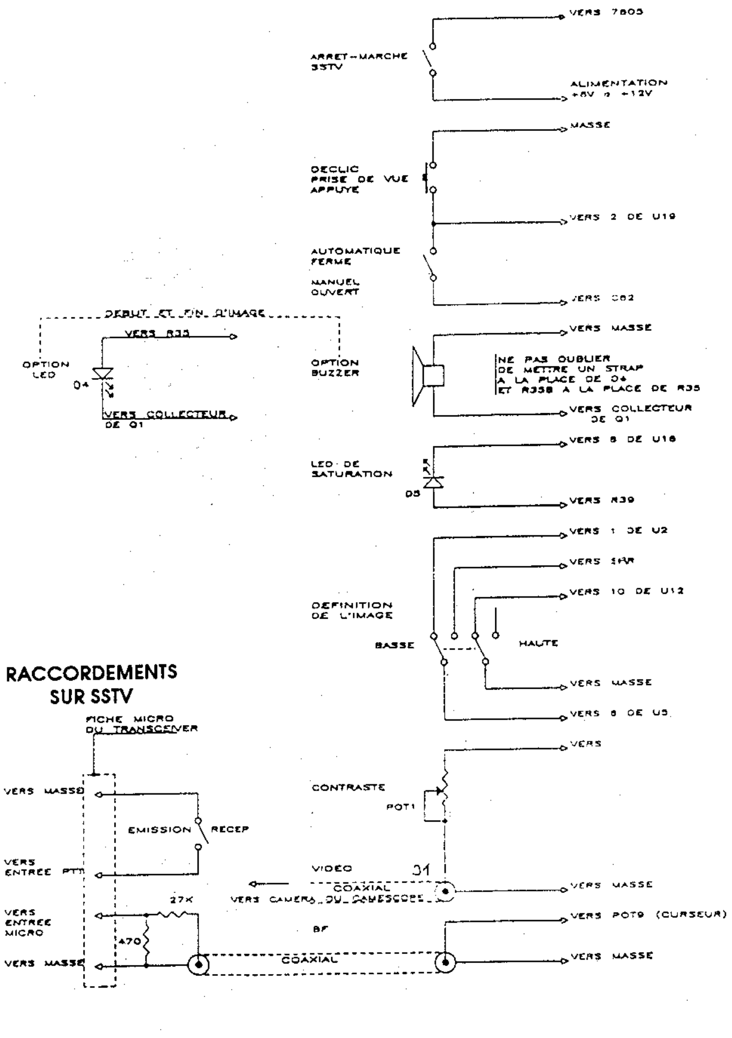


Fig.1d: Control Interconnection details

A Digital SSTV Transmit Coder

Introduction

In this chapter we shall describe a digital Slow Scan Television encoder, which will allow you to send SSTV via your usual portable transmitter from any portable location or from your shack, as the unit operates from 12V DC. The unit is complete, in that all that is required is a video source and a transmitter to enable you to transmit SSTV.

The specifications of the unit are as follows:

- portable, requiring between 8V and 15V DC supply
- small size; 30 x 165 x 120 mm
- usable as a fixed station or mobile
- quite light; approximately 400gm
- selection of high (32 seconds) or low-definition (8 seconds) monochrome picture modes
- manual (single-shot) or automatic (continuous) selection of ‘snatched’ picture(s)
- visual (LEDs) and audible (buzzer) indication of completion of scan
- controls can be located on the main case, or on a remote hand-held unit
- the contrast of the transmitted picture can be altered by a potentiometer on the control panel
- the video input can be from any standard composite video source, i.e: camera, computer, VCR, etc.

A Printed Circuit Board and/or a kit of parts is available from KM Publications at the address shown in the reference section at the end of this chapter.

Circuit Description

Picture by Grant Dixon, G8CGK

The circuit diagrams of the complete unit are shown in Fig’s.1a and 1b. The composite video input signal is initially passed through a 2MHz band-pass filter to remove the HF and colour components of the signal. The NE592 (U15) is a signal amplifier, which lifts the filtered video to a level of 2 volts peak-to-peak for the A-D input of the Analogue-to-Digital-to-Analogue (AD-DA) converter U7 (UVC3101 or UVC3130).

The video signal from U15 is also fed to the Sync Separator device U16 (LM1881), which receives its clock signal from the monostable U17B (4528).

A free-running oscillator is designed around U1A (74LS123) and produces the fast clock sampler, HR. A crystal-controlled is configured around U6 (4060) which produces, after the necessary division the slow picture-sampling clock, HL, either 4800 Hz for low-definition and 2400 Hz for high-definition transmissions, which is selected by U12A (4053).

When switch S2 pressed the picture transmission cycle is activated. U5 (74LS157) clocks the address counters U3 and U4 (both 74LS393) at video frame rate, the 20ms controlling pulse being generated by U2 (4013). The video signal is digitised by U7 and then routed by the tri-state buffer U8 (74LS366) to the memory devices U9 and U10 (43256), which have been switched to write by U2 (4013).

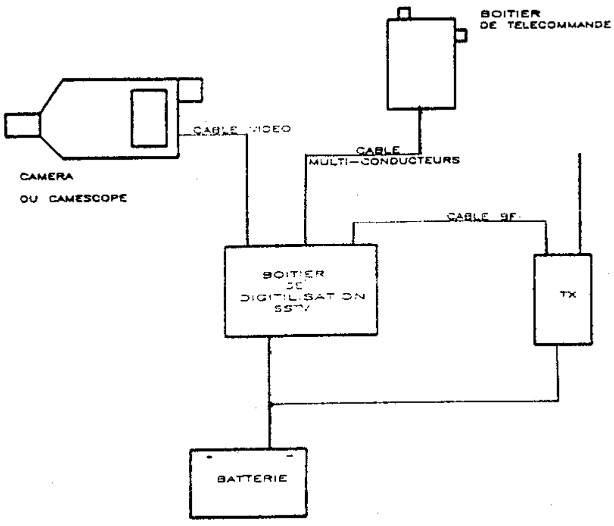
When switch S2 is released the 'snatched' picture is locked in the memories (in manual picture 'snatch' mode the video source can now be removed if desired), buffer U8 goes to a high impedance state, U2 switches U9 and U10 to read and the address counter clock U5 is switched to the selected SSTV rate, the sync pulses generated by U1B (74LS123) being corrected for the selected speed (i.e: 8 or 32 seconds) by U2(4013) before being fed to U5.

The stored digital image in the memories is read back into U7 for conversion back into an analogue signal at the selected SSTV speed. The analogue output from U7 is routed to the frequency converter U13 (NE566), which is configured to operate in the range 1200 to 2400 Hz. The extreme ends of the range are adjustable by two 10-turn potentiometers, one for 1500 Hz 'Black' and the other for 2300 Hz 'White'. U12C injects the Sync signal of 1200 Hz, which is adjusted by means of a third 10-turn potentiometer, under the control of U11 (4528).

Finally, the output signal is filtered by U14 (741) and presented to the output socket, BF, for connection to the transmitter's microphone input.

An LED (D4) or a buzzer indicates the end of transmission of a picture and a saturation LED assists the setting of the level of the input video signal. However, it is better where possible to adjust the saturation level by monitoring the transmission with an SSTV receive system.

The DC supplies are quite straightforward. If you have +8 to 15 volts and -8 to 15 volts available, then simple 7805 and 7905 regulators will suffice. However, for portable operation, or where only a +8 to 15 supply is available, the DC-DC converter VP5 will be required to generate the -5 volt rail.



The Principle of Portable SSTV Operation

Construction

The double-sided printed circuit board layout is shown actual size in Fig's.2a and 2b, with a component overlay in Fig's.3a and 3b. All the integrated circuits should be fitted in sockets, as many of them have to be removed during the adjustment and set-up procedure.

Resistors R30 and R32 at U11 should be adjusted-on-test, as should R16 and R17 at U17, to give the correct pulse-widths as shown on the circuit diagrams.

The values of L4 and L9 are not critical, 15 or 22uH values will be quite acceptable. All potentiometers are upright 10-turn types. Strap S1 should be fitted to suit your video input signal polarity, either positive or negative going. Please also note the orientation of input capacitor C5, according to the polarity of the input video signal.

As mentioned earlier, the 'snatch' switch S2, the on/off switch and the manual/automatic switch may be located on a unit remote from the main case and can thus be wired in place using 1.5 to 2 metres of coaxial cable terminating in a 5-pin plug, with a matching socket on the main unit. The video gain potentiometer can also be mounted on the remote unit, or on its own at the camera. The supply regulators are mounted at the edge of the printed-circuit-board so that they can be bolted to the metal case for heat-sinking. Please note that if a 7905 regulator is used, then its case must be insulated from the chassis.

Adjustments and Set-up

Remove U8, U9, U10 and U11 from their sockets and adjust POT11 so that the frequency of the clock signal at pin-18 of U7 is 5 MHz. Set POT10 to approximately half way and adjust POT9 for maximum signal at the output socket, BF.

Solder a strap across pins-7 and 8 of the U11 socket (still with the ICs removed from the circuit) and adjust POT7 for a frequency of 1200 Hz at the output socket. remove the strap and set POT8 to approximately half way.

Strap together pins-12, 13, 14, 15, 16, and 17 of U19, connecting the strap to pin-14 first (again with the ICs still removed from the circuit board). Adjust POT6 for a frequency of 2300 Hz at the output socket.

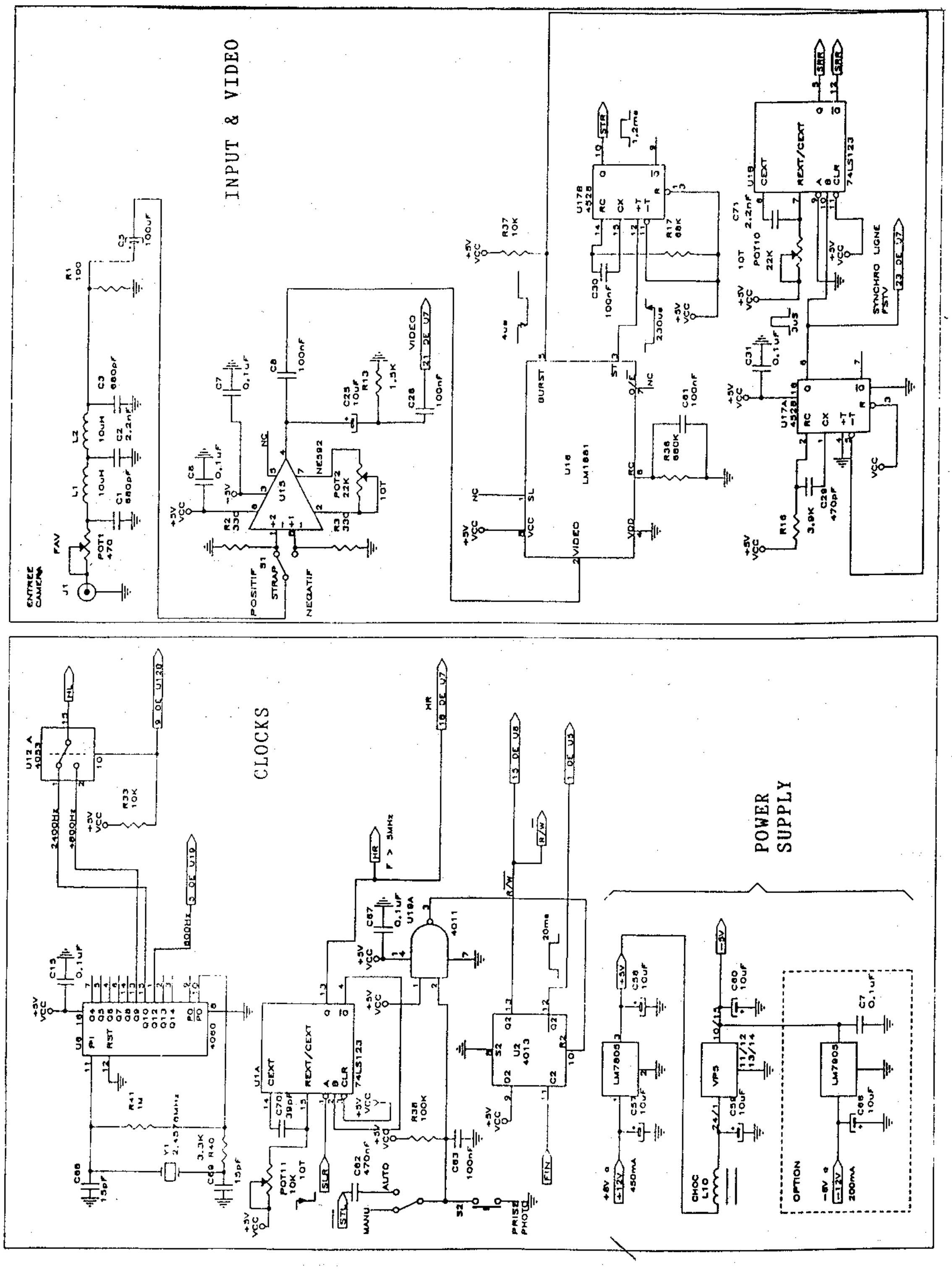


Fig.1a: Circuit Diagram of the Clock, Power Supply and Input stages

Connect the six used outputs of U9 to +5 volts (pin-28). Adjust POT8 for a frequency of 1500 Hz at the output socket.

Repeat the last two adjustments as they interact with each other, until both frequencies are correct.

Fit U11 in its socket and ensure that the 128-line low-definition mode is selected.

Adjust the values of R30 and/or C12 to give a positive-going pulse with a pulse width of 5ms +/-0.2ms at pin-6 of U11. Adjust the value of R32 to give a pulse width of 30ms (or more) at pin-10 of U11. Please note that the pulse only occurs every 7.5 seconds.

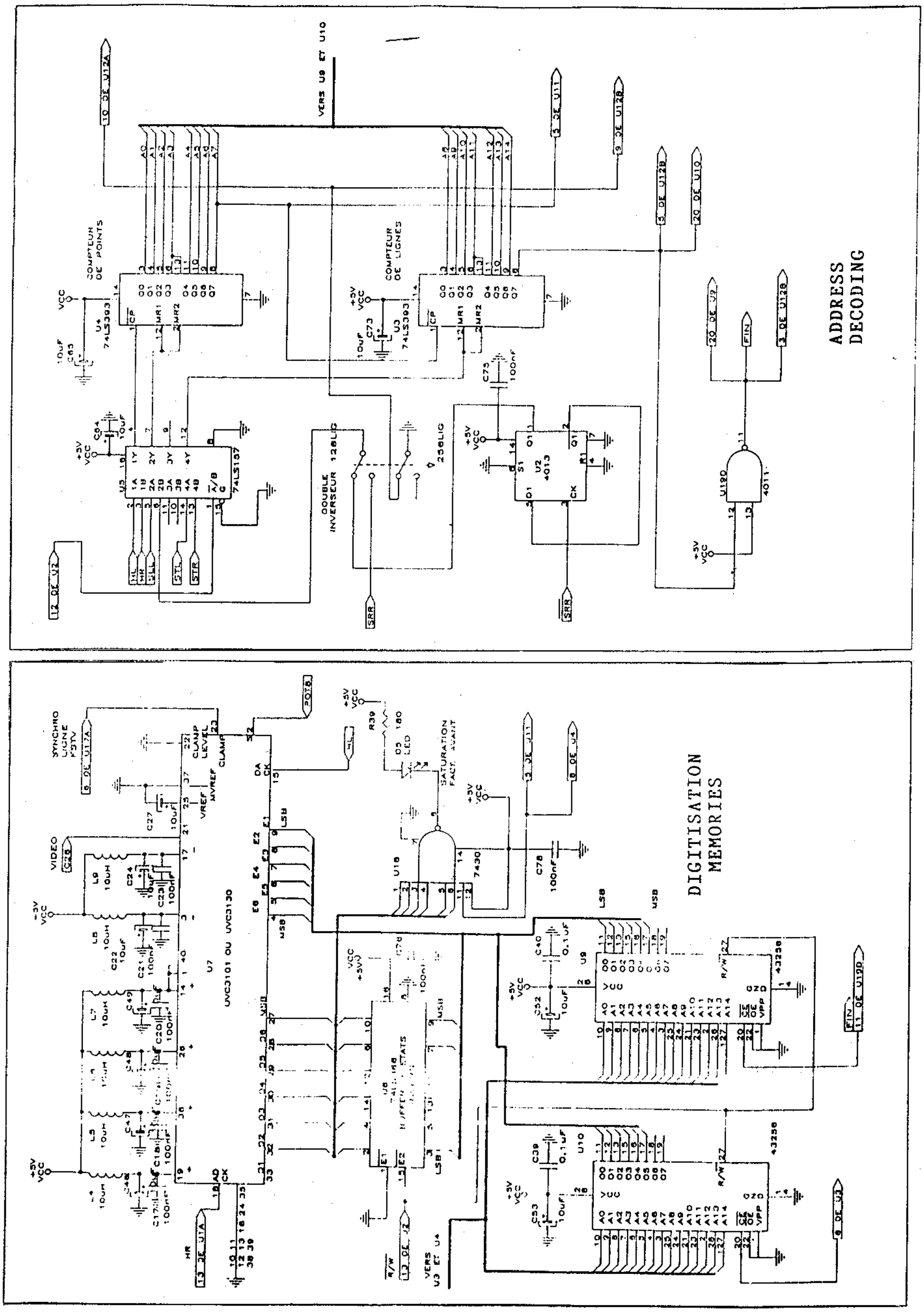


Fig.1b: Circuit Diagram of the Address Decoding, Digitisation, and Memory

Fit U8, U9 and U10 into their sockets, set the input saturation control POT1 to maximum, connect a video source and press S2. Adjust POT2 so that the saturation LED illuminates just before the transmitted picture starts to distort due to overload.

Adjust POT10 to centre the picture on the receive screen, if the picture is too wide or narrow, then slight adjustment of POT11 will correct this.

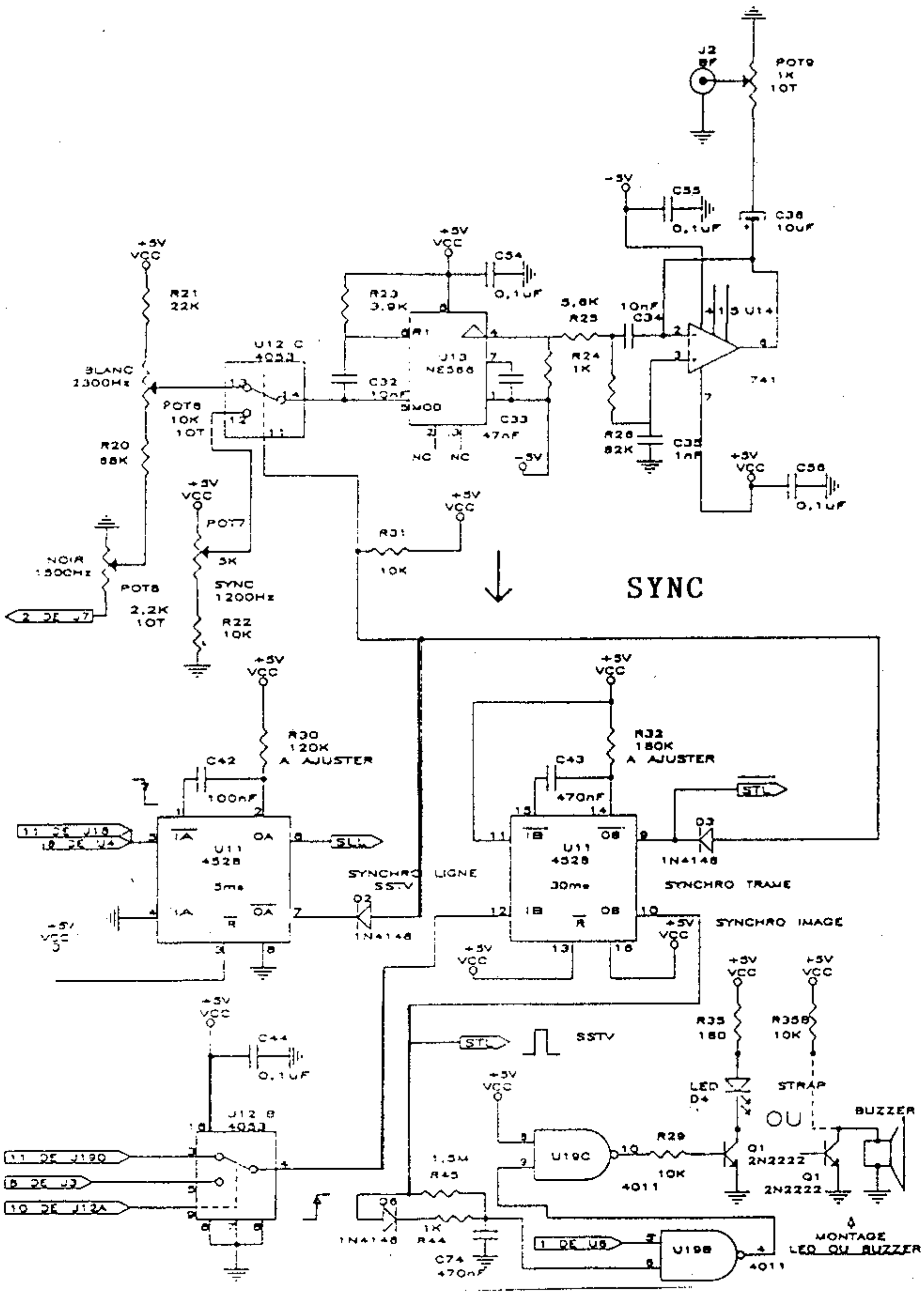


Fig.1c: Circuit Diagram of the Sync stages

That completes the set-up procedure and the unit should now transmit good-quality 8 second or 32 second black and white pictures.

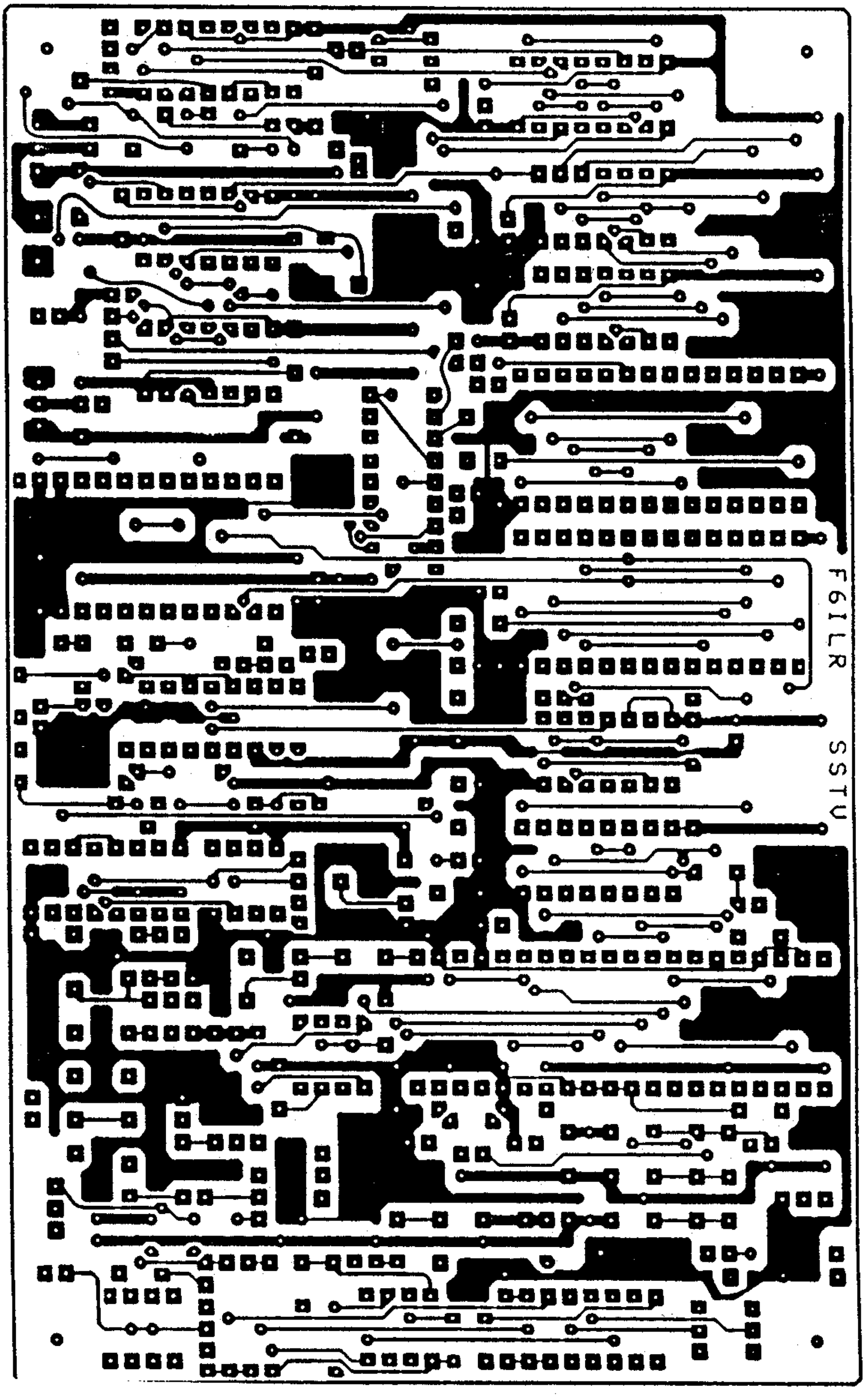


Fig.2a: PCB Layout Track side (actual size)

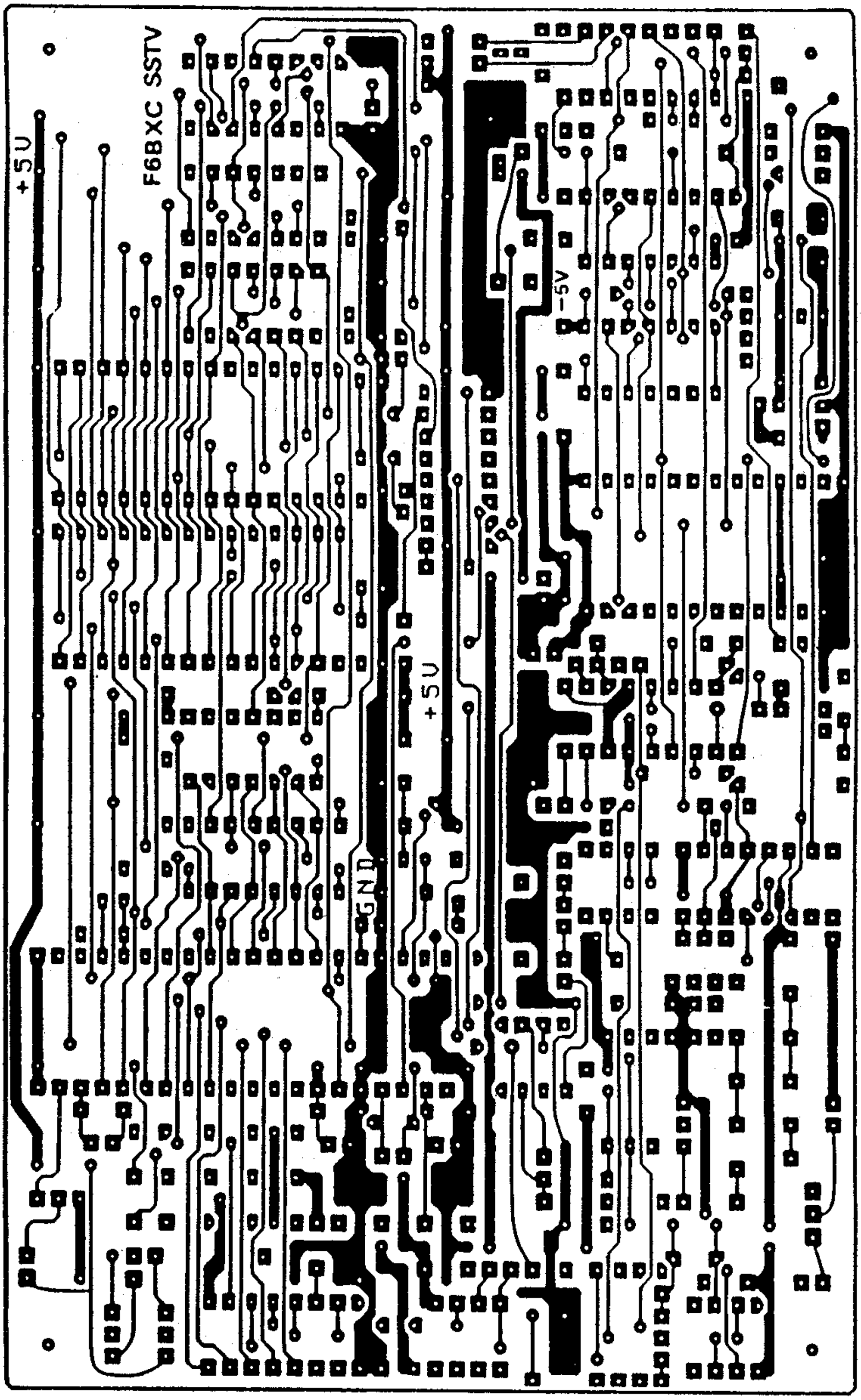


Fig.2b: PCB Layout Component side (actual size)

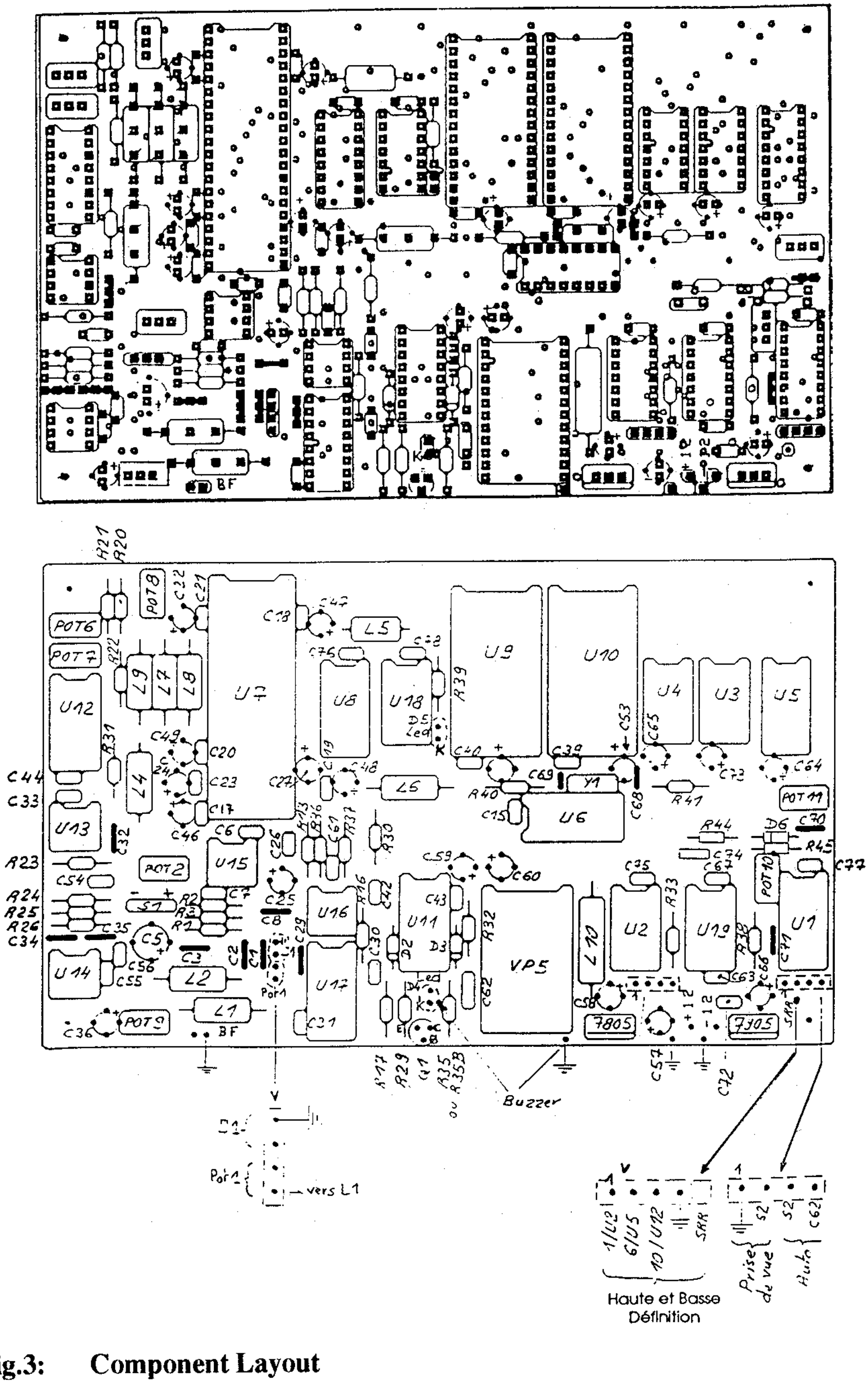


Fig.3: Component Layout

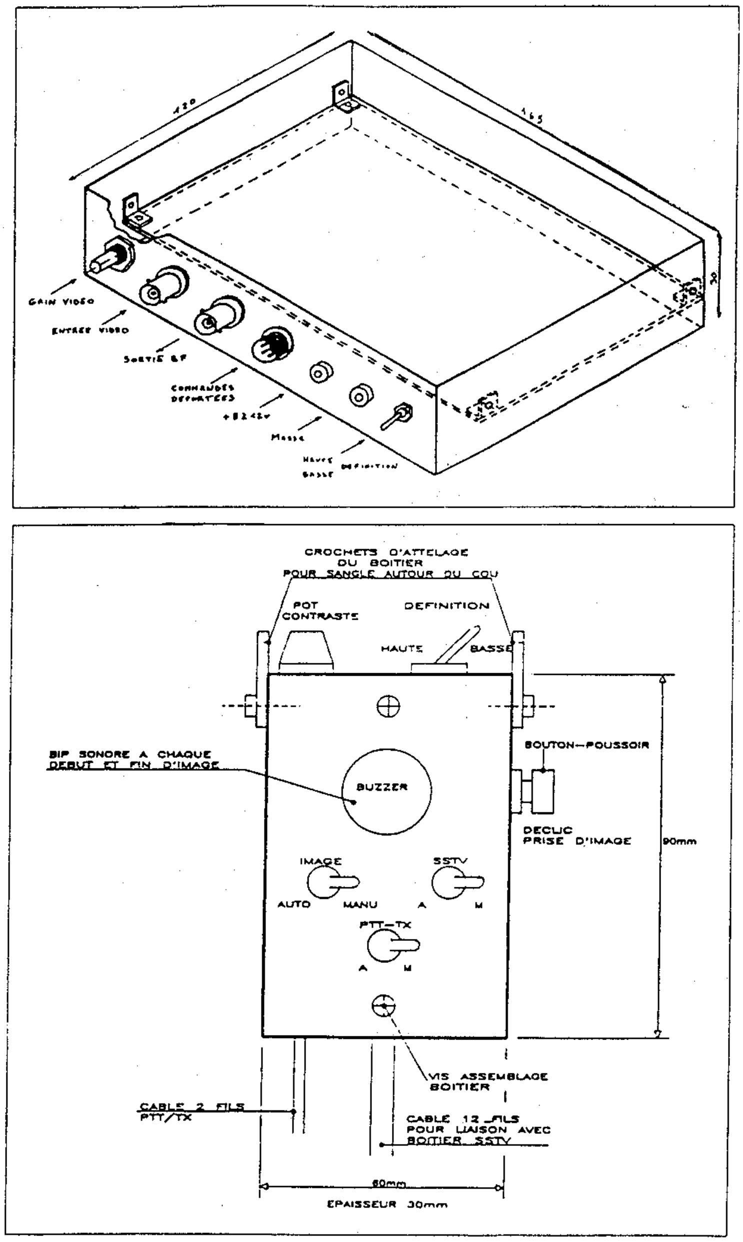


Fig.4: Mechanical details of main enclosure and optional remote hand-held unit

Component List

Integrated Circuits

U1	74LS123	U2	4013
U3, U4	74LS393	U5	74LS157
U6	HEF4060	U7	UVC3101 or UVC3130
U8	74LS366	U9, U10	43256 or 20256 (32k x 8)
U11, U17	4528	U12	4053
U13	NE566	U14	UA741 (8-pin)
U15	NE592	U16	LM1881
U18	7430	U19	4011

Transistors and Diodes

Q1	2N2222	D2, D3, D6	1N4148

Regulators

If + and - supplies available

LM7805 LM7905
VP5 or any DC-DC converter outputting -5V

Inductors

L1 to L9 10uH L10 50 turns, 0.2mm diameter on 4mm ferrite 15mm long

Potentiometers

POT9	1k	POT8	2.2k
POT7	4.7k	POT6, POT11	10k
POT2, POT10	22k		

Capacitors (Ceramic)

C68, C69	15pF	C70	39pF
C29	470pF	C1, C3	680pF
C2, C71	2.2nF	25 off	100pF

Resistors 1/4W

R1	100	R35, R39	180
R2, R3	330	R44, R24	1k
R13	1.5k	R40	3.3k
R16, R23	3.9k	R25	5.6k
R22, R29, R31, R33, R35, R37	10k	R21	22k
R17, R20	68k	R26	82k
R38	100k	R30	120k
R32	180k	R36	680k
R41	1M	R45	1.5M

Capacitors (Metallised Polyester)

C35	1nF	C32, C34	10nF
C33	47nF	C61, C30, C42, C62, C43, C74	470nF
C56, C55	100nF		

Capacitors Electrolytic

19 off	10uF 25V Tantalum	C5	100uF 16V Radial

Miscellaneous

Y1	2.4576 MHz Crystal	1 high-luminosity Red LED
5V Buzzer		

Literature

Radio REF March 1990, Réseau des Emetteurs Français

The Slow Scan Companion, BATC

Radio Plans No. 42 January 1988

VHF Communications 1/86. KM Publications

Kits and Printed Circuit Boards

KM Publications, 5 Ware Orchard, Barby, Nr. Rugby, CV23 8UF, England.

Computers and Slow Scan Television

Introduction

Now that home micro-computers with large memories are commonplace, it is natural that we should want to use them in an SSTV environment. Unfortunately, most computers capable of analogue to digital conversion do not run fast enough to cope with a fast-scan TV signal, although the now readily available 386 and 486 processor based PCs now have fast digitising systems coming on line that are virtually ‘‘real time’’ in their conversion.

Likewise, the computer does not easily cope with the task of displaying a 128 x 128 pixel SSTV picture. if one’s computer has a graphics capability for displaying a 128 x 128 square and it can make each element have a grey value from 0 to 15 units, then it is merely a question of writing a suitable SSTV program. Such a program should sense the SSTV frame and line sync pulses to effect the correct timing, recognise the grey level of each pixel and store the required data in the screen area of the memory map. As the time taken for one line of SSTV, including sync pulses, is of the order of 60ms, then quite a lot of computation can be carried out for each line and thus within each pixel time. However, this is only the case if machine code or assembler language is used, BASIC is far too slow.

Storing a fast-scan picture in computer memory is best done by converting the signal to SSTV and then arranging an interface which allows the digital information to be sampled at slow scan rate and stored by the computer. The circuit in Fig.1 would serve well for this purpose. The computer samples the 4-bit video, the line and frame sync at an input port; it can also deliver, via an output port, the 4-bit video stored in memory and a control line which is used to switch the two video sources. After the interface the scan converter does a digital-to-analogue conversion and this analogue signal modulates a VCO to give the usual FM SSTV signal.

An alternative method for storing all, or part, of a fast-scan picture is a sampling method. It does not require any modifications to the camera and relies on the fact that the computer’s memory is truly random access. Therefore, although the picture is scanned vertically and stored in memory, the data can easily be read out as horizontal lines.

Once we have got the picture stored in memory what can we do with it? Here are a few suggestions:

1) Switch between the computer picture and the current picture to inlay a small picture.

2) Inlay text in either black, white or grey.

3) Invert the picture; left to right, top to bottom or black to white.

4) Use the computer to generate a test card.

5) Alter the grey scale to give a more contrasty or less contrasty picture.

6) Print the picture using a dot-matrix printer.

Once you have the facility for manipulating the elements of a picture then the sky is the limit and it is a great challenge to the imagination of the reader.

There are one or two facts in connection with the use of a computer in this way which need pointing out. The SSTV line and frame pulses are derived from the camera (or VCR) frame sync by division, and as the computer samples these pulses to determine whereabouts it is in the picture at any given time, then it is essential to have the camera running even if its picture is not being used. The alternative is to write a program which generates SSTV sync pulses. With such a program the computer will be self contained and able to deliver a digital SSTV signal with sync pulses. If your computer has an internal timer, such as a 6522, then the problem is eased considerably. Alternatively, you could use interrupts to service routines for the line and sync pulse requirements from an external Sync Pulse Generator (SPG).

So far we have discussed methods of using a computer as part of an already existing SSTV transceiver. However, the more usual method of using a home computer is to actually employ it as either a receiver, or transceiver, in it’s own right. This entails, in some cases, a simple interface between the radio receiver and the computer and a sophisticated program. As will be discussed later not all computers require an interface, but the basic techniques of the software program are the same.

As we have already seen, a picture with at least 16 levels of grey is desired to produce an image with good depth and definition. The problem with many home computers is that such control of the grey scale is not possible at individual pixel level. However, quite a reasonable compromise can be reached by using varying pixel concentrations to represent the changing brightness of the SSTV picture. (It may be pertinent here to define that a pixel is the smallest picture element that the computer can produce to make up a picture.) Many programs do not use this technique to its full advantage, in that they take each line of the picture as it comes and plot the pixels without regard to the pixels in adjacent lines. This can lead to a vertical streaking effect in the resultant picture as shown in Fig.2. In reality every pixel should be considered along with the eight pixels surrounding it, or at least those above and to the left of it.

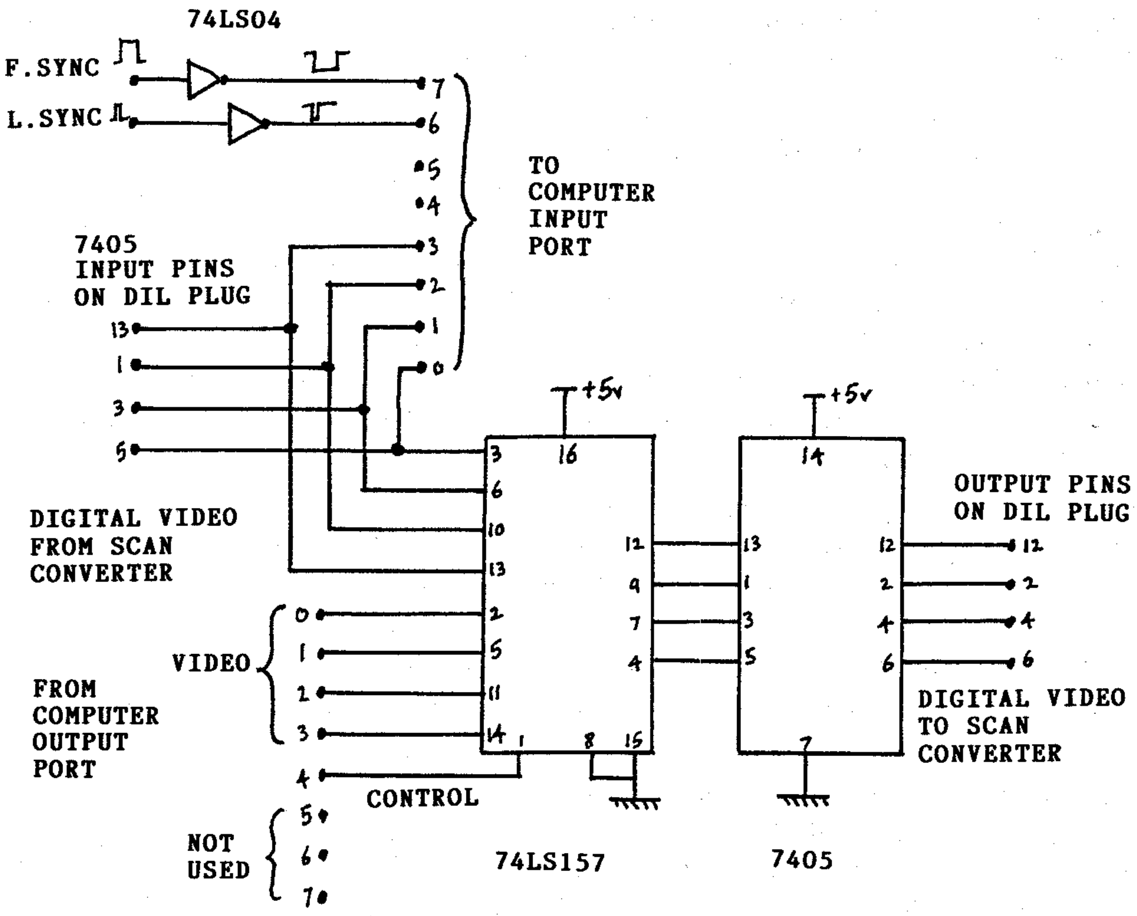


Fig.1: Computer Interface for an SSTV Scan Converter

Another major problem for the software is maintaining linearity across each scan line. The program needs to know accurately where and when the next pixel is to be plotted, or the picture will slowly disintegrate as it reaches the right hand side of the screen. This problem can be overcome in two ways, either by using the on-board programmable counter and zeroing it with each line sync pulse, or, if your computer does not have one, by rigorous timing within the program and the maintenance of a software counter.

A computer based SSTV system is very flexible and can be made to perform equally as well as a hardware based one can (i.e: the G3WCY/G4ENA system described a computerised picture in Chapters 5 and 6). In some areas it may well be that a computer based system can provide better results. Such techniques as ''intelligent'' noise rejection, false sync rejection and flywheel synchronising are more easily achieved with a computer. Also, the relationship between input frequency and displayed brightness can be varied much more easily with the software system.

Fig.2: Vertical streaking can occur in a computerised picture

Many of the available programs have facilities built into them that allow for an oscilloscope mode, where the SSTV video waveform is displayed along with the sync comparison value. Another feature that is available with some is an audio spectrum analyser which draws a graph of the relative occurrence of the various audio frequencies. Thus, it can be seen that a computer based SSTV system can provide results compatible with the more conventional methods of operating SSTV, with the advantage that the computer is not dedicated only to SSTV, as is a hardware system. Another advantage to be taken into account with a computer based system is the immediate ability to store a received picture, or a picture for transmission, on whatever type of filing system you are operating, i.e: tape or disc. With the trend towards modern home computers having better and better graphics capabilities, computer based systems now provide excellent results and are rapidly taking prime position in the field of SSTV operating.

The Spectrum, although rather limited in this application, can provide a simple and cost effective SSTV terminal, especially since it may not need any hardware interfacing between the computer and radio equipment.

G4ENB Spectrum SSTV System

This system has been designed to be used in conjunction with an existing SSTV converter. It provides the facility to generate call-sign captions and other information itself so leaving the camera and converter available for actual pictures. However, the system can be used quite independently of an existing converter providing a full transceive SSTV terminal on its own.

In receive there has had to be a compromise due to the limitations of the Spectrum which does not allow more than two colours to be in any one character square at the same time.

This means that the full eight grey levels with high resolution are not possible. To give some level of grey, noise is inserted where the normal grey areas would be. The level of this noise and the threshold between white and black can be adjusted for best contrasting on the picture. With any picture displayed on the screen it is possible to obtain a hard copy on the printer, also any received picture can be re-transmitted from the Spectrum. When receiving pictures which are not of the correct width the use of two of the arrow keys will adjust the horizontal scan rate to compensate. The software also allows for the reception of 24-second line-sequential colour pictures, one line in three is displayed giving one of the colour separations and each colour separation can be preselected as required (a colour picture can not be displayed). Some examples of pictures received using this system are shown in Fig.3.

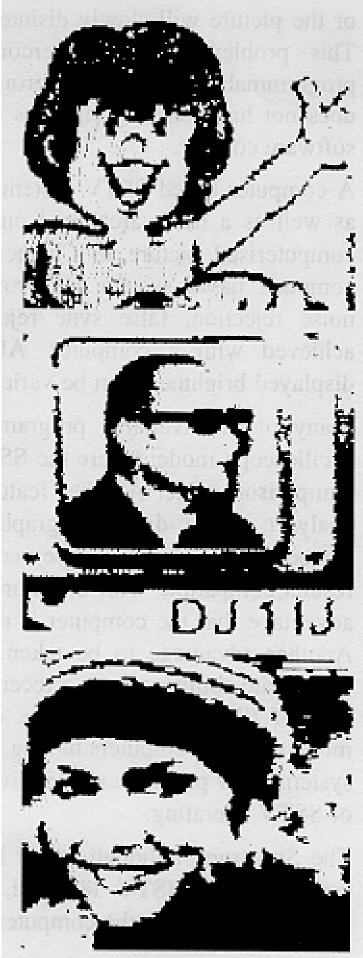


Fig.3: Spectrum Pictures

To transmit SSTV from the Spectrum a programmable sound generator is used to generate the required frequencies. Using this method means that no calibration of the output is required since the frequency is defined in the software. The program allows for two different sizes of text; 3 lines of 5 characters per line or 4 lines of 8 characters per line. Each individual character colour can be defined and each line of text can have a different paper (background) colour. A full screen 8-level grey scale is available with an automatic grey scale at the bottom of each transmitted picture but not displayed.

A Union flag with call-sign and rainbow patterns is held in memory with a further area reserved for another user defined caption. There is a cursor to show the transmission point and also a facility for character correction and half spacing. Character sizes can also be mixed. Monochrome transmission is achieved by @,he software converting each colour to its appropriate grey level. Colour transmissions can be in 8 second frame sequential or 24 second line sequential mode. Two examples of captions are shown in Fig.4.

Fig.4: Example Captions

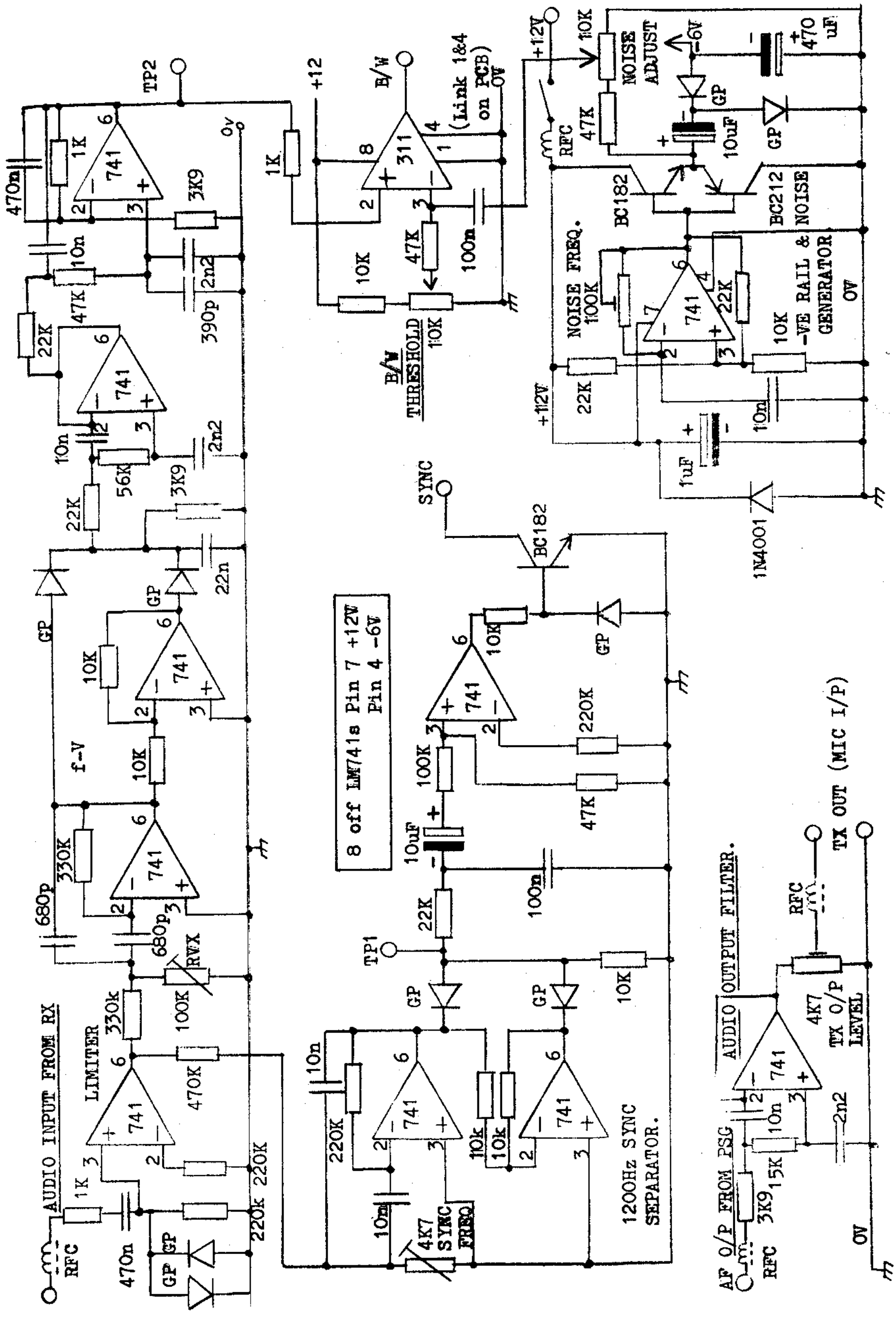
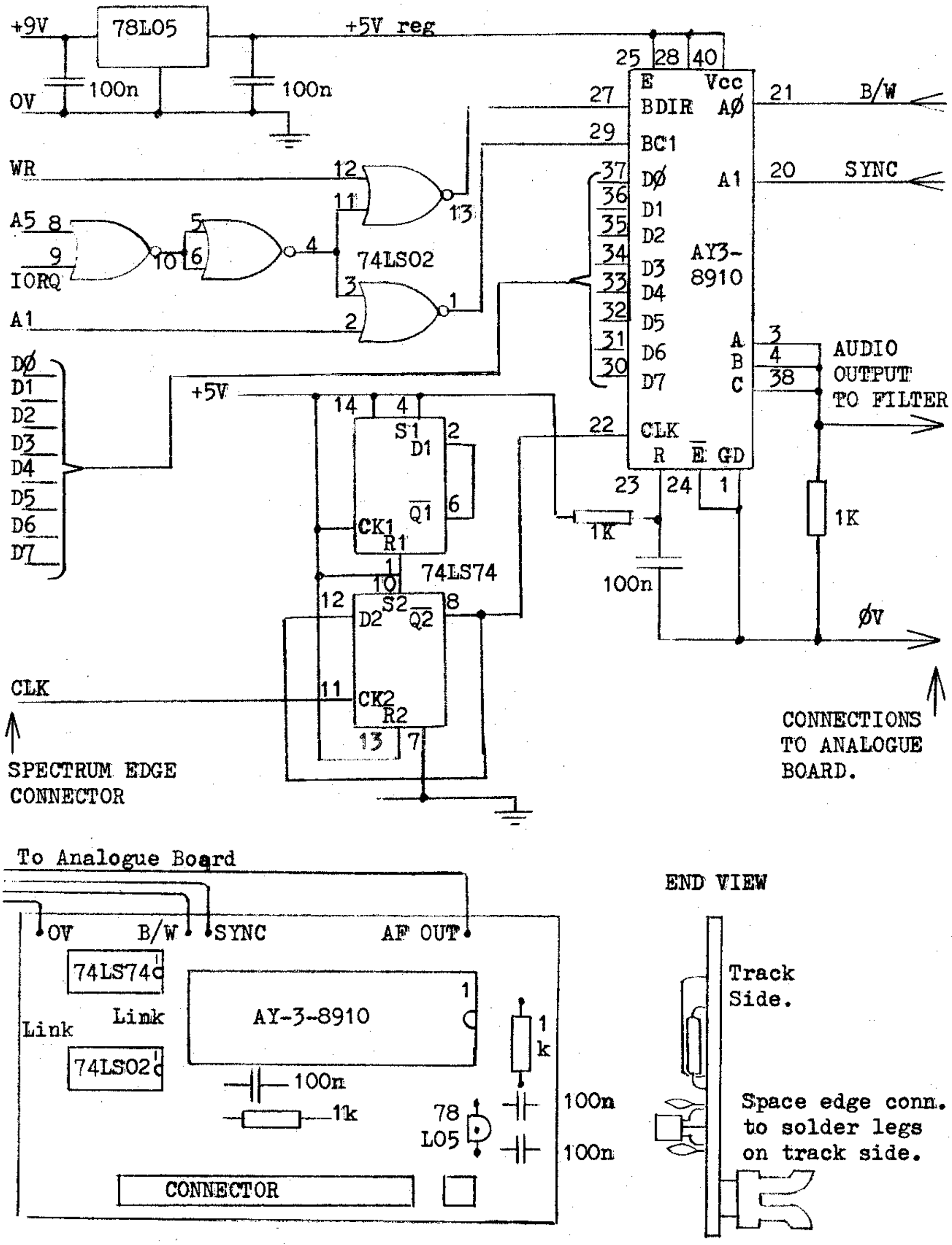


Fig.5: G4ENB Spectrum SSTV Analogue Board

Interface

The interface circuitry is contained on two printed circuit boards; one handling analogue and the other the digital signals. All the frequency-to-voltage conversion and sync detection for receive is mounted on the Analogue board (Fig.5), as well as the transmit audio bandpass filter. Interfacing to the Spectrum is on the



N.B. The 74LS74 must be an 'LS' device.
The length of the leads to the Analogue board is not critical.

Fig.6: G4ENB Spectrum SSTV Digital Board

Digital board (Fig.6), which is plugged directly onto the user port. The programmable sound generator and address decoding are also on the digital interface board. A separate 5 volt regulator drops the +9 volts taken from the Spectrum to provide a +5v supply. The Analogue board requires +12 volts and -6 volts for the Op-Amps which is derived from an on-board oscillator that also provides the ‘‘noise’’ input to simulate the grey level on receive.

The Analogue board is best mounted in a box so that the potentiometers, audio connections and switches are rigidly supported. The Digital board can be quite satisfactorily used unboxed and plugged directly into the Spectrum or printer.

Fig.7a

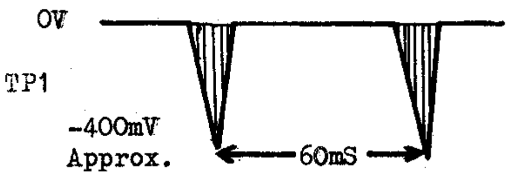
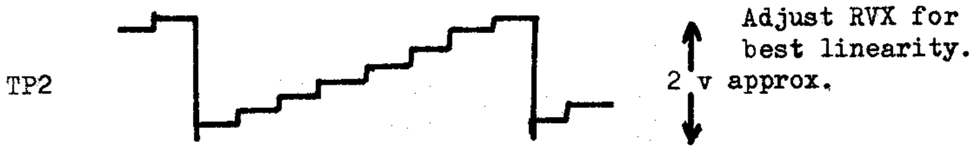


Fig.7b



Calibration

a) Connect TX OUT to RX INPUT. Set Tx output level to maximum.

b) Load the program, set paper colour to white and select 8 sec. black and white Tx.

c) Adjust the SYNC FREQ potentiometer to obtain the waveform shown in Fig.7a.

d) Press BREAK, press CAPSHIFT G for grey scale and select 8 sec black and white Tx. Monitor TP2 and adjust RVX to obtain the waveform shown in Fig.7b.

e) The 100k potentiometer in the noise generator circuit should be adjusted to give the best grey pattern on receive.

Connect the system to the radio transceiver and make final discrete adjustments on received pictures to your own requirements.

The software, full instructions and printed circuit boards can be obtained from Mr.C.A.Asquith G4ENB, 25 Wychwood Avenue, Luton, LU2 7HT.

Commercial Software

There are many different home computers in popular use, many of which have SSTV software packages written for them, so let us look at a selection of the available software, and in some cases firm and hard ware, for the most popular machines.

Sinclair Spectrum

J.&.P.Electronics Spectrum Slow-Scan - This program is in three parts which are all loaded automatically by a single load command. Once loading has been completed the program self-starts presenting the menu on the screen. There is no interface required so the computer is connected directly to the receiver. The computer can also be connected to a cassette recorder if received pictures are to be stored on tape. A simplified oscilloscope mode is built into the program which allows correct tuning of the receiver by aligning the sync pulses with a reference line on the screen as the signal is tuned in.

A rather useful noise cancelling routine is included to help overcome processor noise generated within the computer. A quick check to see if your machine suffers from this problem is to switch to the oscilloscope mode and remove the input from the receiver. If a large amount of noise is present then it will show up on the screen and operation of the noise cancel mode should rectify it, although this will not be evident in the oscilloscope mode as it is rendered inoperative.

The program can only receive 128 line, 8 second black and white pictures with the facility to store up to eight complete received frames in the memory.

To allow an idea to be gained of the various functions and facilities typically available in computer programs of this sort, the key functions for this package are listed overleaf:

The following keys are active on the menu page:

R	Receive mode.
T	Tuning aid.
L	Loads picture from cassette
I	Noise canceller on.

0	Noise canceller off
U	Contrast level up.
D	Contrast level down.
5 & 8	Move the ^ on screen to select the background colour.

The following keys are active in receive mode:

SPACE	Dumps screen to printer
N	Picture attributes to normal white
B	Picture attributes to bright white
3	Normal video
4	Inverse video
W	Contrast level up
Q	Contrast level down
CAPS SHIFT	Stops receive mode, on screen prompt for saving received picture to one of the eight memory stores or to the printer, before returning to menu.

The following keys are active once a picture has been loaded in from tape:

SPACE	Dumps picture to printer
B	Picture attributes to bright white
N	Picture attributes to normal
4	Inverse video. (To revert to normal video press N)
CAPS SHIFT	Return to menu.

In use the program appears to be quite responsive and produces pictures as good as the Spectrum will allow. The noise cancelling routine had quite a marked affect on the computer used in the test, but not all machines suffer internally generated noise to the same degree.

The program comes supplied with full instructions and is available from: J.&.P.Electronics, New Road Complex, Kidderminster, Worcestershire, DY10 1AL. Telephone 0562 753893.

NOTE: Another system available for the Spectrum is ‘‘Technical Software’s RX-4’’ program (without interface for this computer) which is described in the Commodore section.

BBC

The second computer to be looked at is the BBC. This machine is well suited to SSTV applications due to its superior graphics and screen handling.

G3LIV SSTV Terminal

This system for the BBC model-B requires an interface and comprises a printed circuit board and a program tape. The printed circuit board is well produced and the component overlay quite explicit. All the components can be easily obtained, the only specific item being a modular DC-to-DC converter which is available from Electromail (RS Components) although an external power supply can be used instead.

Once assembled the unit is easily set-up using test signals supplied on the reverse side of the program tape and an oscilloscope. Fine tuning of the input filters and the balancing of the diode bridges (both easily accomplished with potentiometers) is recommended whilst receiving ‘‘off-air’’ pictures, to achieve the best black to white balance and ‘‘spotting’’ reduction.

The program runs immediately on loading although, unless the interface is connected, there is no visible sign on the screen that anything is happening. With the interface connected and the program loaded a scanning bar appears at the top of the screen, upon receipt of SSTV signals from the receiver (or tape) this scanning bar moves down the screen producing the picture line by line as it does so.

Facilities available:

- 7.2 second frame timing (128 line).
- 16 second frame timing (256 line).
- 32 second frame timing (256 line).
- Reduce picture width.
- Increase picture width.
- Fill in even lines. (this highlights captions and gives a more contrasty picture - 7.2sec only).
- Positive and Negative video.
- Hard copy to printer (only if a ‘‘Printmaster’’ ROM is fitted). Frame re-trigger.
- Clear screen.

The usual U.K. standard for SSTV is 7.2 seconds. If 7.2sec signals are being received 16sec frame timing can be selected to give reduced picture size and higher resolution.

All these facilities are keyboard selected and can be used at any time during receipt of pictures. In use the system produces very good results with a good range of grey scale and the software is very responsive to the keyboard commands. It appears to be quite immune to interference and noise when a reasonable level signal is being received.

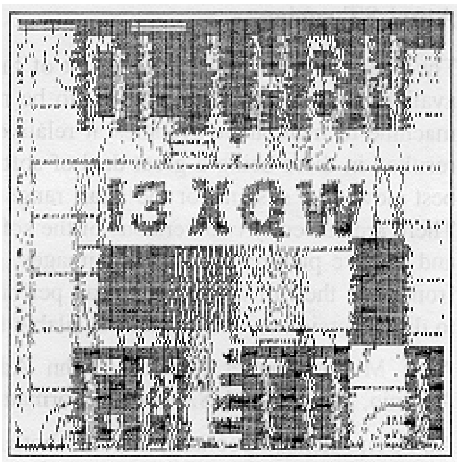
The program and circuit board are available from: Mr.J.Melvin, 2 Salters Court, Gosforth, Newcastle, Tyne and Wear, NE3 53H. Telephone 091 284 3028.

NOTE: Another system available for the BBC is Technical Software’s RX-4 program and interface which is described under the Commodore section.

Commodore VIC-20 & CBM64

Although one of the more powerful home computers, the CBM64 is somewhat lacking in commercial software for amateur use. This is in part due to the less straightforward manner in which it is programmed, making it less attractive to software writers

RX-4 Multimode Receive Program - This package, as its name implies, is divided into four sections: SSTV, RTTY, MORSE and AMTOR, and is also available for the Spectrum and BBC computers (when used with the Spectrum no interface is required). When used with the Commodore range (and the BBC) a simple interface is required which can be purchased either as a kit, or ready built and tested.



A typical off-air frame taken on the G4BMK Dragon system. The picture shows some received noise.

The CBM64 with it’s large area of user memory (32K) is well suited to this application and the program makes full use of the excellent screen handling capabilities of the computer.

Features of this package include:

- Horizontal scan of either 128 pixels (60ms) or 256 pixels (120ms)
- Vertical scan of either 128 or 256 lines shown on the screen display.
- Frame sequential colour pictures are displayed as a set of monochrome frames.
- Line sequential colour pictures are displayed in colour.
- The grey scale can be adjusted from the keyboard as the picture is received.

As with most SSTV programs, when a picture has been completely scanned the printing point is returned to the top of the screen to resume scanning. However, with this system when the next picture scan starts a different background colour is automatically selected, thus showing clearly where on the screen the scan has reached. As each new line is reached it is cleared of old text thus making the screen easier to read.

Received pictures can be stored in a separate area of memory and the various storage options are shown below:

CBM64	4 Pictures
VIC-20 + 8K	2 Pictures
VIC-20 + 16K	6 Pictures
VIC-20 + 24K	10 Pictures

Alternatively, a received picture can be stored in the same location as a previously stored one, thus avoiding filling up the RAM area with unwanted pictures. Received pictures can also be stored on disc or tape, or dumped to a printer for hard copy. A ‘‘hold’’ facility freezes a completed picture on the screen for examination, storing or printing.

The program is available on either tape or disc and the interface can be obtained either in kit form or as a ready-built, boxed and tested unit. Technical Software, Upper Llandwrog, Caernarfon, Gwynedd, LL54 7RF. Telephone 0286 881886.

Dragon 32/64 & TRS-80 Colour

G4BMK SSTV Receive Program

This program enables standard SSTV pictures to be received and displayed through Dragon or TRS-80 computers, although the TRS-80 needs extended BASIC and 32k of RAM for tape and 16k or 32k for the cartridge version. No hardware interface is required, the audio signal from a receiver being fed directly to the cassette socket. An on-screen visual indicator enables accurate tuning of the received signal.

Pictures are produced with 4 levels of grey using the high resolution graphics mode. This means that a resolution of 128 lines of 256 pixels is produced, although an intelligent ‘‘fill-in’’ facility expands the picture vertically to 192 lines giving an enhanced presentation and the correct 1:1 aspect ratio. A printer dump routine, enabling the production of hard copy printouts, is included in the package and most printers can be supported (state which when ordering). Principal commands for the software are as follows:

- Receive (and cassette motor on).
- Freeze picture at end of frame.
- Scroll picture.
- Adjust width.
- Freeze picture immediately.
- Black and white invert.
- Fill-in - expand vertically.
- Dump picture to printer.

The program is available on cassette tape or disc (Dragon DOS/Cumana 2.0) or cartridge, and includes some demonstration pictures. (G4BMK), 2 Beacon Close, Seaford, East Sussex BN25 2JZ.

There are several other such programs and systems for the computers discussed, some of which unfortunately have not stood the test of time and are no longer available new. Also there are other makes of computer for which SSTV software is available, therefore the above information should be considered as typical, well tried examples of the type of package available for a computer orientated SSTV system.

It should be stated that the use of ‘‘ordinary’’ 8-bit personal computers is somewhat restrictive and they cannot be expected to attain the standards reached by purpose-built scan converters. The increasing use of 16, 32 and even 64-bit processors, however, means that a great step forward is being taken in this respect and more sophisticated systems are becoming available using the latest generation of home computers. Nevertheless, for an outlay of considerably less than that required for the purchase of an SSTV converter, one can set-up a useful and rewarding transceive station using an 8-bit machine.

Atari ST series

The Atari ST was probably the first of the 16-bit home computers to become readily available, it was certainly the first to be mass-marketed in the UK. The ability of the machine to manipulate graphics at relatively high speed and with good resolution has resulted in there being a great deal of software developed for the computer. By far the best slow-scan system for the Atari range is a combination of software and hardware. There are currently two versions of the software; Version 0.9 has the capability to send and receive pictures, manipulate images, generate test patterns, and read picture files from disk; the full version, 1.1, can perform all the functions of 0.9, plus save images to disk. Version 0.9 is available available from the following two Atari user Groups:

Atari Microcomputer Network, John Adams KC5FW, 17106 Happy Hollow, San Antonio, TX 78232, USA. (send a formatted disc and $2)

ASTUR, Michael Geeraert, W. Elsschotlann 21, B-8460 Koksijde, Belgium (send two discs and three IRCs)

The hardware is in the form of either a low-cost simple interface, or a higher-performance version. The high-performance interface, which requires Version 1.1 of the software, along with a visual tuning indicator PCB, is available as printed circuit board only, a kit including the software, or as a fully built and tested unit complete with the software. For current prices etc., contact: A & A Engineering, 2521 W. La Palma, Unit K, Anaheim, CA 92801, USA.

The Program

The screen is divided into several regions (see Fig.8). The top line contains messages, and a prompt for keyboard input, when necessary. The menu contains a list of the available commands. The selection line indicates the currently selected monitor and images. Each ‘‘TV monitor’’ displays an image with 128 by 120 pixels with 256 colours. You can adjust brightness and contrast with the aid of the colour bars.

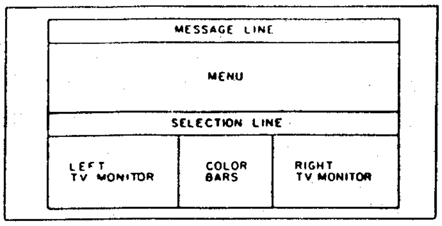


Fig.8: Program Screen Layout

How can 256 colours be displayed at once? In low resolution mode, the ST can normally display from a palette of 16 colours picked from the 512 possibilities. You can increase the number by reloading with a different set of colours during horizontal blanking interrupts. However, there is still a maximum of only 16 colours on each scan line. This program uses a different technique. Two different screen images are built in memory. Each has a different palette of 16 carefully chosen colours. During each vertical blanking interrupt, the opposite screen and palette is selected to produce a total of 256 colours. The 30 Hz flicker becomes a little wearing to stare at all day, but it works very well for shorter periods.

The first column of the command menu contains the commands to receive, transmit, print, load from disk, save to disk, and quit from the program. The second column shows the transmission formats. The third column contains functions to manipulate images. The last column contains commands to generate test patterns. The currently selected format is highlighted with a yellow background.

Most commands require only a single keystroke. Menu items ending with...... require additional input. For instance, when saving an image to a disk, you must specify a file name. A flashing text cursor appears along with a prompt for input. While a command is being executed, the menu item is highlighted by a red background. This assures you that you have pressed the correct key. When the background colour returns to normal, you know the command has been carried to completion.

At any time, one of the two ‘‘TV monitors’’ is the active or ‘‘selected’’ one. Most of the commands use the content of the selected monitor. Press the left arrow key to select the left monitor. The ’’ <-’’ on the selection line is then highlighted in red. Press the right arrow key to select the right monitor; ’’ -> ’’ will then be highlighted.

The 10 image buffers in memory are numbered 0 through 9. The TV monitors can display any of the image buffers. A number above the monitor will be highlighted to show which image buffer it is displaying. You can select an image for the currently selected monitor by pressing one of the digit keys, 0 through 9. Press the up or down arrow key to select the next higher or lower image buffer.

There is one more image buffer that is not displayed on the screen. Commands that modify an image buffer first copy the old image to the save buffer. The UNDO key exchanges the currently selected image and the saved image.

Sending and Receiving

The first step for sending or receiving is to select the transmission format from the second column of the menu. Press ‘‘R’’ to start receive mode. The first frame. will go into the current image. Subsequent frames will go into consecutive image buffers, and the selected monitor will alternate. Terminate receive mode by pressing the space bar.

Function key ‘‘n’’ transmits the current image n times. Press the shift key at the same time to transmit consecutive images, once each. For example, if image 6 is in the selected monitor and you press Shift-F3, images 6, 7, and 8 will be transmitted. Press the space bar to terminate transmission early.

Printing: You can print the image on an Epson or compatible dot matrix printer by pressing ‘‘P,’’ for Print. Each screen pixel is converted to a 4 x 4 group of dots on the printer. Each group can have 0 through 16 dots printed, gray levels are available when viewed from a distance.

Loading and Saving Images: Press ‘‘L’’ to load a picture from a disk file, and ‘‘S’’ to save a picture to a disk file. This program accepts the file formats of the most popular drawing programs. The proper conversion routine is selected by the file extension: NEO for NEOchrome, PI1 for Degas, or SSTV for its own file format with 256 colours. ‘‘V’’ saves the entire screen in a file called SCREEN.NEO. You can load this file into memory to transmit a self portrait.

Image Manipulation: You can manipulate the image in a variety of ways. Uncolour (U) converts a colour image to black and white so that you can see what a colour picture will look like transmitted or printed in black and white. However, you have to uncolour a picture before transmitting it in black and white or printing it out. Mirror (M) swaps the left and the right sides of a picture. Rotate (0) turns the image 90 degrees. Negative (N) inverts all the colours: white becomes black, blue becomes yellow, etc.; medium gray is hardly affected.

Zoom (Z) expands one-quarter of the image by a factor of two so that it fills the entire ‘‘monitor’’. At the prompt, type a single digit to select which quarter of the screen you want to expand: 7, upper left corner; 5, centre; 2, centre bottom; and so on. These positions conform to the numeric keypad. Shrink (S) does the opposite of Zoom.

Finally, use Merge (E) to combine multiple images into one. Specifying only one source image produces a copy of that image. Not specifying a source image clears the current image buffer.

Pattern Generation: ‘‘C’’ produces a traditional 8 x 8 black and white checkerboard pattern. ‘‘K’’ produces a more colourful alternative. Press ‘‘G’’ for a gray scale pattern, ‘‘W’’ for colours arranged in rainbow order, and ‘‘A’’ to produce 256 rectangles with all , the possible colours. Finally, ‘‘B’’ generates overlapping red, green, and blue circles. The intersections of these circles are yellow, cyan, magenta, and white.

Low Cost Interface

Figure 9 shows the station configuration for the low-cost interface. The Atari ST has a built-in sound generator chip which may be used to produce tones for SSTV transmission, good signal reports can be achieved by holding a microphone up to the computer’s speaker, but the exact placement has a big effect on the resulting signal quality. The computer has no provision for audio input, so you will need a simple interface for receiving. The schematic is in Fig.10 and the parts list is given Table 1 on page 110.

U I is a phase-locked loop which locks onto the strongest tone present. U2 produces a square wave with exactly a 50% duty cycle. Q1 provides protection for the computer; the output of U2 may exceed 5 volts.

The RS-232 port is used only as a source of plus and minus 5 or 6 volts. The busy input of the printer port happens to be connected to a hardware timer which is used to measure the length of each pulse. You must adjust R3 for an output of roughly 1750 Hz with no input. You do not need a frequency counter for this adjustment; pressing the ‘‘*’’ key on the numeric keypad will display on screen the approximate frequency of the signal from the interface.

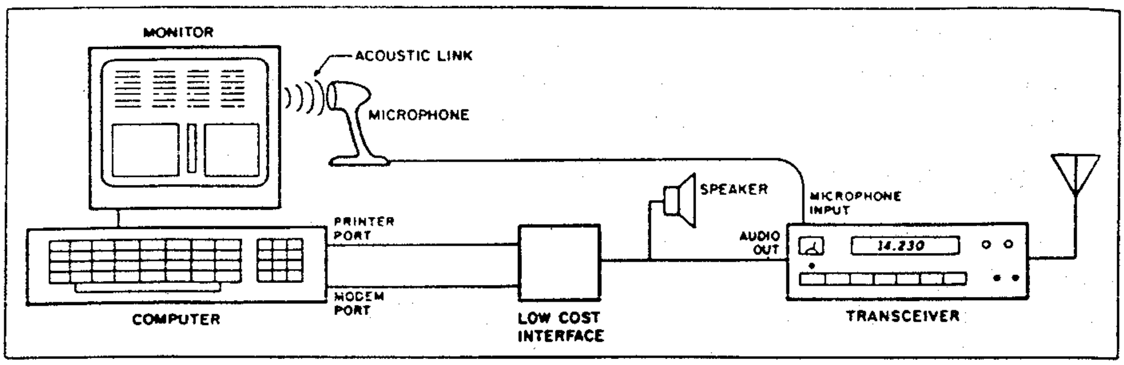


Fig.9: Station Layout using the Low-Cost Interface

Summary of Features:

- Sends and receives these popular formats: Robot: 8 second black and white 12, 24 & 36 second colour; Volker Wraase: 24, 48, and 96 second colour; AVT: 40 second colour, 24, 94 second colour, receive only.
- Screen contains: Two images with 128 x l20 pixels of 256 colours and the Menu of available commands.
- Test pattern generation: Checkerboard, rainbow. all colours.
- Image manipulation: Mirror. rotate. zoom, shrink.
- Load and save images with various file formats: NEOchrome, Degas, Own format with 256 Colours.
- Keep ten images in memory for instant access.
- Print images with 17 gray levels.
- Can use either low cost interface connected to modem and printer ports, or high performance interface connected to MIDI port.

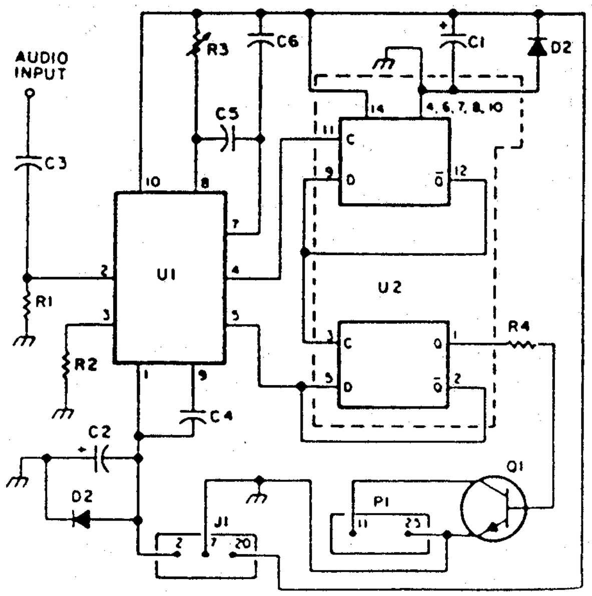


Fig.10: Low-cost Receive Interface

Table 1: Parts list for Low Cost Interface

C1,C2	100uF	C3	0.1uF disc ceramic
C4	0.01uF mylar	C5	0.001uF mylar
C6	0.033uF mylar	D1, D2	1N4001
Q1	2N39064 or similar	R1, R2	4k7
R3	10k trim pot	R4	22k
U1	NE565 phase-locked loop	U2	CD4013 dual D-type flip flop
J1	DB-25S connector for modem port		
P1	DB-25P connector for printer port		
2 off	14-pin IC sockets		

Upgrading

Figure 11 shows the station configuration for the high performance interface. The program also supports this interface, which connects to the MIDI port. MIDI stands for Musical Instrument Digital Interface, a standard for connecting computers and electronic musical instruments. The MIDI port is simply a serial interface similar to an RS-232 modem port. However, MIDI is permanently configured for 8-bits per character, no parity, one stop bit, and 31250 baud. It also uses a current loop rather than a bipolar voltage. A MIDI port is available as an option for most home computers, it is standard equipment on the Atari ST.

The demodulator converts the received audio to a video signal of 0 volts (black) to 5 volts (white), and a positive TTL-compatible sync signal. The computer sends bytes to the interface at the desired pixel sampling rate and a video signal of 0 to 5 volts is converted to an eight-bit number in the range of 0 to 255. This is then converted to serial form by a UART and it is sent to the computer.

The tone generator produces a crystal controlled, phase coherent, sine wave and requires no adjustment. The output frequency is 250,000/(256-n) Hz, where n is the data from the computer. When the two most significant bits of the byte are ones, the tone generator is turned off.

Adjustment

The demodulator must be adjusted to produce the proper mapping of frequency to voltage. Many construction articles simply instruct you to whip out your audio signal generator, digital frequency counter, digital voltmeter, etc., and twiddle with the pots until it is right. Many amateurs do not have all this fancy test equipment, however, so a program called HPITEST is included with the software. During adjustment, the output from the tone generator is connected to the demodulator input. The computer sweeps the tone generator output across the range of about 1000 to 2400 Hz and plots the output on the screen.

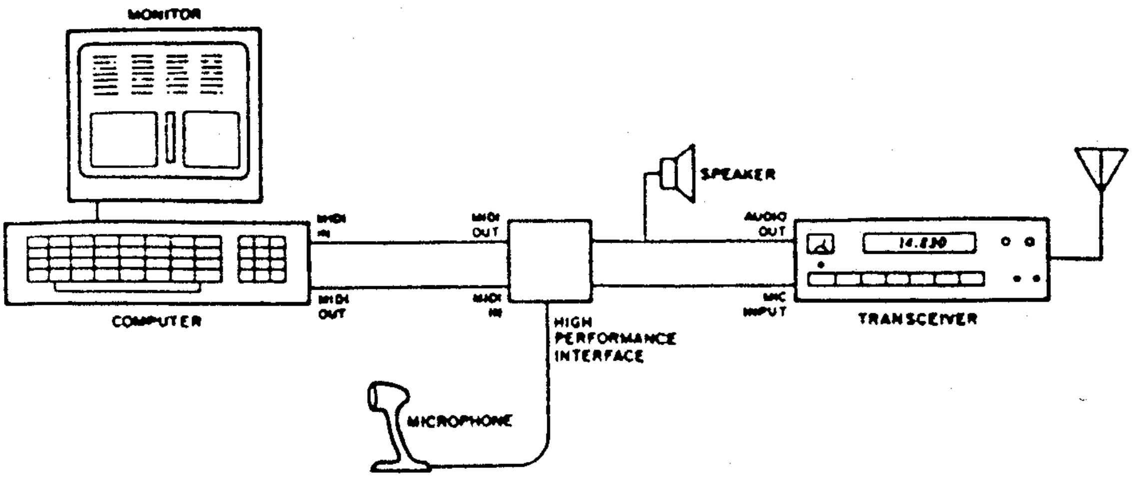


Fig.11: Station Layout using the High-Performance Interface

Signal Analyser

Some people can tune in RTTY and packet signals very accurately by ear, but most, myself included, can not do this. Tuning does not seem to be as critical for SSTV, but a visual tuning aid still helps. The optional signal analyser/tuning indicator has a 20-segment LED display, each segment corresponding to a frequency range of about 70 or 80 Hz.

The HPITEST program has another option for calibrating this display. While the computer is rapidly cycling the tone generator between 1200, 1500, and 2300 Hz, the pots are user-adjusted to position the dots in the desired locations. A properly tuned signal appears as a big blur in the 1500 to 2300 Hz range (depending on the particular picture), and as a separate sync dot at 1200 Hz.

Conclusion

A phase-locked loop works well with a strong, clean signal, but not so well under noisy conditions. Holding a microphone near a speaker driven by a square wave as is necessary with the low-cost interface is not ideal for generating a clean signal, and swapping cables to receive or print is an annoyance. The low-cost interface, however, provides a quick, easy, and cheap way to enter the exciting World of slow-scan television.

The high-performance interface is not a state-of-the-art system, but it is a great way to try a new mode of communication with very little investment.

The kits for the high-performance interface and the visual tuning indicator are available for A & A Engineering at the address given earlier in this section. The kits include all components, DIN connectors and software. They do not include cabinets, microphone connectors, or cables. The kits requires only a + 12V supply, so most people can use their transceiver power supplies.

Amiga

The Amiga Video Terminal is marketed in this country by ICS Ltd., Arundel, West Sussex. It supports all the SSTV modes, including the NewModes (M1,M2,S1,S2), and also 60, 120, 240 line analogue FAXIMILE transmissions (not office type digital FAX).

The system consists of a fairly small metal cased interface unit, a very well screened multicore cable, a bag of various plugs for user terminations, a very thick manual and a single 3 1/2 inch disk. The interface requires a 12 volt supply, which can adequately be supplied by a ‘‘battery eliminator’’ type of unit, since the interface only draws about 150 mA.

The software really requires an Amiga with a minimum of 1.5 M of RAM to operate to its best, but there is documentation on the disk (and from ICS themselves) for reconfiguring the system for as little as 1 M machines. A more up to date manual is also on the disk, but it is suggested that a new ribbon is fitted and a fresh box of paper found before attempting to print it out, as it is about 145 Kbytes in length.

The software originally issued with the AVT package was the v3.0d BETA and there were a few problems to be sorted out for use in this country, especially with our accepted sizes of picture image compared with the American NTSC standard. There had been an attempt to change the system to PAL for the actual running of the software but, for instance, the NewMode pictures were all 16 lines too short. However, I am now led to believe that the later version of the software has had these problems sorted out.

The AVT system can be preset using ‘‘trimmer’’ values in order that a straight edged picture will be received from a station using Martins M1 or M2, or Scottie S1 or S2 modes of operation. The actual AVT mode also promises great things.

There is one apparent problem with this package, the received SSTV picture on the Amiga monitor screen is seriously degraded compared with the image that was sent to it, even in the NewModes. The HAM (Hold And Modify) picture shows very poor boundaries of colours, which gives a very rough looking picture at present. It is suspected that this is totally a function of the Amiga display mode, since the ‘‘picture’’ can be retransmitted back to the originating source and it looks very reasonable. In other words, the data is captured by the Amiga but not displayed properly with this version. Perhaps this has also been improved with subsequent versions of the software.

As a colour picture is sent to the AVT system it is displayed in black and white as it scrolls down the screen, then changes to colour after the receive period, very strange when compared with the normal systems. The screen display also looks a bit disarranged in the receive mode, but it clears itself up a lot for the final colour image display, so that makes up for the first impression. The ability to snatch screens from within the Amiga environment means that the system is rather more versatile than the system would at first appear. It means that Digiview images and the like can be used for SSTV, and also the received SSTV pictures can be saved in IFF form for use in slideshows, or printed out, if the image is considered to be of reasonable quality.

Facilities within the software are almost boundless, and only a few of them would be used normally, so in this context the big icon panel does seem to get in the way when the program is in use, being rather more bewildering in its complexity than useful.

Overall the AVT system seems to be not as good as it surely could be. The well recognised superior screen and graphics handling capabilities of the Commodore Amiga could, one feels, be surely be used to greater advantage than this software package does. However, it does represent a useful method of transmitting and receiving SSTV for a price of around œ300.

The system is available from: ICS Electronics Ltd., Unit V, Rudford Industrial Estate, Ford, Arundel, West Sussex, BN18 0BD. Tel: 0903 731101.

IBM PC and clones

Pasokon TV is a very new full featured, low cost alternative to conventional SSTV converters. It is a software and hardware package, but the hardware is in the form of a card that slots into one of the expansion slots inside a PC computer. The system is only just being released as this book is being published, so I have only had the initial pre-launch information release and have yet to actually see a unit. A pity since I contacted the developer and supplier, John Langner, without reply some time ago. However, a brief description follows, but based only on the press release and not on hands-on experience.

The advance information claims the following specification:

Send and receive all popular modes: Robot Colour: 12, 24, 36, 72 second; Robot B&W: 8, 12, 24, 36 second; AVT: 24, 90, 94, 188 second; Martin: M1, M2, M3, M4; Scottie: S 1, S 2, S 3, S4; Wraase SC-1: 24,48,96 second.

- Interface fits inside the computer.
- No extra power supply required.
- Does not tie up serial or printer port.
- Read and write popular image file formats.
- Graphical user interface with mouse support.
- On-screen tuning indicator.
- Resolution of 320 x 240 with 32768 colours.
- Full screen images on standard VGA with 320 x 200 256 colour mode.
- 32768 simultaneous colours on super VGA with Sierra IEColor RAMDAC.
- Test pattern generation and image manipulation.

The launch price is advertised as $199.95, which represents a major breakthrough, even with UK import duty and VAT added. If the unit meets only half of its claimed specifications then I feel that it could sound the death knoll for conventional scan converters, especially as more and more amateur shacks are becoming home to a PC or clone.

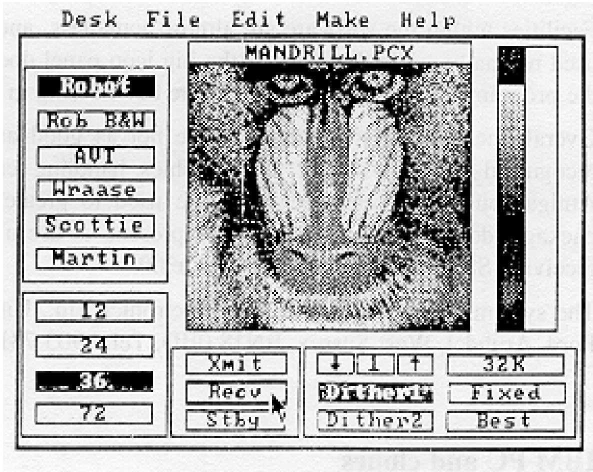
The minimum computer hardware requirements are as follows:

IBM PC/AT or compatible.286 or later CPU, 640 K memory.VGA display (HiColor option supported). Mouse strongly recommended.

For further information, or to order your system, please contact: John Langner WB20SZ, 115 Stedman St. #N, Chelmsford, MA 01824-1823, USA.

ViewPort for the PC

ViewPort VGA has added another less expensive means of getting into colour SSTV than buying a conventional scan converter. Centred round dedicated software the system uses an interface based on a modified John Langner design for the Atari. The interface links to the computer via the printer port and to the transceiver audio in and out analogue signal sources. Also there is a PTT controlled microphone facility. All displays are on the computer monitor screen.



The Pasokon Screen

Using a mixture of ‘‘dirty’’ wiring and wire-wrap efforts with the experimental system were doomed not to work satisfactorily, but picture files transmitted and received by other experimenters were clearly heading in the right direction. It was an ambitious project which consumed over 1000 hours of work, always limited by the graphic resolution of the standard VGA display, colour palette algorithms and the diversity of PC computers in use. Very much a middle path option which would present problems at a later stage, when the transmission of modes reliant on the presence of a high stability oscillator running at 12 MHz was to be included. Typically, the frequency deviation of most computers is around 95%, which taken together with the diversity of fundamental frequencies used by different XT and AT computers, is a complication with no easy answer.

Fortunately such frequency stability restrictions are of lesser importance when considering solely Robot modes of operation. It is claimed that in practice ViewPort will work up to 486 machines and that most 4.77 XT types should be OK, although there may be exceptions.

Hardware

The computer is required to be IBM compatible with at least 640K of memory, a standard printer port and a VGA display capable capable of 320 x 200 x 256 colour mode. The system will work agonisingly slowly from a floppy disk, a hard drive is really essential. Most clones are quite adequate.

Software

The programme will not run reliably with TSR (Terminate and Stay Resident) programmes present, e.g: PC-Tools, Sidekick, etc. Neither will it run with Windows loaded. The DOS file ‘‘MORE’’ should be added to the ‘‘AUTOEXEC.BAT’’ file path, so that the picture directories function correctly. It is also recommended that ‘‘ANSI.SYS’’ is remmed out of the ‘‘CONFIG.SYS’’ file, to allow the menu screens to assume their intended colour. If this is not done text appears white against a black background, on trial the displays were quite acceptable without this modification.

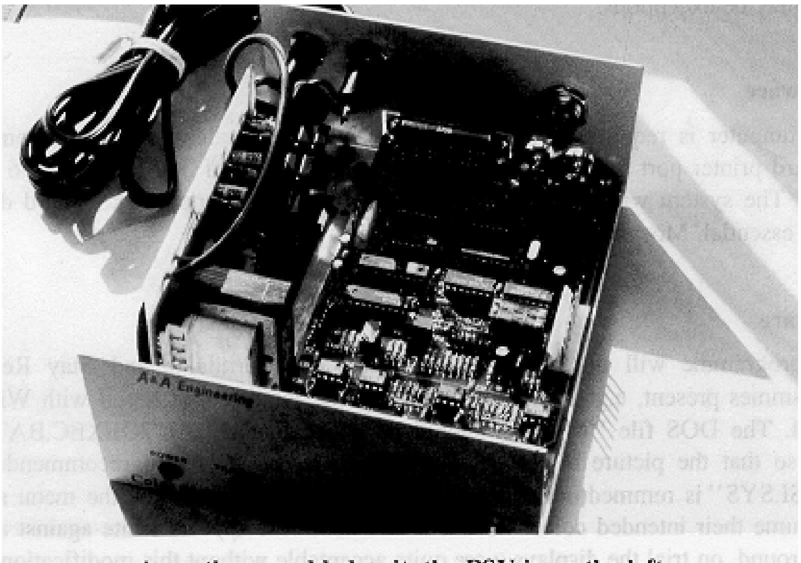
The software programme comes on a single 5.25’’ disk, is not write-protected and can be passed around. It contains a printable dissertation on aspects of the setting-up procedures, helpful notes, comments and addresses. There is a file checklist in the documentation so that the actual disk can be verified, one amateur had three files missing from the software disc, so it is as well to make sure all is correct upon receipt.

The Kit

The kit forming the basis for this review was the full version ordered from A & A Engineering (a price list appears below) paying by Visa the statement showed a total charge of £117.50; this was inclusive of shipping charge and a 240V transformer, for which there was a small surcharge. After four weeks a substantial, well-packed, box duly arrived labelled ‘‘AMATEUR RADIO PARTS’’ ‘‘NO COMMERCIAL VALUE’’ and was carried off to the workshop for opening, checking and construction.

The documentation consisted of coloured duplicated sheets with clear unambiguous illustrated instructions, schematics, layouts, pictorial component identification and set-up hints, following these should be well within the ability of any occasional constructor. The components supplied were of superior quality, complete down to the smallest detail of minute ferrite beads and plugs for the mike in and out cables, a generous assortment of nuts, bolts, clips, washers and wire, although the latter was sufficient there was little surplus. It seems important to trim to the lengths given in the assembly sketches.

The single-sided main PCB is of the layered type, no connecting tracks being visible, the plated through holes virtually eliminating the possibility of a dry-joint. The silk-screened component layout was adequate, all ICs are fitted into sockets, as is the relay. Care was needed to identify correctly diode locations. I have in my time built-up hundreds of PCBs and this board was amongst the finest quality encountered, a pleasure to work on. The supplementary PSU board was of standard open copper track construction, but equally well turned-out.



A partly assembled unit, the PSU is on the left.

The method of installing the three heat-sinks containing the voltage regulators by interference fit was fiddly and needed a judicious amount of bending the heat-sink prongs to line-up with the pre-drilled hole. Once assembled an error would not be easy to reverse, correct identification of the regulators needs triple checking before committing the soldering iron. The PSU board supplied stabilised +/-12, and +5 volts and was a snug bracketed fit, this required careful assembly, the tracks being perilously close to the enclosure side. Thoughtfully , a sheet of paxolin insulation with prepunched holes was included to prevent any likely shorts and although not mentioned in the text its use is obvious.

The enclosure case supplied continued the theme of excellence. Cleanly printed layout both front and rear makes it a visually attractive addition to the shack and with LEDs to indicate power on and transmit status, no further adjustment is required once the mike-gain control is set.

All components were contained in polythene bags, grouped according to use and designation. Construction from start to the completion of setting-up took 10 hours in three sessions. I was impressed with this kit, which was well designed and thought-out. Messrs. A & A Engineering are to be congratulated in producing a first-class kit, which assembled without difficulty and worked first time!

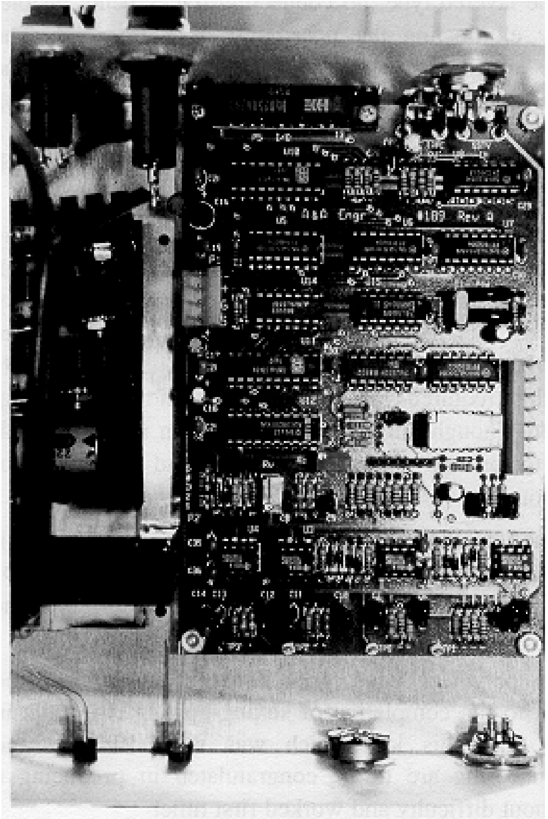
Setting-Up

Once the construction was finished and voltage levels checked the initial setting-up involved the simple adjustment to set parameters for the black and white levels corresponding to 0V and +5V. This was done via two 15-turn cermet potentiometers and assumes that the constructor has access to an audio generator giving 1200 and 2300Hz. An alternative method is provided in the software in the form of a visual display, which is effected by shorting the SSTV input to the tape output and observing on the monitor. Four frequencies are generated by the software equating to white, grey, black and sync, and are displayed as arrows with adjacent corresponding lines. The potentiometers are then adjusted so that the lines are brought as close to the arrow heads as possible. A very accurate alignment is possible with this very clever and sophisticated method. An additional on screen check is available by observing changing numeric values which vary according to the setting of the potentiometers. It certainly takes out the hassle from setting up. Once the optimum setting is attained the case can be assembled and screwed down, all further setting-up being done via the software ‘‘SSTV.CFG’’ file.

The Programme

The programme is on a single disk which should be copied across to a ViewPort directory on the computer ‘‘C’’ drive. According to the information, the version supplied supported the 32K colour boards now available, but did not seem to make any discernable difference to the display on the test computer fitted with the Pro-Designer 32K Sierra-dac board. This board is not one of the 32K colour types tested and known to function, so it was not possible to say what difference this might make.

Once installed and with the interface connected to the transceiver several menu screens are available. Transmit, Receive, General and a further Options screen. On the review software the following menus were available:-



The assembled Circuit Boards

Transmit: 8, 12, 24, 36 second black and white, 36 and 72 second Robot colour. These are selected via the function keys. As a bonus it is also possible to transmit in Scottie S1 mode, this does not appear on the menu or in the instructions. A tuning signal can also be sent using the ‘‘+’’ key.

Receive: 8, 12, 24, 36 second black and white and 36 and 72 second Robot colour. S1 and S2 Scottie modes, M1 and M2 G3OQD modes.

Additional Functions: Grey Scale and colour bars, Alignment tone, Save to Disk, Delete file from disk. Load TGA format, Load PCX format, Load IMG (Gest) format, Load HRZ (Hi-Res) format, Load Custom palette, Image directories. (Two functions viz Display Live Image and Digitise Image are listed but not implemented).

Parameter Set-Up: Visual set-up, Oscilloscope, Tuning Indicator, Change Drive, Change Printer path, View Luminance, view R-Y, view B-Y. All pictures have to be preprepared in one of 4 formats PCX, TGA, HRZ, IMG. The last two being picture images saved under Hi-RES and GEST. F9 offers a choice of directory listing for any of the formats supported. Unless you have a Robot 1200c which can be used as a frame-grabber (which defeats the whole purpose of ViewPort) then recourse must be made to preparing PCX format pictures via an art package such as ‘‘PC Paintbrush’’. My first attempt at preparing a PCX picture from GIF format was not immediately successful until it was realised that the PCX file also required some additional format scaling to an exact 256 x 240 size, once that was done picture load and transmit was satisfactorily. To effect the accurate scaling necessary a programme such as ‘‘Alchemy GWS version 6.1’’ or ‘‘HiJaak version 3’’ is essential. This information is buried in the documentation, which needs careful study.

And the TX Quality ?

Robot quality was not expected on either transmit or receive, indeed ViewPort do not claim to match this standard and the best possible conditions were used for initial testing, the local 2m FM SSTV net. As a control to monitor exactly what was being transmitted and received a Robot 1200C was also hooked up, which slaved both incoming and outgoing signals. What was received was surprisingly good and very acceptable once the understanding that the picture loaded for transmission and viewed on the computer monitor was not being sent as seen!, i.e: the colours and format when viewed on the computer monitor are comprised of a VGA palette of 256 colours and appear with a pronounced vertical elongation, whereas the picture actually transmitted is in 32K colours with an aspect ratio nearer 4:3 and fully compatible with other scan convertors.

There was a great improvement in both colour rendering and contrast when the transmission was made in Scottie S1 mode, although picture received on the 1200C was sloping by some 15 degrees top right to bottom left, this would not be the case when received by a similar ViewPort system. All the pictures sent on 2m were received on 1200C convertors with reports of very good stable pictures in all the Robot modes used. A comment made was that had the net not been told they were ViewPort transmissions they would have passed as general Robot mode pictures, except as mentioned the S1 pictures were better in both colour and resolution but sloping.

Receive

ViewPort has no means of identification of incoming pictures and unless the correct mode is selected at the precise moment the picture signal commences, the image on the PC monitor either begins to scroll prematurely or misses the opening lines. Put more simply, there is no automatic standby to accept an incoming VIS. The vertical interval signal which precedes 1200C transmissions is not recognised by ViewPort, so it is important to know in advance which mode and speed is being used.

The review software did have a basic form of VIS on transmit which triggered a 1200C, but not another ViewPort. Having set the correct mode, it was found that the resultant pictures very good and although the 8 second B/W occupied only the left quadrant of the monitor, it was sharp with good contrast. Superior it was thought to the the same picture being received on the Robot!. The colour palette was as good a compromise as could be expected and acceptable, pictures received in M1 and S1 modes appeared more square that usual and did not occupy all the monitor screen. This could possibly be explained by incorrect parameter settings of the SSTV.CFG. This file is supplied with arbitrary settings found to give the best average results. It appears that some computers will need a modicum of fine tuning via this lengthy and enigmatical file.

What was found irksome when receiving black and white 8 second was the need to activate the appropriate ‘‘F’’ key to initiate consecutive frames, timing was vital to get a full picture displayed. It was the impression that ViewPort handled noise and QRM very well, equal if not better than the 1200C in Robot mode, and it did not easily drop out of sync. A facet of picture receive worth mentioning is that colour picture scrolling reaches the bottom of the monitor screen before the end of the incoming transmission, the apparent loss of part of the picture is rectified once transmission is complete and the PC enter key is pressed, a recomposed full image is then displayed.

Several received pictures were saved using the F5 save routine and this worked flawlessly, the image being saved in TGA format. All other routines worked smoothly as intended.

What ViewPort Cannot Do

With only a single memory for both TX and RX images, the exchange of pictures is slowed down, a good line of waffle is needed to fill-in the gap whilst pictures are changed over, and with no provision for the addition of any text it is necessary to anticipate in advance any captions, e.g: a call-sign. Without a Robot to hand, this has to be done by using an external paint programme and saved in a similar format before going on the air. An exceptionally good waffler might manage this during a session, this would entail a considerable amount amount of work and the format must be correct. It is easy to use the 1200C to do this, but again, this defeats the principle of ViewPort.

As previously mentioned there is no way at present to input directly from a camera or frame-grabber. This looks to be a future important addition. Stills saved on VCR and a tape-recorder were loaded successfully, and it was also very easy to use a DOS path to load a picture from a disk library. On transmit there is no indication of the progress of the transmission, the picture being sent is not visible, the only indication is the illumination of a red LED on the front of the interface. It would have been nicer to have had some means of knowing the state of the transmission, an expanding line or some other visual indication at the bottom of the monitor display would be useful.

Sources

PCBs and Kits: A & A Engineering, 2521 W. La Palma, Unit K, Anaheim, CA 92801. U.S.A. Telephone: (714) 952-2114; Fax: (714) 952-3280.

Software and technical information: John Montalbano KA2PYJ, 10646 106th Place, Indianapolis, Indiana, 46032, U.S.A.

Price Summary: Blank PCB $19.95; Both board level kits (SSTV and PSU) $129.95; Full kit (Case, Hardware, SSTV and PSU) $169.95; Complete Assembled and tested unit $229.95; 6ft x 25-pin M to M cable $10.00.

Note: a 20% surcharge is added to these prices for all foreign orders which need special handling arrangements and approximately $5 extra for a suitable 240V transformer, which must be specifically requested. Dependant on how the phrase ‘‘Of No Commercial Value’’ is interpreted by customs, VAT may or may not be levied on delivery! This could add to the total cost.

Conclusion

If you want to get into compatible colour SSTV without having to find the œ1500 or so for a basic Robot 1200c and colour monitor, and you already have a PC compatible computer, then ViewPort is one option to fulfil your ambition.

The quality on transmit is good and it certainly receives a fair picture. The system could expand and improve if KA2PYJ refines and adds to the software and overcomes the oscillator stability obstacle. It does have the ability to make use of the new 32k graphics board, this is an asset, although not everyone will want to meet the high cost of these boards.

There are limitations, the single picture memory, absence of graphic text facility, VIS pulse and live picture input, but these will not be missed if you have nothing else to begin with, and there are future updates. The kits are fair value even with the foreign surcharge and possibly VAT. If you can handle a low wattage soldering iron and do not mind hunting around for components, buying the bare boards could get you on the air for around £60.

This is an arrangement which works extremely well within its limitations and will satisfy the appetite of budget conscience amateurs and SWL's having access to a PC. Whether it can be developed to a full system only time will tell. Having got so far John Montalbano will certainly be sticking to the task and is to be commended for producing a viable system.

This ends our look at computerised slow-scan television systems. There are, no doubt, many other packages and systems available, many of which are perhaps as versatile as those described here. However, I have tried to provide a look at what is available and have attempted to show what can be achieved by using a computer as the basis of an SSTV station. The way ahead will no doubt be that computers, probably the PC, will become the major force in use by SSTVers as their slow-scan station.

Some Useful SSTV Circuits

An SSTV Character Generator

Unless one is fortunate enough to have an SSTV keyboard, or a computer which can produce large characters, it is difficult for SSTV users to generate a bold, personalised identification caption. Of course a camera could be used but this would have to be set up, lights switched on and the correct card found each time you wanted to use your ident caption, not the best way to get on the air in a hurry!

The character generator described here is designed to electronically produce two lines of up to eight characters which you can customise to your own requirements. The large characters produced will stand out even when they are being received off air under weak signal or noisy conditions. The unit is quite versatile in that it allows you to change the vertical size of the characters as well as providing on-board switching, so that either the top line, bottom line, both lines together or no characters at all (blank raster) is produced. It is also possible to change the overall width and position of the display by selecting appropriate resistors, or even by providing variable controls.

A printed circuit board for this project is available from BATC Members' Services, and some add-on units are also available to further enhance the project.

The circuit of the unit is shown in overleaf Fig.1 and is built around a custom character generator chip the RO- 3-2513UC. This chip produces upper case (capital) letters, however a lower case version of the device is available suffixed LC.

Programming

In the basic unit described here the character generator is programmed by connecting diodes in a matrix which programmes the ROM to produce the required characters. To choose each individual character diodes connect the A4 to A9 inputs to the binary-to-hexadecimal chip IC10. A four-bit code is presented to the input of IC10 which changes each time a new character is output. The output of IC1O has 16 pins, each of which goes low in turn as a different character is addressed.

The inputs to IC9 are held high by pull-up resistors so that the code input to IC9, with no diodes in circuit, is 1 1 1 1 1 1 which produces the ''?'' character. A diode between an IC9 input and an IC10 output will cause one of the logic-1 states to be taken to logic 0.

On the board the inputs to IC9 comprise six address lines which run parallel towards one edge of the board. The outputs from IC10 are brought out on wire links, the link at the end of the address bus (nearest the edge of the board) representing the first letter.

The program chart below shows the placing of diodes to create any character. In the case of ‘‘G’’ , for example, there is an ‘‘x’’ in the first three columns, ‘‘x’’ indicating that a diode is required, therefore the A9, A8 and A7 inputs require diodes whilst A6, A5 and A4 are left blank. The bus nearest the edge of the PCB is A9 and represents the first column on the programming chart.

The diodes are wired with the anode to the data bus and the cathode (marked end) soldered to the wire link corresponding to their position, e.g: if the first letter of the top line is ‘‘G’’ then diodes connect from A9, A8 and A7 to link-1 (see Fig.2 overleaf). The wire links are formed by bending a piece of tinned copper wire into a wide ‘‘U’’ shape Link and soldering this at each end to the board tracks. The diodes are then stood on end, one wire passing through the appropriate hole in the PCB and the other (marked end) connected to the link. In this way diodes can be easily re-arranged simply by disconnecting the link end, this saves the risk of damage to the PCB.

Additional Circuitry

A sync pulse generator having the required TTL level output is described Chapter 10. If the output pulses are the wrong way up it will be necessary to invert the signals either in invert or two-input NAND gates. The video produced by this generator can be used to drive the modulator also detailed in the same chapter, however an alternative simple and rather novel circuit is shown in Fig.3.

IC1 is a voltage-controlled audio oscillator which is very stable and independent of supply fluctuations. The frequency is set by the 3.9k resistor at pin-6 together with a 68nF capacitor and whichever capacitor in Tr1 or Tr2's collector is switched in.

Inverted sync pulses fed to Tr1 ensure that it conducts during sync periods only. This causes the 82nF capacitor in its collector to be switched in parallel with the 68nF making IC1 oscillate at 12OO Hz (SSTV sync frequency). The sync signal also blanks the video to stop interference during sync periods.

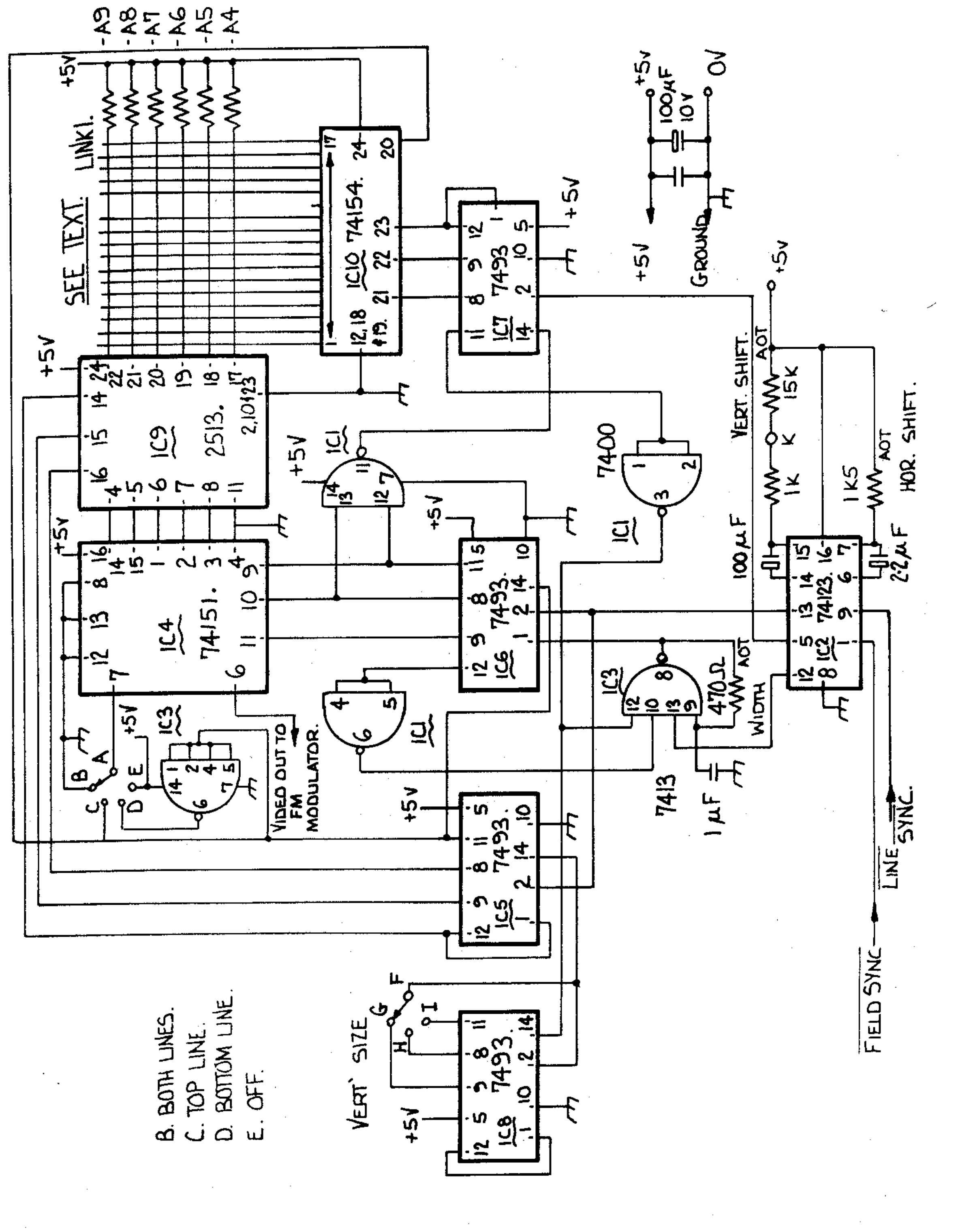


Fig.1: SSTV Character Generator Circuit

Peak white video from the character generator is represented by a logic zero and black level by logic one. During the line period Tr1 is switched off whilst a logic one will switch Tr2 on, making the oscillator time constant capacitors 68nF plus 47nF which will cause the oscillator to run at 1500 Hz SSTV black level. When characters are present in the video the input will be at logic zero which means that neither transistor will be switched on therefore the time constant is set by the single 68nF making the oscillator run at peak white (2300 Hz). Since the resulting SSTV is largely comprised of square waves, the combined signal is passed through a simple 3 kHz active filter (IC2) which produces near sine waves in the 1200 - 2300 Hz range. The output level to the transmitter is set by the ‘‘gain’’ control.

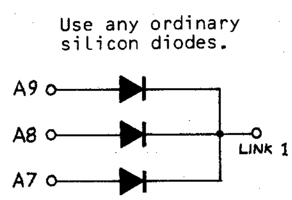


Fig.2 Diodes required for a "G"

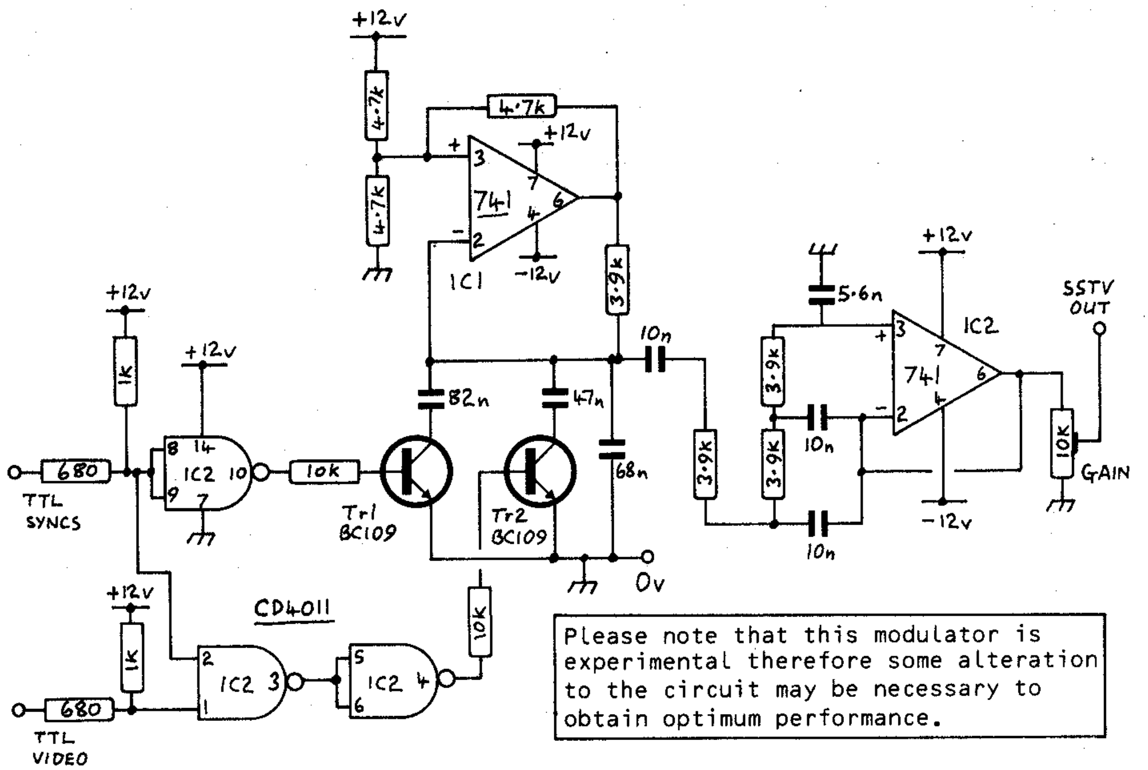


Fig.3: SSTV Modulator and Filter

An SSTV Pattern Generator

This design produces five different black and white test patterns, invaluable when,setting up SSTV equipment. Also provided are the three standard test frequencies used in SSTV: 1200 Hz, 1500 Hz and 2300 Hz. A printed circuit board for this unit is available from BATC Members' Services and is supplied complete with a component layout diagram.

PROGRAMMING CHART

Char'	A9	A8	A7	A6	A5	A4	Char'	A9	A8	A7	A6	A5	A4
A	x	x	x	x	x		V	x		x			x
B	x	x	x	x		x	W	x		x			
C	x	x	x	x			X	x			x	x	x
D	x	x	x		x	x	Y	x			x	x	
E	x	x	x		x		Z	x			x		x
F	x	x	x			x	blank		x	x	x	x	x
G	x	x	x				0			x	x	x	x
H	x	x		x	x	x	1			x	x	x	
I	x	x		x	x		2			x	x		x
J	x	x		x		x	3			x	x		
K	x	x		x			4			x		x	x
L	x	x			x	x	5			x		x	
M	x	x			x		6			x			x
N	x	x				x	7			x			
O	x	x					8				x	x	x
P	x		x	x	x	x	9				x	x	
Q	x		x	x	x		-		x			x	
R	x		x	x		x	/		x				
S	x		x	x			&		x	x			x
T	x		x		x	x	?						
U	x		x		x								

'x' indicates where a diode is required

The pattern generator (Fig.4) is based on a hex inverting buffer IC1 which is configured as a digital-to-analogue (D/A) converter. The digital ''word'' is selected by means of a 4-pole/6-way rotary switch wired as shown in Fig.6, page 129. This digital ‘‘word’’ is decoded by the D/A, which is also fed with line and frame sync from the frequency generator, and the resultant analogue signal is fed to an op-amp IC2, which feeds the corrected level to the voltage controlled oscillator (VCO) IC3. The VCO converts the analogue output from the D/A stage into a frequency corresponding to an SSTV signal. This signal is then fed to another op-amp, IC4, configured as a low-pass filter, whose output can then feed to a single pole 4-way rotary switch to select between either the pattern generator output or the standard frequencies.

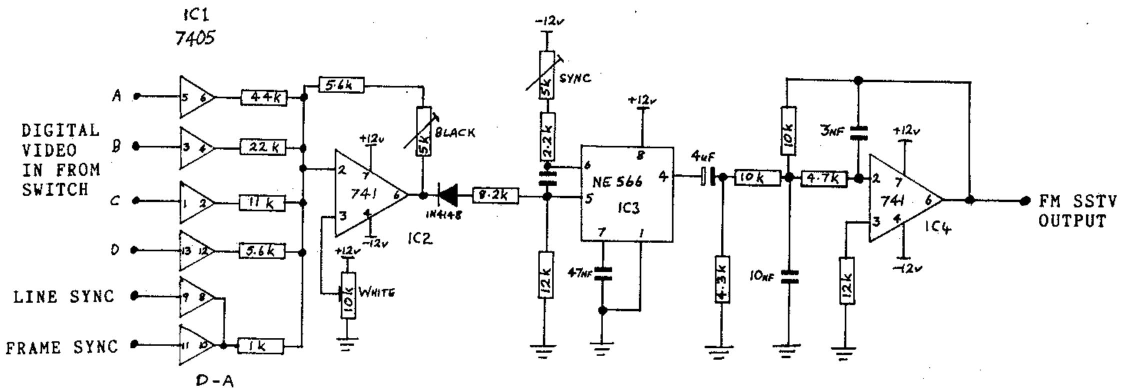


Fig.4: Circuit Diagram of the SSTV Pattern Generator

The standard frequency generator (Fig.5) provides the three standard frequencies from a single master oscillator, IC5, running at 276 kHz. This oscillator is fed to a series of divider chains to produce the three frequencies, IC6 and 7 for 23OO Hz, (peak white), IC8, 9 and 10 for 1500 Hz (black level) and IC11 for 1200 Hz (sync). The 1200 Hz is then further divided by IC12, 13 and 14 to derive the line frequency of 16.3 Hz for the UK and 15 Hz for US standards, selectable by SI. Further division again by IC17 and 18 gives the frame frequency for 120 or 128 lines, selected by IC16 and S2.

The power supply circuitry is not catered for on the board but a simple regulated supply is all that is required. Power requirements are: +5V @ 220mA, +12V @ 2OmA and -12V @ 20mA, although if some ICs are replaced (where appropriate) with ‘‘LS’’ versions the current drawn from the +5v can be reduced.

Construction

The master oscillator capacitor is given as 5600pF, but this will depend on the tolerance of other components, so a second position on the PC board is provided where a capacitor may be placed in parallel with it. This will allow for the oscillator to be adjusted to it’s correct frequency at the mid-point of the potentiometer travel. All resistors should be 5% tolerance, with the exception of the summing resistors associated with the D/A, IC1, which should be 1% if possible. These summing resistors should be in the ratio 1:2:4:8, with 5.5k being the value of the first. Where resistors have an awkward value they may be built up by series/parallel combinations.

Setting Up

1) Using a dual-beam oscilloscope monitor the line sync waveform at the output point on one channel and a 50 Hz waveform on the other. Adjust the master oscillator until the sync pulses are stationary with respect to the 50 Hz waveform. Alternatively, a single-beam oscilloscope may be used if it has the facility to trigger the input waveform from an external source. If this method is used then the line sync pulses should be stabilised against an external 50 Hz trigger input.

2) Adjust the line sync pulse width to 5ms and the frame sync pulse width to 30ms.

3) Connect the output of the unit to an SSTV receiver and connect the oscilloscope to a point where the SSTV signal has been demodulated. Feed in 1200 Hz from the frequency generator and note the position of the trace, the (oscilloscope has to be operated in the DC-coupled mode for these adjustments). Now feed the output from the pattern generator into the SSTV receiver and, with no pattern selected, adjust the SYNC potentiometer to give the same trace position on the oscilloscope as with the 1200 Hz. Repeat this process selecting Black and White patterns, adjusting the ‘‘BLACK’’ and ‘‘WHITE’’ potentiometers respectively to position the trace at the same position. These adjustments are somewhat interdependent so the whole process must be repeated to achieve perfect results.

Alternative Master Oscillator

For those wishing to use a more stable master oscillator, Fig.7 shows a suitable circuit using a standard colour TV subcarrier crystal at 4.433619 MHz. Although when this frequency is divided by sixteen the resulting frequency is 277.101 kHz (instead of the required 276 kHz), it is nevertheless within one percent of the standard and therefore perfectly suitable for general use. Provision for this oscillator is NOT provided on the pattern generator printed circuit board.

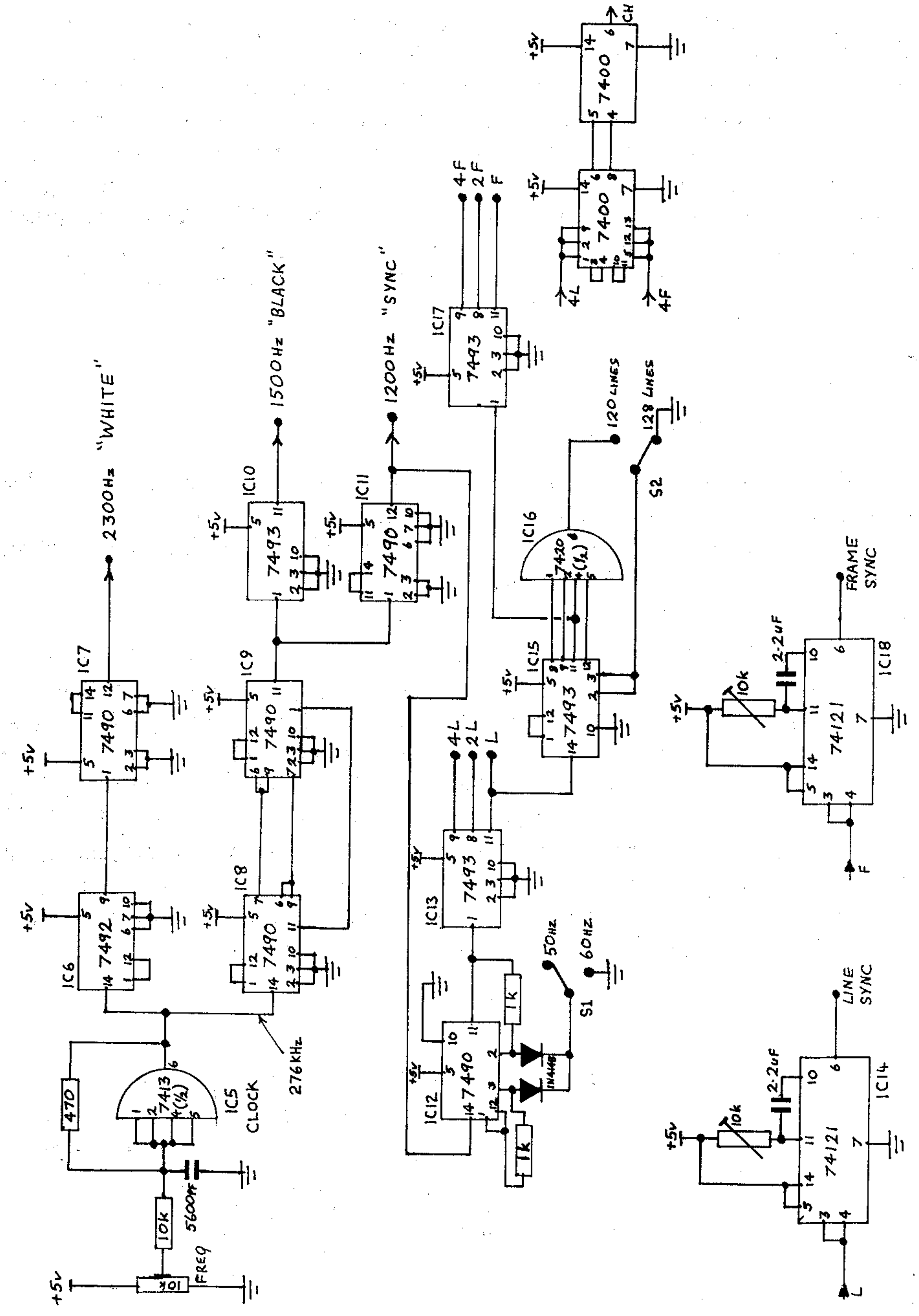


Fig.5: Standard Frequency Generator

Filters

Audio filters are extensively used in SSTV equipment arid, because of the almost universal use of operational amplifier ICs these days, such filters are invariably of the ‘‘active’’ (rather than passive) kind. This means that filter designs can be more accurately reproduced and have a better overall performance than those using passive components.

Input Filter

The first filter to be described is a low-pass design whose purpose is to reject all signals above about 2500 Hz (just above white frequency) and pass everything below. It is used right at the audio input to an SSTV receiver and effectively rejects unwanted co-channel interference. Fig.8 shows the circuit of the design which uses all passive components. It has a medium input/output impedance (around 2k) and is thus suitable for installing in an audio line. The 88mH toroidal inductors may sometimes be found lying around in the shack, especially by those whose interests also lie with RTTY, however if you have to buy them they are available from the British Amateur Radio Teleprinter Group (BARTG) at reasonable cost. The odd looking capacitor values may be made up by connecting two or more preferred values in parallel.

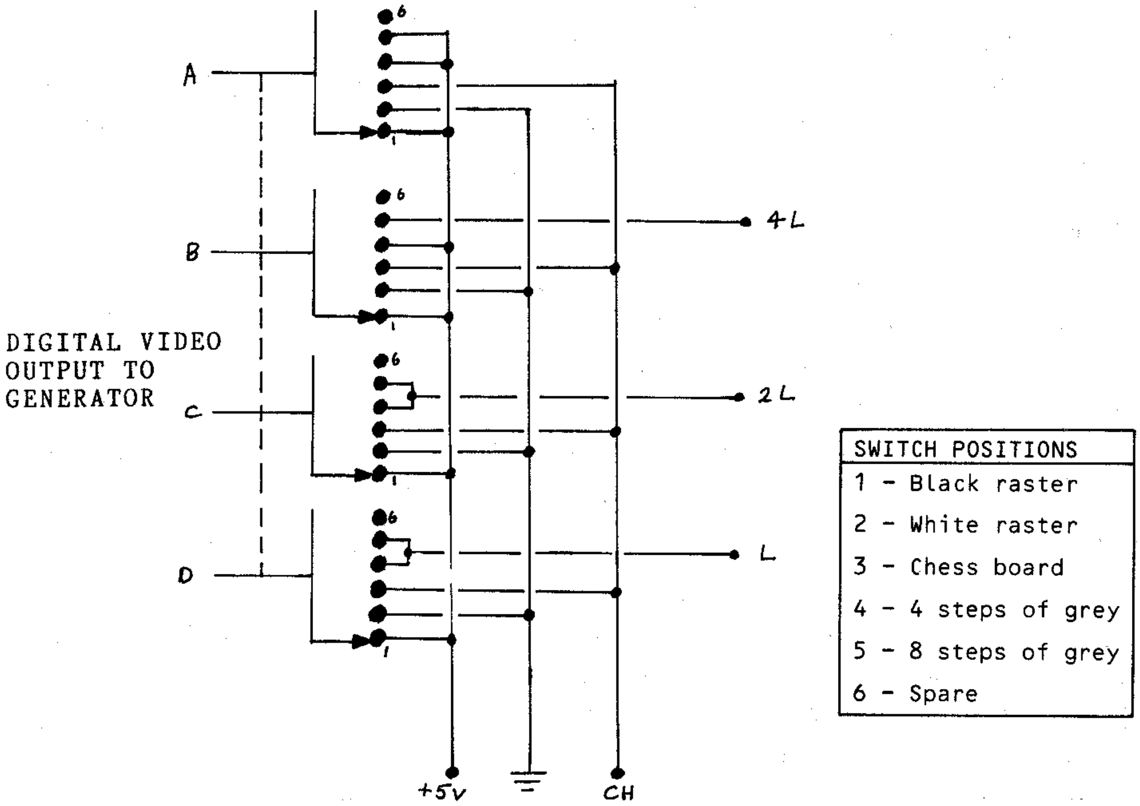


Fig.6: Pattern Select Switch

The circuit in Fig.9 does the same job as the passive design but has a somewhat better response. It also uses easy to get components, has a medium input/output impedance and may be built quite easily on a small piece of Vero board. Again the odd capacitor values should be made up from parallel capacitors. The circuit has approximately unity gain.

Sync Filters

Once the SSTV audio signal is present in a receiver it is necessary to separate the synchronising pulses from the video (picture) information. The sync frequency is 1200 Hz, therefore a filter having a centre frequency of 1200 Hz and a bandwidth of around 400 Hz would be about right to extract the SSTV sync signals.

Fig.10 shows a simple passive sync extraction filter using an 88mH toroid. Although this circuit will perform quite well it does not exhibit the excellent performance of the active filter shown in Fig.11.

The circuit in Fig.11 is called a multiplier feedback active bandpass filter and, using this circuit it is possible to set the required gain as well as providing a good bandpass response. This design has a gain of around ten and VR1 is used to finely adjust the centre frequency.

To test the circuit an audio signal generator should be fed into the input and the output monitored on an oscilloscope. Set the generator to 1200 Hz and adjust VR1 for maximum indication on the oscilloscope.

Now check the passband by varying the input frequency and plotting the output level on graph paper, in this way the passband response can be examined accurately. The output level is adjusted by VR2.

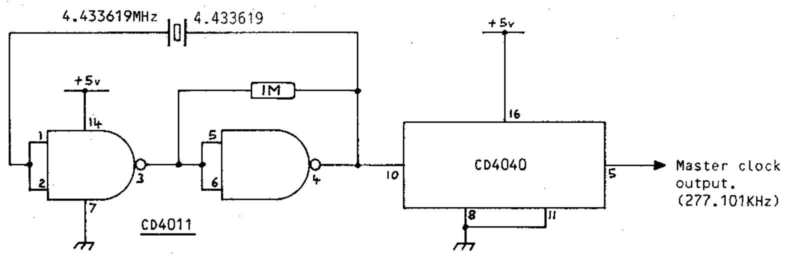


Fig.7: Crystal Controlled Master Oscillator

Sync Extraction

Most slow scan monitors rectify the 1200 Hz sync burst in order to recover the video sync pulse. The easiest method is to use full-wave rectification and a suitable circuit is shown in Fig.12. This uses a miniature audio transformer and a pair of diodes to produce a positive-going sync pulse. An alternative, and much nicer and more versatile rectifier, is illustrated in Fig.13. Here a couple of op-amps are used to provide the correct clipping level as well as adjustment of rectifier balance. With a sync signal from the filter applied to the input and a oscilloscope to the output, RV1 is adjusted to achieve a correct rectifier balance (see waveforms inset). In Fig.14a is illustrated the sync burst before rectification (note the very low level video signal either side of the sync burst) and in Fig.14b the rectified signal showing a positive-going sync pulse and a clipping level set well above the noise in order to produce a ‘‘clean’’ sync pulse.

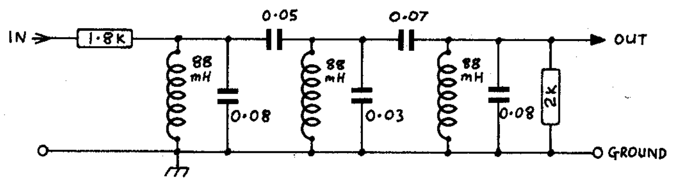


Fig.8: Passive Low-Pass Filter

Fig.15 shows the circuit of a simple sync separator using discrete transistors. Available at the outputs are both line and frame pulses, both of which have adjustable clipping levels. The outputs are negative-going and are suitable for driving deflection coil assemblies.

SSTV Modulator - Digital Inputs

SSTV modulators for analogue inputs are detailed elsewhere in this book, however with all the digital hardware around these days it is likely that a requirement for a suitable modulator will be high on the constructor’s priority list. Such a circuit is shown overleaf in Fig.16.

IC1a accepts a TTL composite sync signal and presents the pulse to Tr1 which in turn passes it on to the video/sync mixer circuit. IC1b accepts a TTL video signal which is either passed directly to the mixer or it can be inverted in IC1b to produce a ‘‘negative’’ picture effect. The two signals are combined and the levels may be individually adjusted before being applied to a 741 amplifier. The combined signal is then used to modulate a voltage controlled oscillator (NES66) which has been suitably designed to produce the correct SSTV frequencies. A control is provided on this VCO for the accurate setting of the white frequency (23OO Hz). The SSTV signal is then passed through an active filter in order to restrict its overall bandwidth prior to feeding a transmitter.

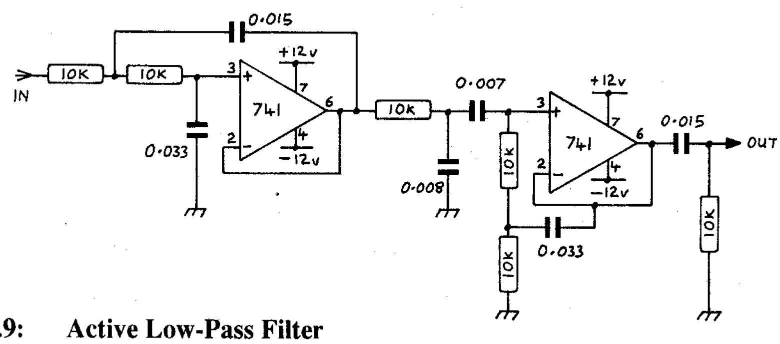


Fig.9: Active Low-Pass Filter

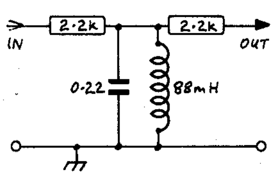


Fig.10: Passive Sync Bandpass Filter

In Chapter 10 of this book a flying spot scanner is described. This unit employs one or two photomultiplier tubes to detect the relatively small amount of light reflected back from the picture, which produces the fluctuating video signal. The photomultiplier has been the mainstay of light detection for decades and is still widely used, nevertheless they are relatively

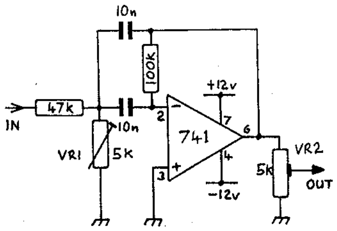


Fig.11: Active Sync Bandpass Filter

large and expensive and, moreover, need a high voltage power supply as well. With all the modern optical sensors available it should be possible to dispense with photomultipliers for SSTV work.

Fig.17 shows the circuit of a video head amplifier which uses a solar cell as its detector. This circuit was in fact designed by Deryck Aldridge for use in an NBTV drum camera and thanks are expressed to the NBTVA for permission to reproduce the circuit here.

Tr1 and Tr2 are chosen for their low-noise characteristics. Tr1 is used as an emitter follower stage to allow the solar cell to be loaded with the preferred value for ‘‘R’’. Although 4.7k is used here other values may be needed to suit different cells. Tr2 is a straightforward amplifier with its gain controlled by RV1. Tr3 and 4 form a compensating amplifier which enables correction for the inherent Capacity of the cell thus avoiding signal distortion. The stage allows for variable degrees of HF compensation and adjustments must be carried out on test to achieve best results. ideally a LED should be driven from a square-wave oscillator and the light produced used to illuminate the solar cell (in the dark). The output from the amplifier is then fed into an oscilloscope and adjustments made to RV2 and RV3 until a good approximation of a square-wave is achieved. This may necessitate some adjustments to Cl and C2 (e.g. C2 may be increased to 0.02uF whilst Cl may be found completely unnecessary) . Note that reducing both RV2 and 3 to zero at the same time will cut off the signal since bias to Tr3 would be removed. RV3 could be altered to 3k plus a fixed resistor of 1k to stop this happening.

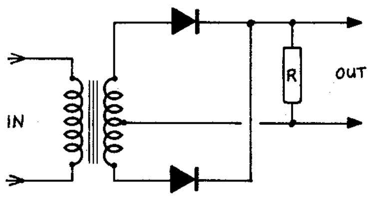


Fig.12: Full-Wave Sync Rectifier

The square-wave frequency is not important, anything from about 100 to 1000 Hz works OK with the higher frequency being better for checking the upper end of the spectrum. In the absence of an oscilloscope RV2 and 3 can be adjusted by viewing a test card pattern as the picture source.

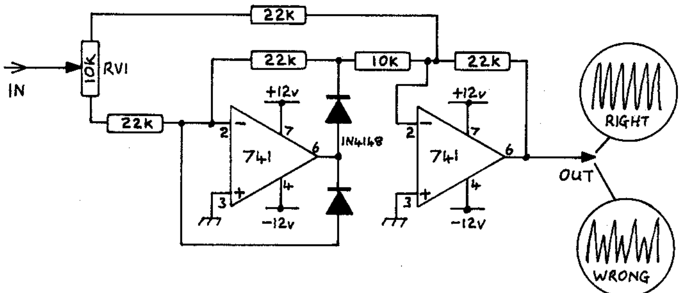


Fig.13: Sync Rectifier

Tr5 is simply an emitter follower stage whose output could be taken to a potentiometer (typically 22k lin) which is then used as an overall video gain control for feeding into a SSTV modulator. The use of a simple voltage regulator isolates the head amplifier from variations in the power supply. The input/output decoupling capacitors should be fitted close to the regulator pins.

Most of the commonly available solar cells seem to work well with this amplifier, the only possible alteration being with the shunt resistor ‘‘R’’.

Audio Analyser

Slow-scan TV has three key frequencies which must be considered in signal analysis: 1200, 1500 and 2300 Hz. It is important that these frequencies are correct so that precise carrier insertion is achieved, thus resulting in the correct reproduction of the sync frequency as well as maintaining the full video swing to ensure best received picture contrast. it is also desirable to know that the three frequencies are correct during transmission. The unit described here is an audio spectrum analyser which will give a visual display, in real time, of these three main frequencies using an ordinary oscilloscope.

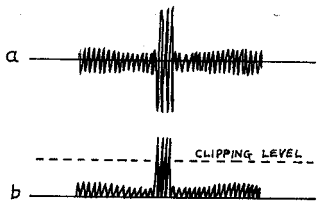


Fig.14

Theory of Operation

The analyser measures the length of time needed for the positive going portion of each cycle in the signal being analysed. A positive going zero-crossing triggers a monostable which starts the oscilloscope timebase after a delay. The next zero-crossing, which is negative going, is used to generate a very narrow pulse which appears as a bright dot on the screen. The trace begins on the left side of the screen and moves to the right. The higher the frequency, the shorter is the time needed to complete the positive half of the cycle. Therefore the vertical spot generated from comparatively high frequencies will appear closer to the start of the trace on the left hand side of the screen, whilst lower frequencies, which require a longer time for completion, results in spots being displayed further toward the right side.

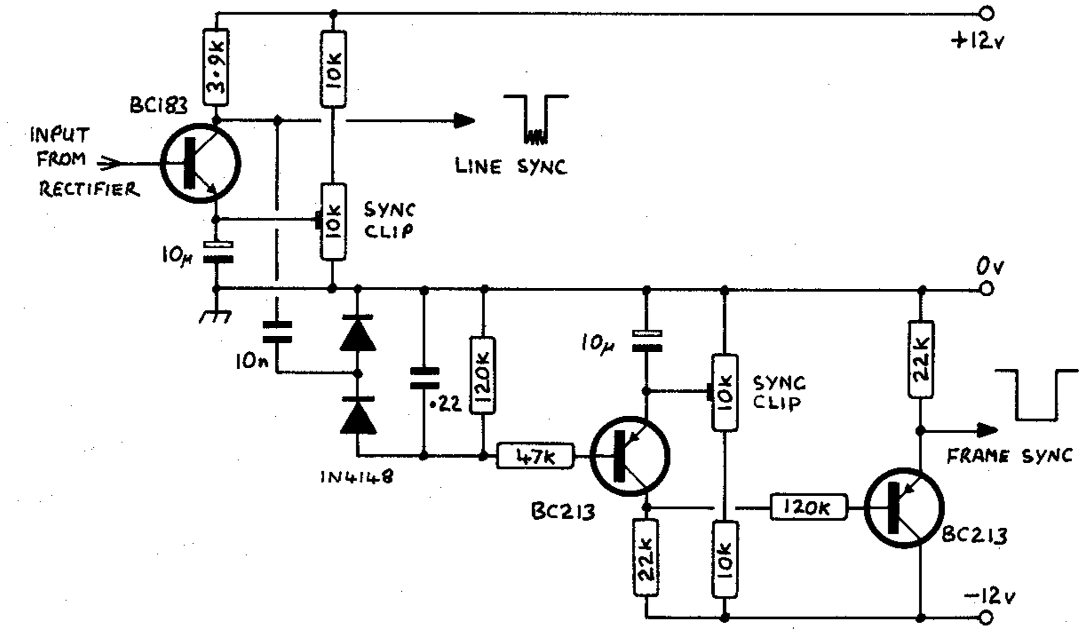


Fig.15: Discrete Transistor Sync Separators

Circuit Description

The SSTV signal is connected to a differential comparator (IC1) whose threshold is governed by the potential divider between output and zero volts, this gives some positive feedback to ensure a rapid transition.

The resulting output is fed to a monostable (IC2) which initiates a vertical pulse triggered from IC1 when the positive half of a cycle is complete. VR1 sets the size and clarity of the vertical pulse. The output of IC2 connects to the oscilloscope's ''Y'' input.

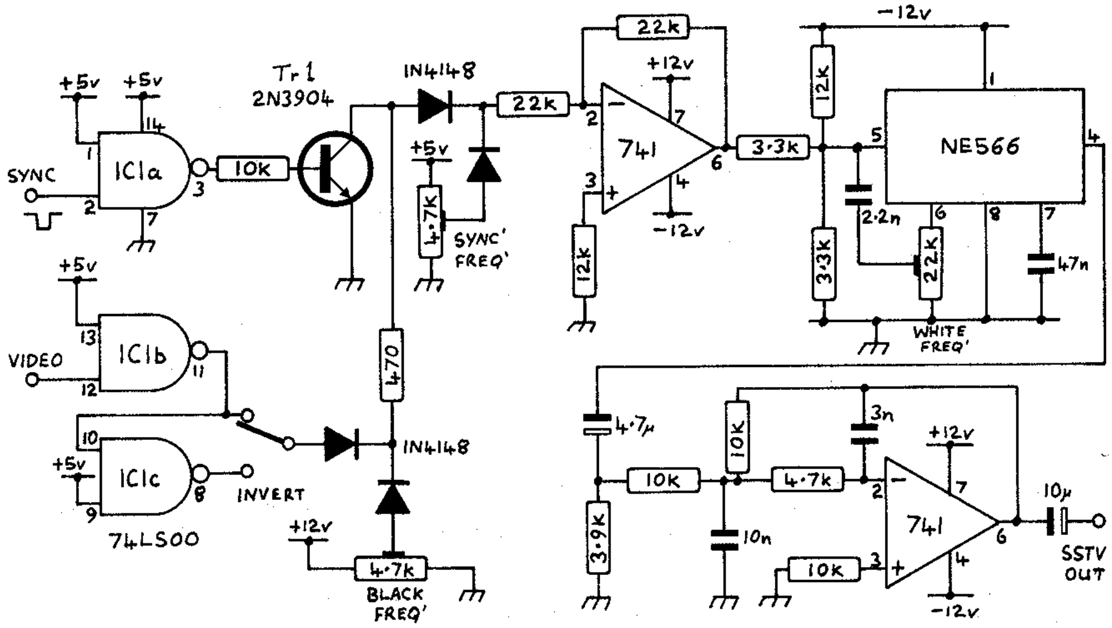


Fig.16: SSTV Modulator with Digital Inputs

The positive-going portion of each incoming cycle triggers a delay monostable (IC3) which starts the sweep just before the beginning of the highest expected frequency (2300 Hz). This delay eliminates the wasted scanning space which would result from triggering the sweep at the beginning of a positive pulse.

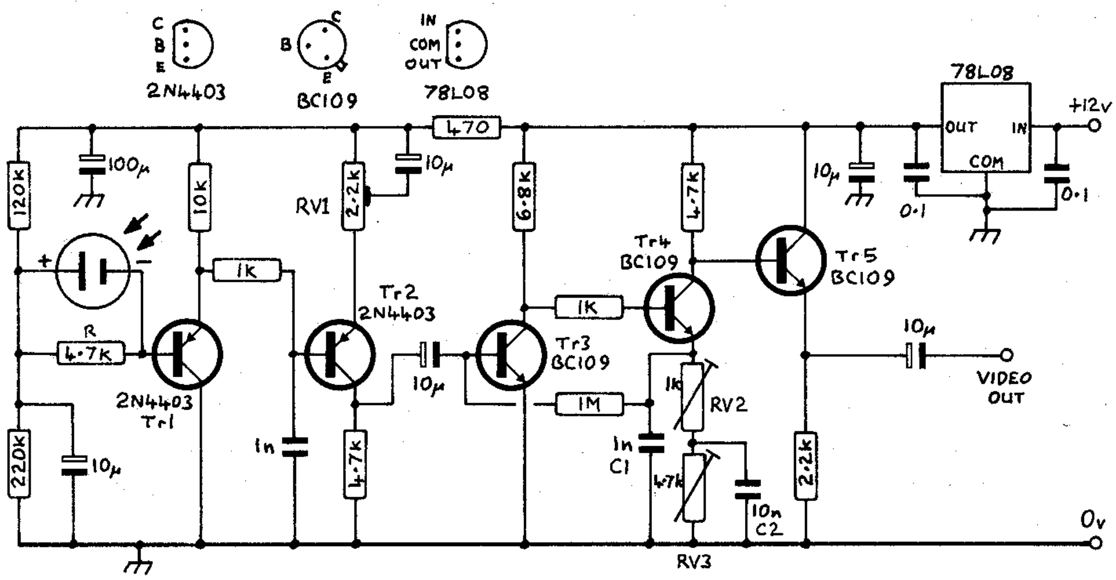


Fig.17: Solar Cell Video Amplifier

VR2 adjusts the delay time and provides pulse positioning on the display. The output of IC3 connects to the oscilloscope's TRIGGER input.

Fig.19 shows the various waveforms to further illustrate the principle of operation.

Construction and Adjustment

The circuit shown in Fig.18 may be built on a printed circuit board or on a small piece of perforated stripboard. IC1 requires +12V and -6v supplies however, if only +/- 12V is available an extra resistor and zener diode may be used (as shown)to obtain -6.2V from the -12V line. +5v for the TTL circuits could similarly be derived from the +12V rail or a 3-terminal voltage regulator type 78L05 could also be used.

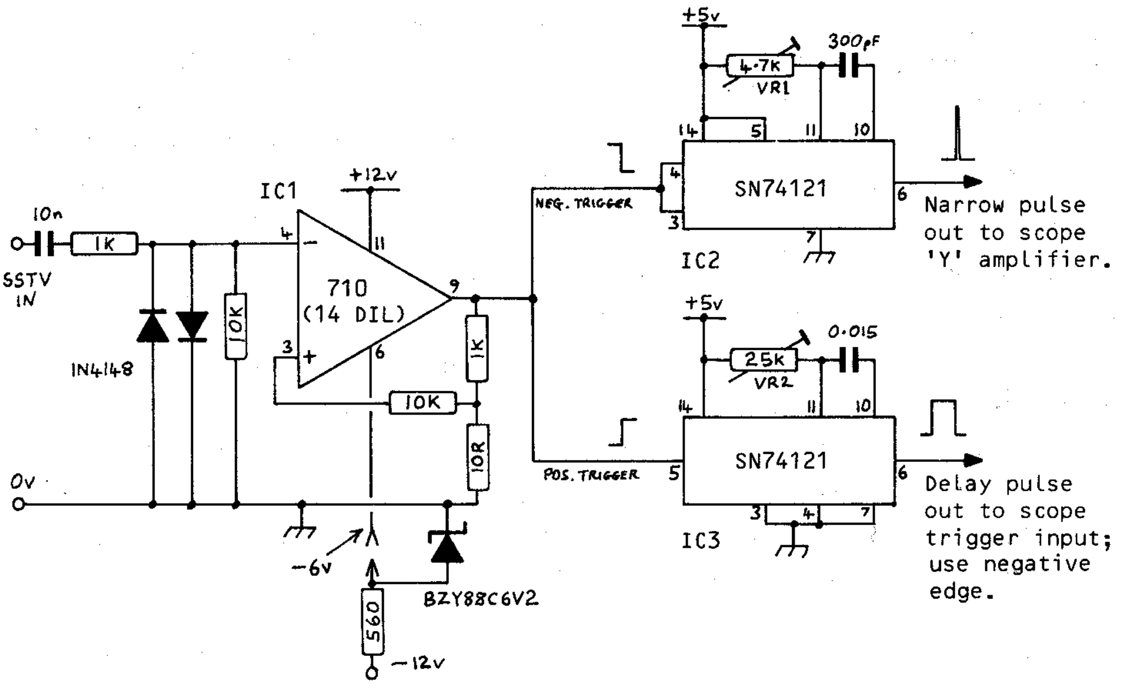


Fig.18: Circuit of the Audio Analyser

Calibration of the analyser should be carried out with the aid of an accurate audio frequency generator. Set the oscilloscope to 2V/cm for the ''Y'' amp., and 5OuS/cm for the ''X'' timebase. Apply a 1500 Hz signal and adjust the oscilloscope to display a faint vertical line at the centre of its screen. Adjust VR1 for a suitable pulse amplitude. Set the audio generator to 2300 Hz and adjust VR2 so that the pulse appears just inside the left-hand edge of the screen. Now adjust the generator for 1200 Hz and make sure the new pulse is displayed towards the right-hand edge. Further adjustments to VR2 and the oscilloscope ''position'' control may be needed to centre up the display and show all three frequencies at once. Now calibrate the oscilloscope screen by either marking with a felt tipped pen the precise positions of each pulse on the graticule, or make a note of the pulse positions for future reference.

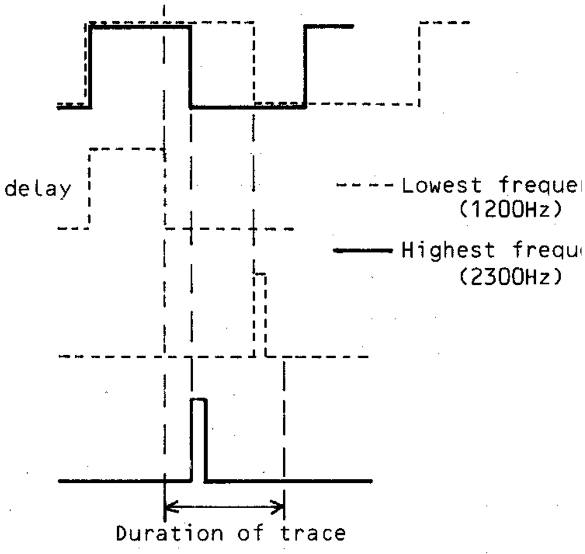


Fig.19: Waveforms

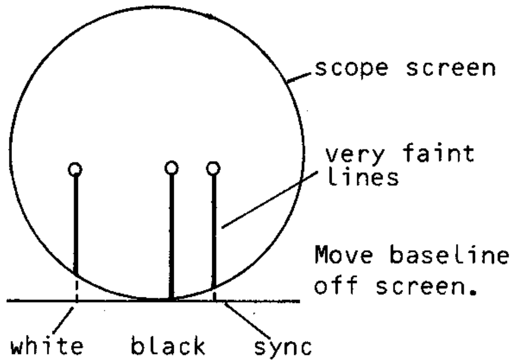


Fig.20: Appearance of trace for a chessboard signal, which contains white, black and sync.

The baseline is usually moved to just off the bottom of the screen (see Fig.20) and because of the narrowness of the vertical pulse, it is likely that only the ‘‘spot’’ at the top of each will actually appear on the scope.

A Flying Spot Scanner

Although flying spot scanners are considered by many to be out of date, and therefore not worth bothering with in a book such as this, I have included a complete design, if for no other reason than to satisfy the purists amongst us. However, it is true to say that, to a limited extent, flying spot scanners are still used in broadcast TV circles and continue to provide a source of high quality pictures without the need to tie up expensive cameras.

Whilst compiling this and the previous book (The Slow Scan Companion, BATC 1987) many SSTVers expressed the view that slow scan was becoming totally ‘‘black box’’ orientated, but they felt that they would still like to construct at least some of their own equipment. Many of them were somewhat put off by the sheer complexity of modern digital computerised construction projects, preferring instead to build useful, but mare down-to-earth designs.

This article is designed not just to illustrate the method of building a flying spot scanner but also to describe circuits which may prove useful in other equipment. The timebases for example could just as easily be used in a CRT display monitor as could the EHT supply. The sync generator could form the basis for a simple pattern generator, although it serves as a useful piece of test equipment by itself, and the video modulator can be fed with any suitable video signal.

A Magnetic Scanner

This design is based around a magnetically deflected CRT such as the 5FP7 (the type most often used in SSTV monitors) or other ex-radar tubes. It would be quite possible for the flying spot scanner to double as a monitor, or vice-versa, thus making construction easier by utilising much of the circuitry for either purpose.

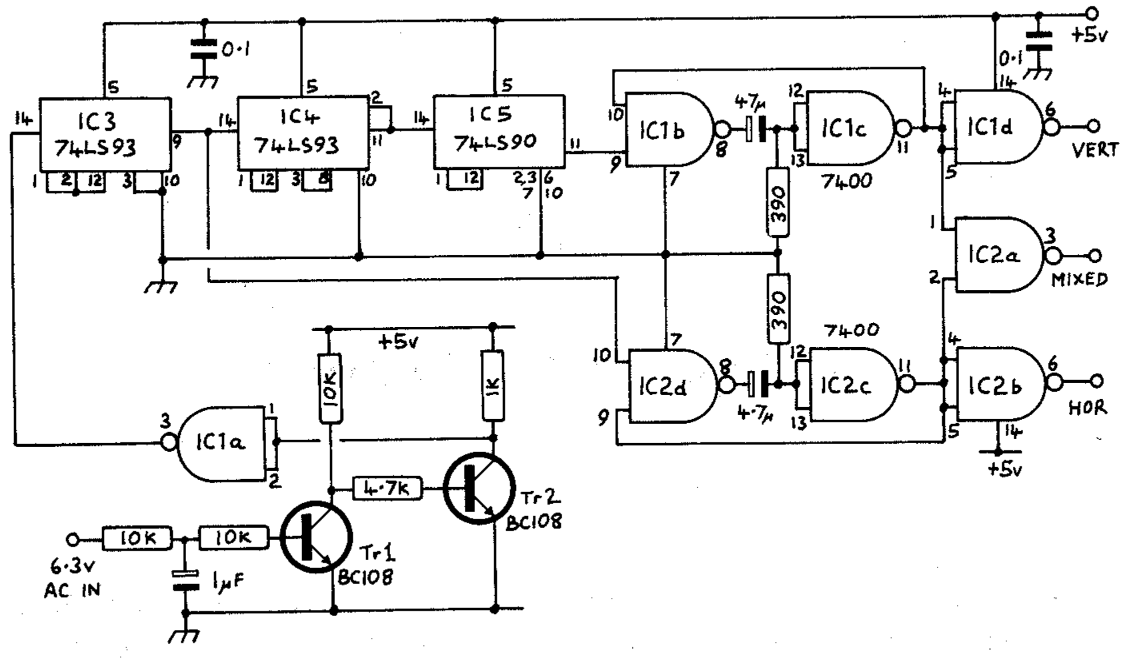


Fig.1: SSTV Sync Generator Circuit

Sync Generator

Fig.1 shows a slow-scan sync pulse generator which forms the heart of the system. The generator is mains-locked by deriving its source from a winding on the mains transformer. This 50 Hz signal is squared in Tr1, Tr2 and IC1a and the resulting 50 Hz pulses are divided by three in IC3 to obtain line frequency (16.6 Hz). These line pulses are further divided by 12 in IC4 and then by 10 in IC5 resulting in a frame frequency of 7.2 seconds. Both pulses are shaped and fed to individual output gates as well as being combined to provide a mixed sync output. Common TTL is used for IC1 and 2 in order to provide adequate fan-out to subsequent circuitry. This circuit provides 120 lines in 7.2 seconds. However, if the 128 line/7.68secs standard is required IC4 should be replaced by a -16 circuit and IC5 by a L8. If mains is not available then a 50 Hz oscillator may be provided as a source instead. A switchable standard sync generator is described in the Chapter 9.

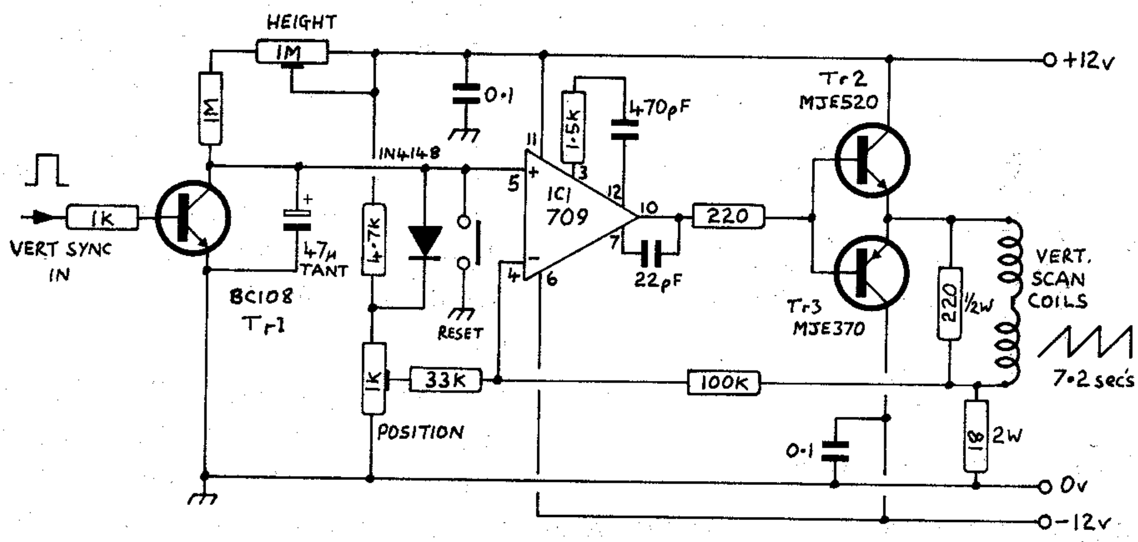


Fig.2: Vertical Timebase Circuit - Magnetic Deflection

Deflection Circuits

A vertical sweep driver is shown in Fig.2. Tr1 discharges a 47uF capacitor, the voltage across which is set by the ''height'' control. Sync pulses are applied to the base via a 1k resistor and the sweep period is entirely controlled by the sync pulses.

Sweep centring is accomplished by applying a positive voltage to the inverting input of IC1. The sawtooth waveform will be symmetrically placed around ground or in the centre of the CRT display. The output of IC1 drives a transistor complementary pair (Tr2 and 3) which directly drives the scanning coils. Gain and linearity are controlled

by providing a current sensing resistor (18 Ohm) to the inverting input of IC1.

The circuit in Fig.2 shows a ''reset'' button. This is mainly for applications in a monitor and is used to reset the frame manually in the event of the monitor trigger circuits failing to respond to an incoming frame pulse. The button should be mounted on the front panel if it is required. In the absence of vertical sync the 47uF capacitor will charge up and the trace will be deflected well off the screen, useful in avoiding tube burns.

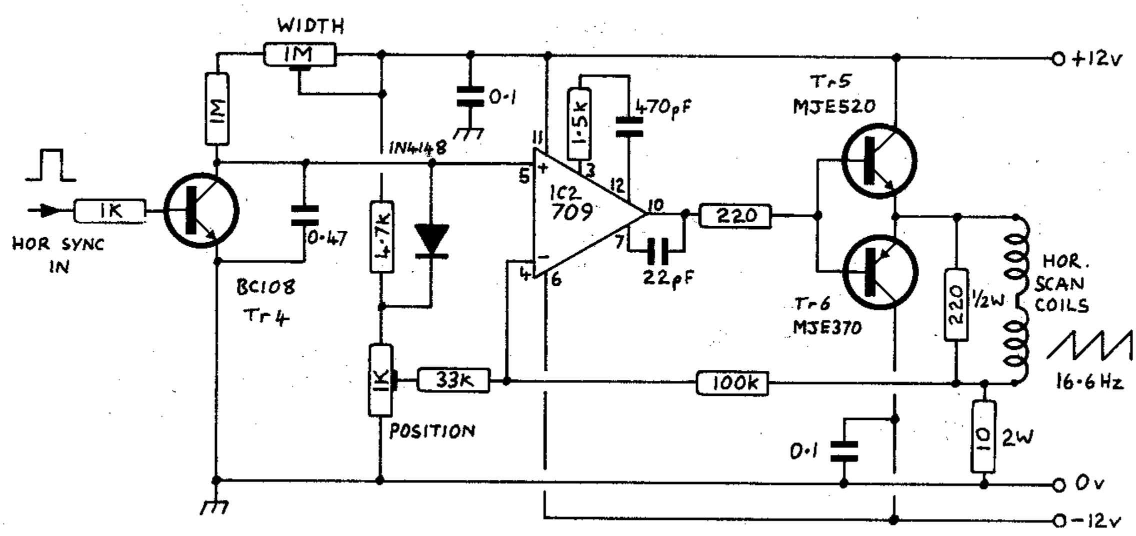


Fig.3: Horizontal Timebase Circuit - Magnetic Deflection

The horizontal sweep driver in Fig.3 is virtually identical to the vertical except for a different value discharge capacitor at Tr4. The 16.6 Hz sweep should show a linear sawtooth waveform on an oscilloscope and any clipping or crushing can be removed by adjusting the ''width'' and '''position'' controls.

The circuitry for controlling the CRT is illustrated in Fig.4. For flying spot scanner use, only a brilliance control need be provided since the tube is only required to produce an even-brightness raster without modulation. This diagram also illustrates a winding to supply AC drive for the sync generator. Fig.5, shows a simple EHT supply, the output of which is suitable for many types of cathode ray tube. The circuit is based on a modified domestic TV line output transformer which is described below.

Tr1 is a simple oscillator whose frequency can be varied by the ‘‘freq. adj’’ control. The necessary feedback comes from L1 and L2 which are both wound on the transformer ferrite. EHT is taken from the original overwind coil and multiplied by the D/C network. A separate winding is also provided to obtain the 250 to 300V required by the CRT.

Transformer

Most ordinary ‘‘open’’ types of line output transformer as found in old TV sets may be used. The types which are sealed in resin cannot be dismantled and are therefore not suitable for this application.

A typical transformer is illustrated in Fig.6.

Carefully dismantle the transformer into its component parts. Remove all the wire from the primary winding by cutting through it with a small saw. Re-assemble the core and overwind ensuring that there is a gap between the ferrite core ends where they go into the winding. A thin piece of paper should be sufficient.

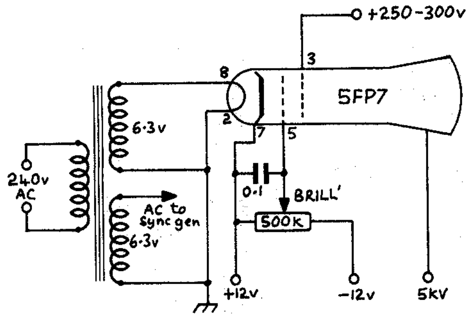


Fig.4: CRT Circuitry

On the other limb of the ferrite core wind on a couple of layers of electrical insulation tape, then wind L1 onto it to form the first part of the new secondary. Slip sleeving over the free connecting wires and trap part of each sleeve under a couple more turns of insulation tape which should cover the new winding. Repeat the process with L2 and then the same with L3. L3 will need to have several layers although each layer can be somewhat longer that L1. Each layer should be insulated from the previous one with adhesive tape.

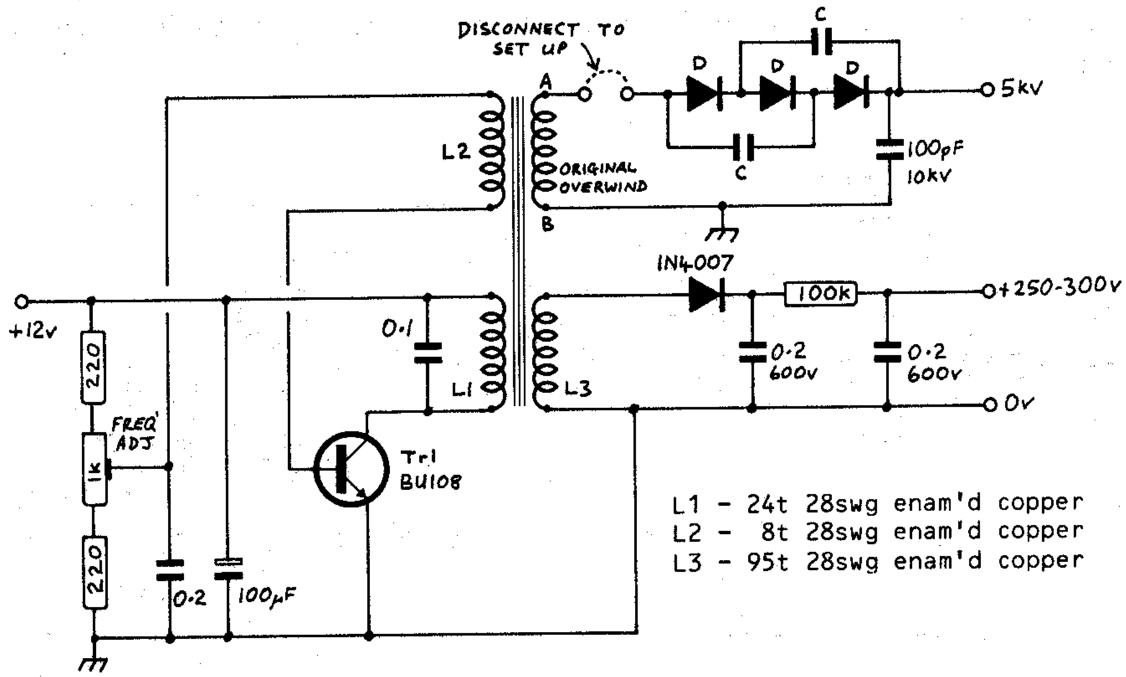


Fig.5: EHT Power Supply Circuit

The EHT diodes and capacitors were taken from the original EHT line output assembly but most EHT trays will serve as well. If too much EHT is generated then a diode and capacitor may be omitted. If such diodes are not available they may be purchased from many component shops. Ensure that each diode and capacitor has a working voltage of several kV. The capacitor values are not critical and can be around l00pF each.

Adjustment

Ensure that the EHT link is disconnected and apply +12V via a current meter. If the meter reads more than 1 amp then adjust the ‘‘freq adj’’ control to try and reduce it. If the current is still greater than 1 amp reverse the connections to L2 and try again. The oscillator frequency should now be audible and the ‘‘freq adj’’ control will set it for a smooth continuous ring. If the ringing is annoying to the ear try tightening the transformer clamps or else enclose the assembly in an insulated compartment.

Connect the link and carefully check the EHT voltage which may be adjusted by altering the supply voltage. Always start low and raise the voltage gradually until the required EHT is reached.

BE CAREFUL WHAT YOU TOUCH.

It is good practice when working on such units to keep one hand in your pocket, this reduces the risk of shorting high voltages to ground - via you! Also stand on a good insulated mat or floor covering such as rubber. Having said that, this form of EHT unit is considerably safer than those derived from mains transformers.

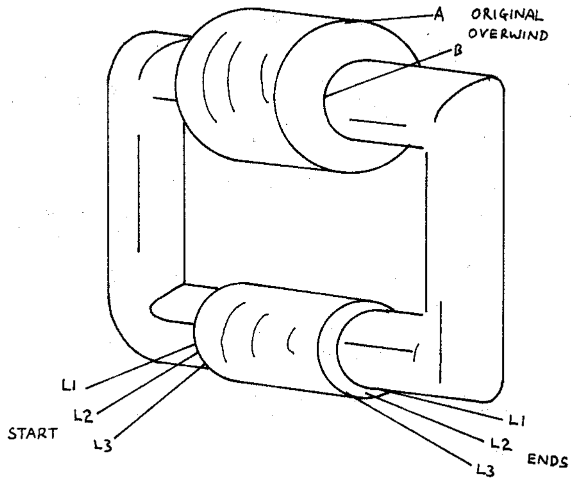


Fig.6: Details of the EHT Transformer

Photomultiplier

By far the most common type of photomultiplier tube available is the 931A and Fig.7 shows its base wiring and signal output to the video modulator. Fig.8 is the photomultiplier power supply circuit which provides around -700V.

Video Circuits

The video amplifier and modulator circuitry is shown in Fig.9.

Since photomultiplier tubes have an output in the absence of light (dark current) it is necessary to balance this by inserting some bias current into the inverting input of a 741 op-amp (IC1). In general the ‘‘dark current’’ control is set to make IC1’s output near to zero volts after the gain has been correctly set.

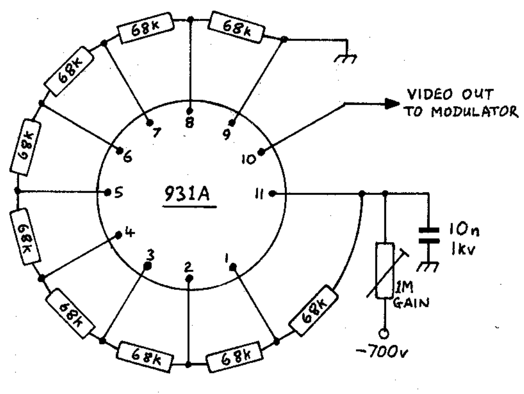


Fig.7: Photomultiplier Wiring

Amplifier IC2 has unity gain and the input is switched to provide a video inversion facility. A black frequency adjust control is included which provides an offset current into the inverting input of IC2. Positive-going sync pulses are applied to the inverting input which drives the output to near zero thus producing the correct VCO frequency.

Tr1 is a unijunction relaxation oscillator whose frequency is determined by the resistance in its gate circuit and the capacity to ground. The oscillator is set to run at twice the operating frequency (2400 Hz) and this is divided by two in IC3 to produce the required 1200 Hz squarewaves. These squarewaves are filtered in the active filter IC4 which produces near sine waves in the frequency range 1200 to 2300 Hz.

The composite slow scan signal is available at the slider of the output gain control which sets the required amplitude to the transmitter.

Construction Notes

Construction of the flying spot scanner cabinet is a matter for personal choice but is likely to be similar to one of the designs outlined in the chapter on transmitting SSTV. A wooden, lightproof cabinet is probably ideal and this should be painted matt black on the inside to prevent any light reflections.

The lens (if used) should be mounted centrally in a partition which is made adjustable between the picture and CRT face. Fig.10 shows the lens arrangement for a typical scanner and has some suggested measurements to act as a guide. The distances and geometry for a 50mm lens are detailed since this is the focal length of a

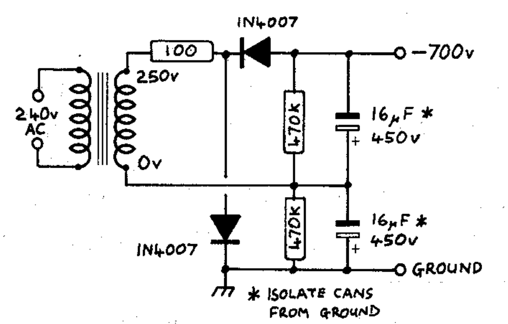


Fig.8: Photomultiplier Power Supply

standard 35mm camera lens and the most likely one to be used by amateurs.

It is quite possible to use two photomultipliers (as shown in Fig.10). Simply duplicate Fig.7 and connect the two video outputs together. In this application the ‘‘gain’’ controls will also act as ‘‘balance’’ controls to even out the sensitivity between the two.

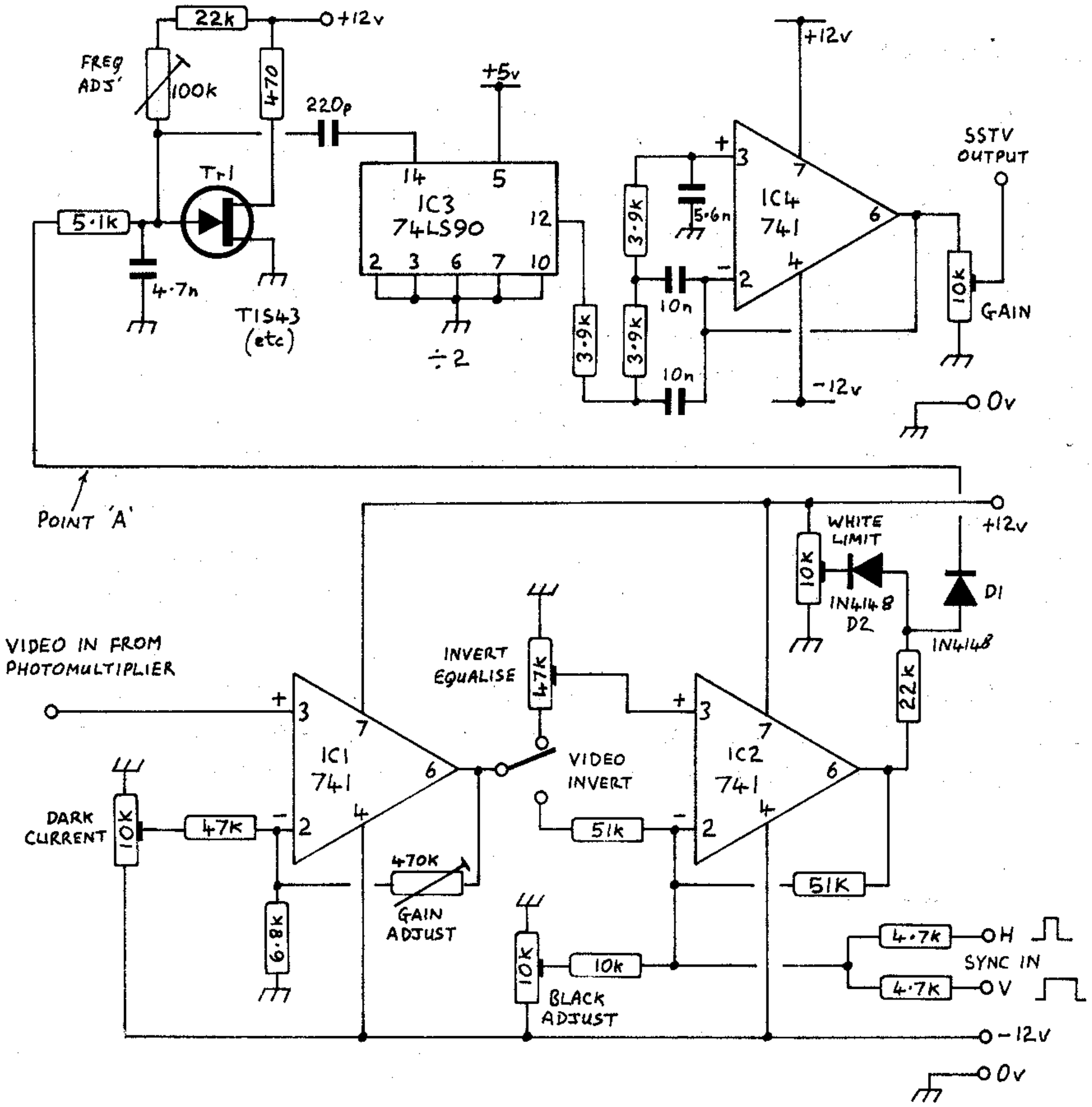


Fig.9: Video Amplifier and Modulator Circuit

Care should be taken if mains transformers are enclosed in the same cabinet since the 50 Hz fields can easily introduce hum on the CRT raster causing scanning lines which are not straight. Placing the transformer directly behind the CRT and as far back as possible is usually the best choice, although a separate power supply (excluding the EHT generator) is probably best. A shrouded or toroidal transformer could also help.

The CRT scanning yoke is usually obtained from a very old TV tube neck (not the modern ones with the slim necks). Alternatively you will no doubt find a slow-scanner who has a spare yoke which was probably used on an early monitor and which he would be pleased to pass on to a good home. The yoke should be stripped of all capacitors and resistors and the four wires from the horizontal and vertical deflection coils freed for use. The coils having the lower resistance are used as the horizontal ones. The resistor across the coils (Fig’s.2 and 3) is to prevent ringing on the sweep. It should be noted that some old yokes had high impedance frame coils, these should be avoided unless you are using valves to drive them.

A permanent magnet focus assembly may be obtained from the same source as the yoke and is slid onto the tube neck behind the scanning yoke. Focus is adjusted by moving one magnet relative to the other or by sliding them along the tube.

Adjustments

Set the photomultiplier ‘‘gain’’ control to maximum resistance (Fig.7).

Set the ‘‘gain adjust’’ pot (Fig.9) to mid range and break the connection from pin-6 of IC1 to the invert switch.

With the photomultiplier in total darkness adjust the voltage at pin-6 of IC1 to zero volts using the ‘‘dark current’’ control.

Without re-connecting pin-6 apply a variable voltage to the common of the switch. Adjust this voltage to zero (ground). Move the slider of the ‘‘white limit’’ control to the earthy end when the voltage at IC2 pin-6 should read zero. Adjust the input voltage to some positive potential (say +2V) and with the switch to ‘‘invert’’ the output should read -2V. Now change the switch to normal and alter ‘‘invert equalise’’ to produce +2V. Now re-connect IC1 pin-6 to the switch common.

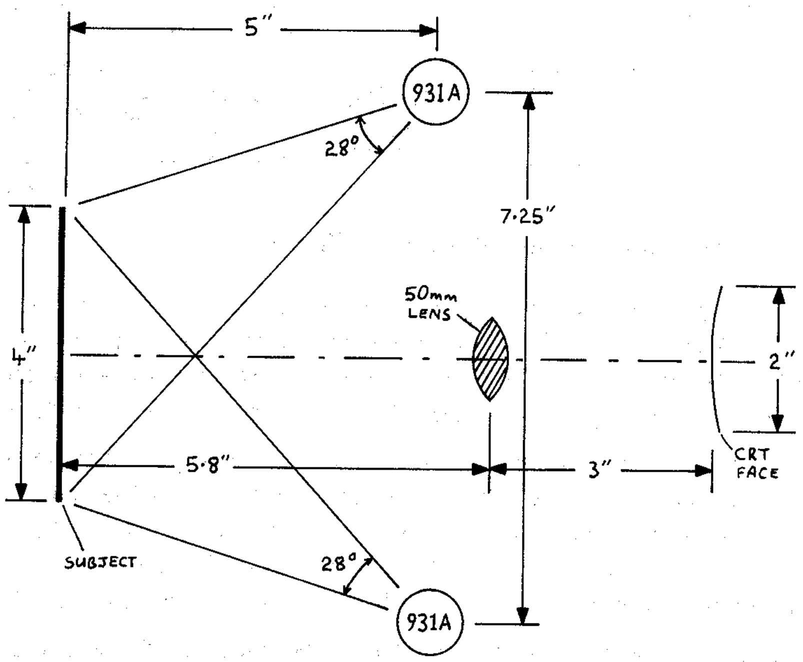


Fig.10: Flying Spot Scanner Optics

The sync frequency of the VCO is set by grounding point ‘‘A’’ and adjusting the ‘‘freq adjust’’ control for an output of 1200 Hz from IC4. Up-end the 5.lk resistor at the diode end and apply a variable voltage to it. Plot a frequency versus voltage curve measuring frequency at the output and voltage applied with a multimeter. The frequency should increase linearly from 1200 to 2300 Hz. Note the voltage required to obtain 2300 Hz.

Still with the photomultiplier in darkness turn the ‘‘black adjust’’ control to produce 1500 Hz at the SSTV output. With the aid of the ‘‘white limit’’ control set the slider to read the same voltage as that noted in 5 which produced 2300 Hz.

Connect the sync pulses to the timebase circuits and turn up the brightness, there should be a raster on the CRT face. Adjust focus for the clearest scanning lines (do not keep the brightness too high otherwise you may damage the CRT phosphor).

Place a high contrast picture in front of the lens and focus the raster onto the picture (do this in subdued light - it’s easier to see). Now close the lid of the photomultiplier compartment to shut out all external light.

Set the ‘‘gain adjust’’ control to drive the VCO up to white limiting level, this is most easily observed by observing the signal on the cathode of D1 with an oscilloscope. Now connect the output to a slow scan monitor and a picture of sorts should appear. Some readjustment to the various circuits may be required for optimum performance. If there is a lack of uniformity in the displayed picture this could be caused by the two photomultipliers being out of balance or they are not facing the subject at the correct angle.

Final Notes

The use of a blue filter in front of the 5FP7 tube may eliminate (or at least reduce) the afterglow, although since the 931A photomultiplier is itself blue sensitive, filtering may not be very effective.

Constructors are reminded that this design simply brings together a number of separate circuits, therefore some adjustments and minor alterations may be required to gain optimum performance. The object of this article has been to illustrate how standard SSTV circuits may be used and to show one possible practical application to help constructors.