S-VHS/CVBS-TO-RGB CONVERTER

PART 1: INTRODUCTION

Although the technical advantages of the Super-VHS video system are well proven, many owners of an S-VHS video recorder balk at the expense of a compatible monitor or TV set with separate luminance and chrominance inputs. This article describes an obvious missing link in the apparently ever-incompatible field of video equipment connections. An advanced circuit is discussed that converts S-VHS or CVBS (composite) video signals into RGB components. The upshot is that you can use your existing monitor with an RGB input (i.e., with a SCART or Euro-AV connection) to benefit from the improved picture resolution offered by an S-VHS video recorder. This month we discuss the basics of the video standards involved.

H. Reelsen

The compatibility issue has played a significant role in the development of both the NTSC and the PAL TV transmission systems. In both cases, there were two conflicting aspects: on the one hand, existing monochrome TV sets were not to be affected by colour transmissions; on the other hand, existing bandwidths of about 5 MHz for the luminance (brightness) signal were to be maintained.

The compatibility requirement automatically dictates that the black-and-white information (luminance or 'Y' signal) must also be conveyed in colour transmissions. The Y signal forms the sum of all basic colours, red (R), green (G) and blue (B), but only as far as their relative brightness is concerned. From perception experiments, the brightness appears to determine the overall sharpness of the picture. Hence, the luminance bandwidth must be as large as possible (up to 5 MHz) for monochrome as well as colour TV sets. However, this raises the problem of where to put the colour information.

Colour components and transmission

Any colour can be reproduced on a picture tube by actuating in the correct proportion the basic colours it is composed of. The final colour is obtained by controlling the intensity at which the RGB pixels at the inside of the picture tube light up. To the human eye, the three individual basic colours in a pixel group appear as one, composite, colour or hue at a particular saturation.

The need to convey R, G and B, is, therefore, obvious. Since the sum of the equivalent luminance values of all three is already contained in the Y signal, only two further signals, R–Y and B–Y, are generated by means of a differential operation with the Y signal. R–Y and B–Y are therefore referred to as the colour difference signals. Before these signals are transmitted, they are given relative brightness factors. The resulting chrominance signals may be written as

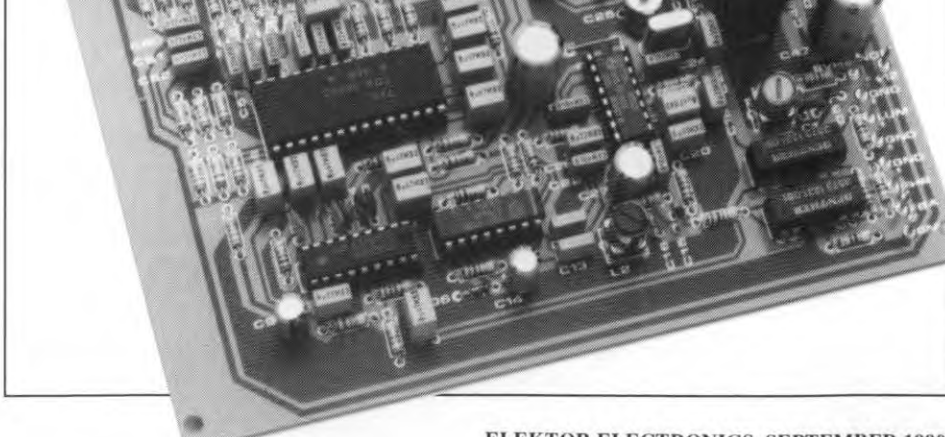
$$U = 0.49(B-Y)$$
$$V = 0.88(R-Y)$$

and the luminance, Y, as

$$Y = 0.3R + 0.59G + 0.11B$$

The RGB intensity information required to control the respective electron guns in the picture tube is obtained from the R–Y, B–Y and Y information with the aid of an addition operation in a matrix circuit.

A problem that remains to be solved is how to include the colour difference signal in the bandwidth already occupied by the Y signal, without causing interference on monochrome TV sets, or reducing the picture sharpness on colour sets. At this point, design engineers are in a position to profit from a characteristic of human eye, namely its reduced ability to resolve colour contours as compared to brightness values. This means that the colour infor-



Y = luminance = 0.3R + 0.59G + 0.11B
U = 0.49(B–Y)
V = 0.88(R–Y)
U + V = chrominance
The amplitude of a subcarrier f_c is modulated with U and V:
sin $2\pi f_c t$ modulated with U → U sin $2\pi f_c t$
and
cos $2\pi f_c t$ modulated with V → V cos $2\pi f_c t$
The complete PAL signal, X,
X = Y + U sin $2\pi f_c t$ ± V cos $2\pi f_c t$

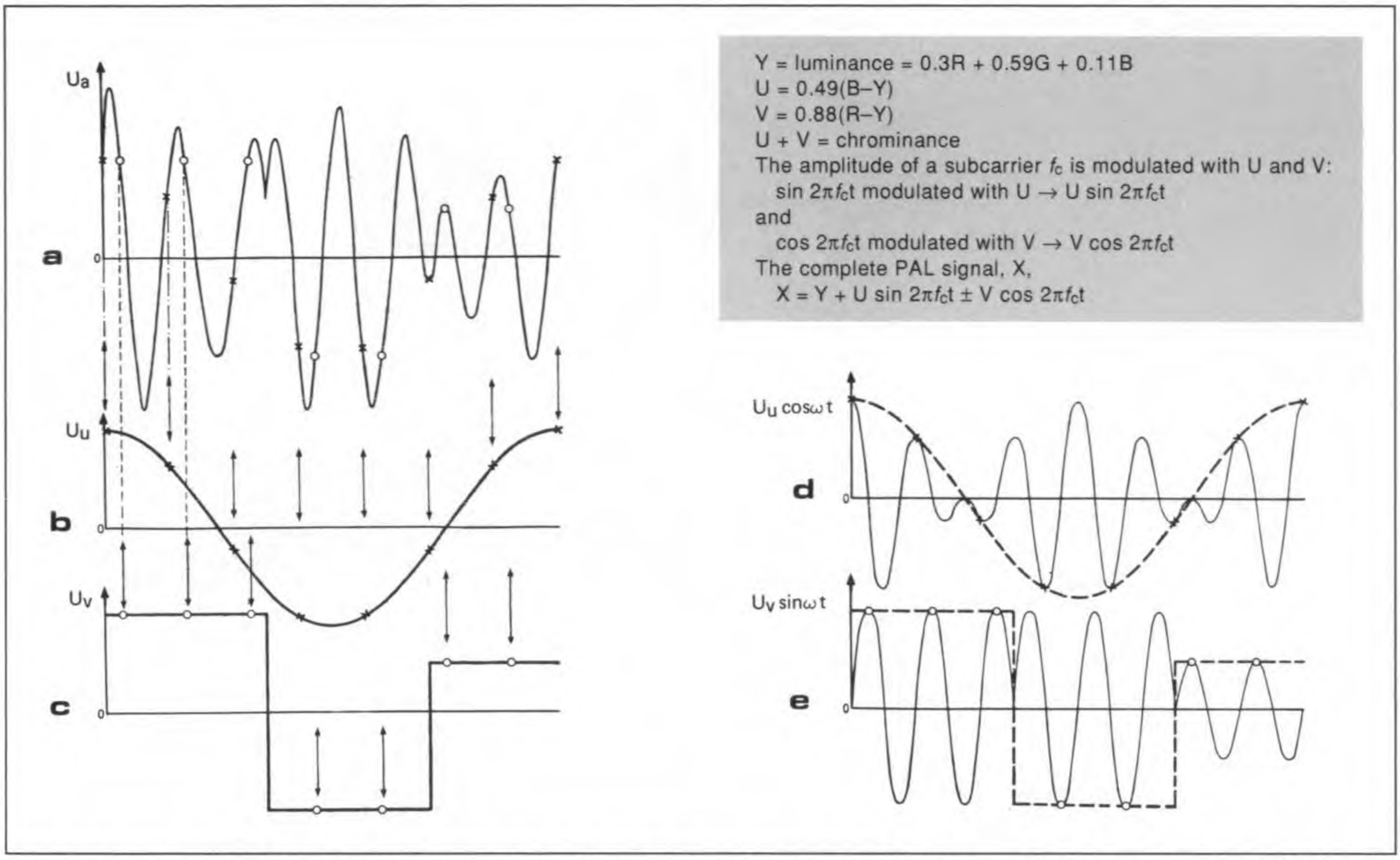


Fig. 1. Signal waveforms resulting from quadrature modulation of the colour difference signals U_u = 0.49(B–Y) and U_v = 0.88(R–Y). Drawing 'a' shows the quadrature-modulated signal U_a, while 'b' and 'c' show the modulation signals U_u and U_v, which for clarity's sake are formed by a sinusoidal waveform and a rectangular waveform respectively. Drawings 'd' and 'e' illustrate how these signals are modulated on to the 90-degrees shifted carriers. The waveform shown in drawing 'a' is the result of adding the signals in 'd' and 'e'.

mation may be transmitted at a relatively low bandwidth without significantly degrading the overall sharpness of the picture. In the PAL system, the colour (or chrominance) bandwidth is about 1 MHz.

The colour difference signals are readily embedded in the frequency spectrum of the Y signal by making use of the fact that the spectral lines of the Y signal occur at even multiples of the line frequency (15,625 Hz). Also, the amplitude of these spectral lines decreases with frequency.

The colour difference signals modulate a subcarrier of which the frequency, f_c, is an odd multiple of the line frequency divided by four, plus the picture refresh frequency (see Ref. 1):

$$f_c = 1135 \times (15{,}625/4) + 25 \quad \text{(Hz)}$$

This causes the spectral lines of the colour difference signal to be slotted in between those of the Y signal. The colour subcarrier frequency is set at 4.43361875 MHz, and the colour difference signals are quadrature-amplitude modulated (QAM). The B–Y and R–Y components modulate the amplitude of the colour subcarriers of 0 degrees and 90 degrees respectively (see Figs. 1d and 1e). The carrier itself is suppressed, so that it has an amplitude of nought in the absence of a colour difference signal. This is done to keep the picture free from interference caused by the otherwise continuously present subcarrier.

In order to eliminate the risk of phase shifts in the transmission path, the phase of the R–Y component is inverted every other picture line. Details of this operation peculiar to the PAL system may be found in Refs. 2 and 3.

The use of amplitude modulation with suppressed carrier requires a phase- and frequency-synchronized subcarrier at the receiver side. In a TV set, the modulated R–Y and B–Y components are recovered from the chrominance subcarrier with the aid of a 4.433-MHz quartz crystal oscillator whose phase and frequency are corrected every 64 µs by a 2-µs long burst signal slotted into the rear porch in the blanking period at the end of every picture. The burst consists of 8 to 11 cycles of the colour subcarrier frequency and follows the line sync pulse as shown in Fig. 2. A phase comparator is used to keep the crystal oscillator synchronized to the received burst, which also contains the PAL switch signal for the line-by-line R–Y phase reversal. This arrangement ensures that the R–Y signal in the receiver is inverted in synchronism with that at the transmitter side to ensure that the demodulation operation can work correctly.

Pitfalls...

In practice, the 'packaging' of the luminance and the chrominance information into a single CVBS (chrominance-video-blanking-synchronisation) signal is not without problems. Since the colour subcarrier falls in the spectrum of the luminance signal, it causes a finely patterned type of interference known as moiré. Luminance circuits in all modern TV sets are therefore fitted with a 'colour trap', which is a relatively simple filter that removes most of the moiré effects with the exception of those occurring at areas with sharp colour transitions. Here, large phase jumps give rise to subcarrier sidebands that fall outside the stop band of the 4.43-MHz colour trap. Unfortunately, Y signals in this stop band are also suppressed, which results in reduced picture resolution because some of the high-frequency components disappear. Incidentally, most monochrome sets also contain a colour trap to eliminate moiré.

The (possible) interference between chrominance and luminance also works the other way around: since the lumin-

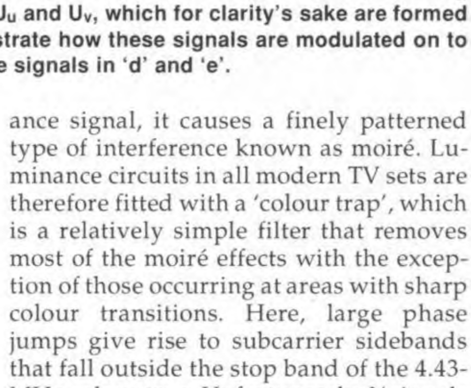


Fig. 2. Structure and timing of a composite video signal (PAL standard).

ance band includes the frequency range for the colour subcarrier, high-frequency Y signals can cause interference in the frequency range around 4.43 MHz. The result is a quasi-random type of patterning and colouring in and around picture areas of fine detail. Notorious examples of this happening can be seen virtually every evening in jackets, shirts or ties of people on television.

Standard VHS video recorders

Some 15 years ago, during the development of the VHS video system, a luminance bandwidth of 3 MHz was deemed satisfactory for VCRs considering the technical limitations imposed by the drum head speed and the tape consumption. In the original VHS system, the colour subcarrier is mixed down to 627 kHz to keep it well way from the lower end of the spectrum of the Y information, which is recorded as a frequency-modulated (FM) signal (see Fig. 3)

The FM recording improves the signal-to-noise ratio of the Y signal and makes it largely independent of amplitude variations of the tape signal. The frequency sweep ranges from 3.8 MHz to 4.8 MHz.

Returning to the colour information, this is recorded as an analogue signal in 'helical scan' mode (Ref. 3). The different frequencies used allow ready separation of the two signals. However, the bandwidth of the colour information is inevitably reduced to about 500 kHz. The result is noticed as 'smeared' colour transitions, to which the reduced (3-MHz) luminance bandwidth adds an impression that the picture is blurred.

These imperfections of the original VHS system were soon recognized by VCR manufacturers. Their answer, the HQ video recorder, was based on small improvements to the recording method and a better edge definition of the Y signal. The resultant picture quality improvement was marginal and not really a step forward. It was, however, the best that could be achieved given the need for continued compatibility. Clearly, real improvements to the picture quality offered by VCRs could be achieved only by changing some of the standards.

The Super-VHS system

The bandwidth of the recorded video signal was increased significantly (at the existing relative speed of 4.85 m/s between the tape and the head) by virtue of two technological developments. First, new metallurgic techniques allowed the size of the air gap of the video head to be reduced. Second, tapes with a very high magnetic particle density became available.

To maintain compatibility with older VHS recorders, the S-VHS system is based on the same method of colour recording (see Fig. 3). However, the frequency sweep of the Y signal is shifted up to a band from 5.4 MHz to 7.0 MHz to give a much higher noise margin. At the same time, the frequency of the FM subcarrier allows the luminance signal to be recorded at its full bandwidth of about 5 MHz.

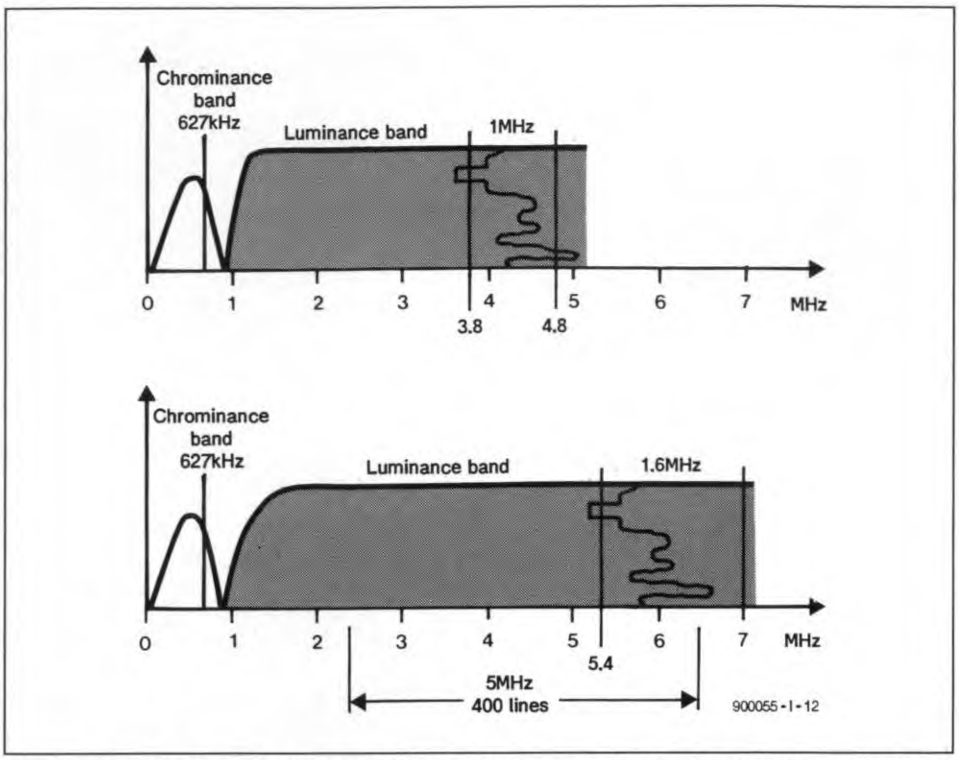


Fig. 3. Typical standard-VHS and S-VHS spectra. In both cases, the quadrature-modulated colour signal is recorded with the aid of a carrier which is mixed down to 627 kHz, while the luminance signal (Y) is recorded in FM. S-VHS recorders use a luminance carrier frequency of 5.4 MHz and a frequency sweep of 1.6 MHz. This offers a bandwidth of 5 MHz for the Y signal, as opposed to about 3 MHz for the standard-VHS video recorder.

In most standard VHS video recorders, the chrominance and luminance signals are processed separately until they are combined to give a CVBS signal with all the previously mentioned risks of running into trouble with interference.

By contrast, the S-VHS system is based on separate chrominance and luminance signals right up to the two associated outputs on the VCR. Evidently, this separation is not perfect when, for instance, a TV programme is recorded, since then the chrominance and luminance components must be extracted from the composite signal before they can be recorded, played back and fed separately to a monitor. The process of extracting the components has pitfalls as described before. Not so, however, with video sources that do supply the components separately. Examples include S-VHS cameras, some prerecorded S-VHS video tapes and MAC decoders.

Connection problems

So far, so good. A look at the rear panel of the TV set, however, reveals that there is at best a SCART connector, which does not allow luminance and chrominance signals to be taken in separately. The TV set is, therefore, not S-VHS compatible. This unfortunate discovery forces owners of S-VHS recorders to connect the monitor and the recorder via a CVBS link, forgoing most of the advantages of better picture reproduction offered by the new video system.

Considering the cost of an S-VHS compatible monitor, the only way to benefit from the separate chrominance and luminance signals supplied by S-VHS recorders and other video sources is to convert these to RGB signals that can be applied to the existing monitor or TV set via its SCART input. Next month's second instalment of this article discusses a circuit to accomplish this. In addition, the circuit provides a colour transition improvement (CTI) function, and is capable of converting CVBS to RGB.

From composite to RGB

Although most standard video recorders have a SCART socket, this rarely supplies RGB signals. Likewise, most set-top TV tuners and indoor units for satellite TV reception supply a CVBS (composite video) signal only. A problem arises when this equipment is to be connected to a high-resolution colour monitor with analogue RGB inputs, or a TV set with a SCART (Euro-AV) input. In both cases, the converter to be described next month can link this equipment and ensure optimum picture quality. ❑

References:

1. Chrominance-locked clock generator. *Elektor Electronics* July/August 1988.
2. Video line selector. *Elektor Electronics* April 1990.
3. *Video Handbook* (second edition). by R. van Wezel. Published by Heineman Newnes, ISBN 0 434 92189 0.

CTIONS CORRECTIONS CORRE

400-watt laboratory power supply

October 1989 and November 1990

A number of constructors of this popular project have brought the following problems to our attention.

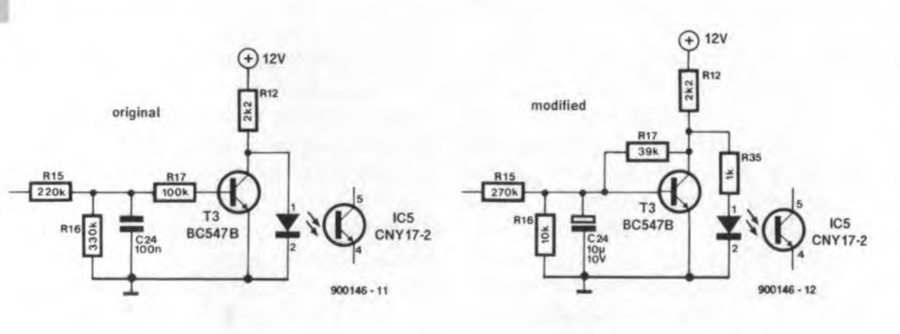
1. The onset point of the current limit circuit lies at about 3 A, which is too low. Solve this problem by replacing T1 with a Type BC517 darlington transistor, and R20 with a 82kΩ resistor.

2. Depending on the current transfer ratio of the optocoupler used, the transformer produces ticking noises. This effect, which is caused by overshoot in the pre-regulation circuit, may be traced with the aid of an oscilloscope monitoring the voltage across C26 at a moderate load current. The capacitor must be charged at each cycle of the mains frequency, and not once every five cycles. The problem is best solved by reducing the amplification of the regulation circuit. Replace R17 with a 39 kΩ resistor, and create feedback by fitting it between the base and the collector of T3. Also add a resistor in series with the optocoupler. These two changes are illustrated in Figs. 1 and 2. Lower R16 to 10 kΩ, increase C24 to 10 μF, and increase R15 to 270 kΩ.

3. Excessive heating of the transformer is caused by a d.c. component in the primary winding. This is simple to remedy by fitting a capacitor of any value between 47 nF and 470 nF, and a voltage rating of 630 V, across the primary connections. This capacitor is conveniently mounted on to the PCB terminal block that connects the transformer to the mains.

4. One final point: when using LED DVMs for the voltage/current indication, their ground line must be connected to the **positive** terminal of C12.

1



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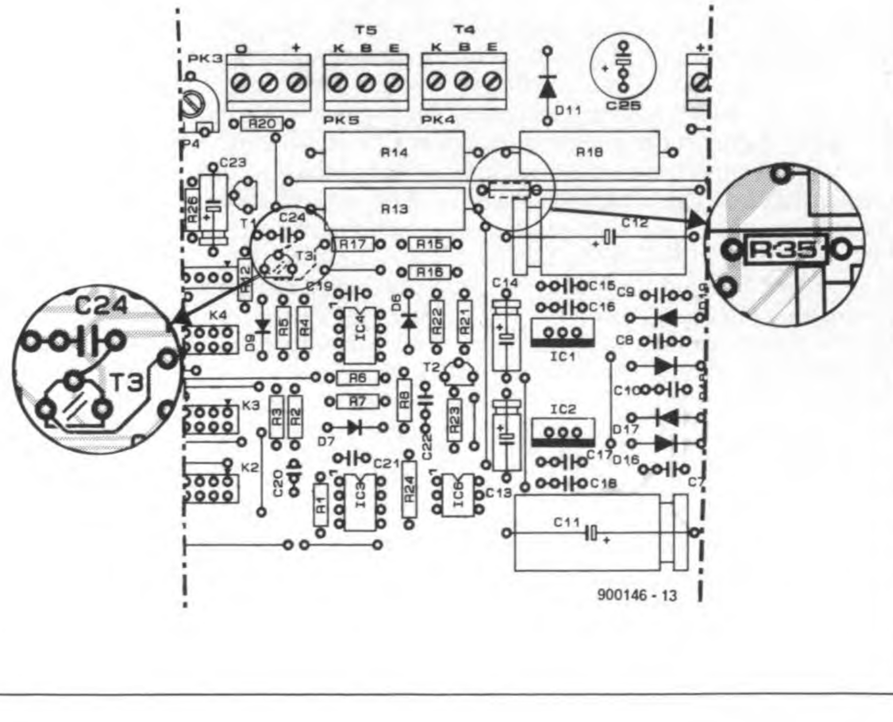


Hard disk monitor

December 1989

In some cases, the circuit will not reset properly because the CLEAR input of IC3A is erroneously connected to ground. Cut the ground track to pin 3 of IC3, and use a short wire to connect pin 3 to pin 16 (+5 V).

Microprocessor-controlled telephone exchange

October 1990

In some cases, the timing of the signals applied to IC17 causes a latch-up in the circuit, so that the exchange does not detect the state of the connected telephones properly. Solve this problem by cutting the track to pin 1 of IC17, and connecting pin 1 to ground (a suitable point is the lower terminal of C6).

The text on the fitting of wires on the BASIC computer board (page 19, towards the bottom of the right-hand column) should be modified to read: 'Finally, connect pin 6 of K2 to pin 7 of IC3 ($\overline{Y7}$ signal).'

S-VHS/CVBS-to-RGB converter (2)

October 1990

The capacitor marked 'C37', next to R21 on the component overlay (Fig. 7b and ready-made printed circuit board), should be marked 'C39'.

In case they are difficult to obtain locally, inductors type 119-LN-A3753 (L1) and 119-LN-A5783 (L2) may be replaced with the respective types 119-ANA-5874HM and 119-ANA-5871HM, also from Toko, Inc. Suggested suppliers are Cirkit Distribution Ltd., and C-I Electronics.

EPROM simulator

December 1989

Counters IC3 and IC4 may not function properly owing to a too low supply voltage. This problem may be solved by replacing IC12 with a 7806. Alternatively, use BAT85 diodes in positions D1 and D2.

Programmer for the 8751

November 1990

The ready-programmed 8751 for this project is available at £35.25 (plus VAT) under order number **ESS 7061**, not under order number ESS 5951 as stated on the Readers Services pages in the November and December 1990 issues.

CORRECTIONS

6-metre band converter

April 1991, p. 38-43

The components list and the inductor overview in the top left hand corner of the circuit diagram should be corrected to read:

L1, L2 = 301KN0800.

Capacitor C16 (4.7 pF) must not be fitted on the board.

Finally, a few constructional tips:

- Fit a 10 nF ceramic decoupling capacitor at junction L7-R36.
- Fit a 18 kΩ resistor between the base of T3 and ground. This reduces the Q factor of L2, and prevents too high signal levels at the base of T3.
- For improved tuning, inductor L9 may be replaced by a Toko Type 113KN2K1026HM.

Multifunction measurement card for PCs

January and February 1991

We understand that the 79L08 (IC17) is no longer manufactured and, therefore, difficult to obtain. Here, the IC may be replaced by a 7908, which, although physically larger than the 79L08, is pin-compatible, and should fit on the PCB.

Dimmer for halogen lights

April 1991, p. 54-58

In the circuit diagram of the transmitter, Fig. 2, pin 14 of the MV500 should be shown connected to pin 13, not to junction R1-R2-C2. The relevant printed-circuit board (Fig. 6) is all right.

RDS decoder

February 1991, p. 59

Line A0 between the 80C32 control board and the LC display is not used to reset the display, but to select between registers and data.

We understand that the SAF7579T and the associated 4.332 MHz quartz crystal are difficult to obtain through Philips Components distributors. These parts are available from C-I Electronics, P.O. Box 22089, 6360 AB Nuth, Holland. For prices and ordering information see C-I's advertisement on page 6 of the May 1991 issue.

S-VHS-to-RGB converter

October 1990, p. 35-40

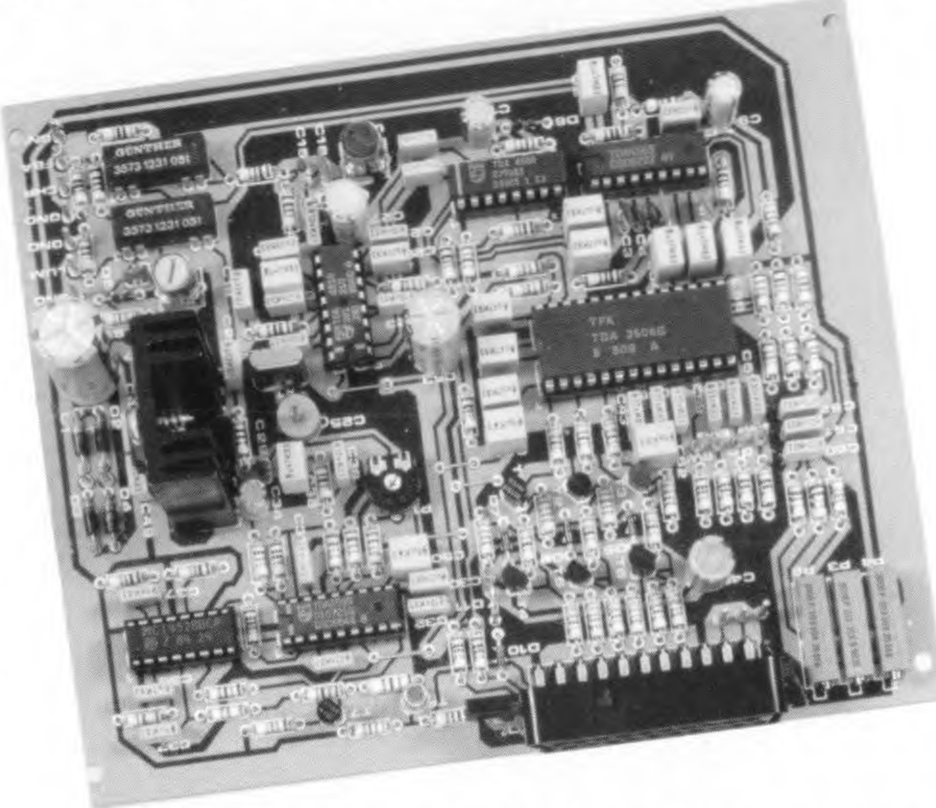
Relays Re1 and Re2 must be types with a coil voltage of 5 V, not 12 V as indicated in the components list. Constructors who have already used 12-V relays may connect the coils in parallel rather than in series.

Suitable 5-V relays for this project are the 3573-1231.051 from Günther, and the V23100-V4305-C000 from Siemens.

The components list should me modified to read:

6	33nF	C57-C62

S-VHS/CVBS-TO-RGB CONVERTER



PART 2: CIRCUIT DESCRIPTION AND CONSTRUCTION

Following last month's introduction into the main characteristics of the Super-VHS system, we close off the article with details of a practical converter circuit that allows an S-VHS VCR or camcorder to be connected to the RGB inputs of a colour TV or monitor. The circuit presented here forms a state-of-the-art approach to all-analogue picture standard conversion, and is based on the latest in IC technology available for this purpose.

H. Reelsen

It seems odd that the introduction of S-VHS camcorders and video cassette recorders (VCRs) last year has not been followed by more TV sets with separate chrominance and luminance inputs. After all, these recorders need a suitable display to match their advanced features. True, some buyers will opt for the fairly expensive TV receivers that have separate colour processing facilities, but many others are either not prepared to pay the current high price for such a set or net yet willing to replace their existing set. What can they do unil they have acquired a suitable new set?

The circuit presented here converts the separate colour signals supplied by an S-VHS source into the three basic colour signals, red, green and blue (RGB), which may be applied to the respective inputs of a TV set fitted with a SCART socket or separate RGB sockets. The performance of the integrated circuits used in the converter is so good that it is also worthwhile to have them convert CVBS (composite video) into RGB. A separate input is provided for this application, which also allows some types of RGB computer monitor to be used as a video display.

Circuit description

As shown in the circuit diagram, Fig. 4, the converter has three video signal inputs:

- **CVBS** (chrominance-video-blanking-synchronisation) with an input impedance of 75 Ω. This input is suitable for connecting to signal sources (VCRs, cameras, camcorders and home computers) that supply the standard CVBS signal level of about 1 V_{pp}.
- **Y** (luminance, or brightness) with an impedance and sensitivity of 75 Ω and 1 V_{pp} respectively. The Y signal is processed without a colour trap at a bandwidth of up to 7 MHz.
- **U/V** (chrominance, or colour information) with an input impedance and sensitivity of 75 Ω and 0.5 V_{pp} respectively. This input feeds the colour signal to the PAL decoder in the circuit.

Luminance processing

The function of the separate Y, U and V signals that together make up a colour video sig-

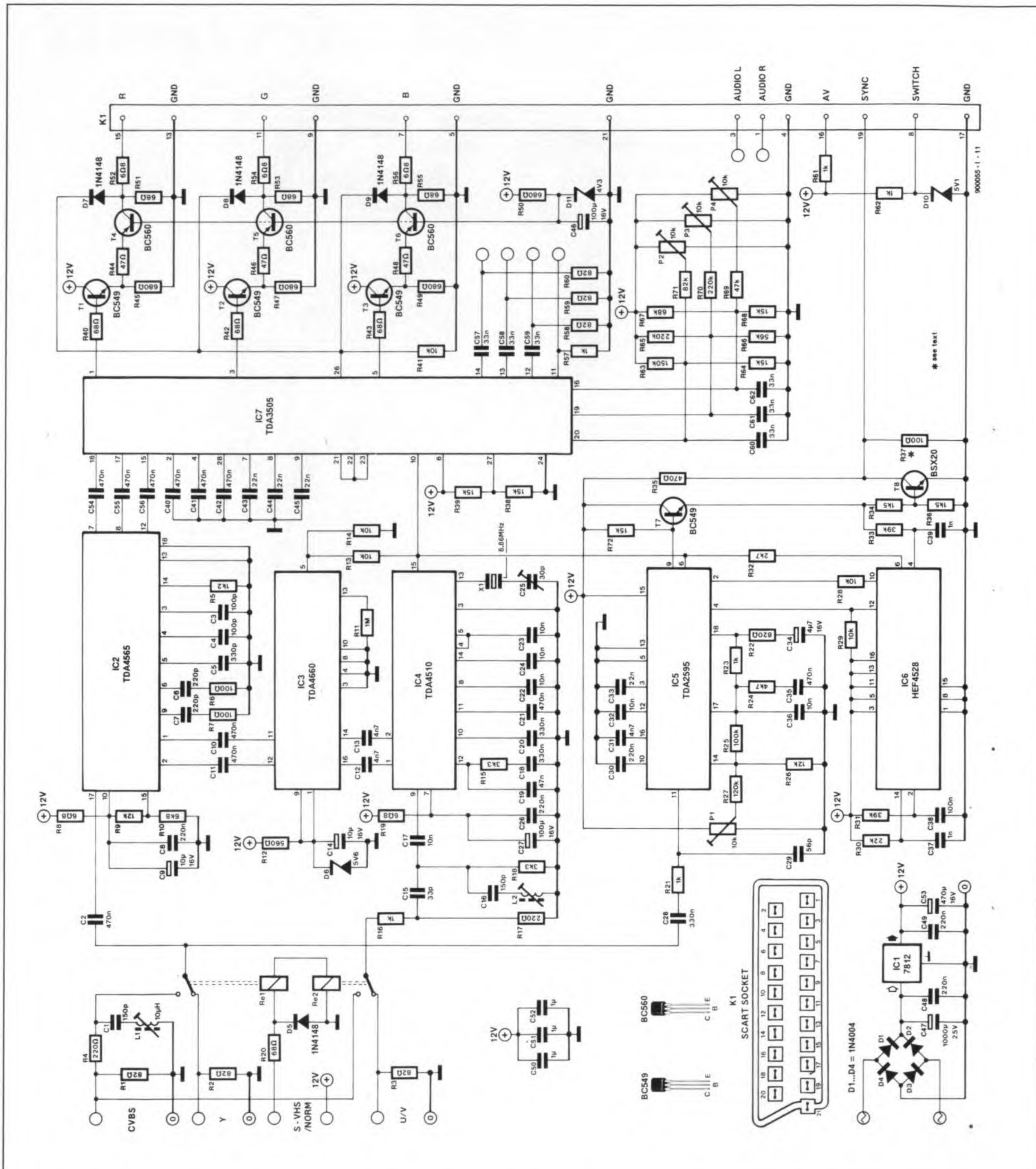


Fig. 4. Circuit diagram of the video standards converter. The unit is connected to the TV set or monitor via SCART socket K1.

nal is discussed in Part 1 of this article. The Y and U/V inputs are used with S-VHS equipment. The CVBS input may be connected to equipment that supplies a composite video signal. Two relays, Re1 and Re2, are used to switch between S-VHS and CVBS operation. The converter is switched to CVBS operation by applying +12 V to the S-VHS/NORM control input. S-VHS operation is selected by leaving the input open-circuited. Relay Re1 then feeds the Y (luminance) signal to IC2 via coupling capacitor C2. As shown in the block diagram in Fig. 5, the TDA4565 contains a colour transient improvement (CTI) circuit and a delay line for the Y signal. This delay line is an essential part in any colour TV set because the luminance signal has a much greater bandwidth than the chrominance signal and hence requires a delay of about 800 ns. A number of gyrators in the TDA4565 allow delay times between 690 ns and 960 ns to be set in steps of 90 ns with the aid of a control voltage applied to pin 15. In the present circuit, the delay is set to 780 ns by potential divider R9-R10. Coupling capacitor C56 feeds the delayed Y signal supplied by pin 12 of the TDA4565 to pin 15 of the colour matrix circuit, a TDA3505 (IC7). The delayed Y signal has an amplitude of about 0.5 V_{pp}.

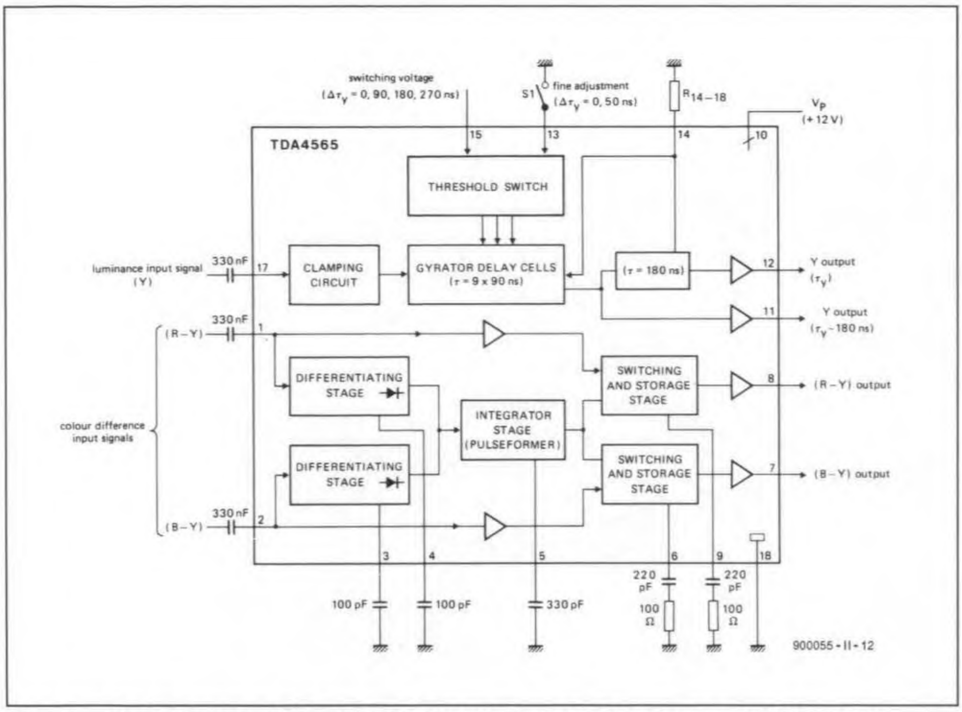


Fig. 5. Block diagram of the TDA4565 Colour Transient Improvement (CTI) circuit.

Chrominance processing

The chrominance signals are passed to the decoder via the contact of Re2. Before they arrive at the PAL decoder, a TDA4510 (IC4), the U/V signals are attenuated by R16-R17, and taken through a high-pass filter composed of C15-C16-L2.

The TDA4510 was originally designed for use with a glass delay line which serves to store the chrominance signal of the previous picture line. In the present circuit, the TDA4510 works without this crucial part whose delay time of one picture line enables the colour correction operation in the PAL TV system to correlate the colour information in two successive picture lines. In a PAL TV receiver, the R–Y and B–Y components modulated on the 4.43 MHz colour subcarrier are delayed and subsequently added to the undelayed signals. Since this addition is critical in respect of phase and amplitude, a preset and a small inductor are fitted to optimize the adjustment which, unfortunately, requires a calibrated PAL signal source.

The recently introduced TDA4660 provides a welcome alternative to the glass delay line and at the same time eliminates the associated complex phase and amplitude adjustments. The baseband delay element in the TDA4660 may be used by configuring the PAL decoder as shown in the circuit diagram. The demodulated colour difference signals at output pins 1 and 2 of IC4 are applied to the respective inputs of the CCD-based analogue shift register in the TDA4660 (see the block diagram in Fig. 6). After the shift operation, the delayed signal and the undelayed signal are added in the IC to give the conventional R–Y and B–Y components. The clock for the CCD register is provided by a PLL (phase-locked loop) circuit contained in the TDA4660. The reference clock of the PLL is formed by the line frequency, obtained from the super-sandcastle pulse applied to the chip via R13-R14. The origin and the function of the super-sandcastle pulse is discussed further on in this article.

CTI function

The colour difference signals, R–Y and B–Y, are applied to the inputs, pins 11 and 12, of the baseband delay element, IC3. The typical signal levels are 1.0 V_{pp} at the R–Y input (pin 11) and 1.3 V_{pp} at the B–Y input (pin 12). An oscilloscope connected to these IC pins will reveal sluggish rise and fall times of the colour difference signals as a result of, say, the standard colour bar test chart. This is caused mainly by the limited bandwidth (about 1 MHz) of the chrominance signal. The bandwidth is reduced even further (to about 0.5 MHz or smaller) when a normal VHS tape is played back. Obviously, this makes the signal edges even slower and results in degraded colour transient definition, or, in other words, a picture that is not very sharp. In not a few cases, the picture quality from a VCR is degraded further by moiré effects in the already blurred colour transients. As already explained in Part 1, this moiré is caused mainly by insufficient suppression of the colour subcarrier sidebands.

Fortunately, the picture quality can be improved considerably by a colour transient improvement (CTI) chip. Here, the TDA4565 (IC2) is used in a standard application circuit. The way in which CTI is implemented without introducing overshoot and additional noise is discussed below.

The TDA4565 detects a colour transient by differentiating the colour difference signals. This is achieved by an internal difference amplifier and capacitors C3 and C4. When a transient is detected, an internal pulse shaper, which uses C5 as an external part, is actuated. The pulse shaper in turn causes the input signal to be stored in a sample-and-hold circuit which retains the current signal level until the transient is over. Next, 100 ns pass before the new level is supplied. The sample-and-hold function is implemented by external components R6, R7, C6 and C7. The re-shaped colour difference signals at output pins 7 and 8 of the TDA4565 are fed to the matrix circuit via a pair of coupling capacitors, C54 and C55.

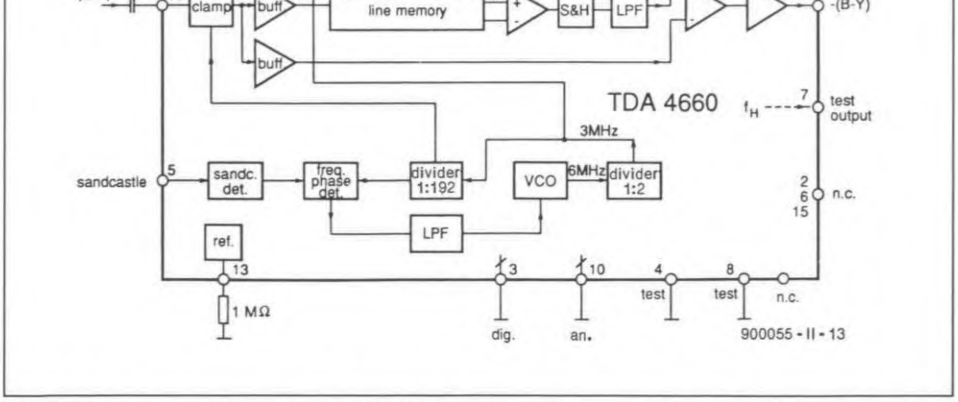


Fig. 6. Block diagram of the TDA4660 CCD-based baseband delay element with PLL-controlled line frequency generator.

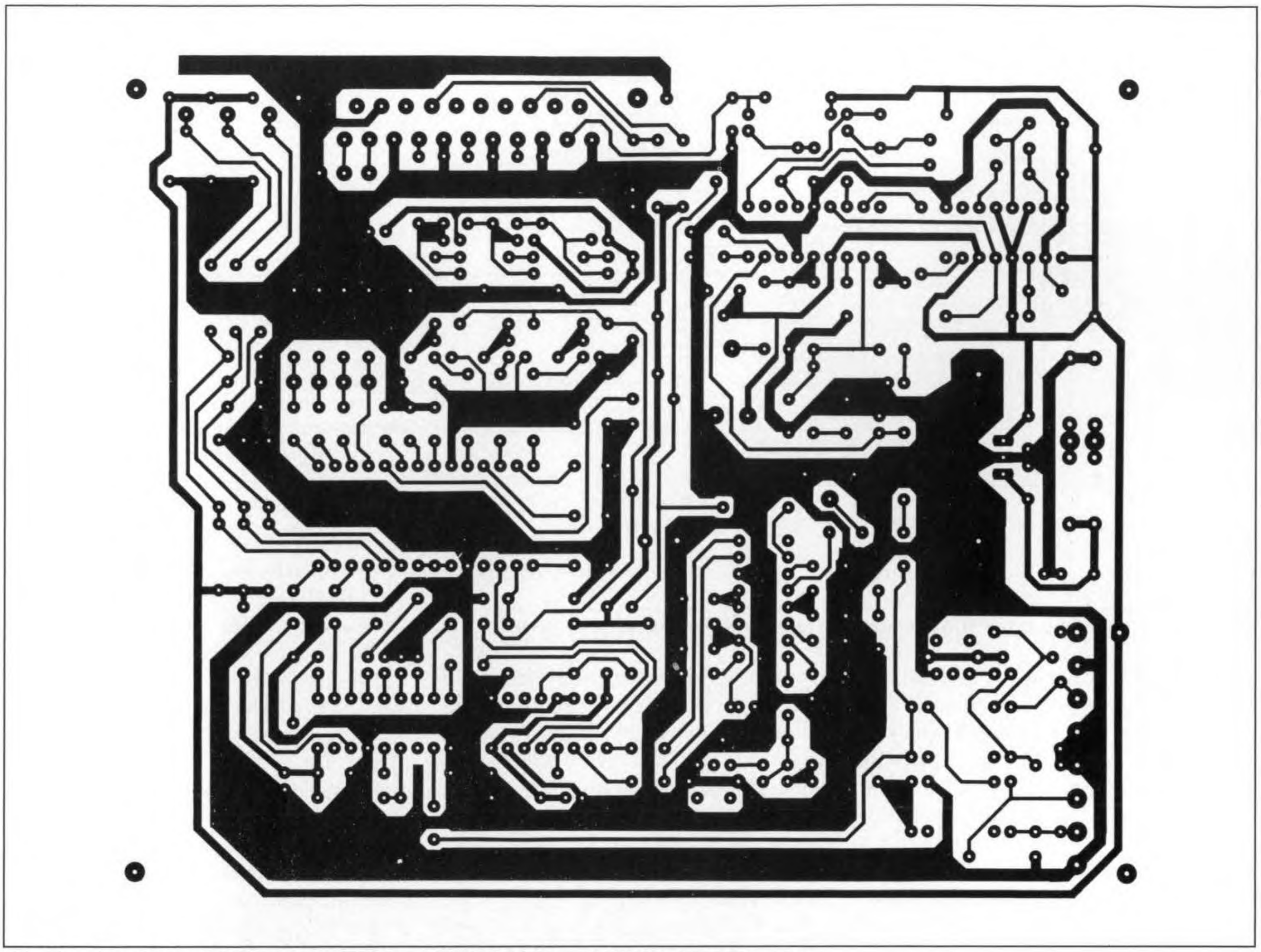


Fig. 7a. Track layout (mirror image) of the printed-circuit board for the video converter.

RGB output circuit

The colour matrix circuit is based on another video IC from Philips Components: the TDA3505 (IC7). In this, the luminance and chrominance signals meet (in S-VHS mode) or meet again (in CVBS mode). The basic colours, R, G and B, are recovered, by a summing operation, from the colour difference signals and the luminance (Y) component. The picture settings, contrast, brightness and colour saturation, are adjusted by direct voltages that determine the bias and the gain at a number of points in the matrix. Here, the relevant components are R63-R71 and presets P2, P3 and P4. The presets are used to adjust the brightness (P2), the contrast (P3) and the colour saturation (P4). The multiturn presets on the circuit board may, of course, be replaced by front-panel mounted potentiometers to give a continuous control range rather than fixed settings.

Two-stage level shifters/buffers are required at the outputs of the matrix because these do not supply levels down to 0 V, and are not capable of driving a 75-Ω load direct. The buffering and level shifting are achieved with three combinations of an emitter follower and a common-base amplifier (T1-T6). The output impedance of the three drivers is 75 Ω.

Each colour output driver has a diode which allows the operating point of the two-transistor stage to be monitored via pin 26 of the TDA3505. The operating point is monitored and, if necessary, corrected, during the vertical blanking interval, i.e., when the scanning beam in the TV set is quenched. The direct voltage required for this function is stored in capacitors C40, C41 and C42 during the current picture. The matrix circuit

COMPONENTS LIST

Resistors:

6	82Ω	R1;R2;R3;R58;R59;R60
2	220Ω	R4;R17
1	1k2	R5
3	100Ω	R6;R7;R37
5	6Ω8	R8;R19;R52;R54;R56
2	12kΩ	R9;R26
1	6k8	R10
1	1MΩ	R11
1	560Ω	R12
5	10kΩ	R13;R14;R28;R29;R41
2	3k3	R15;R18
6	1kΩ	R16;R21;R23;R57;R61;R62
7	68Ω	R20;R40;R42;R43;R51;R53;R55
1	820Ω	R22
1	4k7	R24
1	100kΩ	R25
1	120kΩ	R27
1	22kΩ	R30
2	39kΩ	R31;R33
1	2k7	R32
2	1k5	R34;R36
1	470Ω	R35
5	15kΩ	R38;R39;R64;R68;R72
3	47Ω	R44;R46;R48
4	680Ω	R45;R47;R49;R50
1	150kΩ	R63
2	220kΩ	R65;R70
1	56kΩ	R66
1	68kΩ	R67
1	47kΩ	R69
1	82kΩ	R71
1	10kΩ preset H	P1
3	10kΩ multiturn preset	P2;P3;P4

(continued →)

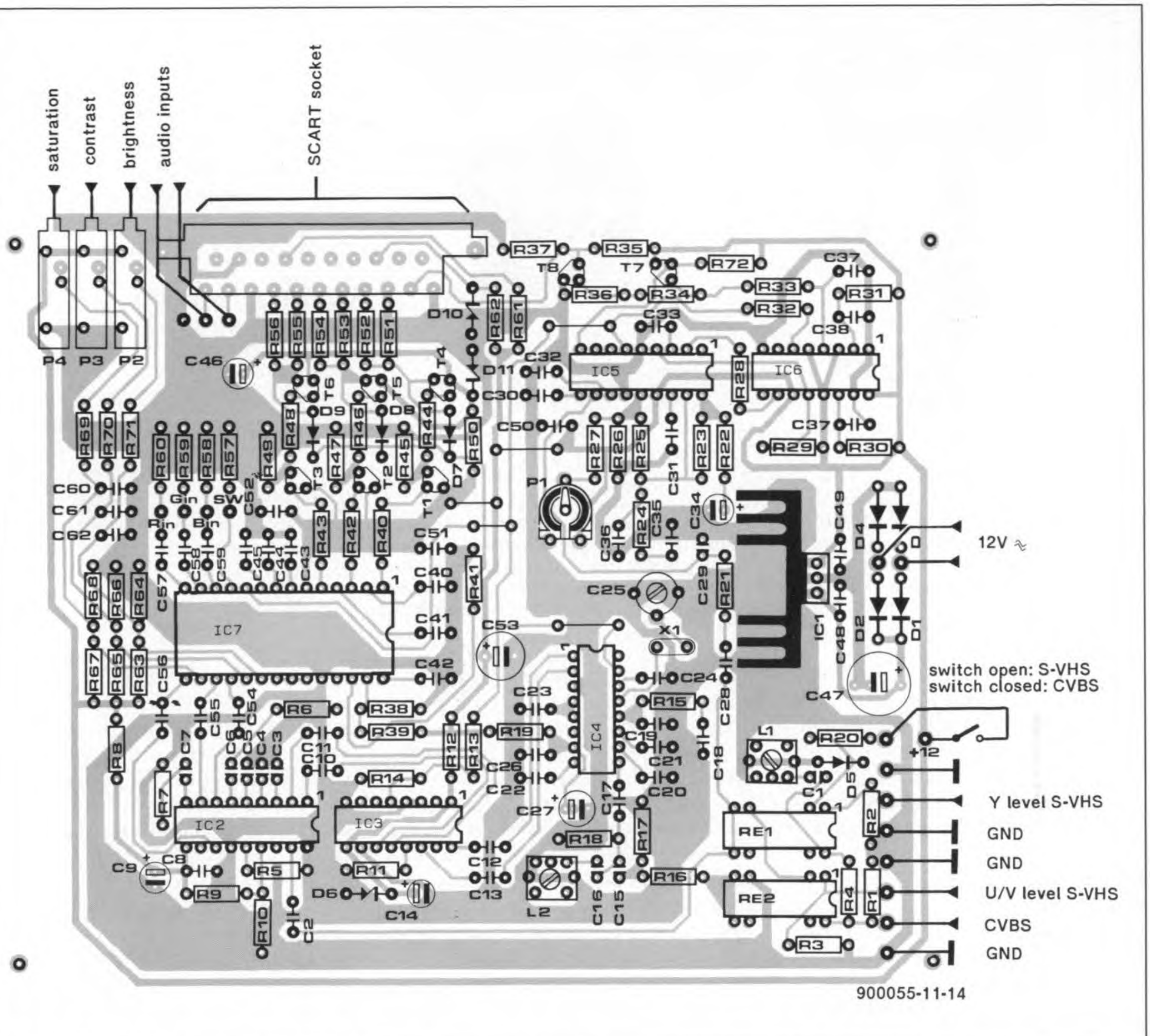


Fig. 7b. Component mounting plan of the printed-circuit board, and connections to external parts and video/audio equipment.

COMPONENTS LIST

Capacitors:

2	150pF	C1;C16
11	470nF	C2;C10;C11;C21; C35;C40;C41; C42;C54;C55;C56
2	100pF	C3;C4
1	330pF	C5
2	220pF	C6;C7
5	220nF	C8;C26;C30;C48; C49
2	10µF 16V radial	C9;C14
3	4n7	C12;C13;C31
1	33pF	C15
6	10nF	C17;C22;C23; C24;C32;C36
3	330nF	C18;C20;C28
1	47nF	C19
1	30pF trimmer	C25
2	100µF 16V radial	C27;C46
1	56pF	C29
4	22nF	C33;C43;C44;C45
1	4µ7 16V radial	C34
2	1nF	C37;C39
1	100nF	C38
1	1,000µF 25V radial	C47
3	1µF	C50;C51;C52
1	470µF 16V radial	C53
6	33nF	C57–C60

Semiconductors:

4	1N4004	D1–D4
4	1N4148	D5;D7;D8;D9
1	5V6 0.4W zener diode	D6
1	5V1 0.4W zener diode	D10
1	4V3 0.4W zener diode	D11
4	BC549B	T1;T2;T3;T7
3	BC560C	T4;T5;T6
1	BSX20	T8
1	7812	IC1
1	TDA4565	IC2
1	TDA4660	IC3
1	TDA4510	IC4
1	TDA2595	IC5
1	HEF4528	IC6
1	TDA3505	IC7

Inductors:

1	10µH adjustable; Toko 119 LN-A3753	L1
1	50µH adjustable; Toko 119 LN-A5783	L2

Miscellaneous:

2	12-V SPDT DIL reed relay	Re1;Re2
1	PCB-mount SCART socket	K1
1	quartz crystal 8.867238 MHz (HC18/U)	X1
1	heat-sink for IC1	
22	solder pins	
1	printed-circuit board	900055

Fig. 8. S-VHS equipment is gaining rapid acceptance. Pictured to the right is JVC's Super-VHS compact recorder with built-in LCD screen. The recorder is claimed to be the world's lightest and smallest at a weight of only 530 g and a size of 131×58×118 mm. The associated Super-VHS camera with stereo sound has a size of 39×69×122 mm. The camera and the recorder are part of the SC-F007 mini-video system, kindly put at our disposal by JVC Holland.

recognizes the vertical blanking period with the aid of the super-sandcastle pulse.

The SCART socket that supplies the RGB output signals also carries the (stereo) sound signals via pins 3, 1 and 4, and the AV and SWITCH voltages (+12 V and +5 V for automatic switch-over to AV and RGB mode respectively).

CVBS mode

The operation of the circuit in CVBS (composite video) mode is much simpler than in S-VHS mode. When the S-VHS/NORM control input is connected to +12 V, both relays are actuated. Like the chrominance signal, the CVBS signal is applied direct to the colour filter, so that the PAL decoder receives the colour components, which, obviously, the Y channel must not be allowed to 'see'. The filtered composite signal is applied to IC2 after passing a colour trap composed of R4 and tuned circuit L1-C1. The CVBS (or Y) signal is 'tapped' behind Re1 and fed to the synchronization separator, IC5, via a low-pass filter, R21-C29.

Power supply

The 12-V power supply on the board is conventionally based on a rectifier, D1-D4, a smoothing capacitor, C17, and a voltage regulator, IC1. The input of the supply may be provided with an alternating voltage between 10 V and 12 V.

Syncs and sandcastles

The horizontal sync generator and sync separator is formed by IC5, a TDA2595. This IC also generates the previously mentioned sandcastle pulse.

When pin 9 of the TDA2595 is connected to +12 V via a 15-kΩ resistor, the complete synchronization signal is available as positive-going pulses with a swing of 12 V_{pp}. Inverter T8 is driven by T7, an emitter follower. The open-circuited signal level at the SYNC output of the SCART socket is set to about 2 V_{pp} by voltage divider R35–R37 at the collector of T8. When this output is loaded, the signal level drops to about 1 V_{pp}. When a multi-sync monitor with a TTL-compatible sync input is used, resistor R37 must be changed to 390 Ω.

The TDA2595 requires the horizontal and the vertical blanking pulse to generate the super-sandcastle pulse. This four-level pulse contains the following timing information:

- 0 V = picture period and reference level
- +2.5 V = vertical blanking
- +4.5 V = horizontal blanking
- +11 V = burst gate

The burst gate is obtained from the PLL-controlled line frequency generator in the TDA4660. It enables the PAL decoder to time the insertion of the 4.43 MHz colour burst in the horizontal blanking period. Since the horizontal and vertical blanking pulses are normally generated in the deflection circuits of the TV set, they must be generated separately in the converter. This is achieved by a dual monostable, IC6.

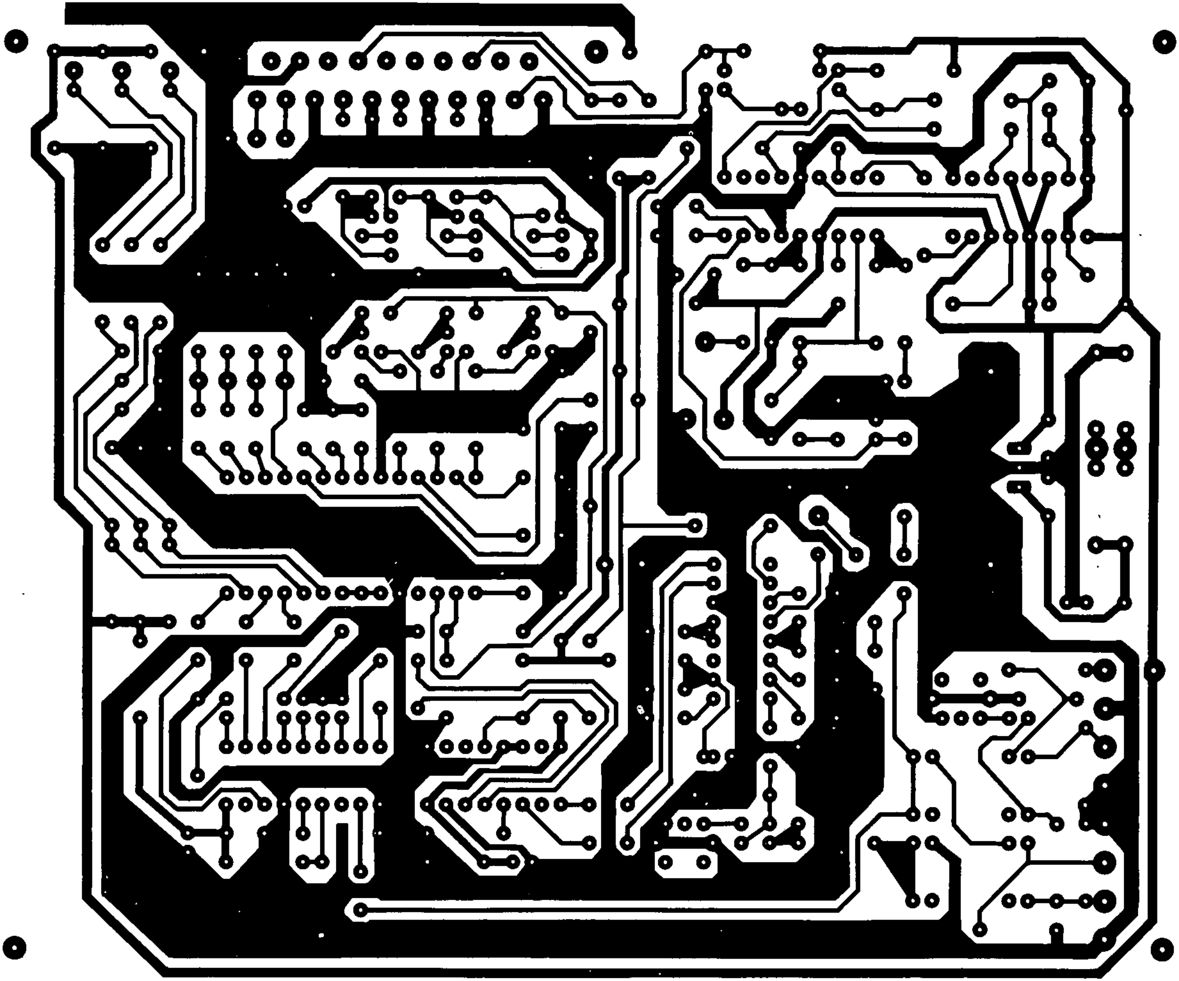
The positive-going composite synchronization signal at the emitter of T7 is passed through low-pass filter R33-C39, so that the vertical synchronization component remains. It triggers one of the monostables via pin 4. At the output, a 1.2-ms long pulse appears, which is mixed with the sandcastle pulse via R32. The output signal of the horizontal sync oscillator (at pin 4 of IC5) is fed to the second monostable in IC6. This supplies a 10-µs long pulse which is fed back to the TDA2595 for use as the horizontal blanking level in the sandcastle pulse.

Construction and adjustment

Although the circuit is relatively complex, its construction on the single-sided printed-circuit board shown in Fig. 7 is straightforward. Start the construction by fitting the five wire links on the board. The voltage regulator, IC1, must be bolted to a fairly large, vertically mounted heat-sink before its terminals are soldered. If the SCART socket has mounting holes in the flanges, they must be used to secure the plastic body to the printed-circuit board with the aid of two small screws (M3) and nuts. Some SCART sockets have snap-in arms at the sides for which holes must be drilled in the PCB. Do not forget to set the three multiturn presets to the centre of their travel before or after they are mounted: else, strange picture effects may occur when the converter is first switched on, and you may have a hard time finding the cause of the problem, when there is nothing wrong with the circuit.

On completion of the solder work, inspect the printed-circuit board very carefully. Check the orientation of all ICs, diodes and electrolytic capacitors against the overlay printed on the board and shown in Fig. 7b.

Apply power to the converter and check that its current consumption is about 350 mA at 12 V. Next, adjust preset P1 until the PLL runs free at the line frequency, 15,625 Hz (64 µs), which can be measured at pin 4 of IC5. Apply a colour input signal, and adjust trimmer capacitor C25 until the monitor switches to colour. In most cases, the colour will be on already with the trimmer set to roughly half-way of its travel. Check that the 8.86 MHz oscillator starts properly by switching the converter on and off a few times. The colour should come on immediately after switching on. If it does not, carefully re-adjust the trimmer. Finally, adjust the colour trap, L1. Apply a CVBS signal and adjust the inductor for minimum chrominance subcarrier amplitude. This measurement is best carried out with an oscilloscope connected to pin 12 of IC2. When an oscilloscope is not available, adjust L1 for minimum moiré interference in the colour picture. ■



400-watt laboratory power supply

October 1989 and November 1990

A number of constructors of this popular project have brought the following problems to our attention.

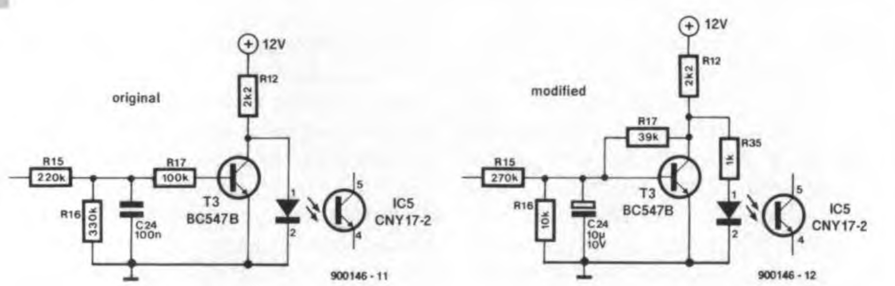
1. The onset point of the current limit circuit lies at about 3 A, which is too low. Solve this problem by replacing T1 with a Type BC517 darlington transistor, and R20 with a 82kΩ resistor.

2. Depending on the current transfer ratio of the optocoupler used, the transformer produces ticking noises. This effect, which is caused by overshoot in the pre-regulation circuit, may be traced with the aid of an oscilloscope monitoring the voltage across C26 at a moderate load current. The capacitor must be charged at each cycle of the mains frequency, and not once every five cycles. The problem is best solved by reducing the amplification of the regulation circuit. Replace R17 with a 39 kΩ resistor, and create feedback by fitting it between the base and the collector of T3. Also add a resistor in series with the optocoupler. These two changes are illustrated in Figs. 1 and 2. Lower R16 to 10 kΩ, increase C24 to 10 μF, and increase R15 to 270 kΩ.

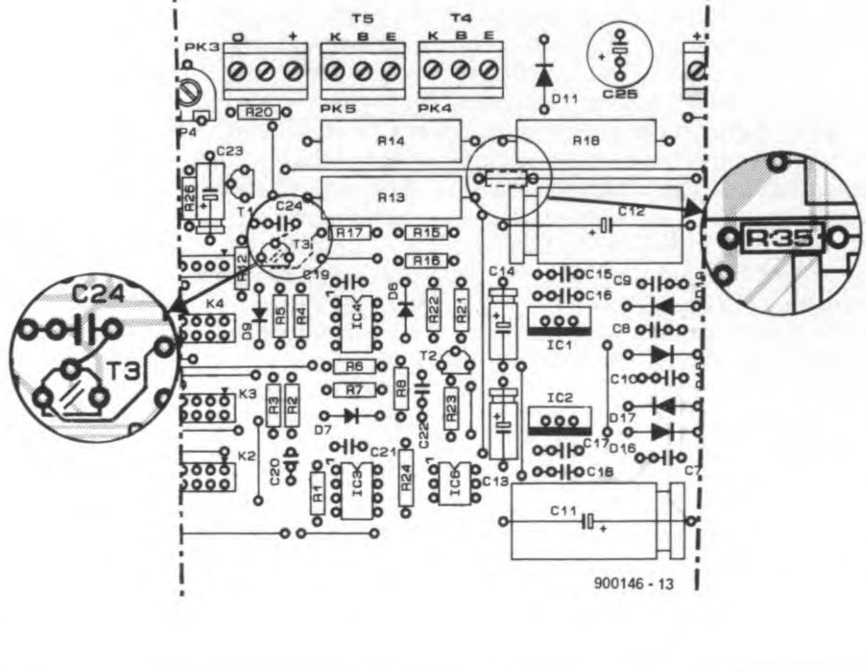
3. Excessive heating of the transformer is caused by a d.c. component in the primary winding. This is simple to remedy by fitting a capacitor of any value between 47 nF and 470 nF, and a voltage rating of 630 V, across the primary connections. This capacitor is conveniently mounted on to the PCB terminal block that connects the transformer to the mains.

4. One final point: when using LED DVMs for the voltage/current indication, their ground line must be connected to the **positive** terminal of C12.

1



2



Hard disk monitor

December 1989

In some cases, the circuit will not reset properly because the CLEAR input of IC3A is erroneously connected to ground. Cut the ground track to pin 3 of IC3, and use a short wire to connect pin 3 to pin 16 (+5 V).

Microprocessor-controlled telephone exchange

October 1990

In some cases, the timing of the signals applied to IC17 causes a latch-up in the circuit, so that the exchange does not detect the state of the connected telephones properly. Solve this problem by cutting the track to pin 1 of IC17, and connecting pin 1 to ground (a suitable point is the lower terminal of C6).

The text on the fitting of wires on the BASIC computer board (page 19, towards the bottom of the right-hand column) should be modified to read: 'Finally, connect pin 6 of K2 to pin 7 of IC3 ($\overline{Y7}$ signal).'

S-VHS/CVBS-to-RGB converter (2)

October 1990

The capacitor marked 'C37', next to R21 on the component overlay (Fig. 7b and ready-made printed circuit board), should be marked 'C39'.

In case they are difficult to obtain locally, inductors type 119-LN-A3753 (L1) and 119-LN-A5783 (L2) may be replaced with the respective types 119-ANA-5874HM and 119-ANA-5871HM, also from Toko, Inc. Suggested suppliers are Cirkit Distribution Ltd., and C-I Electronics.

EPROM simulator

December 1989

Counters IC3 and IC4 may not function properly owing to a too low supply voltage. This problem may be solved by replacing IC12 with a 7806. Alternatively, use BAT85 diodes in positions D1 and D2.

Programmer for the 8751

November 1990

The ready-programmed 8751 for this project is available at £35.25 (plus VAT) under order number **ESS 7061**, not under order number ESS 5951 as stated on the Readers Services pages in the November and December 1990 issues.

CORRECTIONS

6-metre band converter

April 1991, p. 38-43

The components list and the inductor overview in the top left hand corner of the circuit diagram should be corrected to read:

L1, L2 = 301KN0800.

Capacitor C16 (4.7 pF) must not be fitted on the board.

Finally, a few constructional tips:

- Fit a 10 nF ceramic decoupling capacitor at junction L7-R36.
- Fit a 18 kΩ resistor between the base of T3 and ground. This reduces the Q factor of L2, and prevents too high signal levels at the base of T3.
- For improved tuning, inductor L9 may be replaced by a Toko Type 113KN2K1026HM.

Multifunction measurement card for PCs

January and February 1991

We understand that the 79L08 (IC17) is no longer manufactured and, therefore, difficult to obtain. Here, the IC may be replaced by a 7908, which, although physically larger than the 79L08, is pin-compatible, and should fit on the PCB.

Dimmer for halogen lights

April 1991, p. 54-58

In the circuit diagram of the transmitter, Fig. 2, pin 14 of the MV500 should be shown connected to pin 13, not to junction R1-R2-C2. The relevant printed-circuit board (Fig. 6) is all right.

RDS decoder

February 1991, p. 59

Line A0 between the 80C32 control board and the LC display is not used to reset the display, but to select between registers and data.

We understand that the SAF7579T and the associated 4.332 MHz quartz crystal are difficult to obtain through Philips Components distributors. These parts are available from C-I Electronics, P.O. Box 22089, 6360 AB Nuth, Holland. For prices and ordering information see C-I's advertisement on page 6 of the May 1991 issue.

S-VHS-to-RGB converter

October 1990, p. 35-40

Relays Re1 and Re2 must be types with a coil voltage of 5 V, not 12 V as indicated in the components list. Constructors who have already used 12-V relays may connect the coils in parallel rather than in series.

Suitable 5-V relays for this project are the 3573-1231.051 from Günther, and the V23100-V4305-C000 from Siemens.

The components list should me modified to read:

6	33nF	C57-C62