

The SONY VO1810 VCR

Part 1

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DURING August-November 1975 we published a series of four articles on videotape recording, particular attention being paid to the Philips VCR. Following a number of requests we are now going to examine closely the Sony VO1810 videocassette recorder which was designed for the industrial and educational television markets. Readers unfamiliar with videotape recording techniques will find the basic principles described in the series of articles published last year.

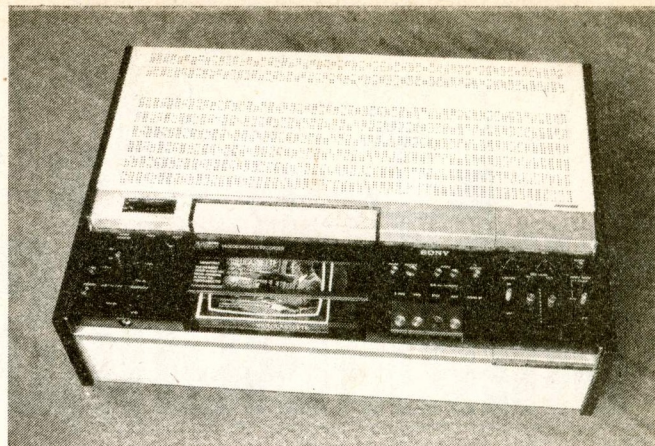
The $\frac{3}{4}$ in. U standard tape format used in the Sony VO1810 is compatible with the JVC Nivico CR6000E tape recorder — these are the only videocassette recorders on the market at the time of writing whose tapes can be interchanged. Both the Sony and JVC recorders offer similar video and audio facilities, the main difference between the two being in their size and operational modes. The JVC CR6000E recorder is rather smaller and lighter than the Sony machine and includes feather-touch electrical switching for the record, playback and wind modes, video and audio editing facilities, remote control and separate audio record controls in the two audio channels.

The cassette tape used by both these machines is $\frac{3}{4}$ in. wide and is housed in a reel-to-reel cassette that is similar in design to the type widely used in audio cassette recorders. A photograph of the cassette is shown with the lid removed. Because the Sony machine is specifically designed for use in educational and closed circuit installations, the technical specification is considerably fuller and to a higher standard than the domestic Philips VCR. A closer look at the specification will give the reader an idea of the technical standard and the complexity of the electronics involved.

VCR Specification

The machine is designed to work with 625-line PAL signals in the record and playback modes, or 525-line (modified) NTSC signals for playback only. Video resolution is 300 lines on monochrome and 240 lines on colour, with a signal-to-noise ratio greater than 40dB. Colour or monochrome operation is self sensing but mechanical switching is used between the PAL and NTSC standards. The machine operates with a video input signal of 1V peak-to-peak into 75 Ω unbalanced. Should off-air recordings be required a separate off-air receiver must be used to provide the necessary audio and video signals. Two outputs are provided, one a direct video output (standard level) and the second a u.h.f. output which can be adjusted to lie anywhere between channels 50 to 54.

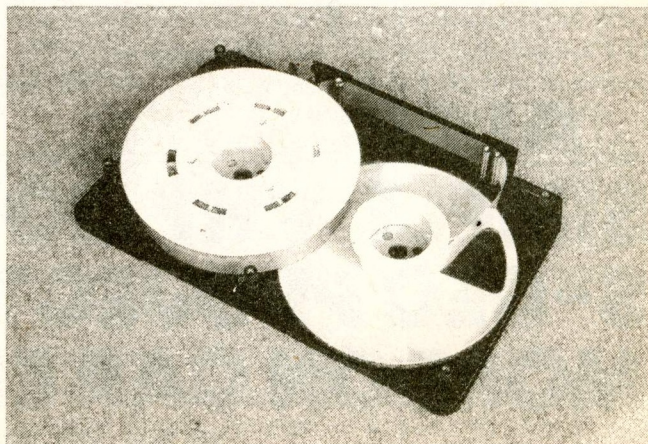
Two audio inputs can be used, one from a microphone at -72 to -30dB into 600 Ω unbalanced, or a line input at -22



to +10dB unbalanced into 100k Ω . There are two audio channels on the tape, giving the user the option of stereo sound with a colour programme or mono sound with the second sound track containing instructions for possible editing procedures or a second language. Audio outputs are 0dB into 10k Ω unbalanced with the added facility of a headphone output designed to work into 8 Ω . The audio frequency response is between 50Hz and 12kHz with a signal-to-noise ratio of 42dB, using a tape speed of 3 $\frac{3}{4}$ i.p.s. and with wow and flutter better than 0.25%.

Apart from the much improved specification compared with the domestic Philips N1500 VCR there are also additional operating features worthy of mention. Programmes can be continuously repeated, i.e. the operator can play back the same cassette over and over again without having to operate the machine manually. This is of particular use where the machine is being used to provide visual displays at exhibitions and conventions. Mode switching between record, playback and wind is selected by key controls which utilise a combination of mechanical and electrical switching. Much of the electronics involved with the switching is relatively complex: with a little more ingenuity on the part of Sony's designers I am sure that a completely electronic switching system could have been devised at very little extra cost.

Whilst in a critical mood I feel I must comment on the technical description and block diagrams supplied in the workshop manual. During the course of research into the electronics of this VCR I found a total of 12 errors in either the block diagram or the circuit description. The technical description was much too brief and lacked the detail that



The videocassette, shown with the lid removed.

one would expect for a machine of this complexity. Circuit diagrams, voltages, waveforms and printed circuit layouts are excellently presented however. It is a pity that the overall standard of the service manual was lowered by mistakes in the descriptive text. Having had this little grouse, let's settle down to the task in hand and examine the techniques employed in this VCR.

Block Diagram

The block diagram shown in Fig. 1 includes all the record/playback electronics together with the servo and audio sections of the machine. Tape servo and control circuits will be described in a following issue. To start with we will deal with the audio and video signal paths.

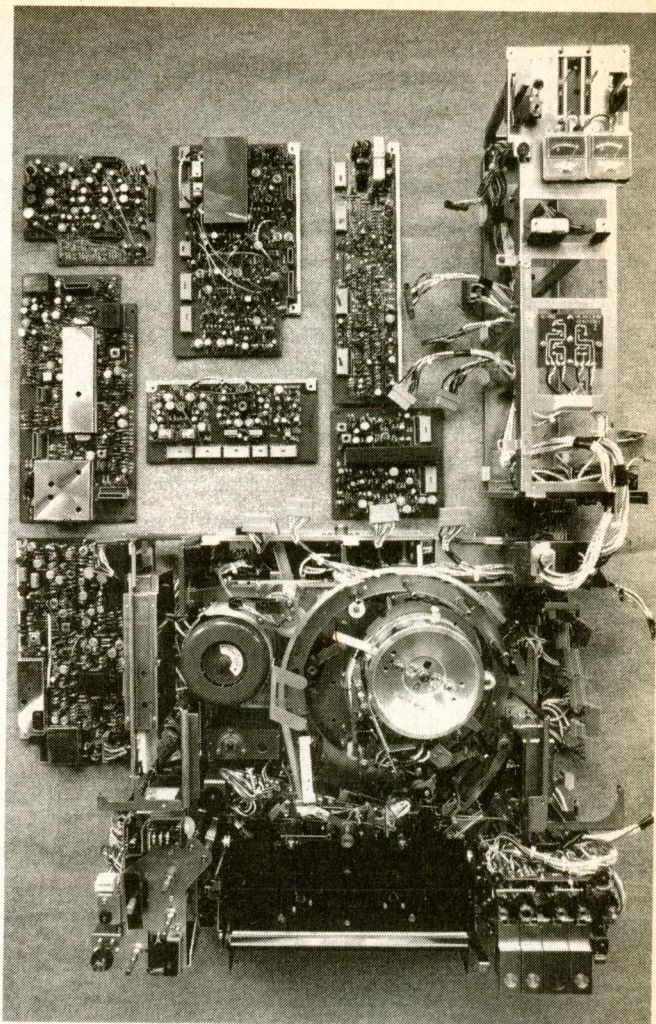
Modular construction is used for the major sections, and in this respect Sony should be given a very big pat on the back for using plugs and sockets on the boards rather than the directly soldered interconnections one is used to finding in their domestic TV and audio equipment. Having pulled one of these machines apart – a photograph has been included to show how accessible most of the machine is – I must say that all the circuitry was easy to reach and in many respects is a joy to work with.

Returning to the block diagram, boards G1 and G2 contain the video record electronics, and boards HL and Ep house the audio record circuits. The video playback circuits are split between the B1 board r.f. section and the A1 board. The demodulator and dropout compensator circuits are mounted on a separate module (K1), and the audio playback circuits are on board C1.

Video Recording

The video input to the machine is via either a u.h.f. connector (Line Input) or an 8-pin socket designed to be connected to a Sony off-air receiver/monitor. Either of these two inputs is switched via S201 to the input pins of board G1 where it is split into four separate video feeds. These will be described in the order that they appear to the video input signal.

The first is to transistor Q11 which is an emitter-follower providing isolation between the input sockets and the following chrominance filter. Chrominance information is removed by this filter and the remaining luminance signal is coupled to the electronic switch Q13 and Q14. A second signal to this switch is taken directly from the video input, and will therefore contain any chrominance information present. Colour sensing circuits on the G2 board make the electronic switch select either the filtered monochrome

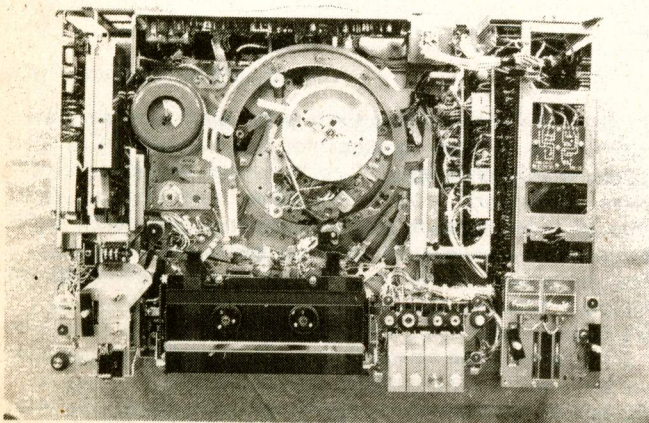


Interior view with all the main panels removed.

signal or the full bandwidth colour signal depending on the presence of burst on the sync pulse back porch. The selected output from the electronic switch is then fed to a video a.g.c. circuit. A third feed from the video input drives a sync separator which provides delayed line pulses for the video a.g.c. circuit, field pulses which are used to lock the head drum servo in the record mode and to provide a control track record signal, and finally a third feed which is used as a burst gating signal for the colour sensor on the G2 board. The final video input path on the G1 board is simply linked through to the colour sensor without passing through any electronic processes.

Before considering the major processing operations carried out on the G2 board we'll look briefly at the video a.g.c. circuit which is used to control the amplitude of the signal applied to the f.m. modulator. It's basically a gated a.g.c. system but contains some rather novel ideas which in practice work extremely well.

The circuit, shown in Fig. 2, consists of an a.g.c. level control stage (Q7), a video amplifier (Q8 and Q9), and a voltage doubler (D2 and D3). The selected video output from the switch previously described is coupled via C15 and R28 to the drain of f.e.t. Q7 which forms part of a potential divider between the incoming video feed and chassis. This potential divider is formed by the drain/source resistance of the f.e.t., R26 (set a.g.c. level) and R25. The load presented to the video input signal between the drain of the f.e.t. and chassis can be adjusted either by altering the value of R26 or by altering the drain/source resistance of the f.e.t. This drain/source resistance is controlled by



Interior view of the machine.

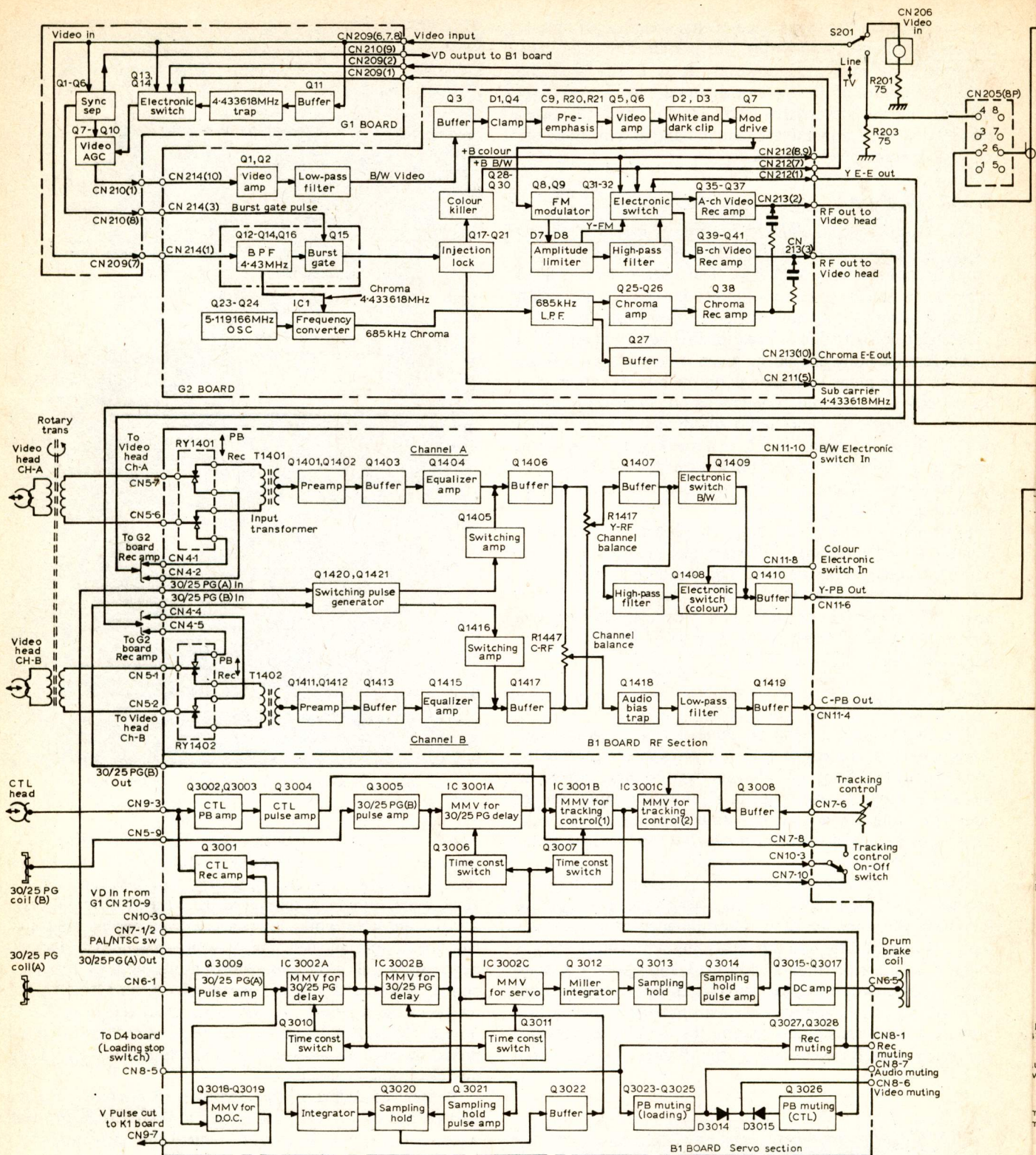


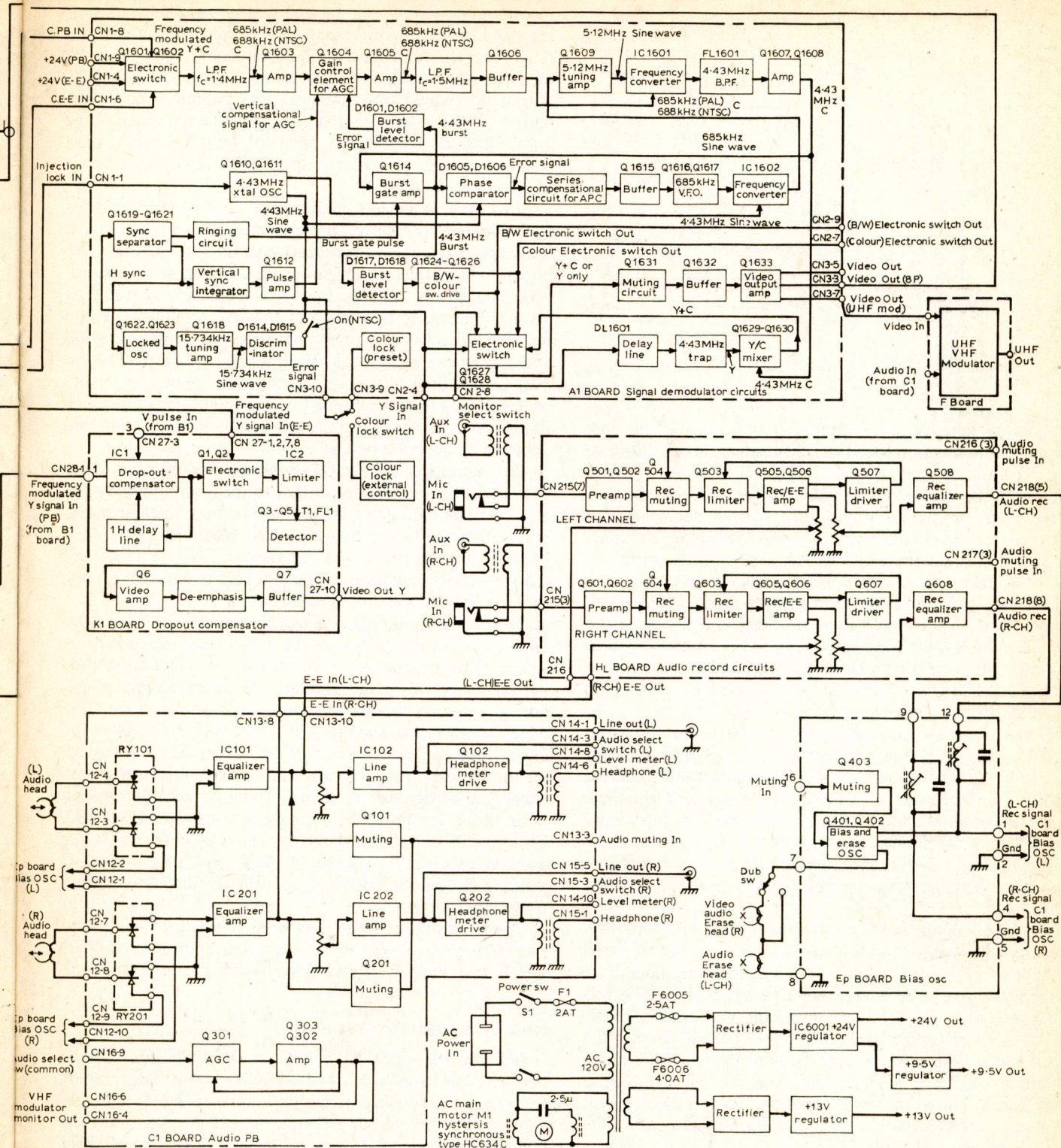
Fig. 1: Block diagram of the Sony VCR

Some of the abbreviations used in the block diagram above may not be too clear to those not familiar with VCRs. The following list may help: CTL control head, amplifier etc.; PG pulse generator; MMV monostable multivibrator; DOC dropout compensation; Y-PB luminance playback; C-PB chrominance playback; E-E mode, record monitoring path. The operations carried out by the various boards are as follows:

G1 board: Video input, a.g.c. and sync circuit which provides a burst gating pulse for the G2 board and a reference pulse for the servo section of board B1.

G2 board: Provides r.f. signals for the video recording heads and E-E outputs.

B1 board (r.f. section): Initial playback circuits, providing



V01810 videocassette recorder.

luminance and chrominance outputs.

B1 board (servo section): Servo control system.

K1 board: Dropout compensation and luminance f.m. demodulation.

A1 board: Accepts chrominance from the B1 board and demodulated luminance from the K1 board. Signal processing to provide video output signals.

F board: Modulator board. Converts video to v.h.f. and then to u.h.f. for output to the receiver.

HL board: Audio recording circuits.

C1 board: Audio playback circuits.

Ep board: Bias and erase oscillator board. One erase head covers the video and right audio channel tracks, the other the left audio channel track.

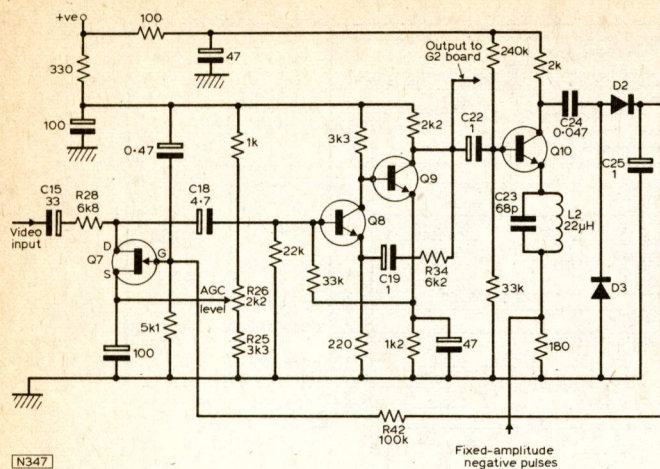


Fig. 2: The video a.g.c. circuit on the G1 panel.

applying a positive d.c. voltage to the gate. If the gate voltage becomes more positive, the drain/source resistance will decrease. In consequence there will be a lower resistance between the incoming video signal and chassis, thus attenuating the signal. If the gate voltage decreases, the drain/source resistance will increase providing a higher resistance to the video signal resulting in less attenuation.

The gain-corrected video signal from the f.e.t. is fed via C18 to the base of the common-emitter amplifier Q8 which in turn feeds Q9. Heavy negative feedback is applied from the collector of Q9 via R34 and C19 to the emitter of Q8 to maintain the wide bandwidth of the signal. The output from the collector of Q9 is fed to the output of the G1 board and also to the input of the a.g.c. detector.

Q10 acts as a common-emitter amplifier for the input signal at its base, the emitter being tuned at subcarrier frequency by C23 and L2. This tuned circuit applies current negative feedback to the transistor at subcarrier frequency, thus attenuating the burst on the sync pulse back porch and the picture chrominance content of the input signal. The positive-going video at the base of this transistor appears inverted at its collector, i.e. positive sync pulses and negative video.

A second signal is applied to the emitter of Q10. This consists of a fixed-amplitude negative pulse which is timed to appear on the back porch. Q10 acts as a grounded-base amplifier to the pulse which therefore appears in the same polarity at the collector of the transistor, i.e. negative going. Hence the waveform at the collector of Q10 will consist of a video signal with positive syncs and negative video, added to which will be a negative pulse on the line sync pulse back porch. The fixed amplitude of this pulse is so set that it is always more negative than the maximum peak white content of the video signal.

These combined signals are coupled via C24 to the voltage-doubler circuit D2, D3, C25. The resulting d.c. voltage stored by C25 will be equal to twice the peak amplitude of the video input to the voltage-doubler circuit. As the most negative input is the fixed-amplitude added pulse, and the most positive input is the sync pulse amplitude, the resulting d.c. voltage is proportional to the amplitude of the incoming sync pulses. Picture content variations will not affect the a.g.c. voltage thus developed since they will always be lower in amplitude than the inserted negative pulse. Hence the circuit is immune to picture variations and is sensitive only to amplitude changes. The a.g.c. voltage is coupled via R42 to the gate of the gain-controlling f.e.t. Q7.

From this point onwards the techniques employed in the

record mode follow standard videotape recording technology and do not therefore require a detailed circuit description. The gain-controlled video signal from board G1 is fed to a two-stage amplifier (Q1 and Q2) on board G2. Q2's output is coupled to a low-pass filter which removes the higher video frequencies that lie outside the passband of the VCR. If these frequencies were not removed they would produce moiré patterning when the video signal was frequency modulated.

Now that the video signal has been band limited it is fed to Q3, an emitter-follower incorporating a gain control in its base circuit to enable the deviation of the f.m. modulator to be set. Q3's output is clamped using simple sync tip restoration. This allows the sync tip d.c. voltage to be preset, thus setting the carrier frequency of the f.m. modulator. From here the video signal is pre-emphasised and amplified by Q5 and Q6 before being peak white limited by D2 to prevent over-modulation of the f.m. carrier. The dark clip facility provided by D3 prevents the f.m. modulator being deviated below its carrier frequency by any negative information that could lie below the sync tips.

The modulator driver Q7 is an emitter-follower which provides a low-impedance output to the f.m. modulator Q8 and Q9. The modulator consists of the usual astable multivibrator, with the modulating video signal applied to the bases of the two transistors. By varying the base voltage of the transistors a change in the d.c. bias is caused, altering the frequency of the output squarewave.

The frequency-modulated signal from Q8/Q9 is fed to an amplitude limiter which clips the bottom and top of the f.m. signal, thus producing a waveform free from amplitude variations. At this point there are two possible signal paths, one which goes directly to switch Q31/Q32, and the other which is applied to the input of a high-pass filter. Here the lower-frequency components of the f.m. signal are removed, making room for the 685kHz frequency transposed chrominance signal to be added. The high-pass filter output is fed to the second input of the electronic switch Q31/Q32. This switch is controlled by the same buss bars that are used in module G1, hence the high-pass filter output is selected for colour operation and the direct limiter output for monochrome.

Once the output signal has been selected it is split into two feeds and coupled to the two record current amplifiers which drive their respective video heads.

Colour Signal Processing

Because the video bandwidth of the VCR does not go high enough to include the 4.433MHz colour information, frequency transposing of the chrominance signal is necessary so that the colour information can be fitted into the machine's passband. In this VCR a frequency of 685kHz has been chosen for the chrominance signal.

The direct video feed from board G1 is coupled to the input of a bandpass filter. This allows the chrominance frequencies to pass but blocks the luminance information. Also incorporated in this section is an a.c.c. circuit that samples the amplitude of the colour burst and uses a d.c. voltage derived from this to adjust the gain of a chrominance amplifier stage.

The output of the bandpass filter feeds two separate circuits, one a burst gate and the other a frequency converter (IC1). The burst gate is triggered by delayed line pulses from the sync separator on the G1 board, its burst output being used to ring a crystal tuned circuit operating at subcarrier frequency. Because the crystal is being rung by a colour burst at regular intervals the tuned circuit is able to

maintain subcarrier oscillation throughout the length of a TV line. The output of the injection lock stage therefore is a continuous subcarrier signal. This feeds a colour sensing circuit which operates the electronic switches previously mentioned. A second output from the injection lock stage is used to lock another subcarrier oscillator in the playback circuitry of the machine. This enables the stability of the off-tape chrominance information to be compared and locked to the video input to the machine. If there is no input to the VCR the oscillator Q1610/Q1611 (A1 board) will free run.

The second output from the bandpass filter is fed to the frequency converting i.c. which is in fact a balanced modulator using the chrominance input signal as a modulating signal. A carrier input is provided by a 5.119166MHz crystal oscillator which is operational only when a colour signal is being recorded. The output from this balanced modulator will contain all the mixing products between its two input signals, therefore a low-pass filter tuned to 685kHz is required to reject the unwanted output frequencies, passing just the subtractive frequencies.

Two signal feeds are produced at the output of the low-pass filter: one is fed to the emitter-follower Q27 which provides an E to E output for the A1 board; the other feed is amplified by Q25 and Q26 and applied to the chroma record drive amplifier Q38. Here the signal is again increased in level so that enough power is produced to drive the video record heads. Sony have adopted the standard technique of using the video f.m. signal as h.f. bias for the transposed chrominance signal.

The complete frequency spectrum of the signals applied to the video record heads is shown in Fig. 3.

Audio Recording

There are two separate audio channels which are identical. Only the left channel will be described in the following description.

Either an auxiliary or microphone input signal is selected and fed to the first section of the audio processor, a preamplifier comprising Q501 and Q502. This is a simple two-stage audio amplifier which increases the signal level, enabling the audio muting stage to be driven. This stage, transistor Q504, is a simple shunt switch across the audio feed. It removes the audio signal in every mode apart from record. This action prevents the incoming audio signal being passed through the electronics in the E to E mode and appearing at the audio output when the machine is in the stop or wind modes. It should be noted that when the machine is being used for audio dubbing the right hand channel is muted.

After the record muting switch a simple a.g.c. limiter is used to compensate for high audio levels that would cause the head to saturate the tape and produce distortion. The control signal for this limiter is derived from a simple half-wave rectifier and smoothing circuit which is fed with the audio signal – it's very similar to the conventional limiter used in audio recorders.

The next stage after the limiter is the combined record/E to E amplifier. This stage has two audio outputs. One is sent via a potentiometer to the record equalising amplifier Q508 and from there to the audio head. The second audio feed goes via another potentiometer to the line amplifier IC102 on the C1 audio playback board. This second audio path enables the operator to monitor the audio output of the machine while a recording is being made.

An audio bias and erase oscillator is situated on the Ep board, the bias oscillator being inhibited by Q403 in all

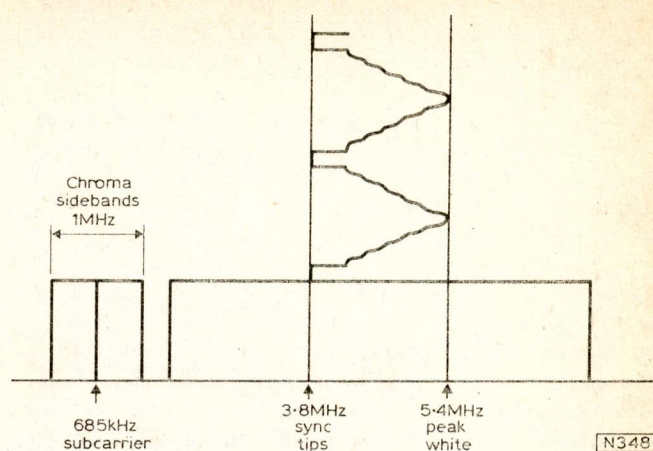


Fig. 3: Frequency spectrum of the recorded signal.

except the record mode. The oscillator output is split into two feeds. One supplies an erase signal for the two erase heads. The other is added as h.f. bias to the output of the record equalising amplifier Q508.

Audio Playback

The off-tape audio signal from the playback head is coupled to the record playback change over relay RY101. This relay switches either the record or playback signal between the head and the audio electronics. In the playback mode the common switch is connected to the black contacts, coupling the signal to the equalisation amplifier IC101. The signal at the output of this amplifier is applied to the playback level control and from here to the line output amplifier IC102. The playback muting circuit Q101 can ground this coupling feed between IC101 and IC102 when the machine is either lacing or unlacing the cassette. This prevents random audio information from the tape appearing at the output of the VCR during tape lacing.

As well as being fed to the output of the machine the audio signal is coupled to an emitter-follower which drives the headphone output transformer and the record/playback level meter. The direct line output feeding the socket at the rear of the machine is taken directly from the output of IC102.

Finally in the audio playback path we have Q301 (a.g.c.) and Q302/Q303 (audio amplifier). These two sections are connected to a switch which selects L, R, or L+R signals, these being gain controlled in the normal way and then fed to either the u.h.f. modulator or the monitor output point.

Video Playback

The f.m. signal from the two video heads mounted on the drum is coupled to the main board B1 via two rotary transformers. The output from the secondary of these transformers is connected to a record/playback switching relay RY1401/2. From this point to the output buffers Q1406 and Q1417 the f.m. playback path is identical for each head, therefore only one head channel will be described.

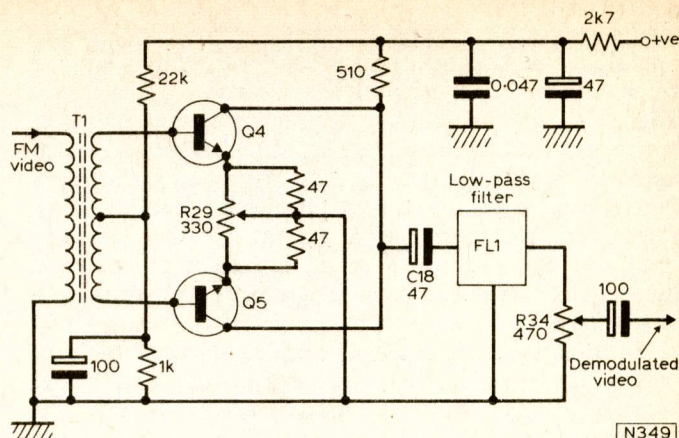
Head switching relay RY1401 is energised in the record mode. In the playback mode the signal is coupled from the head to the input matching transformer T1401. The secondary of this transformer is coupled to a preamplifier Q1401/02. These components form a low-noise cascode amplifier with an f.e.t. driving the common-base section. An emitter-follower Q1403 matches the high output impedance of this amplifier to the equalising amplifier Q1404. This is a

Between the equaliser Q1404 and the emitter-follower Q1406 there is a switching transistor Q1405 which shunts the output of the equaliser to earth when the head is not scanning the tape. The bistable circuit Q1420/Q1421 produces the switching pulses for Q1405/Q1416: they are timed so that as head (a) is scanning the tape Q1416 is conducting, and as head (b) scans the tape Q1405 conducts. This switching action prevents noise generated in the playback path while the head is scanning fresh air being added to the signal from the head that is scanning the tape. Pulses to steer the switches are derived from the tape servo section. The outputs from Q1406 and Q1417 are combined across two variable resistors R1447 and R1417, and from the sliders of these two controls f.m. signal feeds are supplied to the monochrome and the colour vision processing circuits.

Q1407 acts as a buffer which drives an electronic switch and a high-pass filter. During monochrome operation the series switch Q1409 is "closed" and the f.m. signal is coupled directly to the output buffer Q1410. When the colour mode is selected Q1409 becomes open-circuit and Q1408 conducts, coupling the output from the high-pass filter to the buffer Q1410. This high-pass filter is designed to remove any transposed 685kHz chrominance information. The output from board B1 is coupled directly to board K1 which contains the dropout compensator.

Following dropout compensation the signal is fed to yet another electronic switch. This selects either the output from the dropout compensator or from the f.m. modulator on board G2. In the playback mode the dropout compensator output is selected while in the record mode the modulator output is passed through. This enables the operator to view the signal being recorded at the output of the machine. E to E signals are very helpful to the operator because, having passed through most of the electronics in the VCR used in both the record and playback modes, they enable an accurate check to be made of the performance of the equipment.

The f.m. signal is applied to the primary of transformer T1, appearing in push-pull across the centre-tapped secondary winding. Q4 and Q5 are so biased that Q4 conducts on the positive half cycles and Q5 on the negative half cycles, the exact conduction point of the transistors



being set by R29. The full-wave rectified signal at the collectors of the two transistors is capacitively coupled via C18 to the low-pass filter FL1 where it is integrated. This action produces a voltage output proportional to the frequency of the pulse input. As the input pulses are negative-going the output of the low-pass filter will be at its maximum negative voltage when the carrier frequency is high, thus producing a negative-going video output signal.

Colour Playback Path

The signal then goes to the main chrominance processing board A1, where it is retransposed back to 4.43MHz and added to the luminance signal. The first stage of chrominance processing is to select either the off-tape or E to E chrominance signal, the off-tape signal coming from Q1419 on board B1 and the E to E signal from Q27 on board G2. The electronic switch Q1601/Q1602 selects the required signal and feeds it to a low-pass filter which removes all frequencies above 1.4MHz.

During the field sync period the colour burst is not transmitted and the a.c.c. amplifier is then inhibited by a field

sync pulse from Q1612. If this was not done large errors would be caused by the absence of the colour burst, and the time taken for the circuit to settle down would exceed the length of the field blanking period.

The amplitude controlled signal from Q1604 is further amplified by Q1605 before being fed to a low-pass filter with a cut-off frequency of 1.5MHz. This filter removes any signal that could be present above the chrominance frequency range. The band-limited output from this filter is fed via the emitter-follower Q1606 to the frequency converting i.c. IC1601. This i.c. reconverts the 685kHz off-tape chrominance signal to 4.433MHz. This is done by using the 685kHz signal as the modulating input and a 5.12MHz signal as the carrier input to a balanced modulator in the i.c. The signal produced will contain subtractive components that lie at the true chrominance frequency of 4.433MHz. Once the off-tape chrominance has been reconverted to its correct frequency it's fed to a 4.433MHz bandpass filter before being coupled to Q1607/Q1608 to produce an amplified output signal.

The 5.12MHz carrier input to the frequency converting i.c. is derived by beating two signals together, one at 4.433MHz and the other at 685kHz. This frequency mixing is carried out in IC1602, the 4.43MHz carrier input being provided by the crystal oscillator Q1610/Q1611 which is locked by the inject lock circuit we described when dealing with the record mode, the second input coming from the oscillator Q1616/Q1617. This 685kHz input signal is produced by the variable frequency oscillator Q1616/Q1617 which is controlled as follows. The phase of the 4.433MHz off-tape chrominance colour burst is compared with the stable frequency of the crystal oscillator Q1610/Q1611 in the comparator D1605/D1606. The resulting d.c. error signal is amplified by Q1615 which controls the variable frequency oscillator Q1616/Q1617.

Correction of off-tape phase errors produced by variations in the head to tape speed is automatically compensated in the following way.

If the off-tape colour burst frequency or phase increases, the reference burst to the burst gate amplifier Q1614 also increases. The resulting d.c. error signal from D1605/D1606 advances the phase/frequency of the 685kHz oscillator, in turn advancing the output of IC1602. Because one of the inputs to IC1602 has risen then the resultant beat frequency at the i.c. output will also rise. We now have a situation where both the inputs to IC1601 have risen by exactly the same amount. Therefore the *difference* frequency between the two will remain the same, i.e. 4.433MHz. Should the off-tape chrominance frequency fall then the reverse procedure will take place.

Output Signal Switching

The machine automatically selects the correct output signal path. When colour operation has been established, the colour burst output from Q1614 is detected by D1617/D1618 and amplified by Q1624/Q1626 to produce push-pull switching voltages for the electronic switch Q1627/Q1628.

When monochrome operation has been established, the luminance output from the K1 board is passed by the switch to Q1631. This stage shorts the signal to chassis when the machine is either lacing or unlacing the tape. At all other times it's open-circuit. From here the signal passes via the emitter-follower Q1632 to the output amplifier Q1633.

When a colour programme is being replayed the luminance output from board K1 is passed through the

short-duration delay line DL1601 which compensates for the delay of the chrominance processing circuits due to their narrow bandwidth. The output from DL1601 is fed via a chrominance trap to the mixer stage Q1629/Q1630, where the corrected chrominance signal is added to the luminance information to produce the complete video signal. From the mixer the complete signal is fed to the second input of the switch Q1627/Q1628 and then via the signal path previously described to the output of the machine.

A manual over-ride to the electronic switch is provided so that the operator can if he wishes remove the chrominance information if a monochrome monitor is being used to display the output of the machine.

Pulse Generation

During colour operation additional pulses are required to operate the burst gate, a.g.c. and NTSC stages of the VCR. These pulses are produced in the following way. The off-tape luminance signal from board K1 is coupled to the sync separator stage Q1619-Q1621. One output from this stage is coupled to a low Q ringing circuit which delays the line pulses to produce a burst gating pulse for Q1614. The other output is fed to an integrator circuit whose output is amplified by Q1612 before being used as a field blanking pulse for the a.g.c. stage Q1604.

NTSC Operation

Throughout the service manual there is no mention at all of the NTSC sections of the machine, and everyone the author has questioned on this topic has just replied with a blank face or "your guess is as good as mine"! So the following description owes something to surmise.

The VCR is designed only to playback prerecorded NTSC tapes to a colour TV receiver which is capable of receiving a 30 f.p.s., 525-line NTSC signal whose chrominance frequencies have been transposed to 4.433MHz.

When an NTSC tape is recorded the chrominance signals are transposed down to 688kHz instead of 685kHz which is used for PAL signals. To reconvert this signal to 4.433MHz in the playback process the output of the frequency converter IC1602 has to be increased from 5.12MHz to 5.121MHz so that the difference frequency between 5.121MHz and 688kHz remains 4.433MHz. To change the output frequency of IC1602 accurately, the oscillator Q1616/Q1617 has to run at 688kHz instead of 685kHz. This is achieved by adding an offset d.c. voltage to the phase comparator D1605/D1606 that controls the oscillator frequency. This d.c. voltage is derived in the following way.

The 525-line line sync pulses from the sync separator Q1619-Q1621 are used to lock a line frequency oscillator whose output is tuned by the amplifier Q1618. The tuned output at 15.734kHz is then fed to an a.f.c. discriminator D1614/D1615 whose centre frequency is set to the 625-line frequency of 15.625kHz. Hence when the VCR is operating with a PAL signal the output of the discriminator is zero, but when the standard is changed to NTSC a d.c. voltage caused by the change in line frequency is produced. This is added to the input signal of the phase comparator D1605/D1606 as the offset voltage. The colour lock controls enable this d.c. voltage to be adjusted manually so that accurate subcarrier phasing can be achieved.

The tape path together with the servo and control systems of the Sony VCR will be described in a following issue.