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VERSATILE LINE CLAMP AMPLIFIER

INTRODUCTION

WHENEVER A TELEVISION SIGNAL is transmitted between two points some degradation occurs. The amount and types of distortion depend upon the nature and length of the path between the two points. The signal at the input to any path should be of the highest possible quality, but at the receiving end, correction may have to be made for high-frequency attenuation, low-frequency disturbances and noise due to long transcontinental or satellite paths. The addition of colour information to the signal emphasizes the need for signal processing to ensure acceptable standards. An examination of the facilities required for processing equipment suitable for use at either end of a signal path reveals many basic functional requirements which have been taken into account in the design of the semi-conductor Line Clamp Amplifier.

GENERAL

All solid-state active devices, including considerable use of both linear and digital integrated circuits, enable this Line Clamp Amplifier to provide an extensive range of facilities in a relatively small space. There are two fundamental versions of the equipment:

1. The Line Clamp Amplifier with Pulse Reshaping, (Fig. 1), provides synchronizing pulse insertion on synchronous signals and is suitable for use within the station or studio where local synchronizing and blanking pulses are available.

2. The Line Clamp Amplifier with Pulse Regeneration (Fig. 2) provides complete regeneration of all pulses from the incoming signal, and, therefore, is suitable for use at any point in the signal path.

The equipment consists of thirteen individual modules, from which a large number of useful combinations can be assembled.

BASIC FACILITIES AND PERFORMANCE

The power supply provides positive and negative 12V supplies to operate the modules. Should either of these two supplies fail the front panel indicator lamp is extinguished. Mains input voltages within the ranges 100V to 125V and 200V to 250V (50–60Hz) can be accommodated.

The synchronizing pulses are obtained from the incoming signal before any video processing operations (except equalization) take place. The unit functions over a range of input levels from +3dB to

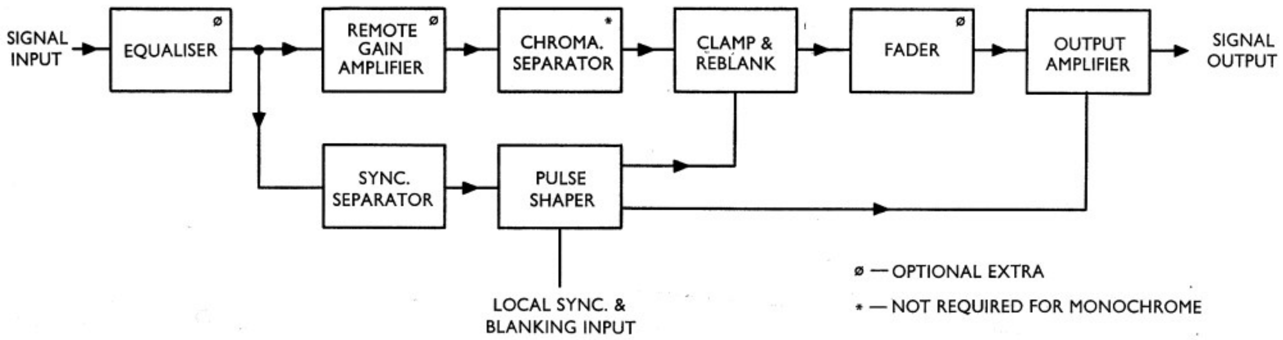


Fig. 1. Simplified block diagram of Line Clamp Amplifier with Pulse Reshaping.

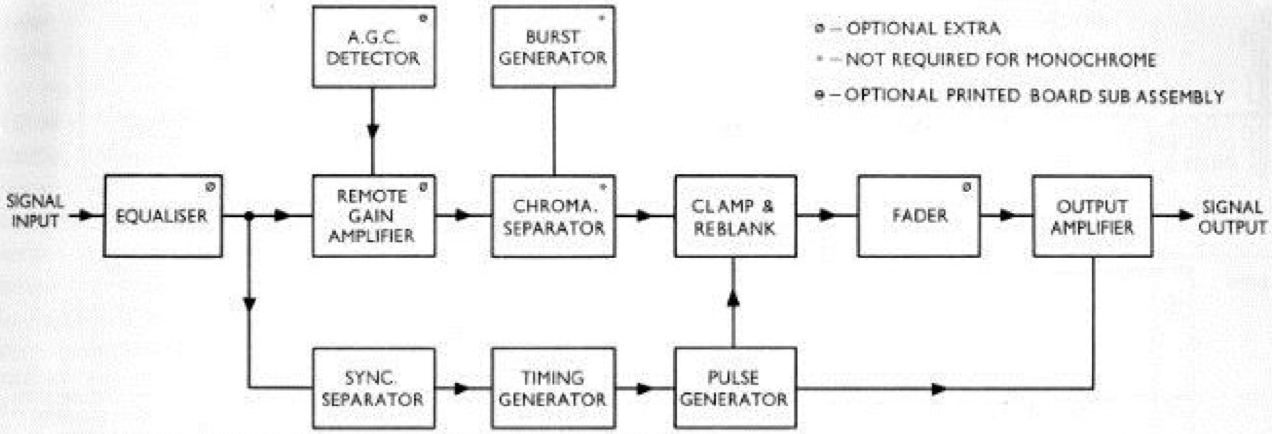


Fig. 2. Simplified block diagram of Line Clamp Amplifier with Pulse Regeneration.

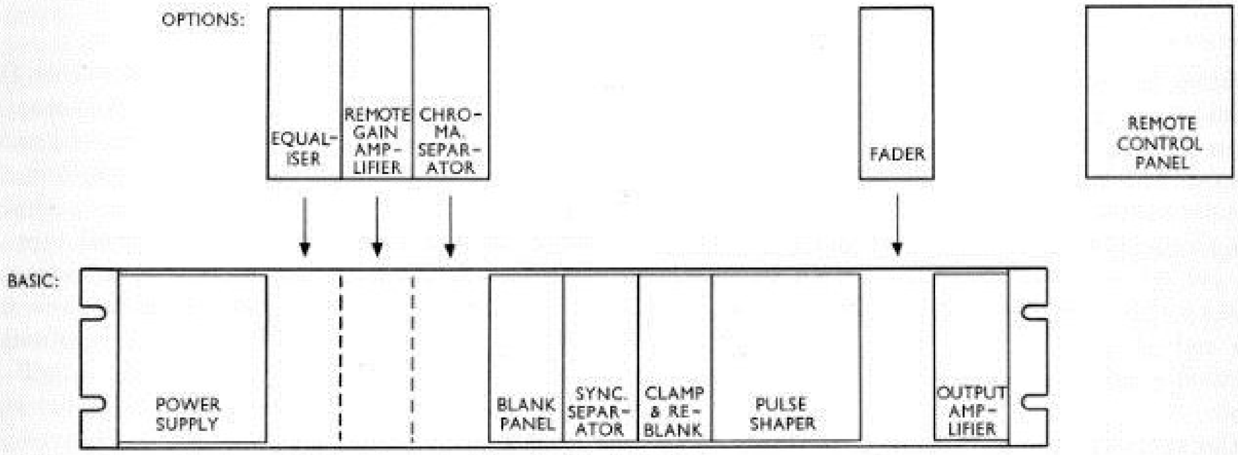


Fig. 3. Simplified assembly diagram for Line Clamp Amplifier with Pulse Reshaping.

−15dB relative to a standard 1V signal and will accept picture to synchronizing pulse ratios between 1 : 1 and 8 : 1 over this range. In order to be able to handle the consequent wide variation of synchronizing pulse amplitude, an automatic gain control amplifier is used in the synchronizing pulse channel.

The clamp included, provides either 20dB or 30dB hum reduction at 50Hz (slightly less at 60Hz), selectable by a switch on the equipment or alternatively on a remote control panel. Peak white-and-black level clippers are adjusted by preset controls on the module front panel. The peak white clipper covers the range of 80% to 150% of nominal peak white amplitude and the black level clipper 10% of video to 130% of synchronizing pulse amplitude. Adjustment of set-up covering ±10% is provided on both the equipment and the remote control panel. This facility, in addition to providing set-up on an outgoing signal, can remove set-up, if desired, from an incoming signal. The signal is reblanked during the blanking period and this removes noise and the original synchronizing pulse in preparation for insertion of a regenerated or reshaped synchronizing pulse.

There are three direct coupled outputs from the Line Clamp Amplifier having black level set at earth potential by means of a clamp circuit. A gain control is provided allowing the output signal to be set between −1dB and +6dB relative to 1V level. When the unit is set to the 'by-pass' position, the input signal is fed directly to one of the output sockets. A white reference pulse during field blanking can be added to permit the use of automatic gain control amplifiers in the following pieces of equipment.

PULSE GENERATION AND SHAPING

The Line Clamp Amplifier with Pulse Regeneration utilizes the Timing Generator and Pulse Generator modules to derive synchronizing, blanking, burst gating and sundry other pulses required by the equipment. This is achieved by phase locking a multivibrator running at twice the system line frequency and then counting, by means of decade and binary

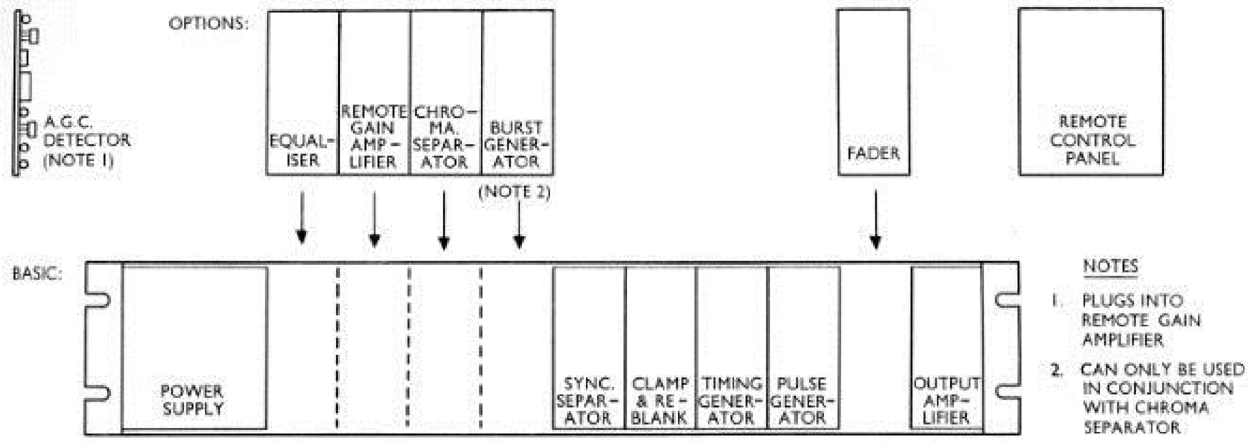


Fig. 4. Simplified assembly diagram for Line Clamp Amplifier with Pulse Regeneration.

dividers, to obtain the various waveforms required. Blanking can be modified during the field interval to allow vertical interval test signals to be passed or deleted. This pass/delete facility will cover any consecutive number of lines up to a maximum of six and has a variable position starting on any line between 16 and 20 inclusive. The white reference pulse, if added to the output, occurs on the first line following the end of the vertical interval test signal pass position whether set to either the 'pass' or 'delete' mode.

One module replaces the pulse regeneration modules in the version of the Line Clamp Amplifier with Pulse Reshaping. The shaped synchronizing pulses added to the output may be derived from either local or separated synchronizing pulses. Some of the optional modules, for example the Automatic Gain Control Detector and Burst Generator, require certain special pulses for their operation. Since these pulses are unobtainable from the Pulse Shaper it is not possible to use these optional modules other than on the pulse regeneration versions of the Line Clamp Amplifier.

The synchronizing pulse rise time on the output video is generally $0{\cdot}25\mu s \pm 0{\cdot}05\mu s$ approximately skew symmetrical. The exception to this is in a simple Video Processor version which is available by omitting the pulse processing modules. In this either the original synchronizing pulses are preserved intact or removed by the black clipper and substituted by unshaped separated synchronizing pulses.

OPTIONAL FACILITIES AND PERFORMANCE

Additional facilities can be added to any version of the Line Clamp Amplifier at any time.

Equalization

Two types of frequency equalization are provided. The first has a characteristic which closely approximates to the inverse of the loss occurring in a coaxial cable. This equalization is variable up to the equivalent of a thousand feet of colour-grade cable, or a shorter length of lower-grade cable. The second type of equalization is a general purpose one, consisting of two variable gains, both with variable onset frequencies. This allows a wide variety of equalization characteristics to be obtained (up to +10dB at 10MHz) to compensate for other losses not conforming to the simple cable law.

Remote Gain Amplification

Normally the output from the Line Clamp Amplifier is required to be at standard level. To achieve this over a wide range of input levels, a Variable Gain Amplifier is used. This module has continuous adjustment between −3dB and +9dB, together with a front panel switch providing an additional +6dB, making a total gain range of −3dB to +15dB. The variable adjustment is alternatively available on the remote control panel.

Operation on Colour Signals

For colour signals, the chrominance and luminance components of the incoming waveform are separated, by means of a filter network, so that the two components may be processed independently. The chrominance signal is reblanked in order to remove noise during the blanking interval. An additional gating pulse allows the burst to pass through unaffected in versions not incorporating burst generation. An improvement in the burst is obtained in all circumstances since noise outside the chrominance band is removed by the luminance channel blanking. The same gating pulse also separates out burst to feed to the Fader and Burst Generator modules, when used. Separation of the chrominance components allows the luminance signal to be passed through the clamping and clipping stages which would otherwise seriously impair the colour information. The luminance and chrominance components are ultimately recombined to produce the output signal, compensation for any chrominance to luminance delay errors being provided by a variable luminance delay. An overall delay inequality of less than 5ns is attained.

Fading

Fading is accomplished by variation of a d.c control potential applied to a variable gain amplifier. If the signal contains a colour burst, it is kept substantially constant in amplitude by feeding burst alone into a second similar amplifier which is faded up as the other is faded down. The same technique is used to provide fixed set-up, when faded down, by adding a small amount of inverted blanking to the second amplifier input. Non-linearity of the fade does not exceed $\pm 10\%$ variation in the rate of change of fade over the major part of the range. The actual fade control must be provided externally, usually at the mixer control panel. It should be noted that fading the signal also fades the input vertical interval test signal although the white reference pulse, if used, is unaffected.

Remote Control

Front panel controls duplicated on the Remote Control Panel are: bypass, set-up, clamp speed, vertical interval test signal selection and remote gain. Two paralleled connectors are provided on the rear of the equipment, one to connect to the Remote Control Panel, and the other to connect to a Mixer Control Panel so that the fader and synchronizing pulse interlock (on the Pulse Shaper) can be operated. Obviously the Remote Control Panel facilities are only operational when the Line Clamp Amplifier version used includes the necessary modules.

Further facilities can be added in certain circumstances and the simplified module assembly diagrams, Figs. 3 and 4, show the various combinations for the two basic forms of the Line Clamp Amplifier.

Burst Generation

Burst generation to either the 525 NTSC standard or 625 PAL standard is achieved by using a phase-locked oscillator referenced to the incoming burst. Phase error is held to within 0·2° with NTSC and the mean error to within 0·3° in the case of PAL for a noise-free

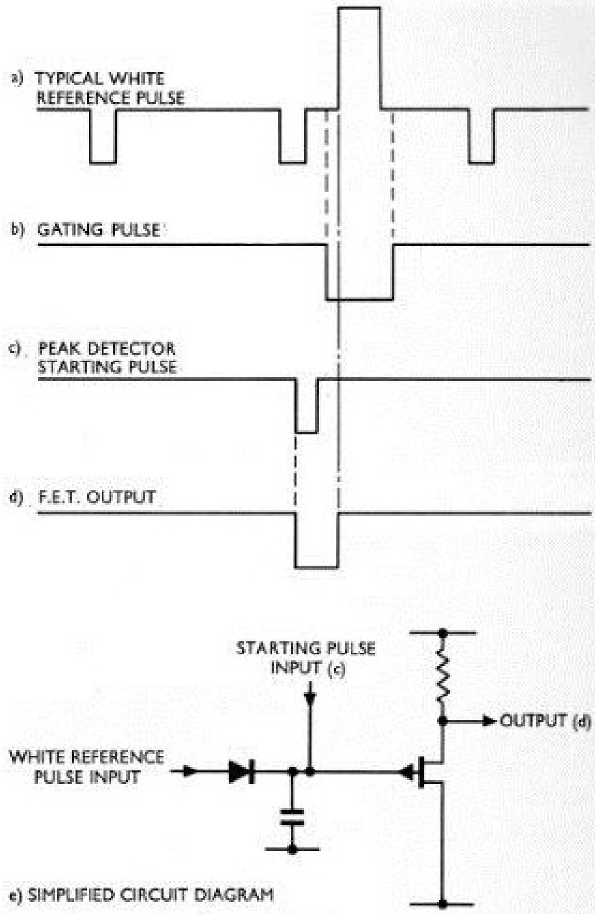


Fig. 5. Automatic Gain Control Detector.

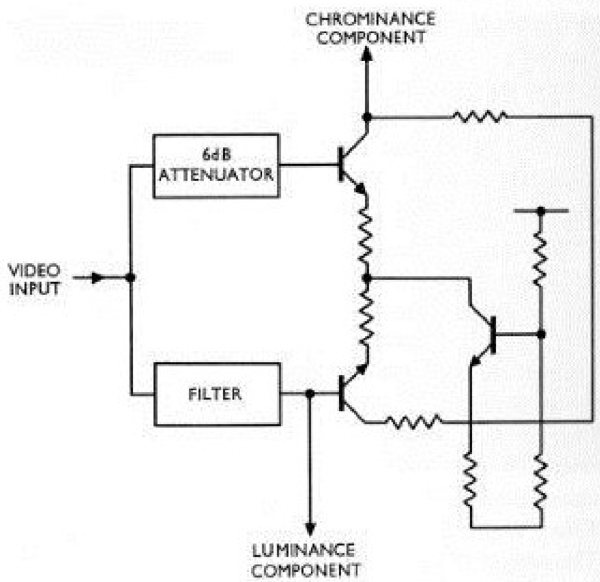


Fig. 6. Chrominance Separator.

standard level input signal. For PAL operation the 'swinging' burst is held to within $\pm 2°$ of the nominal $90°$ swing, and the correct burst field blanking sequence is preserved. If the incoming burst amplitude falls below -6dB with respect to standard level, or is removed as in a monochrome signal, the burst generator is automatically cut out and the original burst left on the signal.

Automatic Gain Control Operation

An automatic gain control system can be used in conjunction with the Remote Gain Amplifier module, into which it plugs. This operates by detecting the amplitude of a suitable reference white pulse on either an incoming vertical interval test signal or one generated by a similar Line Clamp Amplifier located at the sending end of a line. Output level variations are less than 2dB for an input range of $+3$dB to -12dB relative to standard level. In the absence of a reference white or when the signal falls below -16dB the gain reverts to manual control.

405-, 525- AND 625-LINE STANDARDS

The Line Clamp Amplifier will operate on the 405-, 525- and 625-line monochrome systems together with 525 NTSC and 625 PAL colour systems. Change of standard is accomplished by internal connections and change of subcarrier crystal where burst generation is used.

SOME CIRCUIT TECHNIQUES

Automatic Gain Control Detector

The adoption of a single reference white pulse only once per field for automatic gain control purposes, as shown in Fig. 5a, involves the generation of suitable gating pulses and high performance 'sample-hold' circuitry. From a field pulse produced by the Pulse Generator, the Automatic Gain Control Detector generates a pulse, which is adjusted, by front panel controls, to coincide with the white reference pulse (*Fig.* 5b). This pulse opens a gating circuit allowing the white reference pulse through to a peak detector. This peak detector has a very long time constant keeping the detected signal level constant throughout the ensuing field. Just before the next white reference pulse appears, a further locally generated pulse (Fig. 5c) prepares the peak detector for the next reference pulse. To enable a high impedance to be maintained at the peak detector, a p-channel Field Effect Transistor (FET) is used as a source follower. The output of the Field Effect Transistor (Fig. 5d) is smoothed and amplified before being fed to the Remote Gain Amplifier. A simplified circuit of the detector is shown in Fig. 5e.

Chrominance Separator

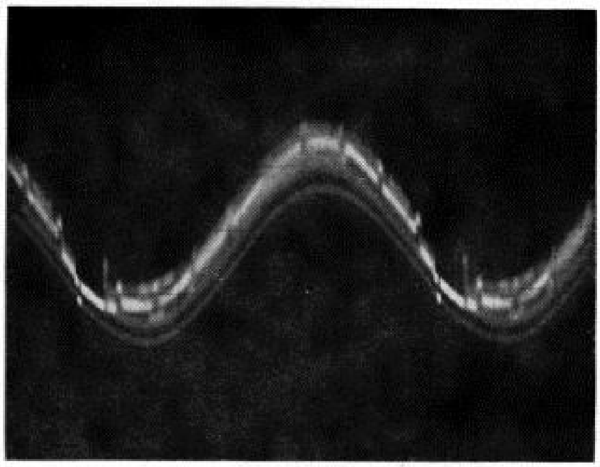
The video fed into the Chrominance Separator is split two ways, as shown in Fig. 6. The first path is fed through a filter removing the chrominance information and passing the luminance component to one side of a differential amplifier. The second path is fed through a 6dB attenuator, to compensate for the loss introduced by the terminated filter, before being fed to the other side of the differential amplifier. The output from the differential amplifier is fed to the chrominance channel, the luminance signal being obtained directly from the filter. Providing the two separate channels have equal delays and small losses, the output, after recombining the two processed signals in the Clamp and Reblank module, will faithfully reproduce the input signal. By suitable design of the filter circuits it is possible to deal with any subcarrier frequency, in the range 3·0MHz to 5·0MHz, encompassing both NTSC and PAL colour standards without circuit readjustments.

Synchronizing Pulse Separator

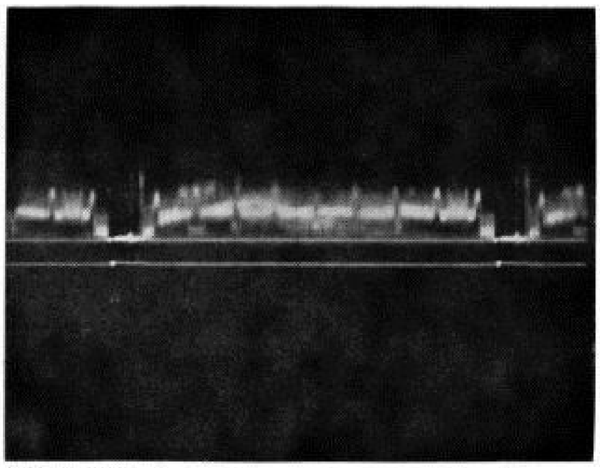
The video signal is clamped at black level during the back porch interval. The amplitude of the synchronizing pulse tips is then measured and compared to a reference voltage. The difference provides the control voltage to the Automatic Gain Control circuit which, in turn, keeps the synchronizing pulse amplitude substantially constant over a wide range. The separated synchronizing pulses are then fed through a delay network so that all pulses of less than $0{\cdot}5\mu s$ duration are removed, to give immunity against random interference pulses and noise. The resultant waveform is then used to trigger a monostable multivibrator, the period of which is greater than half-line but less than a whole-line duration. This gives additional rejection of interference pulses during the first half of each line, as well as removing the half-line pulses during field blanking. The resultant output is used to generate the clamp pulses for this and other modules.

OVERALL PERFORMANCE

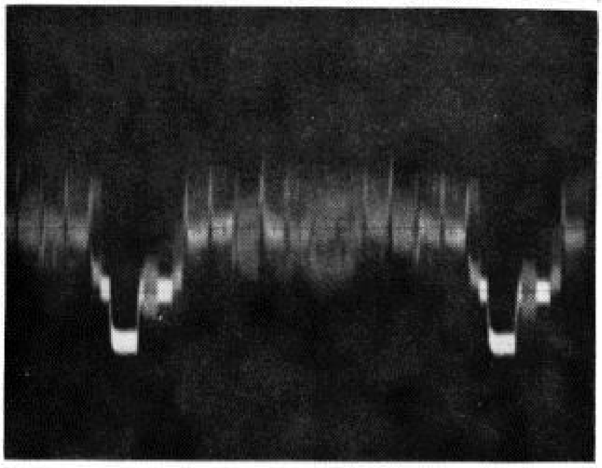
The Line Clamp Amplifier has been designed to operate over a temperature range of $-10°$C and $+45°$C. Silicon transistors are used except for the series regulator transistors in the power supply, which are germanium power types. Digital integrated circuits are used extensively for pulse counting and



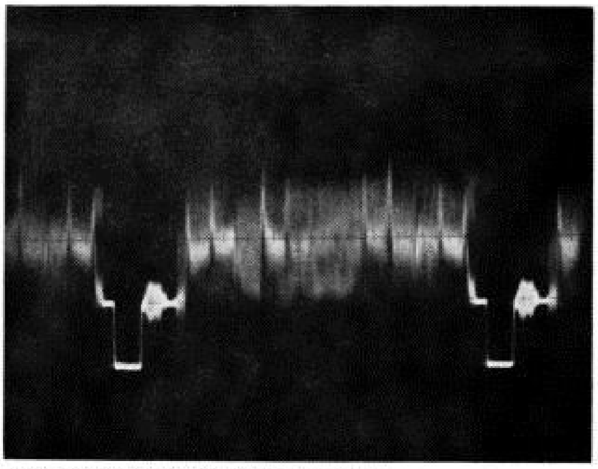
Input signal 1 volt P-P video plus 2 volt P-P 5OHz.



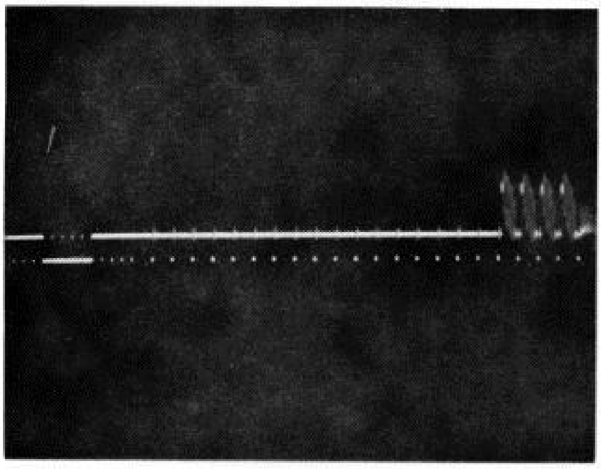
Output signal.



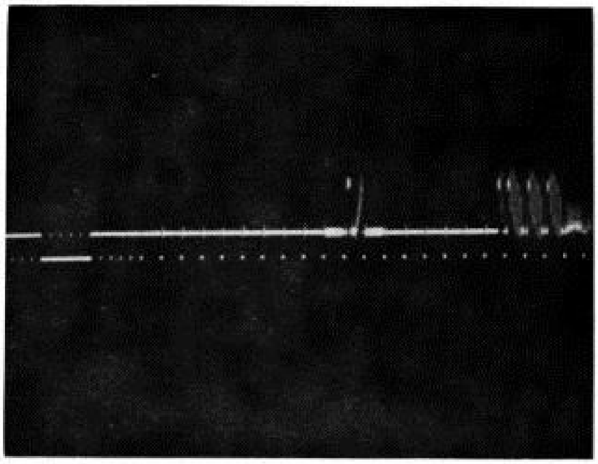
Input signal (test card).



Output signal with reblanking and regenerated syncs.



Output signal test signal removed.



Output signal test signal passed.

Fig. 7. Waveforms obtained with a Line Clamp Amplifier.

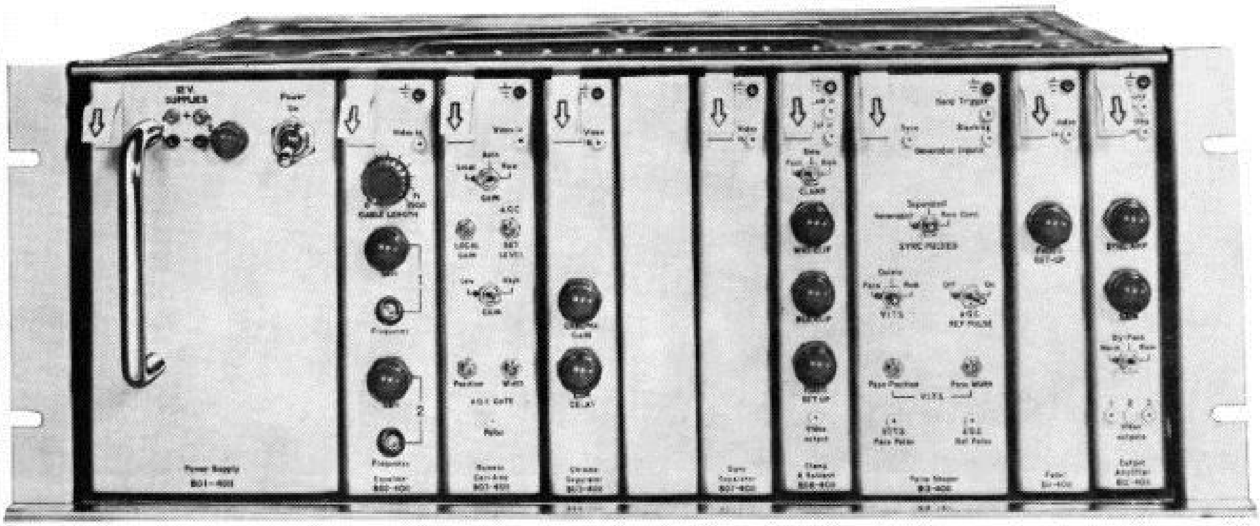


Fig. 8. Front view of Line Clamp Amplifier with Pulse Regeneration.

generation, and integrated circuit operational amplifiers where a high stable d.c gain is required as, for example, in the phase-locked loop of the Burst Generator.

The overall frequency response is ±0·2dB to 6MHz, falling by not more than 3dB to 10MHz, for all versions at standard level video signal. When operating with colour signal inputs the differential phase and gain distortions are typically 0·3° and 0·3% respectively.

The gain of the chrominance channel may be varied, over a range of ±3dB, to correct inequality relative to the luminance component. The signal path delay through the unit depends upon the version of the Line Clamp Amplifier being used, being in the range 40ns to 400ns. Fig. 7 shows actual waveforms obtained with a Line Clamp Amplifier.

CONSTRUCTION

The equipment is of modular construction and housed in a frame 7-in high in a standard 19-in rack (Fig. 8). The modules (Fig. 9) slide in the frame, plugging into connectors mounted on a printed wiring 'Mother' board at the rear. This provides the interconnections between the modules, as well as to the external control and signal sockets at the rear of the unit.

In the positions occupied by the optional modules, signal path continuity is maintained by reed switches. These are placed across the input and output connections of the appropriate socket on the 'Mother' board. Each reed switch is mounted on the 'Mother' board

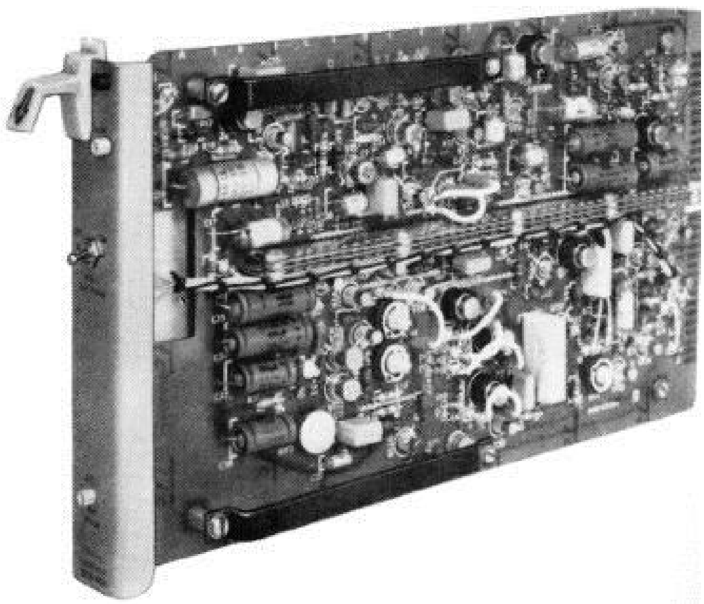


Fig. 9. Typical Line Clamp Amplifier module.

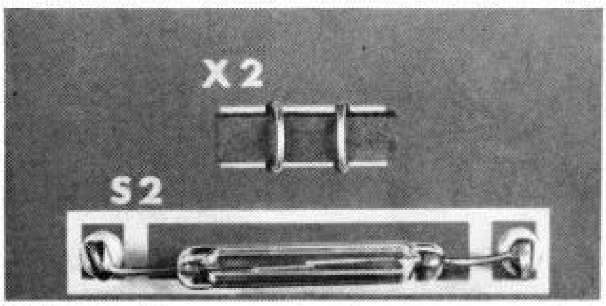


Fig. 10. Reed switch.

and has a permanent magnet adjacent to it (Fig. 10). The magnet, X2, normally biases the reed switch S2, to the closed position. Each optional module has a magnetic screen attached to it which comes between the reed switch and the magnet. Removal of the magnetic field opens the switch, thereby passing the signal through the inserted module. This facility enables a simple version of the Line Clamp Amplifier to be easily extended to a more complex version at any future time. It also allows interchange of optional modules between different units.

This procedure is slightly modified in the simple Video Processor version of the Line Clamp Amplifier where a link board is used in place of some modules.