SECTION 9

FIELD PULSE INSERTER UNIT UN1/505

Introduction

The Field Pulse Inserter Unit UN1/505 can be used to insert field pulses in the output of test generators such as the Sine-squared Pulse and Bar Generator GE4/504 and the Nonlinearity Test Signal Generator GE4/505. These generators can then be used to test apparatus, such as video-tape machines and camera channels, which can only function properly on a fully composite waveform. Although primarily intended for use with the two above-mentioned generators, the UN1/505 may be used with any generator of a line waveform that can be locked to a local source of mixed syncs or line-trigger pulses.

The inserter unit can be switched to operate on either the 405 or 525/625 line-standard.

General Description

The primary use of the UN1/505 is as a field pulse inserter unit, but it also has a secondary function as a waveform generator.

When used as a field pulse inserter unit, the UN1/505 removes the original line-sync pulses from the incoming video waveform and also removes the signal during the field blanking period. Then, by inserting pulses derived from mixed syncs and mixed blanking, the unit supplies a fully composite video output.

When used as a waveform generator, with inputs of mixed sync and mixed blanking pulses only, the unit supplies a composite video signal consisting of a full-width bar on every active line. The amplitude of this bar may be varied from below blanking level to white level by the operation of a *Lift* control on the front panel of the unit.

The unit requires supplies of mixed-sync and mixed-blanking pulses at 2 volts p-p and, when used in conjunction with a test generator, a line waveform at 1 volt p-p. There are two composite outputs; one is of normal polarity and has an amplitude of 1 volt p-p, the other is of inverted polarity and has an amplitude of −4·5 dB with respect to the normal output. The two outputs are interdependent, and if one is not being used it has to be terminated in 75 ohms to obtain the specified amplitude from the other.

Mechanical Description

The inserter unit consists of two chassis contained in a portable case constructed from Imhof framework. The signal chassis is mounted vertically at the front of the unit and the power supply chassis is mounted horizontally at the rear. Removal of the back panel gives access to the valves on both chassis while removal of the front and bottom panels reveals the components on the signal and power supply chassis respectively.

Overall dimensions are: height 16 in., width 17 in., depth $13\frac{5}{8}$ in. The weight is 26 lb.

Circuit Description (Fig. 19)

A block diagram of the unit is shown in Fig. 9.1. The sub-headings of the following description correspond broadly to the individual blocks of this diagram.

First Feedback Amplifier

The video input signal to the unit is applied to a three-valve feedback amplifier consisting of two cascode stages and a cathode-follower. Provision for adjusting the video input is made by using a 75-ohm variable resistor as the input termination. Negative feedback is applied from the cathode of V3 to the cathode of V1b via the feedback network C7, C6 and R16.

The d.c. component of the signal on the grid of V3 is maintained at black level by the double-diode clamp V8. Although the circuit of V8 is that of a conventional clamp it operates inside the feedback loop and the action of the circuit is such that the diodes merely restore a d.c. value to the signal at the grid of V3. The usual effect of a clamp, which is greatly to reduce the amplitude of any spurious l.f. waveform that may be superimposed on the video signal, does not take place.

The grid of V3 is effectively returned to the junction of R100 and the *Lift* control, RV3. This control, by varying the grid base of V3, varies the current through the valve and thus the amount of lift superimposed on the signal at the cathode.

Mixed-blanking Gate

The mixed-blanking pulses are amplified by TR1 and a large positive-going pulse is applied to the base of TR2. The collector of TR2 is taken to the junction of R17 and R18, which form part of the cathode load of V3. When a positive pulse is applied to its base TR2 conducts and, for the duration of the pulse, the junction of R17 and R18 is effectively connected to the junction of the two Zener diodes ZD2 and ZD3; this junction is at a potential of 5 volts. A 5,000-μF capacitor is connected across ZD2 so that the a.c. signal at the junction of R17 and R18 is shorted to earth during line and field blanking periods; the line-sync pulses of the input waveform are thus removed.

Sync Pulse Amplifier and Clipper

Mixed-sync pulses are amplified by V9a and the resulting positive-going pulses are applied to the grid of V10b. Valve V10 operates as a cathode-coupled limiter or slicer circuit and clips the sync pulses prior to their insertion into the blanked video signal. Mixing is achieved by connecting the anode load of V10a to the junction of R22 and R23; these two resistors form the anode load

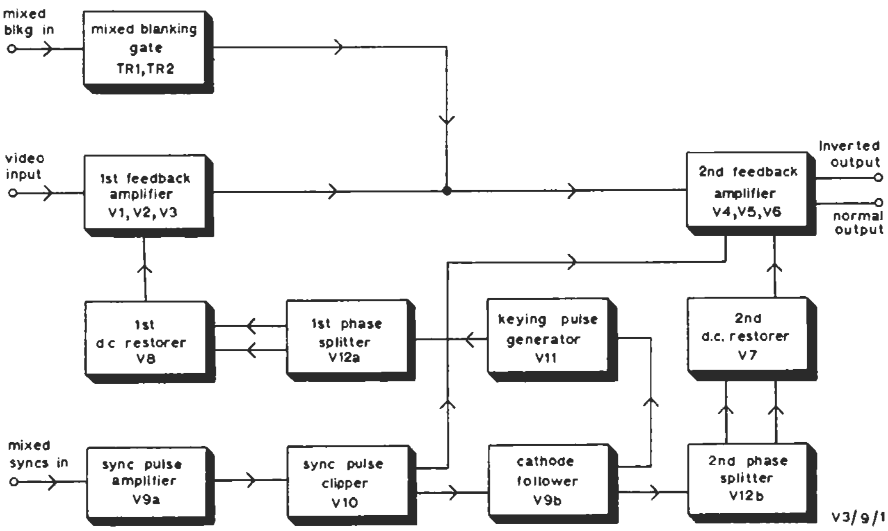

Fig. 9.1. Field Pulse Inserter Unit UN1/505: Block Diagram

of V4a and their values are chosen to provide an approximately correct picture-sync ratio, but fine control of sync-pulse amplitude is given by the *Sync Amp* control in the cathode circuit of V10.

Second Feedback Amplifier

The output of the first feedback amplifier, with the line-sync pulses removed, is d.c.-coupled to the second feedback amplifier. This second feedback amplifier is very similar to the first one. Sync pulses are reinserted at the anode of V4a and the signal at the grid of the output valve, V6, is d.c.-restored to sync bottoms by the double-diode clamp V7. As before this clamp operates inside the feedback loop and merely restores the d.c. component to the signal at the grid of V6.

Adjustment of the *D.C. Output Level* control, RV2, varies the potential to which the signal at the grid of the output valve is d.c.-restored and so allows the black level of the normal-polarity output signal to be set to zero volts.

Two outputs are taken from V6; the direct output from the cathode is of normal polarity and of 1 volt p-p amplitude; the output from the anode is of inverted polarity, is a.c.-coupled and has an amplitude, with respect to the normal output level, of —4·5 dB.

Cathode-follower and Second Phase-splitter

An output from the anode of V10a is differentiated by C29 and R67 and applied to the grid of cathode-follower V9b which operates as a buffer stage and supplies two outputs from its cathode. One output is applied to the multivibrator V11, the other is fed to the grid of the second phase-splitter V12b. The outputs from the anode and cathode of V12b are used to key the second clamp, V7.

Keying Pulse Generator and First Phase-splitter

The keying pulse generator consists of the astable multivibrator V11, the differentiating circuit C35-R79 and the clipper MR1. To ensure that the keying pulse, derived from the trailing edge of the multivibrator pulse, is delayed sufficiently to occur during the back porch period the width of the multivibrator pulse is adjusted to be 1 μs wider than the maximum width of the line-sync pulse. The negative-going pulses at the anode of V11b are differentiated by C35 and R79, the negative spikes are clipped by MR1 and the positive spikes are applied to the grid of the first phase-splitter V12a. The outputs from V12a are used to key the first clamp, V8.

Standards switching is carried out by switch B. This switch alters the values of the grid-leak resistors of V11a and V11b and so alters the operating frequency of the multivibrator.

Power Supplies

The power supplies used by the UN1/505 are:

1. 200-volt positive stabilised supply,
2. 15-volt negative stabilised supply,
3. 10-volt positive unstabilised supply,
4. 6·3-volt a.c. supply for power-supply valve heaters,
5. 6·4-volt a.c. supply for signal-chassis valve heaters.

The total power consumption is about 80 watts.

The 200-volt supply is derived from a 230-volt winding on T1; this is rectified by the full-wave bridge circuit MR2-MR5 and applied to the anode of the series stabiliser valve V13; the associated shunt amplifier consists of the two halves of V14 connected in cascode. C38 and R88 form a switching-surge protection circuit.

The gain of the cascode stage is given by the product of the anode load of the upper triode V14a and the mutual conductance of the lower triode V14b. The mutual conductance of the lower triode V14b is increased by increasing the current flow through it via R93. The preset control RV5 varies the grid voltage of V14b and so provides fine control of the 200-volt h.t. line. A reference voltage is provided by the neon V15.

Positive 10-volt and negative 15-volt supplies, via MR6 and MR7 respectively, are obtained by half-wave rectification of the output of a 20-volt winding on T1. The negative 15-volt line is stabilised by Zener diodes ZD4 and ZD5.

Valve and Transistor Data

Tables 1 and 2 give voltages measured on the appropriate ranges of an Avometer Model 8. All anode voltages are measured on the 250-volt range. All grid and cathode voltages are measured on the 100-volt range. All transistor measurements are made on the 25-volt range.

TABLE 1: VALVE DATA

Valve	*Anode Volts*	*Grid Volts*	*Cathode Volts*
V1a	167	89	92
E88CC			
V1b	92	1	3·5
V2a	177	88	92·5
E88CC			
V2b	92·5	0	2
V3a	200	7	12·4
E88CC			
V3b	200	7	12·4
V4a	174	90·5	94·5
E88CC			
V4b	94·5	3·1	4·7
V5a	192·5	91	95·5
E88CC			
V5b	95·5	0	2
V6	155	−5·5	0·5
EL822			
V9a	105	0	2·2
E88CC			
V9b	200	0	7
*V10a	140	90	93·2
E88CC			
†V10b	186	57	93·2
V11a	105	76	78
E88CC			
V11b	175	72·5	78
V12a	179	2·8	7·4
E88CC			
V12b	180	0	5·2

* Pin 1 † Pin 6

TABLE 2: TRANSISTOR DATA

Transistor	*Collector Voltage*	*Base Voltage*	*Emitter Voltage*
TR1 OC140	2·9	0·6	0·5
TR2 OC140	6·1	4·6	5·4

Operating Instructions

Use with External Test-waveform Generators

1. Remove front and rear panels to allow access to internal controls.
2. Set switch B at the back of the unit to the appropriate line standard.
3. Connect supplies of mixed-sync and mixed-blanking pulses to the appropriate sockets on the front. Terminate both pulse inputs in 75 ohms by setting switch A to *On*.
4. Connect the output of the generator to the input of the inserter unit. Note that the external waveform generator being used must be synchronised to the local pulse system.
5. Connect the d.c. input of a suitable oscilloscope to the *Normal Output* socket of the inserter unit and terminate in 75 ohms. Adjust the *Sync Amp*, *Lift* and *Picture Amp* controls to obtain the required amplitudes of sync pulse, lift and picture respectively. Set black level to zero volts by adjustment of the *D.C. Output Level* control.

Use as a White Bar Generator

1. Connect syncs and blanking as described in 3 above. (No video input is required.)
2. Adjust controls as described in 5 above but note that, with no video input to the unit, the *Picture Amp* control is inoperative and the amplitude of the bar is governed by the setting of the *Lift* control.

Test Specification

Apparatus Required

Avometer Model 8.
Tektronix Oscilloscope Type 545.
Plug-in unit Type 53/54K. (For use with Tektronix oscilloscope.)
10-megohm 11·5-pF Probe Type P6000. (For use with Tektronix oscilloscope.)

NOTE:—A Tektronix oscilloscope Type 515A may be used except when the frequency response of the feedback amplifiers is being adjusted.

A 75-ohm variable attenuator adjustable from 0 to 6 dB in 0·5 dB steps.
A 625-line Sine-squared Pulse and Bar Generator GE4/504C.
A 405 or 625-line Nonlinearity Test Signal Generator GE4/505 or GE4/505A.
A 405 or 625-line Nonlinearity Measurement Filter FL1/509A or FL1/509B.
A Nonlinearity Distortion Processing Amplifier AM1/505 or a General Purpose Amplifier AM5/501.
A source of mixed syncs (405-line standard).
A source of mixed syncs, mixed blanking and line-trigger (625-line standard).

Power Supply Chassis

1. With the Avometer, measure the voltage between pins 1 and 12 of socket A. (This socket is easily accessible if the bottom panel is removed.) Adjust RV5 to obtain a reading of 200 volts.
2. Check that the following voltages are present at socket A:
   Between pins 2 and 12 −15 V d.c. ±1·2 V.
   Between pins 3 and 12 +10 V d.c. ±1 V.
   Between pins 7 and 10 6·4 V a.c. ±0·1 V.
3. Connect Avometer between pins 4 and 5 of V13 and check that 6·3 volts a.c. are present.
4. With the oscilloscope measure the hum levels on each of the three h.t. lines. These should be as follows:
   200 V line < 25 mV p-p
   −15 V line < 20 mV p-p
   +10 V line < 20 mV p-p

Signal Circuits

5. Remove the front panel. Set switch A to *On* and switch B to *405*, and connect a supply of 405-line mixed-sync pulses to the appropriate socket on the front of the unit.
6. Monitor at V9 pin 7 and check that the inverted sync waveform is approximately 40 volts in amplitude.
7. Monitor at V10 pin 1 with the *Sync Amp* control turned fully anticlockwise; the displayed pulse amplitude should be 45 volts ±20 per cent. Now turn the control fully

clockwise; the pulse amplitude should be 80 volts ±20 per cent.

8. Monitor at the junction of R22 and R23, leaving the sync amplitude control fully clockwise; the amplitude of the waveform at this point should be about 2·4 volts. Attenuate the mixed-sync pulses by 6 dB and check that no change occurs in the amplitude of the waveform. Remove the attenuation.
9. Monitor the waveform at V9 pin 8. This waveform should consist of a large amplitude positive-going spike followed by a small negative-going spike. The amplitude of the positive-going spike should be about 60 volts.
10. Monitor the waveforms at V7 pins 1 (positive-going) and 2 (negative-going). These waveforms should be of opposing polarity and 26 volts in amplitude.
11. Disconnect the mixed-sync pulse feed and monitor at V11 pin 1. Adjust C33 to obtain a pulse duration of 11 μs. Adjust C31 to obtain a line period of about 108 μs. Reconnect the mixed syncs and check that the multivibrator output waveform is in synchronism with the mixed-sync waveform; it may be necessary at this stage to readjust C33. The waveform should have an amplitude of about 95 volts.
12. Disconnect the 405-line mixed-sync pulses and connect a source of 625-line mixed-sync pulses. Set switch B to *625*. Check that the multivibrator output waveform is in synchronism with the mixed-sync waveform and that the pulse duration is 5·9 ±0·5 μs. The waveform should have a line period of between 65 and 67 μs and an amplitude of about 90 volts.
13. Monitor at V8. Check that the keying pulses are negative-going on pin 5 and positive-going on pin 7 and are about 26 volts in amplitude.
14. Connect a source of 625-line mixed-blanking pulses to the appropriate socket on the front of the unit. Monitor at the junction of R50 and R51. The amplitude of the inverted blanking pulses at this point should be 5·5 volts.
15. Attenuate the amplitude of the mixed-blanking pulses by 6 dB and check that no change of amplitude occurs in the waveform at the junction of R50 and R51. Remove the attenuation.
16. Monitor at the junction of R17 and R18. Check that, with the *Lift* control fully clockwise, the amplitude of the mixed-blanking gating pulses is about 2·2 volts.
17. Synchronise the 625-line pulse and bar generator to the mixed-sync pulses and connect the output of the generator to the inserter unit video input. Terminate both the normal and the inverted output sockets in 75 ohms and monitor at the *Normal Output* socket with the oscilloscope set up for d.c. measurement. Adjust the *Lift* control to give zero lift and set the *Picture Amp* control to give 0·7 volt of picture.
18. Monitor at the junction of R17 and R18. Check that the original line-sync pulses have been removed from the video signal.
19. Monitor at the *Normal Output* socket with the oscilloscope set up for d.c. measurement and the signal output terminated in 75 ohms. Examine the front and back porches of the waveform. The small positive-going spikes occurring at the leading edge of line-blanking pulses should be less than 0·04 volt in amplitude and the negative-going spike that occurs coincident with the trailing edge of line-blanking should not exceed 0·1 volt.

Amplifier Frequency Response

20. Monitor the output of the pulse and bar generator and check that the T and 2T waveforms have a pulse-to-bar ratio of unity. Remove V3 from the generator, thus removing the sync pulses from the output. Remove the mixed-blanking pulses from the inserter unit and connect a feed of 625-line line-trigger pulses to the sync input sockets on both the inserter unit and the pulse and bar generator. Lock the pulse and bar generator to the line-trigger pulses and set the output switch to *2T*.
21. Monitor at the *Normal Output* socket of the inserter unit with the oscilloscope set up for d.c. measurement and the signal output terminated in 75 ohms. Adjust the *Sync Amp* control to obtain 0·3 volt of sync pulse and the *D.C. Output Level* control to bring the black level of the output signal to earth potential.
22. In making the following measurements of sag it is important that at each attenuator setting, and at each sweep speed used for the measurement, the oscilloscope should be checked against a waveform known to be immaculate and that any sag introduced by the oscilloscope should be allowed for.

Measure the sag over the duration of the 25-μs bar; ignoring the first and last 1 μs, sag should be less than 1 per cent of bar amplitude.

Switch the pulse and bar generator output to *50-c/s* and, again ignoring the first and last 1 μs, measure the sag present on the 10-ms bar. This should be less than 1 per cent of bar amplitude.

23. Set the pulse and bar generator output to *2T* and adjust the oscilloscope timebase so that the displayed pulse sits in the middle of the bar. (Double triggering.)

Monitor at the *Normal Output* socket of the unit and adjust C6 until the amplitude of the pulse is exactly the same as that of the bar.

Set the pulse and bar output to *T* and adjust C13 until the amplitude of the pulse is equal to that of the bar. Examine the base of the pulse for distortion. It should be possible to remove any distortion present by slight re-adjustment of C6 but, should this be necessary, the response of the amplifier to the *2T* pulse must be rechecked.

Monitor at the *Inverted Output* socket. Double-trigger the oscilloscope timebase and measure the pulse-to-bar ratio; this will be slightly greater than unity but should not exceed 1·02 : 1 and the shape of the pulse should be free from distortion.

Set the pulse and bar generator to *2T* and, still on the *Inverted Output* socket, check that the pulse-to-bar ratio is unity and that the pulse is undistorted. Replace V3 in the pulse and bar generator.

Connect supplies of 625-line mixed-sync and mixed-blanking pulses to the inserter unit and synchronise the pulse and bar generator to the mixed-sync pulse chain. Check that a fully composite waveform appears at the two output sockets of the inserter unit.

Range of Controls

24. Monitor at the *Normal Output* socket of the inserter unit with the oscilloscope set up for d.c. measurement and the signal output terminated in 75 ohms. Attenuate the output of the pulse and bar generator by 2·5 dB and connect it to the video input of the inserter unit. Set the *Lift* control to give zero lift. Check the range of the *Picture Amp* control; it should be possible to obtain at least 0·7 volt of picture. Remove the attenuation and turn the *Picture Amp* control fully anticlockwise.

25. Turn the *Lift* control fully anticlockwise. The picture component of the video signal should go below blanking level but this excursion should not exceed 0·15 volt. Turn the *Lift* control fully clockwise; the value of lift obtained should be between 0·7 and 0·9 volt. Readjust the *Lift* control to obtain zero lift. It may be necessary to change the value of R55 to obtain correct operation of the *Lift* control if V8 or either of the transistors TR1 or TR2 is changed.

26. Adjust the *D.C. Output Level* control so that blanking level is at earth potential. The range of this control should be —0·5 volt to +0·5 volt (approximately).

Picture Rejection during Field Blanking Period

27. Monitor at the *Normal Output* socket. Display the waveform on the oscilloscope at field frequency and measure the amount of picture present during the field blanking period. This should be reduced in amplitude by at least 40 dB with respect to the overall signal amplitude of 1 volt.

Nonlinearity Distortion

In making the following measurements of nonlinearity distortion the slight distortion inherent in the signal must be taken into account.

28. Nonlinearity distortion may be measured on either the 405-line or the 625-line standard. Assuming the 625-line standard is to be used, trigger a 625-line nonlinearity test signal generator GE4/505A from a suitable source of line-trigger pulses, set the generator controls to *10 Steps*, *C.C.I.R.* and *Bar On*, and connect the output to the video input of the inserter unit. Adjust the controls of the inserter unit to obtain 0·3 volt of sync, 0·68 volt of picture and 0·02 volt of lift.

29. Connect a filter FL1/509B to the *Normal Output* socket of the inserter unit, connect an amplifier AM1/505 to the output of the filter and connect the oscilloscope to the output of the amplifier. Measure on the oscilloscope the nonlinearity for the two conditions of *Bar On* and *Bar Off*. (For information on the measurement of nonlinearity, see Instruction V3, Section 6.) The nonlinearity in either condition should not be greater than 1 per cent.

Disconnect the filter from the *Normal Output* socket and connect it to the *Inverted Output* socket. Measure the nonlinearity as above; again it should not exceed 1 per cent.

30. Switch the nonlinearity test signal generator to *Bar Full* and *Auto*. Monitor at the *Normal Output* socket of the inserter unit with the oscilloscope in the d.c. condition and its timebase set to 1 sec/cm. Ignoring any overshoots that may occur, measure the change in black level as the bar is switched on and off, this should be less than 20 mV.

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