Sheet No.	141/1821/2
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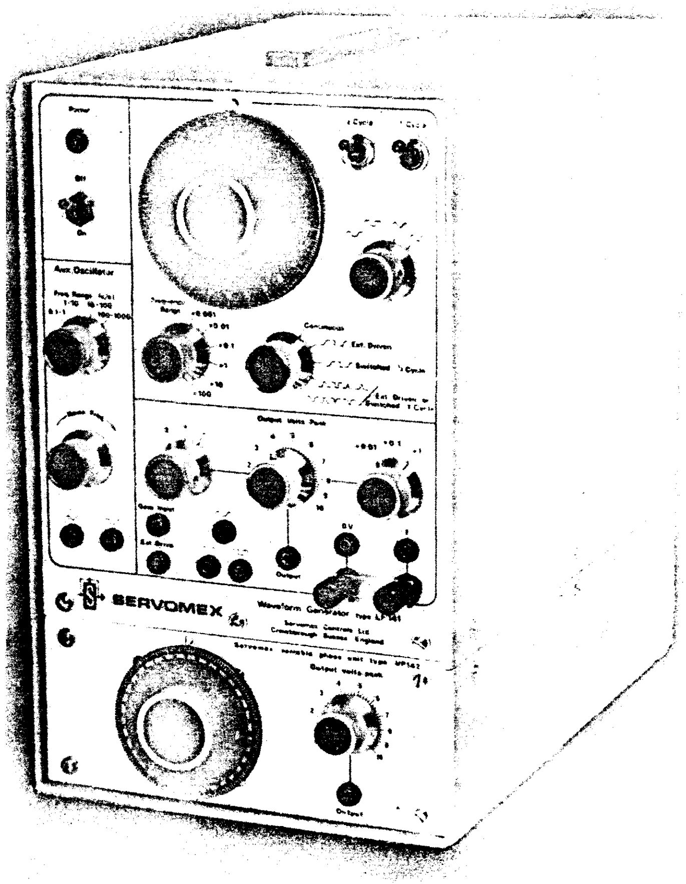
Low Frequency Waveform Generator Type LF. 141 and Variable Phase Attachment Type VP.142



This versatile signal generator has an important improvement over the earlier type — the F.E.T integrator in place of the electrometer valve

TAYLOR SERVOMEX
SYBRON CORPORATION

This new instrument is a source of low-frequency electric signals of many different sorts. It is designed particularly for measuring the dynamic response of automatic control systems, but previous experience has shown us that this type of device has a much wider range of applications than that. It has a great many of the advantages of our de-luxe LF.51, and some new ones.

Over 90 distinct waveforms from the main generator	Auxiliary generator triggers the main set, or external oscilloscopes
Portable—the first truly 'one hand' servo test set	Variable phase output for phase measurements

Main Generator

The heart of the main generator is a new type of integrator (patents applied for) which is a distinct advance on the type used on earlier instruments, eliminating the delay after applying a trigger pulse This integrator is connected to a square wave generator in a feedback arrangement so that it is self-oscillatory, generating square waves and triangular waves at the same time The triangular waves are shaped by a non-linear resistance into sinewaves of low distortion

As in the LF 51, further patented features permit the main generator to be run for just one whole cycle, or for half a cycle A 'gate' terminal is also brought out to the front panel, which allows the main generator to be keyed producing bursts of pulses of any number from one upwards

In the half-cycle condition, the generator rests at the positive or negative limit of voltage, so a d c voltmeter connected to the output terminal reads the amplitude In low frequency servo testing this is a point of great importance—one simply turns the amplitude knob until the required movement of the servo is obtained By flicking the '½ cycle' switch (or applying a voltage pulse to 'sync in') the voltage goes to the other limit, stepwise rampwise, or according to the waveform selected One can now verify that the other end of the movement is correct Then, turning to continuous operation or any of the other modes, one knows that the voltage, at all frequencies, and all shapes, will be precisely that just set on zero frequency. (Anyone who has attempted to set the amplitude of very slow sine waves will know what a boring procedure this can be)

A new feature of the present design is the ability to cut off either the positive or negative half of the waveform Mainly this is useful for generating pulses 'from earth' instead of balanced positive and negative It can also result in some further interesting waveforms and delayed waveforms Remember that from the auxiliary output terminals the complete square, triangle and sinewaves are simultaneously available

Auxiliary Generator

The auxiliary generator supplies a suitable square wave for triggering the main generator to make waveforms 37 to 48 and 73 to 96 It has the important advantage of generating simultaneously a triangular wave, mainly for triggering an oscilloscope. Given a modern type of oscilloscope with adequate d c. level control of the triggering, one can 'slide' up and down the triangular wave. Thus considering waveform 80, for example, one can adjust the oscilloscope to have either the leading or trailing edge at exactly the best part of the screen This is a low frequency equivalent of the delay line supplied in fast oscilloscopes for the same purpose, with the advantage of continuous variation.

Variable phase attachment

This uses the same unique circuit principle as the attachment for the LF.51, generating variable phase waves of constant amplitude from a single phase generator. Its main purpose is for phase measurement using Lissajous figures on an oscilloscope.

This question of phase measurement in low frequency systems is complicated by the question of noise and distortion. One occasionally meets the problem of a very noisy signal in which the simple Lissajous figure method would fail because one cannot accurately distinguish the point at which the ellipse degenerates into a straight line (which is the way the phase is compared). In this case a suitable filter can always provide a satisfactory solution—bandpass filter with negligible phase shift at the frequency in question. This way one can also measure the harmonics.

A good many people have persuaded themselves that this simple method of measurement is unsuitable for servo-frequency work, and they then purchase transfer function analysers at five or ten times the price (our T.F.A. 46 being a good example). We therefore wish to emphasise that it is only very occasionally that the direct Lissajous figure method fails through noise and distortion, and that a variable LF filter can then be used with complete ease. Furthermore, there is no difficulty whatever in getting rapid phase measurements even at very low frequencies. For example, if the frequency is one cycle per minute, one requires a normal d.c. oscilloscope (long persistence trace not needed). One adjusts the shifts at some high frequency so that the spot will pass through the centre of the screen. Applying the test signal one moves the variable phase knob to 'steer' the spot to the centre. After a few minutes experience one can do this in half a cycle.

A small refinement on the new instrument is the amplitude control on the variable phase output, so that if the Lissajous figure is reduced first to a straight line (for phase measurement) and also to 45° one can read the amplitude as well, because under these conditions the signals are equal in amplitude. To do this we have naturally made sure that the variable phase output is of sufficiently constant amplitude at all settings. We do not pretend that this is a very accurate measure of amplitude, depending as it does on the oscilloscope amplifiers.

The complete outfit is really as different as could be from 'a low frequency oscillator' as some people insist on calling it. There are so many different tricks one can play with it that one could not possibly list them all here, but only a few that come to mind.

1. **Phase measurement in power systems.** The main generator to be 'phase locked' to the supply. Quite easily done by using the '1 cycle driven' mode, and using the variable phase output as just described. There is nothing critical in the frequency control, and if it is slightly wrong the sine-wave will be a little distorted—of no importance for phase measurement in this way.

2. **Demonstrating the 'starting surge' in a.c. systems.** By removing a paralysing voltage from the GATE terminal one can start a train of sine waves at any desired phase angle, for driving classroom or experimental arrangements.

3. **Square wave with variable rise time.** In waveform 43 both the repetition rate and the rise time are separately controllable—a useful test in some non-linear systems.

4. **Sine-Squared pulses.** Waveform 73 is 'sinesquared' which has the valuable feature of generating harmonics inside an accurately known bandwidth, unlike the rectangular pulse which has excessive high frequency energy for many tests. (If the half-amplitude duration is l/f seconds, the spectrum contains no components above f c/s).

5. **Keying with a batch counter.** In medical and other applications one sometimes requires a train of pulses of known number. This is easily done with the LF.141 paralysed on the gating terminal by a voltage from a batch counter. The counter can be counting square pulses of fast rise time (as needed to operate it) from the auxiliary squarewave output terminal. Meanwhile the main output terminal is emitting whatever waveform is required.

LF.141 main generator

Frequency. 0·002 to 2,000 c/s in six ranges with overlap at each end of each range. Absolute accuracy ±3% of setting.
Amplitude. 0 to 20 volts peak to peak (undamaged by short circuits). Accuracy of amplitude dial ±6% of full scale. There are three ranges with full scale 20, 2, and 0·2 volts peak to peak respectively.
Output impedance and current.
20 volts range, 10 ohms, 10 mA maximum (more will cause distortion, not damage).
2 volts range, 110 ohms, safe for short circuit
0.2 volt range, 11 ohms, safe for short circuit
Square wave rise time. 5 μS max.
Linearity of ramp. better than 3%.
Sinewave distortion. better than 2%.
Auxiliary output terminals. Sine and square wave outputs at 20 volts peak to peak and triangular wave at 32 volts peak to peak are available from the three auxiliary outputs. No damage will be caused by shorting these to earth, but the generator will not work with more than 250 μA peak drawn from them.
Sync. input requirements. A sharp leading edge of 10 volts will initiate the trigger action. (Not more than 10 μS rise time). Input resistance 22 kΩ.
GATE input requirements. 20 volts DC, positive or negative. This must not exceed 30 volts, or damage will be caused Input resistance 27 kΩ.
DC biassing of output. By removing the link between Earth and 0 volts the output may be biassed to a maximum of 100 volts positive or negative by a suitable battery or power supply.
Temperature Rating. The instruments are suitable for use in ambient temperatures up to 40°C.

Auxiliary Oscillator

Frequency Range. Approx 0·1 to 1,000 c/s, uncalibrated in four ranges with overlap.
Outputs. Square waves of about 10 volts peak to peak at a mean of about —14 volts, and triangular waves of 20 volts peak to peak at a mean of about 0 volts.

Variable Phase Unit

Output. Sinewave of the same frequency as the LF.141 and variable in phase 0 to 360 .
Voltage. 0 to 10 volts peak covered in one range.
Angle accuracy. ±3
Voltage accuracy. ±0·5 volts.
Output impedance. 10Ω.

Power Requirements

12 to 15 VA, 45 to 65 c/s single phase a c. The voltage selector can be set to 105, 110, 115, 120, 125, 210, 220, 230, 240, 250 and the instrument will operate satisfactorily with variations not exceeding ±10% from the set voltage.

Construction

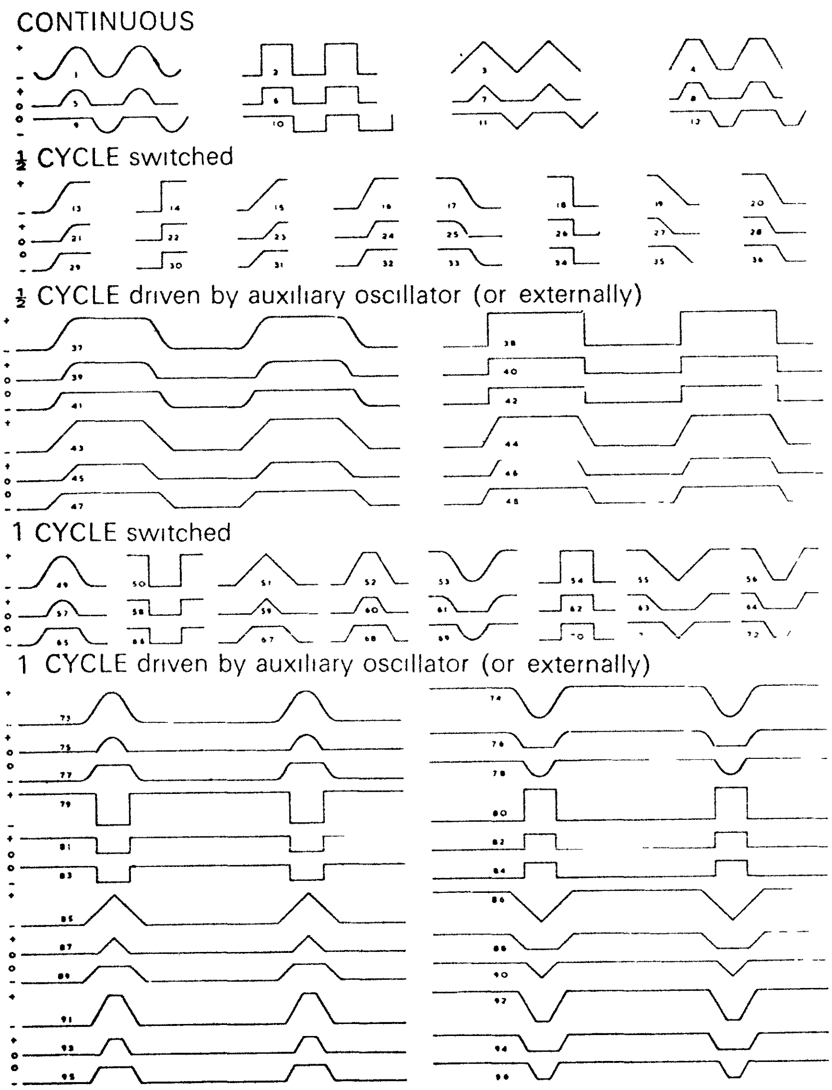
The variable phase unit is screwed to the bottom of the LF.141, receiving its inputs from a multiway plug and socket. The electronic components are on printed circuit boards, hinged for easy servicing. Most of the components are chosen from the inter-service approved list, and are run at the proper Service ratings.

Departures from the specification during the first twelve months of proper use will be corrected free of charge.

Shipping Details

	Net Size	Net Weight	Packed Size	Packed Weight
LF 141 alone	11"x8·3"x14·1" (28·0 x 21·1 x 35·8 cms)	17 lbs 7·7 Kgs	29"x19"x24" (74 x 48 x 61 cms)	74 lbs 34 Kgs
VP. 142 alone	4·2"x8·3"x14·1" (13·2 x 21·1 x 35·8 cms)	5·3 lbs 2·4 Kgs	22"x17·5"x18" (56 x 44 x 46 cms)	44 lbs 20 Kgs
LF. 141+VP 142	14·4"x8·3"x14 1" (36·5 x 21 1 x 35·8 cms)	22·3 lbs 10·1 Kgs	29"x19 x 24" (74 x 48 x 61 cms)	80 lbs 36 Kgs

The range of waveforms available on the LF141



NB The timing as well as the amplitude is to scale

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S E R V O M E X   C O N T R O L S

L I M I T E D

L O W   F R E Q U E N C Y   W A V E F O R M   G E N E R A T O R

T Y P E

L.F. 141

I N S T R U C T I O N   B O O K

This handbook should be available to the actual user of the equipment. Additional copies can be obtained at the price of £1.

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I N D E X

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SPECIAL NOTES

1. It is inadvisable to alter any of the preset controls without careful consideration and suitable measuring instruments.

2. Synchronizing Voltage. A voltage step of 10 volts and rise time not more than 10µS is required to initiate the trigger action.

3. Gate Voltage. A positive or negative D.C. voltage of 20 volts applied to the gate terminal will stop the main generator. More than 30 volts will cause damage.

4. Driven Operation. Attempts to 'drive' the main generator faster than the actual frequency setting will result in frequency division or other forms of mal-operation.

5. In later instruments the terminal referred to as SYNC IN is re-labelled EXT DRIVE.

6. WARNING. The circuits and methods of operation are the subject of patents pending in many countries.

Designed and manufactured by
SERVOMEX CONTROLS LTD.,
CROWBOROUGH, SUSSEX, ENGLAND

INSTALLATION

1. After unpacking the instrument, remove the dust cover and check that there is no visible damage and that the voltage selector is correctly set to the nominal value of your A.C. supply. For voltages 200 to 250V use fuse rated at 0.5 amps. For voltages 100 to 120Vuse a 1 amp fuse.

2. Connect a suitable plug. The GREEN wire is earth; RED is line and BLACK is neutral.

3. Switch on, with an oscilloscope connected between OV and output terminals, leaving the connecting strip joined between OV and E. Set the main FREQUENCY dial to 10, FREQUENCY MULTIPLIER to x 100, OUTPUT VOLTAGE controls to maximum, and CONTINUOUS AND SINEWAVE on the other switches. Verify that 1000 c/s sinewaves appear. Turn the top right hand switch to square, triangle, and ramp, and verify they also are working.

4. Connect the oscilloscope between OV and squarewave output of the auxiliary oscillator. With both knobs turned fully clockwise the output should be a squarewave of 10V p - p at approximately 1000 c/s.

5. If the preliminary tests above are satisfactory it may be assumed that the instrument is in normal working order.

OPERATING NOTES

The following notes tell how to get any of the 96 numbered waveforms illustrated in the data sheet.

1 - 4 Normal continuous wave - method obvious.

5 - 12 As above, but half-wave-rectified by using the ±, + or - switch.

13 - 36 Set the mode selector switch (5 o'clock from main frequency dial) to 2 positions round from CONTINUOUS. Operate the switch at top right marked 1/2 cycle. The main generator is now moving from the lower limit voltage to the upper limit voltage or vice versa, doing just half a cycle. Thus the entire process takes half the period corresponding to the frequency setting. But, where the output has been "held" at half way by the polarity selector switch the output voltage will be changing during only part of this time.: e.g. wave 15 corresponds to 1/2 cycle. 31 is the first half and 23 the second half of 15, so each lasts only 1/4 cycle.

NOTE: Wave 14 only lasts a few microseconds, whatever the frequency setting may be. BUT the main generator is still going, and attempts to flick the 1/2 cycle switch before it has ended its excursion will not reverse the wave.

37 - 38 Set the mode selector switch to the appropriate position (2nd, counting CONTINUOUS as 1). Apply to the SYNC IN terminal a suitable source of square waves or pulses which may very well come from the LF.141 AUX OSCILLATOR. Make sure the driving frequency is slow enough for the main generator to have time for its cycle as set on main frequency controls. No. 43 is now set as to repetition frequency, by the external oscillator, and as to rise time by the main frequency controls. Thus 43 is simply an alternation of 15 and 19, both of which are in turn based on 3. Note that for completeness wave 4 is shown as giving rise to waves 16, 20, 44 and their half versions. In all of these, as in 4 the ramp period is not the same as in 3. The reason for making them available is that there may be occasions when one uses 3 and its derivatives from the triangular wave special terminal, while using the more rapid ramps from 4 and its derivatives from the main output terminal.

49 - 72 Set the mode selector switch to positions 4 or 5 (counting CONTINUOUS as 1) and operate the 1 CYCLE switch at top right. Each depression will cause the main generator to go through one complete cycle of operation.

As always, it is no good pressing it again before the cycle is over. Note that 57, 59, 60 etc do not start at once - not due to any fault in the operation but because one has to wait until the voltage appears above (or below) the earth line.

HENCE one has the immediate response from the square wave special terminal followed by the pulse, e.g. 59. This delay may be useful.

73 - 96 Mode selector in positions 4 or 5 (counting CONTINUOUS as 1.) apply the recommended driving voltage to SYNC IN terminal.

73 is merely 49 repeated after a period determined by the frequency of the driving wave. For that matter, 73 (etc.) can be driven at random moments, by noise, provided only that the main generator will 'miss' if too-rapid repetition is demanded. This is in itself useful, as it allows one to count the proportion of pulses which follow within a certain period after the initial pulse. Thus groups of pulses applied to SYNC IN terminal will be translated into spaced pulses.

GATED OR KEYED WAVES Whatever the other conditions, driving voltages and so forth, the main generator can be paralysed by applying a d.c. voltage of 20V. to the GATE terminal. On removing this d.c. voltage the main generator will run normally.

MISCELLANEOUS ADJUSTMENTS Set the ±20V H.T. supplies within 1% of their nominal values before making any other adjustment. Always set the + 20V first since the - 20V stabiliser uses the +20V supply as a reference. The ±9.4V reference supplies are adjusted in accordance with the procedure for amplitude calibration (see below).

The zero of the output amplifier is checked by turning the 'output volts' knob fully anti-clockwise and then measuring the output voltage with a d.c. voltmeter. If the d.c. present is too high, short circuit base VT21 to 0 V., adjust RV9 to get 0 V. out, remove short circuit base VT21 to 0V, adjust RV8 to get 0 V out.

Subsequent minor adjustments may be made by adjusting RV9 only.

The amplitude calibration can be checked by turning the volts output knob to 10, waveform selector to 'squarewaves' mode selector to '1/2 cycle switched'. By moving the '1/2 cycle' switch (SW7) to alternate positions the output may be set to +10V and -10V, using RV16 (-ref) and RV14 (+ref) respectively.

Now turn to 'continuous' triangle waves (2000 c/s) and adjust RV4 for 0 output (this sets the mean d.c. level of the integrator output to 0V).

Set to 200 c/s squarewaves and adjust RV6 for zero output (adjust mark-space ratio of squarewaves to unity).
Use multi-range meter set to 10V range.

It is important to realise that these adjustments not only affect the mark-space ratio but also the frequency and the distortion present on sinewaves.

The frequency accuracy may be checked against a suitable source and, if adjustment is required it can be effected at the 20 mark of the dial by means of RV22 and at the 2 mark of the dial by means of RV23. These controls are slightly interdependent so successive adjustment is usually necessary. The best frequency range to set absolutely correct is the x 0.1 range (0.2 c/s to 2 c/s).

The three fastest ranges are adjusted by C7.
This enables these ranges to be corrected as closely as the tolerance on the integrating resistors (R51/52/53 or R54/55/56 or R57/58/59) will allow.

GENERAL DESCRIPTION

Two oscillators are present in the LF.141 the auxiliary oscillator and the main generator. Both circuits are based on an arrangement of trigger plus integrator with overall feedback to produce a self oscillating condition.

Auxiliary Oscillator. (Circuit diagram A.141/6)

VT31 and VT32 form the Schmitt trigger circuit which produces square waves (not at 0 V potential) across R153. These squarewaves, reduced in size and brought to 0 V potential, form the input to the integrator (VTs 33, 34, 35, 36). The integrator output is at a mean potential of approximately 0 V, and is fed back to the trigger circuit input in such a polarity and amplitude that at the required maximum positive or negative excursion of integrator output the trigger circuit output voltage is reversed abruptly.

In this way the circuit is self-oscillating. RV3 is the fine frequency control, the coarse frequency setting being obtained by S6 switching C27, 28, 29, 30. RV10 sets the base bias current of VT33 and is normally set so that the mark-space ratio of the square wave output varies only slightly when RV3 is rotated fully. RV3 is not calibrated but covers a range greater than 10:1 giving some overlap on the ranges. This circuit is only suitable for continuous oscillation and is intended to trigger the main generator by means of its square wave output. The triangle wave output is useful for triggering oscilloscopes and other equipment since by sliding up and down the triangle to a suitable level they may be triggered in advance of the square wave output if required.

Main Generator.

Please refer to the following drawings:

Trigger circuit B141/9 left hand side.
Pre-amplifier circuit B141/9 right hand side.
Integrator amplifier circuit B141/8 left hand side
Sine shaper circuit B141/8 right hand side
Block schematic diagram B141/2
Simplified block schematic diagram B141/11 A, B, C.

The basis of this oscillator is the 'controlled integrator' i.e. the combination of pre-amplifier and integrator with overall feedback applied.

For this circuit, wherever an input voltage greater than about ± 200 mV is applied the pre-amplifier output, V2, is limited at ± 10 ref D1 or D2. This voltage is applied to the integrator input causing the integrator output voltage to move linearly until the condition $\frac{V\ out}{V\ in} \Omega \frac{R2}{R1}$ is satisfied, then the integrator output becomes steady again and V2 returns to 0 V. In practice V in is the output voltage of the trigger circuit so is always ± 10 V., so it is much larger than the minimum input required for correct operation of the circuit. Waveforms for the circuit are given in Fig.(2)

With the addition of the trigger circuit and further feedback loops the system may be ma e oscillatory or not at will; the simplified circuit then becomes as in Fig.(3).

(See Figs. (1), (2), (3) & (4))

The sequence of events is:-

V in, V1, V2 all positive, V out falling linearly and taking V in with it at a lesser rate. When V out = $-V1. \frac{R6+R7+R8}{R4 + R5}$ then V2 falls to 0 V allowing V in to reverse polarity and operate the trigger circuit. V in, V1, V2 are all immediately negative and V out rises linearly again taking V in with it at a lower rate. Again when V out = $-V1. \frac{R6+R7+R8}{R4+R5}$, V2 falls to 0 V, the trigger circuit is operated and the cycle resumes again.

If a d.c. input is applied via the 'Gate Input' terminal then the trigger circuit will be held, according to the polarity of input applied, and oscillation will be inhibited. This is 'gated' operation and enables the oscillations to be started and stopped at will. By choosing the correct polarity of held off potential the oscillations may be made to start from either the positive or negative extremity as required.

NOTE: The correct condition for oscillations to be produced is OV. at the 'gate' terminal, so if a square wave is to be used as the 'gate' input (to produce short bursts of oscillation) then it must be of a sort which applies 0 V. to the 'gate' terminal during the relevant period of time.

When point X is open circuit (see drawing No. B141/11B) an input is required to operate the trigger circuit. This may take the form of a d.c. voltage applied via a switch (provided on the front panel (SW7) and marked '1/2 cycle') or a succession of alternately positive and negative pulses. C19, R144 form a differentiating circuit to convert a square wave applied at the 'EXT. SYNC. INPUT' terminal to this form. For each input change the circuit will now produce 1/2 cycle of output change; the form of the output change may be selected at will by SW2.

When a diode is inserted at point X (see drawing B141/11C) then the triggering action will be produced in one direction only, depending upon the polarity of the diode. The circuit output voltage will thus remain stationary at the corresponding positive or negative extremity until an input pulse of the correct polarity is applied, when it will perform one complete cycle of operation and then wait for another triggering pulse. In this condition the circuit may be triggered by either SW8 or by means of a square wave applied to the 'EXT. SYNC. INPUT' terminal. A diode is included in the sync input circuit to ensure that only the correct polarity pulses are applied. This precaution prevents spurious triggerings from the back edge of a narrow triggering pulse.

'Locked' or 'Synchronized' Continuous Oscillation

The main generator may be 'locked' to an external source.

(a) If the external source is of sinusoidal from then 5 - 10V p - p should be applied to the 'gate input' terminal and the LF.141 set to either 'continuous' or '1/2 cycle ext. driven'. The main frequency dial can then be adjusted for positive synchronizing with minimum distortion. The lock obtained is good but the phase angle between the source voltage and the LF.141 output voltage is indeterminate.

(b) If the external source is of square wave form approximately 10V p - p should be applied to the 'ext. sync. input' terminal and the LF141 set to either 1/2 cycle or 1 cycle ext. driven. By adjustment of the main frequency dial a positive lock can be obtained with the phase angle between source and LF.141 output fixed at approximately 90°.

DETAILED CIRCUIT NOTES

Trigger circuit. (Drawing No. B141/9 left hand side)

This is a simple D. C. Amplifier with input and output mean voltage at 0 V. Overall voltage feedback is applied to produce the trigger effect. The output voltage is limited to ± 10 V. by diodes MR2 and MR3. This output is used as the square wave output of the LF.141

Integrator Pre-amplifier. (Drawing No. B141/9 right hand side)

Another simple D. C. amplifier with balanced input stage for low D. C. drift. D. C. drift of this stage will cause drift of the mean level of the triangular wave output. RV4 therefore sets the D. C. level of the triangular wave output.

Integrator Amplifier. (Drawing No. B141/8 left hand side)

This is a fairly high gain D. C. amplifier with very high input impedance and very low input current. This is necessary because the integrating resistance changes from about 150 kΩ to about 15 MΩ at various settings of the frequency multiplier. A specially selected pair of field effect transistors are used as the input element, RV6 s ts the bias on this input stage. This control therefore sets the slopes of the triangular wave to be equal in both the negative and positive going directions; it therefore sets the mark/space ratio of the square wave output to unity.

Sine Shaper. (Drawing No. B141/8 centre section)

This is a simple network of diodes and resistors; the diodes are biassed by voltages derived from the ± reference supplies. Four diodes are used for positive inputs and four more for the negative input. They have the effect of reducing the slope of the output wave at successively higher break points and in this way the output is made approximate to a sine curve. The actual output obtained consists of straight line segments, but the distortion is very small. The output impedance of the shaper is quite high and is loaded only by the high input impedance of the emitter follower circuit. (Drawing No. B141/8 right hand side). This circuit is of a simple D. C. amplifier with high input impedance, low output impedance, gain of approximately unity, and low D. C. drift; its function is simply to provide the power necessary to drive the following relatively low impedance circuits.

Clipper & Polarity Selector. (Drawing B141/2 centre, connected to SW2 and SW3

This circuit uses four diodes, MR29, 30, 31, 32, and four resistors, R139, 140, 141, 142, to form a circuit capable of either:-

(a) Clipping waves to ± 10 V. peak (used for forming 'ramp' waves) or

(b) enabling the selection of all, only the positive half, only the negative half, of any input wave. This feature enables the user to select any waveshape and select its polarity at will.

Output Amplifier (Drawing A141/10)

This is a straightforward high gain, low drift D. C. amplifier. The input stage is a long-tailed pair of transistors (VT21, VT22). Two zero setting potentiometers are provided. RV9 sets the input voltage to zero and should be initially set with the base of VT21 shorted to 0 v. RV8 sets the input current to zero. The long-tailed pair input stage gives good D. C. stability; VT23 is another amplifier with emitter biassed by Zener diodes MR26 and MR27 in series. VT24 is the output emitter-follower and VT25 is a constant current source provided to reduce the current loading on Vt 24. This output is essentially short-circuit proof even when the short-circuit is sustained for a very long time. Diodes MR25 and MR28 are protection devices for the emitter to base junctions of VT23 and Vt.24 respectively.

Power Supplies

These are series element type with simple long-tailed pair amplifiers and compound emitter followers. MR51 is the reference diode for the +20 V. supply, the -20 V. supply uses the +20 V. supply as a reference and has an auxiliary negative supply using MR52 to give linear operation of the amplifier transistor VT41. The reference supplies give an output, for the shaper network and the 'catching' diodes of the trigger and pre-amplifier outputs, of about ± 9.4 V. They are derived from the ± 20 V. supplies, use separate Zener diodes MR53 and MR54 and are of the shunt stabiliser type.

Controls.

RV15 sets the +20 V. supply and should be set correctly first.
RV13 sets the -20 V. " " " " " " second.
RV13 setting depends upon the +20 V. being correct, hence the need to set RV15 (+20 V.) first.
RV14 sets the + ref.
RV16 sets the - ref.

Note: The ± ref, supplies are adjusted by making the square wave output amplitude correct. Due to the phase inversion property of the output amplifier RV14 (+ref.) actually sets the negative output to -10 V. RV16 (- ref.) actually sets the positive output to +10 V.

FAULT FINDING

By removing the dust cover and the bottom cover, you expose every part of the instrument. The printed circuit boards are hinged at the front end so that by removing the screw at the upper rear end of each board if may be swung out giving access to both sides of all boards.

If the instrument stops it is advisable to switch to '1/2 cycle switched' and check whether ± 10 V. appears at the output terminals when the 1/2 cycle switch is moved. Check for each position of the waveform selector (ensure that attenuator is at 1 and 'output volts' at 10). It may be found that only one waveform is affected or that the instrument is all right on 1/2 cycle but not on continuous.

If the output is 0 V. at all times, check the ± 20 V. and ± ref., then suspect the output amplifier.

If the output is +10V or -10V at all times, then suspect the triggering mechanism first, integrator and pre-amplifier next.

NOTE: If RV6 (set mark-space ratio) is inadvertently rotated too far in either direction, oscillation may cease; readjust in accordance with the foregoing instruction. Always turn the main frequency dial to 20 when trying to cure the non-oscillating condition, as RV6 has least effect at this end of the dial. Also if RV4 is rotated too far from the correct position oscillation may cease; again readjust as above, again have main frequency dial at 20 initially.

If no results are obtained either on continuous or 1/2 wave, then switch to 1/2 wave and connect a voltmeter to OV and the square wave high impedance terminal. On operating the 1/2 wave switch, the voltage should change from +10 to -10V or vice-versa. If it does not change or is at some voltage far removed from +10V then suspect the trigger circuit. If it does change, reconnect the voltmeter to the junction RV22 - R1. This voltage should also change in the same way; if not, then suspect the pre-amplifier circuit or the resistor chain R4, R5, R6, R7, R8. If this voltage does change then reconnect the voltmeter to the triangle wave high impedance terminal. This voltmeter should change also, but the peak value is ±16.1V and the rate of change depends on the frequency setting; therefore turn to 2000 c/s for quick response. If this voltage does not change suspect the integrator amplifier, integrating resistors and capacitors, or the resistance chain RV22, RV1, RV23, R10.

By using these techniques the possible area of fault may be reduced, thereby easing the work.

The following voltages may be found useful for general servicing and fault finding. They were all measured on an AVO 8 (20,000 Ω/V) on an appropriate range. It is advisable to adjust the mains voltage to be as near correct as possible.

Voltage	across	C42	=	28.5V
"	"	C41	=	28.5V
"	"	C32	=	20V
"	"	MR52	=	6.9V
"	"	MR54	=	6.9V
"	"	MR53	=	6.9V
"	"	MR51	=	5.6V
"	at emitters	VT40 & VT41 from OV.	=	+0.5V
"	across	R189	=	5.1V
"	"	R168	=	1.4V
"	"	R17	=	6.3V
"	"	R20	=	4.7V
"	"	R29	=	6.3V
"	"	R33	=	4.7V
"	"	MR40	=	5.6V
"	"	MR10 + MR11 + MR12 all in series	=	11.9V
"	"	R76	=	1.4V
"	"	R80	=	2.1V
"	"	R104	=	9.5V
"	"	MR26 + MR27 in series	=	13.6V
"	"	R136	=	9V

A.C. ripple voltages (maximum values for LF.141 without VP.142)

Across	C42	=	1.3V	p - p	100 c/s
"	C41	=	1.3V	p - p	100 c/s
"	C32	=	1.5V	p - p	50 c/s

On	-20V	line	from	0 V	=	10mV	p - p
"	+20V	"	"	"	=	5mV	p - p
"	-ref	"	"	"	=	4mV	p - p
"	+ref	"	"	"	=	4mV	p - p

WARNING: The circuit and methods of working of this variable phase device are subject to patents and patents pending in many countries.

FITTING THE VARIABLE PHASE ATTACHMENT

Unscrew the rubber feet of the LF141 and remove the bottom cover.
Remove the LF.141 upper cover and take the six plastic washers from the inside of this cover.
Remove the VP.142 cover and fix the two instruments together, using the same screws and washers.
Connect the 11-way plug and its spring retainer.
The VP.142 should now be checked for correct operation and, if it needs adjustment, do this as detailed below and then:
Fix the cover of the VP.142 by the 4 rubber feet and screws and then put back the LF.141 top cover.

CHECK OF CORRECT OPERATION

Set the LF.141 to give continuous sinewaves at any convenient frequency, say, 100 c/s. Examine the output from the VP.142 and verify that it is a substantially undistorted sinewave and that the amplitude does not vary by more than about ±2% as you rotate the phase dial. Verify that the phase does in fact alter continuously and that the amplitude is 10V peak with the amplitude control full up.

ADJUSTMENT OF THE VP.142

NOTE: In ordinary use it is not necessary to adjust either of these instruments except after a fault or some other exceptional circumstance. When it is necessary to do so, first adjust the LF.141 exactly as in the handbook and then proceed with the VP.142 as follows. Although these instructions appear complicated, the whole setting up procedure should not take more than almost 5 minutes, given a suitable oscilloscope and d.c. voltmeter.

1. Set the LF.141 to continuous sinewaves at 20 c/s.

2. Put a d.c. voltmeter (about 10V f.s.d) on terminal TP1 and adjust RV2 to give OV. At TP1 there should be a 20 c/s triangular wave of about 32V p-p.

3. Connect the d.c. voltmeter and a CRO to TP2 and adjust RV8, RV9 and RV1 to give a triangular wave of amplitude about 32V p - p, no d.c. content, and no discernable discontinuities. (It is best to set RV1 first by shorting the junction of R26, R27 and R32 to OV and adjust for O d.c. by RV1. After adjusting the other two controls, RV1 may need further small adjustment).

4. Transfer the meter and CRO to TP3 and check the presence of a good sinewave of about 20V p - p with less than 100 mV d.c. (The d.c. level at TP3 is set by factory adjustment of R135 and should not need alteration).

5. Transfer to TP4 and check a good sinewave of 20V p - p with less than 100 mV of d.c. using RV3.

6. Transfer to TP5 and find a good sinewave of 20V p - p. The d.c. level at TP5 is set by factory adjustment of R149 and should not need alteration.

7. Transfer to TP6, adjusting the d.c. to 0 by RV4.

8. Transfer to the VP.142 output terminal, turn the amplitude control fully up and short circuit TP7 to OV, and then adjust RV7 for zero output. Remove the short and adjust RV5 for zero output. Subsequent minor adjustments may be made, using RV7 only.

Turn the amplitude control to maximum and verify that there is a good sinewave of about 20V p - p amplitude with less than 100 mV d.c. at all positions of the variable phase dial, and also that the amplitude control is working normally.

9. Set the amplitude control to 10V and the phase dial to 0° and adjust RV6 so that the peak output voltage is 10.15V. (This can be done on a d.c. meter by putting the mode selector switch to 'half cycle switched').

The instrument is now ready for use.

GENERAL DESCRIPTION

(Refer to drawings B142/2, B142/16 and B142/17).

The VP.142 accepts the sine, square and triangular waves from the LF.141 via the 11-way plug and socket, which also connects the power (±20V) supplies, reference (±9.5V) supplies, OV and earth.

The sine, square and triangular wave inputs are modified and combined in a special circuit arrangement to produce a triangular wave which differs in phase from the triangular wave output of the LF.141 by exactly 90° at all frequencies.

The amplifier A1 accepts the triangular wave input and produces, at TP1, an inverted version of the same amplitude. Amplifier A3 accepts the square wave input and produces an amplified and clipped version at its output.

The three voltage waves thus obtained are applied via the diode resistor network to the input of A2, which combines and adds the required components in such a way as to produce a 90° shifted triangular wave at the A2 output.

This 90° shifted triangular wave is applied to the sine shaper which produces a sine wave output. Because of the high impedance present this sine wave is applied to emitter follower 1, which lowers the impedance. At this point in the circuit we now have a sine wave of the same frequency and amplitude as that from the LF.141 but leading in phase by 90°. This wave is now inverted by A4 to provide the -90° sine wave.

is first applied to emitter follower 2 and thus provides the -180° sine wave. This wave is also inverted, in amplifier A5, to provide the 0° sine wave.

The four sine waves, 0°, -90°, -180°, -270°, are all of equal amplitude (about 10V p - p) and are applied via a resistor network, consisting of R184 to R203 inclusive, to the twelve taps of potentiometer RV11. This network ensures the application to each tap of a voltage of the correct amplitude and phase angle. Since the taps are at 30° accurately spaced intervals the 'phase' dial is linear and the output voltage sensibly constant at all angular settings.

The voltage from RV11 is applied to RV10 which acts as the voltage output control. This voltage is amplified by means of amplifier A6 to produce a maximum output of 10V p - p at quite low impedance.

DETAILED CIRCUIT NOTES

AMPLIFIERS A1 and A2 (drawing No. B142/16)

These amplifiers are identical in internal circuit and have balanced input stages for low d.c. drift. The d.c. level of A1 is set to OV by RV2: d.c. drifts of this amplifier will cause malfunctioning of the diode resistor summing network, MR14 to MR19 and R26, R27, R180 and R181, resulting in discontinuities and high d.c. content in the triangular wave at TP2. The d.c. level of A2 is set to OV by RV1; d.c. drifts of this amplifier will cause excessive d.c. content in the triangular wave at TP2.

AMPLIFIER A3 (drawing No. B142/16)

This is a 'clipping' type amplifier so it has no d.c. zero set provided, nor are its d.c. drifts important. The clipped output voltage is larger than required. The positive and negative correction inputs to the diode/resistor summing network being separately adjustable by means of RV8 and RV9. If these adjustments are not correct or the clipping levels drift the effect will be to produce discontinuities and/or excessive d.c. content in the triangular wave output.

DIODE & RESISTOR SUMMING NETWORK. (drawing B142/16 & B142/2)

This network accepts a 0° triangular wave, a 180° triangular wave and a square wave input and by means of rectification and addition of these applies the correct inputs to A2 via R26 and R27 to produce a triangular wave at TP3 which is displaced in phase from either of the input triangular waves by 90°. Whether the displacement is +90 or -90° from the LF.141 triangular wave depends upon the polarity of the square wave applied and in the case of the VF.142 the displacement is $+90^\circ$ (-270°).

The resistors R180 and R181 remove most of the diode errors by keeping them forward biased for zero input. The resistors R182 and R183 feed forward a small amount of square wave input voltage which assist in reducing the effect of the finite rise time of the output of amplifier A3. A slow rise time here will result in severe discontinuities in the triangular wave at TP3. With correct adjustment the circuit shown produces negligible discontinuities up to a frequency of 200 c/s and only slight deterioration up to 2000 c/s (The steps in a 20V p - p sine wave at 2000 c/s are about 1V amplitude which corresponds to about 5%).

SINE SHAPER (drawing B142/16)

This shaper network is exactly as that fitted in the LF.141; a description is given in the 141 handbook.

EMITTER FOLLOWER No. 1 (drawing B142/17)

This circuit accepts the sine wave high impedance output from the shaper network and provides unity voltage gain and enough current gain to lower the output impedance to drive the resistor network at RV11 and the input impedance of A4. The d.c. drift of this circuit is low and the d.c. output voltage, for zero input voltage, is set to OV +100mV at the factory by adjustment of R135.

EMITTER FOLLOWER No. 2 (drawing B142/17)

This circuit is identical to No. 1 and performs the same sort of job. The factory adjusted resistor for d.c. level is R149.

AMPLIFIERS A4 and A5 (drawing No. B142/17)

These amplifiers are identical in circuit and feedback component values. They have balanced input stages for low d.c. drift. D.c. output is adjusted to OV by means to RV3 for A4 and RV4 for A5. D.c. drifts of these amplifiers will not prevent the instrument from function correctly but will cause d.c. to appear at the output terminal. The function of these amplifiers is:-

A4 inverts the -270° wave to give the -90° wave.

A5 inverts the -180° wave to give the 0° wave.

OUTPUT AMPLIFIER A6 (drawing No. B142/17)

This is a straightforward high gain, low drift, d.c. amplifier almost identical to the LF.141 amplifier. RV7 sets the output voltage to OV for OV input, RV5 sets the input current of VT40 correct for OV input and output. Instructions for setting these potentiometers are given under 'Miscellaneous Adjustments'. The output of this amplifier is essentially short circuit proof even for long periods of time. The overall gain is adjustable by means of RV6 over a small range having a mean value of about X2.45. This is necessary to take up the tolerances in the resistors, a. used for gain-setting in all the amplifiers and b. in the network around RV11.

The adjustment of RV6 is made with the phase dial set to '0'° RV10 (voltage output) set to '10' and the LF.141 set to 1/2 cycle switched. The output voltage, measured by means of a d.c. meter, is then set by RV6 to 10.15V. If the d.c level is not exactly zero then allowance may be made for this by switching the '1/2 cycle' switch (SW7) and setting RV6 so that the mean of the output excursions $\frac{(+V_o-(V_o))}{2}$ is 10.15V but this is not usually required since the d.c. content is too small. The output is set to 10.15V at 0° because it falls by about 3.4% at the 15° intervals, the average of the maxima and minima is then approximately 10V.

NOTE: The phase angles given above, and in the setting up procedure, are those actually present at the Test points. Due to the 180° phase reversal of the output amplifier the slider of RV11 is actually on the -180° tap when the dial is set to 0° and so on all round RV11; for each dial setting the actual position of the slider is always 180° different from the dial reading.

FAULT FINDING

By removing the lower dust cover one of the printed circuit boards of the VP.142 is visible. By undoing the 4 x 2BA screws the VP.142 chassis may be disconnected from the LF.141 and if the instruments are stood with front panels facing upwards it is possible to part the VP.142 from the LF.141 (opening like the pages of a book), without disconnecting the 11-way plug. In this position the instruments may be run providing care is taken not to contact the mains wiring in the LF.141.

One of the printed circuit boards of the VP.142 is screwed into place and may be removed by undoing these screws and disconnecting the wires to TP1 and TP2. The earth (chassis) connection is made via one of these screws and must be replaced when the screws are refitted. When undone the printed circuit board may be swung out of the chassis allowing access to both sides of both boards. It is usually best to work in the range 20 to 2000 c/s for signal tracing as these frequencies are easier to deal with, using an oscilloscope. In case of faulty operation check first that the LF.141 is operating correctly. If it is, then check in the VP142 for the presence of ±20V, ± ref, sine wave, square wave, triangular wave, CV and earth inputs. If any of these are incorrect check the 11-way plut and socket and its connections in the VP.142 and the LF.141. If no signal output at all is produced check for presence of signal voltage at RV10. If signal is present here then suspect the output amplifier, or the wirint to and from it.

If signal not present at TV10 then check for signal at RV11. If present here suspect the wiring from RV11 to RV10or RV10 for an open circuit.

There will normally always be some signals present at RV10 since a minimum of two faults at once is required to cause no signals at all here. However, if this fault shoul occur, assuming all the correct signals and volt ges are present at the inputs fro PL1, then check for signal at TP2; if no signal here then check for signal at TP1 and at each end of RV8 and RV9, also at the input end of R1 and the base of VT13. Also check for signal at the base of VT30 and collector VT30.

A more likely condition is when the signal at one of the cardinal points, e.g. TP3, TP4, TP5 and TP6, is either missing or of incorrect amplitude. This fault will show itself on the output as a much larger variation than normal of output voltage as the 'phase' dial (RV11) is rotated. It will also result in large errors of angle. In this case check for correct signal, about 10V p - p at each of TP3, 5, and 6 and then when the faulty signal is identified proceed directl to the amplifier feeding this test point. Note that, in connection with this type of fault, incorrect signals at two of the cardinal points, say 0° and 180°, will usually only mean one fault somewhere since the 180° opposing voltage is derived from its opposite number; therefore consult the drawing No. B142/3 and investigate the most likely cause of the trouble first.

By use of the above methods the likely area of trouble may be reduced and the work made easier. Power supply and reference voltages are as for the LF.141, signal voltages are listed here for guidence:

INPUTS FROM LF.141

Sine 20V p - p
Square 20V p - p
Triangle 32V p - p
TP1 and TP2, triangular wave of about 32V p - p
Output of A3, square wave of about 35V p - p
Output of sine shaper (do not load, .5MΩ min) sine wave 20V p - p.
Inputs and outputs of emitter followers 1 and 2, A4, A5, sine waves 20V p - p.
At the actual taps of RV11 and its slider, sine waves of approximately 5V p - p.
Input and output of A6, sine wave of amplitude as set by RV10.

All these signals are large and relatively free from distortion in the correctly operation instrument. In the case of the emitter follower units this si true also of the signals right through from input to output. For instance in emitter follower No. 1 the same 20V p - p sine wave should be present at emitter, base, and collector VT30, base and emitter VT33, collector VT32.

In the case of the feedback amplifiers A1, A2, A4, A5, A6, the input and output signals are very large but the signals present at some of the intermediate points are very small and highly distorted normally.

In the case of amplifier A3 the signals are all very large because there is no overall feedback applied. All the transistors except VT16 are either fully conducting or cut off depending upon the polarity of the input voltage.

The following d.c. voltages may be found useful for servicing and fault finding. They were all measured on an AVO 8 meter set to an appropriate range; the mains input was set to the correct value.

Emitters, A1 w.r.t. OV

VT1	0.525V	These voltages also apply to the corresponding emitters in A2.
VT2	0.525V	
VT3	-19.1V	
VT5	18.25V	

Emitters, A3 w.r.t. OV

VT13 & 14	-4.6V
VT15	-18.5V
VT16	18.5V

Emitters, Emitter follower No.1 w.r.t. OV

VT30	0.45V	These voltages also apply to the corresponding emitters in emitter follower No. 2.
VT31	12.5V	
VT32	-13.5V	

Emitters, A4, w.r.t.OV

VT18	0.5V	These voltages also apply to the corresponding emitters in A5.
VT19	0.5V	
VT20	-18.75V	
VT22	-11.5V	

Emitters, A6, w.r.t. 0V

VT40	0.5V
VT41	0.5V
VT42	-13.25V
VT44	-11.0V

COMPONENTS REFERENCE LIST for LF.141

Ref.	Value	Item	Type	Voltage	Tol.	Code No.
C 1	330pF	Capacitor	CM11G	750V	10%	2747-019
C 2	.002µF	"	CP31G	500V	20%	2741-069
C 3	0.5µF	"	Polystyrene	125V	1%	2762-209
C 4	0.05µF	"	"	500V	"	2762-323
C 5	.005µF	"	"	"	"	2762-314
C 6	460pF	"	"	125V	5%	2762-201
C 7	4-74pF	"	Variable			2781-158
C10	.005µF	"	CP31G	500V	20%	2741-075
C11	.001µF	"	"	500V	"	2741-065
C12	0.01µF	"	"	350V	"	2762-507
C13	.022µF	"	C281	250V	"	2762-503
C15	10pF	"	CCA1G	750V	5%	2768-021
C16	.002µF	"	CP31G	500V	20%	2741-069
C17	0.01µF	"	"	350V	"	2741-079
C18	.001µF	"	"	500V	"	2741-065
C19	.001µF	"	"	"	"	2741-065
C25	.002µF	"	CP31G	500V	20%	2741-069
C26	100pF	"	CM11G	750V	10%	2747-013
C27	.001µF	"	CP31G	500V	20%	2741-065
C28	0.01µF	"	"	350V	"	2741-079
C29	0.1µF	"	CPM2G	150V	25%	2743-002
C30	1 µF	"	CPM2K	150V	"	2743-011
C32	50µF	"	BR4070	50V		2773-385
C33	.005µF	"	CP31G	500V	20%	2741-075
C34	.005µF	"	"	"	"	2741-075
C35	500µF	"	CE7-T	25V		2771-256
C36	500µF	"	"	"	"	2771-256
C37	100µF	"	BR0908	"	"	2773-475
C38	100µF	"	"	"	"	2773-475
R 1	22KΩ	Resistor	RFG5-E	1/2W	2%	2631-305
R 2	22KΩ	"	"	"	"	2631-305
R 3	33KΩ	"	"	"	"	2631-309
R 4	100 Ω	"	"	"	"	2631-249
R 5	10KΩ	"	"	1/4W	1%	2633-297
R 6	150 Ω	"	"	1/2W	2%	2631-253
R 7	15KΩ	"	"	1/4W	1%	2633-301
R 8	1.1KΩ	"	"	"	"	2633-274
R 9	2.2MΩ	"	"	1/2W	2%	2631-353
R 10	330 Ω	"	"	1/4W	1%	2633-261
R 11	100KΩ	"	"	1/2W	2%	2631-321
R 12	68KΩ	"	"	"	"	2631-317
R 13	1.5KΩ	"	"	"	"	2631-277
R 14	1.5KΩ	"	"	"	"	2631-277
R 15	39KΩ	"	"	"	"	2631-311
R 16	1KΩ	"	"	"	"	2631-273
R 17	680 Ω	"	"	"	"	2631-269
R 18	2.7KΩ	"	"	"	"	2631-283
R 19	6.8KΩ	"	"	"	"	2631-293
R 20	2.2KΩ	"	"	"	"	2631-281
R 21	68KΩ	"	"	"	"	2631-317
R 22	1.2KΩ	"	"	"	"	2631-275
R 23	1.2KΩ	"	"	"	"	2631-275

COMPONENT REFERENCE LIST for LF.141

Ref.	Value	Item	Type	Wattage	Tol.	Code No.
R 24	100KΩ	Resistor	RFG5-E	1/2W	2%	2631-321
R 25	18KΩ	"	"	"	"	2631-303
R 26	1 KΩ	"	"	"	"	2631-273
R 27	1 KΩ	"	"	"	"	2631-273
R 28	18KΩ	"	"	"	"	2631-303
R 29	680 Ω	"	"	"	"	2631-269
R 30	2.7KΩ	"	"	"	"	2631-283
R 31	6.8KΩ	"	"	"	"	2631-293
R 32	1 KΩ	"	"	"	"	2631-273
R 33	2.2KΩ	"	"	"	"	2631-281
R 34	47KΩ	"	"	"	"	2631-313
R 35	27KΩ	"	"	"	"	2631-307
R 51	100KΩ	"	"	1/4W	1%	2633-321
R 52	39KΩ	"	"	"	"	2633-311
R 53	4.7KΩ	"	"	"	"	2633-289
R 54	1 MΩ	"	"	"	"	2633-345
R 55	390KΩ	"	"	"	"	2633-335
R 56	47KΩ	"	"	"	"	2633-313
R 57	10MΩ	"	RC2-B	1W	"	2617-769
R 58	3.9MΩ	"	"	"	"	2617-759
R 59	470KΩ	"	RFG5-E	1/4W	"	2633-337
R 69	39KΩ	"	"	1/2W	2%	2631-311
R 70	27KΩ	"	"	"	"	2631-307
R 71	100 Ω	"	"	"	"	2631-249
R 72	68KΩ	"	"	"	"	2631-317
R 73	10KΩ	"	"	"	"	2631-297
R 74	12KΩ	"	"	"	"	2631-299
R 75	18KΩ	"	"	"	"	2631-303
R 76	330 Ω	"	"	"	"	2631-261
R 77	6.8KΩ	"	"	"	"	2631-293
R 78	100 Ω	"	RFH3-2.5	2.5W	10%	2661-049
R 79	220 Ω	"	RFG5-E	1/2W	2%	2631-257
R 80	1 KΩ	"	"	"	"	2631-273
R 81	8.2KΩ	"	"	"	"	2631-295
R 82	10KΩ	"	"	1/4W	1%	2633-297
R 83	220 Ω	"	"	1/2W	2%	2631-257
R 84	750 Ω	"	"	1/4W	1%	2633-270
R 85	180 Ω	"	"	"	"	2633-255
R 86	2.2KΩ	"	"	"	"	2633-281
R 87	180 Ω	"	"	"	"	2633-255
R 88	2.2KΩ	"	"	"	"	2633-281
R 89	560 Ω	"	"	"	"	2633-267
R 90	10KΩ	"	"	"	"	2633-297
R 91	10KΩ	"	"	"	"	2633-297
R 92	560 Ω	"	"	"	"	2633-267
R 93	3.9KΩ	"	"	"	"	2633-287
R 94	680 Ω	"	"	"	"	2633-269
R 95	9.1KΩ	"	"	"	"	2633-296
R 96	680 Ω	"	"	"	"	2633-269
R 97	1 KΩ	"	"	"	"	2633-273
R 98	39KΩ	"	"	"	"	2633-311
R 99	5.6KΩ	"	"	"	"	2633-291
R100	1 KΩ	"	"	"	"	2633-273
R101	910 Ω	"	"	"	"	2633-272
R102	910 Ω	"	"	"	"	2633-272
R103	1.2MΩ	"	"	1/2W	2%	2631-347

COMPONENTS REFERENCE LIST for LF.141

Ref.	Value	Item	Type	Wattage	Tol.	Code No.
R104	10KΩ	Resistor	RFG5-E	1/2W	2%	2631-297
R105	2.7KΩ	"	"	"	"	2631-283
R106	10KΩ	"	"	"	"	2631-297
R107	470 Ω	"	"	"	"	2631-265
R108	39KΩ	"	"	"	"	2631-311
R109	1 KΩ	"	"	"	"	2631-273
R110	100 Ω	"	"	"	"	2631-249
R111	100 Ω	"	RFH3-2.5	2.5W	10%	2661-049
R121	1MΩ	"	RFG5-E	1/2W	2%	2631-345
R122	100KΩ	"	"	1/4W	1%	2633-321
R123	2.7KΩ	"	"	1/2W	2%	2631-283
R124	470 Ω	"	"	"	"	2631-265
R125	100KΩ	"	"	1/4W	1%	2633-321
R126	220KΩ	"	"	1/2W	2%	2631-329
R127	470 Ω	"	"	"	"	2631-337
R128	120KΩ	"	"	"	"	2631-323
R129	18KΩ	"	"	"	"	2631-303
R130	1 KΩ	"	"	"	"	2631-273
R131	1 KΩ	"	"	"	"	2631-273
R132	18KΩ	"	"	"	"	2631-303
R133	1.8KΩ	"	"	"	"	2631-279
R134	22KΩ	"	"	"	"	2631-305
R135	750 Ω	"	"	1/4W	1%	2633-270
R136	3.9KΩ	"	"	1/2W	2%	2631-287
R137	3.9KΩ	"	"	"	"	2631-287
R138	390 Ω	"	RFH3-2.5	2.5W	5%	2661-063
R139	28KΩ	"	RFG5-E	1/4W	1%	2633-303
R140	1.8KΩ	"	"	1/2	2%	2631-279
R141	1.8KΩ	"	"	"	"	2631-279
R142	18KΩ	"	"	1/4W	1%	2633-303
R143	1 MΩ	"	"	1/2W	2%	2631-345
R144	22KΩ	"	"	"	"	2631-305
R145	2.2KΩ	"	"	"	"	2631-281
R151	22KΩ	"	"	"	"	2631-305
R152	12KΩ	"	"	1/4W	1%	2633-299
R153	12KΩ	"	"	"	"	2633-299
R154	1 KΩ	"	"	1/2W	2%	2631-273
R155	100KΩ	"	"	1/4W	1%	2633-321
R156	22KΩ	"	"	1/2W	2%	2631-305
R157	22KΩ	"	"	1/4W	1%	2633-305
R158	56KΩ	"	"	"	"	2633-315
R159	27KΩ	"	"	"	"	2633-307
R160	27KΩ	"	"	"	"	2633-307
R161	100KΩ	"	"	"	"	2633-321
R162	160KΩ	"	"	"	"	2633-325
R163	10KΩ	"	"	1/2W	2%	2631-297
R164	10MΩ	"	RC2-B	1W	1%	2617-769
R165	560KΩ	"	RFG5-E	1/2W	2%	2631-339
R166	330KΩ	"	"	"	"	2631-333
R167	27KΩ	"	"	"	"	2631-307
R168	470 Ω	"	"	"	"	2631-265
R169	10KΩ	"	"	"	"	2631-297
R170	1 KΩ	"	"	"	"	2631-273
R171	18KΩ	"	"	"	"	2631-303
R181	47 Ω	"	"	"	"	2631-241
R182	150KΩ	"	"	"	"	2631-325
R183	1.8KΩ	"	"	"	"	2631-279
R184	150KΩ	"	"	"	"	2631-325

COMPONENTS REFERENCE LIST for LF.141

Ref.	Value	Item	Type	Wattage	Tol.	Code No.
R185	1.8KΩ	Resistor	RFG5-E	1/2W	2%	2631-279
R186	3.3KΩ	"	"	"	"	2631-285
R187	6.8KΩ	"	"	"	"	2631-293
R188	3.3KΩ	"	"	"	"	2631-285
R189	27KΩ	"	"	"	"	2631-307
R190	820 Ω	"	"	"	"	2631-271
R191	2.7KΩ	"	"	"	"	2631-283
R192	180KΩ	"	"	"	"	2631-327
R193	82KΩ	"	"	"	"	2631-319
R194	47KΩ	"	"	"	"	2631-313
R195	3.9KΩ	"	"	"	"	2631-287
R196	3.9KΩ	"	"	"	"	2631-287
R197	12KΩ	"	"	"	"	2631-299
R198	6.8KΩ	"	"	"	"	2631-293
R199	6,8KΩ	"	"	"	"	2631-293
R200	12KΩ	"	"	"	"	2631-299
R201	1.2KΩ	"	"	"	"	2631-275
R202	470 Ω	"	"	"	"	2631-265
R203	470 Ω	"	"	"	"	2631-265
R204	1.2KΩ	"	"	"	"	2631-275
R212	3.9KΩ	"	"	1/4W	1%	2633-287
R213	10 KΩ	"	"	1/2W	2%	2631-297
R214	6.2KΩ	"	"	"	"	
R15	1 KΩ	"	"	1/4W	1%	2633-273
R216	100 Ω	"	"	"	"	2633-321
R217	11.1KΩ	"	"	"	"	
R231	22KΩ	"	"	1/2W	2%	2631-305
R232	18KΩ	"	"	"	"	2631-303
R233	470 Ω	"	"	"	"	2631-265
R234	470 Ω	"	"	"	"	2631-265
R235	18KΩ	"	"	"	"	2631-303
R236	5.6KΩ	"	"	"	"	2631-291
R237	2.7KΩ	"	"	"	"	2631-283
MR1		Diode	1N914			2862-149
MR2		"	"			2862-149
MR3		"	"			2862-149
MR4		"	"			2862-149
MR5		"	"			2862-149
MR6		"	"			2862-149
MR7		"	"			2862-149
MR10		"	MR56H-2			2864-119
MR11		"	1N914			2862-149
MR12		"	MR56H-2			2864-119
MR13		"	1N914			2862-149
MR14		"	"			2862-149
MR15		"	"			2862-149
MR16		"	"			2862-149
MR17		"	"			2862-149
MR18		"	"			2862-149
MR19		"	"			2862-149
MR20		"	"			2862-149
MR21		"	"			2862-149
MR25		"	"			2862-149
MR26		"	BZY88/C6V8			2864-152

COMPONENTS REFERENCE LIST for LF.141

Ref.	Value	Item	Type	Wattage	Tol.	Code No.	
MR27		Diode	BZY88/C6V8			2864-152	
MR28		"	1N914			2862-149	
MR29		"	"			2862-149	
MR30		"	"			2862-149	
MR31		"	"			2862-149	
MR32		"	"			2862-149	
MR40		"	MR56H-2			2864-119	
MR46		"	BYX22/400			2863-325	
MR47		"	"			2863-325	
MR48		"	"			2863-325	
MR49		"	"			2863-325	
MR50		"	"			2863-325	
MR51		"	MR56H-2			2864-119	
MR52		"	BZY88/C6V8			2864-152	
MR53		"	"			2864-152	
MR54		"	"			2864-152	
MR55		"	1N914			2862-149	
VT 1		Transistor	BCY31			2865-427	
VT 2		"	BFY10			2865-551	
VT 3		"	BCY31			2865-427	
VT 4		"	"			2865-427	
VT 5		"	BFY10			2865-551	
VT 6		"	BCY31			2865-427	
VT 7		"	BFY10			2865-551	
VT 8		"	BCY31			2865-427	
VT10		"	BCY70			2865-290	
VT11		"	BFY10			2865-551	
VT12		"	"			2865-551	
VT13		"	2N1131			2865-325	
VT14		"	BCY31			2865-427	
VT15		"	BFY10			2865-551	
VT16		"	BCY31			2865-427	
VT17		"	BFY10			2865-551	
VT27		"	E5047			2866-035	(Matched Pair)
VT28		"	E5047			2866-035	
VT29		"	BC107			2865-555	
VT21		"	BCY31			2865-427	
VT22		"	"			2865-427	
VT23		"	BFY10			2865-551	
VT24		"	2N1131			2865-325	
VT25		"	BCY31			2865-427	
VT37		"	BCY31			2865-427	
VT38		"	"			2865-427	
VT39		"	"			2865-427	
VT40		"	"			2865-427	
VT41		"	"			2865-427	
VT42		"	"			2865-427	
VT43		"	"			2865-427	
VT44		"	"			2865-427	
VT45		"	2S701			2865-526	
VT46		"	"			2865-526	
VT47		"	BCY31			2865-427	
VT48		"	"			2865-427	
VT31		"	"			2865-427	

Ref.	Value	Item	Type	Wattage	Tol.	Code No.
VT32		Transistor	BCY31			2865-427
VT33		"	"			2865-427
VT34		"	"			2865-427
VT35		"	2S701			2865-526
VT36		"	BFY10			2865-551
RV 4	1 KΩ	Potentiometer	CLR/1206/11S			2723-308
RV 6	1 KΩ	"	"			2723-308
RV 8	10 KΩ	"	"			2723-411
RV 9	1 KΩ	"	"			2723-308
RV10	10 KΩ	"	"			2723-411
RV13	1 KΩ	"	"			2723-308
RV14	2.5KΩ	"	"			2723-341
RV15	500 Ω	"	"			2723-275
RV16	2.5KΩ	"	"			2723-341
RV22	1 KΩ	"	"			2723-308
RV23	250 Ω	"	"			2723-240

COMPONENTS REFERENCE LIST FOR VP.142

Ref.	Value	Item	Type	Wattage	Tol	Code N°.
R 1	22KΩ	Resistor	RFG5-E	1/4W	1%	2633-305
R 2	120 Ω	"	"	1/2W	2%	2631-2518
R 3	470 Ω	"	"	"	"	2631-2657
R 4	470 Ω	"	"	"	"	2631-2657
R 5	120KΩ	"	"	"	"	2631-3232
R 6	22KΩ	"	"	1/4W	1%	2633-305
R 7	100KΩ	"	"	1/2W	2%	2631-3218
R 8	18KΩ	"	"	"	"	2631-3030
R 9	330 Ω	"	"	"	"	2631-2619
R 10	820 Ω	"	"	"	"	2631-2710
R 11	18KΩ	"	"	"	"	2631-3030
R 12	330 Ω	"	"	"	"	2631-2619
R 13	6.8KΩ	"	"	"	"	2631-2936
R 14	47KΩ	"	"	"	"	2631-3131
R 15	470 Ω	"	RFG5-C	2W	5%	2631-6659
R 16	680 Ω	"	RFG5-E	1/2W	2%	2631-269
R 17	8.6KΩ	"	"	"	"	2631-2950
R 18	1 KΩ	"	"	"	"	2631-2734
R 26	22KΩ	"	"	1/4W	1%	2633-305
R 27	22KΩ	"	"	"	"	2633-305
R 28	120 Ω	"	"	1/2W	2%	2631-2518
R 29	470 Ω	"	"	"	"	2631-2657
R 30	470 Ω	"	"	"	"	2631-2657
R 31	120KΩ	"	"	"	"	2631-3232
R 32	22KΩ	"	"	1/4W	1%	2633-305
R 33	100KΩ	"	"	1/2W	2%	2631-3218
R 34	18KΩ	"	"	"	"	2631-3030
R 35	330 Ω	"	"	"	"	2631-2619
R 36	820 Ω	"	"	"	"	2631-2710
R 37	18KΩ	"	"	"	"	2631-3030
R 38	47KΩ	"	"	"	"	2631-3131
R 39	330 Ω	"	"	"	"	2631-2619
R 40	6.7KΩ	"	"	"	"	2631-2936
R 41	470 Ω	"	RFG5-C	2W	5%	2631-6659
R 42	680 Ω	"	RFG5-E	1/2W	2%	2631-269
R 43	8.2KΩ	"	"	"	"	2631-2950
R 44	1 KΩ	"	"	"	"	2631-2734
R 51	27KΩ	"	"	"	"	2631-3078
R 52	10KΩ	"	"	"	"	2631-2974
R 53	680 Ω	"	"	"	"	2631-269
R 54	330 Ω	"	"	"	"	2631-2619
R 55	6.8KΩ	"	"	"	"	2631-2936
R 56	8.2KΩ	"	"	"	"	2631-2950
R 57	1 KΩ	"	"	"	"	2631-2734
R 61	22KΩ	"	"	1/4W	1%	2633-305
R 62	680 Ω	"	"	1/2W	2%	2631-269
R 63	100KΩ	"	"	"	"	2631-3218
R 64	470 Ω	"	"	"	"	2631-2657
R 65	470 Ω	"	"	"	"	2631-2657
R 66	120KΩ	"	"	"	"	2631-3232
R 67	22KΩ	"	"	1/4W	1%	2633-305
R 68	330 Ω	"	"	1/2W	2%	2631-2619
R 69	18KΩ	"	"	"	"	2631-3030
R 70	330 Ω	"	"	"	"	2631-2619
R 71	820 Ω	"	"	"	"	2631-2710
R 72	18KΩ	"	"	"	"	2631-3030
R 73	330 Ω	"	"	"	"	2631-2619
R 74	6.8KΩ	"	"	"	"	2631-2936

Ref	Value	Item	Type	Wattage	Tol	Code N°.
R 75	22KΩ	Resistor	RFG5-E	1/2W	2%	2631-305
R 76	470 Ω	"	RFG5-C	12W	5%	2631-6659
R 77	1.8KΩ	"	RFG5-E	1/2W	2%	2631-2796
R 78	3.9KΩ	"	"	"	"	2631-2873
R 79	3.3KΩ	"	"	"	"	2631-2859
R 86	22KΩ	"	"	1/4W	1%	2633-305
R 87	680 Ω	"	"	1/2W	2%	2631-269
R 88	100KΩ	"	"	"	"	2631-3218
R 89	470 Ω	"	"	"	"	2631-2657
R 90	470 Ω	"	"	"	"	2631-2657
R 91	120KΩ	"	"	"	"	2631-3232
R 92	22KΩ	"	"	1/4W	1%	2633-305
R 93	330 Ω	"	"	1/2W	2%	2631-2619
R 94	18KΩ	"	"	"	"	2631-3030
R 95	330 Ω	"	"	"	"	2631-2619
R 96	820 Ω	"	"	"	"	2631-2710
R 97	18KΩ	"	"	"	"	2631-3030
R 98	22KΩ	"	"	"	"	2631-305
R 99	330 Ω	"	"	"	"	2631-2619
R100	6.7KΩ	"	"	"	"	2631-2936
R101	470 Ω	"	"	2W	5%	2631-6659
R102	1.8KΩ	"	"	1/2W	2%	2631-2796
R103	3.9KΩ	"	"	"	"	2631-2873
R104	3.3KΩ	"	"	"	"	2631-2859
R111	10KΩ	"	"	1/4W	1%	2633-2976
R112	220 Ω	"	"	1/2W	2%	2631-2570
R113	2.2KΩ	"	"	1/4W	1%	2633-2813
R114	10KΩ	"	"	"	"	2633-2976
R115	180 Ω	"	"	"	"	2633-2558
R116	560 Ω	"	"	"	"	2633-2673
R117	680 Ω	"	"	"	"	2633-269
R118	1 KΩ	"	"	"	"	2633-2736
R119	910 Ω	"	"	"	"	2633-2729
R120	750 Ω	"	"	"	"	2633-2705
R121	3.9KΩ	"	"	"	"	2633-2875
R122	9.1KΩ	"	"	"	"	2633-2969
R123	39KΩ	"	"	"	"	2633-311
R124	5.6KΩ	"	"	"	"	2633-2914
R125	180 Ω	"	"	"	"	2633-2558
R126	2.2KΩ	"	"	"	"	2633-2813
R127	560 Ω	"	"	"	"	2633-2673
R128	10KΩ	"	"	"	"	2633-2976
R129	680 Ω	"	"	"	"	2633-2697
R130	1 KΩ	"	"	"	"	2633-2736
R131	910 Ω	"	"	"	"	2633-2729
R132	560 Ω	"	"	1/2W	2%	2631-3395
R133	12KΩ	"	"	"	"	2631-2998
R134	8.2KΩ	"	"	"	"	2631-2950
R135	150 Ω	"	"	"	"	2631-253
R136	8.2KΩ	"	"	"	"	2631-2950
R137	8.2KΩ	"	"	"	"	2631-2950
R138	12KΩ	"	"	"	"	2631-2998
R139	1.2KΩ	"	"	"	"	2631-2758
R140	470 Ω	"	RFG5-C	2W	5%	2631-6659
R146	360KΩ	"	RFG5-E	1/2W	2%	2631-3395
R147	12 KΩ	"	"	"	"	2631-2998

Ref	Value	Item	Type	Wattage	Tol	Code N°.
R148	8.2KΩ	Resistor	RFG5-E	1/2W	2%	2631-2950
R149	150 Ω	"	"	"	"	2631-253
R150	8.2KΩ	"	"	"	"	2631-2950
R151	8.2KΩ	"	"	"	"	2631-2950
R152	12KΩ	"	"	"	"	2631-2998
R153	1.2KΩ	"	"	"	"	2631-2758
R154	470 Ω	"	RFG5-C	2W	5%	2631-6659
R160	43KΩ	"	RFG5-E	1/4W	1%	2633-312
R161	2.7KΩ	"	"	1/2W	2%	2631-283
R162	1 MΩ	"	"	"	"	2631-2458
R163	110KΩ	"	"	"	1%	2633-322
R164	470 Ω	"	"	"	2%	2631-2657
R165	120KΩ	"	"	"	"	2631-3232
R166	470 Ω	"	"	"	"	2631-2657
R167	220KΩ	"	"	"	"	2631-3294
R168	18KΩ	"	"	"	"	2631-3030
R169	1 KΩ	"	"	"	"	2631-2734
R170	1 KΩ	"	"	"	"	2631-2734
R171	18KΩ	"	"	"	"	2631-3030
R172	22KΩ	"	"	"	"	2631-3054
R173	1.8KΩ	"	"	"	"	2631-2796
R174	390 Ω	"	RFH3-2.5	2.5W	5%	2661-063
R175	750 Ω	"	RFG5-E	1/4W	1%	2633-2705
R176	3.9KΩ	"	"	1/2W	2%	2631-2873
R177	3.9KΩ	"	"	"	"	2631-2873
R180	470KΩ	"	"	"	"	2631-3371
R181	470KΩ	"	"	"	"	2631-3371
R182	330KΩ	"	"	"	"	2631-333
R183	330KΩ	"	"	"	"	2631-333
R184	13KΩ	"	"	"	1%	2633-3001
R185	7.5KΩ	"	"	"	"	2633-2945
R186	10KΩ	"	"	"	"	2633-2976
R187	7.5KΩ	"	"	"	"	2633-2945
R188	13KΩ	"	"	1/4W	1%	2633-3001
R189	13KΩ	"	"	"	"	2633-3001
R190	7.5KΩ	"	"	"	"	2633-2945
R191	10KΩ	"	"	"	"	2633-2976
R192	7.5KΩ	"	"	"	"	2633-2945
R193	13KΩ	"	"	"	"	2633-3001
R194	13KΩ	"	"	"	"	2633-3001
R195	7.5KΩ	"	"	"	"	2633-2945
R196	10KΩ	"	"	"	"	2633-2976
R197	7.5KΩ	"	"	"	"	2633-2945
R198	13KΩ	"	"	"	"	2633-3001
R199	13KΩ	"	"	"	"	2633-3001
R200	7.5KΩ	"	"	"	"	2633-2945
R201	10KΩ	"	"	"	"	2633-2976
R202	7.5KΩ	"	"	"	"	2633-2945
R203	13KΩ	"	"	"	"	2633-3001

COMPONENTS REFERENCE LIST FOR VP.142

Ref	Value	Item	Type	Voltage	Tol	Code No.
C 1	0.005µF	Capacitor	CP31G	500	±20%	2741-0754
C 2	100pF	"	CMM1G	750	±10%	2747-0130
C 4	0.005µF	"	CP31G	500	±20%	2741-0754
C 5	100pF	"	CMM1G	750	±10%	2747-0130
C 7	0.002µF	"	CP31G	500	±20%	2741-0691
C 8	10pF	"	CC1D	750	±0.5%	2768-0216
C10	0.002µF	"	CP31G	500	±20%	2741-0691
C11	10pF	"	CC1D	750	±0.5%	2768-0216
C13	0.002µF	"	CP31G	500	±20%	2741-0691
C14	19pF	"	CC1D	750	±5%	2768-0331
C15	0.01µF	"	CP31G	350	±20%	2741-0792
RV 1	1 kΩ	Potentiometer	Colvern DC/I/P	1/2Watt	±10%	2723-3106
RV 2	1 kΩ	"	"	1/2W	±10%	2723-3106
RV 3	1 kΩ	"	"	"	±10%	2723-3106
RV 4	1 kΩ	"	"	"	±10%	2723-3106
RV 5	10 kΩ	"	"	"	±10%	2723-4109
RV 6	10 kΩ	"	"	"	±10%	2723-4109
RV 7	1 kΩ	"	"	"	±10%	2723-3106
RV 8	10 kΩ	"	"	"	±10%	2723-4109
RV 9	10 kΩ	"	"	"	±10%	2723-4109
RV10	25 kΩ	"	Reliance T.W.	2 W	±5%	2726-4412
RV11	30.8kΩ	"	Colvern Spec.	3W	±5%	2726-4513
MR 1		Diode Rectifier	IN914			2862-1494
MR 2		"	"			2862-1494
MR 3		"	"			2862-1494
MR 4		"	"			2862-1494
MR 5		"	"			2862-1494
MR 6		"	"			2862-1494
MR 7		"	"			2862-1494
MR 8		"	"			2862-1494
MR 9		"	"			2862-1494
MR10		Diode Zener	BZY88/C6V8			2864-1528
MR11		"	"			2864-1528
MR12		Diode Rectifier	IN914			2862-1494
MR13		"	"			2862-1494
MR14		"	"			2862-1494
MR15		"	"			2862-1494
MR16		"	"			2862-1494
MR17		"	"			2862-1494
MR18		"	"			2862-1494
MR19		"	"			2862-1494

COMPONENTS REFERENCE LIST FOR VP.142

Ref	Item	Type	Code No.
VT 1	Transistor, Silicon	BCY31	2865-4270
VT 2	"	BCY31	2865-4270
VT 3	"	BFY10	2865-5514
VT 4	"	BCY31	2865-4270
VT 5	"	BCY31	2865-4270
VT 7	"	BCY31	2865-4270
VT 8	"	BCY31	2865-4270
VT 9	"	BFY10	2865-5514
VT10	"	BCY31	2865-4270
VT11	"	BCY31	2865-4270
VT13	"	BCY31	2865-4270
VT14	"	BCY31	2865-4270
VT15	"	BFY10	2865-5514
VT16	"	BCY31	2865-4270
VT18	"	BCY31	2865-4270
VT19	"	BCY31	2865-4270
VT20	"	BFY10	2865-5514
VT21	"	BCY31	2865-4270
VT22	"	BCY31	2865-4270
VT24	"	BCY31	2865-4270
VT25	"	BCY31	2865-4270
VT26	"	BFY10	2865-5514
VT27	"	BCY31	2865-4270
VT28	"	BCY31	2865-4270
VT30	"	BCY31	2865-4270
VT31	"	BCY31	2865-4270
VT32	"	BFY10	2865-5514
VT33	"	BFY10	2865-5514
VT35	"	BCY31	2865-4270
VT36	"	BCY31	2865-4270
VT37	"	BFY10	2865-5514
VT38	"	BFY10	2865-5514
VT40	"	BCY31	2865-4270
VT41	"	BCY31	2865-4270
VT42	"	BFY10	2865-5514
VT43	"	2N1131	2865-3253
VT44	"	BCY31	2865-4270

IMPORTANT NOTE - SPECIFICATION CHANGES

In many circuits alternative components can be used without degrading our published specification. We therefore reserve the right to substitute such alternatives without notice.

Where possible alternative components are given in the reference lists.

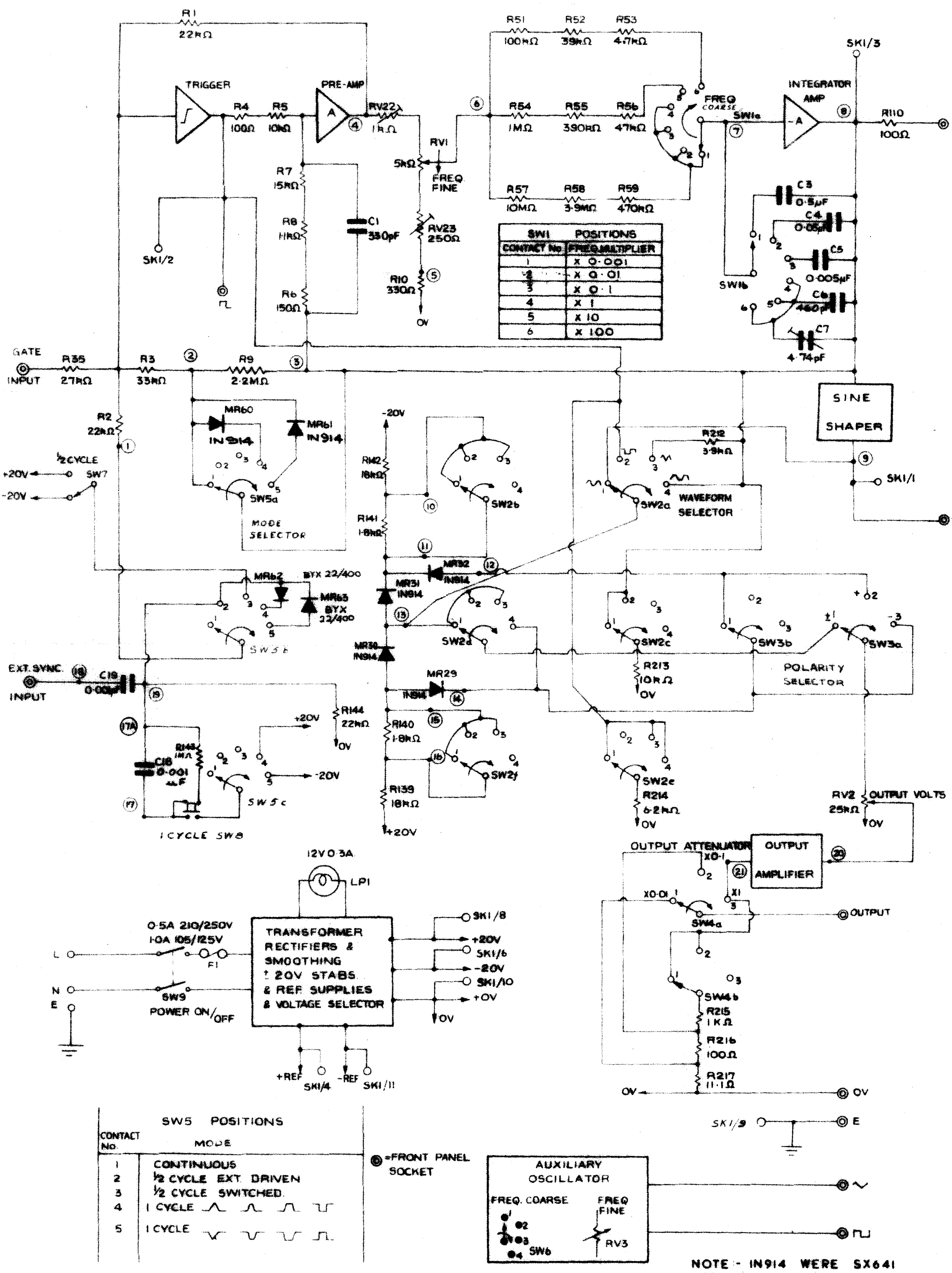
We also reserve the right to change the specification of any standard instrument without notice.

Taylor Servomex Ltd.

Crowborough
Sussex
TN6 3DU

Telephone - Crowborough (089-26) 2181
Telex - 95113

Sheet No. C/0000/12/73



SW1 POSITIONS	
CONTACT No.	FREQ. MULTIPLIER
1	x 0·001
2	x 0·01
3	x 0·1
4	x 1
5	x 10
6	x 100

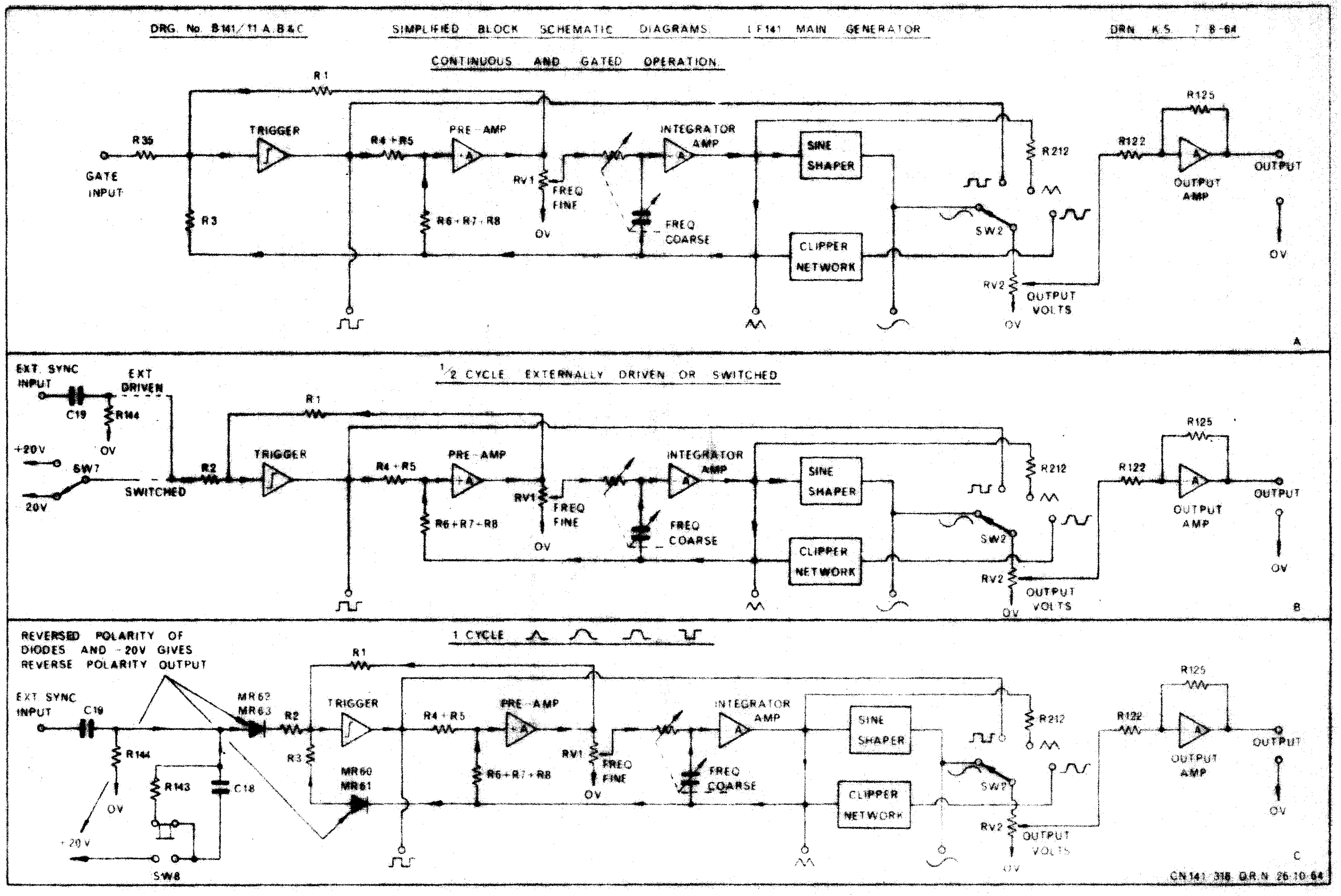
SW5 POSITIONS	
CONTACT No.	MODE
1	CONTINUOUS
2	½ CYCLE EXT. DRIVEN
3	½ CYCLE SWITCHED
4	1 CYCLE
5	1 CYCLE

NOTE :- 1N914 WERE SX641 BEFORE SERIAL No. 141/41

DRG No. B141/2

BLOCK SCHEMATIC LF141

CN141/480 D.R.N. 26·8·65
CN141/318 D.R.N. 26·10·64
CN141/307 D.R.N. 6·10·64
CN141/302 D.R.N. 10·9·64
CN141/685 M.R.C. 4·9·67
CN141/564 M.R.C. 31·3·67



DRG. No. B141/11 A.B&C
SIMPLIFIED BLOCK SCHEMATIC DIAGRAMS. LF141 MAIN GENERATOR
DRN K.S. 7 8 64
CONTINUOUS AND GATED OPERATION.
GATE INPUT
R35
R1
R3
TRIGGER
R4+R5
R6+R7+R8
PRE-AMP
RV1
FREQ FINE
OV
FREQ COARSE
INTEGRATOR AMP
SINE SHAPER
CLIPPER NETWORK
SW2
R212
RV2
OUTPUT VOLTS
R122
R125
OUTPUT AMP
OUTPUT
A
EXT. SYNC INPUT
C19
R144
EXT DRIVEN
+20V
SW7
20V
SWITCHED
R2
1/2 CYCLE EXTERNALLY DRIVEN OR SWITCHED
B
REVERSED POLARITY OF DIODES AND -20V GIVES REVERSE POLARITY OUTPUT
1 CYCLE
MR62 MR63
MR60 MR61
R143
C18
SW8
C
CN141 318 D.R.N 26 10 64

SERVOMEX CONTROLS LIMITED

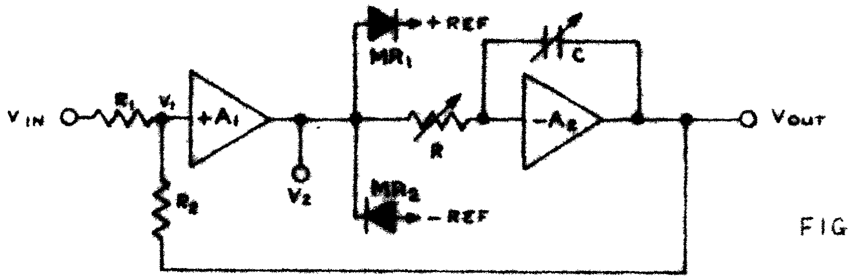


FIG 1

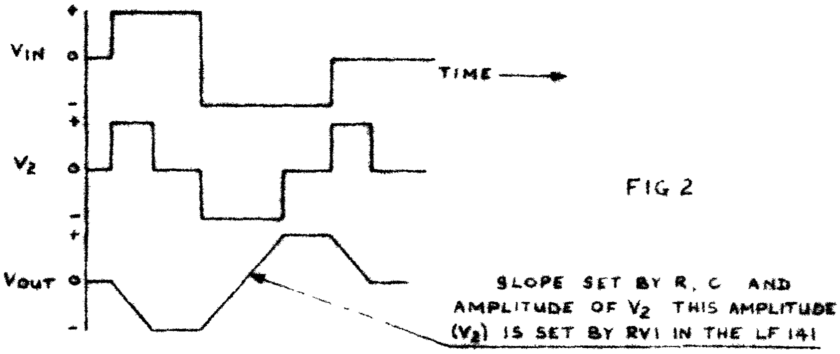


FIG 2

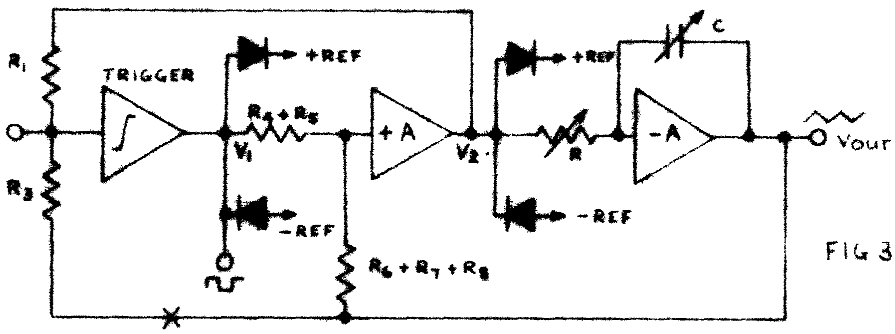


FIG 3

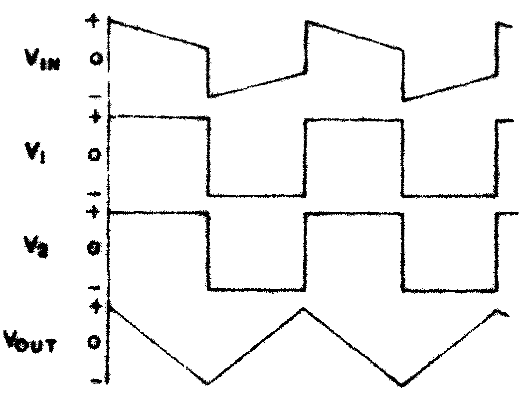


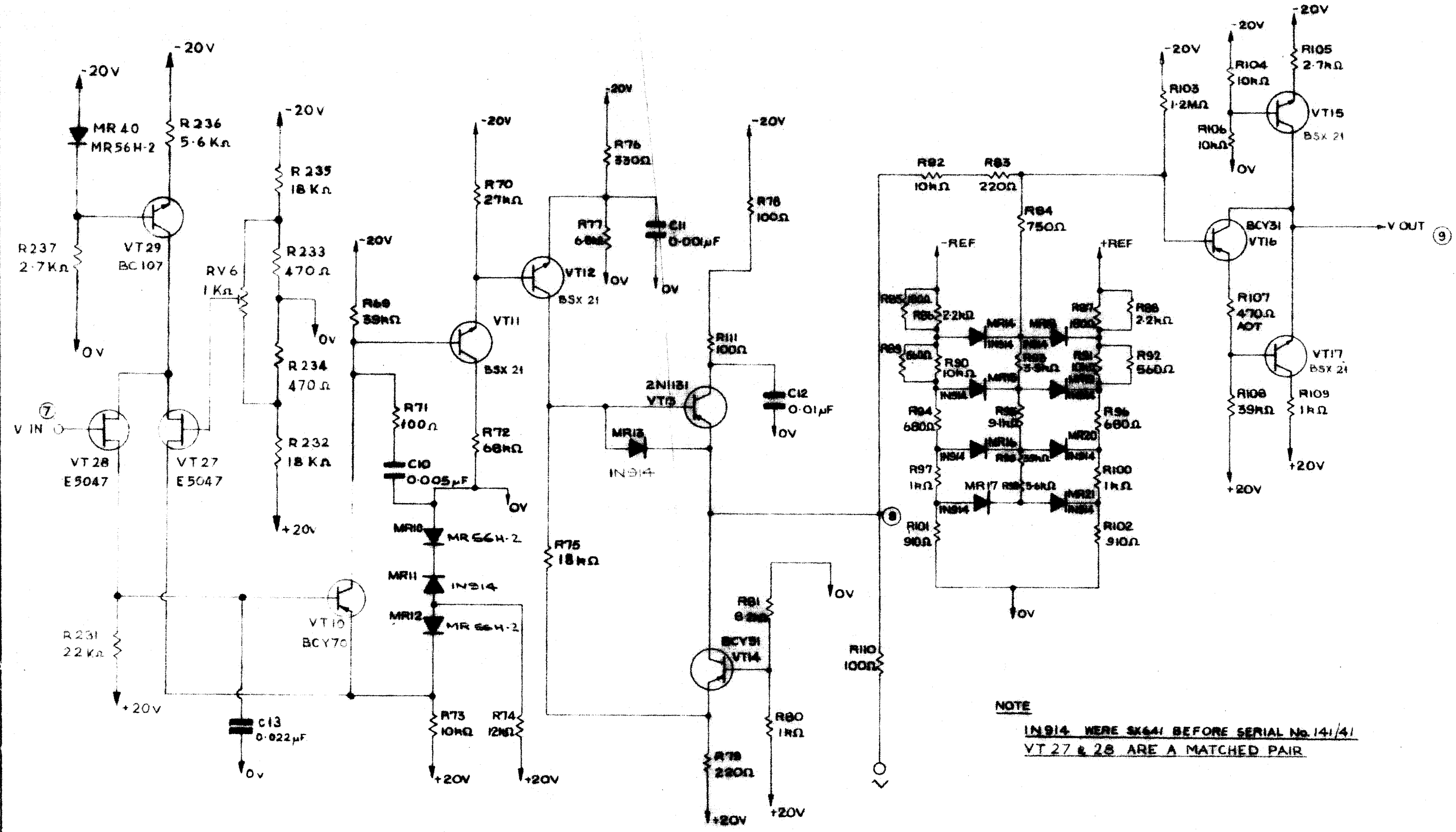
FIG 4

THE WAVEFORMS ARE NOT TO SCALE

CN 41/584 31.3.67 MRC

A141/12

USE THIS SIZE FOR DRAWINGS WHICH HAVE TO BE FILED



NOTE

IN914 WERE SX641 BEFORE SERIAL No. 141/41
VT 27 & 28 ARE A MATCHED PAIR

ALL COMPONENTS ON THIS CIRCUIT ARE ON BOARD 4 A141/75c

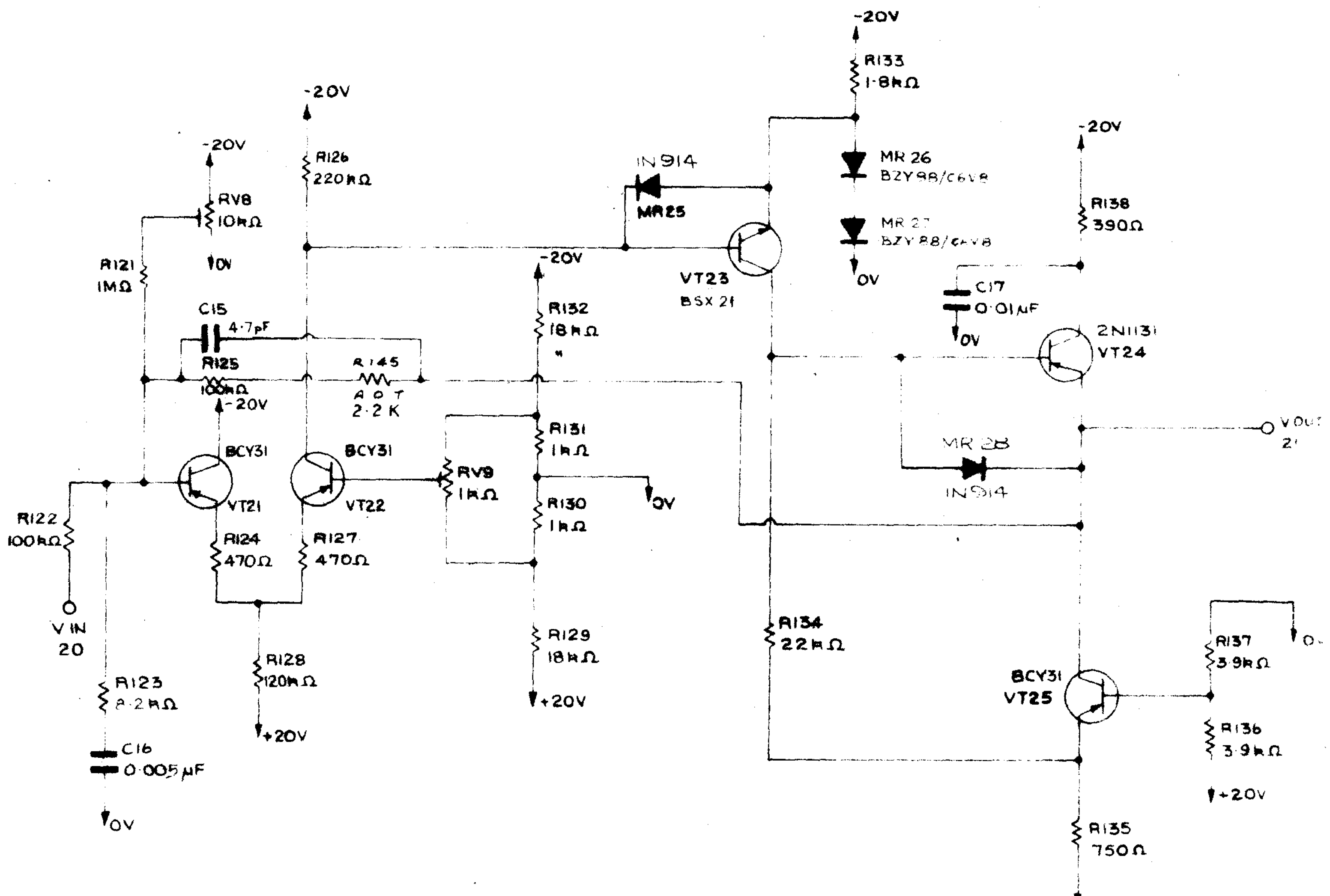
TITLE CIRCUIT INTEGRATOR AMPLIFIER & SINE SHAPER LF141 DATE 19-8-64 DRAWN KS

DRG No 8141/[illegible]

CN 1564	M.R.S.	26 JUN 72
CN 141 / [illegible]	M.R.S.	[illegible] · 1 · 69
CN 141 / 978	M.R.S.	1[illegible] · 7 · 68
CN 141 / 855	M.R.S.	18 · 4 · 68
CN 141 / 807	M.R.S.	10 · 1 · 68
CN 141 / 584	M.R.C.	31 · 3 · 67
CN 141 / 376	G.S.	22 · 3 · 65
CN 141 / 307	B.R.N.	6 · 10 · [illegible]

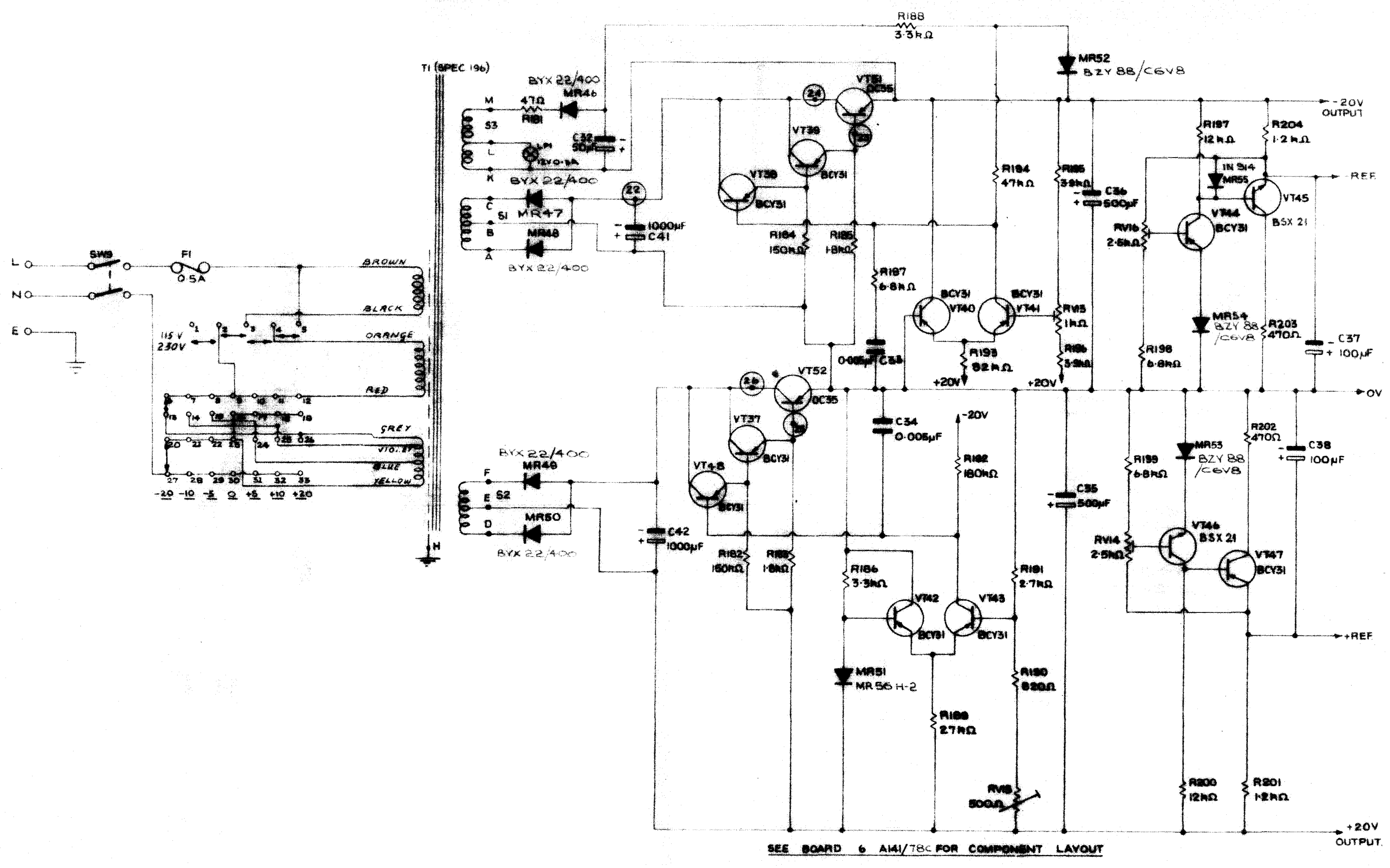
DATE	FM	ED
16 FEB 68	[signature]	[signature]

Issue 6



SEE BOARD 1 (B141-??C) FOR COMPONENT LAYOUT.

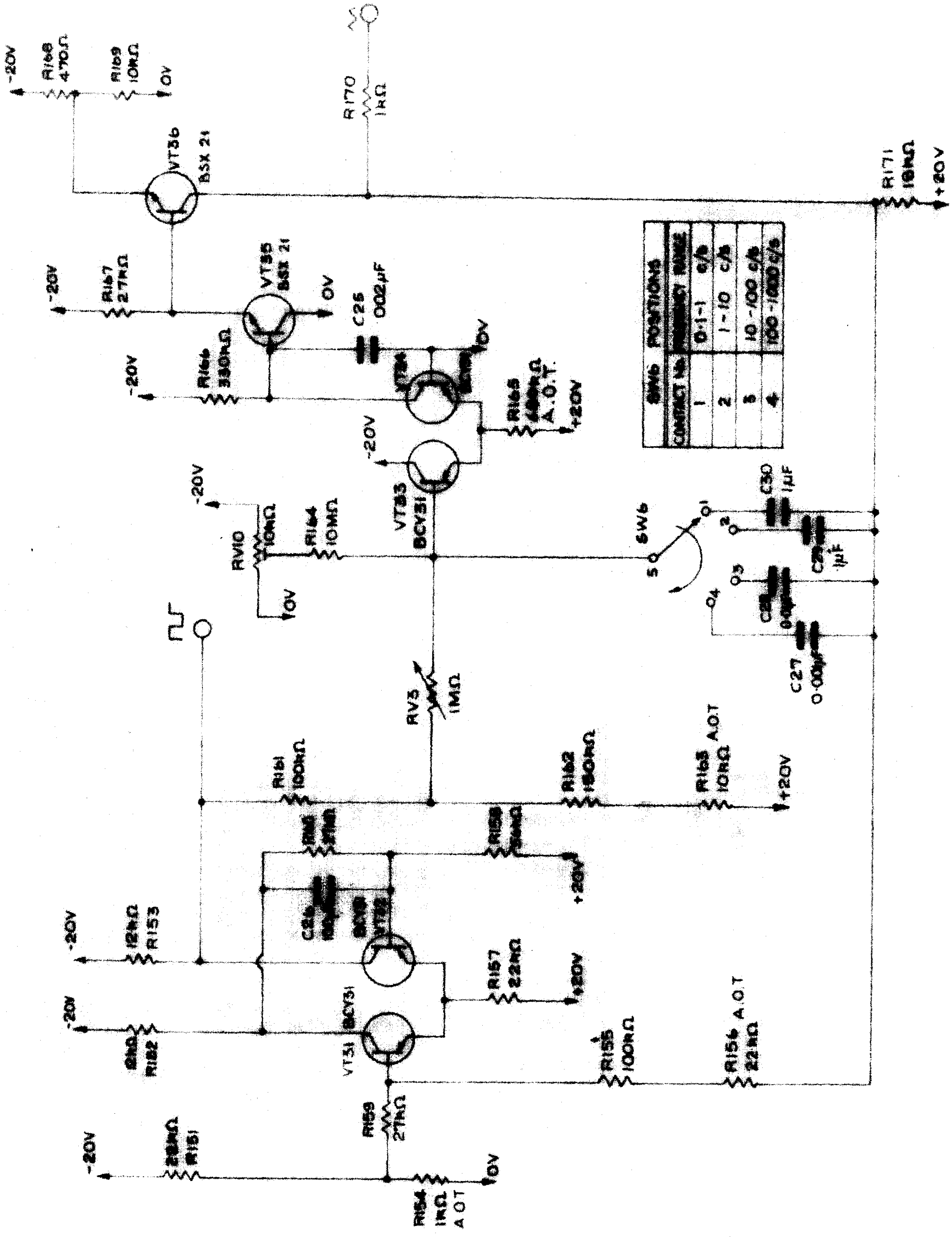
TITLE CIRCUIT, OUTPUT AMPLIFIER LF141 DRAWN KS DATE 13-8-64 DRG. No. A141/10/3



SEE BOARD 6 A141/78C FOR COMPONENT LAYOUT

DRG No B141/7/3

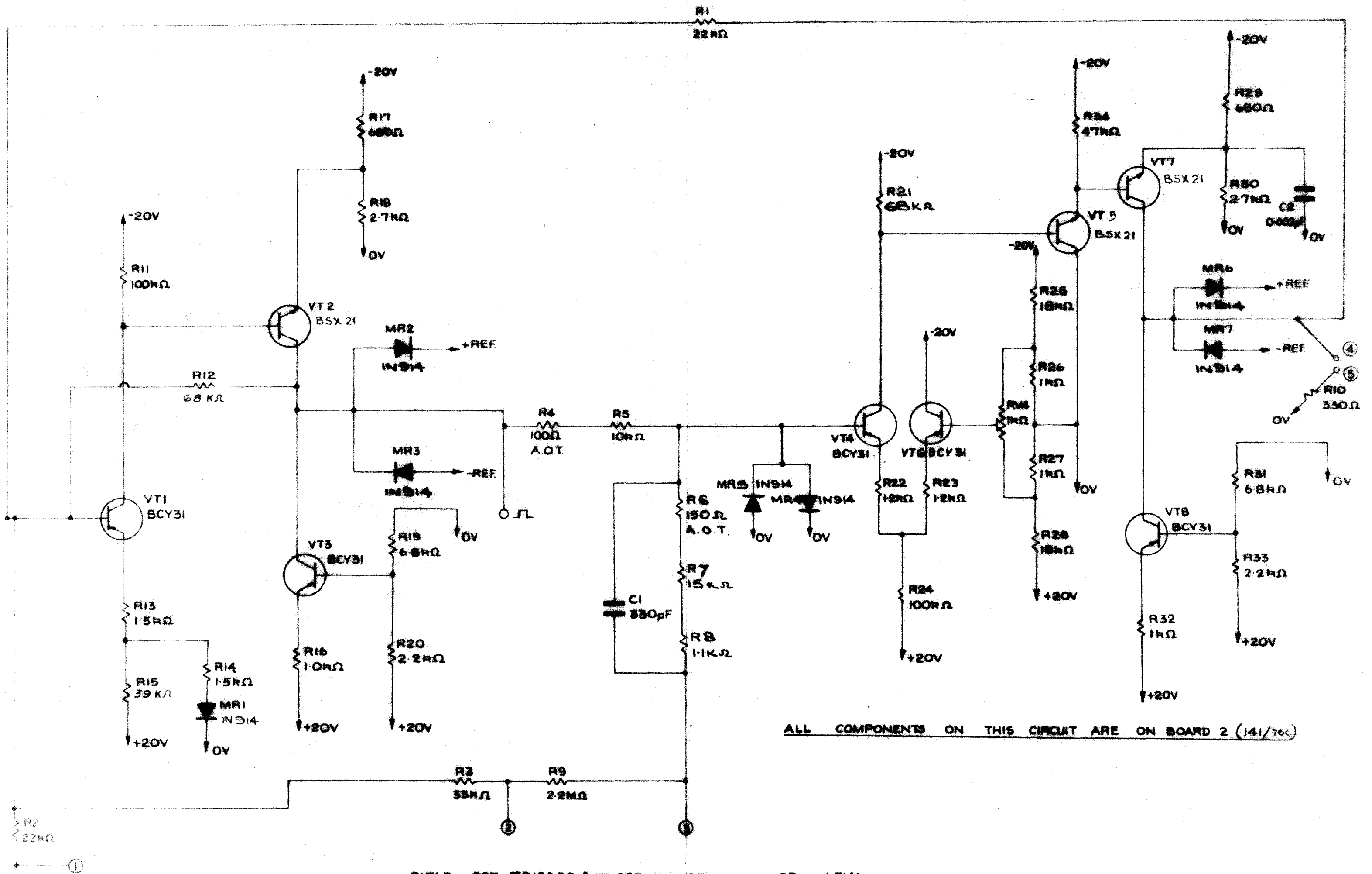
TITLE CIRCUIT, RECT. & SMOOTHING, ± 20V. STABILISERS ± REF. SUPPLIES. LPM1 DRAWN KS DATE 14-8-64



ALL COMPONENTS ON THIS CIRCUIT ARE ON BOARD 5 A141/74 C

TITLE AUXILIARY OSCILLATOR C.C.T. LF141 DRAWN K.S. DATE 20-8-64

DRG. No. A141/6/4



ALL COMPONENTS ON THIS CIRCUIT ARE ON BOARD 2 (141/76C)

TITLE CCT. TRIGGER & INTEGRATOR PRE-AMPLIFIER LF141

DRAWN K.S. DATE 21-8-64 DRG. No. B141/9/3

NOTE
IN914 WERE SX641 BEFORE SERIAL No. 141/41