

PHILIPS



Service



RADIATION MEASURING EQUIPMENT

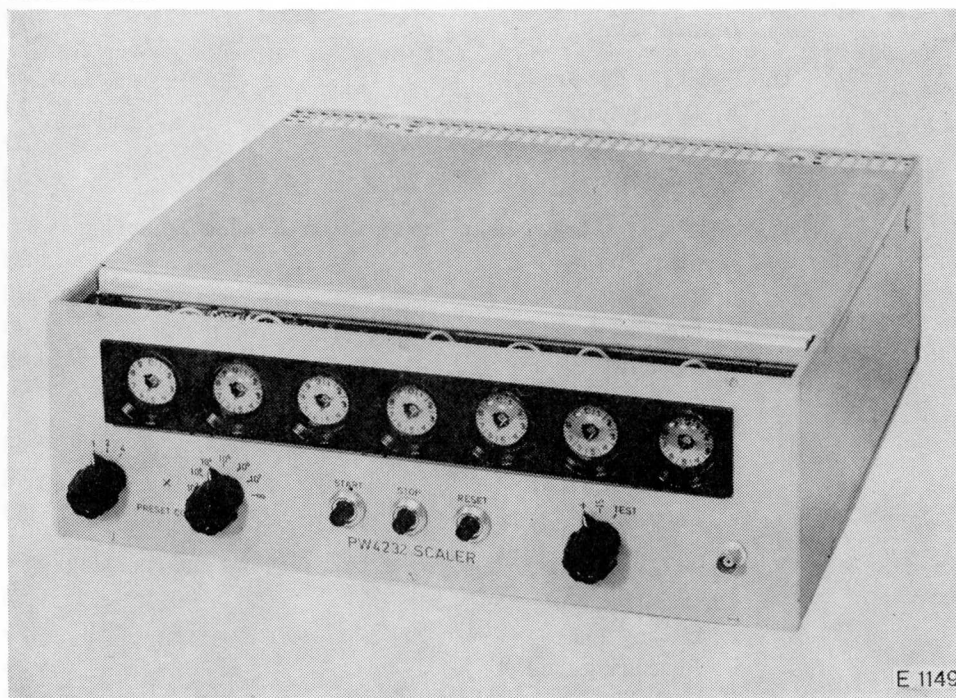
RADIATION MEASURING EQUIPMENT

Manual

Scaler PW 4232

93 772 37.1-10

Printed in Holland



E 1149

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In correspondence concerning this apparatus, please quote the type and serial numbers as given on the type plate.

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GENERAL PART

Introduction



The scaler PW 4232 can be used for counting all kinds of pulses from various sources. The principal application lies however in counting processes.

The resolution is better than 0.1 μ sec.

Moreover, there are many decades and preset-count possibilities. Decade indicator tubes are used for visual display, although this scaler may also be used in combination with a printer control unit and a printer.

The apparatus is provided with a start, stop and reset circuit which can be operated manually by means of push-buttons. After connection of a timer PW 4260 or PW 4261 (the latter with visual display) a number of pulses per unit of time can be measured.

Technical data

Input sensitivity	0.5 V _p , positive, negative or sinewave
Input impedance	1,500 Ω in parallel to 100 pF
Permissible overload	20 V
Waveform	minimum pulse duration 0.05 μsec maximum pulse duration 5 msec
Resolution	0.1 μsec
Counting speed	10 Mc/s
Number of decades	7
Maximum store capacity	10 ⁷ - 1
Preset count possibilities	$\left. \begin{array}{l} 1 \times \\ 2 \times \\ 4 \times \end{array} \right\} 10^2, 10^3, 10^4, 10^5, 10^6, 10^7$
Test facilities	internal - with double the mains frequency external - with a known frequency
Control pulses required	start - stop - reset amplitude 4 V neg. rise time < 3 μsec duration > 20 μsec input impedance > 2,000 Ω
Preset count signal	amplitude 6 V neg. rise time < 2 μsec duration > 20 μsec
Decade output signal	amplitude 5 V pos. rise time: amplifier < 25 nsec 10 Mc/s decade < 0.2 μsec other decades < 1 μsec
Power supply	340 mA at -15 V d.c. 160 mA at 2 × 17.5 V _{r.m.s.} } from PW 4210
Dimensions	4 $\frac{3}{4}$ × 14 $\frac{2}{8}$ × 12 $\frac{2}{4}$ inches (6/7 of the size of a 19" panel)
Weight	35 lbs

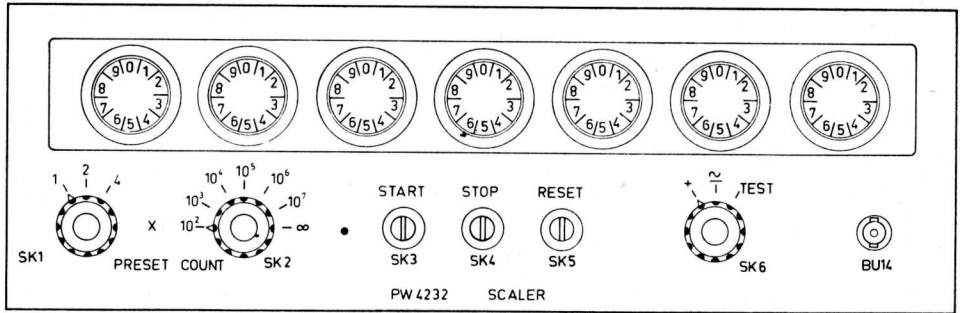


Controls, input and output sockets

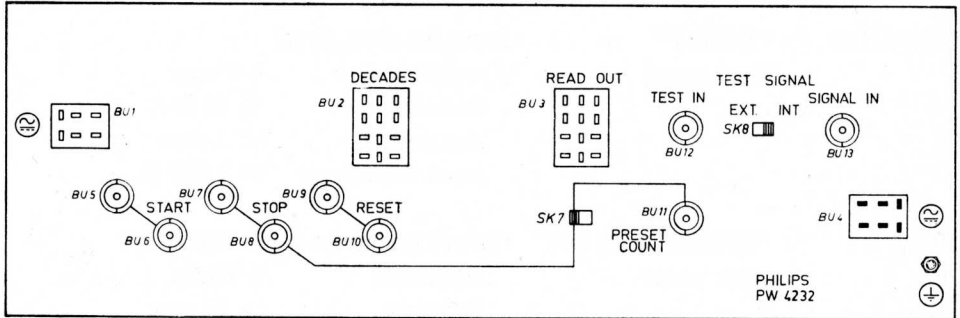
<i>Control or socket</i>	<i>Description and position</i>	<i>Purpose</i>
SK1, SK2	“PRESET COUNT” Front panel	By means of SK1 and SK2, any of the range of preset count possibilities may be selected.
SK3	“START” “STOP” “RESET” Front panel	To operate the apparatus itself and, if desired, other equipment via the sockets at the rear side. The “START” button can be locked by depressing it and giving it a quarter turn. Then it is impossible to stop or reset erroneously.
SK4		
SK5		
SK6	Front panel	The instrument can be adjusted to count positive or negative pulses or a sinewave by means of this switch. In the third position either an internal or external test signal, dependent upon the position of SK8, is applied to the input.
SK7	Rear panel	Interconnect the “PRESET COUNT” (BU11) and the “STOP” sockets (BU7-BU8), so that the preset count signal can be used to stop the whole process.
SK8	“TEST SIGNAL” Rear panel	With SK8 in position “INT.” and SK6 in position “TEST”, a signal of twice the mains frequency is applied internally to the counter. With SK8 in position “EXT.” any suitable test signal may be applied to socket BU12, e.g. the 10 kc/s signal from timer PW 4260.
BU1	Supply output Rear panel	Connected in parallel with BU4, supply input Pin 1 } Pin 2 } mains voltage Pin 3 } Pin 4 } 2 × 17.5 Va.c. Pin 5 -15 V Pin 6 Earth

<i>Control or socket</i>	<i>Description and position</i>	<i>Purpose</i>
BU2	Decade output Rear panel	Pin 1 – 7th decade 2 – 6th decade 3 – 5th decade 4 – 4th decade 5 – 3rd decade 6 – 2nd decade 7 – 1st decade 8 – Output of the input signal after having been shaped and amplified 9 – blank 10 – blank 11 – earth 12 – earth
		} Each decade produces a + 5 V signal when it is full
BU3	Decade input Rear panel	Pin 1 – input 7th decade 2 – input 6th decade 3 – input 5th decade 4 – input 4th decade 5 – input 3rd decade 6 – input 2nd decade 7 – input 1st decade 8 – common output of all the decades 9 – blank 10 – blank 11 – earth 12 – earth
BU4	Supply input Rear panel	Connected in parallel with BU1
BU5-BU6	“START” Rear panel	Input signal to start counting process amplitude 4 V neg. duration > 20 μ sec rise time < 3 μ sec input impedance > 2,000 Ω

<i>Control or socket</i>	<i>Description and position</i>	<i>Purpose</i>
BU7-BU8	“STOP” Rear panel	Input or output for stop signal Input: amplitude 4 V neg. duration > 20 μ sec rise time < 3 μ sec input impedance > 2,000 Ω Output: amplitude 6 V neg. duration > 20 μ sec rise time < 2 μ sec
BU9-BU10	“RESET” Rear panel	Input for reset signal amplitude 4 V neg. duration > 20 μ sec rise time < 3 μ sec input impedance > 2,000 Ω
BU11	“PRESET COUNT” Rear panel	Output for preset count signal amplitude 6 V neg. duration > 20 μ sec rise time < 2 μ sec
BU12	“TEST IN” Rear panel	Input for external test signal. Characteristics same as for main input.
BU13	“SIGNAL IN” Rear panel	Input signal: positive, negative or sinewave
BU14	Signal input Front panel	Input signal: positive, negative or sinewave



SMA 668
E 1170



SMA 667
E 1150

Fig. 1. Front and rear view

Description of the block diagram

IV

The input signal of the scaler is first of all applied to an amplitude limiter. This is necessary because too large pulses will damage the transistors. The signal is then applied to a stage which can select the polarity of the pulse to be measured, according to the position of switch SK6. This switch has also a test position, so that a signal with a known frequency can be applied to the scaler for a performance check. Depending on the position of switch SK8 either an internal test signal with a frequency of 100 c/s, obtained from full-wave rectification of the mains voltage, or an external signal can be applied to the input of the scaler. For the external test source use can be made of e.g. the 10-kc/s signal from timer PW 4260. After the phase inverter, the signal is applied to a gate. This is controlled by the start and stop pulses. As a result of this the gate is only open during counting periods. After the gate there is a Schmitt-trigger to provide the fast rise times required for reliable operation of the 10 Mc/s decade. The interrogation pulses for the 10 Mc/s decade are fed in at this point, so that they have to pass the Schmitt-trigger too. The purpose of these pulses will be described further on.

Now a chain of seven divide-by-ten stages connected in series follows. These decades consist of a scale-of-two circuit connected to a scale-of-five circuit. The two output lines of the scale-of-two circuit and the five output lines of the scale-of-five circuit are combined by means of ten "and"-gates to ten lines which control the decade indicator tube. To avoid interference phenomena when the frequency of the signal applied is higher than 120 c/s, a diode pump circuit in series with a Schmitt trigger is connected between the decade input and the zero line of the indicator tube. In case the frequency is higher, the Schmitt-trigger switches over, keeping the tube in its zero position. The decade, however, counts normally. After the counting process is finished, no signal is applied to the decades any longer. Consequently the Schmitt-trigger assumes its original position and the tube indicates the digit stored in the decade.

The first decade has to operate at a high frequency and the circuitry is therefore somewhat different from the rest. The second and third decades also slightly differ from the other four for the same reason. Any of the six outputs of the second to the seventh decade inclusive may be selected by means of switch SK2. So after 10^2 , 10^3 , 10^4 , 10^5 , 10^6 or 10^7 pulses, dependent on the position of SK2, a pulse will be applied to the preset count circuit. This circuit consists of two scale-of-two circuits. Depending

on the position of switch SK1, the decade output pulse is applied, via two or one scale-of-two circuits or directly, to a gate and an emitter follower. This results in possible multiplication factors of 4, 2 and 1 for the preset count.

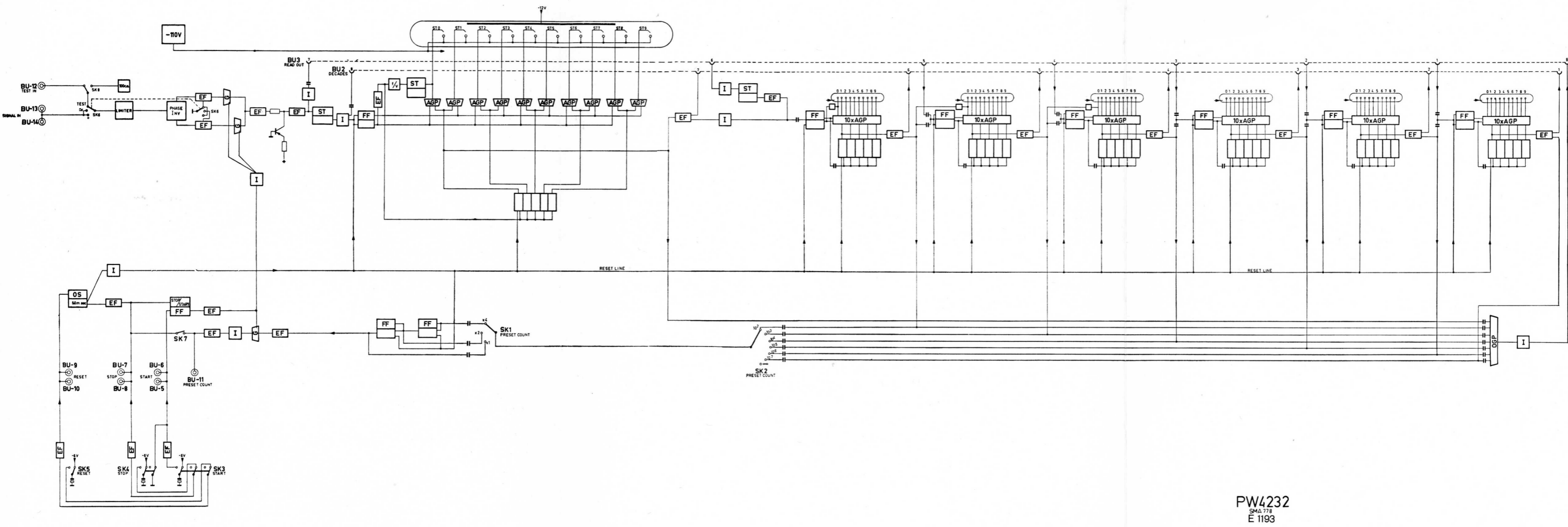
The gate, through which the decade output pulse has to pass, is only open when the scaler is actually counting. Its purpose is to block the decade output pulses during the interrogation process.

After passing this gate, the pulse is available at socket "PRESET COUNT" (BU11) and can be used for operating other apparatuses. If switch SK7 is closed, the pulse also reaches the "STOP" sockets (BU7-BU8). The start-stop flip-flop is triggered into the stop state and as a result of this the input gate is closed and the counting process is stopped.

This stop signal can also be applied to printer control unit PW 4200 to initiate the read-out process. During the read-out, the printer control unit generates interrogation pulses, which are applied to each decade in turn and to a memory circuit in the printer control unit, circuited in parallel with each decade interrogated. The interrogation pulses are first applied to the decade on panels T (scale-of-two circuit) and U (scale-of-five circuit). When this decade is full, it produces an output pulse in the normal manner. This pulse is applied to the printer control unit via an "or"-gate. The number of pulses to fill this decade, recorded in the digit determinator, selects a particular printer key, which will be actuated when the operational command is received from the decade, i.e. the pulse produced when this decade is full. The next decade is then interrogated in a similar way and so on, until all the decades have been interrogated. Now the printer prints out the information and the printer control unit produces a print-finished pulse which can be used as a reset signal to return all the decades, scale-of-two stages and the start-stop circuit to their stand-by positions.

This reset pulse may also originate from the built-in control circuit, if a manual reset is required.

When preset count switch SK1 is set to position " ∞ " (infinite), the scaler does not provide a stop pulse. This pulse is obtained from the built-in control circuit or from a timer which has reached a preset time. The output from each decade is available at BU2 and can be used to operate a rate meter or similar equipment.



PW4232
SMA 778
E 1193

Fig. 2. Block diagram

Measuring data



A. PRESALE TEST

Recommended measuring apparatus

Oscilloscope	Time base: 25 nsec/cm; sensitivity 1 V/cm
D.C. microvoltmeter	GM 6020
H.F. generator	GM 2893
L.F. generator	GM 2308
Pulse generator	GM 2314
Amplifier	Amplification: 10×; frequency response: flat up to 20 Mc/s
Multi-meter	P 817 00
Low-voltage supply	PW 4210

Mechanical check

- Check the soldering joints of the wiring to the sockets and panels.
- Check the position of the wiring.
- When the panels are raised, the wiring should not be damaged.
- The mounting of the panels on the spindle should show no signs of play.
- The spindle should be greased a little with vaseline.
- The panels should turn easily.
- Components or soldering pins should not protrude from the panel.
- The switches should function properly.
- Check that the knobs do not damage the text plate.
- Plugs should be properly mounted in the right position.
- All screws and nuts should fit. The apparatus should have a neat appearance.

Electrical check

- The sockets BU1 and BU4 should be properly connected in parallel.
- The sockets for start (BU5-BU6) should be connected in parallel, as well as the sockets for stop (BU7-BU8) and reset (BU9-BU10).
- If SK7 is closed (left-hand position), the preset count socket (BU11) should be connected to the stop sockets (BU7-BU8).

Connect the low voltage supply PW 4210 to BU4 of the scaler. The current drain at -15 V amounts to $330-360\text{ mA}$. The current drain at $2 \times 17.5\text{ V}_{\text{r.m.s.}}$ amounts to $160-180\text{ mA}$.

The voltage between the terminals 1 (+) and 7 (-) of panel Z1 should lie between 110 and $120\text{ V}_{\text{d.c.}}$

Start, stop and reset circuit

When pressing the start, stop and reset push-buttons, a signal as shown in Fig. 3 should appear on the start sockets (BU5-BU6), the stop sockets (BU7-BU8) and the reset sockets (BU9-BU10) respectively.

When pressing the start push-button while the stop push-button is kept depressed, no signal will appear on the start sockets (BU5-BU6).

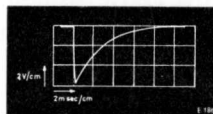


Fig. 3. Start, stop or reset signal

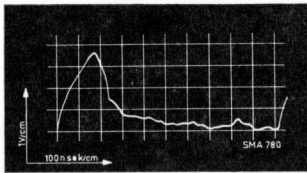
When the stop or reset push-button is pressed while the start push-button is kept depressed, no signal will appear on the stop sockets (BU7-BU8) or reset sockets (BU9-BU10).

This pulses should be measured under load. This can be done by connecting a $220\text{-}\Omega$ resistor between the signal line of the socket and earth. Set switch SK6 to position "TEST" and SK8 to position "INT.". Apply a negative pulse of 4 V with a pulse duration 0.5 msec and a rise time $< 5\text{ }\mu\text{sec}$ to the start, stop and reset sockets. Now the apparatus should start, stop and reset respectively.

Decades

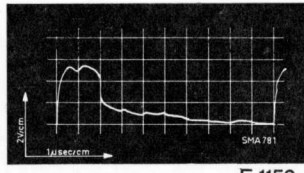
Apply a sinusoidal signal with a frequency of 10 Mc/s and an amplitude of $2\text{ V}_{\text{p-p}}$ to the input. Preset count adjusted to " ∞ " and the polarity switch SK6 in position " \sim ". Measure the signals at socket "DECADES" (BU2).

The amplitude of the signals at pins 4, 3, 2 and 1 of BU2 is as shown in Fig. 6, only these signals are more differentiated as the frequency decreases.



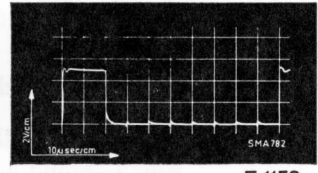
E 1151

Fig. 4. Signal at pin 7 of socket BU2



E 1152

Fig. 5. Signal at pin 6 of socket BU2



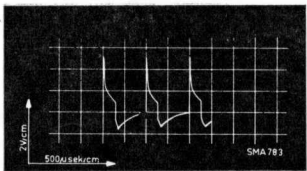
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Fig. 6. Signal at pin 5 of socket BU2

Both scale-of-two circuits

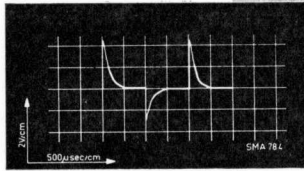
Apply an input signal as mentioned in the above section. The preset count selector may not be in position “∞”. Switch SK7 should be in the right-hand position.

At terminal 7 of panel A the following signals are measured.



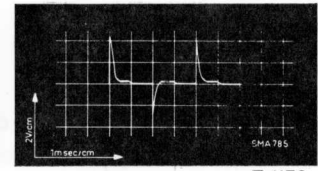
E 1154

Fig. 7. SK1 in position '1'



E 1155

Fig. 8. SK1 in position '2'



E 1156

Fig. 9. SK1 in position '4'

Polarity choice

Apply a positive signal with a frequency of 1 kc/s, a pulse duration of 1 µsec and an amplitude of 2 V_{p-p} to the input.

In position “+” of switch SK6 the apparatus should function. In position “~” the counting process does not proceed.

Invert the phase of the input signal. Now in position “~” the apparatus starts functioning.

In position “TEST” of selector SK6 no input signal should be counted, only a test signal (internal or external).

Test signals

Set switch SK8 at the rear of the apparatus to position "INT.", switch SK7 to the left-hand position and adjust a preset count of 1×10^3 by means of switches SK1 and SK2. Ten seconds after starting, the counter stops.

It will be obvious that this value only applies to a mains frequency of 50 c/s.

Set switch SK8 to position "EXT.". Apply a positive signal with a frequency of 1 kc/s, a pulse duration of 1 μ sec and an amplitude of $2 V_{p-p}$ to socket "TEST IN" (BU12). Adjust a preset count of 1×10^4 by means of switches SK1 and SK2. Ten seconds after starting, the counter stops. If this signal is inverted in phase the scaler should not count.

Sensitivity

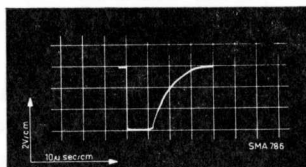
The input sensitivity for positive or negative pulses at a p.r.f. of 0.2 Mc/s and a pulse duration of 0.75 μ sec amounts to maximum $0.5 V_{p-p}$.

Apply a sinusoidal voltage with a frequency of 10 Mc/s. The sensitivity should lie between 600 and 1600 mV_{p-p}.

Adjust the amplitude to $2 V_{p-p}$ and determine up to which frequency the scaler functions correctly. This should be 13 Mc/s or more.

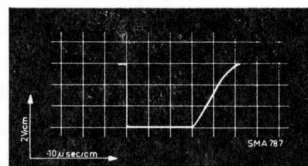
Preset count

Apply a signal of 10 kc/s to the scaler and set switch SK7 to right-hand position. The pulses will appear on socket BU11 at an interval depending on the position of the preset count switches SK1 and SK2. The signal at BU11 should be measured under load. This can be done by connecting a 220- Ω resistor between the signal line of this socket and earth.



E 1157

Fig. 10. Preset count signal, switch SK1 in position 1



E 1158

Fig. 11. Preset count signal, switch SK1 in position 2 or 4

CIRCUIT DESCRIPTION

Introduction



This following description deals with the circuits which are not described in the booklet "Basic Considerations"*)).

The electrical circuitry of the apparatus consists of printed wiring boards mounted in frames as described in the above mentioned booklet. The panels are named after the letters of the alphabet in such a way that seen from the rear of the apparatus panel A is situated at the extreme left, after that panel B, etc., with the exception of the panels V, W and X. The panels V and W are mounted in the back part of the apparatus and panel X in the front part. At the extreme right the power supply is mounted, which comprises two printed wiring boards: Z₁ and Z₂.

The sequence of the description is:

Pre-amplifier,	panel D
10 Mc/s scale- of-two circuit, read-out and clamping,	panel E
10 Mc/s scale-of-five circuit,	panel F
1 Mc/s scale-of-two circuit, read-out and clamping circuit,	panel G
1 Mc/s scale-of-five circuit,	panel H
100 kc/s scale-of-two circuit, read-out and clamping circuit,	panel K
100 kc/s scale-of-five circuit,	panel L
10 kc/s scale-of-two circuit, read-out and clamping circuit,	panel M
10 kc/s scale-of-five circuit,	panel N
10 kc/s scale-of-two circuit, read-out and clamping circuit,	panel O
10 kc/s scale-of-five circuit,	panel P
10 kc/s scale-of-two circuit and read-out circuit,	panel R
10 kc/s scale-of-of-five circuit,	panel S
10 kc/s scale-of-two circuit and read-out circuit,	panel T
10 kc/s scale-of-five circuit,	panel U

* This booklet can be ordered under ordering number 66 480 63.1-10

Two scale-of-two circuits, "or"-gate and input for interrogation pulses for 1 – Mc/s decade,	panel B
Start, stop and reset circuits,	panel A
Control circuit,	panel C
Power supply,	panels Z ₁ and Z ₂
Interconnecting panel,	panel V
Input panel,	panel W
Signal input panel,	panel X

Attention

As the frequencies of the signals applied are 10 Mc/s and higher earthing is very important. Therefore, see to it that a good connection between the earth terminals of the scaler and the measuring apparatus has been provided.

LIST OF PARTS NOT MOUNTED ON PRINTED WIRING PANELS

<i>Position</i>	<i>Description</i>	<i>Code number</i>	<i>Quantity</i>
BU1	Panel socket, 6-pole	W4 101 61	1
BU2-BU3	Panel socket, 12-pole	W4 101 63	2
BU4	Panel plug, 6-pole	W4 101 60	1
BU5-BU14	Coaxial socket	W4 101 66	10
SK1	Divider switch	W4 151 71	1
SK2	Preset count switch	W4 151 75	1
SK3	Push-button switch	970/½ × 350	1
SK4	Push-button switch	970/½ × 350	1
SK5	Push-button switch	970/½ × 350	1
SK6	Polarity selector	W4 151 79	1
SK7-SK8	Slide switch	970/29	2
LA1-LA7	Decade indicator tube	Z 550 M	7
	Tube socket	B8 700 67	7
LA8	Indication lamp	8108 N	1
	Lamp holder	976/1 × 9	1
	Knob	973/08	3
	Text plate	4822 172 01359	1
C1	Polyester capacitor, 56,000 pF 125 V 10%	906/L56K	1

Panel D - Pre-amplifier



A. DESCRIPTION

As input pulses with large amplitudes may damage the first transistor, some limiting circuit must be incorporated. The diodes Gr3, Gr4, Gr5 and Gr6 with the resistors R1, R2, R3, R4, R5 and R6-R7 form such a circuit. With no input pulse, the voltage at the base of transistor TS1 is controlled by the two parallel-circuited voltage dividers, one of which is formed by the diode circuit and the other by the resistors R6 and R7. A positive input pulse makes diode Gr3 conductive and changes the potential at junction Gr3 and Gr4 into a positive value. The diodes Gr4 and Gr5 will now be biased in the reverse direction, which means that now only the resistors R3, R4 and R5 are in parallel with the voltage divider R6-R7. This results in a positive-going signal at the base of transistor TS1.

A negative input pulse makes diode Gr5 conductive and changes the potential at junction Gr5 and Gr6 into a negative value. The diodes Gr6 and Gr3 will now be biased in the reverse direction, which means that now only resistors R1 and R2 are in parallel with the voltage divider R6-R7. This results in a negative-going signal at the base of transistor TS1.

A negative pulse at the base of this transistor causes it to become more conductive. As a result of this the emitter potential becomes more negative and the diode Gr9 draws current. Therefore the voltage drop across resistor R14 increases and the emitter of TS2 becomes more negative.

A negative pulse on the base of TS1 causes a positive pulse on its collector. Via the amplifier stage TS3 the pulse is applied to emitter follower TS6. When negative pulses are counted, switch SK6 is in position “ \sim ” and in this position resistor R21 is free from earth. So the potential at junction R19-R21 is about -14 V and diode Gr10 is biased in the reverse direction. A positive pulse at the cathode of Gr10 will therefore have no effect. As a result of the negative pulse at the input, the emitter of TS2 becomes more negative. The collector becomes also more negative and this negative pulse is applied to emitter-follower TS5 via TS4. As the resistor R22 is earthed via switch SK6, the potential at junction R20-R22 is -8.9 V, so that the diode Gr12 is biased in the forward direction and the negative pulse passes through the gate. In the start position the potential at the cathodes of Gr11 and Gr13 is -9.3 V. The potential at the anode of Gr13

is -8.9 V, so that this diode is conductive. The potential at the anode of Gr11 is -14 V, so that this diode is cut off. In the stop position the potential at the cathodes is -6.8 V, so that both diodes are cut off. Transistor TS7 is controlled by the start-stop flip-flop on panel A.

If positive pulses are applied to the input, the various voltages are as indicated in the diagram.

The negative pulses are applied to emitter follower TS8.

Transistor TS9 serves as a constant current source. By means of this circuit the pulse-height is reduced by a constant amount (the product of the current and the value of R27) to control Schmitt trigger TS12, TS13 and TS14 via emitter follower TS10. Inverter stage TS11 is used to feed in the interrogation pulses for the 10 Mc/s decade (panels E and F) during the read-out. The Schmitt trigger transmits a constant pulse to the decades via amplifier TS15. To enable fast switching Zener diode Gr18 is used as coupling between the transistors TS13 and TS14.

B. MEASURING DATA

Load current

The load current, caused by the negative supply voltage of 15 V, amounts to 45-55 mA, positive side of the supply voltage connected to terminal 9, negative side to terminal 6.

The load current, caused by the positive supply voltage of 15 V, amounts to 15-20 mA, positive side of the supply voltage connected to terminal 7, negative side to terminal 9.

Gate control terminal 5 carrying a voltage of -4 V and terminal 4 earthed.

D.C. voltages

Measure the voltage at the base of TS1 with respect to earth. This should be ≤ 50 mV. The voltage at terminal 1 of this print should be 150 mV with respect to earth. Measure the voltage at the collectors of TS3 and TS4. These should be $9.4 \text{ V} \pm 5\%$. The difference between these two voltages should not exceed 600 mV.

Measure the voltage at the emitter of TS8. This should be -9 V. When increasing the gate-control voltage at terminal 5 from -4 V to -10 V, the emitter voltage of TS8 should rapidly change from -9 V into -6.5 V at a gate-control voltage of about -7 V.

Decrease the gate-control voltage to -4 V again. Measure the cut-off voltage of transistor TS12. This positive V_{be} should be > 700 mV.

Input sensitivity

Apply a signal with a frequency of 10 kc/s, a pulse duration of 1 μ sec and a variable amplitude to the input. Measure the sensitivity. Minimum input voltage should lie between 300 and 500 mV_{p-p}.

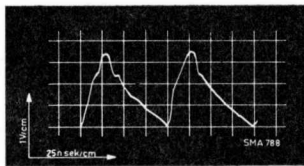
Determine the input sensitivity with a 10 Mc/s and a 50 c/s - sinusoidal signal in the same way. The minimum input voltage for either signal should lie between 600 and 1600 mV_{p-p}. Check these sensitivities in position “+” as well as in position “ \sim ”.

Input frequency

Apply a sinusoidal signal with an amplitude of 1 V_p to the input. Increase the frequency and determine the frequency up to which the scaler functions properly. This should be ≥ 13 Mc/s. Check this in position “+” as well as in position “ \sim ”.

Output signal

Apply a sinusoidal signal with a frequency of 10 Mc/s and an amplitude of 2 V_{p-p} to the input. The shape of the output signal at terminal 11 should be as shown in Fig. 12.



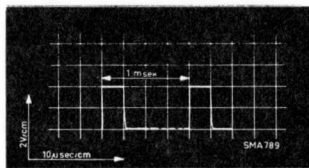
E 1159

Fig. 12. Output signal at terminal D.11

Interrogation pulses

Apply a positive signal with a frequency of 1 kc/s, a pulse duration of 100 μ sec and an amplitude of 4 V to terminal 8. Apply a d.c. voltage of -12 V to terminal 5.

The output signal shape should be as shown in Fig. 13.



E 1160

Fig. 13. Output signal from interrogation pulses

Apply the same signal to the input and increase the amplitude from 4 V to 20 V. The shape of output signal should be as shown in Fig. 13.

C. PARTS LIST

<i>Description</i>	<i>Codenumber</i>	<i>Value</i>
All transistors except TS11	ASZ21 OC141	
Diodes		
Gr1	OAZ203	
Gr2	OAZ203	
Gr3	OA90	
Gr4	OA90	
Gr5	OA90	
Gr6	OA90	
Gr7	OAZ201	
Gr8	AAZ13	
Gr9	AAZ13	
Gr10	AAZ13	
Gr11	AAZ13	
Gr12	AAZ13	
Gr13	AAZ13	
Gr14	OAZ204	
Gr15	AAZ13	
Gr16	AAZ13	
Gr17	AAZ13	
Gr18	OAZ204	
Gr19	OAZ203	
All resistors except R4	B8 305 80B/... 902/P...	0.1 W 5% $\frac{1}{4}$ W 5%
R6	B8 305 80A/220K	0.22 M Ω 10%
R9	901/1K5	1,500 Ω $\frac{1}{8}$ W 2%
R10	901/1K5	1,500 Ω $\frac{1}{8}$ W 2%
R13	901/4K7	4,700 Ω $\frac{1}{8}$ W 2%
R14	901/4K7	4,700 Ω $\frac{1}{8}$ W 2%
R27	901/3K	3,000 Ω $\frac{1}{8}$ W 2%
R29	901/5K6	5,600 Ω $\frac{1}{8}$ W 2%
All capacitors ceramic	904/...	
except C2	909/W10	10 μ F 16 V
C8	909/W10	10 μ F 16 V

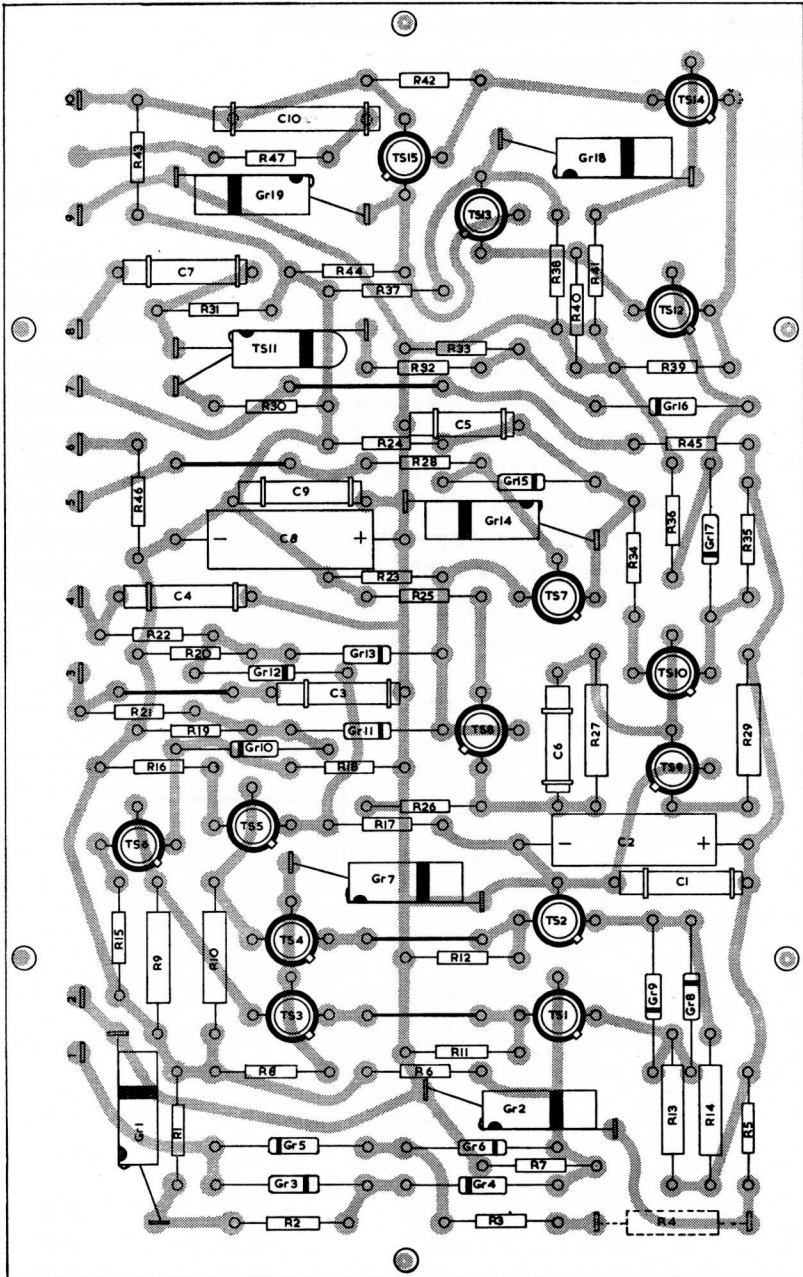
SMA 674
E 1184

Fig. 14. Circuit lay-out of panel D

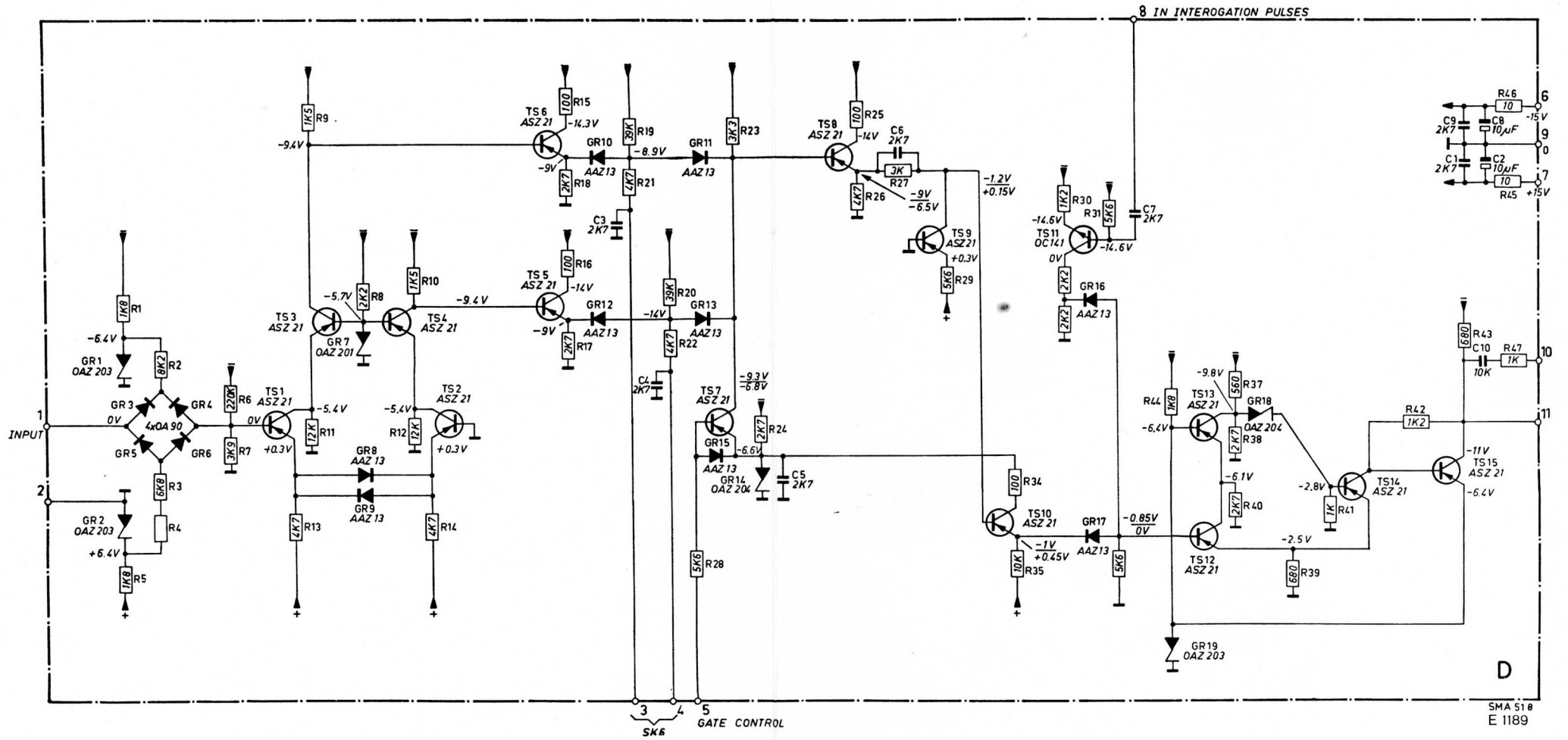


Fig. 15. Diagram of panel D

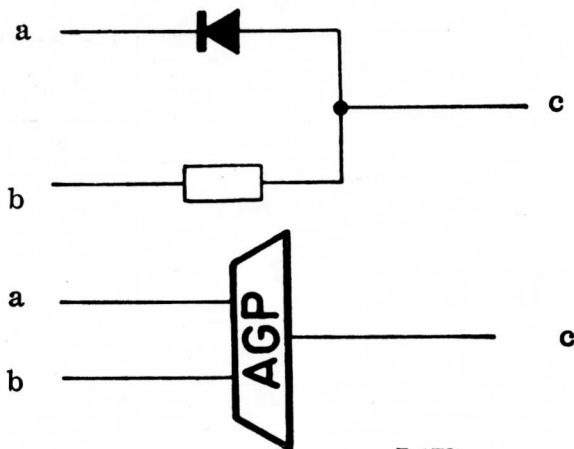
Panel E - 10 Mc/s scale-of-two circuit, read-out and clamping circuit



A. DESCRIPTION

The pulses originating from the pre-amplifier on panel D are applied to bistable multivibrator TS1-TS2.

The first positive pulse is applied to the base of transistor TS2 via diode Gr7. The diodes Gr2 and Gr7 are conductive because the anode voltage is less negative ($-5.6\text{ V} = \text{collector voltage of TS2}$) than the cathode voltage ($-5.8\text{ V} = \text{base voltage of TS2}$). This positive pulse blocks this transistor and the collector voltage becomes -13.7 V . Consequently the diodes Gr2 and Gr7 are blocked. As a result of the negative pulse at the collector of TS2 transistor TS1 becomes conductive and the collector potential rises to -5.6 V . Thus the diodes Gr1 and Gr2 becomes conductive and the next positive pulse can reach the base of transistor TS2. The input pulses are differentiated by the capacitors C2 and C1 and by the diodes Gr2 and Gr1. The diodes Gr6 and Gr3 prevent the base-emitter voltage becoming too high.



E 173

a	-12 V	-5 V	-12 V	-5 V
b	-12 V	-12 V	-5 V	-5 V
c	-12 V	-12 V	-12 V	-5 V

Fig. 16. "And"-gate, positive

The five output lines of the scale-of-five circuit on panel F and the two output lines of the scale-of-two circuit on this panel are combined by means of "and" gates to ten output lines for controlling the decade indicator tube.

An "and" gate positive is a circuit which gives a positive output signal with respect to the normal output signal if all inputs are positive with respect to the normal state.

The starters of the indicator tube are connected to the outputs of the "and" gates. The table below shows the lighting positions of the tube and the corresponding voltages at the output lines of the electronic circuit.

<i>positive</i> →	<i>line a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>
↓					
line A	1	3	5	7	9
line B	0	2	4	6	8

The ten-position cold-cathode indication tube is operated by a signal of 5 V. The main power source is a rectified a.c. voltage of 110 V. The working principle is as follows.

An additional voltage of 5 V with respect to the remaining starters is applied to one of the ten starters. This will cause a discharge as soon as the alternating d.c. voltage exceeds the ignition voltage. The voltage drop across the common cathode resistor prevents a breakdown in the other positions of the tube. As soon as the alternating d.c. voltage becomes lower than the operating voltage, the tube extinguishes and will glow again when the voltage exceeds the ignition value. Consequently the tube will glow 100 times per second and the position in which it glows is fully dependent upon the fact which starter carries a positive signal. It follows, that, if the frequency of the signal to be counted is exactly 1000 c/s, the indication of the tube remains the same. But if the frequency deviates from 1000 c/s the indication of the tube turns slowly clockwise or counterclockwise and does not really indicate the position of the electronic circuit on that moment. To avoid this, a diode pump circuit followed by a Schmitt-trigger has been incorporated. As soon as the counting frequency applied to this circuit becomes higher than 60 c/s, i.e. 120 c/s at the input of the panel, the d.c. output level of the diode-pump circuit exceeds the threshold of the Schmitt-trigger. In this case the output

voltage of this Schmitt-trigger keeps the zero input line of the indicator tube at a positive voltage. As soon as the measuring process is stopped, the input signal is blocked by the input gate and the decade indicator tube indicates the digit stored in the decade.

The output pulse of the scale-of-two circuit is applied to the scale-of-five circuit via an emitter follower.

B. MEASURING DATA

Load current

The load current is 23–28 mA, positive side of the supply voltage connected to terminal 4, negative side to terminal 6.

D.C. voltages

Transistor TS1 conductive

$$V_{BE} \text{ of TS2} \geq + 0.1 \text{ V}$$

$$V_{CE} \text{ of TS1} \leq - 0.5 \text{ V}$$

Transistor TS2 conductive

$$V_{BE} \text{ of TS1} \geq + 0.1 \text{ V}$$

$$V_{CE} \text{ of TS2} \leq - 0.5 \text{ V}$$

A transistor can be made conductive by connecting its base to the -15 V supply line via a resistor of $6,800 \Omega$.

Reset

Block transistor TS2 by setting TS1 in a conductive state. Then briefly connect terminal 3 to -12 V and make sure that transistor TS2 is now conductive.

Input frequency

Apply a sinusoidal signal with an amplitude of $2 V_{p-p}$ to the input of the scaler. Measure the maximum counting frequency by connecting an oscilloscope to terminal 5. This frequency should be higher than 13 Mc/s .

Output signal

Apply a sinusoidal signal with a frequency of 10 Mc/s and an amplitude of $2 V_{p-p}$ to the input of the scaler. Measure the output signal at terminal 5 of this panel. The shape of this signal should be as shown in Fig. 17.

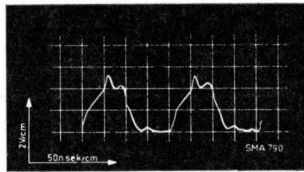


Fig. 17. Output signal at terminal E.5

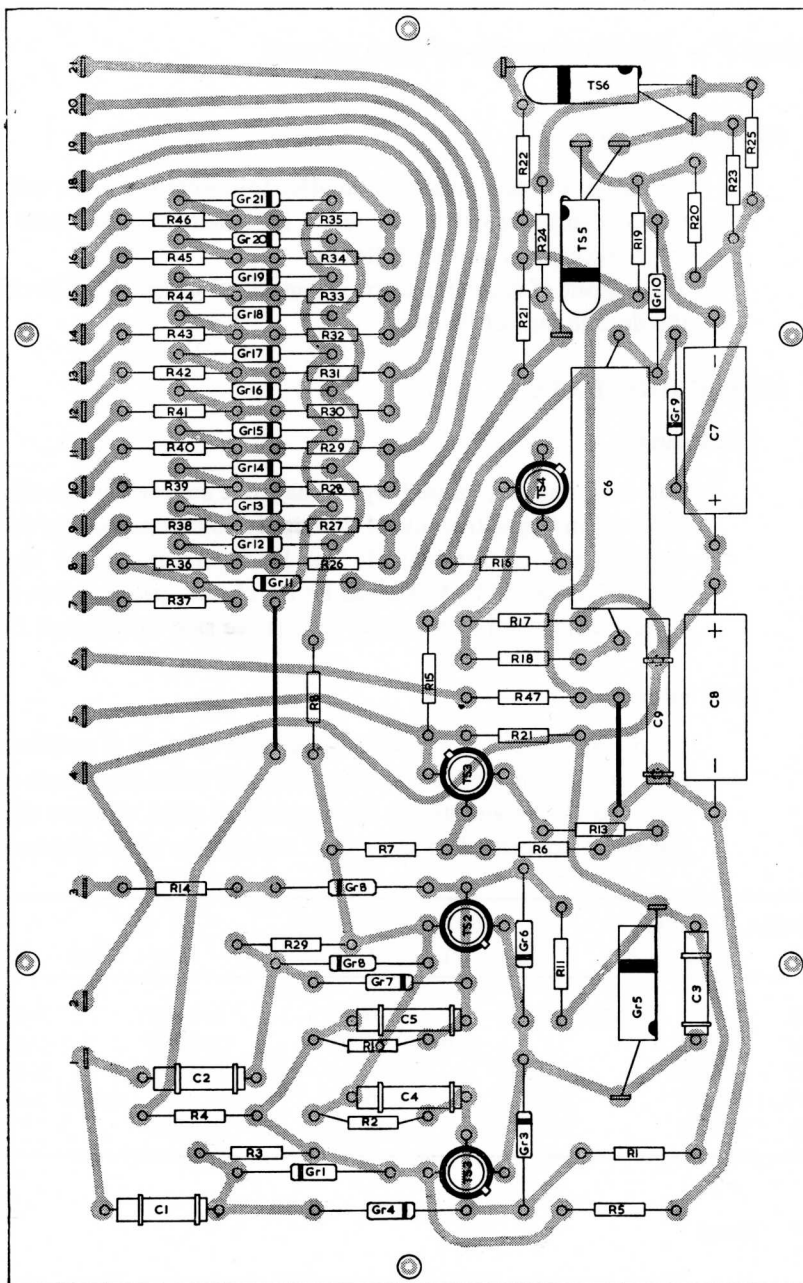
Schmitt trigger

Measure the voltage at the collector of TS5 without an input signal. This voltage should be more negative than -10.5 V.

Apply a signal with a pulse duration of $1 \mu\text{s}$ and an amplitude of 4 V to the input of the scaler. At a frequency between 120 and 170 c/s the Schmitt trigger switches over. In this state the voltage at the collector of TS5 should be more positive than -2 V. At a frequency between 50 and 30 c/s the Schmitt-trigger should revert to its original state. Before the Schmitt trigger reaches this position, the collector voltage of TS5 should be more positive than -4.5 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except	ASZ21			
TS5	OC47			
TS6	OC47			
All diodes except	OA95			
Gr1	AAZ13			
Gr2	AAZ13			
Gr3	AAZ13			
Gr4	AAZ13			
Gr5	OAZ203			
Gr6	AAZ13			
Gr7	AAZ13			
Gr11	OA200			
All resistors except	B8 305 80 B/...		0.1 W	5%
R19	B8 305 80 A/150 K	0.15 M Ω	0.1 W	10%
R36	B8 305 80 A/150 K	0.15 M Ω	0.1 W	10%
R37	B8 305 80 A/180 K	0.18 M Ω	0.1 W	10%
R38	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R39	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R40	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R41	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R42	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R43	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R44	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R45	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R46	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
All capacitors ceramic	904/...			
except				
C6 (polyester)	4822 069 00542	0.68 μ F		
C7 (electrolytic)	C427 AR/C20	20 μ F	6.4 V	
C8 (electrolytic)	909/W10	10 μ F	16 V	



SMA 673
E 1183

Fig. 18. Circuit lay-out of panel E

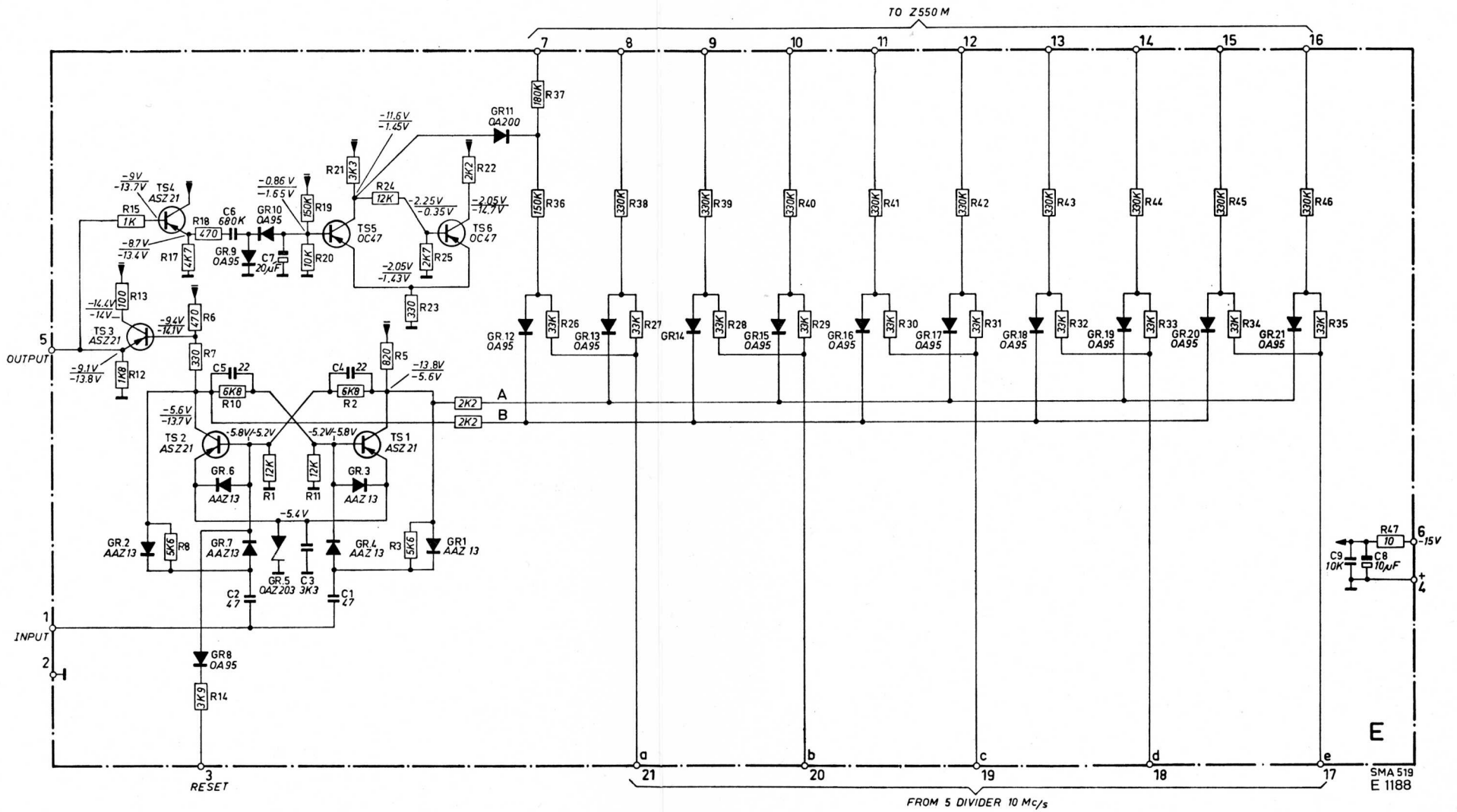


Fig. 19. Diagram of panel E

Panel F - 10 Mc/s scale-of-five circuit

IV

A. DESCRIPTION

This circuit is equipped with emitter followers for faster switching. Now the coupling capacitor can reach its original value faster via the low impedance of an emitter follower.

The output of each transistor is connected to the AGP circuit to control the decade indicator tube.

B. MEASURING DATA

Load current

The load current, caused by the negative supply voltage of 15 V, should be 35–45 mA, positive side of the supply voltage connected to terminal 12, negative side to terminal 11. The load current, caused by the positive supply voltage of 15 V, should be 12–15 mA, positive side of the supply voltage connected to terminal 4, negative side to terminal 12.

D.C. voltages

To measure the d.c. voltages successively connect a multimeter between the base and emitter of one transistor and make the others conductive in turn. To set a transistor in the conductive state, connect the base of the transistor concerned to the -15 V supply line via a resistor of 6,800 Ω .

Conduc- tive	TS1		TS3		TS5		TS7		TS9	
	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}
TS1		<0.5V	>0.25V		>0.25V		>0.25V		>0.25V	
TS3	>0.25V			<0.5V	>0.25V		>0.25V		>0.25V	
TS5	>0.25V		>0.25V			<0.5V	>0.25V		>0.25V	
TS7	>0.25V		>0.25V		>0.25V			<0.5V	>0.25V	
TS9	>0.25V		>0.25V		>0.25V		>0.25V			<0.5V

Reset

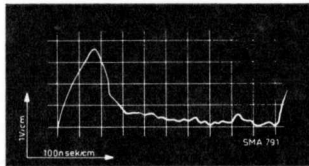
Block transistor TS1 by making TS3 conductive. Then connect terminal 13 for a short moment to -12 V and make sure that TS1 is now conductive.

Input frequency

Apply a sinusoidal signal with an amplitude of $2 V_{p-p}$ to the input of the scaler. Measure the maximum counting frequency by connecting an oscilloscope to terminal 2 of this panel. This frequency should exceed 13 Mc/s.

Output pulse

Apply a sinusoidal signal with a frequency of 10 Mc/s and an amplitude of $2 V_{p-p}$ to the input of the scaler. Measure the output signal at terminal 2 of this panel. The shape of this signal should be as shown in Fig. 20.



E 1162

Fig. 20. Output signal at terminal F.2

Also, measure the signals at terminals 5, 6, 7, 8 and 10. The shape of these signals is as shown above, except that the amplitude amounts to 5 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except TS12	ASZ21 OC141			
All diodes except Gr1	AAZ13 OA95			
All resistors except R6 R13 R20 R27 R34 R37	B8 305 80 B/... 901/8K2 901/8K2 901/8K2 901/8K2 901/8K2 901/1K2		0.1 W 1/8 W 1/8 W 1/8 W 1/8 W 1/8 W	5% 2% 2% 2% 2% 2%
All capacitors ceramic except C14 (electrolytic)	904/... 909/W10		10 μ F 16 V	

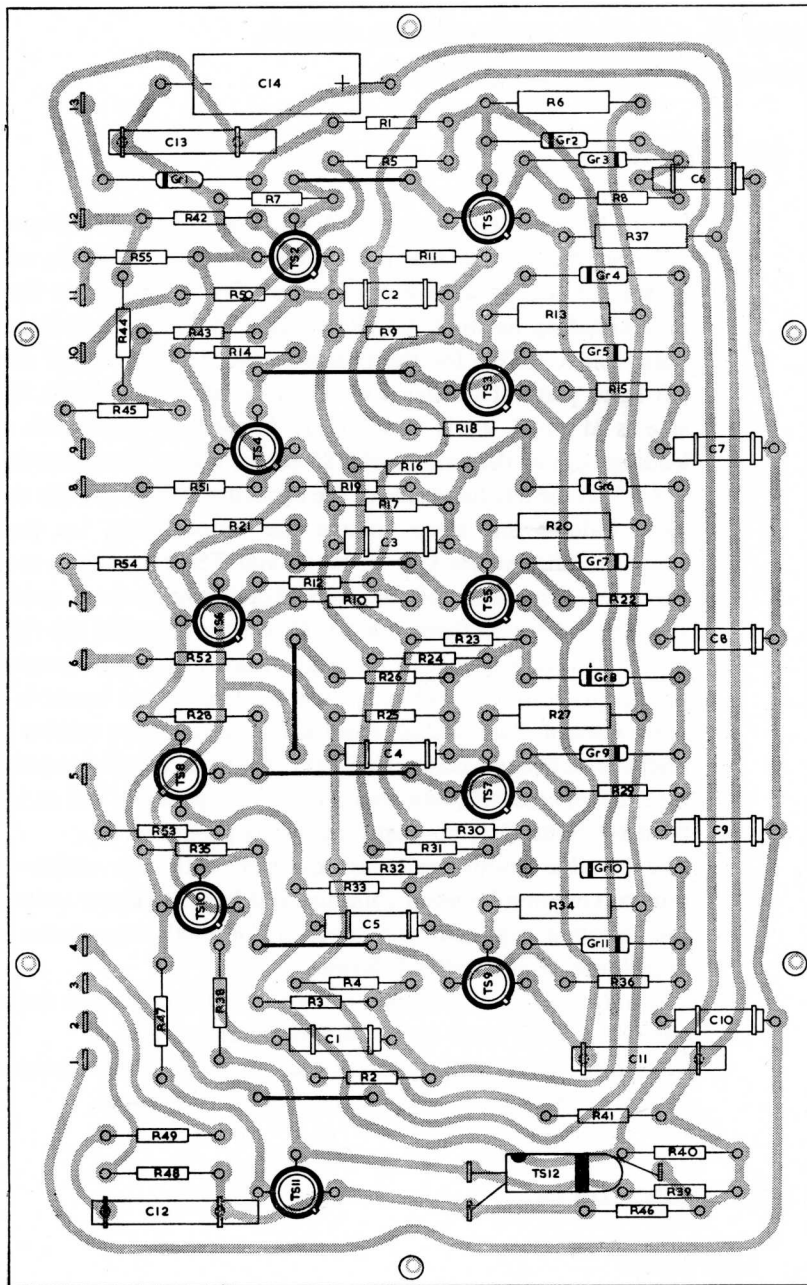
SMA 671
E 1182

Fig. 21. Circuit lay-out of panel F

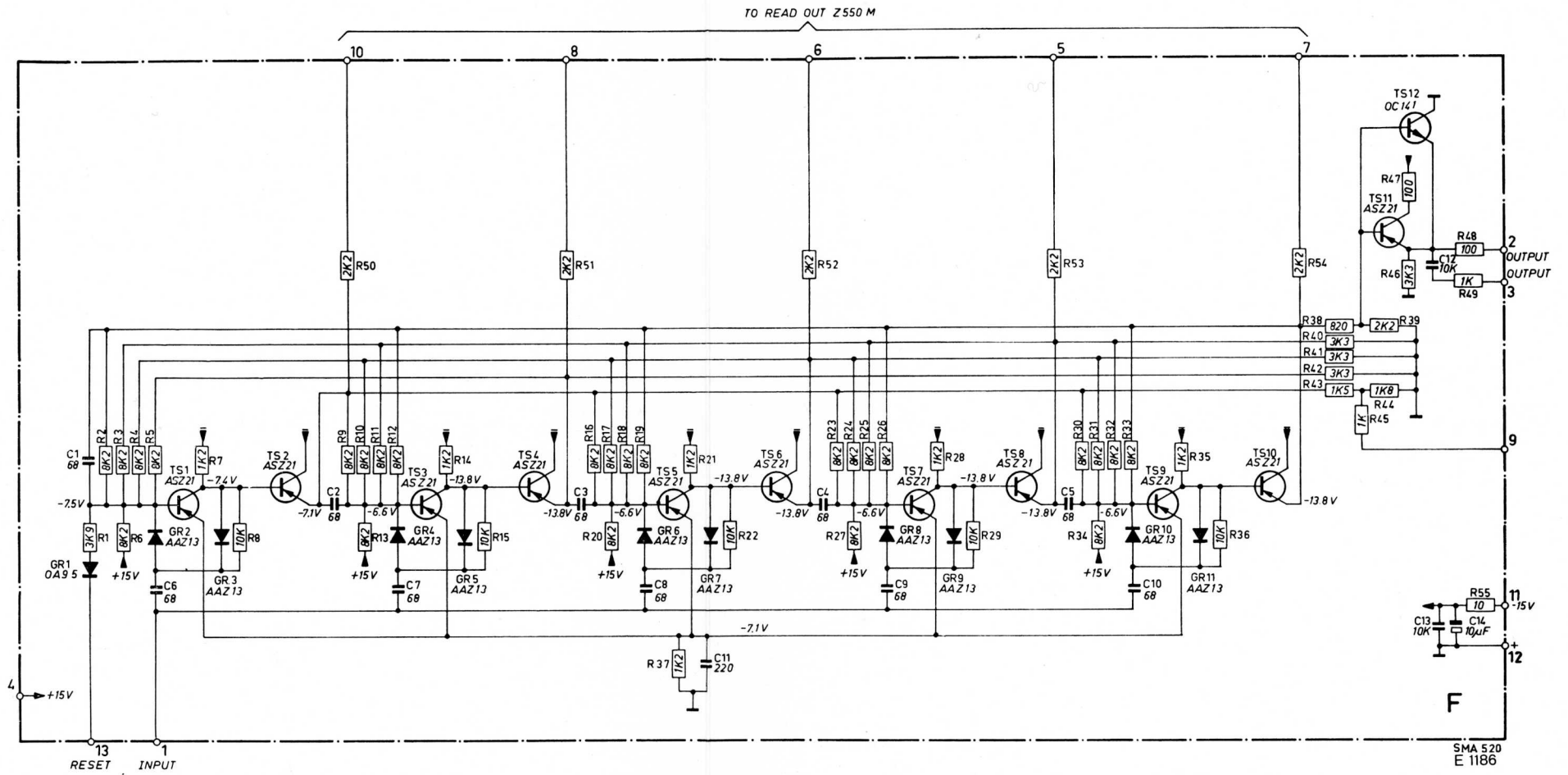


Fig. 22. Diagram of panel F

Panel G - 1 Mc/s scale-of-two circuit, read-out and clamping circuit



A. DESCRIPTION

The 1 Mc/s scale-of-two circuit starts with emitter follower stage TS5, followed by a pulse shaping circuit, in order to obtain needle shaped pulses for the bistable multivibrator. These pulses are formed by the differentiating network C3, R12 and TS6 for the negative edge of the pulse and C3, Gr1 for the positive edge. Under normal conditions the left-hand plate of C3 has a voltage level of -7.5 V, whilst the right-hand side is at -14.5 V via diode Gr1. A negative pulse with a very steep leading edge at the emitter of TS5 causes a very fast potential increase to -14.5 V at the left-hand side of the capacitor. Consequently the right-hand plate follows this steep voltage rise immediately, i.e. becomes more negative. This causes Gr1 to block and TS6 to become conductive. As the input impedance of this transistor (common-base configuration) is very low (although there is a $120\text{-}\Omega$ resistor in series) the right-hand side of C3 returns very fast to its original potential, thus causing a negative needle pulse at the collector of TS6. This signal controls the bistable multivibrator. The trailing edge of the pulse across emitter resistor R11 resets the left-hand plate of C3 very fast to its original value. This means that the right-hand plate also tends to go positive, but as its potential is fixed by diode Gr1, no positive pulse is produced.

The bistable multivibrator is equipped with two emitter-followers in mutual coupling between collector and base for faster switching, so that the coupling capacitor can reach its original value faster via the low impedance of an emitter follower.

The output pulse of this scale-of-two circuit is applied to the scale-of-five, panel H via the same special differentiating circuit.

To avoid interference phenomena the same diode pump circuit and Schmitt-trigger as on panel E has been incorporated.

B. MEASURING DATA

Load current

The load current is 25–27 mA, positive side of the supply voltage connected to terminal 2, negative side to terminal 1.

D.C. voltages

Transistor TS3 conductive	
V_{BE} of TS3	< -0.25 V
V_{CE} of TS3	$-2 - -4$ V
V_{BE} of TS4	$0.5 - 1$ V
Transistor TS4 conductive	
V_{BE} of TS4	< -0.25 V
V_{CE} of TS4	$-2 - -4$ V
V_{BE} of TS3	$0.5 - 1$ V

A transistor can be made conductive by connecting its base to the -15 V supply line via a resistor of $3,300 \Omega$.

Reset

Block transistor TS3 by setting transistor TS4 in a conductive state. Then briefly connect terminal 3 to -12 V and make sure that transistor TS3 is now conductive.

Input frequency

Apply a negative signal with an amplitude of 5 V and a pulse duration of $0.2 \mu\text{sec}$ to the input terminal 4. Measure the maximum counting frequency by connecting an oscilloscope to terminal 5. This frequency should be higher than 2 Mc/s.

Input sensitivity

At an input frequency of 1 Mc/s and a pulse duration of $0.2 \mu\text{sec}$, the input sensitivity lies between 1 and 3 Vp.

Output signal

Apply a signal with a frequency of 1 Mc/s, an amplitude of 5 Vp and a pulse duration of $0.2 \mu\text{sec}$ to the input. The shape of the output signal at terminal 5 be as shown in Fig. 23.

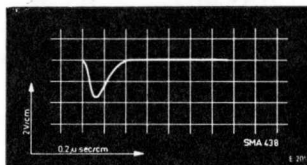


Fig. 23. Output signal at terminal G.5

Schmitt trigger

Measure the voltage at the collector of TS10 without an input signal. This voltage should be more negative than -10.5 V. Apply a negative

signal with a pulse duration of 1 μs and an amplitude of 5 V_p to the input via a capacitor of 10,000 pF. At a frequency between 80 and 120 c/s the Schmitt-trigger switches over. In this state the voltage at the collector of TS10 should be more positive than -2 V. At a frequency between 50 and 30 c/s the Schmitt-trigger should revert to its original state. Before the Schmitt-trigger reaches this position, the collector voltage of TS10 should be more positive than -4.5 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except	OC47			
TS6	OC141			
TS8	OC141			
All diodes except	OA95			
Gr1	AA Y11			
Gr3	AA Y11			
All resistors except	B8 305 80 B/...		0.1 W	5%
R18	B8 305 80 A/150 K	0.15 M Ω	0.1 W	10%
R34	B8 305 80 A/150 K	0.15 M Ω	0.1 W	10%
R35	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R36	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R37	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R38	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R39	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R40	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R41	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R42	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R43	B8 305 80 A/330 K	0.33 M Ω	0.1 W	10%
R48	B8 305 80 A/180 K	0.18 M Ω	0.1 W	10%
All capacitors ceramic except	904/...			
C5 (polyester)	4822 069 00542	0.68 μF		
C6 (electrolytic)	C427 AR/C20	20 μF	6.4 V	
C7 (electrolytic)	909/W10	10 μF	16 V	

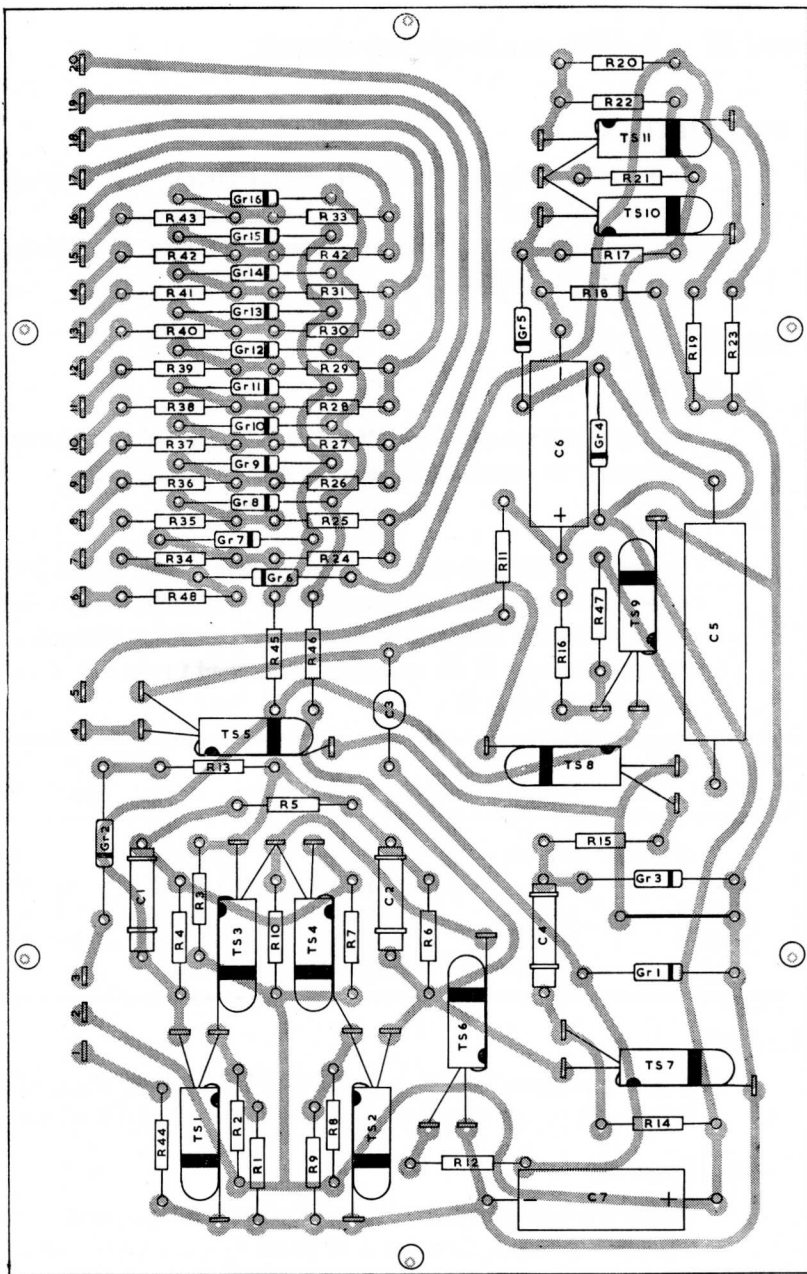
SMA 365
E 1181

Fig. 24. Circuit lay-out of panel G

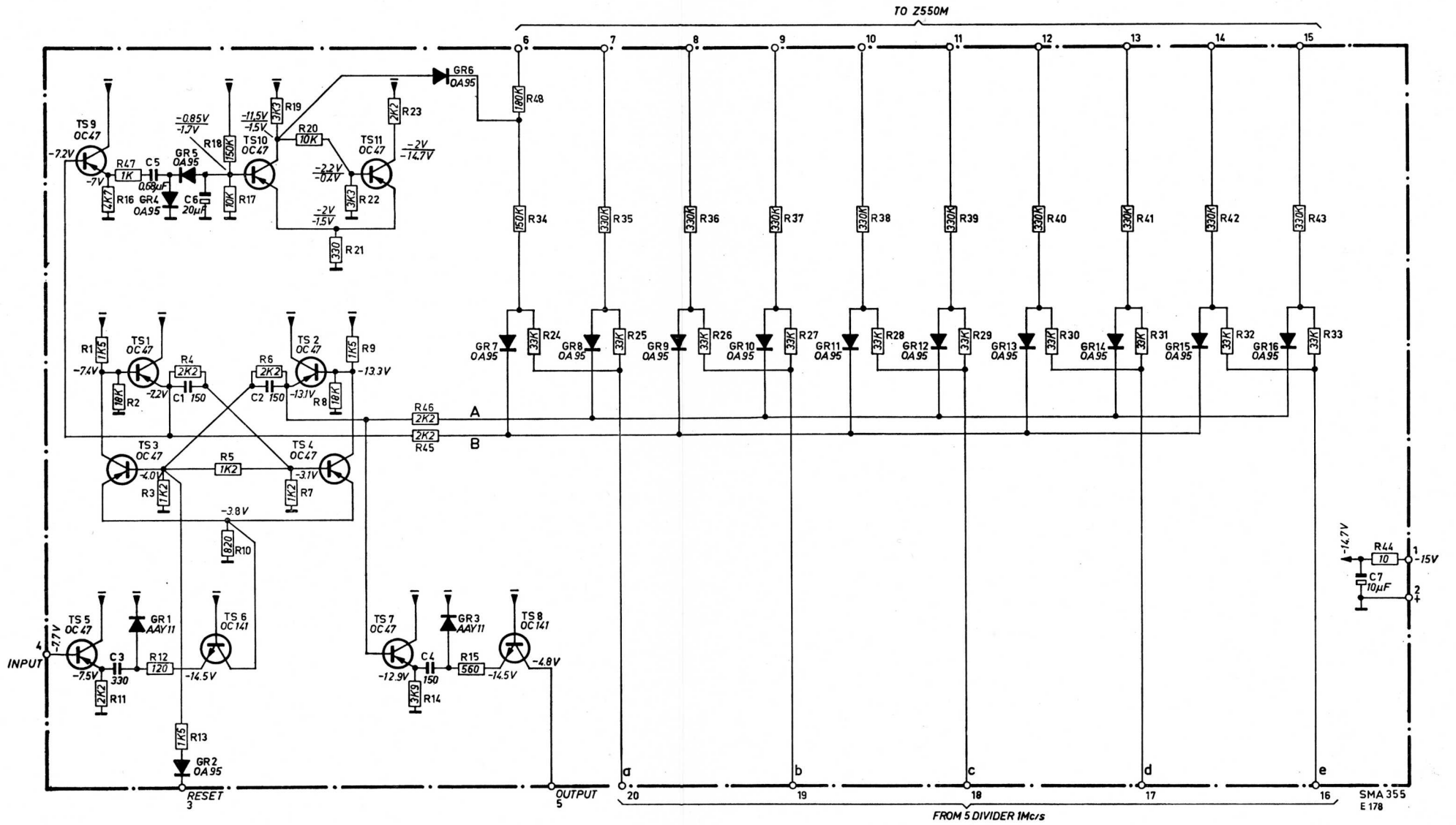


Fig. 25. Diagram of panel G

Panel H - 1-Mc/s scale-of-five circuit

VI

A. DESCRIPTION

Just like the flip-flop in panel G this circuit has been equipped with emitter followers so as to enable faster switching.

The output of each transistor is connected to the AGP circuit to control the decade indicator tube.

B. MEASURING DATA

Load current

The load current should be 26–28 mA, positive side of the supply voltage connected to terminal 11, negative side to terminal 10.

D.C. voltages

To measure the voltages in a scale-of-five circuit successively connect a multimeter between the base and emitter of each transistor and make the other transistor conductive in turn. To make a transistor conductive, connect the base of the transistor concerned to the -15 V supply line via a resistor of $3,300\ \Omega$.

Conduc- tive	TS1		TS3		TS5		TS7		TS9	
	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}
TS1		$-2\text{ V--}3\text{ V}$	$>0.15\text{ V}$		$>0.15\text{ V}$		$>0.15\text{ V}$		$>0.15\text{ V}$	
TS3	$>0.15\text{ V}$			$-2\text{ V--}3\text{ V}$	$>0.15\text{ V}$		$>0.15\text{ V}$		$>0.15\text{ V}$	
TS5	$>0.15\text{ V}$		$>0.15\text{ V}$			$-2\text{ V--}3\text{ V}$	$>0.15\text{ V}$		$>0.15\text{ V}$	
TS7	$>0.15\text{ V}$		$>0.15\text{ V}$		$>0.15\text{ V}$			$-2\text{ V--}3\text{ V}$	$>0.15\text{ V}$	
TS9	$>0.15\text{ V}$		$>0.15\text{ V}$		$>0.15\text{ V}$		$>0.15\text{ V}$			$-2\text{ V--}3\text{ V}$

Reset

Block transistor TS1 by making TS3 conductive. Then briefly connect terminal 2 to -12 V and make sure that transistor TS1 is now conductive.

Input frequency

Apply a negative signal with an amplitude 5 V_{p-p} and a pulse duration $0.2\ \mu\text{sec.}$ to input terminal 4 of panel G via a capacitor of $10,000\ \text{pF}$. Measure the maximum counting frequency by connecting an oscilloscope to terminal 5 of panel H. This frequency, measured at input terminal 1 of panel H, should exceed 1 Mc/s .

Output signal

Apply a signal with a frequency of 1 Mc/s, an amplitude of $5 V_{p-p}$ and a pulse duration of $0.2 \mu\text{sec}$ to the input. The shape of the output signal at terminal 6 should be as shown in Fig. 26.

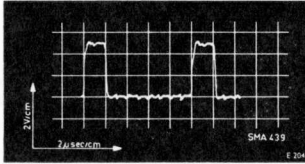


Fig. 26. Output signal at terminal H.6

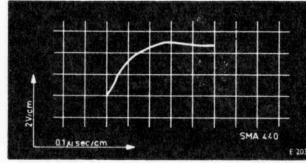


Fig. 27. Leading edge of the pulse at terminal H.6

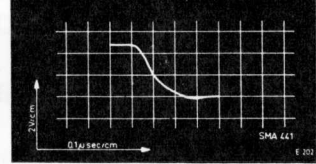


Fig. 28. Trailing edge of the pulse at terminal H.6

Also, measure the signals at terminals 3, 4, 7, 8 and 9. The shape of these signals is as shown above except that the amplitude at this part amounts to 6 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except	OC47			
TS11	OC141			
Diode Gr1	OA95			
All resistors except	B8 305 80 B/...		0.1 W	5%
R7	901/1K3	1300 Ω	0.125 W	2%
R8	901/200E	200 Ω	0.125 W	2%
R15	901/1K5	1500 Ω	0.125 W	2%
R22	901/1K5	1500 Ω	0.125 W	2%
R29	901/1K5	1500 Ω	0.125 W	2%
R36	901/1K5	1500 Ω	0.125 W	2%
All capacitors ceramic except	904/...			
C7 (electrolytic)	909/W10	10 μ F	16 V	

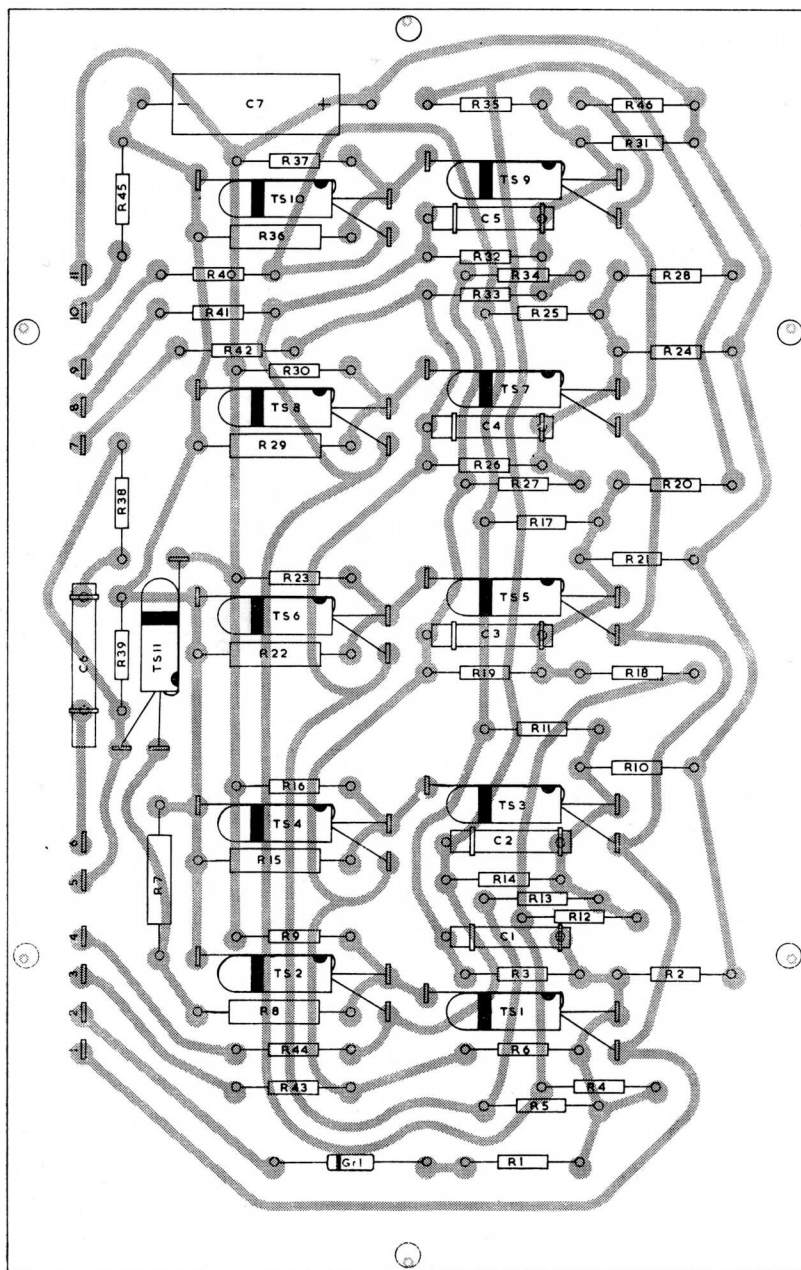
SMA 415
E 1180

Fig. 29. Circuit lay-out of panel H

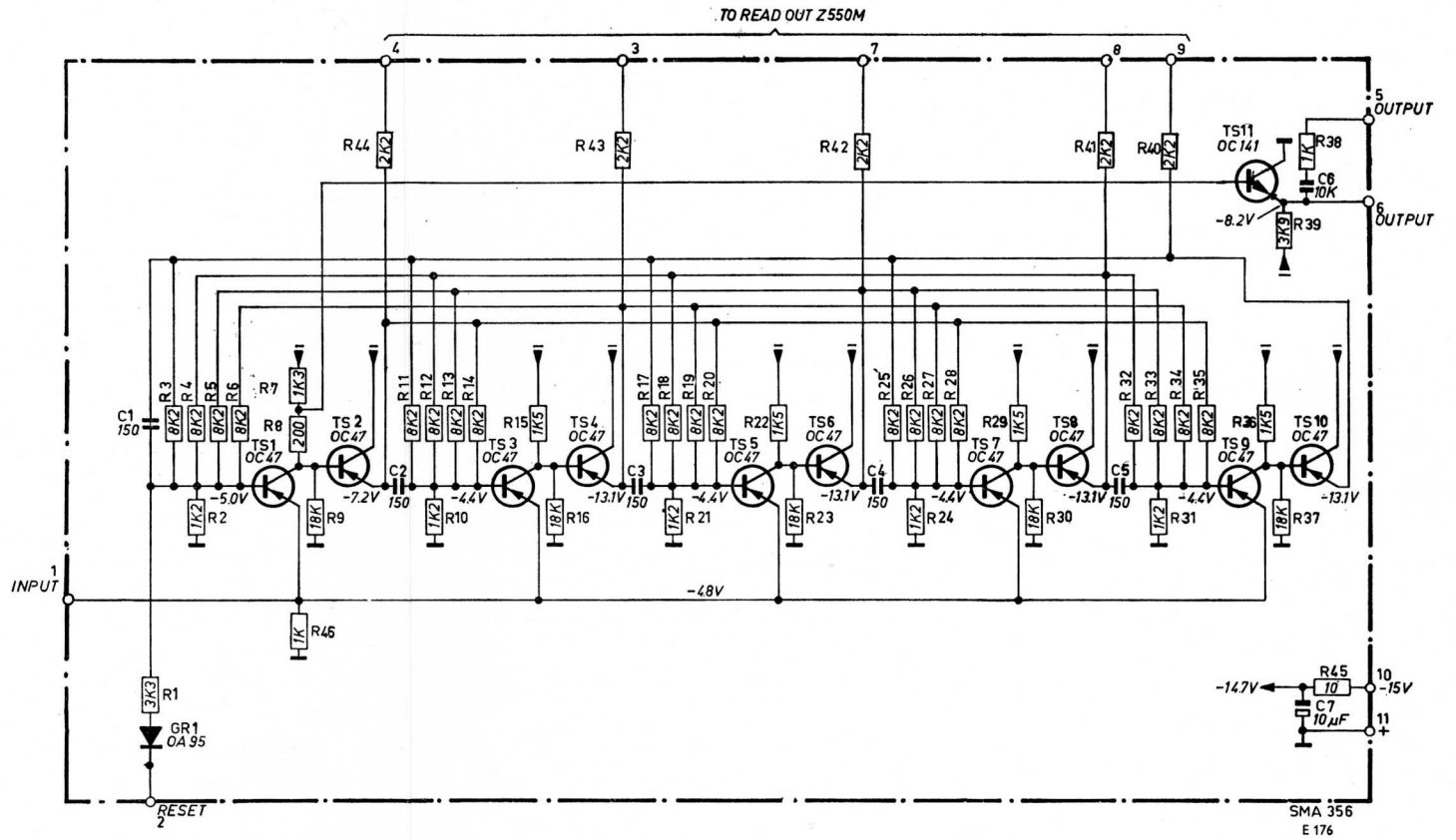


Fig. 30. Diagram of panel H

Panel K - 100 kc/s scale-of-two circuit read-out and clamping circuit

VII

A. DESCRIPTION

The function of the circuit on this panel is the same as that of panel G. But as the counting frequency is a factor 10 lower, simpler circuits without emitter follower coupling can be employed. The input of the clamping circuit on this panel is not connected to the output of the flip-flop, but to the input. Yet the clamping frequency amounts also to 120 c/s, because this frequency does not determine the output d.c. level of the diode pump circuit but also the amplitude and the duty cycle of the signal applied. The duty cycle of the 60-c/s signal is $\frac{1}{2}$, which means that the time during which capacitor C20 discharges, reckoned over 1 sec, amounts to $\frac{1}{2} \times 1 \text{ sec} = 0.5 \text{ sec}$. The duty cycle of the 120 c/s signal is $\frac{1}{5}$, i.e. the time during which C20 discharges amounts to $\frac{4}{5} \times 1 \text{ sec} = 0.8 \text{ sec}$. Consequently the possible discharge times have a ratio of 5 : 8. As the amplitudes have a ratio of 6 : 5 and the frequencies of 1 : 2, the final charge of the capacitors, will after 1 sec, have a ratio of $\frac{6 \times 1}{5} : \frac{5 \times 2}{8} = 24 : 25$.

This means that after a certain time the d.c. levels are approximately equal to one another.

B. MEASURING DATA

Load current

The load current amounts to 12–14 mA, positive side of the supply voltage connected to terminal 6, negative side to terminal 3.

D.C. voltages

Transistor TS1 conductive

V_{BE} of TS1	$< -0.25 \text{ V}$
V_{CE} of TS1	$< -0.15 \text{ V}$
V_{BE} of TS2	2.3 V–2.5 V

Transistor TS2 conductive

V_{BE} of TS2	$< -0.25 \text{ V}$
V_{CE} of TS2	$< -0.15 \text{ V}$
V_{BE} of TS1	2.3 V–2.5 V

To make a transistor conductive, connect the base of the transistor concerned to the -15 V via a resistor of $3,300 \Omega$.

Reset

Block transistor TS2 by making TS1 conductive. Then connect terminal 1 for a short moment to -12 V and make sure that transistor TS2 is now conductive.

Input frequency

Apply a positive signal with an amplitude of $4\text{ V}_{\text{p-p}}$ and a pulse duration of $1/5$ of the p.r.f. to the input terminal 5. For measuring the maximum counting frequency of this decade, connect an oscilloscope to terminal 4. The maximum input frequency should amount to 200 kc/s . Check this also at terminal 2.

Input sensitivity

At an input frequency of 100 kc/s and a pulse duration of $2\text{ }\mu\text{sec}$, the input sensitivity lies between $2\text{--}3\text{ V}_{\text{p-p}}$.

Output signal

Apply a signal with a frequency of 100 kc/s , an amplitude of $4\text{ V}_{\text{p-p}}$ and a pulse duration of $2\text{ }\mu\text{sec}$ to the input. The shape of the output signal at terminal 4 should be as shown in Fig. 31.

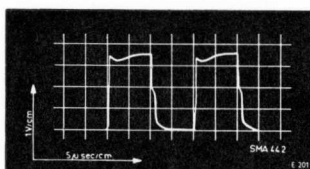


Fig. 31. Output signal at terminal K.4

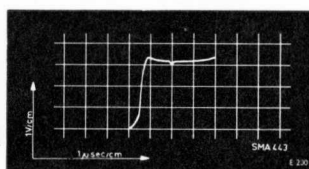


Fig. 32. Leading edge of the pulse at terminal K.4

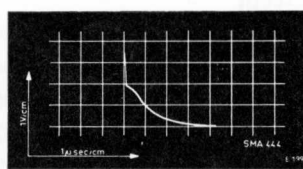


Fig. 33. Trailing edge of the pulse at terminal K.4

Schmitt trigger

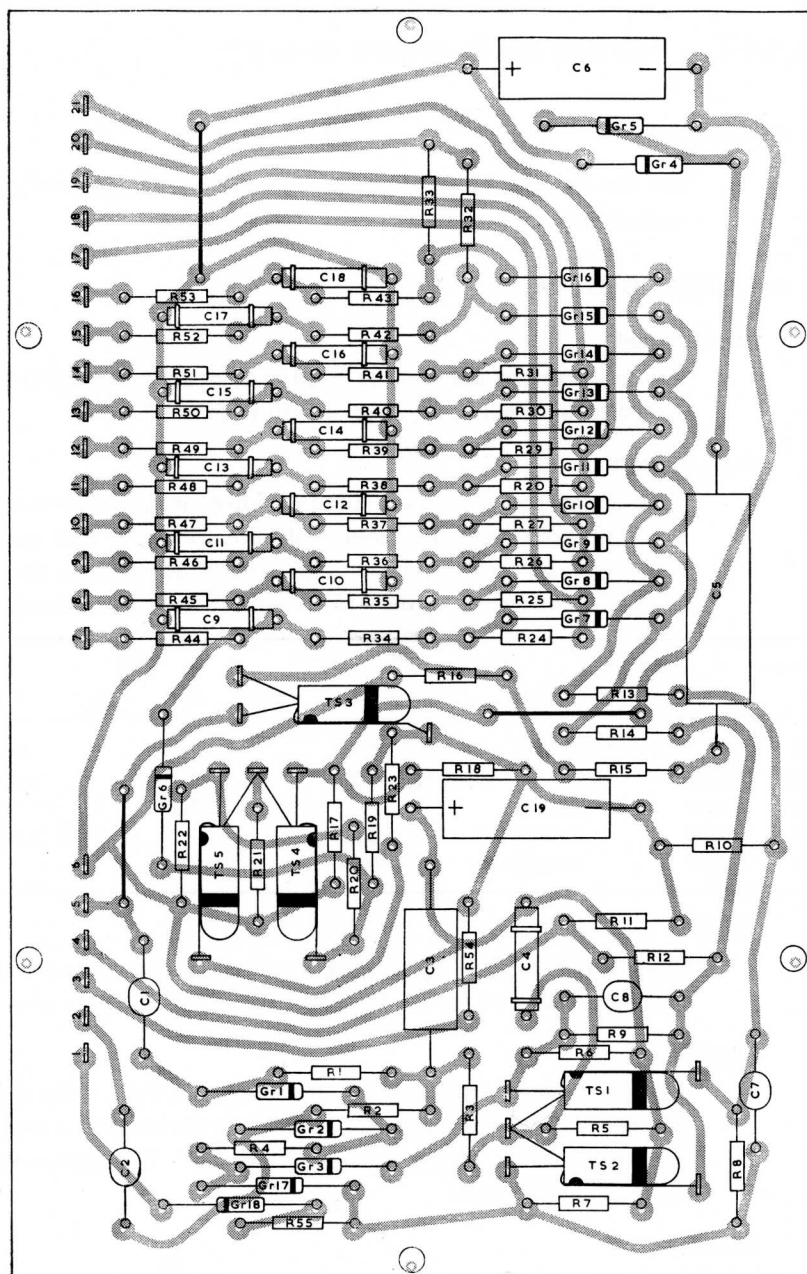
Measure the voltage at the collector of TS4 without input signal. This voltage should be more negative than -10.5 V .

Apply a positive signal of $5\text{ V}_{\text{p-p}}$, pulse duration $1/5$ of the p.r.f. to input terminal 5. At a frequency between 120 c/s and 160 c/s , the Schmitt trigger must switch over. In this state the voltage at the collector of TS4

should be more positive than -2 V. At a frequency between 40 and 20 c/s the trigger circuit should revert to its original position. Just before reaching this position, the collector voltage of TS4 should be more positive than -4.5 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>			
All transistors	OC47				
All diodes	OA95				
All resistors except	B8 305 80 B/...			0.1 W	5%
R18	B8 305 80 A/150K	0.15	M Ω	0.1 W	10%
R34–R43	B8 305 80 A/150K	0.15	M Ω	0.1 W	10%
R44–R53	B8 305 80 A/180K	0.18	M Ω	0.1 W	10%
All capacitors ceramic except	904/...				
C1 (ceramic pin-up)	904/P470E	470	pF		
C2 (ceramic pin-up)	904/P470E	470	pF		
C3 (polyester)	906/L56K	56,000	pF		
C5 (polyester)	4822 069 00542	0.68	μ F		
C6 (electrolytic)	C427 AR/C20	20	μ F	6.4 V	
C7 (ceramic pin-up)	904/P470E	470	pF		
C8 (ceramic pin-up)	904/P470E	470	pF		
C19 (electrolytic)	909/W10	10	μ F	16 V	



SMA366
E 1179

Fig. 34. Circuit lay-out of panel K

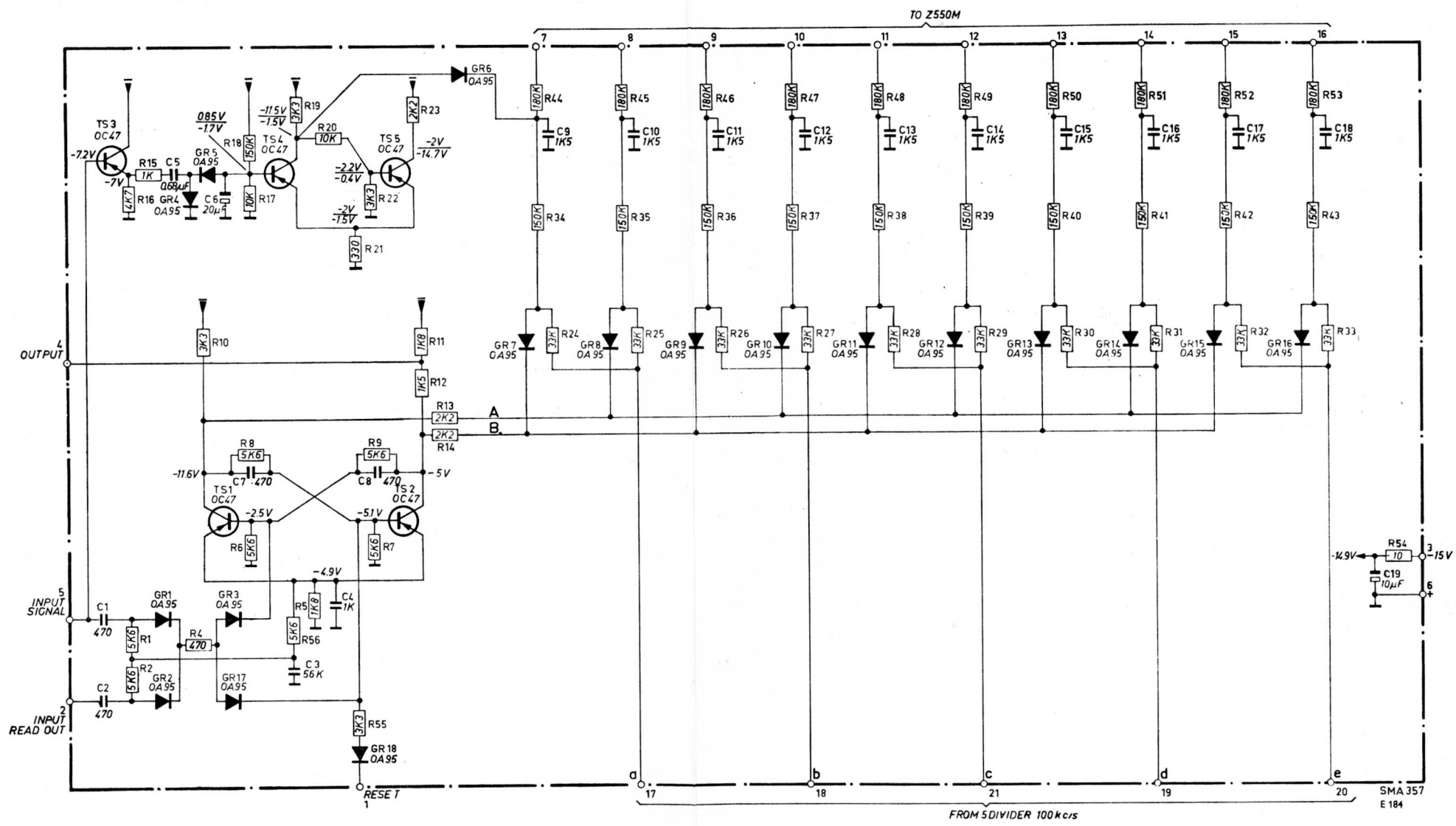


Fig. 35. Diagram of panel K

Panel L - 100 kc/s scale-of-five circuit



A. DESCRIPTION

For the description of this panel see "Basic Considerations". For the read-out circuit see the description of panel G.

B. MEASURING DATA

Load current

The load current amounts to 9–10 mA, positive side of the –15 V connected to terminal 3, negative side to terminal 2.

D.C. voltages

To measure the voltages in a scale-of-five circuit successively connect a meter between base and emitter of each transistor and make the other transistors in turn conductive, by briefly connecting the base of the transistor concerned to the –15 V-supply line via a resistor of 6,800 Ω .

Conduc- tive	TS1		TS2		TS3		TS4		TS5	
	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}
TS1		<-0.2V >0.2V			>0.2V		>0.2V			>0.2V
TS2	>0.2V		<-0.2V >0.2V				>0.2V			>0.2V
TS3	>0.2V		>0.2V			<-0.2V >0.2V				>0.2V
TS4	>0.2V		>0.2V		>0.2V			<-0.2V >0.2V		
TS5	>0.2V		>0.2V		>0.2V		>0.2V			<-0.2V

Reset

Block transistor TS1 by making transistor TS2 conductive. Then briefly connect terminal 4 to –12 V and make sure that TS1 is now conductive.

Input frequency

Apply a positive signal with an amplitude of 4 V_{p-p} and a pulse duration of $\frac{1}{2}$ the p.r.f. to input terminal 1. Measure the maximum input frequency by connecting an oscilloscope to terminal 11. This frequency should be higher than 100 kc/s.

Output signal

Apply a signal with a frequency of 50 kc/s, an amplitude of 2 V_{p-p} and a pulse duration of $\frac{1}{2}$ of the p.r.f. to the input. The shape of the output signal at terminal 11 should be as shown in Fig. 36.

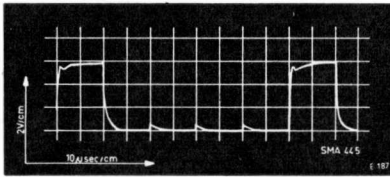


Fig. 36. Output signal at terminal L.11

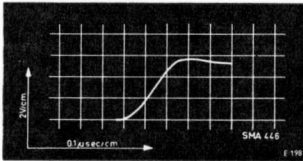


Fig. 37. Leading edge of the pulse at terminal L. 11

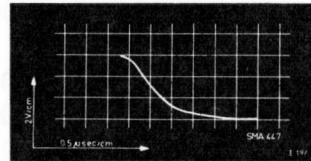
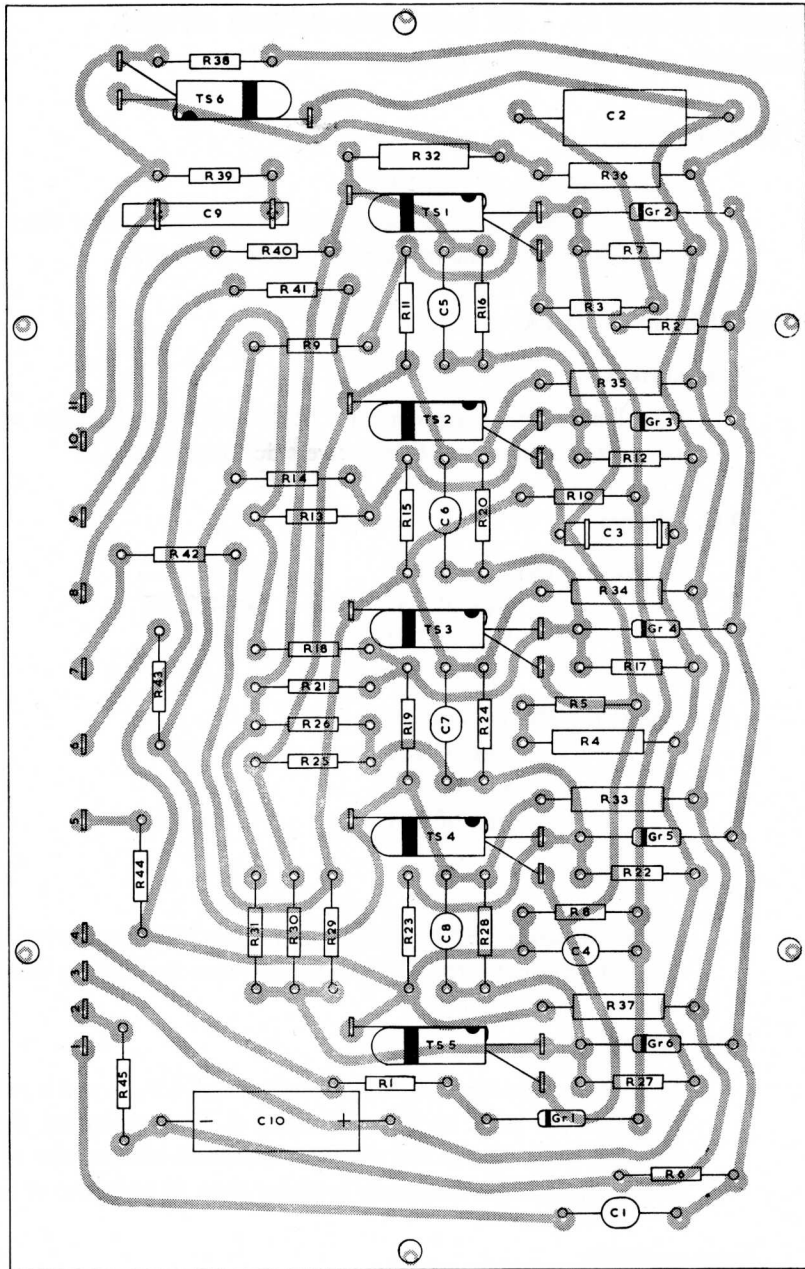


Fig. 38. Trailing edge of the pulse at terminal L. 11

Also measure the signals at terminals 5 up to 9. The shape of these signals is as shown above, except that the amplitude at these points amounts to $6 V_{p-p}$.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except TS6	OC47 OC140			
All diodes	OA95			
All resistors except R4	B8 305 80 B/...		0.1 W	5%
R32	901/1K2	1,200 Ω	0.125 W	2%
R33	901/510E	510 Ω	0.125 W	2%
R34	901/2K7	2,700 Ω	0.125 W	2%
R35	901/2K7	2,700 Ω	0.125 W	2%
R36	901/2K2	2,200 Ω	0.125 W	2%
R37	901/2K7	2,700 Ω	0.125 W	2%
All capacitors (ceramic pin-up) except C2 (polyester)	904/P330E	330 pF		
C3 (ceramic)	906/L56K	56,000 pF		
C9 (ceramic)	904/1K5	1,500 pF		
C10 (electrolytic)	905/10K	10,000 pF		
	909/W10	10 μ F	16 V	



SMA 426
E 1177

Fig. 39. Circuit lay-out of panel L

Panels M and O - 10 kc/s scale-of-two circuit, read-out and clamping circuit

IX

A. DESCRIPTION

See description of panel K.

Note - Input coupling capacitors have larger values than the ones on panel K because the frequency applied is lower.

B. MEASURING DATA

Load current

The load current amounts to 12-14 mA, positive side of the -15 V connected to terminal 6, negative side to terminals 3.

D.C. voltages

Transistor TS1 conductive

$$V_{BE} \text{ of TS1} < -0.25 \text{ V}$$

$$V_{CE} \text{ of TS1} < -0.15 \text{ V}$$

$$V_{BE} \text{ of TS2} 2.3 \text{ V} - 2.5 \text{ V}$$

Transistor TS2 conductive

$$V_{BE} \text{ of TS2} < -0.25 \text{ V}$$

$$V_{CE} \text{ of TS2} < -0.15 \text{ V}$$

$$V_{BE} \text{ of TS1} 2.3 \text{ V} - 2.5 \text{ V}$$

Reset

Block transistor TS2 by making transistor TS1 conductive. Then briefly connect terminal 1 to -12 V and make sure that TS2 is conductive.

Input frequency

Apply a positive signal with an amplitude of $4 V_{p-p}$ and a pulse duration of $1/5$ of the p.r.f. to input terminal 5. For measuring the maximum counting frequency of this decade connect an oscilloscope to terminal 4. Check whether this frequency is higher than 40 kc/s, also at terminal 2.

Input sensitivity

At an input frequency of 10 kc/s and a pulse duration of 20 μsec , the input sensitivity is between 2 and 3 V_{p-p} .

Output signal

Apply a signal with a frequency of 10 kc/s, an amplitude of $4 V_{p-p}$ and a pulse duration of $20 \mu\text{sec}$ to the input. The shape of the output signal at terminal 4 should be as shown in Fig. 41.

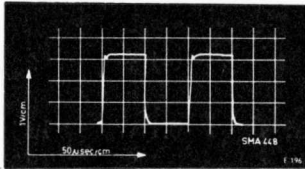


Fig. 41. Output signal at terminals O.4 and M.4

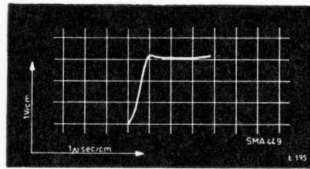


Fig. 42. Leading edge of the pulse at terminals O.4 and M.4

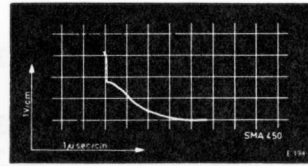


Fig. 43. Trailing edge of the pulse at terminals O.4 and M.4

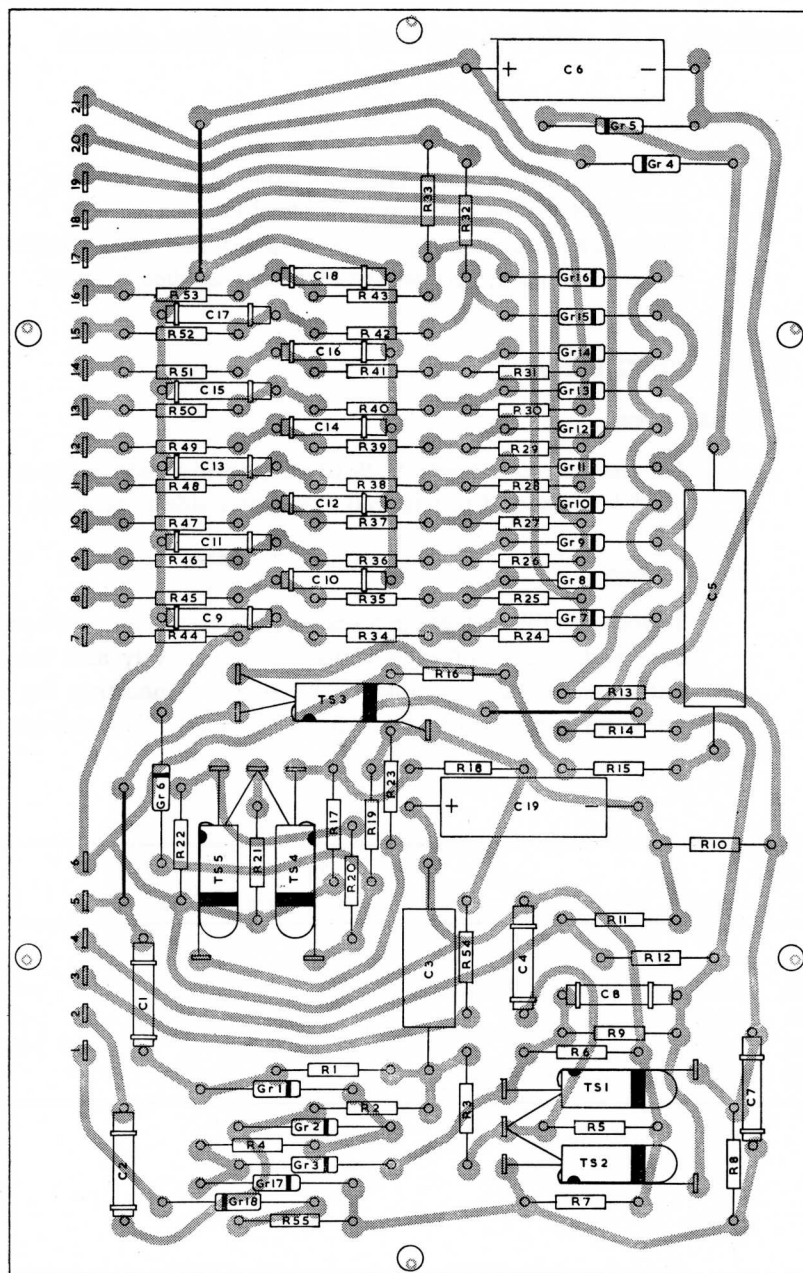
Schmitt trigger

Measure the voltage at the collector of TS4 without an input signal. This voltage should be more negative than -10.5 V .

Apply a signal with a pulse duration of $1/5$ of the p.r.f. and an amplitude of $5 V_{p-p}$ to the input. At a frequency between 120 and 160 c/s the Schmitt trigger switches over. In this state the voltage at the collector of TS4 should be more positive than -2 V . At a frequency between 40 and 20 c/s the Schmitt trigger should revert to its original state. Before the Schmitt trigger reaches this position, the collector voltage of TS4 should be more positive than -4.5 V .

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors	OC47			
All diodes	OA95			
All resistors except	B8 305 80 B/...		0.1 W	5%
R18	B8 305 80 A/150K	0.15 M Ω	0.1 W	10%
R34-R43	B8 305 80 A/150K	0.15 M Ω	0.1 W	10%
R44-R53	B8 305 80 A/180K	0.18 M Ω	0.1 W	10%
All capacitors ceramic except	904/...			
C3 (polyester)	906/L56K	56,000 pF		
C5 (polyester)	4822 069 00542	0.68 μ F		
C6 (electrolytic)	C427 AR/C20	20 μ F	6.4 V	
C19 (electrolytic)	909/W10	10 μ F	16 V	



SMA 367
E 1178

Fig. 44. Circuit lay-out of panels M and O

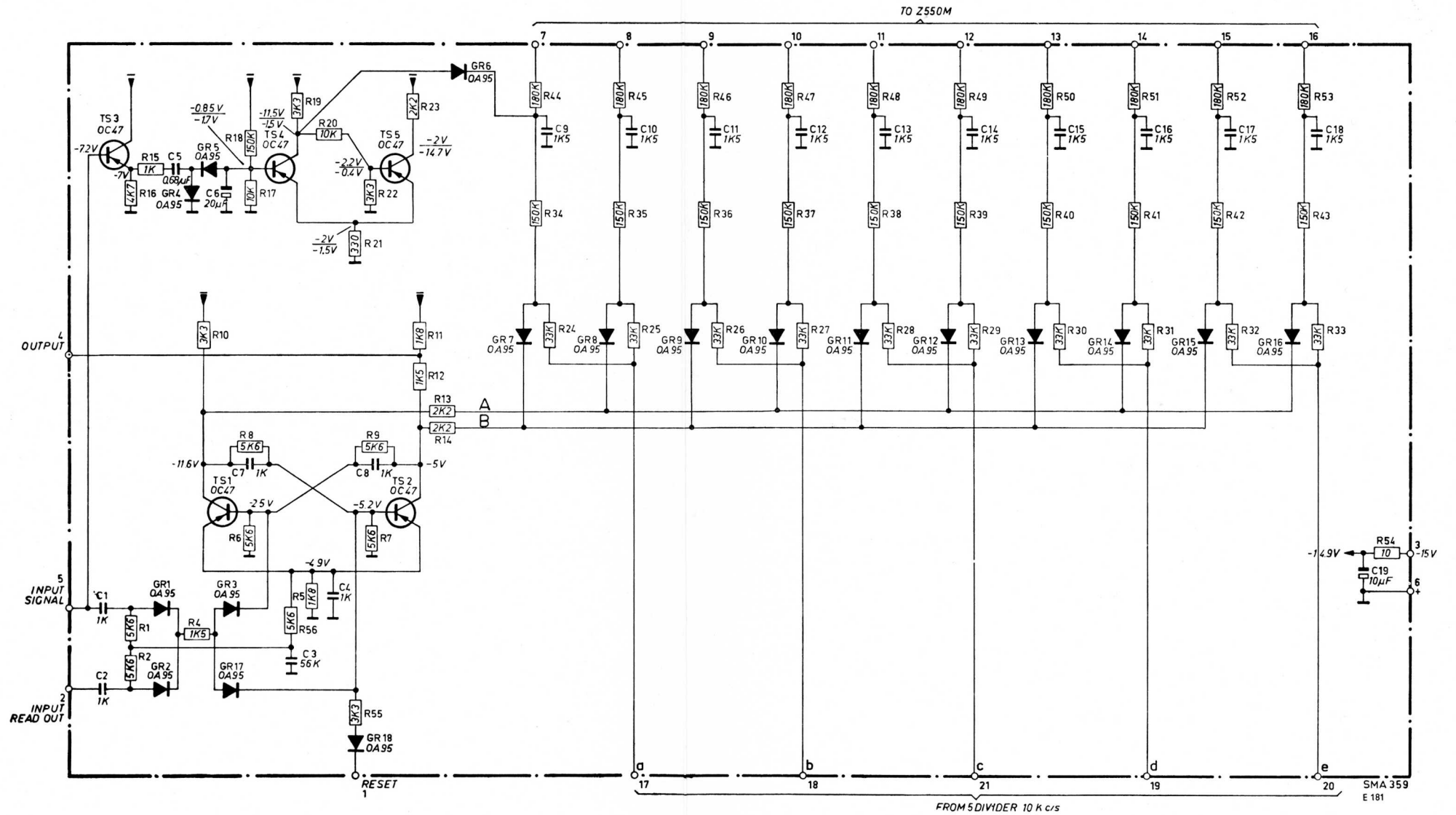


Fig. 45. Diagram of panels M and O

Panels N, P, S and U - 10 kc/s scale-of-five circuit

X

A. DESCRIPTION

For a description of this panel see "Basic Considerations". For the read-out circuit see the description of panel G.

Note - The coupling capacitors in this circuit have a higher value than those on panel L, because the frequency applied is lower.

B. MEASURING DATA

Load current

The load current should be 9–10 mA, positive side of the supply voltage of 15 V connected to terminal 3, negative side to terminal 2.

D.C. voltages

To measure the voltages in a scale-of-five circuit connect a meter between base and emitter of each transistor successively and make the other transistors in turn conductive by briefly connecting the base of the transistor concerned to the -15 V-supply line via a resistor of 6,800 Ω .

Conduc- tive	TS1		TS2		TS3		TS4		TS5	
	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}	V_{BE}	V_{CE}
TS1		<-0.2V >0.2V		>0.2V		>0.2V		>0.2V		>0.2V
TS2	>0.2V		<-0.2V >0.2V		>0.2V		>0.2V		>0.2V	
TS3	>0.2V		>0.2V		<-0.2V >0.2V		>0.2V		>0.2V	
TS4	>0.2V		>0.2V		>0.2V		<-0.2V >0.2V		>0.2V	
TS5	>0.2V		>0.2V		>0.2V		>0.2V			<-0.2V

Reset

Block transistor TS7 by setting transistor TS2 in a conductive state. Then briefly connect terminal 4 to -12 V and make sure that TS1 is now in a conductive state.

Input frequency

Apply a square wave signal with an amplitude of $2 V_{p-p}$ and pulse duration of $\frac{1}{2}$ of the p.r.f. to input terminal 1. Measure the maximum input frequency of the scale-of-five circuit by connecting an oscilloscope to terminal 11. This frequency should be higher than 20 kc/s.

Output signal

Apply a signal with a frequency of 5 kc/s, an amplitude of $2 V_{p-p}$ and a pulse duration of $\frac{1}{2}$ of the p.r.f. to the input. The shape of the output signal at terminal 11 should be as shown in Fig. 46.

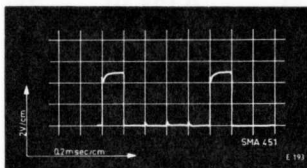


Fig. 46. Output signal at terminals N.11, P.11, S.11 and U.11

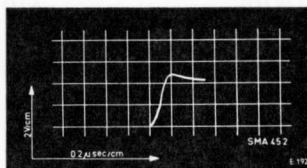


Fig. 47. Leading edge of the pulse at terminals N.11, P.11, S.11 and U.11

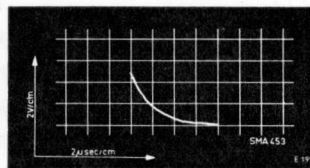


Fig. 48. Trailing edge of the pulse at terminals N.11, P.11, S.11 and U.11

Also measure the signals at the terminals 5 up to 9. The shape of these signals is as shown above, except that the amplitude at these points amounts to 6 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except TS6	OC47 OC140			
All diodes	OA95			
All resistors except R4 R32 R33 R34 R35 R36 R37	B8 305 80 B/... 901/1K2 901/510E 901/2K7 901/2K7 901/2K7 901/2K2 901/2K7	1,200 Ω 510 Ω 2,700 Ω 2,700 Ω 2,700 Ω 2,200 Ω 2,700 Ω	0.1 W 0.125 W 0.125 W 0.125 W 0.125 W 0.125 W 0.125 W	5% 2% 2% 2% 2% 2% 2%
All capacitors ceramic except C2 (polyester) C10 (electrolytic)	904/... 906/L56K 909/W10	56,000 pF 10 μ F	16 V	

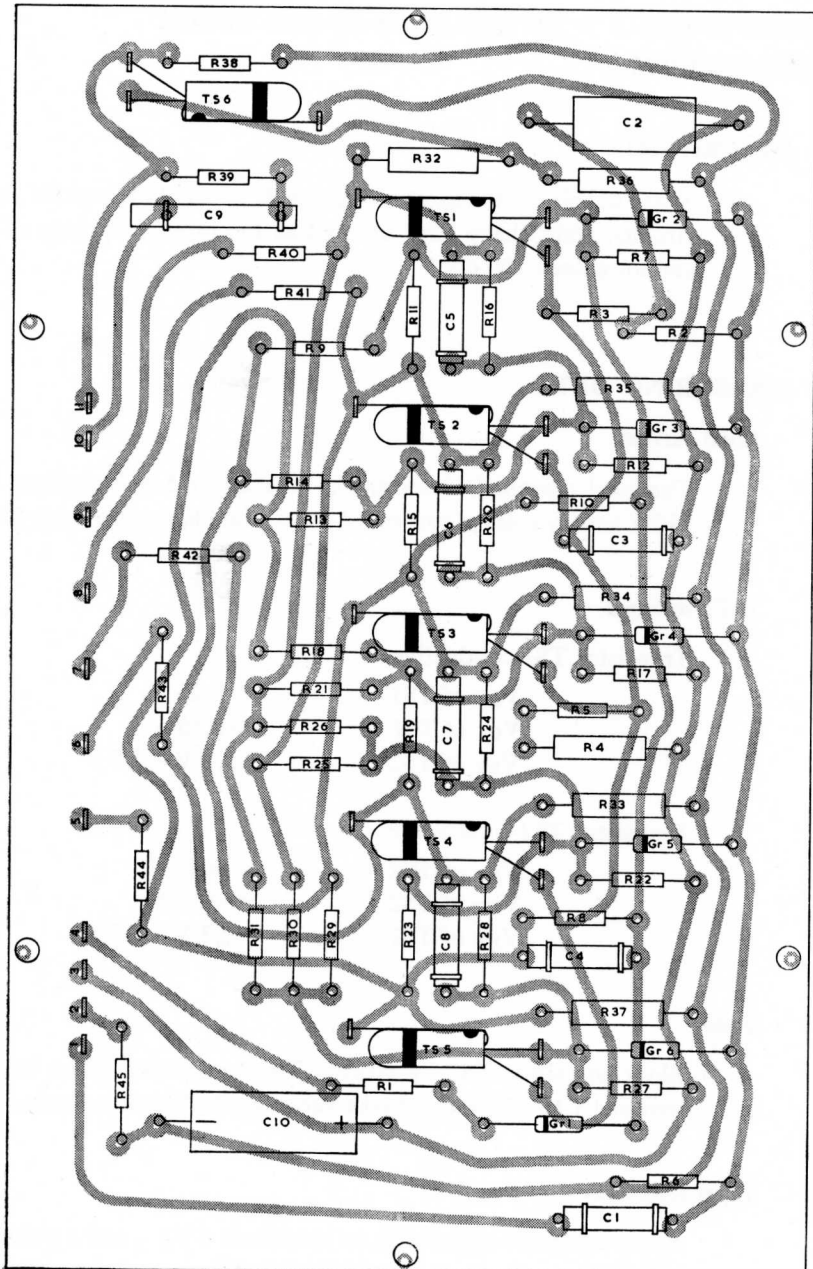
SMA 427
E 1176

Fig. 49. Circuit lay-out of panels N, P, S and U

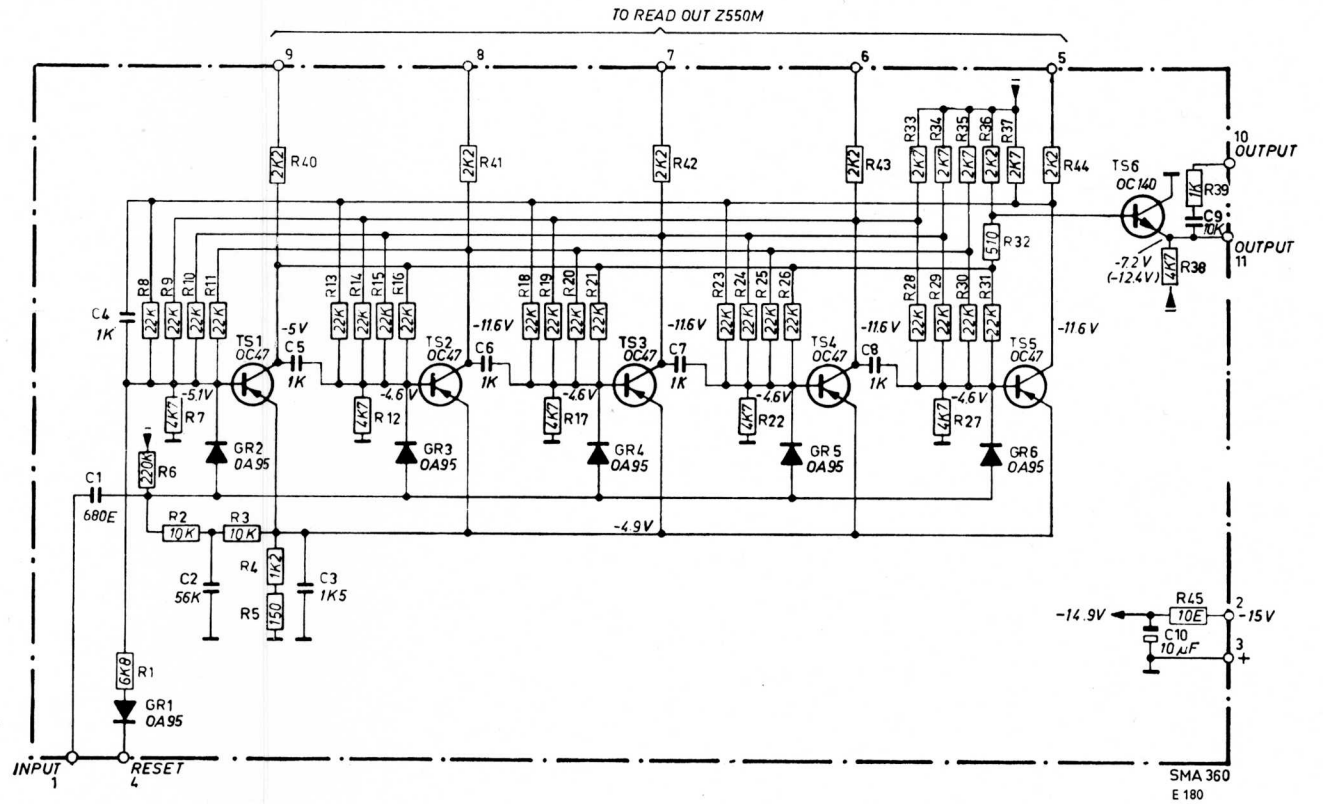


Fig. 50. Diagram of panels N, P, S and U

Panels R and T - 10 kc/s scale-of-two circuit with read out



A. DESCRIPTION

These panels are the same as the panels M and O except for the clamping circuits, which have been omitted as the input frequency of the panels cannot exceed 100 c/s.

B. MEASURING DATA

Load current

The load current is between 3.5 mA and 4.5 mA positive side of the -15 V supply voltage connected to terminal 6, negative side to terminal 3.

D.C. voltages

Transistor TS1 conductive

V_{BE} of TS1	< -0.25 V
V_{CE} of TS1	< -0.15 V
V_{BE} of TS2	2.3 V - 2.5 V

Transistor TS2 conductive

V_{BE} of TS2	< -0.25 V
V_{CE} of TS2	< -0.15 V
V_{BE} of TS1	2.3 V - 2.5 V

Reset

Block transistor TS2 by making TS1 conductive. Then briefly connect terminal 1 to -12 V and make sure that TS2 is now conductive.

Input frequency

Apply a positive signal with an amplitude $4 V_{p-p}$ and a pulse duration of $1/5$ of the p.r.f., to input terminal 2. Measure the maximum counting frequency by connecting an oscilloscope to terminal 4. The maximum input frequency amounts to 40 kc/s.

Input sensitivity

At an input frequency of 10 kc/s, a pulse duration of 1/5 of the p.r.f. the minimum input voltage should be about $2.5 V_{p-p}$.

Output signal

Apply a signal with a frequency of 10 kc/s, an amplitude of 4 V and a pulse duration of 1/5 of the p.r.f. to the input. The output signal at terminal 4 should have the shape shown in Fig. 51.

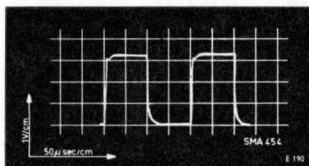


Fig. 51. Output signal at terminals R.4 and T.4

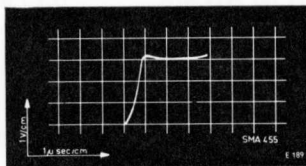


Fig. 52. Leading edge of the pulse at terminals R.4 and T.4

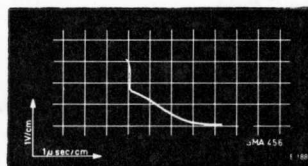
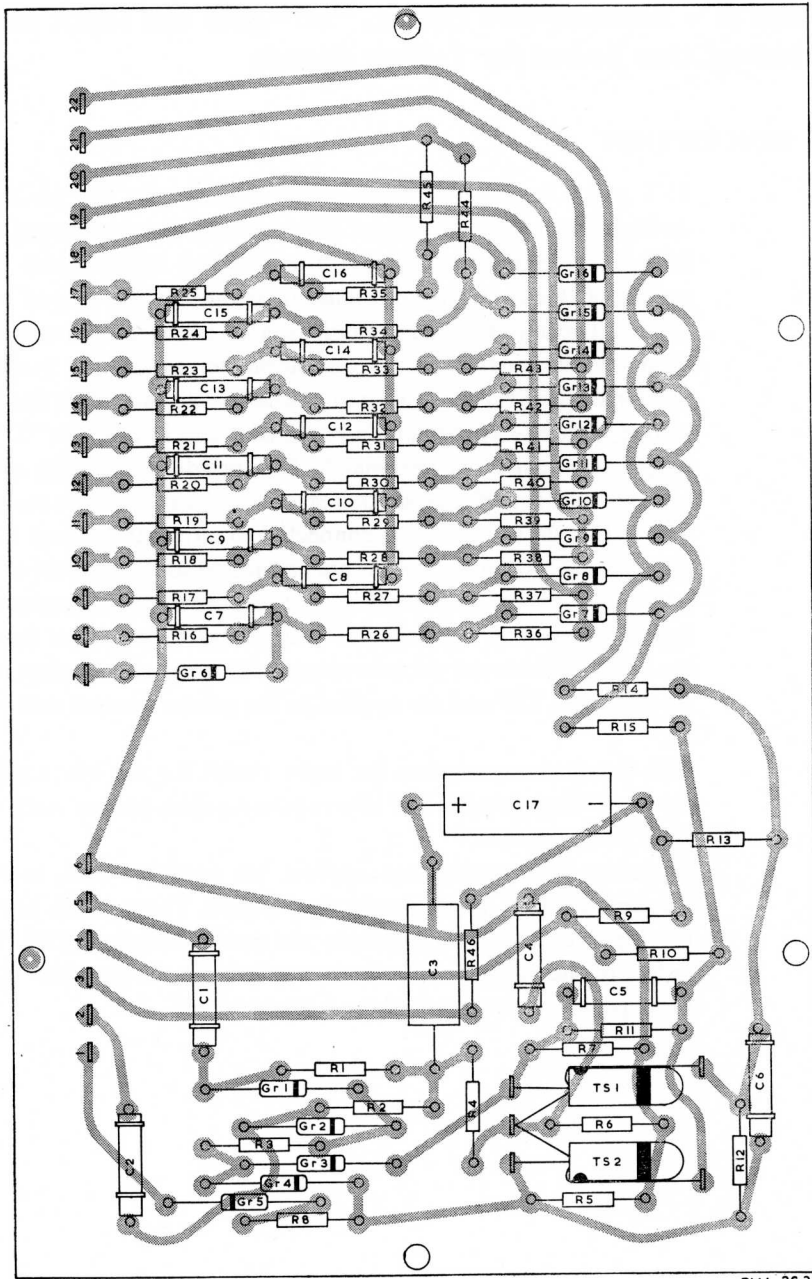


Fig. 53. Trailing edge of the pulse at terminals R.4 and T.4

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors	OC47			
All diodes	OA95			
All resistors except	B8 305 80 B/...		0.1 W	5%
R16-R25	B8 305 80 A/180K	0.18 M Ω	0.1 W	10%
R26-R35	B8 305 80 A/150K	0.15 M Ω	0.1 W	10%
All capacitors ceramic except	904/...			
C3 (polyester)	906/L56K	56,000 pF		
C17 (electrolytic)	909/W10	10 μ F	16 V	



SMA 363
E 1175

Fig. 54. Circuit lay-out of panels R and T

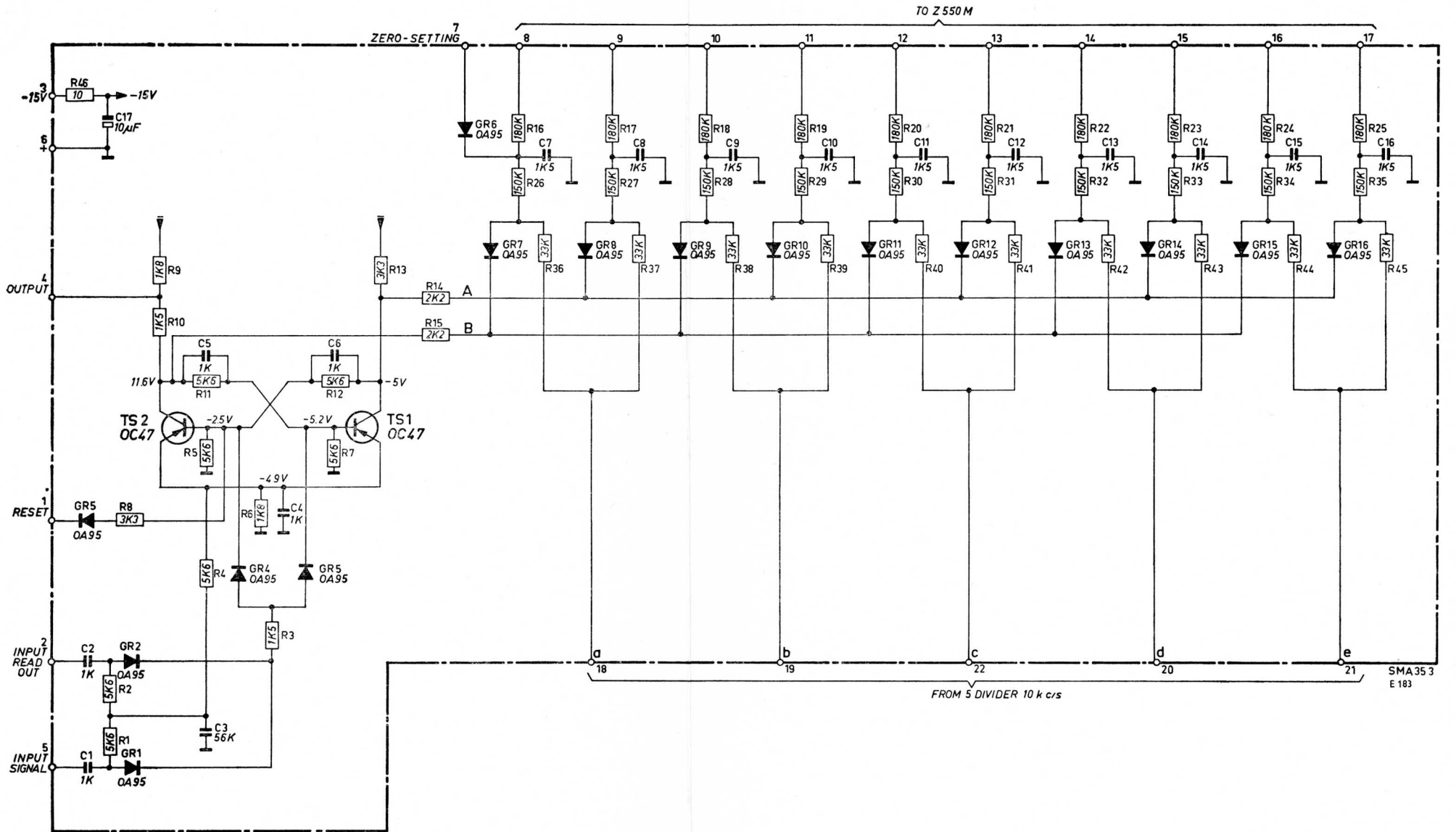


Fig. 55. Diagram of panels Rand T

Panel B - Scale-of-two circuit, "or"-gate and input for interrogation pulses for 1 Mc/s decade



A. DESCRIPTION

This panel comprises two scale-of-two circuits. In position "4" of divider switch SK1 the output of one of the decades chosen with switch SK2, is connected via terminal 9 to the first scale-of-two circuit. The output of this circuit is connected to the input of a second scale-of-two circuit. The input of this circuit is also connected to terminal 8; the output to terminal 6 and to the output terminal 7. In position "2" of divider switch SK1 the output of a decade is connected to the input of the second scale-of-two circuit via terminal 8 and in position "1" directly to output terminal 7 via terminal 6. This provides a facility whereby the original number of output pulses of the decades can be multiplied by 1, 2 or 4. Output terminal 7 is connected to terminal 7, panel A.

Terminals 12-18 on this panel are connected to the outputs of the decade units. The diodes Gr7-Gr13 pass the output pulse produced by each decade when it is interrogated, yet prevent these pulses from reaching the other decades not yet interrogated. These positive pulses are inverted by transistor TS5 and are applied to the printer control unit via terminal 11.

This panel also comprises the input circuit for the interrogation pulses for the 1 Mc/s decade. The interrogation pulses are not steep enough for the 1 Mc/s-decade.

Therefore these pulses are applied, via amplifier TS6, to the Schmitt trigger TS7-TS8, which forms steep pulses. These pulses are applied to the input of the 1 Mc/s-decade via emitter-follower TS9. The output pulses of the 10 Mc/s decade are applied, via the amplifier TS10 on the same panel, to the input of the 1 Mc/s decade.

B. MEASURING DATA

Load current

The load current amounts to 20–25 mA, positive side of the -15 V supply voltage connected to terminal 10, negative side to terminal 5.

Scale-of-two circuits

Reset

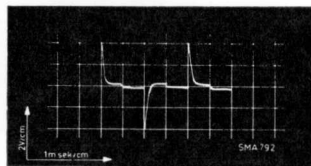
Block the transistors TS2 and TS4 by briefly connecting their bases to the emitters. Then connect terminal 4 to -12 V and check whether these two transistors are conductive again.

Input frequency

Apply a positive signal with an amplitude of $4\text{ V}_{\text{p-p}}$ and a pulse duration of $1/5$ of the p.r.f. to the input terminal 9. For measuring the maximum counting frequency connect an oscilloscope to terminal 7. The frequency should be higher than 40 kc/s .

Output signal

Apply a positive signal with an amplitude of $4\text{ V}_{\text{p-p}}$, a frequency of 1 kc/s and a pulse duration of $10\text{ }\mu\text{sec}$ to the input terminal 9. Check the output signal at terminal 7. The shape of this signal should be as shown in Fig. 56. Apply a positive signal with an amplitude of $4\text{ V}_{\text{p-p}}$, a frequency of 500 c/s and a pulse duration of $10\text{ }\mu\text{sec}$ to terminal 8. The output signal at terminal 7 should have the same shape as shown in Fig. 56.



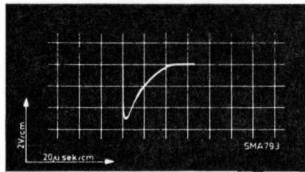
E 1163

Fig. 56. Output signal at terminal B.7

“Or”-gates

Decade “full” signal

Apply a positive signal with a frequency of 500 c/s, a pulse duration of 0.4 msec and an amplitude of $4 V_{p-p}$ to the terminals 12 up to 18 consecutively and measure the decade “full” signal at terminal 11. The pulse shape should be as shown in Fig. 57.



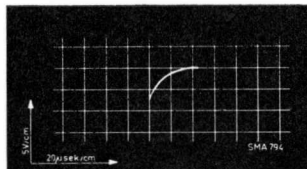
E 1164

Fig. 57. Decade “full” signal

Input for interrogation pulses 1 Mc/s decade

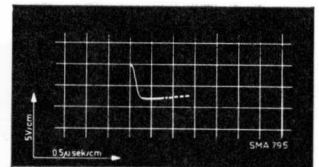
Output pulse

Apply a positive signal with a frequency of 1 kc/s, an amplitude of 4 V and a pulse duration of 100 μ sec to terminal 2. The output pulse at terminal 1 should have the same shape as shown in Fig. 58.



E 1165

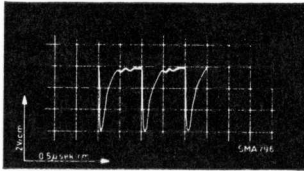
Fig. 58. Output pulse at terminal B.1



E 1166

Fig. 59. Leading edge of the pulse at terminal B.1

Apply a sinusoidal signal with a frequency of 1 Mc/s and an amplitude of $1 V_p$ to the input of the scaler. The shape of the signal at terminal 1 should be as shown in Fig. 60.



E 1167

Fig. 60. Output pulse

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>	
All transistors except	OC47		
TS5	OC140		
TS6	OC141		
TS10	OC141		
All diodes except	OA95		
Gr15	AAZ13		
All resistors except	B8 305 80 B/...	0.1 W	5%
R14 and R15	B8 305 80 A/270K	0.27 M Ω	0.1 W 10%
All capacitors ceramic except	904/...		
C3 (polyester)	906/L56K	56,000 pF	
C10 (polyester)	906/L56K	56,000 pF	
C26 (electrolytic)	909/W10	10 μ F	16 V

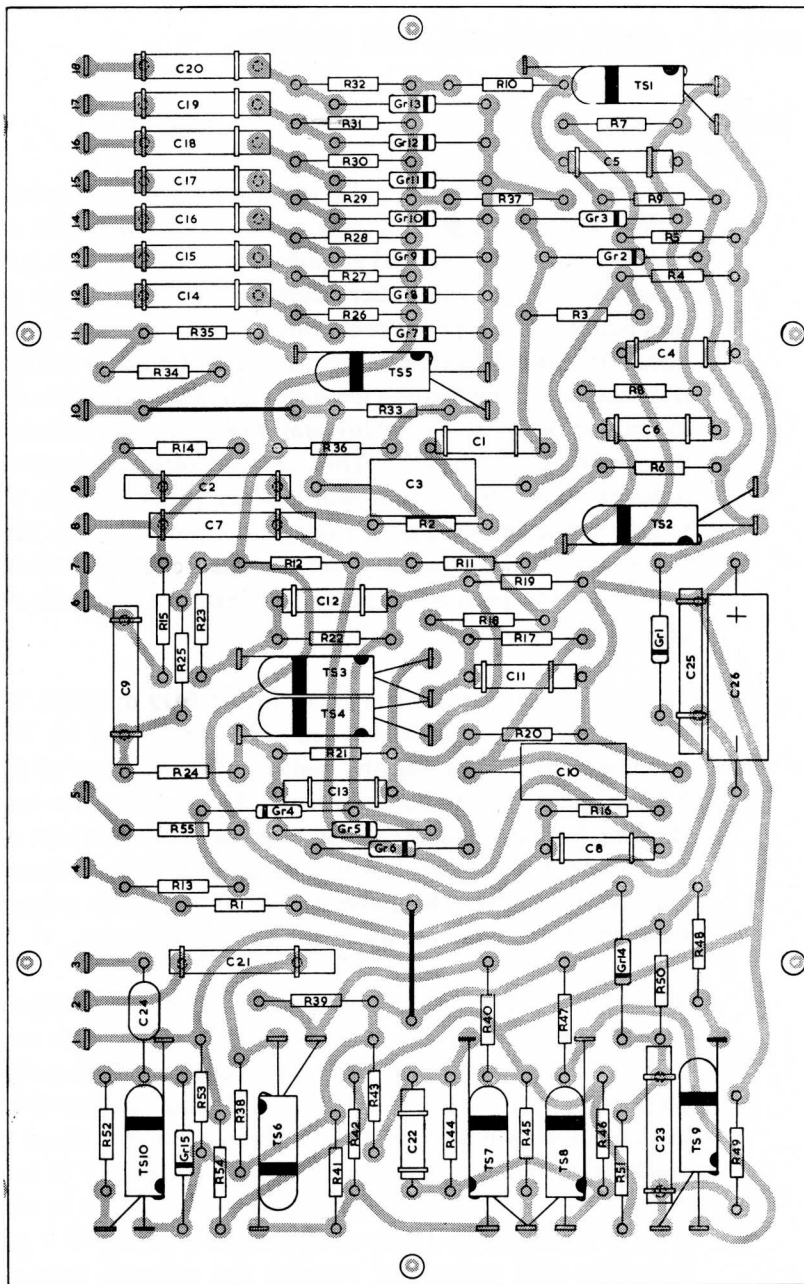


Fig. 61. Circuit lay-out of panel B

SMA672
E 1174

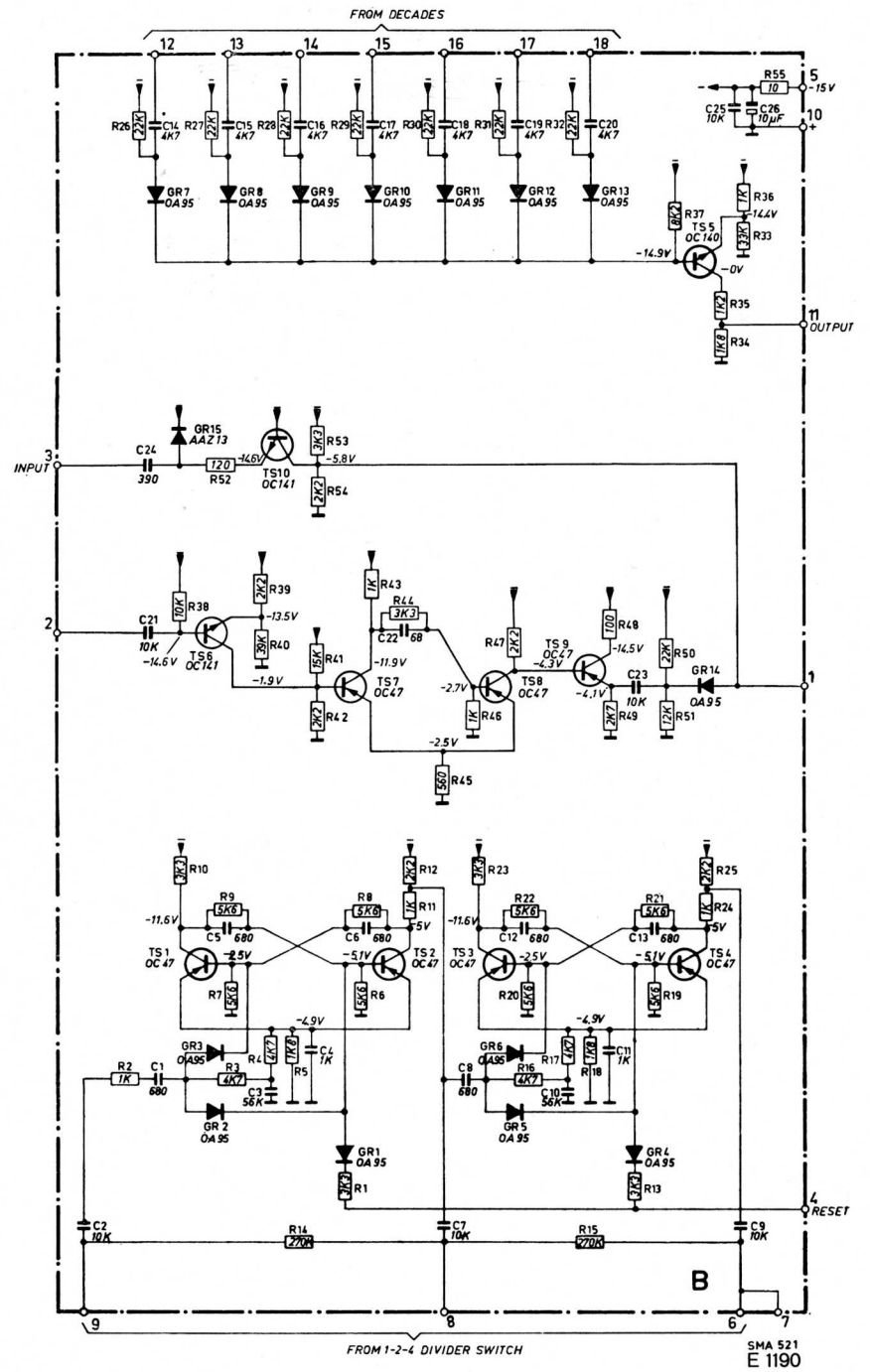


Fig. 62. Diagram of panel B

Panel A - Start, stop and reset circuits

XIII

A. DESCRIPTION

The selected preset count pulse (positive) arriving at terminal 7 passes emitter follower stage TS8, gate circuit GR6 (controlled by start-stop multivibrator TS5-TS6) and amplifier stage TS9. Then it is fed to preset count socket BU11 via emitter follower stage TS10. At this point we find thus pulses with the preset count interval, but only if switch SK7 is open. For, if this switch is closed, the preset count pulse is fed to stop socket BU7 and goes from there to the start-stop multivibrator to set this circuit to the stop position. The multivibrator switches over and the collector of TS6 becomes more negative. This negative potential is applied via emitter follower stage TS7 to transistor TS7 in panel D, thus blocking this transistor and preventing the passage of input pulses. At the same time, by means of the same potential decrease, gate circuit GR6 is blocked, now preventing the passage of pulses originating during the interrogation process or reset period.

To reset the scaler a pulse is fed to socket BU9 or BU10. This negative pulse triggers the monostable multivibrator formed by TS1 and TS2, which will produce a negative pulse with a duration of 50 msec. The 50-msec pulse is fed to both transistors TS3 and TS4. The negative signal resulting from the leading edge of the pulse after it has been differentiated by C5 and R15, causes TS4 to conduct and thus produces a negative pulse at its emitter. This pulse is used to switch the start-stop bistable multivibrator to stop, i.e. transistor TS5 is conductive.

The trailing edge of the 50-msec pulse, after being differentiated, will produce a positive pulse. This will not affect TS4 as it is cut off and the pulse is of the wrong polarity to make it conductive. However, when this pulse is applied to the base of TS3, it will cause this transistor to become conductive since it is an N.P.N. A negative pulse of about 14 V is thus available at terminal 4 and another one of about 7 V is available at terminal 5. GR2 is a silicon diode and does not start to conduct in the forward direction, until there is a potential of about 0.5 V across it. This serves the dual purpose of reducing the collector leakage current to practically zero and providing an 0.5-V base bias which prevents any small, spurious pulses from getting any further.

B. MEASURING DATA

Load current

The load current should be 24–28 mA, positive side of the supply voltage of –15 V connected to terminal 1, negative side to terminal 9.

Input sensitivity of the one-shot TS1 and TS2

Attach a 1-k Ω potentiometer to the reset output of the PW 4201 and take the signal for the scaler from the cursor. Connect an oscilloscope to terminal 4. Start the one shot with the reset signal from the PW 4201 and trigger the oscilloscope with the same signal. Adjust the potentiometer so that the one shot just switches over. Keep the potentiometer in that position and measure the amplitude of the input pulse at terminal 2 with the aid of the oscilloscope; the amplitude should be 2.5 V – 3.5 V.

Output pulse

The oscilloscope is again connected to terminal 4 and triggered by the input signal. The time between the start of the time base and the leading edge of the output pulse at terminal 4 is the duration of the pulse originated from the one shot. This value should be between 25 msec and 50 msec. Check the output pulse at terminals 4 and 5 from Figs. 63 and 64.

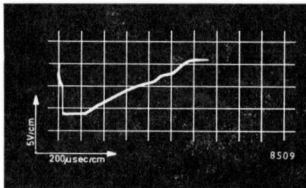


Fig. 63. Output pulse at terminal A.4

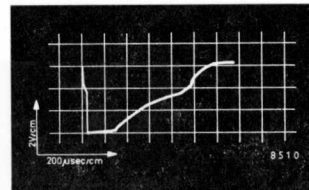


Fig. 64. Output pulse at terminal A.5

D.C. voltages

Transistor TS2 conductive

V_{BE} of TS2	-0.25 V
V_{CE} of TS2	-0.15 V
V_{BE} of TS1	1 V -2 V

Transistor TS5 conductive

V_{BE} of TS5	-0.25 V
V_{CE} of TS5	-0.15 V
V_{BE} of TS6	0.5 V -1 V

Transistor TS6 conductive

V_{BE} of TS6	-0.25 V
V_{CE} of TS6	-0.15 V
V_{BE} of TS5	0.5 V -1 V

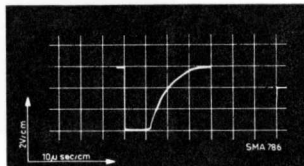
Apply a pulse from control unit PW 4201 to terminal 3 and measure the voltage at terminal 10; this should be -13 V. Apply a pulse to terminal 6. The voltage at terminal 10 should now be -3.4 V. If a pulse is applied to terminal 2 the voltage at terminal 10 should be -13 V.

The input sensitivity of inputs 3 and 6 is measured in the same way as the input sensitivity of the above mentioned one-shot multivibrator and amounts to about -2.5 V.

Apply a positive signal of 100 c/s, pulse duration 2 μ sec, amplitude 4 V, to terminal 7 via a capacitor of 1 μ F. Connect a capacitor of 100 pF between terminal 8 and earth. Measure the signal at terminal 8 (see Fig. 62) in both positions of gate GR6.

Gate open, voltage at terminal 10; -3.4 V.

Gate closed, voltage at terminal 10; -13 V.



E 1168

Fig. 65. Signal at terminal 8, gate open

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except	OC47			
TS3	OC140			
TS7	OC140			
TS9	OC140			
All diodes except	OA95			
Gr2	OA200			
Gr6	OA200			
Gr7	OA47			
All resistors	B8 305 80 B/...		0.1 W	5%
Capacitors				
C1 (ceramic)	904/1K	1000 pF		
C2 (ceramic)	904/10K	0.01 μ F		
C3 (electrolytic)	C 427 AR/H2.5	2.5 μ F	64 V	
C4 (polyester)	906/L56K	0.056 μ F		
C5 (polyester)	906/L56K	0.056 μ F		
C6 (polyester)	906/L56K	0.056 μ F		
C7 (polyester)	906/L56K	0.056 μ F		
C8 (ceramic)	904/10K	0.01 μ F		
C9 (electrolytic)	909/W10	10 μ F	16 V	
C10 (ceramic)	904/10K	0.01 μ F		
C11 (ceramic)	904/10K	0.01 μ F		
C12 (ceramic)	904/10K	0.01 μ F		

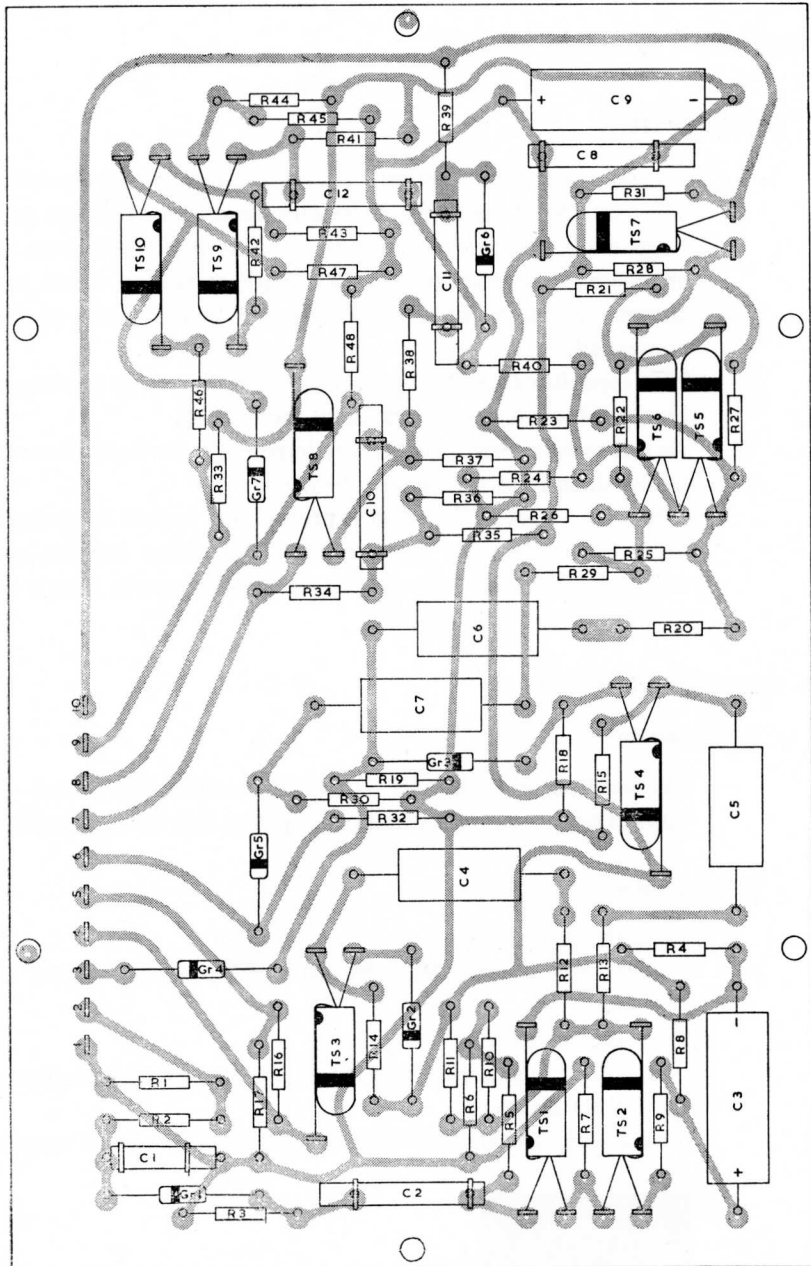
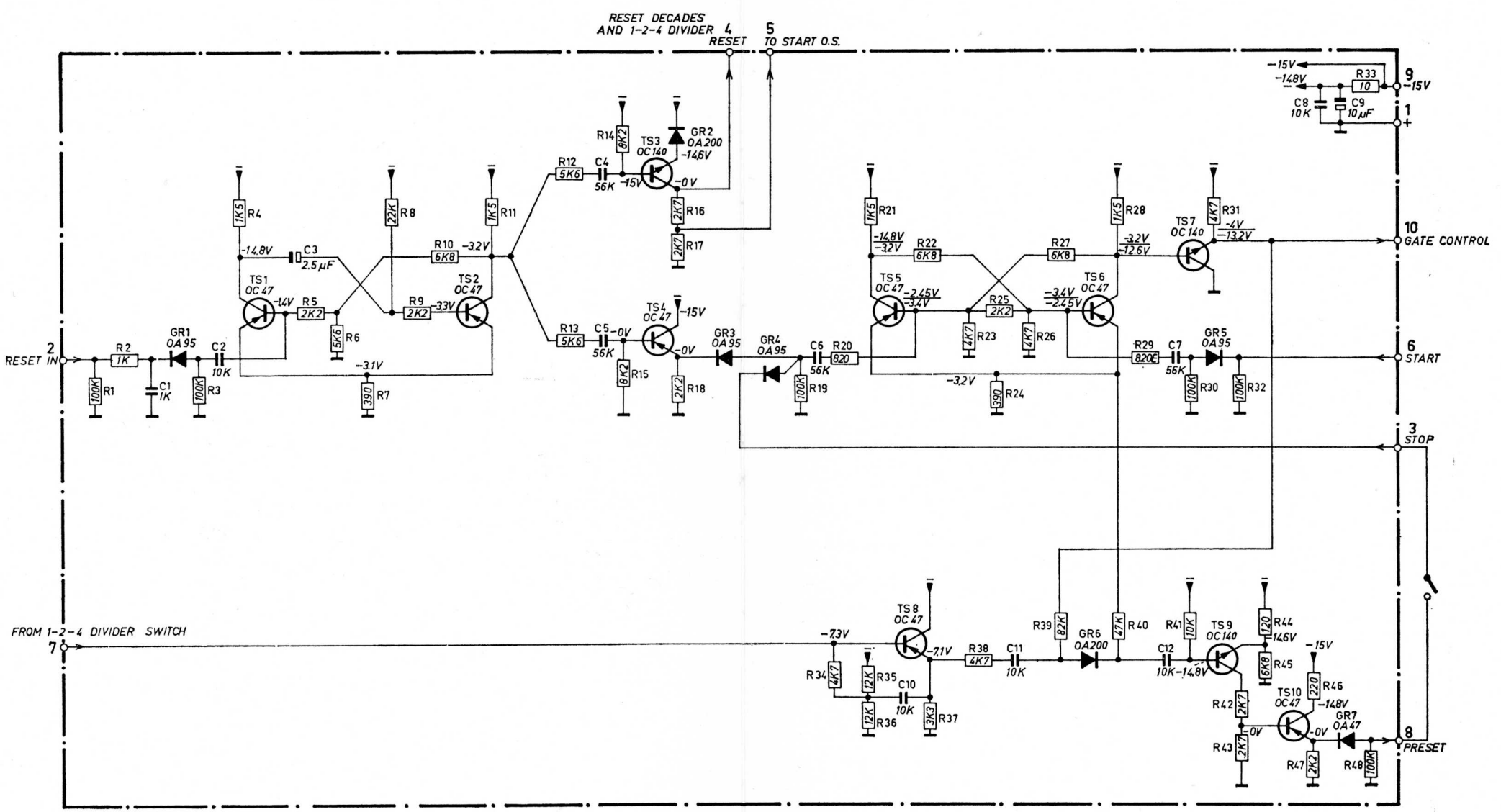
SMA 389
E 1173

Fig. 66. Circuit lay-out of panel A



8539

Fig. 67. Diagram of panel A

Panel C - Control circuit



A. DESCRIPTION

The stop, start and reset pulses are all produced in a similar way by TS5, TS6 and TS7 respectively. Normally these transistors are cut off because there is no potential on their bases. If one of the buttons is pressed, a change-over contact switches a 2.5 μF capacitor which has been pre-charged to -6 V , in parallel with the base resistor of the transistor concerned.

This capacitor then discharges exponentially across the base resistor and thus produces a negative pulse at the emitter.

As this pulse comes from the low-impedance emitter-follower stage, it can be fed directly to the unit controlled by it.

When the "START" button is pressed and locked by giving it a quarter turn, the connection between the change-over contact and the base resistor of the stop and reset circuit is interrupted; thus it is impossible to stop or reset erroneously.

B. MEASURING DATA

Load current

The load current amounts to 15 mA, positive side of the -15 V supply voltage connected to terminal 1, negative side to terminal 9.

Output pulse

Press the reset knob.

At the reset output (BU9–BU10) a pulse should appear as shown in Fig. 68.

Press the start knob.

At the start output (BU5–BU6) the same pulse should appear.

Press the stop knob.

At the stop output (BU7–BU8) the same pulse should appear.

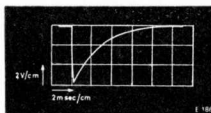


Fig. 68. Output pulse of the control circuit.

If the stop knob is pressed the start-output socket must be connected to earth.

If the stop or reset knob is pressed while the start knob is kept depressed, no output pulse may appear out the stop or reset sockets.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>		
All transistors except TS3	OC47 OC140			
Diodes				
Gr1	OA202			
Gr2	OA95			
Gr3	OA95			
Gr4	OA95			
Gr5	OA47			
Gr6	OA47			
Gr7	OA47			
All resistors	B8 305 80 B/...		0.1 W	5%
Capacitors				
C1 (polyester)	906/L56K	56,000 pF		
C2 (polyester)	906/L56K	56,000 pF		
C3 (electrolytic)	C427 AR/H2.5	2.5 μ F	64 V	
C4 (electrolytic)	C427 AR/H2.5	2.5 μ F	64 V	
C5 (electrolytic)	C427 AR/H2.5	2.5 μ F	64 V	
C6 (ceramic)	904/10K	10,000 pF		
C7 (electrolytic)	909/W10	10 μ F	16 V	

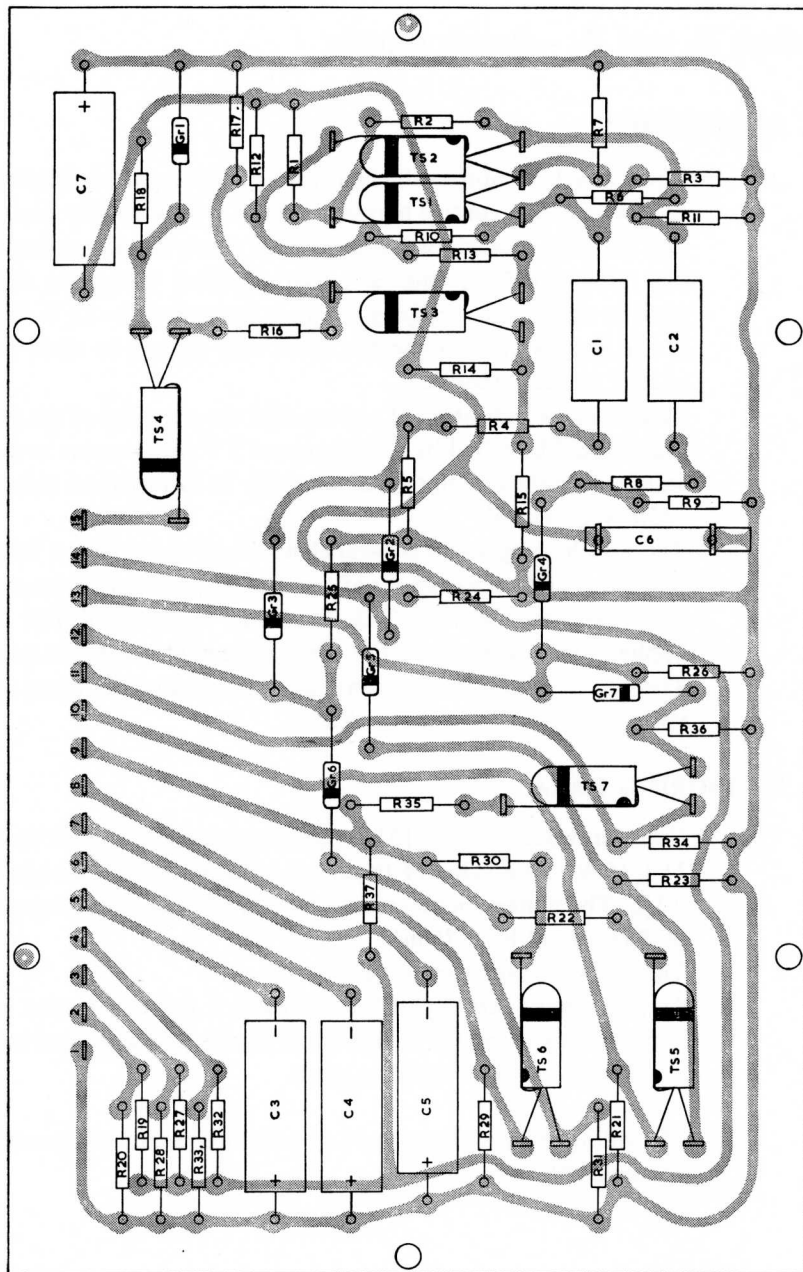
SMA 295
E 1171

Fig. 69. Circuit lay-out of panel C

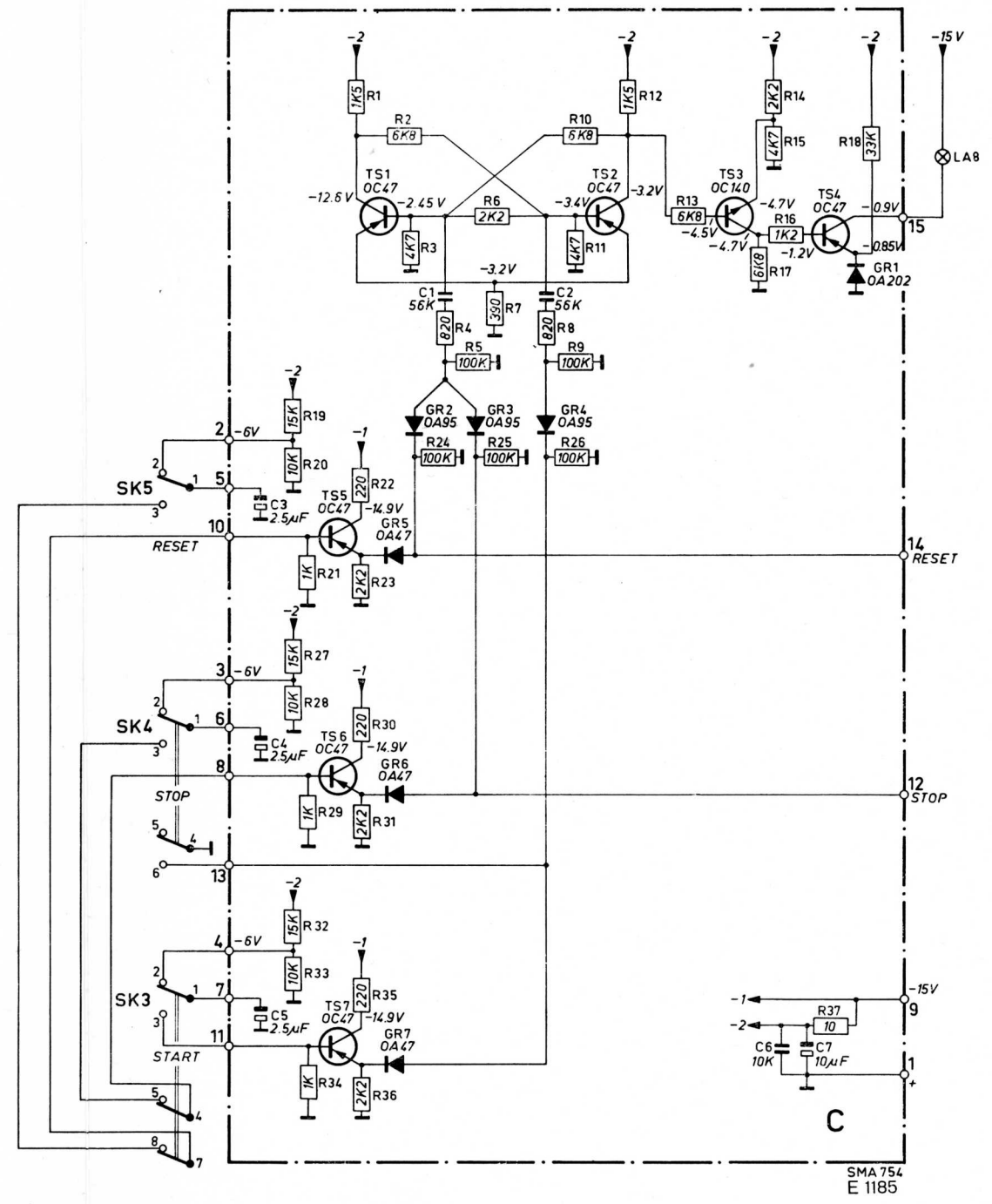


Fig. 70. Diagram of panel C

Panels Z_1 and Z_2 - Power supply



A. DESCRIPTION

These panels comprises the high voltage part for the indication tubes and the rectifier and control amplifier of the +15 V supply part.

For the high voltage of the indication tubes the a.c. voltage is rectified but not smoothed; thus a pulsating direct voltage is obtained. The positive side of the rectifying circuit is connected to -12 V. So the voltage at the anodes of the indicator tubes with respect to earth is -12 V and -122 V at the cathodes.

To obtain the indication of a given digit the potential of the starter of that digit should be raised by a minimum of 5 V with respect to the remaining starters (see the description of panel E). In fact this is a voltage rise from -13.8 V to -5.6 V.

The +15 V-supply part is parallel-stabilised by transistor TS1 (OC23) on panel Z_2 . Voltage variations at terminal 15 of panel Z_1 are applied to the difference amplifier TS2-TS3. From the collector of TS2 the signal is applied to amplifier stage TS1. This stage controls power transistor TS1. The current through this transistor decreases or increases and thus the voltage drops across resistor R20.

B. MEASURING DATA

Connect two resistors of 10 k Ω between terminal 15 (+ 15 V) and terminal 11 (-15 V). The value of these two resistors should be equal, tolerance 0.1%. The voltage between the junction of these resistors and the base of TS3 should be <75 mV.

The ripple voltage should be <4 mV_{p-p}.

As this supply part is parallel-stabilised, it must be loaded in such way, that the load current is 30 mA when the above-mentioned measurements are carried out on a separate panel.

The voltage between terminal 1 (+) and terminal 7 (-) should lie between 110 and 120 V.

C. PARTS LIST

<i>Description</i>	<i>Code number</i>	<i>Value</i>			
Panel Z₁					
All transistors	OC140				
Diodes					
Gr1	BZY59				
Gr2	BY100				
All resistors except	901/...			$\frac{1}{8}$ W	5%
R3	900/P120E	120	Ω	1 W	5%
R20	900/P47E	47	Ω	1 W	5%
All capacitors polyester					
except	906/33K	33,000	pF		
C1 (ceramic)	904/1K5	1,500	pF		
C2 (electrolytic)	909/W10	10	μ F	16 V	
C3 (ceramic)	904/10K	10,000	pF		
C11 (electrolytic)	909/W10	10	μ F	16 V	
Panel Z₂					
Transistor TS1	OC23				
All diodes	BY100				
Resistor					
R2	938/A18E	18	Ω	$5\frac{1}{2}$ W	10%
All capacitors electrolytic					
	C435AL/G160	160	μ F	40 V	
Transformer	4822 167 00447				

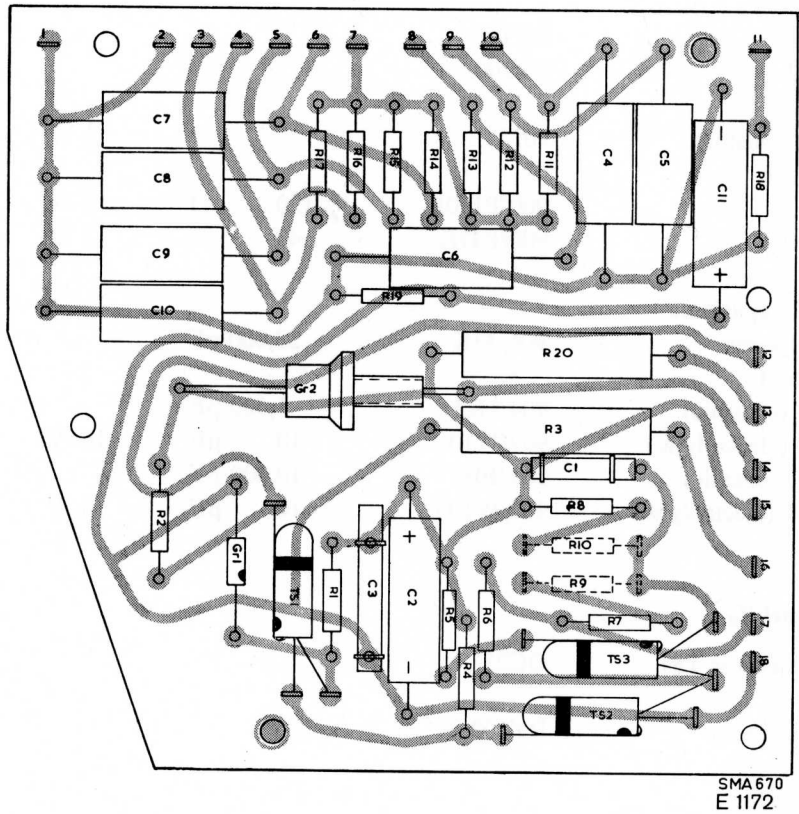


Fig. 71. Circuit layout of panel Z₁

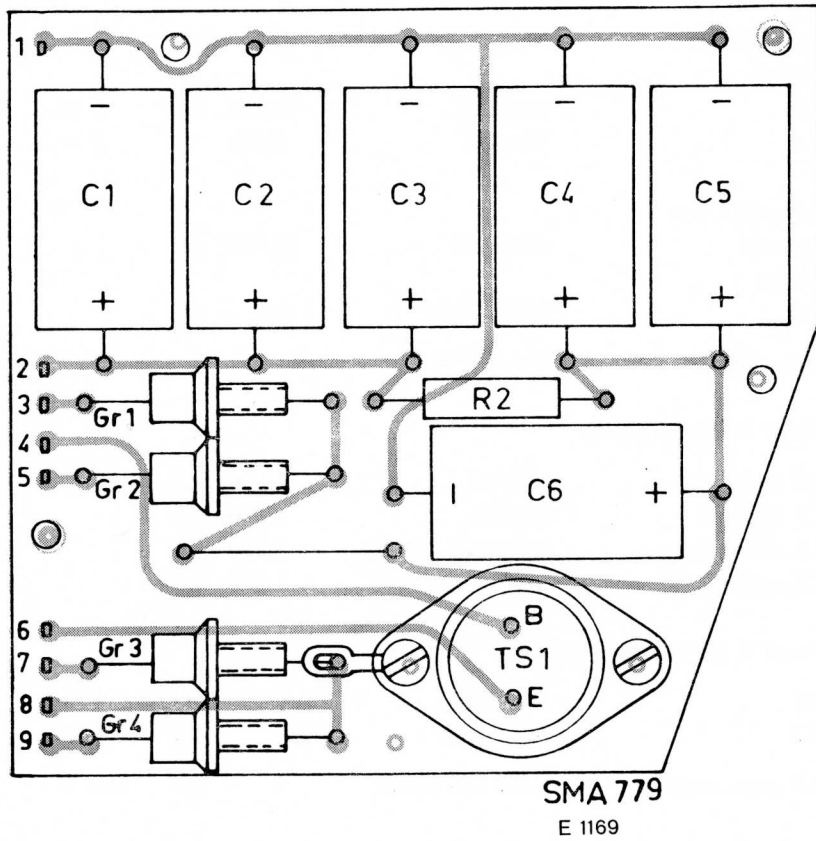


Fig. 72. Circuit lay-out of panel Z₂

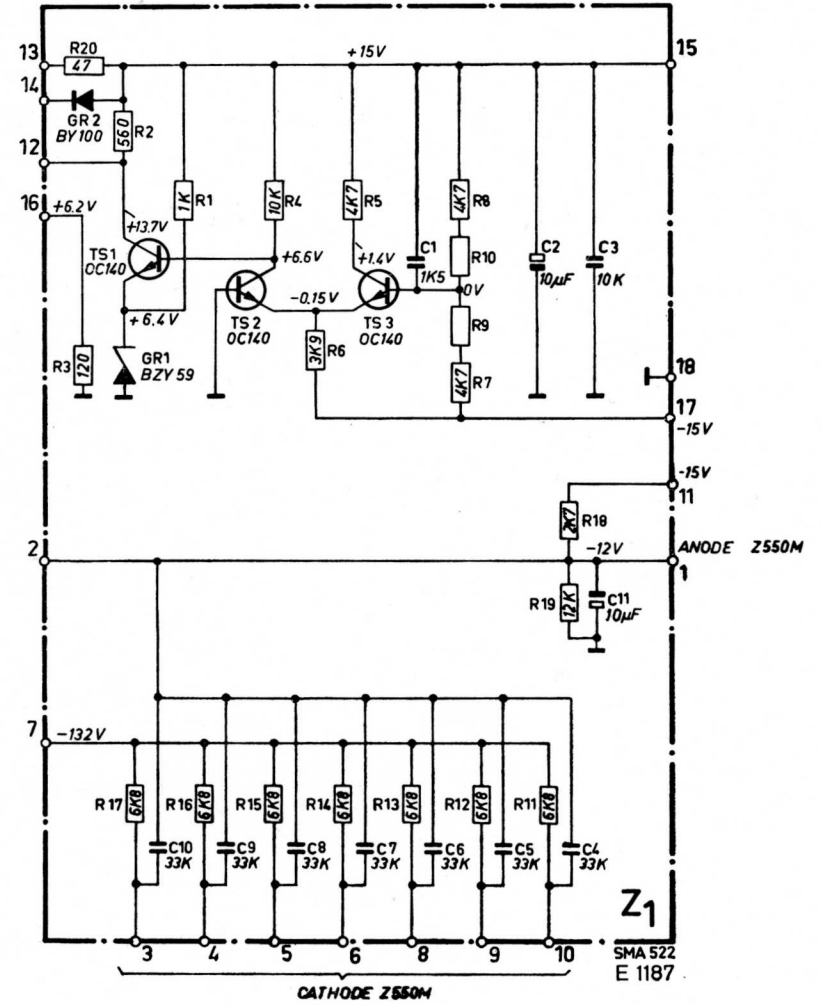
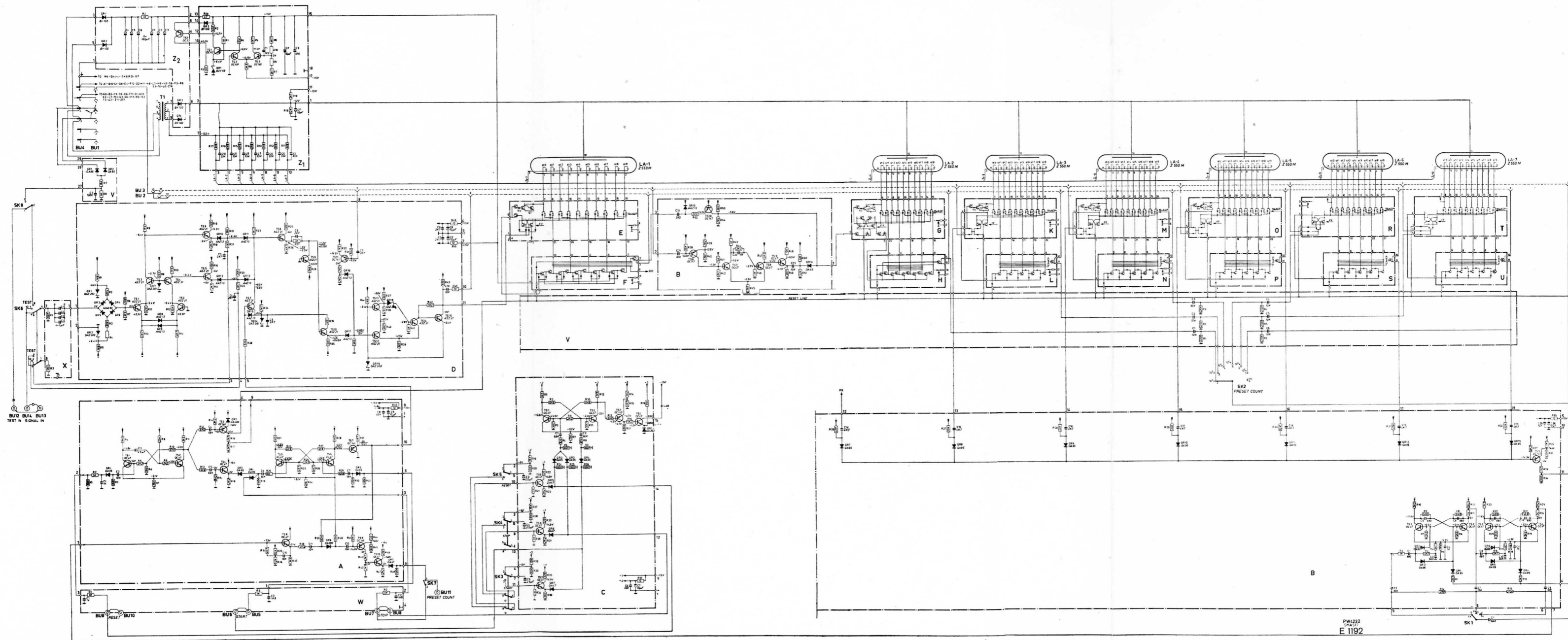


Fig. 73. Diagram of panel Z₁

Panels V, W and X**A. PARTS LIST**

<i>Description</i>	<i>Code number</i>	<i>Value</i>			
Panel V (interconnecting panel)					
All resistors except	901/220K	0.22	M Ω	$\frac{1}{4}$ W	5%
R7	901/18K	18,000	Ω	$\frac{1}{4}$ W	5%
R8	901/1K	1,000	Ω	$\frac{1}{4}$ W	5%
All capacitors ceramic except	904/10K	10,000	pF		
C7	906/L100K	0.1	μ F		
Gr1-Gr2	OA95				
Panel W (input panel)					
All resistors	901/1K	1,000	Ω	$\frac{1}{4}$ W	5%
C1 ceramic	904/1K	1,000	pF		
C2 ceramic	904/1K8	1,800	pF		
C3 ceramic	904/1K8	1,800	pF		
Panel X (signal input panel)					
R1	901/100K	0.1	M Ω	$\frac{1}{8}$ W	5%
R2	901/100E	100	Ω	$\frac{1}{8}$ W	5%
All capacitors	4822 069 00622	1	μ F	160 V	



PW4232
 5MAY57
 E 1192

Fig. 74. Circuit diagram of PW 4232

It may occur, that the "decade full"-signal of the 10-Mc/s decade of scaler PW 4232 is not large enough to control printer control unit PW 4200.

Therefore panel B has been slightly modified.

Resistor R36 (1,000 Ω) is replaced by a 330- Ω one and resistor R33 (33,000 Ω) by a 10,000 Ω one.

This modification has been applied in apparatuses from serial number D700 and onwards; moreover several apparatuses with serial numbers between D600 and D700 have been modified.

Furthermore, the value of resistor R37 of the pre-amplifier (panel D) has been changed from 560 Ω into 680 Ω . This is done from serial number D701 and onwards; moreover several apparatuses with serial numbers between D600 and D701 have been modified.

Item	Obsolete	Replaced by	Code number
Panel B R33	33,000 Ω	10,000 Ω 0.1 W 5 %	B8 305 80B/10K
R36	1,000 Ω	330 Ω 0.1 W 5 %	B8 305 80B/330E
Panel D R37	560 Ω	680 Ω 0.1 W 5 %	B8 305 80B/680E

Es kann passieren, dass das "Dekade-voll"-Signal der 10-MHz-Dekade des Zählers PW 4232 nicht gross genug ist, um Druckersteuereinheit PW 4200 zu steuern.

Deshalb wurde Schaltplatte B einigermaßen geändert.

Widerstand R36 (1.000 Ω) wurde durch einen Widerstand von 330 Ω , und Widerstand R33 (33.000 Ω) durch einen Widerstand von 10.000 Ω ersetzt. Diese Änderung wurde in Geräten mit Seriennummer von D700 an vorgenommen; überdies sind verschiedene Geräte mit Seriennummern zwischen D600 und D700 geändert worden.

Weiter wurde der Wert von Widerstand R37 des Vorverstärkers (Schaltplatte D) von 560 Ω in 680 Ω geändert, und zwar von Seriennummer D701 an; überdies wurden verschiedene Geräte mit Seriennummern zwischen D600 und D701 geändert.

Pos.	Verfallen	Ersetzt durch	Kodenummer
Schaltplatte B R33	33.000 Ω	10.000 Ω 0,1 W 5 %	B8 305 80B/10K
R36	1.000 Ω	330 Ω 0,1 W 5 %	B8 305 80B/330E
Schaltplatte D R37	560 Ω	680 Ω 0,1 W 5 %	B8 305 80B/680E

Il peut arriver que le signal "décade pleine" de la décade de 10 MHz du compteur PW 4232 ne soit pas suffisamment grand pour commander le bloc de commande d'imprimeuse PW 4200.

Pour cette raison le panneau B a été légèrement modifié.

La résistance R36 (1000 Ω) a été remplacée par une de 330 Ω et la résistance R33 (33.000 Ω) par une de 10.000 Ω .

Cette modification a été apportée dans les appareils à partir du no. de série D700; d'ailleurs plusieurs appareils ont été modifiés dont le no. de série est compris entre D600 et D700.

En outre, la valeur de la résistance R37 du pré-amplificateur (panneau D) a été portée de 560 Ω à 680 Ω . Cette augmentation s'applique aux nos. de série D701 et plus hauts.

Plusieurs appareils portant un no. de série entre D600 et D701 ont d'ailleurs également été modifiés.

Pos.	Ancienne	Nouvelle	No. de code
Panneau B R33	33.000 Ω	10.000 Ω 0,1 W 5 %	B8 305 80B/10K
R36	1.000 Ω	330 Ω 0,1 W 5 %	B8 305 80B/330E
Panneau D R37	560 Ω	680 Ω 0,1 W 5 %	B8 305 80B/680E

