ONIC MEASURING INSTRUMENTS

FFV Mätteknik AB

PULSE TRAIN GENERATOR
ZYHK 40101/

Equipment for testing relay sets and

ELMI AS

PULSE TRAIN GENERATOR
ZYHK 40101/

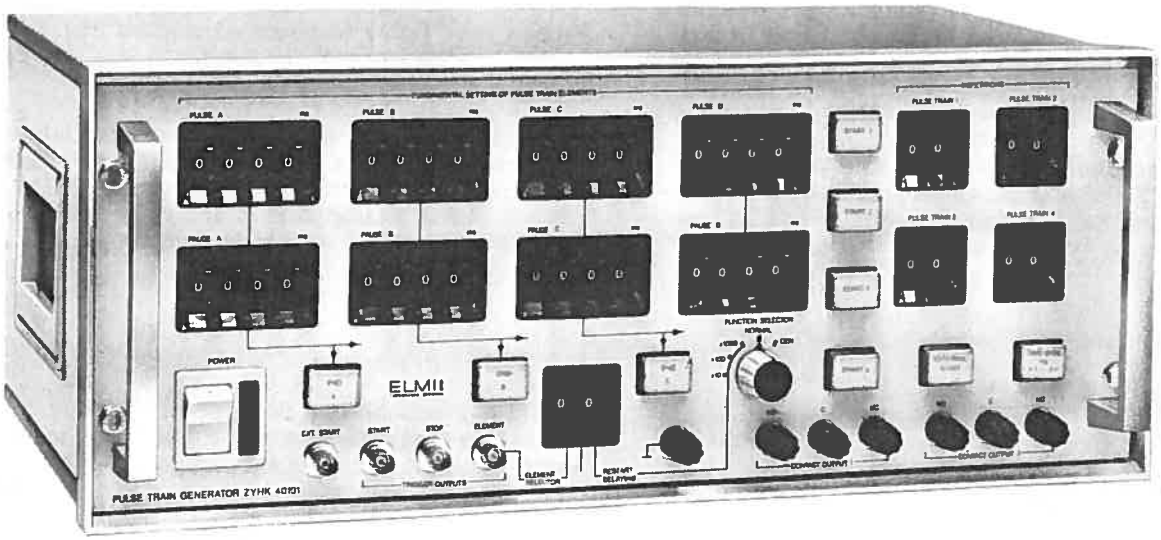
Equipment for testing relay sets and similar relay equipment used in telephone systems, and wherever a pulse-generating devise is required.

LIST OF ILLUSTRATIONS

Figure No.	Caption	Page
1.1	Pulse Train Generator ZYHK 40101	1-1
1.2	Pulse Examples	1-5
2.1	Front Panel View	2-5
2.2	Rear Panel View	2-5
2.3	80-pin Multisocket	2-11
2.4	External Programming	2-13
3.1	Flow Diagram	3-3
3.2	Trigger Pulse Output	3-43
3.3	Principle Diagram Multiplexer	3-62

Furthermore section 3 contains illustrations covering all plug-in cards and wiring diagrams.

1. GENERAL INFORMATION



24778

Fig. 1.1 The ZYHK 40101 Pulse Train Generator.

1.1. Application

The ZYHK 40101 Pulse Train Generator is designed for testing relay sets and similar relay equipment used in telephone systems.

Because of its versatility in programming and wide pulse range the instrument may be used wherever a pulse-generating device is required.

1.2 Description

The Pulse Train Generator employs digital techniques, resulting in simple programming and highly accurate pulse and pause times.

The Pulse Train Generator furnishes Regular, Irregular, and Combined pulse trains.

A pulse train may be generated as a single pulse train or repetitively, with adjustable restart delay.

The basic element of the pulse train may be repeated from 1 to 99 times and may contain from 1 to 4 different pulse /pause times, in which case the Generator is programmable for four types of pulse trains.

Number of pulse /pause times in the basic element of the pulse train is selected with front-panel pushbuttons.

Pulse times, pause times, and number of basic elements in a simple pulse train are selectable with lever switches, combining rapid setting with clear indication of programmed data. Pulse trains are started by depressing front-panel pushbuttons or by an external signal.

Generator output is obtained as a switch function from two mercury-wetted reed-contact units which operate simultaneously but control separate DC circuits.

The two contact units are located on separate circuit boards which are easily replaceable, also with contact units of other types should this be desired.

Additional facilities include:

External programming of pulse times, pause times and number of basic elements in pulse train.

Output for starting another pulse train generator or triggering an oscilloscope.

Mains-voltage switching is easily carried out from the back of the instrument.

1.3 Design

The ZYHK40101 Pulse Train Generator employs semiconductors and integrated circuits. The accuracy of pulse and pause times is determined by a crystal-controlled clock oscillator. The front panel is designed for standard 19" rack mounting, but the instrument is supplied in a metal cassette with a detachable lid which protects the front panel during transport.

The instrument uses replaceable circuit boards. Thanks to this feature, service and repairs can be carried out quickly and at low cost, even by semi-skilled personnel.

1.4 Specifications

1.4.1 PULSE TRAIN

Defined as a series of pulses, determined by number, time (width), and spacing.

1.4.2 BASIC ELEMENT

Defined as the minimum common component of a pulse train. Consists of the same number of pulse times and pause times. All basic elements of a pulse train are identical.

The basic element may be switched to contain either 1, 2, 3 or 4 different pulse /pause times (max. 8 times). Switching is carried out with lighted pushbuttons.

1.4.3 REPETITIONS

Defined as the number of basic elements in a pulse train. Number of repetitions is selectable between 1 and 99 in steps of 1, using easily operated lever switches (2 digits).

1.4.4 PULSE-/PAUSE TIME

Defined as the time during which the Generator's contact unit is operated/not operated.

Selection of pulse /pause time:

Time basic: x1 ms; 1 to 9999 ms in steps of 1 ms.

Time basic: x .1 ms; .1 to 999.9 ms in steps of .1 ms.

Both pulse and pause times are selected with easily operated lever switches (4 digits).

1.5 Programming

1.5.1

With A, B, C and D denoting the Generator's 1st, 2nd, 3rd and 4th pulse /pause elements and a, b, c and d denoting the number of repetitions in the 1st, 2nd, 3rd and 4th pulse trains selected, the chart overleaf lists the various types of pulse trains which the Generator can be programmed to furnish.

Please also refer to pulse examples Fig. 1.2.

1.5.2

Number of pulse trains and number of pulse / pause elements in a basic element are selected by means of lighted pushbuttons END 1, END 2, END 3, logically placed between the four switch groups which determine pulse and pause times.

1.5.3

If no END buttons are depressed it is an indication that only one pulse train whose basic element contains four pulse /pause times is programmed.

1.5.4

If one, two, or three END buttons are depressed it is an indication that two, three or four pulse trains, respectively, are permanently programmed.

1.5.5

The number of pulse /pause times in the basic element of the pulse train is determined, in order from left to right, by the number of pulse /pause time elements counted from the time one END button is depressed till the next END button is depressed, including beginning and end.

1.5.6

Depending on the number of pulse trains which has been programmed the process is started by pressing lighted pushbuttons START 1, START 2, START 3, START 4.

1.6 Generator Modes

FUNCTION SELECTOR: GEN.

Used for continuous generation of regular and irregular pulse trains. a, b, c or d represent continuous generation.

PULSE TRAIN TYPE	PULSE TRAIN NUMBER			
	TRAIN 1	TRAIN 2	TRAIN 3	TRAIN 4
REGULAR	a · A	b · B	c · C	d · D
IRREGULAR 1. IRREGULAR 2. IRREGULAR 3. IRREGULAR 4.	a · A a · (A + B) a · (A + B + C) a · (A + B + C + D)	b · (B + C) b · (C + D) b · D	c · D	
COMBINED 1. COMBINED 2. COMBINED 3. COMBINED 4. COMBINED 5. COMBINED 6. COMBINED 7. COMBINED 8. COMBINED 9.	a · A + b · B a · A + b · B + c · C a · A + b · B + c · C + d · D a · A + b · (B + C) + c · D a · A + b · (B + C + D) a · A + b · (B + C) a · (A + B) + b · C a · (A + B) + b · (C + D) a · (A + B + C) + b · D			

FUNCTION SELECTOR: NORMAL

Used for generation of regular, irregular and combined pulse trains. a, b, c and d should have values from 1 to 99.

FUNCTION SELECTOR: RESTART DELAY (ms)

x1000, x100, x10.

Used for continuous generation of pulse trains. The Generator restarts automatically at the end of a pre-set time which is measured from the moment the preceding pulse train is completed.

Delay times:

x1000: 0 to 9 sec. in steps of 1 sec.
x100 : 0 to 900 ms in steps of 100 ms.
x10 : 0 to 90 ms in steps of 10 ms.

1.7 Accuracy of Generated Times

Electrical control signals for the contact units are generated with an accuracy of ± 50 p.p.m.

1.8 Contact Units

The Generator has two identical contact units whose outputs connect to front panel terminals CONTACT OUTPUT 1 and CONTACT OUTPUT 2.

There is no DC path between the two contact outputs and between them and the chassis.

The contact units are simultaneously operating nonbouncing change-over contacts (mercury-wetted reed relays) each of which has the following data:

1.8.1

Breaking current: max. 2 A.
Breaking power: max. 100 VA.
Contact protection: rapid-acting .3 A fuse in series with contacts. Replaceable from back of instrument.

1.8.2

Contact Operating Times:
Make contacts (C - NO).
Operate time = release time ± .2 ms.
Break contacts (C - NC).
Operate time = release time ± .5 ms.

1.8.3

Difference between CONTACT 1 and CONTACT 2 max. ± .5 ms.

1.8.4

Because the Generator's accuracy on brief pulses is not fully utilized by the standard contact circuit board, the TIME BASE switch is permanently programmed to x1 ms via a jumper on the contact circuit board.

1.8.5

Contact circuit boards are easily replaceable from the back of the instrument. Contact units of other types, such as electronic circuits, can easily be substituted for full utilization of the Generator's brief operating times.

1.9 Trigger Outputs

1.9.1 START PULSE

Triggered by 1st pulse of starting pulse train.

Negative-going pulse, +5 to 0 V.

1.9.2 STOP PULSE

Generated at end of pulse train.

Negative-going pulse, +5 to 0 V.

1.9.3 ELEMENT PULSE

An element pulse is generated at the beginning of time measurement for pulse time or pause time.

Negative-going pulse, +5 to 0 V.

Element pulse is selected with ELEMENT SELECTOR switch.

1.9.4

Positions 1 to 8 mark, in that order, the placement of the element pulse at the beginning of 1st pulse, 1st pause, 2nd pulse...4th pulse, 4th pause.

START PULSE, STOP PULSE and ELEMENT PULSE may be used for starting another pulse generator, or for triggering an oscilloscope.

1.10 EXT. START

With the EXT.START button depressed, the Generator will start when the EXT.START input is briefly short-circuited to 0 V (chassis).

1.11 External Programming

On the rear wall of the Generator facilities are provided for programming the following data:

a Selection of the basic element of the pulse train (pulse /pause times).

b Selection of number of repetitions for pulse trains 1 to 4.

c External starting.

Used for programming of pulse trains via punched-card reader or similar instrumen

1.11.1

Specifications are valid on condition that the following requirements are met:

1.11.2

Nominal mains voltage: 110, 127, 220 or 240

1.11.3

Mains-voltage variation: ±10%.

1.11.4

Mains frequency: 50 - 60 Hz.

1.11.5

Ambient temperature: 0 - 45°C.

1.11.6

Relative humidity: 20 - 80%.

1.11.7

Power consumption: Approx. 44 VA.

1.12 Dimensions with Cover

505 mm wide.

210 mm high.

310 mm deep.

Weight: 15.1 kg.

1.13 Accessories

1.13.1

Equipment Package:	Stock No.
Mains lead	TK3-15001
Protective cover for front panel	Y1-EL10215
1 kit of spare fuses	

1.13.2

Separately Available:

Extender board	ZA0-26980
Multiwire connector, 80-contact	X612917/3

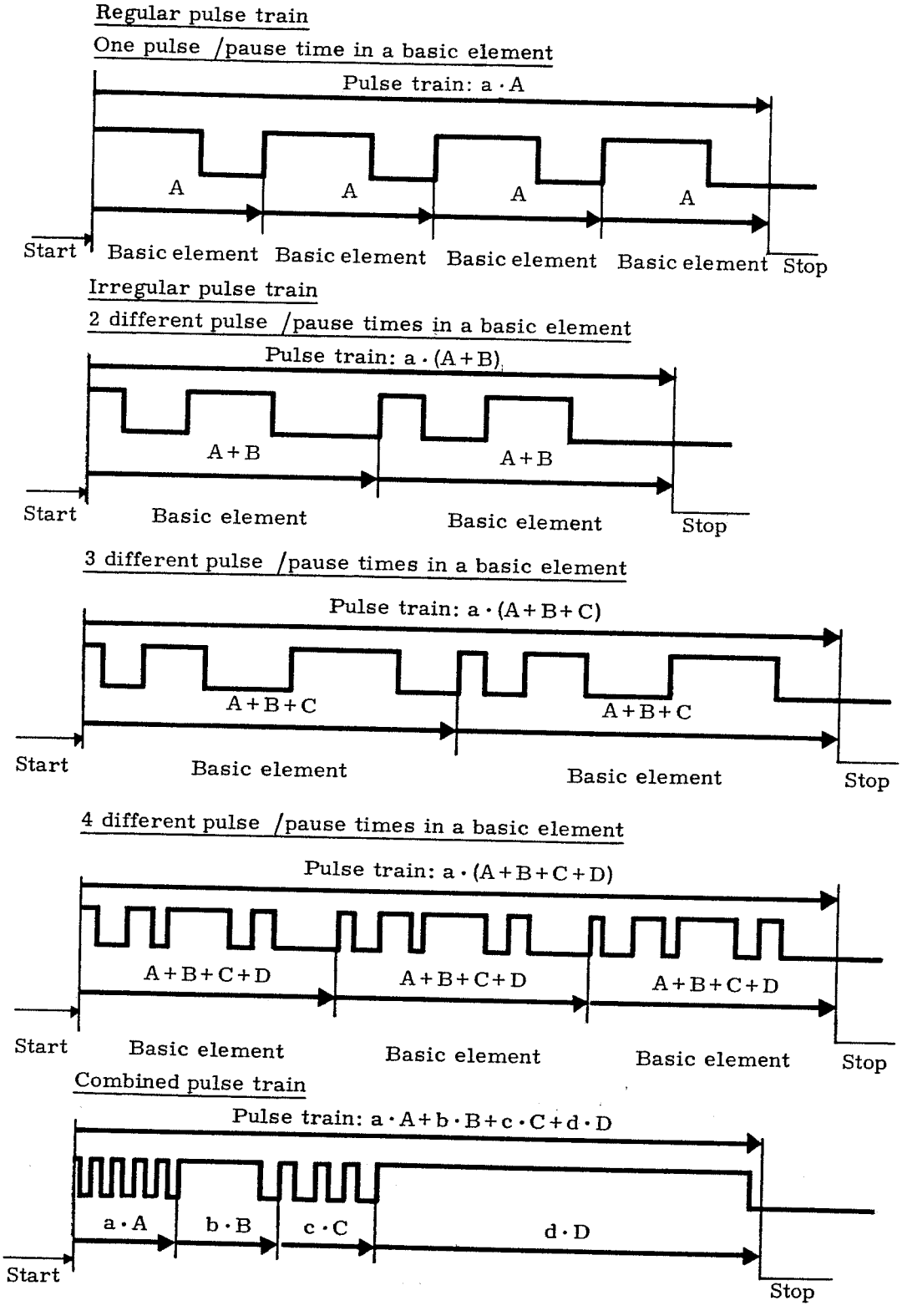


Fig. 1.2 Pulse examples

2. OPERATING INSTRUCTIONS

2.1 Controls and Terminals

This section contains a description of:

1 Functions and uses of controls and terminals.

2 How to operate and program the Generator.

Designations refer to Fig. 2.1 (front panel) and Fig. 2.2 (rear panel).

Pull-out illustrations are used in the interests of clearness.

No.	Component	Function
1	Mains switch	Applies mains voltage to instrument.
2	Pilot lamp	Green light indicates that power is applied to instrument.
3	Selector switch FUNCTION SELECTOR Pos.: GEN. Pos.: NORMAL Pos.: x1000, x100, x10	Selects generator mode. Continuous generation of regular and irregular pulse trains. Generation of regular, irregular and combined pulse trains with limited number of pulses. Generation of regular, irregular a combined pulse trains, repeated after preset delay time.
4	Lever switch RESTART DELAY (ms) Pos.: 0 to 9 in steps of 1 0 to 9 0 to 9 0 to 9	Determines, in combination with FUNCTION SELECTOR positions x1000, x100 and x10, the time after which pulse trains are automatically restarted. x1000: 0 to 9 sec. x100: 0 to 900 ms x10: 0 to 90 ms
5	Lighted pushbutton TIME BASE ms x1 x.1	Determines time unit for pulse/pause times. Depressed, right half lighted: Time base x.1 ms. Released, left half lighted: Time base x1 ms. Note: When using the DL3-10001 Contact Unit (inclusive of mercury-wetted reed relay), the TIME BASE switch is permanently programmed in x1 ms position via strapping on contact units.

No.	Component	Function
6 7 8 9	Lever switch groups PULSE A ms PULSE B ms PULSE C ms PULSE D ms	Determine pulse time durations in basic element of pulse train. Setting: 0000 to 9999. Setting to be multiplied by TIME BASE selected.
10 11 12 13	Lever switch groups PAUSE A ms PAUSE B ms PAUSE C ms PAUSE D ms	Determine pause time durations in basic element of pulse train. Setting: 0000 to 9999. Setting to be multiplied by TIME BASE selected.
14 15 16 17	Lever switch groups PULSE TRAIN 1 (a) PULSE TRAIN 2 (b) PULSE TRAIN 3 (c) PULSE TRAIN 4 (d)	Determine number of basic elements in programmed pulse train(s). Setting: 00 to 99.
18 19 20	Lighted pushbuttons END 1 END 2 END 3	Determine number of pulse/pause elements in basic element of pulse train and number of permanently programmed pulse trains. Pushbutton is lighted when depressed. (See Section 2.2, Programming).
21 22 23 24	Lighted pushbuttons START 1 START 2 START 3 START 4	These pushbuttons when depressed start generation of regular and irregular pulse trains. Left half of pushbutton lights up when button is pressed. Right half of pushbutton lights up to indicate that pulse trains are being transmitted. (See Section 2.2, Programming).
25	Lighted pushbutton EXT.START	This pushbutton when depressed cuts in EXT.START input ㉖ . (Lighted when depressed). May also be used to start COMBINED PULSE TRAIN manually. (See Section 2.2, Programming).
26	BNC socket EXT.START	For external starting of pulse trains. Start pulses: Negative going. Max.100 V DC continuous.
27	BNC socket START	Negative-going pulse coincident with beginning of 1st pulse time of pulse train (+5 to 0 V).

No.	Component	Function
28	BNC socket STOP	Negative-going pulse coincident with end of last pause time of pulse train (+5 to 0 V).
29	BNC socket ELEMENT	Negative-going pulse coincident with beginning of 1st pulse, 1st pause, 2nd pulse .... 4th pulse, 4th pause (+5 to 0 V).
30	Lever switch ELEMENT SELECTOR	Determines placement of ELEMENT pulse relative to basic element of pulse train. Pos.: 0 Not used. - 1 Beg. of 1st pulse - 2 Beg. of 1st pause - 3 Beg. of 2nd pulse - 4 Beg. of 2nd pause - 5 Beg. of 3rd pulse - 6 Beg. of 3rd pause - 7 Beg. of 4th pulse - 8 Beg. of 4th pause - 9 Not used
31	Terminals CONTACT OUTPUT 1 C - NO C - NC	Output terminals for change-over contacts of contact unit, pos. F12. COMMON - NORMALLY OPEN COMMON - NORMALLY CLOSED.
32	Terminals CONTACT OUTPUT 2 C - NO C - NC	Output terminals for change-over contacts of contact unit, pos. F12. COMMON - NORMALLY OPEN COMMON - NORMALLY CLOSED.

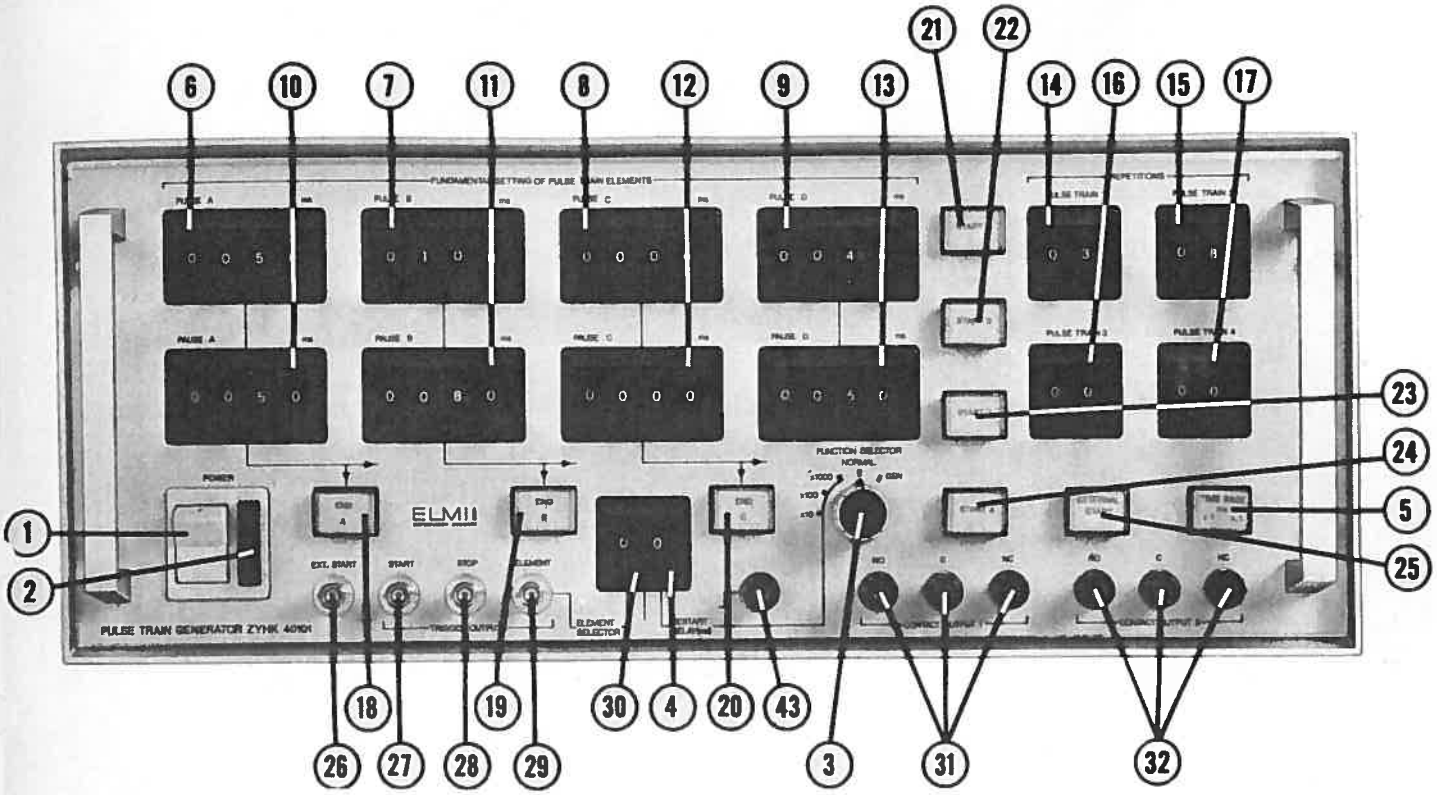


Fig. 2.1 Reference numbers - front panel.

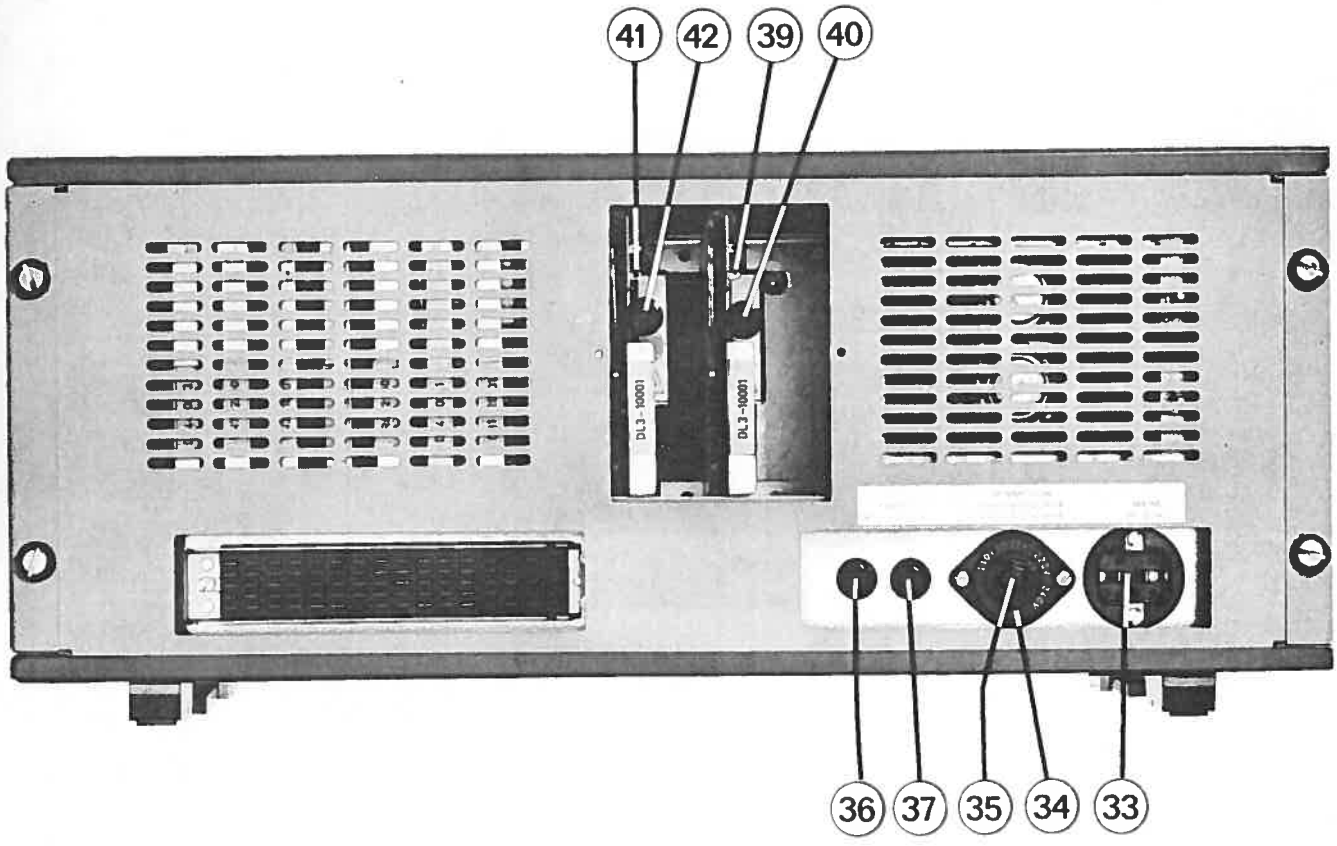


Fig. 2.2 Reference numbers - rear panel.

No.	Component	Function
33	Power socket MAINS 50 - 60 Hz	Socket for mains connection.
34	Mains-voltage change-over switch	Selects between mains voltages of 110 V, 127 V, 220 V and 240 V.
35	Primary mains fuse S1	2 A slow-blow for 110 V and 127 V 1 A slow-blow for 220 V and 240 V.
36	Secondary fuse S2	3 A quick-blow for 5 V supply.
37	Secondary fuse S3	1 A quick-blow for 7 V supply.
38	80-pin multisocket	Multisocket for external programming.
39	Contact unit Fuse for relay contacts	Change-over contact function pos. F12, CONTACT OUTPUT 1. .3 A quick-blow.
41 42	Contact unit Fuse for relay contacts	Change-over contact function pos. F11, CONTACT OUTPUT 2. .3 A quick-blow.
43	Terminal	Chassis termination.

2.2 How to Operate the Pulse Train Generator

a Make sure that the mains-voltage change-over switch has been set to your local mains voltage.

b Connect the instrument to the mains and apply power with the mains switch.

c Set the TIME BASE switch as desired (see note).

d Set the PULSE times A, B, C, D, PAUSE times A, B, C, D, REPETITIONS lever switches, and END pushbuttons for the desired pulse train as described in the Programming Chart.

e Starting REGULAR and IRREGULAR pulse trains

Select generator mode with FUNCTION SELECTOR switch. Start pulse train by pressing the START button (see Programming Chart).

f Starting COMBINED pulse trains

Select generator mode with FUNCTION SELECTOR switch.

1. Release all START buttons.
2. Depress EXTERNAL START button.
3. Depress START buttons in accordance with Programming Chart.
4. Start pulse train by releasing the EXTERNAL START button.

	FUNDAMENTAL SETTING OF PULSE TRAIN ELEMENTS							REPETITIONS				STARTING THE PULSE TRAIN				
REFERENCE NUMBER	6, 10	18	7, 11	19	8, 12	20	9, 13	14	15	16	17	21	22	23	24	25
TYPE OF PULSE TRAIN	PULSE A PAUSE A	END 1	PULSE B PAUSE B	END 2	PULSE C PAUSE C	END 3	PULSE D PAUSE D	PULSE TRAIN 1 a	PULSE TRAIN 2 b	PULSE TRAIN 3 c	PULSE TRAIN 4 d	START 1	START 2	START 3	START 4	EXTERN-AL START
REGULAR, a·A	DATA	PRESS						DATA				PRESS				
REGULAR, b·B		PRESS	DATA	PRESS					DATA				PRESS			
REGULAR, c·C		PRESS		PRESS	DATA	PRESS				DATA				PRESS		
REGULAR, d·D		PRESS		PRESS		PRESS	DATA				DATA				PRESS	
IRREGULAR, a(A+B)	DATA		DATA	PRESS				DATA				PRESS				
IRREGULAR, b(B+C)		PRESS	DATA		DATA	PRESS			DATA				PRESS			
IRREGULAR, c(C+D)		PRESS		PRESS	DATA		DATA			DATA				PRESS		
IRREGULAR, a(A+B+C)	DATA		DATA		DATA	PRESS		DATA				PRESS				
IRREGULAR, b(B+C+D)		PRESS	DATA		DATA		DATA		DATA				PRESS			
IRREGULAR, a(A+B+C+D)	DATA		DATA		DATA		DATA	DATA				PRESS				
COMBINED, a·A+b·B	DATA	PRESS	DATA	PRESS				DATA	DATA			PRESS	PRESS			RELEASE
COMBINED, a·A+b·B+c·C	DATA	PRESS	DATA	PRESS	DATA	PRESS		DATA	DATA	DATA		PRESS	PRESS	PRESS		RELEASE
COMBINED, a·A+b·B+c·C+d·D	DATA	PRESS	DATA	PRESS	DATA	PRESS	DATA	DATA	DATA	DATA	DATA	PRESS	PRESS	PRESS	PRESS	RELEASE
COMBINED, a·A+b(B+C)+c·D	DATA	PRESS	DATA		DATA	PRESS	DATA	DATA	DATA	DATA		PRESS	PRESS	PRESS		RELEASE
COMBINED, a·A+b(B+C+D)	DATA	PRESS	DATA		DATA		DATA	DATA	DATA			PRESS	PRESS			RELEASE
COMBINED, a·A+b(B+C)	DATA	PRESS	DATA		DATA	PRESS		DATA	DATA			PRESS	PRESS			RELEASE
COMBINED, a(A+B)+b·C	DATA		DATA	PRESS	DATA	PRESS		DATA	DATA			PRESS	PRESS			RELEASE
COMBINED, a(A+B)+b(C+D)	DATA		DATA	PRESS	DATA		DATA	DATA	DATA			PRESS	PRESS			RELEASE
COMBINED, a(A+B+C)+b·D	DATA		DATA		DATA	PRESS	DATA	DATA	DATA			PRESS	PRESS			RELEASE

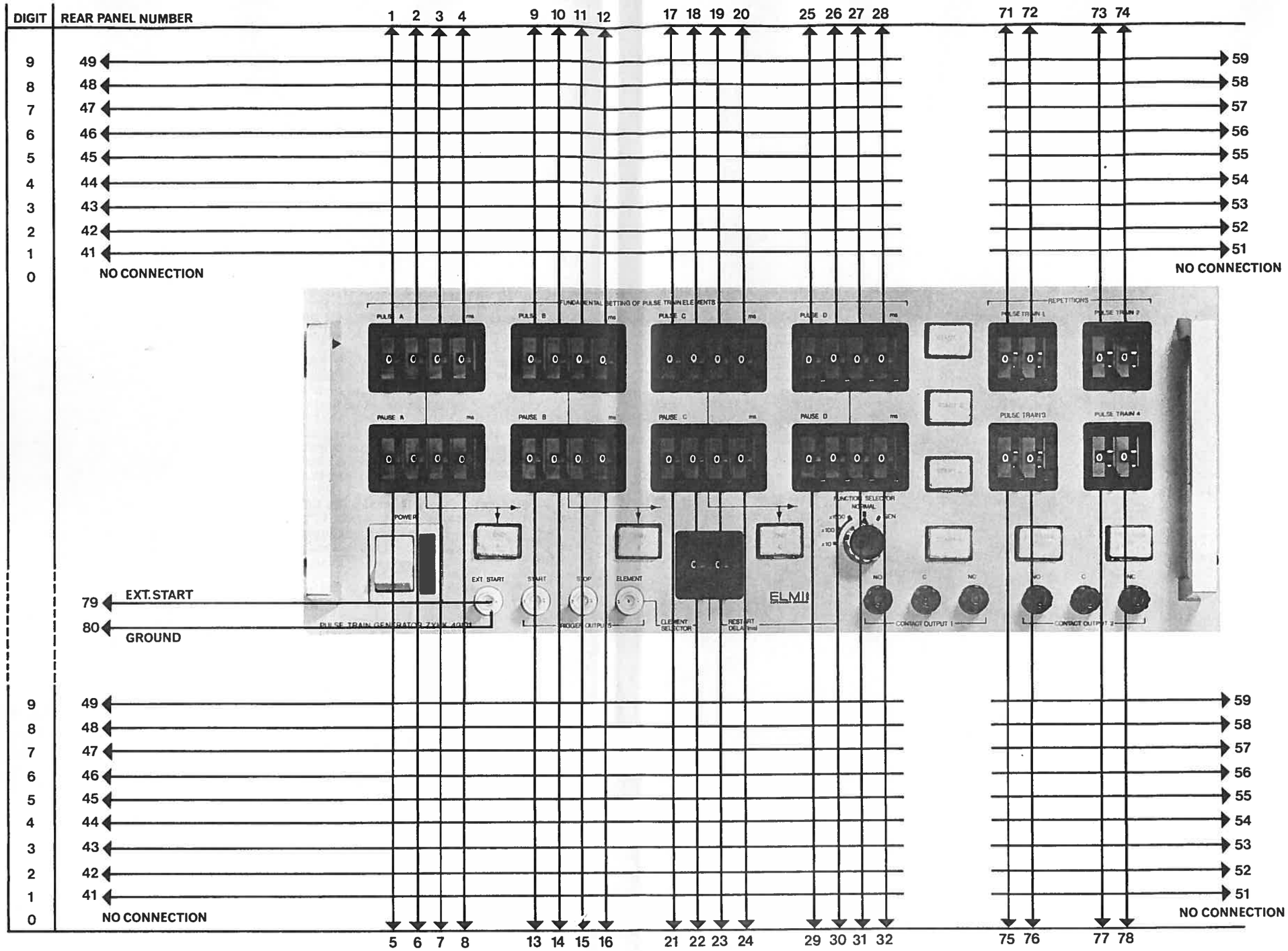


Fig. 2.4 External programming.

2.3 External Programming

External programming of Pulse Times, Pause Times and Number of Repetitions as well as External Starting of the Generator are carried out via the 80-pin multisocket which is accessible from the rear panel of the Generator.

BE SURE TO SET ALL FRONT-PANEL LEVER SWITCHES TO DIGIT 0 BEFORE CARRYING OUT EXTERNAL PROGRAMMING.

As shown in the sketch in Fig. 2.4, the external programming system is built up in the form of a matrix.

A digit is encoded by setting up a connection between a vertical-going switch line and a horizontal-going digit line.

Digit 0 is encoded if, on the switch line in question, no connection is made to any of the horizontal digit lines.

Numbers on the figures correspond to the terminals on the 80-pin multisocket.

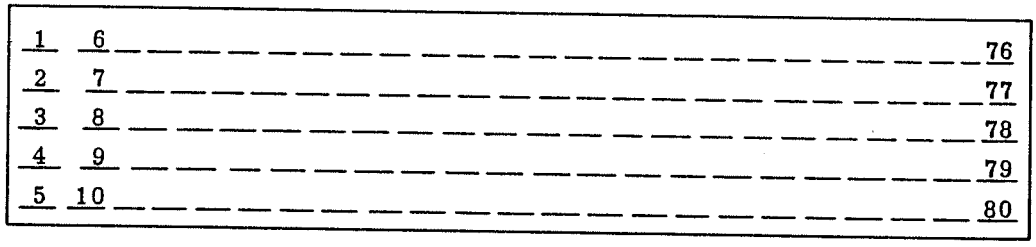


Fig. 2.3 80-pin multisocket viewed from rear panel of Generator.

3. CIRCUIT DESCRIPTION

3.1 Introduction

This section in conjunction with Logic Flow Diagram Fig. 3.1 and detailed Circuit Description explains the general principles of the functioning of the Pulse Train Generator.

Individual circuit functions are described in the section "Detailed Circuit Description".

The detailed description comprises:

1. An explanatory description.
2. A component list.
3. A circuit diagram. A drawing showing component location of the printed wiring cards. The diagram can be unfolded for easy reference.

   The individual circuit description is followed by a description of the wiring lay out of the test equipment covering inter connections as well as components and such details which are not included in the individual description of the circuits.

Circuit boards are numbered F1 - F13 inclusive. Numbers immediately following circuit board numbers are connector socket terminal designations; for example, F6-22 means terminal No. 22 on circuit board F6.

Logic High state is indicated: "1".

Logic Low state is indicated: "0".

3.2 General Description

FUNCTION SELECTOR at NORMAL

A pulse train is started by pressing a start button or by applying an external start pulse to the EXT. START terminal of the Generator.

In either case a SET PULSE is generated to preset one or more of the flip-flops designated A, B, C and D (SELECTOR CIRCUIT on F6). Simultaneously therewith a CLEAR PULSE, F6-22, is generated for REPETITION COUNTER F9 and for PULSE/PAUSE COUNTER F10; furthermore the delay time Δt_3, F7, is started, whereupon inhibit is removed from REPETITION COUNTER F9.

During the time Δt_3 a check is made whether the preset number of repetitions has been reached. This will occur also if the number of repetitions is (0.0), by first scanning x10 and thereafter x1 of the switch positions.

If the desired number is not reached, the following occurs after Δt_3 has elapsed:

(1) A STROBE PULSE, F7-23, is generated to preset flip-flops K, L, M, N (SELECTOR CIRCUIT on circuit board F5).

(2) A CLEAR PULSE, F7-10, is transmitted to PULSE/PAUSE COUNTER F10, whereupon inhibit is removed from F10-30.

(3) Metering of the 1st pulse time commences.

Metering is done by scanning the PULSE/PAUSE switch groups in the sequence x1000, x100, x10, x1 and is determined by output signals a, b on the DIGIT SCANNING counter on circuit board F7. a, b furthermore control the selection of digit in the switch group via SWITCH DRIVER circuit boards F1 and F2 and, via TIME BASE SELECTOR F3, the time base associated with the metering operation.

During metering of a pulse time, (a, b, c) = (a, b, "0"). When (a, b) = ("1", "1"), c will switch to "1"; that is, (a, b, c) = (a, b, "1") while a pause time is being metered.

Metering of one pulse time and one pause time is carried out by scanning all combinations for (a, b, c) and is terminated when a+b+c = "0". Point (1) of the LOGIC FLOW DIAGRAM.

The logic signal c', derived from c, controls contact units F11 and F12 and hence is the time equivalent of the Generator's output signal, disregarding the delay in the contact units.

On the termination of each pulse/pause element a clock pulse derived from c, F7-18, is transmitted to flip-flops K, L, M, N (SELECTOR CIRCUIT F5) to check whether the basic element of the pulse train is to contain more pulse/pause elements than the one just generated.

K, L, M, N successively determine the 1st, 2nd, 3rd and 4th pulse/pause elements, and if K+L+M+N = "1" (corresponding to one of the flip-flops being preset to "1"), another pulse/pause element is to be generated immediately following the preceding one. In other words, the pulse/pause time generation loop is traversed once more.

However, if K+L+M+N = "0", the basic element of the pulse train is not to contain more pulse/pause elements than the one just generated.

The number of basic elements is summed in REPETITION COUNTER F9 by a clock pulse from F5-7 being fed to the counter circuit on the termination of each basic element.

The counting operation is carried out by first counting up to the preset number of tens with a 10-divider inserted ahead of REPETITION

COUNTER F9 and thereafter counting up to the preset number of units without the 10-divider inserted.

The 10-divider, TIME BASE FOR REPETITION COUNTER F8, is inserted when the signal k = "0" (REPETITION CONTROL F7) and is not inserted when k = "1". The REPETITION CONTROL circuit is controlled by the output from the REPETITION COUNTER, F9-23.

Simultaneously with the termination of a basic element (point ② of LOGIC FLOW DIAGRAM), the PULSE/PAUSE COUNTER, F10-30, is inhibited and the delay time Δt_3 is started whereupon a check is made whether the preset number of basic elements have been generated.

If this is not the case, the loop is traversed to start the generation of another basic element.

If the preset number of basic elements have been generated (point ③ of LOGIC FLOW DIAGRAM), REPETITION COUNTER F9 is cleared and inhibited. The REPETITION CONTROL, F7-2, simultaneously therewith transmits a clock pulse to the SELECTOR CIRCUIT, F6-19, for the purpose of scanning whether an additional pulse train has been programmed for generation immediately following the one just generated.

This will be the case if $\bar{A}+B+C+D$ = "1" - in other words, if more than one of flip-flops A, B, C, D have been preset to "1" at the start of the 1st pulse train.

When the succeeding pulse train is transmitted, a STROBE PULSE, F7-23, for flip-flops K, L, M, N (SELECTOR CIRCUIT F5) is not generated immediately after Δt_3 has elapsed. Input data: SET K, L, M, N must first be altered in accordance with the new pulse train.

Accordingly, the delay Δt_4 has been inserted to ensure that flip-flops A, B, C, D (SELECTOR CIRCUIT F6) will have time to change its condition and that this changed output condition arrives at the SET inputs for K, L, M, N before the STROBE PULSE once more presets flip-flops K, L, M, N.

When Δt_4 has elapsed, Δt_3 starts again, and the new pulse train is generated in accordance with the sequence previously covered.

If A+B+C = "0" (point ④ of LOGIC FLOW DIAGRAM) it is an indication that the generated pulse train(s) has (have) been terminated.

With the FUNCTION SELECTOR at NORMAL, the process is ended by clearing the flip-flops concerned and inhibiting the counter circuits.

FUNCTION SELECTOR at RESTART DELAY

Metering of the time for automatic restart is carried out by means of PULSE/PAUSE COUNTER F10. Metered time is determined by RESTART DELAY switch in conjunction with the x1000, x100 and x10 positions of the FUNCTION SELECTOR.

Metering of the restart time commences if the signals s = "1" (CP GENERATOR GATE CONTROL F5) and A+B+C+D = "0" simultaneously therewith. This occurs when the last pulse train is terminated and the signal at F5-2, controlled by the FUNCTION SELECTOR, is "1".

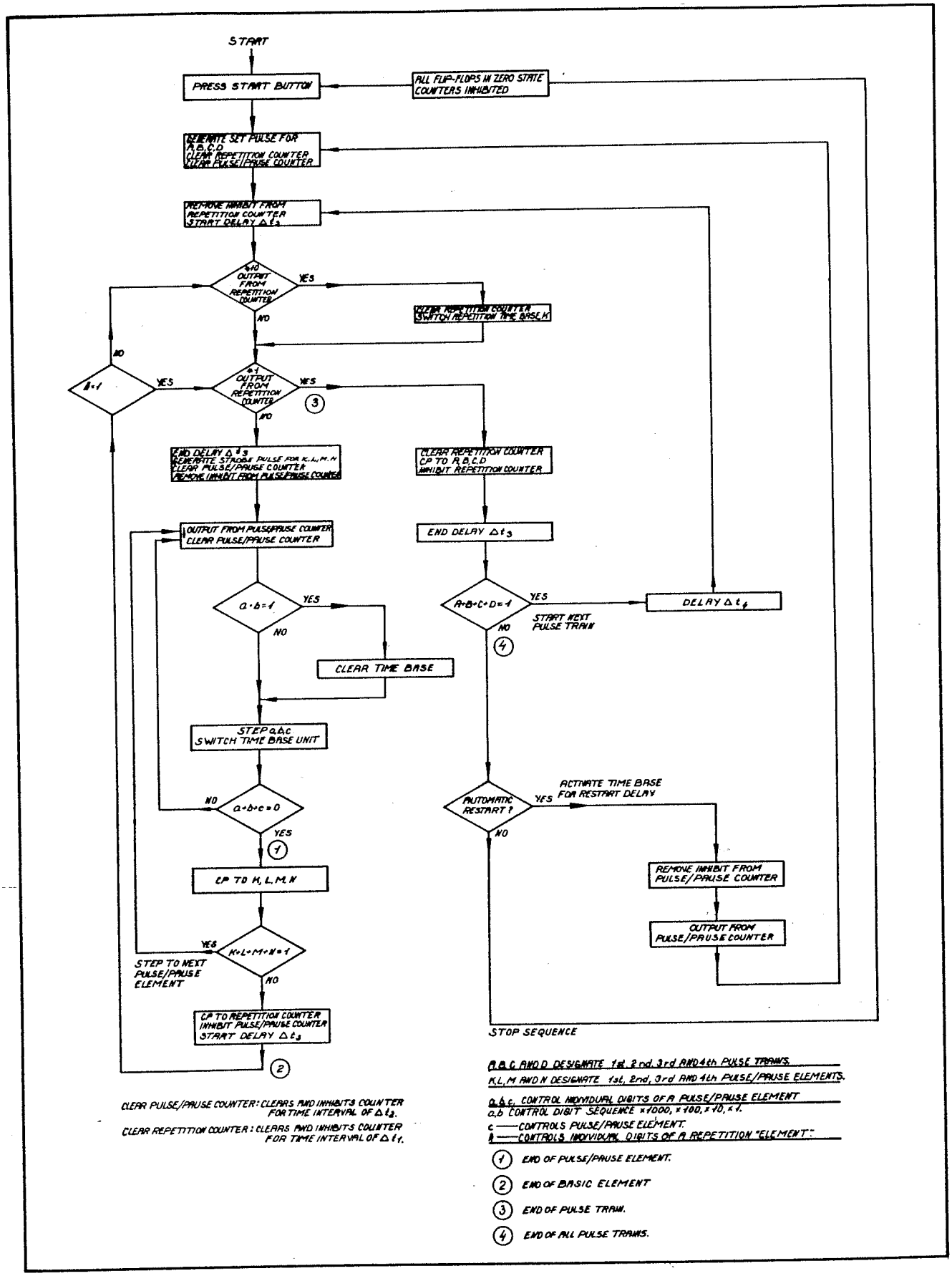
When the restart time has elapsed, the PULSE/PAUSE COUNTER, F10-23, generates an output pulse which causes s to be briefly "0", thus closing CP GATE F4. The output pulse, F10-23, simultaneously therewith functions as another SET PULSE, F6-5, for A, B, C and D and as a clear pulse for the TIME BASE circuit, F3-2, REPETITION COUNTER, F9-25, and PULSE/PAUSE COUNTER, F10-25, via F7-10 from F6-3.

As will appear from the LOGIC FLOW DIAGRAM, the Generator will now traverse the same loops as previously and in so doing repeat the pulse train(s) transmitted.

FUNCTION SELECTOR at GEN.

In this position, the F5-2 signal is constantly "0" via the FUNCTION SELECTOR.

s is identical with A+B+C+D, which means that CP GATE F5 will admit clock pulses as long as one of flip-flops A, B, C or D is preset. Since the REPETITION COUNTER, F9-30, is inhibited simultaneously therewith, likewise via the FUNCTION SELECTOR, the Generator will transmit pulses continously.



128-0872

Fig. 3.1 Logic flow diagram

128-0872

3.3 Detailed Circuit Description

3.3.1 DR4-20003: SWITCH DRIVER F1/F2

The two SWITCH DRIVER circuits are completely identical.

The SWITCH DRIVER circuits perform the function of determining, based on input data a, b, c and $\overline{K}$, $\overline{KL}$, $\overline{KLM}$, $\overline{KLMN}$, the scanning of the lever switches for the determination of pulse/pause times and, based on data K and A, $A\overline{B}$, $A\overline{B}C$, $A\overline{B}\overline{C}D$, the scanning of the lever switches for number of REPETITIONS.

Each of the two SWITCH DRIVER circuit boards comprises two separate circuits, one for CONTROL OF PULSE/PAUSE DIGITS, the other for CONTROL OF REPETITION DIGITS. One circuit board covers one half of the switch groups, the other one covers the remaining half.

The a, b, c outputs of DIGITS SCANNING on F7 are divided up into the combinations possible by gates IC1, IC2, IC3 and IC4, whereupon the combination is strobed to the respective switches via gates IC6, IC7, IC8 and IC10.

The gates are controlled from TRIGGER PULSE GENERATOR F8 which determines the scanning sequence. Scanning sequence is K, L, M, N.

The same principle applies to CONTROL OF REPETITION DIGITS.

A pulse/pause group is determined as follows:

	Pulse Switches				Pause Switches			
abc	x1000	x100	x10	x1	x1000	x100	x10	x1
000	activ-ated							
100		activ-ated						
010			activ-ated					
110				activ-ated				
001					activ-ated			
101						activ-ated		
011							activ-ated	
111								activ-ated

All pulse/pause groups determined as follows:

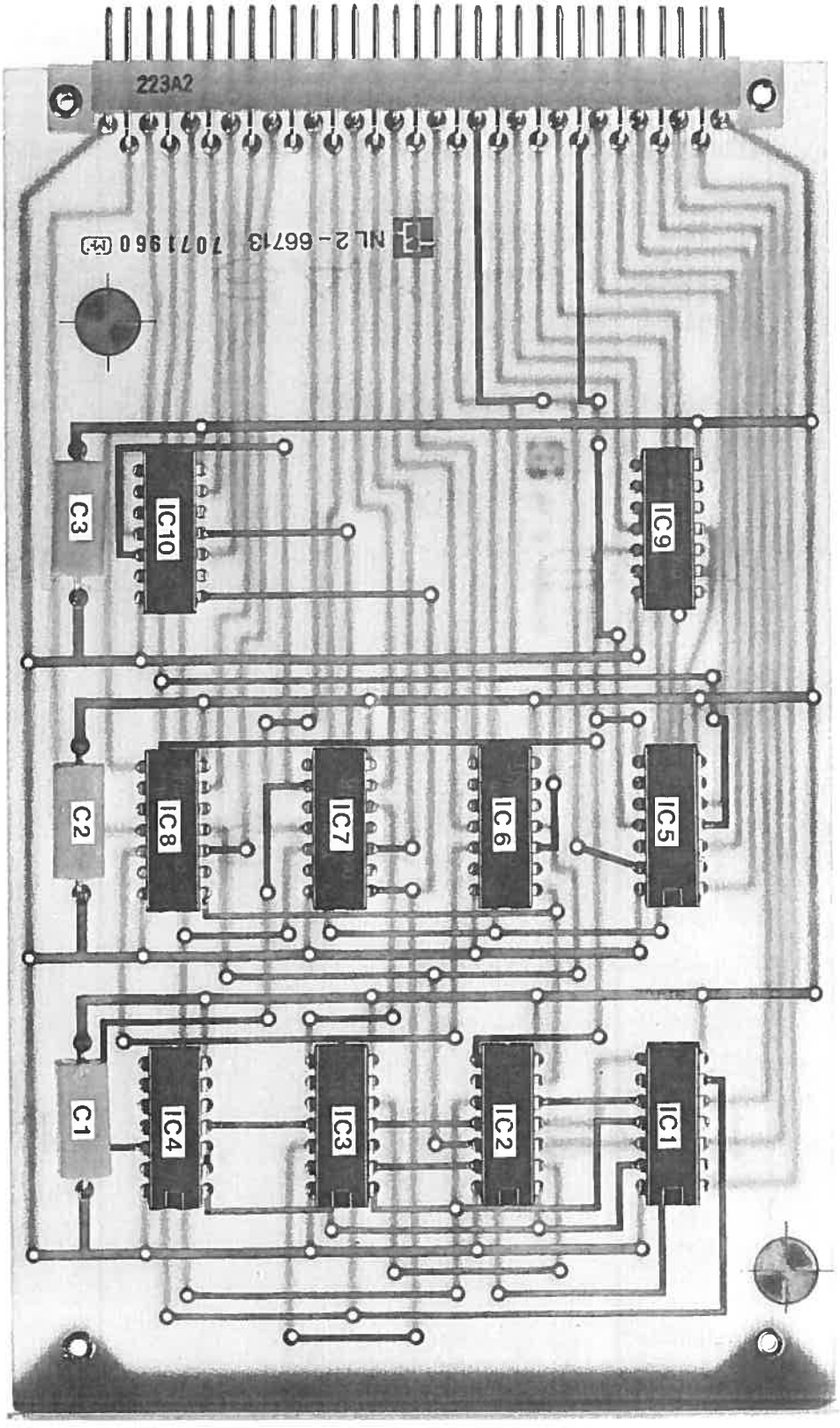
K $\overline{K}$L $\overline{K}\overline{L}$M $\overline{K}\overline{L}\overline{M}$N	A Pulse/Pause	B Pulse/Pause	C Pulse/Pause	D Pulse/Pause
1 0 0 0	activated			
0 1 0 0		activated		
0 0 1 0			activated	
0 0 0 1				activated

Repetitions determined as follows:

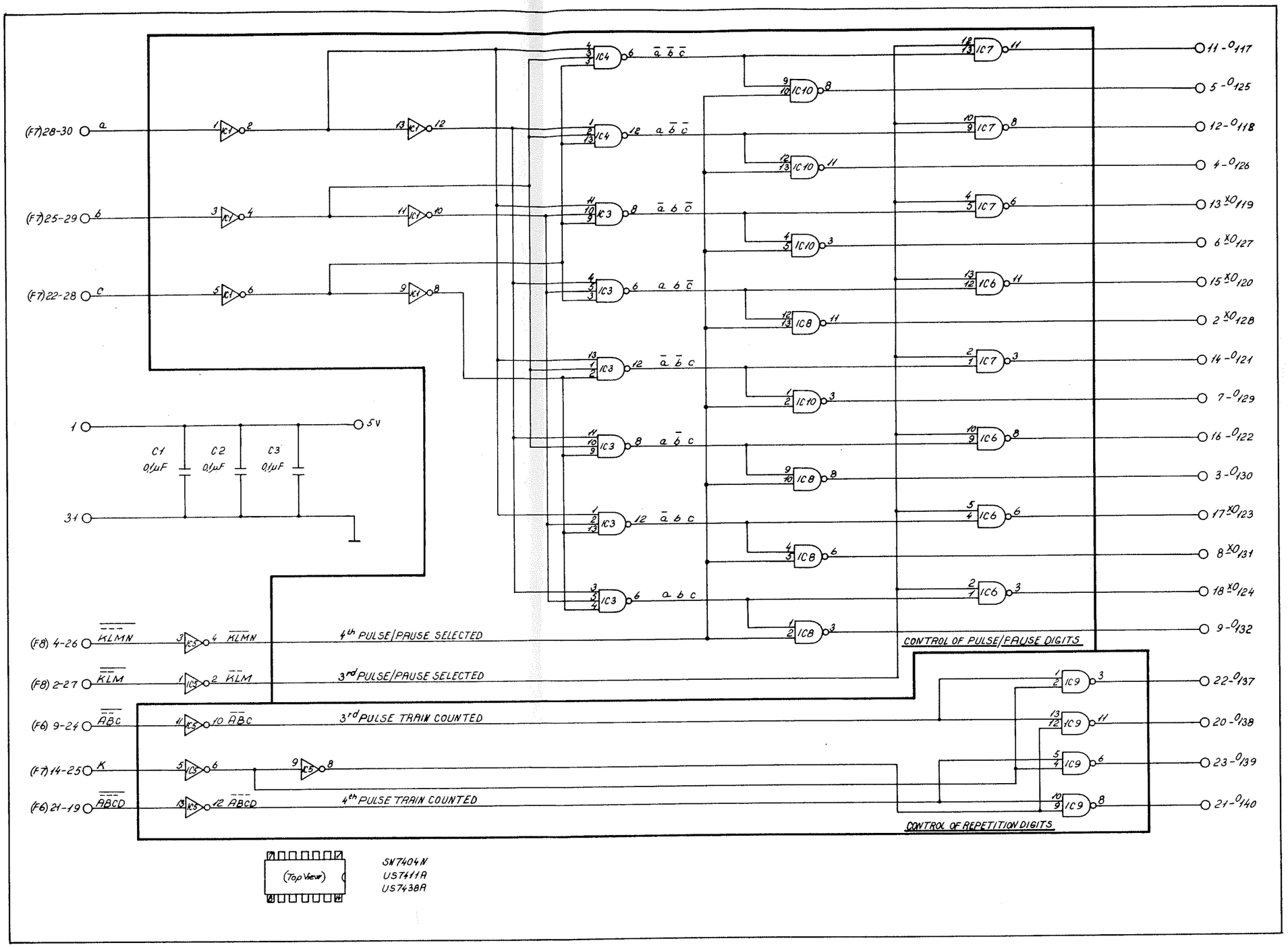
k	A $\bar{A}B$ $\bar{A}\bar{B}C$ $\bar{A}\bar{B}\bar{C}D$	Pulse Train 1		Pulse Train 2		Pulse Train 3		Pulse Train 4	
		x10	x1	x10	x1	x10	x1	x10	x1
0 1	1 0 0 0	actv.	actv.						
0 1	0 1 0 0			actv.	actv.				
0 1	0 0 1 0					actv.	actv.		
0 1	0 0 0 1							actv.	actv.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-3	3	MY2-23667	0,1 µF 10 % - 250 V DC	Philips
IC1+5	2	MY1-51111	SN 7404 N	
IC2-4	3	MY1-51549	US 7411 A	Spraque
IC6-10	5	MY1-51554	US 7438 A	-
	1	NL2-66713	Printed Circuit Board	Elmi

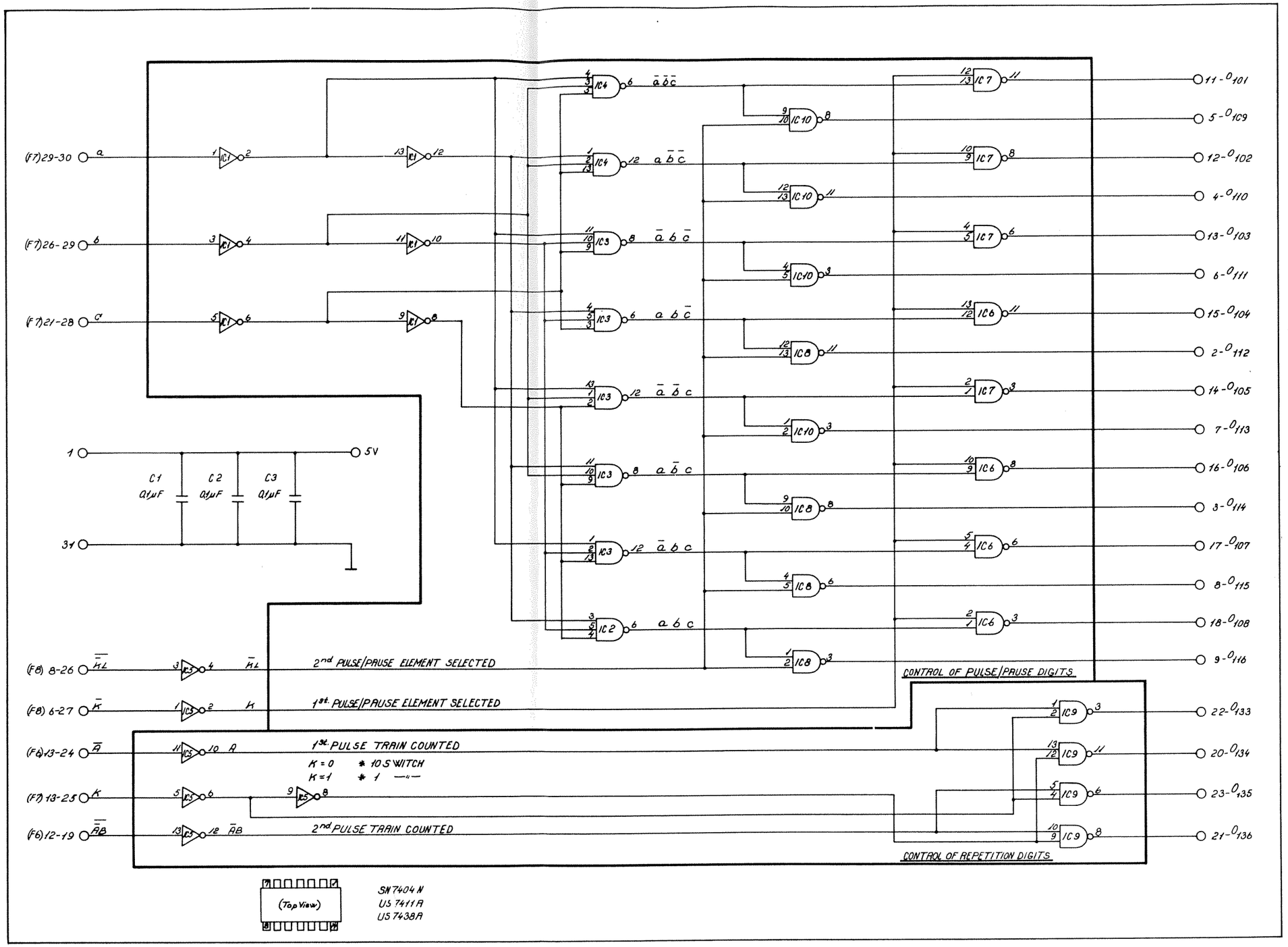
DR4-20003: SWITCH DRIVER F1/F2.
Electrical parts list.



DR4-20003: SWITCH DRIVER F1/F2.
Electrical parts location.



DR4-20003: SWITCH DRIVER F1.
Circuit diagram.



DR4-20003: SWITCH DRIVER F2.
Circuit diagram.

3.3.2 DN7-20001: TIME BASE UNIT F3

This circuit performs the function of generating, based on the clock oscillator, the clock pulses required for measuring out pulse times, pause times and automatic restart delay.

The circuit board carries ten-dividers for deviding the clock frequency down and circuits for selection of TIME BASE.

The separate circuit SWITCHING BETWEEN TIME BASE 1 ms AND .1 ms determines if the CP from CLOCK OSCILLATOR terminal 2 of F4 (10 kHz~ .1 ms) is to be divided by a factor of 10 in IC8 or fed direct to the first one of ten-dividers IC4, IC3, IC2, IC1. "1" at terminal 8 corresponds to TIME BASE x 1 ms; "0" corresponds to x .1 ms.

Output from the divider chain, terminal 1 of IC4, is fed to gate circuit TIME BASE SELECTOR FOR PULSE/PAUSE GENERATION. Output from terminal 1 of IC3 is fed to gate circuit TIME BASE SELECTOR FOR AUTOMATIC RESTART DELAY. CP output, terminal 24, is determined by input data (a, b), (A+B+C+D), and the logic level at terminals 27, 28, 29 is determined by the x1000, x100, x10 positions of FUNCTION SELECTOR 011.

After each pulse/pause time has been measured out - that is, when (a, b) = ("1", "1"), the divider chain is zero set by a CLEAR pulse from terminal 8 of PULSE/PAUSE CONTROL F7.

While pulse/pause times are being generated, A+B+C+D = "1" and CP output is determined by:

	CP Output Terminal 24	
a b	Terminal 8: "1" (x1 ms)	Terminal 8: "0" (x.1ms)
0 0	1000 ms	100 ms
0 1	100 ms	10 ms
1 0		1 ms
1 1	1 ms	1 ms

While the RESTART DELAY TIME is being generated, A+B+C+D = "0" and CP OUTPUT is determined by:

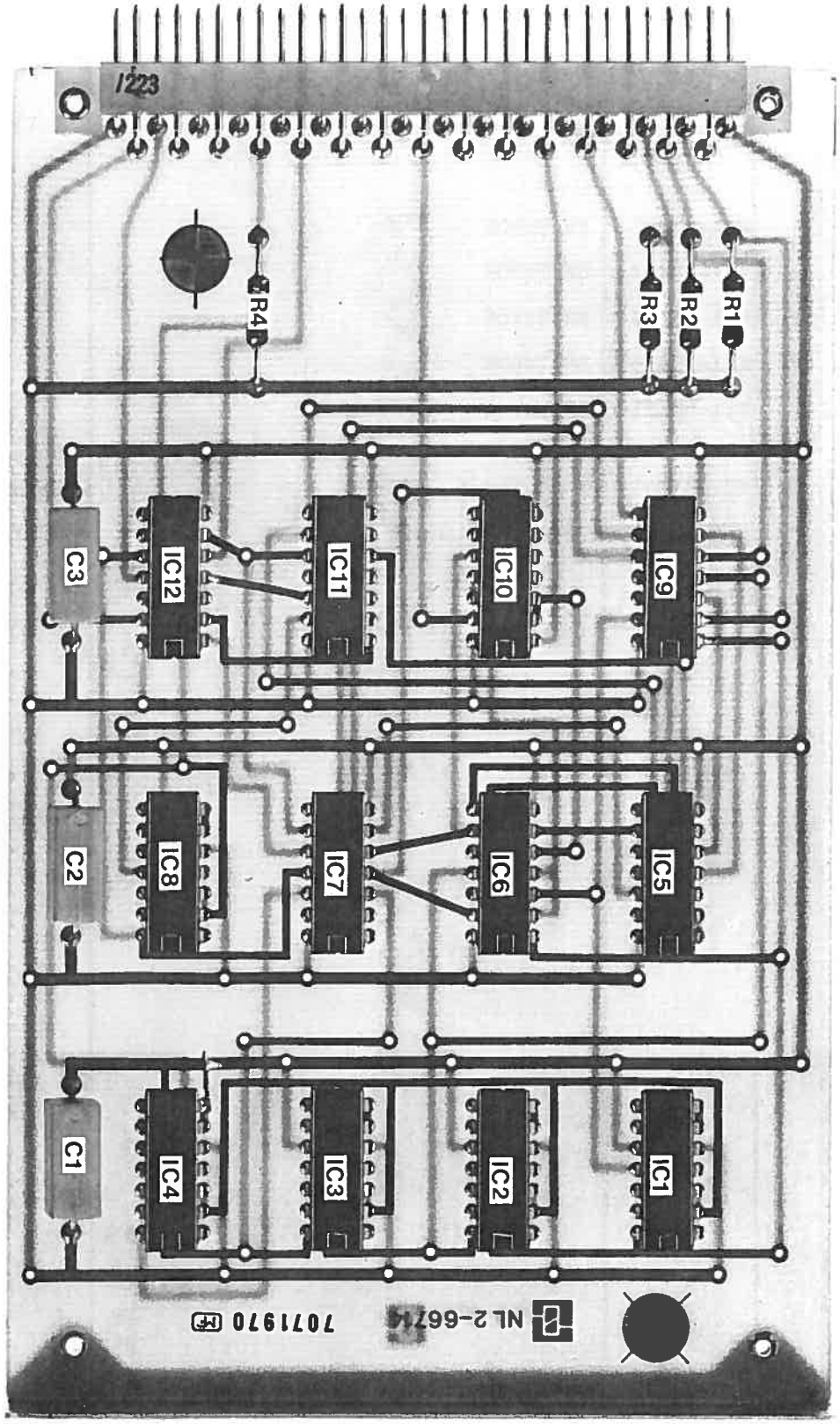
RESTART DELAY (ms)	Terminal 27 29 28	CP Output Terminal 24
x1000	1 0 0	1000 ms
x100	0 1 0	100 ms
x10	0 0 1	10 ms

Since maximum output switching rate is determined by CONTACT UNIT F11/F12, the function of the switch designated SWITCHING BETWEEN TIME BASE x1 AND x .1 ms 09 is determined by the circuit board in use.

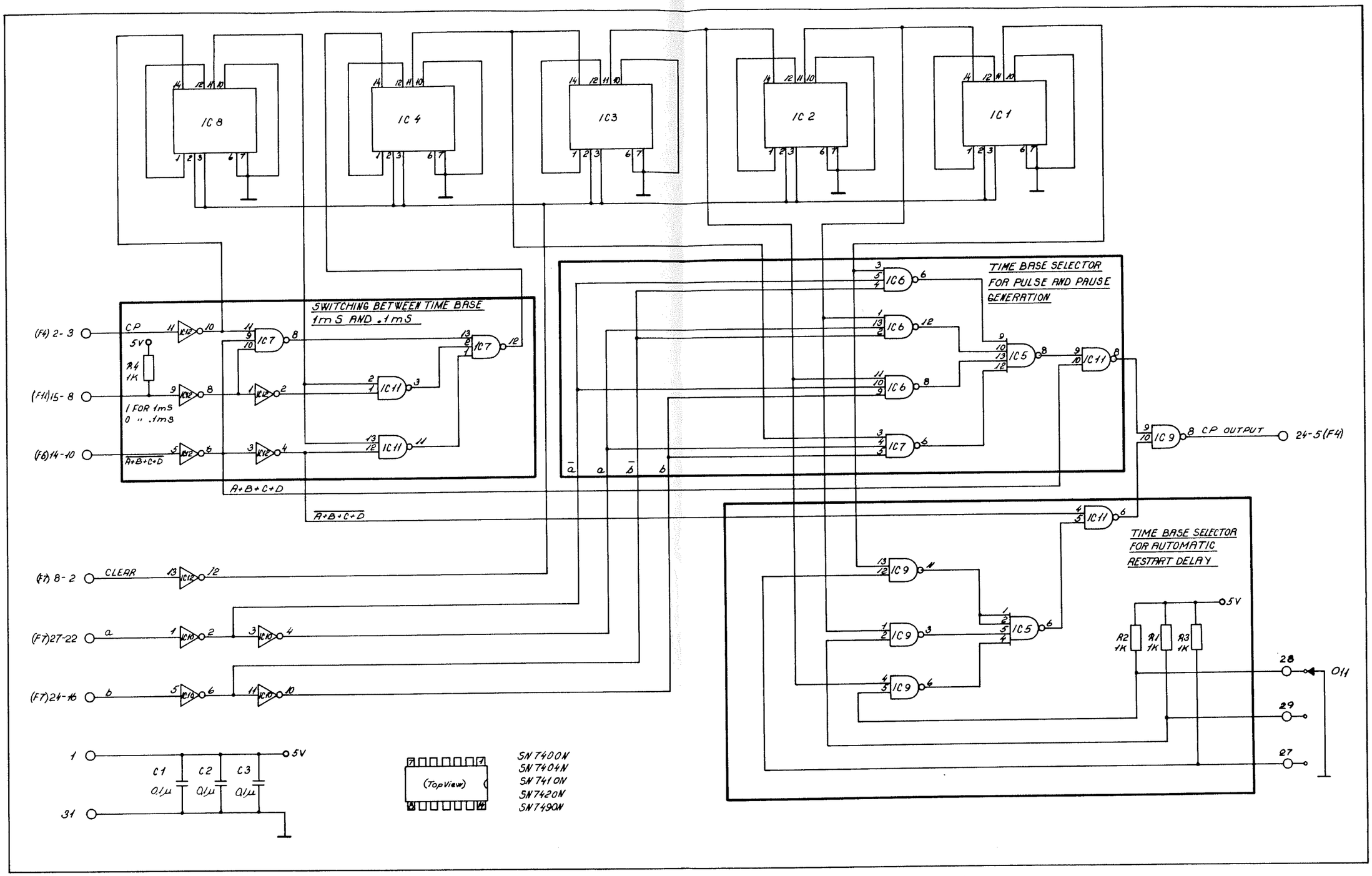
As regards locking, see CONTACT UNIT F11/F12, section 3.3.9.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-3	3	MY2-23667	0,1 µF 10 % - 250 V DC	Philips
IC1-4+ IC8	5	MY1-23410	SN 7490N	
IC5	1	MY1-23413	SN 7420N	
IC6-7	2	MY1-23414	SN 7410N	
IC9+11	2	MY1-23415	SN 7400N	
IC10+12	2	MY1-51111	SN 7404N	
R1-4	4	MY2-31651	1 kΩ 5 % 1/8 W	Beyschlag
	1	NL2-66714	Printed Circuit Board	Elmi

DN7-20001: TIME BASE UNIT F3.
Electrical parts list.



DN7-20001: TIME BASE UNIT F3.
Electrical parts location.



DN7-20001: TIME BASE UNIT F3.
Circuit diagram.

3.3.3 DN3-10001: CLOCK OSCILLATOR F4

This circuit board carries a CLOCK OSCILLATOR circuit, an EXTERNAL START TRIGGER CIRCUIT and a START PULSE GENERATOR.

CLOCK OSCILLATOR

The generator is crystal controlled. It is composed of dual-input nand gates.

The output of the 1 MHz oscillator is controlled on/off via IC3, CP GATE, in turn controlled by the s-signal from the CP GENERATOR GATE CONTROL (terminal 10 of F5) (see simplified description of BASIC ELEMENT SELECTOR F5). The 1 MHz signal is divided by ten in IC5, and a 100 kHz clock frequency of 2:8 pulse/pause ratio is taken off at terminal 2.

EXTERNAL START TRIGGER CIRCUIT

The generator is started externally by connecting terminal 22 to 0 V. The voltage jump is differentiated into a pulse which triggers monostable multivibrator Q_1, Q_2. Output from Q_2 is inverted in Q3 and transmitted to IC2 of the START PULSE circuit.

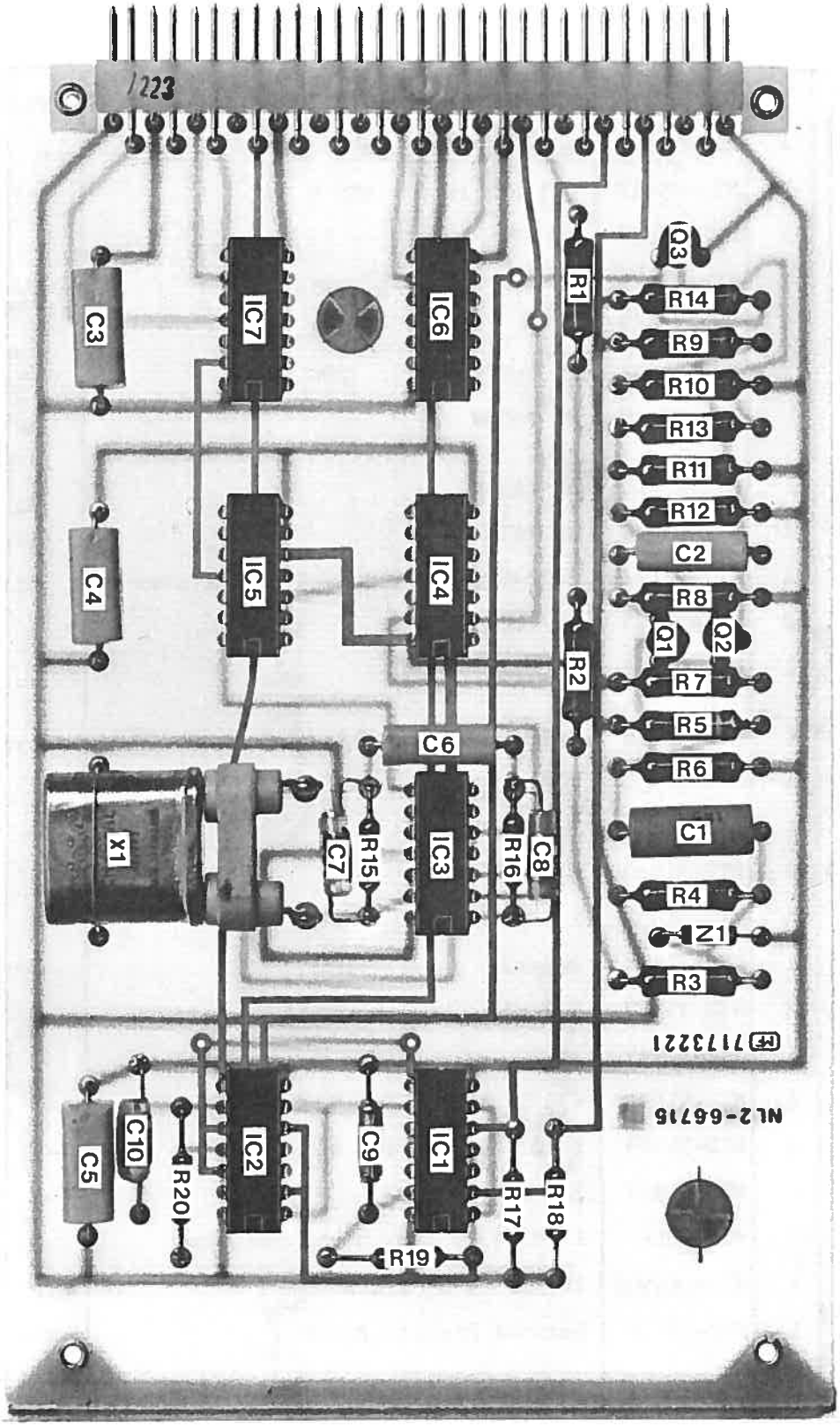
START PULSE

The EXTERNAL START pushbutton (08) controls the flip-flop composed of IC1. On the EXTERNAL START button being depressed, terminal 25 will be at 0 V, with the result that pins 1, 2 and 3 of IC2, and pins 4, 5 and 6 of IC2 permit the external start pulse to pass through to terminals 8 and 19. Releasing the EXTERNAL START button causes a pulse to be generated whose duration is determined by R19 and C9.

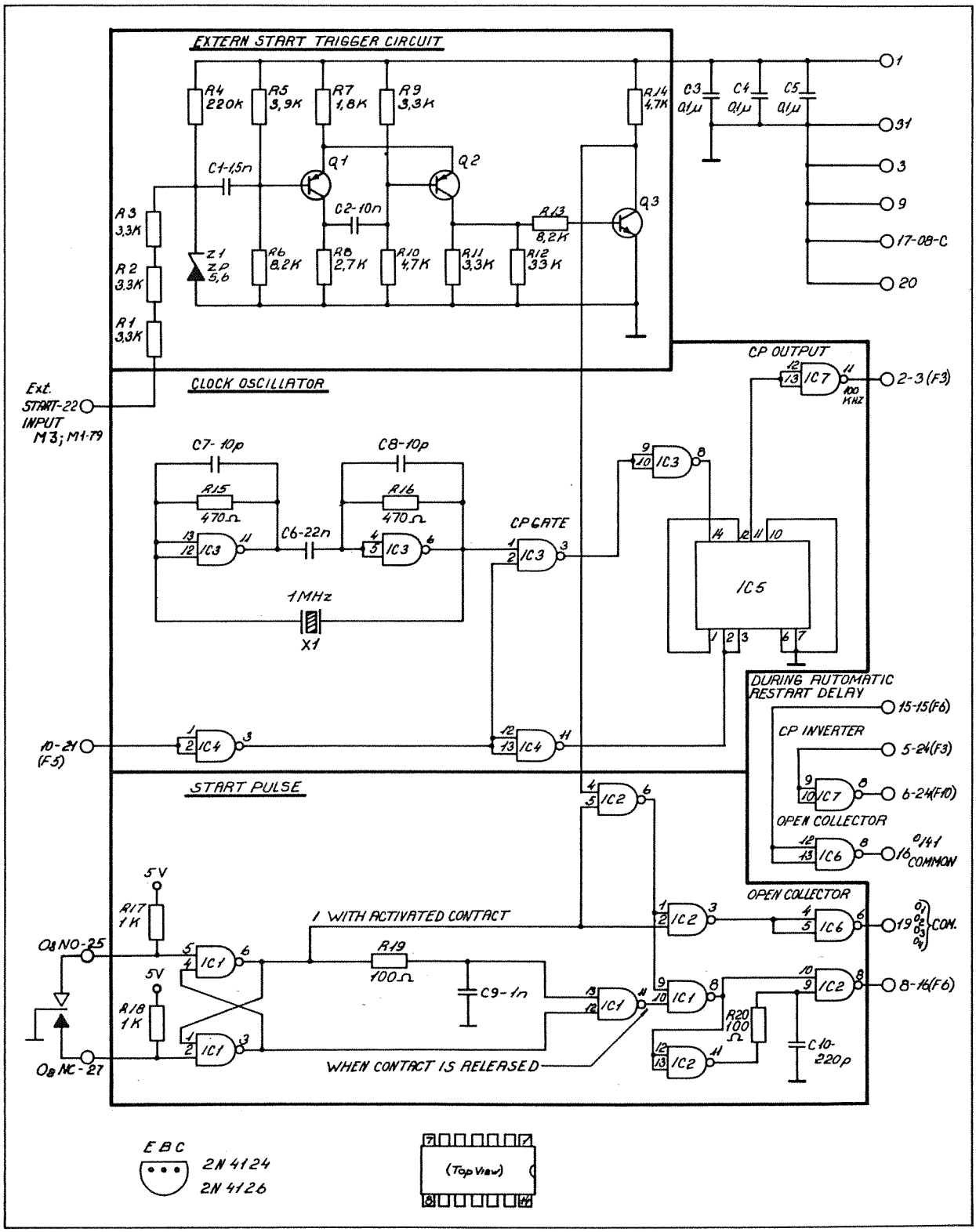
This pulse is employed when starting the COMBINED PULSE TRAIN manually.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1	1	MY2-23978	1,5 nF 5 % 125 V DC	Philips
C2	1	MY2-23955	10 nF 10 % 250 V DC	-
C3-5	3	MY2-23667	0,1 µF 10 % 250 V DC	-
C6	1	MY2-23957	22 nF 10 % -	-
C7-8	2	MY2-11876	10 pF ± 1 pF 63 V	(Siemens)
C9	1	MY2-23995	1 nF 5 % 125 V DC	
C10	1	MY2-23991	220 pF 5 % 200 V	
IC1-4 +7	5	MY1-23415	SN 7400N	
IC5	1	MY1-23410	SN 7490N	
IC6	1	MY1-51554	US 7438A	Spraque
M1	1	MY7-51124	2422-518-00001 Socket for crystal	Philips
Q1-2	2	MY1-23467	2N 4126	
Q3	1	MY1-23466	2N 4124	
R_1-3+ 9+11	4	MY2-31535	3,3 kΩ 5 % - 1/3 W	Beyschlag
R4	1	MY2-31557	220 kΩ	-
R5	1	MY2-31536	3,9 kΩ	-
R6+R13	2	MY2-31540	8,2 kΩ	-
R7	1	MY2-31532	1,8 kΩ	-
R8	1	MY2-31534	2,7 kΩ	-
R10+R14	2	MY2-31537	4,7 kΩ	-
R12	1	MY2-31547	33 kΩ	-
R15+16	2	MY2-51531	470 Ω 5 % 1/8 W	-
R17-18	2	MY2-31529	1 kΩ - 1/3 W	-
R19-20	2	MY2-31517	100 Ω - -	-
X1	1	MY1-51123	1 MHZ ± 10 ppm. serie resonans	-
Z1	1	MY1- 23586	ZP 5.6 5 % 1/4 W	ITT
	1	NL2-66715	Printed Circuit Board	Elmi

DN3-10001: CLOCK OSCILLATOR F4.
Electrical parts list.



DN3-10001: CLOCK OSCILLATOR F4.
Electrical parts location.



DN3-10001: CLOCK OSCILLATOR F4.
Circuit diagram.

3.3.4 DR4-20004: BASIC ELEMENT SELECTOR F5

This circuit controls the apperance of the basic element. The basic element may consist of from one to four different pulse/pause elements, below designated K, L, M and N. The K, L, M and N signals are generated by the four flip-flops (IC1 and IC2) of the selector circuit and are used to activate the four groups of PULSE/PAUSE switches on the front panel. The K signal controls the first pulse/pause switch group farthest to the left on the front panel, L the next group, and so on.

Which ones of the four pulse/pause elements are to be used in a given pulse train depends on

(1) which START button is depressed.

(2) which END buttons are depressed.

E, F and/or G levels in SELECTION OF PULSE/PAUSE ELEMENTS denote when END 1, END 2 and/or END 3 are depressed. In conjunction with A, B, C, D (PULSE TRAIN SELECTOR F6) they determine SET data for the K, L, M and N flip-flops.

The table below shows how the basic element is composed of pulse/pause elements.

END 1	END 2	END 3	START 1	START 2	START 3	START 4
E	F	G	A	$\bar{A}B$	$\bar{A}\bar{B}C$	$\bar{A}\bar{B}\bar{C}D$
1	1	1	K	L	M	N
1	1	0	K	L	M+N	N
1	0	1	K	L+M	N	N
1	0	0	K	L+M+N	N	N
0	1	1	K+L	M	N	N
0	1	0	K+L	M+N	N	N
0	0	1	K+L+M	N	N	N
0	0	0	K+L+M+N	N	N	N

The shaded area in the chart shows that the pulse/pause element N is generated in the event of incorrect programming of the Generator.

The SELECTION OF PULSE/PAUSE ELEMENTS circuit generates a SET PULSE for flip-flops K, L, M and N.

The network is composed of dual-input nand gates. The SET PULSES are determined by the following logic expressions:

SET K ➡ $S_K = A$

SET L ➡ $S_L = \overline{\overline{(\bar{A}B)E} \cdot \overline{A\bar{E}}}$

SET M ➡ $S_M = \overline{S_L \bar{F} \cdot F \cdot \overline{(\bar{A}B)\bar{E}} \cdot \overline{(\bar{A}\bar{B}C)E}}$

SET N ➡ $S_N = \overline{\overline{S_M \bar{G} \cdot (\bar{A}\bar{B}\bar{C}D)} \cdot \overline{S_M \cdot (\bar{A}\bar{B}C)} \cdot (\bar{A}B) \cdot \bar{S}_L}$

Set information is fed to the four flip-flops via STROBE PULSE, terminal 12. This STROBE PULSE is generated at F_7 at the end of Δt_3 if another basic element is to be generated.

CP GENERATOR GATE CONTROL S

S controls the CP GATE on F4 via terminal 10 and keeps the time base at F3 cleared when no pulse train is being generated. With the function switch at NORMAL, S is identical with A+B+C+D; this means that the CP GATE on F4 will admit clock pulses when a pulse train is measured out, S = "1", and otherwise be closed, S = "0".

With the function switch in the RESTART DELAY position, S = "1" both while pulse/pause times are measured out and while the RESTART DELAY time is measured out.

Immediately following the end of AUTOMATIC RESTART DELAY, S goes briefly to "0".

SELECTOR CIRCUIT

SET K, L, M and N are strobed in on the four flip-flops, IC1 and IC2, thus presetting them.

K, L, M and N are clocked in via IC3 and IC4 from terminal 13.

Composite control signals $\bar{K}$, $\overline{\bar{K}L}$, $\overline{\bar{K}\bar{L}M}$ and $\overline{\bar{K}\bar{L}\bar{M}N}$ are generated by means of gates IC3, IC4 and IC10.

The clock pulse at terminal 13 is identical with the pulse (C) (PULSE PAUSE CONTROL, F7) which checks whether a pulse or a pause element is being scanned. Thus, the clock pulse is generated every time a pulse/pause element is terminated. When the basic element is terminated, a clock pulse is transmitted to the repetition counter and a brief pulse is transmitted via terminal 4 to terminal 30 of F7. Thereafter Δt_3 is started.

During the time Δt_3 it is determined whether the basic element just transmitted was the last one in a pulse train; if not, a pulse is generated on circuit board F7 (STROBE K, L, M, N, terminal 23) at the end of Δt_3, and the process is repeated.

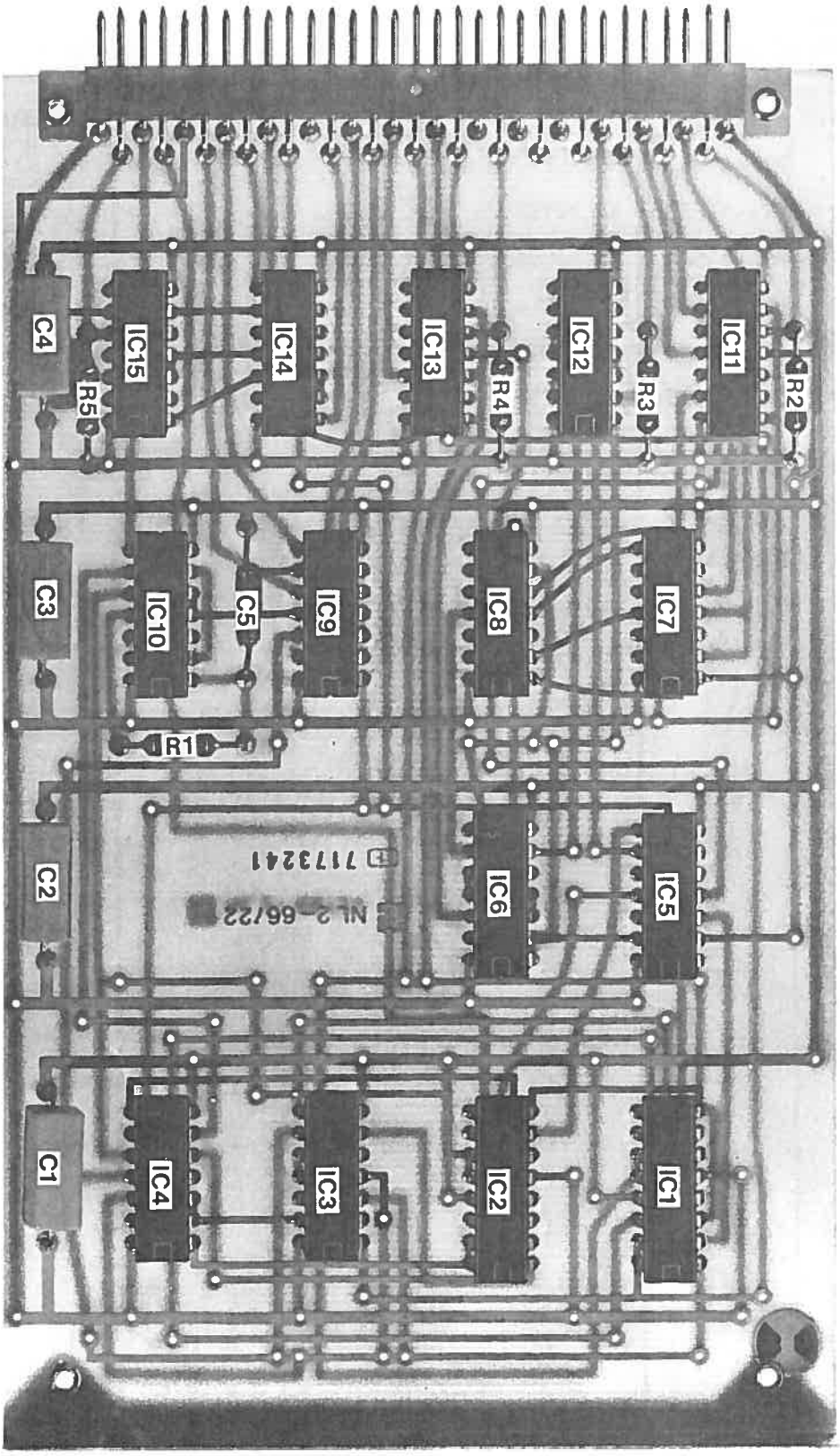
If it is determined during the time Δt_3 that the basic element transmitted was the last one in a pulse train and that no more basic elements are to be transmitted, A = B = C = D = "0" (A+B+C+D = "0"), which concludes the process.

If another pulse train is to be transmitted, a SET PULSE for the four flip-flops will not be generated immediately after Δt_3. The input information must be modified before this is done. Accordingly, a pause, Δt_4, has been introduced while A, B, C and D flip-flops on F6 switch over and the output levels are transmitted. When Δt_4 is terminated, Δt_3 is started; meanwhile a check is made whether the basic element is to be transmitted zero times; only thereafter will the STROBE for K, L, M and N be generated.

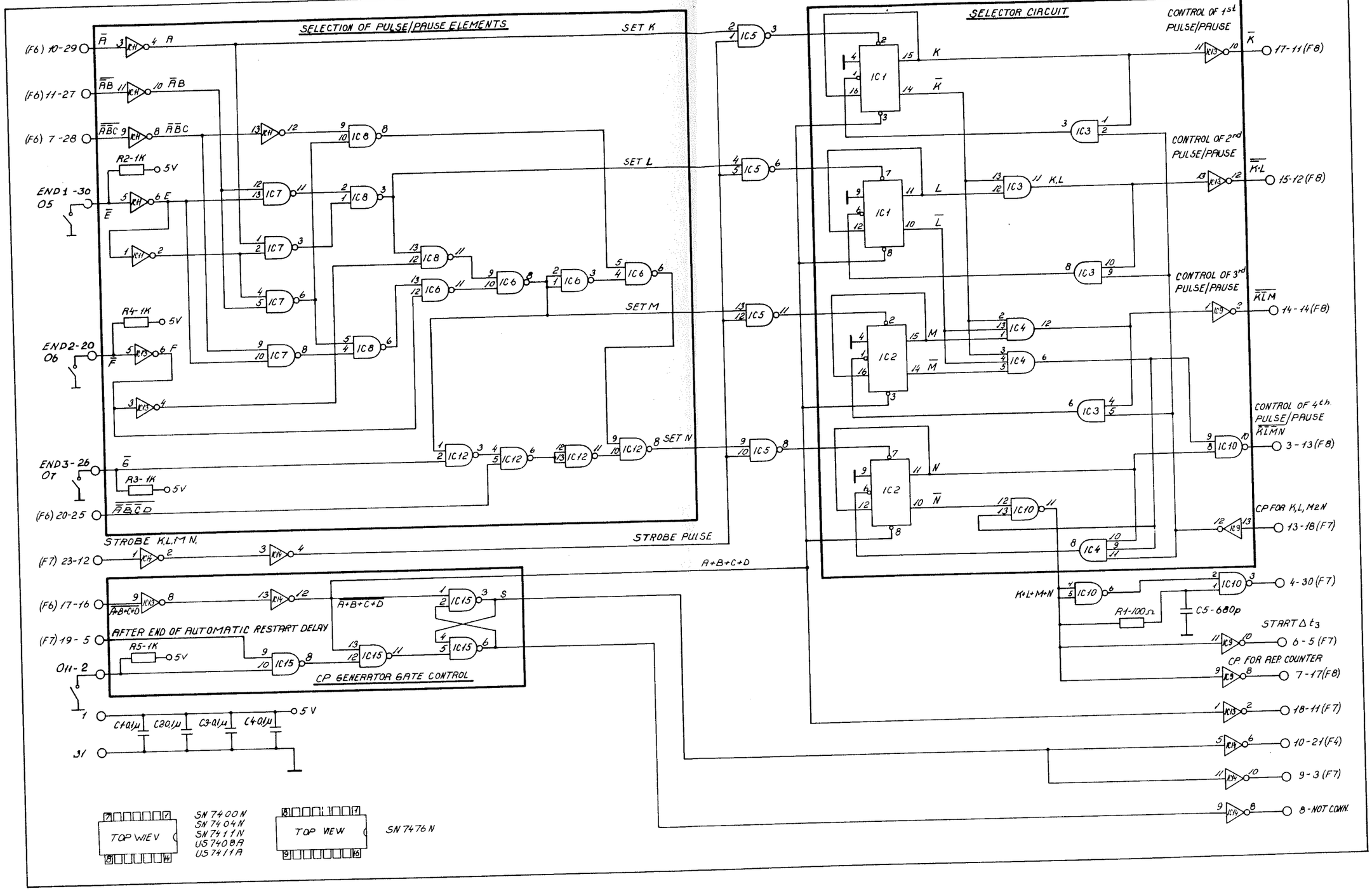
In this way it is ensured that an incorrect pulse will not be generated in case the basic element is to be transmitted zero times. K, L, M and N are zero while this check is made, and in consequence therefore IC6 on F7 is cut off.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-C4	4	MY2-23667	0,1 µF 10 % 250 V DC	Philips
C5	1	MY2-23994	680 pF 5 % 125 V DC	-
IC1-2	2	MY1-51553	SN 7476N	
IC3	1	MY1-51548	SN 7408N	
IC4	1	MY1-51549	US 7411A	Spraque
IC5-8+ 10+12+ 15	7	MY1-23415	SN 7400N	
IC9+11 13-14	4	MY1-51111	SN 7404N	
R1	1	MY2-51529	100 Ω 5 % 1/8 W	Beyschlag
R2-5	4	MY2-31651	1 kΩ - -	-
	1	NL2-66722	Printed Circuit Board	Elmi

DR4-20004: BASIC ELEMENT SELECTOR F5.
Electrical parts list.



DR4-20004: BASIC ELEMENT SELECTOR F5.
Electrical parts location.



DR4-20004: BASIC ELEMENT SELECTOR F5.
Circuit diagram.

3.3.5 DR4-20002: PULSE TRAIN SELECTOR F6

The PULSE TRAIN SELECTOR comprises two separate sections: SELECTION OF PULSE TRAIN and SELECTOR CIRCUIT.

SELECTION OF PULSE TRAIN

This section comprises four identical circuits. These generate SET pulses for the flip-flops of the following SELECTOR CIRCUIT which determines the composition of the pulse train to be transmitted.

A SET pulse is generated

(1) when one of START buttons 1, 2, 3 and 4 is depressed,

(2) by the EXT.START pulse when the EXT. START button and one or more START buttons 1, 2, 3 and 4 have previously been depressed together,

(3) when the EXT.START button is released after START buttons 1, 2, 3 or/and 4 have previously been depressed together,

(4) after the end of the automatic restart delay time when START buttons 1, 2, 3 or/and 4 have previously been depressed together.

Depressing for instance START 1 will change the state of the flip-flop composed of IC10. On account of the time delay caused by R1-C5, the output at pin 6 of IC1 will generate a SET A pulse to preset pin 15 of IC4 to "1". If, on the other hand, START 1 remains depressed, a pulse from AUTO RESTART or EXT.START, as the case may be, will pass through to pin 5 of IC1, thus serving as a SET A pulse.

The circuits for START buttons 2, 3 and 4 function in the same manner as described for START 1 above.

Pulses SET A, B, C and D are fed to IC3, which generates the CLEAR REPETITION COUNTER pulse, terminal 22, and starts the time delay Δt_3 at terminal 3 of F7.

SELECTOR CIRCUIT

The selector circuit comprises four flip-flops, IC4 and IC5.

The output of each of these controls a pulse train. When for instance A = "1", the 1st pulse train is transmitted. As a result of this, k = "1" (right-hand lamp of START 1 is on) and the output at terminal 13 goes to "0" so that the repetition switches associated with the 1st pulse train can be scanned.

Furthermore, the output from terminal 10 is fed to the BASIC ELEMENT SELECTOR on F5 which determines the composition of the basic element in the 1st pulse train.

The other flip-flops operate in the same manner.

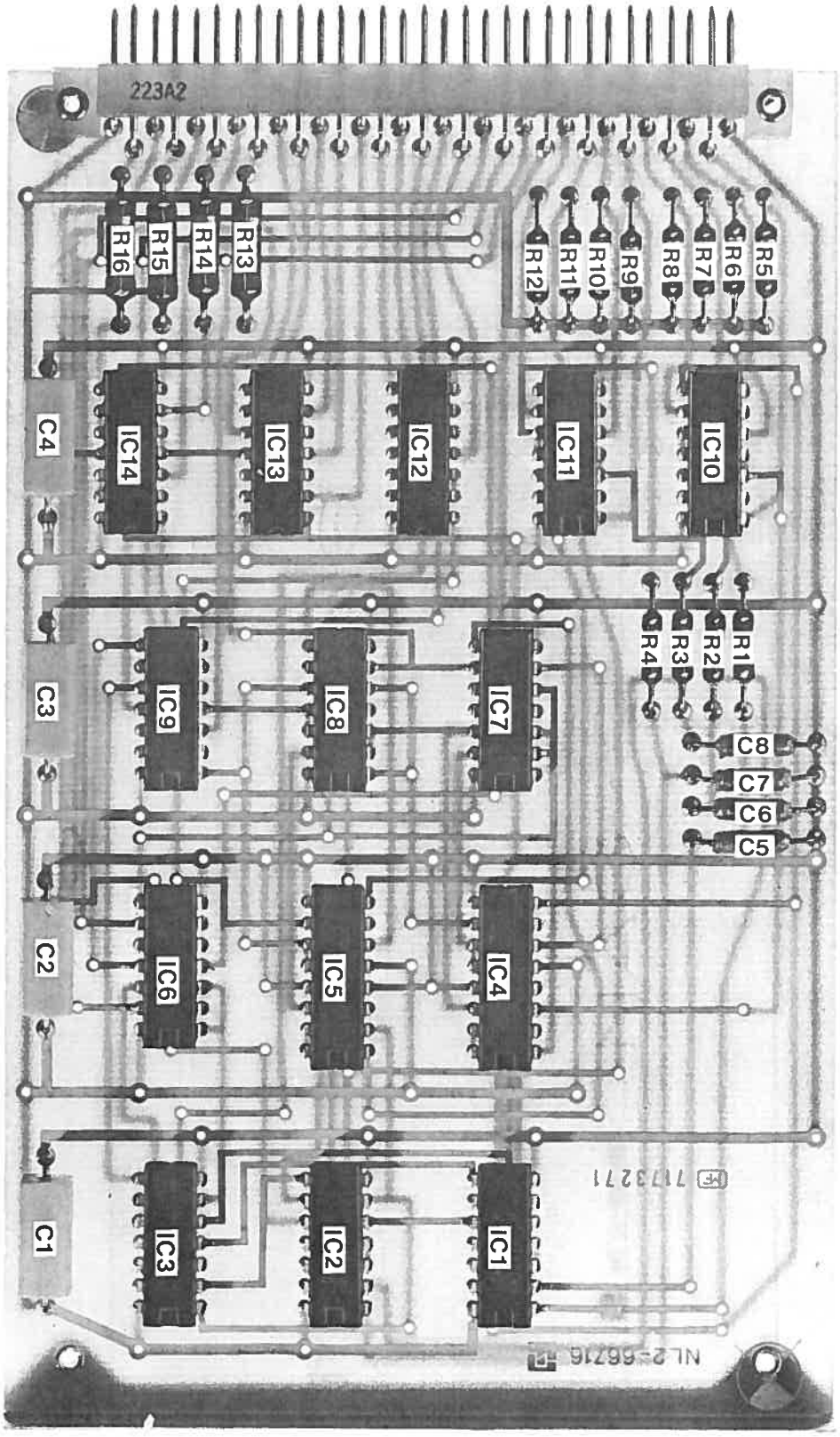
In order to ensure that only the control signals for one pulse train will be sent at a time, the output signals from the four flip-flops are transmitted in this sequence: A, B, C, D. Correct sequence is secured by IC7, IC8, IC9 and IC14.

At the end of a pulse train, a pulse from REPETITION CONTROL, terminal 19 of F7, arrives at terminal 19.

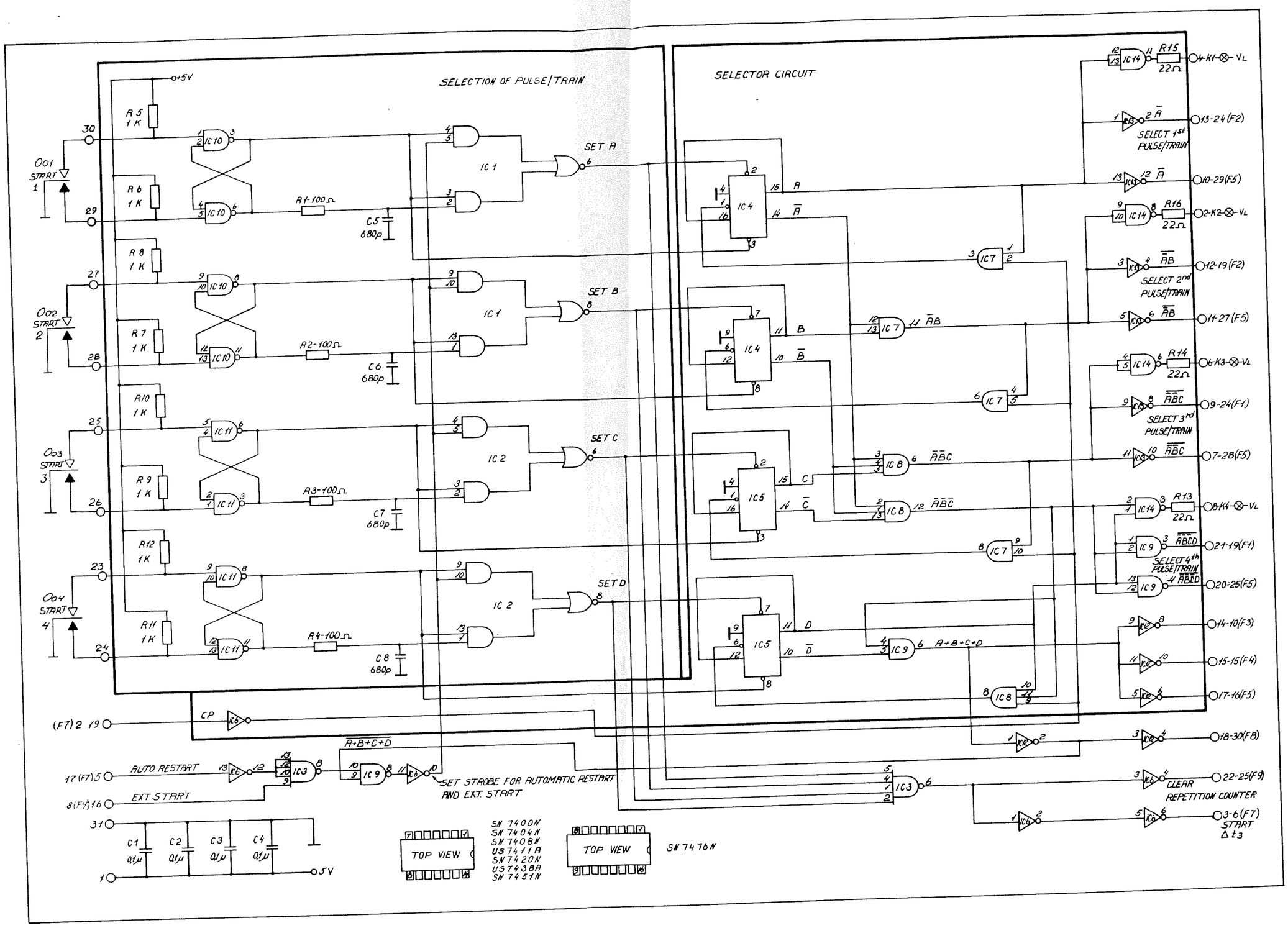
The signal is fed through four gates, IC7 and IC8, and serves as CP for the four flip-flops.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-4	4	MY2-23667	0,1 µF 10 % 250 V DC	Philips
C5-8	4	MY2-23994	680 pF 5 % 125 V DC	
IC1+2	2	MY1-51551	SN 7451N	
IC3	1	MY1-23413	SN 7420N	
IC4-5	2	MY1-51553	SN 7476N	
IC6+12 +13	3	MY1-51111	SN 7404N	
IC7	1	MY1-51548	SN 7408N	
IC8	1	MY1-51549	US 7411A	Spraque
I9-11	3	MY1-23415	SN 7400N	
IC14	1	MY1-51554	US 7438A	Spraque
	1	NL2-66716	Printed Circuit	Elmi
R1-4	4	MY2-51529	100 Ω 5 % 1/3 W	Beyschlag
R5-12	8	MY2-31651	1 kΩ - -	-
R13-16	4	MY2-31509	22 Ω - 1/2 W	-

DR4-20002: PULSE TRAIN SELECTOR F6.
Electrical parts list.



DR4-20002: PULSE TRAIN SELECTOR F6.
Electrical parts location.



DR4-20002: PULSE TRAIN SELECTOR F6.
Circuit diagram.

3.3.6 DR4-20001: PULSE PAUSE CONTROL F7

This circuit board comprises three separate circuits: REPETITION CONTROL, SET-RESET FUNCTIONS and DIGIT SCANNING.

REPETITION CONTROL

This unit contains flip-flop IC7a which generates a signal "k" to control the ten-divider circuit on circuit board F3. See also LOGIC FLOW DIAGRAM, section 3.1. At the start of a pulse train, "k" = "0".

This involves that only the tens repetition switch (x10) can be activated. The ten-divider in repetition counter F3 is inserted, and only every tenth CP will pass from TIME BASE FOR REPETITION COUNTER F8 to REPETITION COUNTER F9.

When the programmed number of repetitions has been counted, a pulse is transmitted from terminal 9 of TIME BASE FOR REPETITION COUNTER F8.

This will cause "k" to go to "1" and allow the units repetition switch (x1) to be activated.

At the same time, the ten-divider is switched off, and TIME BASE FOR REPETITION COUNTER and REPETITION COUNTER will now count each basic element. The wanted numbers of basic elements are counted, and another output is delivered from terminal 9 of TIME BASE REPETITION COUNTER F8. Since "k" is now "1", the change of level is fed to PULSE TRAIN SELECTOR F6 via terminal 2, whereupon "k" once more goes to "0".

DIGIT SCANNING

IC9 and IC5 constitute a 3-bit synchronous counter. The three bits - a, b and c - are used for determining which one of the eight digits of a pulse/pause element is to be activated. Furthermore, a and b control TIME BASE SELECTOR FOR PULSE PAUSE GENERATION on circuit board F3.

Control is performed as tabulated below:

a b c			
0 0 0	Pulse	1st digit	time base x 1000
1 0 0		2nd digit	time base x 100
0 1 0		3rd digit	time base x 10
1 1 0		4th digit	time base x 1
0 0 1	Pause	1st digit	time base x 1000
1 0 1		2nd digit	time base x 100
0 1 1		3rd digit	time base x 10
1 1 1		4th digit	time base x 1

Furthermore, c is used as CP for BASIC ELEMENT SELECTOR on circuit board F5.

Since c is "0" both when a pause time is measured out and when the instrument is not generating a pulse train, c must be combined with a signal to indicate whether or not a pulse train is being transmitted.

When K+L+M+N = "1", a pulse train is transmitted. This means that the output signal c' is generated as

$\overline{(K+L+M+N)\bar{c}} = c'$. Because of the time delay in the instrument, c must be delayed before being gated with (K+L+M+N).

This occurs via R7, C8 and IC7b, thus avoiding the apperance of incorrect pulses at terminal 20. Contact circuit boards F11 and F12 are controlled in synchronism with this signal.

$$c' = \overline{(K+L+M+N) \cdot \bar{c}_{delayed}}$$

SET/RESET FUNCTIONS

This circuit contains two delay circuits which generate two delay times, Δt_3 and Δt_4. These delays have been introduced to counteract transmission delays in the instrument.

Delay time Δt_3 is started by the following events:

(1) A signal at terminal 6 indicating that one or more pulse trains have been set up at F6 (A, B, C or D). This signal is also used to clear PULSE/PAUSE COUNTER F10.

(2) A signal at terminal 30 indicating that a basic element has been terminated.

(3) A signal (a_4) from the output of IC2, generated by Δt_4 (when another pulse train has been programmed).

When Δt_3 ends, a brief pulse (a_1) is generated. During the time Δt_3 a check is made whether the wanted number of repetitions of a basic element, programmed on the front panel, has been reached; this also applies if (0.0) repetitions have been programmed.

Delay time Δt_3 must be long enough so that the repetition counter will have time to generate both x10 and x1 outputs and transmit them to IC7a (k).

If no "1" output from the repetition counter is registered during the time Δt_3 it is an indication that the pulse train has not ended. A STROBE pulse is generated at terminal 23 and fed to flip-flops K, L, M and N on F5.

PULSE/PAUSE COUNTER F10 is cleared via terminal 10 whereupon the inhibit on the PULSE/PAUSE COUNTER is cancelled via terminal 7.

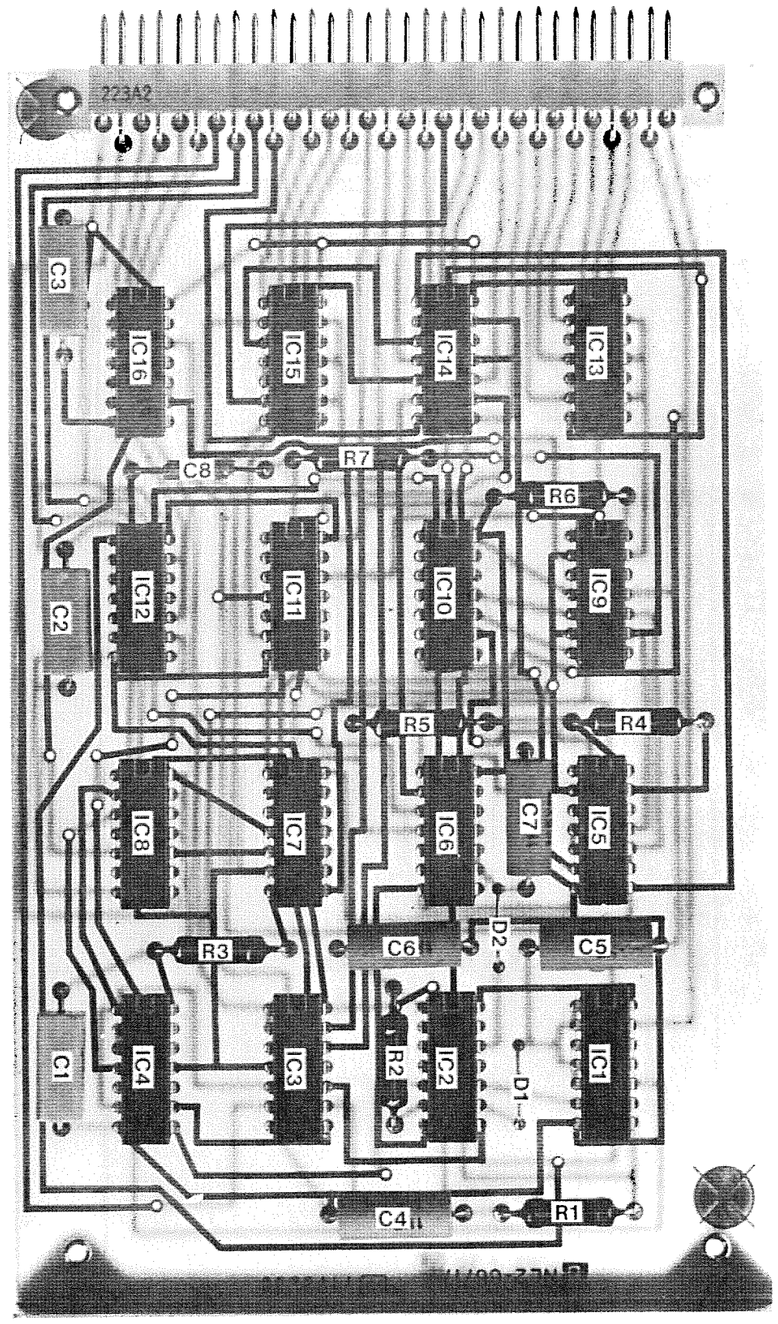
If termination of the pulse train is registered, the REPETITION CONTROL IC8 output goes to "0", preventing IC5 from generating a_6, so that the Generator stops (with the FUNCTION SELECTOR 011 in the NORMAL FUNCTION position).

If (A+B+C+D) from terminal 11 remains "1" after a pulse train has ended it is an indication that another pulse train has been programmed. In this case delay time Δt_4 is generated by means of a_2 whilst the output levels of the new pulse train data A, B, C, D are transmitted to the SET inputs of K, L, M and N. At the end of Δt_4, Δt_3 starts up once more, and the new pulse train is generated.

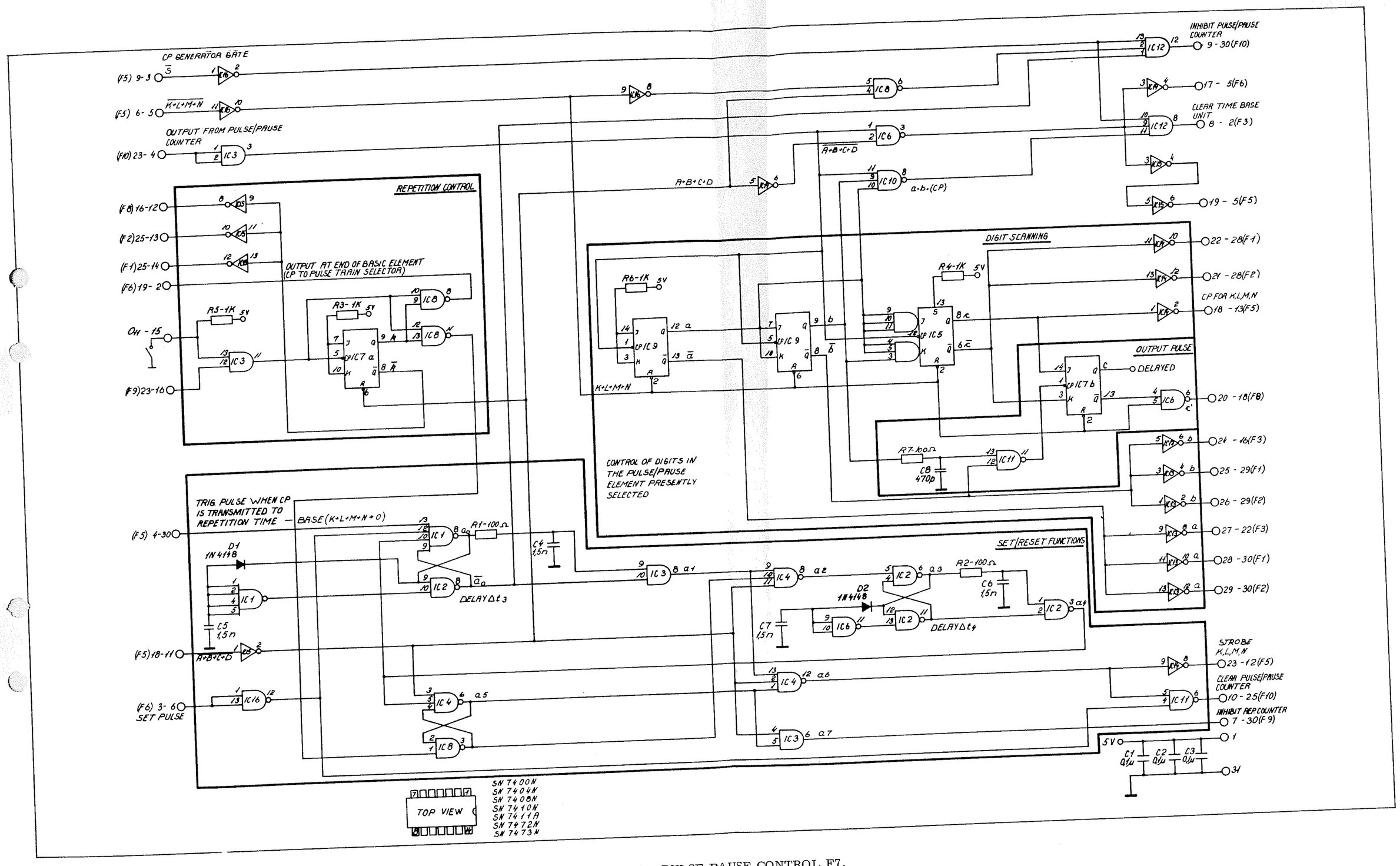
Terminal 9 of INHIBIT PULSE/PAUSE COUNTER is "0" when the CP gate is closed in the interval between the individual basic elements, and in the time interval Δt_3. Terminal 8 of CLEAR TIME BASE gives "0" when the CP gate is closed, after each pulse and pause time, and after automatic restart delay.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-C3	3	MY2-23667	0,1 µF 10 % 250 V DC	Philips
C4-C7	4	MY2-23978	1,5 nF 5 % 125 V DC	-
C8	1	MY2-23993	470 pF 5 % 125 V DC	-
D1-D2	2	MY1-23650	IN 4148	Sesco.
IC1	1	MY1-23413	SN 7420N	
IC1+IC8 IC6	3	MY1-23415	SN 7400N	
IC3+ IC11	2	MY1-51548	SN 7408N	
IC4+ IC1o	2	MY1-23414	SN 7410N	
IC5	1	MY1-51552	SN 7472N	
IC7+ IC9	2	MY1-23411	SN 7473N	
IC12	1	MY1-51549	US 7411A	Spraque
IC13-16	4	MY1-51111	SN 7404N	
R1-2 +R7	3	MY2-31517	100 Ω 5 % 1/3 W	Beyschlag
R3-6	4	MY2-31529	1 kΩ 5 % 1/3 W	-
	1	NL2-66717	Printed Circuit Board	Elmi

DR4-20001: PULSE PAUSE CONTROL F7.
Electrical parts list.



DR4-20001: PULSE PAUSE CONTROL F7.
Electrical parts location.



DR4-20001: PULSE PAUSE CONTROL F7.
Circuit diagram.

3.3.7 DH1-20001: TRIGGER PULSE GENERATOR F8

This circuit board comprises circuits for the three types of trigger pulses, a network for selection of trigger pulses and a TIME BASE FOR REPETITION COUNTER control.

TIME BASE FOR REPETITION COUNTER

This circuit functions as a ten-divider for clock pulses for REPETITION COUNTER F9. Clock pulses for the time base unit are generated each time a basic element has been terminated. Depending on whether a x10 or a x1 repetition switch is being scanned, either every tenth or all clock pulses are fed through to REPETITION COUNTER F9.

TIME BASE FOR REPETITION COUNTER is controlled at terminal 16. When the control signal "k" is "0", clock pulses are fed to decade counter IC8. When "k" is "1", IC8 is maintained reset, and clock pulses are fed via IC4 direct to terminal 9.

TRIGGER OUTPUTS:

TRIG. START and TRIG. STOP

The two pulses are derived from the signal $\bar{A}+B+C+D$, which is "1" when a pulse train is transmitted, and "0" either in the no-signal condition or during the RESTART DELAY time.

The TRIG. START signal is generated on the positive gradient and TRIG. STOP on the negative gradient of the A+B+C+D signal, terminal 30.

The ELEMENT pulse is generated, depending on the setting of ELEMENT SELECTOR 0142, at the beginning or end of the 1st, 2nd, 3rd or 4th pulse/pause time of the basic element (see section 2). The SELECTION OF TRIGGER PULSE circuit determines the time placement of the ELEMENT pulse in the basic element of the pulse train.

Signals $\bar{K}$, $\overline{\bar{K}L}$, $\overline{\bar{K}\bar{L}M}$ and $\overline{\bar{K}\bar{L}\bar{M}N}$, which are "0" while the 1st, 2nd, 3rd and 4th pulse/pause elements are being measured out, in conjunction with the setting of 0142 determine which level changes for c' are to pass through to 8-input gate IC2 and so generate an ELEMENT pulse. c' also controls contact circuit boards F11 and F12.

The START, STOP and ELEMENT pulses are identical in shape and generated in identical circuits.

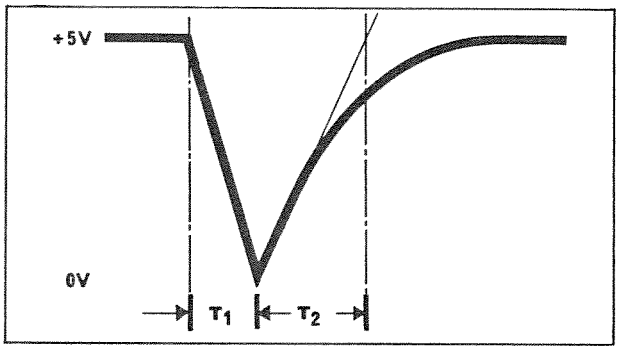


Fig. 3.2

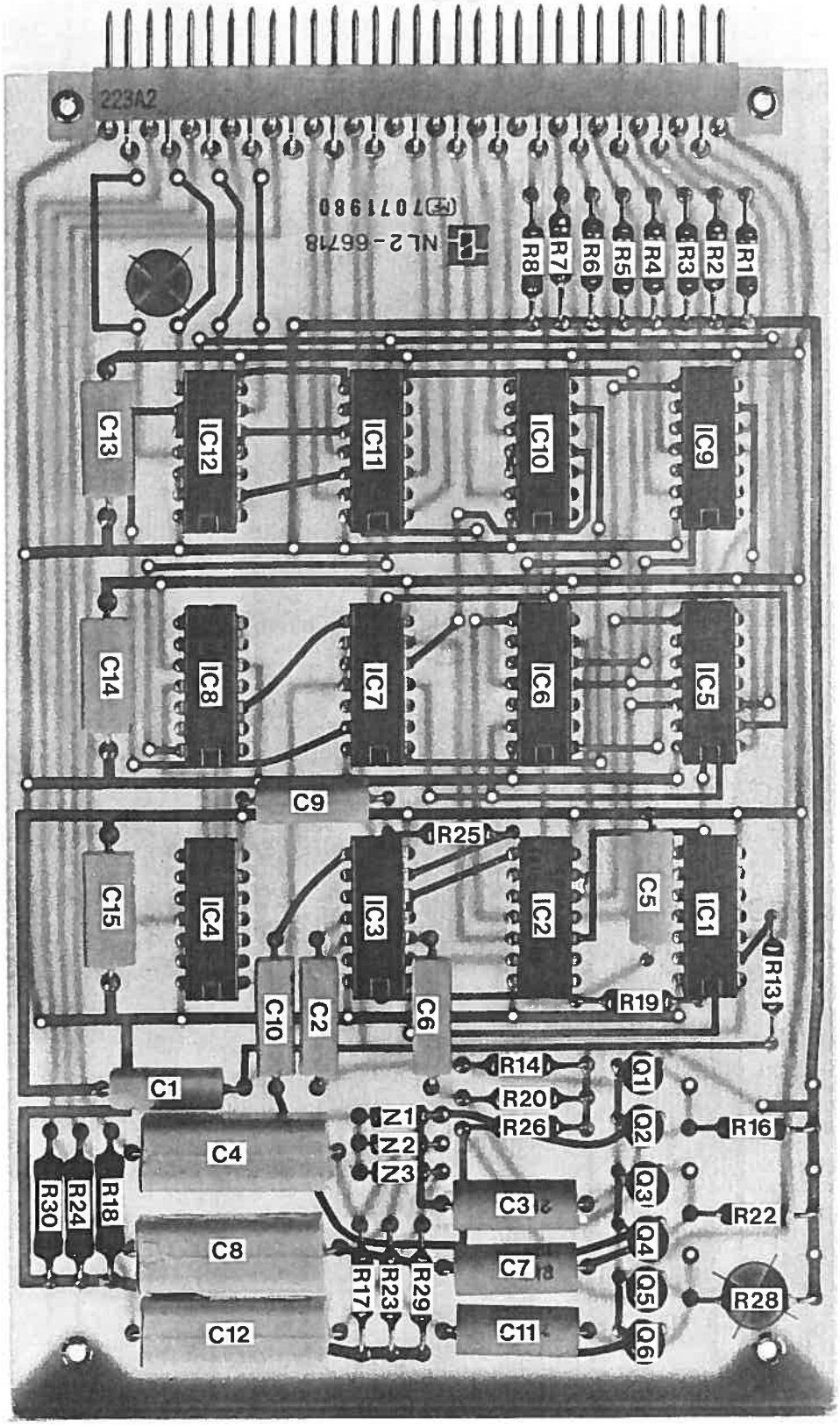
τ_1 and τ_2 are circuit boards for the START pulse, determined by time constants (R15/R16)C3 and R17 · C3, respectively.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1+C2	2	MY2-23955	10 nF 10 % 250 V DC	Philips
C4	1	MY2-23669	0,47 µF 10 % -	-
C5+C6	2	MY2-23955	10 nF 10 % -	-
C8	1	MY2-23669	0,47 µF 10 % -	-
C9+C10	2	MY2-23955	10 nF - -	-
C12	1	MY2-23669	0,47 µF - -	-
C13+C 14+C15	3	MY2-23667	0,1 µF	
C3+C7 +C11	3	MY2-23979	2,2 nF 5 % 125 V DC	Philips
IC1	1	MY1-51111	SN 7404N	
IC2	1	MY1-51550	SN 7430N	
IC3-4	2	MY1-23415	SN 7400N	
IC5-7	3	MY1-23414	SN 7410N	
IC8	1	MY1-23410	SN 7490N	
IC9-11	3	MY1-51111	SN 7404N	
IC12	1	MY1-23415	SN 7400N	
Q1+Q3+ Q5	3	MY1-23466	2N 4124	
Q2+Q4+ Q6	3	MY1-23468	2N 4401	
R1-R8	8	MY2-31651	1 kΩ 5 % 1/8 W	Beyschlag
R13+R 19+R25	3	MY2-51529	100 Ω - -	-
R14+R 17+R20 +R23+R 26+R29	6	MY2-31657	10 kΩ - -	-
R16+R22 R28	3	MY2-51532	560 Ω - -	-
R18+R 24+R30	3	MY2-31541	10 kΩ - 1/3 W	-

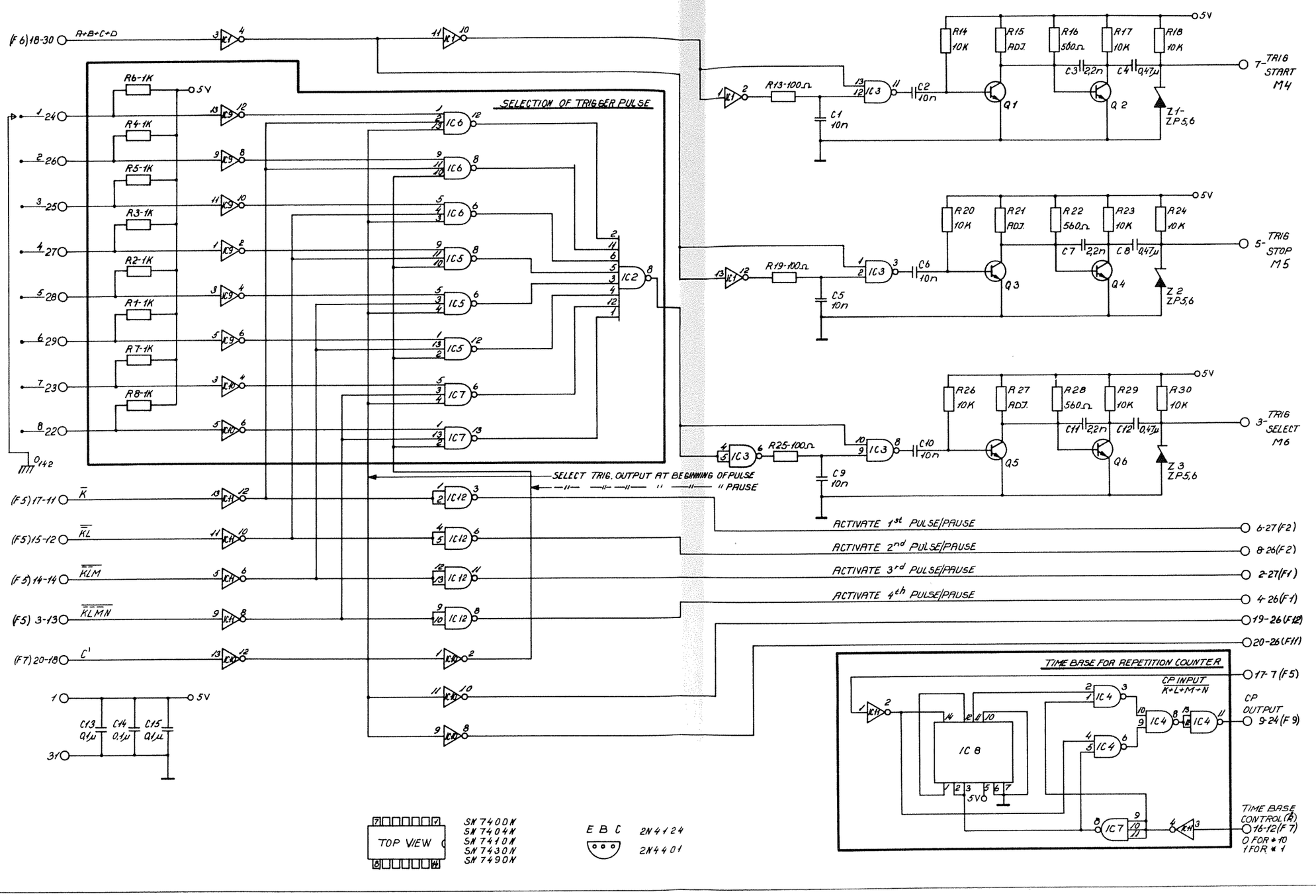
DH1-20001: TRIGGER PULSE GENERATOR F8.
Electrical parts list (1).

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
R15+R 21+R27	3		adj.	
Z1+Z2+ Z3	3	MY1-23586	ZP 5,6 5 % 1/4 W	ITT
	1	NL2-66718	Printed Circuit Board	Elmi

DH1-20001: TRIGGER PULSE GENERATOR F8.
Electrical parts list (2).



DH1-20001: TRIGGER PULSE GENERATOR F8.
Electrical parts location.



DH1-20001: TRIGGER PULSE GENERATOR F8.
Circuit diagram.

3.3.8 DH2-20001: COUNTER F9/F10

Two counter circuit boards are used.

One of them, F10, is used in measuring out pulse and pause times; the other one, F9, for counting the number of basic elements in the pulse train.

Each counter circuit board is composed of a decade counter, a BCD COMPARATOR a DECIMAL TO BCD CONVERTER and two monostable multivibrators for generating OUTPUT and CLEAR PULSES.

The nine input terminals are fed from MULTIPLEXER F13, in turn controlled from one of the front-panel lever switches. At the start, the PULSE/PAUSE COUNTER will be in the 0000 position. On the arrival of a number of clock pulses corresponding to the input data from the multiplexer, the comparator output - pin 6 of IC7 - will change to "0", causing pin 13 of IC8 to change to "1".

If "1" is also present at pins 1 and 2, an output pulse will be generated at terminal 23 when the comparator changes its level. The output pulse also generates a clear pulse whose duration is Δt, (Δt_1 or Δt_2).

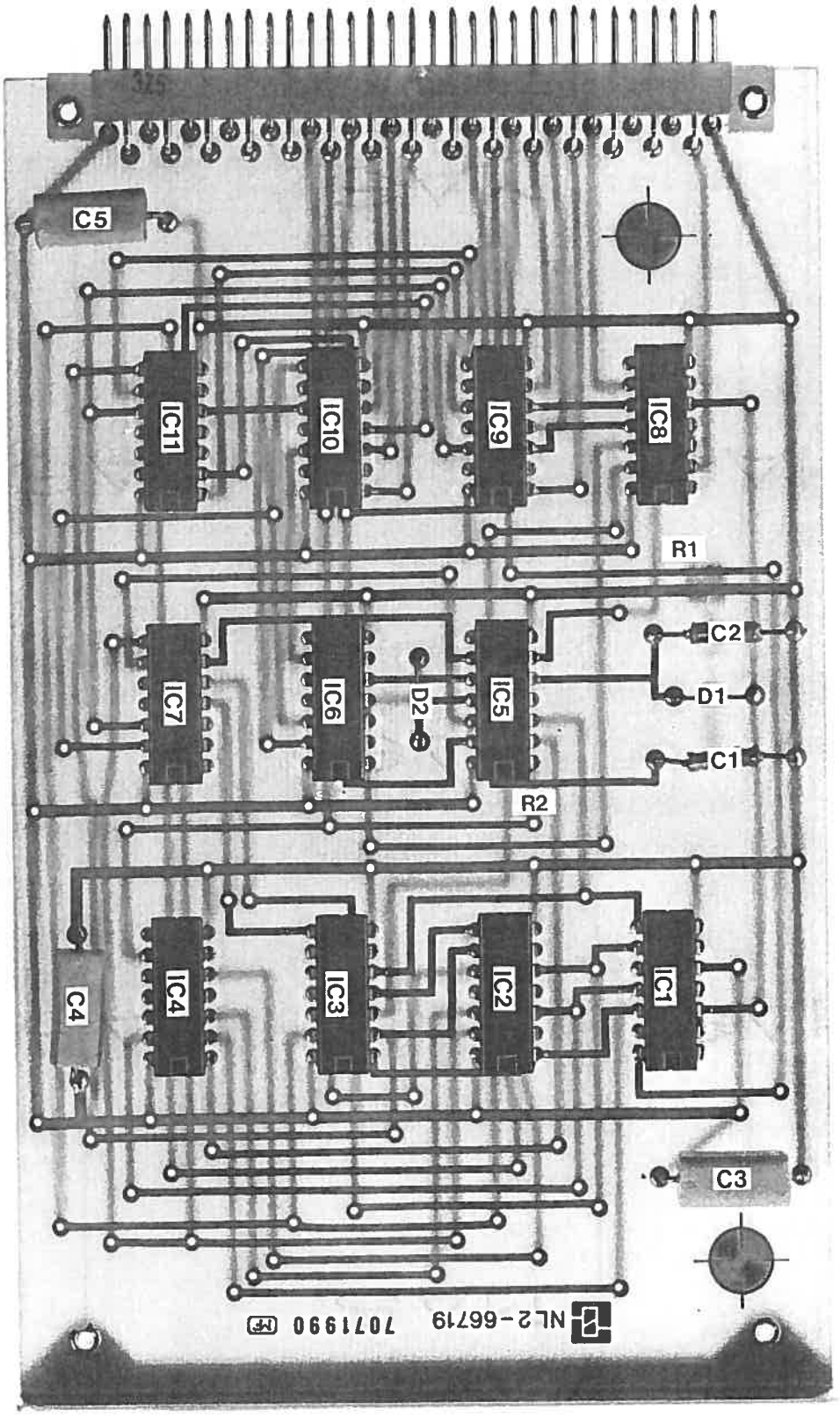
This clear pulse resets the decade counter IC1 and cuts off the output from the BCD comparator (pin 1 of IC8) during the time Δt. This prevents undesired output pulses in case of a changed combination from the multiplexer circuit board - in other words, in case of a change in the lever switch settings. If none of the nine inputs to the DECIMAL-TO-BCD CONVERTER is "1", output from the BCD comparator will be present when the decade counter IC1 is reset. Output from the circuit board (terminal 23) when the clear pulse has ended is prevented by an inhibit level at pin 2 of IC8.

This condition exists when a lever switch is in the "0" position.

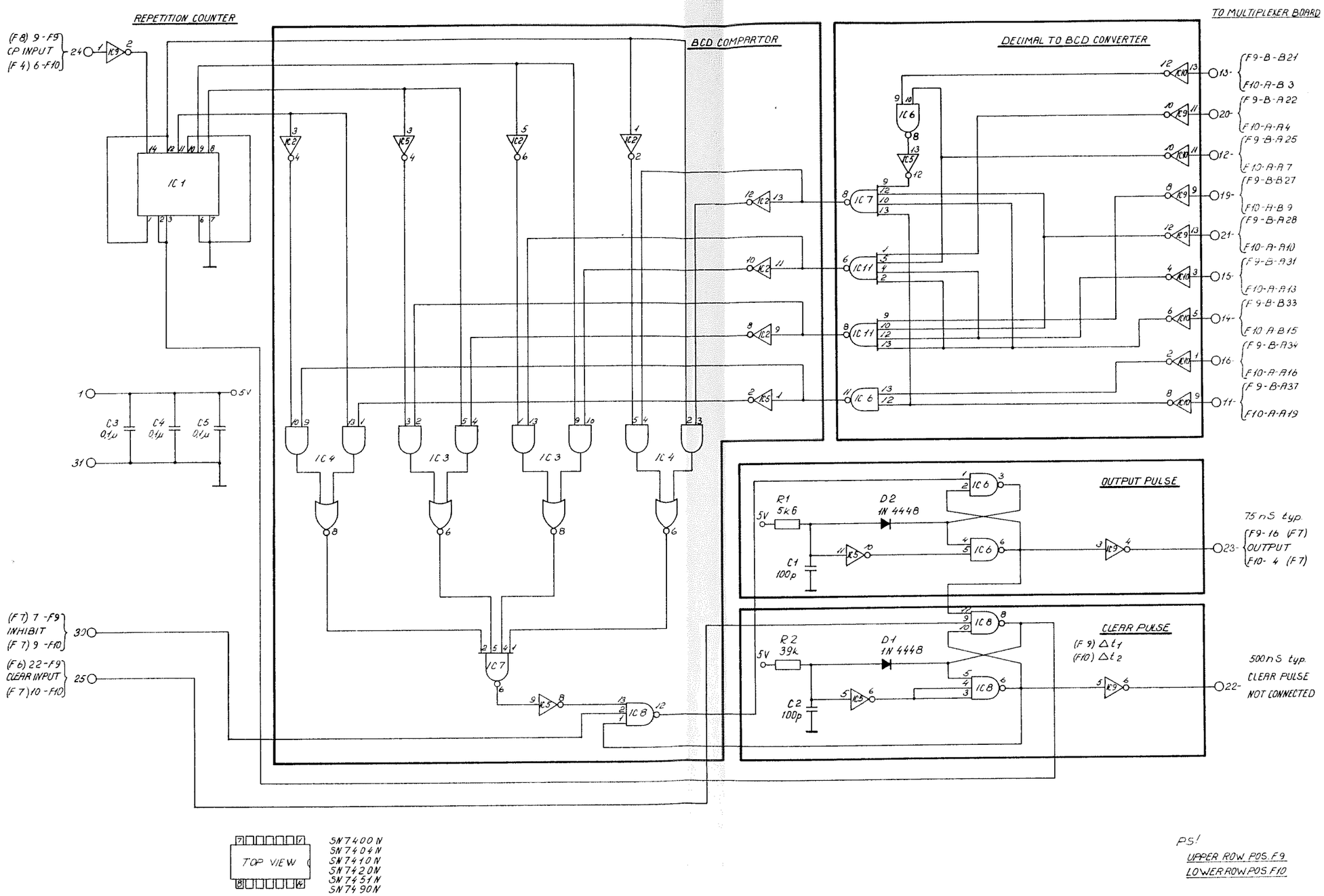
Δt limits the rate at which it is possible to scan through a number of lever switches all of which are in the 0000 position.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-2		MY2-23989	100 pF 5 % 125 V DC	Philips
C3-C5	3	MY2-23667	0,1 µF 10 % 250 V DC	-
D1 D2	2	MY1-51564	IN 4448	-
IC1	1	MY1-23410	SN 7490N	Texas
IC2	1		SN 7404 N	-
IC5	1		SN 74L04N	-
IC9 IC10	2		SN 7404 N	-
IC3-4	2	MY1-51551	SN 7451N	
IC6	1	MY1-23415	SN 7400N	
IC7-IC11	2	MY1-23413	SN 7420N	
IC 8	1	MY1-23414	SN 7410N	
	1	NL2-66719	Printed Circuit Board	Elmi
R 1	1		5k6 CR 25	Philips
R 2	1		39k CR 25	Philips

DH2-20001: COUNTER F9/F10.
Electrical parts list.



DH2-20001: COUNTER F9/F10.
Electrical parts location.



DH2-20001: COUNTER F9/F10.
Circuit diagram.

3.3.9 DL3-10001: CONTACT UNIT F11/F12

The two contact units, F11/F12, are identical and operate in parallel in regard to time. They are controlled from the same electrical signal (c') PULSE/PAUSE CONTROL, F7, via circuit board F8.

Each circuit board consists of a mercury-wetted reed relay and driver transistors Q_1 and Q_2.

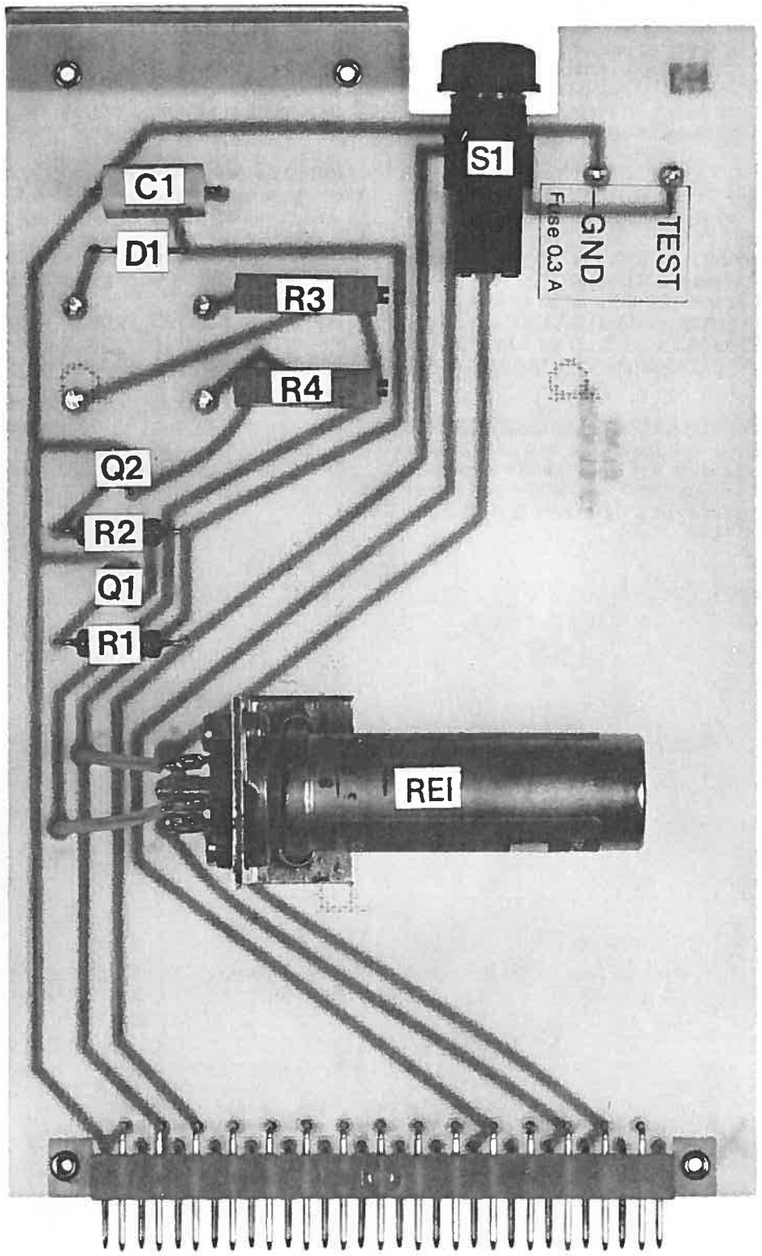
The relay contacts are the Generator's output terminals. They are secured against overloads by fuse S1, located on the circuit board. Relay operating and release times are adjusted to minimum pulse distortion by means of resistors R3 and R2+R3, respectively.

Since a mechanical relay cannot function with full accuracy in times shorter than 5 - 10 ms, the TIME BASE switch is electronically locked in the x1 ms position, via a strap between terminals 30 and 31 of the circuit board. The TIME BASE switch can be made to function in the x .1 ms position in the following manner:

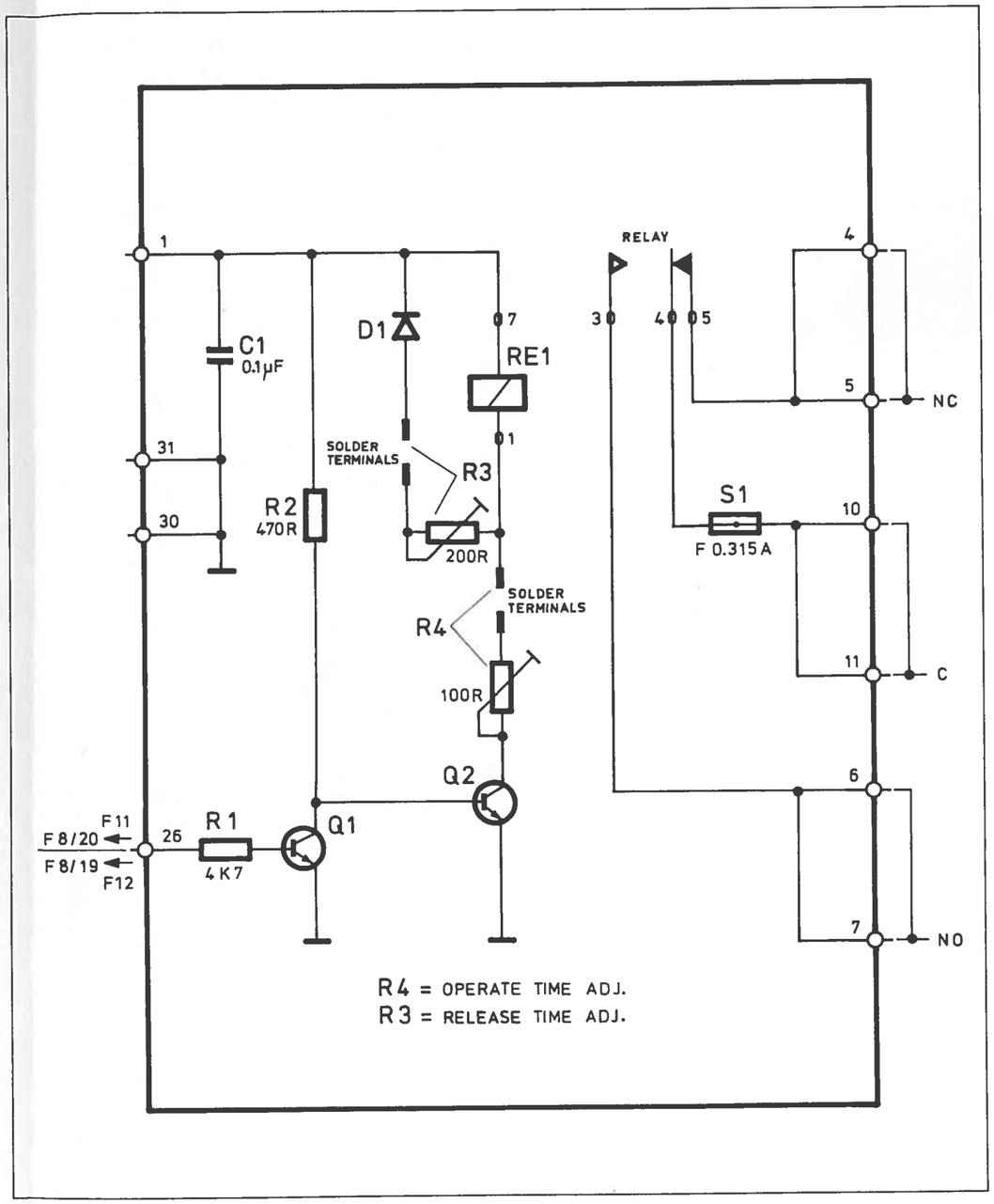
Remove the strap from between terminals 30 and 31. On both contact units connect terminals 14 and 15 and terminals 18 and 19 together.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
			Resistor Carbon Film CR25	
R1	1	o1-o45	4K7	Philips
R2	1	o1-o33	47oR	-
			Potentiometer	
R3	1	o1-189	2ooR 3oo9P	Bourns
R4	1	o1-188	looR 3oo9P	-
			Capacitor Polyester	
C1	1	o2-o53	o,1 µF	Philips
			Diode	
D1	1	o4-oo4	1N 4oo4	Texas
			Transistor	
Q1	1	o3-o5o	2N 4124	N.S.
Q2	1	o3-o51	2N 44o1	Metorola
			Relay	
G1	1	o6-o79	HGSL 51191 H oo	Clare
S1	1	o7-o26	Fuse Holder	Wickmann
			Fuse	
S1	1	o6-o8o	o,315A Flink 5x2o mm	Wickmann
	1	o6-oo5	31 pol connector	Siemens
	1	o7-o27	Miniature 7 Pin Socket	Radio Parts

DL3-10001: CONTACT UNIT F11/F12.
Electrical parts list.



DL3-10001: CONTACT UNIT F11/F12.
Electrical parts location.



DL3-10001: CONTACT UNIT F11/F12.
Circuit diagram.

3.3.10 DR2-10001: MULTIPLEXER F13

The MULTIPLEXER circuit transmits information from the front-panel LEVER SWITCHES and from the multiconnector on the Generator's rear panel to counter circuits F9, F10.

The MULTIPLEXER circuit board contains two functions. One of them transmits information to counter circuit F10 for measuring out pulse/pause times. The other transmits information to counter circuit F9 for counting numbers of repetitions.

The same scanning principle is used in the two circuits. Fig. 3.3 shows the principle employed for measuring out pulse/pause times.

The circuit consists of triple-input nand gates. In each of them, the input is connected to:

(1) the top row of LEVER SWITCHES,

(2) the bottom row of LEVER SWITCHES,

(3) the EXTERNAL PROGRAMMING rear-panel connector M1.

The gate outputs are connected to COUNTER circuit board F9/F10, DECIMAL TO BCD CONVERTER.

When a LEVER SWITCH (determined by the points shown in Fig. 3.3) is depressed, the output from SWITCH DRIVER F1/F2 is "0" whereas "1" is present at all other terminals. Via the connection in the LEVER SWITCH, "0" is applied to the input of the MULTIPLEXER gate for the digit in question.

Output from this gate is transmitted to the COUNTER circuit's DECIMAL TO BCD CONVERTER F9/F10 as "1". Since the other inputs are "0", this will cause the LEVER SWITCH setting to be transmitted to the COUNTER circuit.

If a LEVER SWITCH is set at the digit 0, all nine multiplexer outputs will be "0".

Scanning of the LEVER SWITCHes is determined by SWITCH DRIVER circuits F1/F2. The sequence is determined by their input data a, b, c (see PULSE/PAUSE CONTROL F7, section 3.3.6); and by K, $\bar{K}L$, $\bar{K}\bar{L}M$ and $\bar{K}\bar{L}\bar{M}N$ (see BASIC ELEMENT SELECTOR F5, section 3.3.4).

For EXTERNAL PROGRAMMING, all LEVER SWITCHes are set to digit 0 and a connection (the dots shown in Fig. 3.3) is instead made between the SWITCH DRIVER circuit and the MULTIPLEXER's EXTERNAL input terminals.

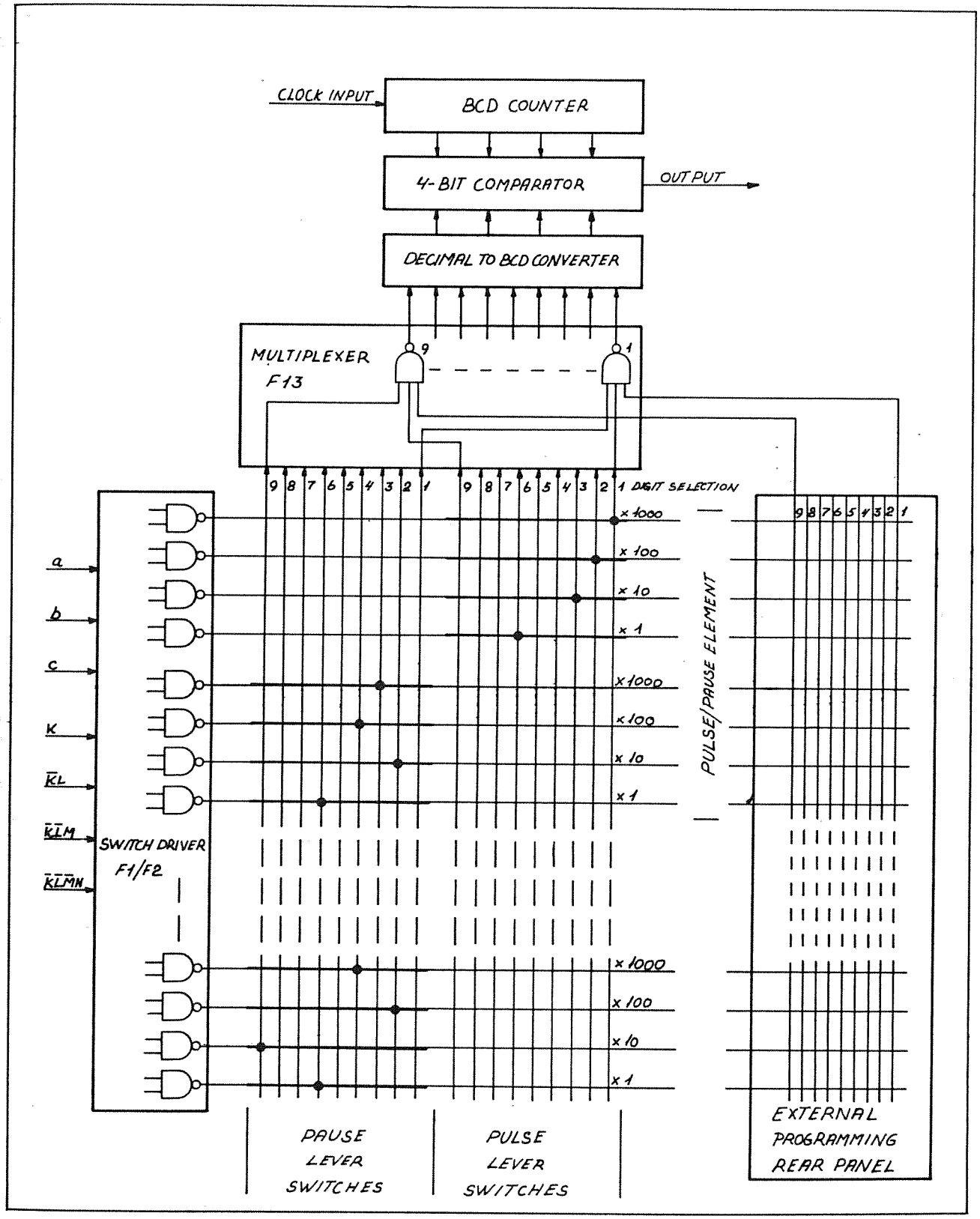
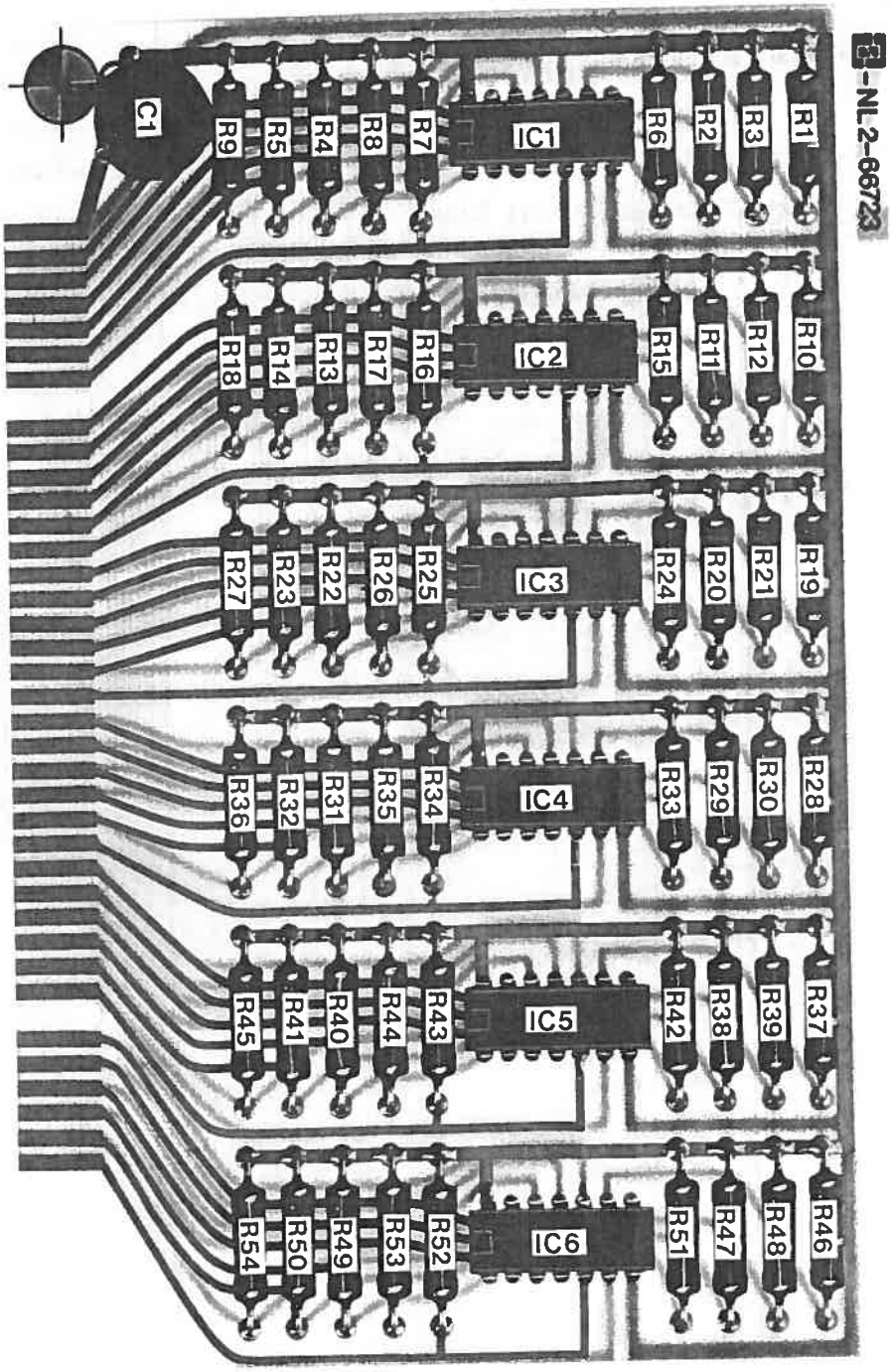


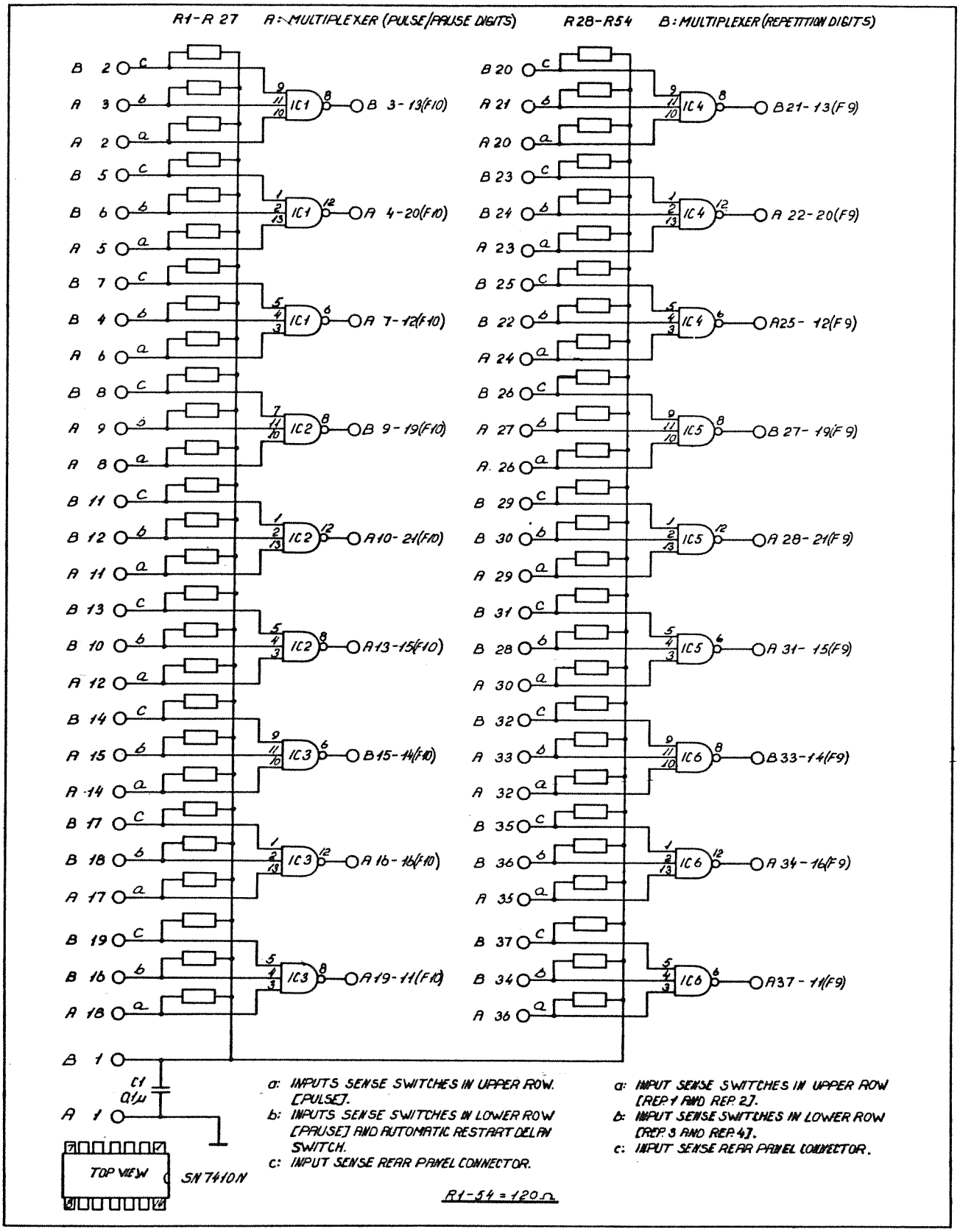
Fig. 3.3 DR2-10001: MULTIPLEXER F13.
Principle diagram.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1	1	MY2-51572	Keramisk 16 V 0,1 µF	Rosenthal
IC1-IC6	6	MY1-23414	SN 7410N	
R1-R54	54	MY2-31518	120 Ω 5 % 1/3W	Beyschlag
	1	NL2-66723	Printed Circuit Board	Elmi

DR2-10001: MULTIPLEXER F13.
Electrical parts list.



DR2-10001: MULTIPLEXER F13.
Electrical parts location.



DR2-10001: MULTIPLEXER F13.
Circuit diagram.

3.3.11 DF1-10003: RECTIFIER CIRCUIT and DF1-10004: POWER SUPPLY

RECTIFIER CIRCUIT

The circuit board is mounted on the mains transformer and consists of three bridge rectifiers and an input capacitor.

In the interest of clearness, the on/off switch, voltage changeover switch, mains transformer and the RECTIFIER and POWER SUPPLY circuits are shown with their associated interconnections.

The mains transformer has three secondaries which deliver 8 V, 9.5 V and 10 V RMS, respectively. Each of these voltages is fed to its separate bridge rectifier and associated input capacitor.

After rectification and filtering, the following nominal voltages result, as measured on the RECTIFIER CIRCUIT.

Terminals 1 - 10: 7.5 V
Terminals 3 - 4 : 11.3 V
Terminals 6 - 7 : 10.5 V

POWER SUPPLY

The instrument uses stabilized voltages of +5 V and +6.8 V.

The heart of the +5 V supply is integrated voltage regulator IC1. The circuit has an electronic protection circuit to protect against both overcurrent and overvoltage. Output current is approx. 1.8 A, making it necessary to provide booster transistor Q1 in integrated circuit IC1, whose maximum output capability is 250 mA. Q1 is powered from a separate supply in order to minimize power losses.

R7 and R4 secure bias current for Q1 and IC1. RF bypassing is provided by RC networks R1, C1 and R6, C3.

Voltage divider R2, R3 determines the control voltage for IC1 and hence the output voltage, 5 V.

Maximum output current is determined by resistor R4. Q2 becomes conductive when the voltage drop across R4 exceeds approx. 0.6 V, thus causing output current limiting.

The unit moreover has an overvoltage protection circuit consisting of SCR1 and Q3 and associated components.

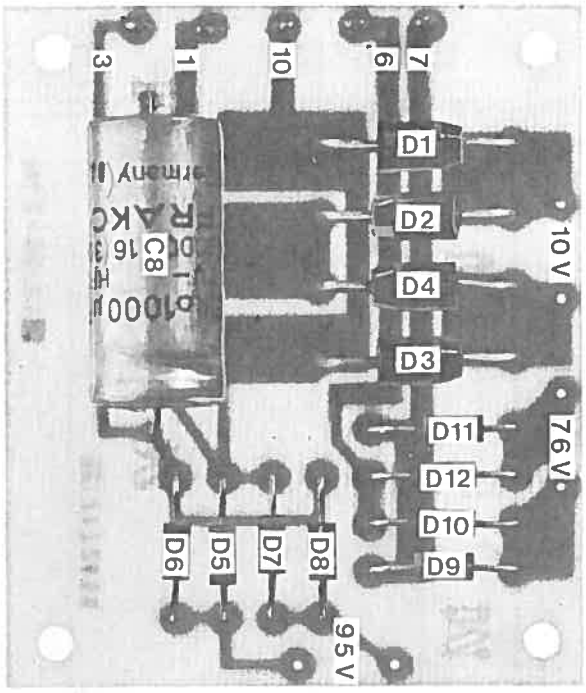
The protection circuit is activated if the collector-emitter junction of Q1 is short-circuited. This will cause SCR1 to be triggered via Q3, so that the regulator output terminals are short-circuited. Besides, fuse S2 will blow, thus making the regulator inoperative.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1	1	MY2-51524	3.000 µF/16 V -10/+50%	Frako
D1-4	4	MY1-51525	IN 5400	Westinghouse
D5-12	8	MY1-23797	IN 4002	Motorola
	1	NL-66721	Printed Circuit Board	Elmi

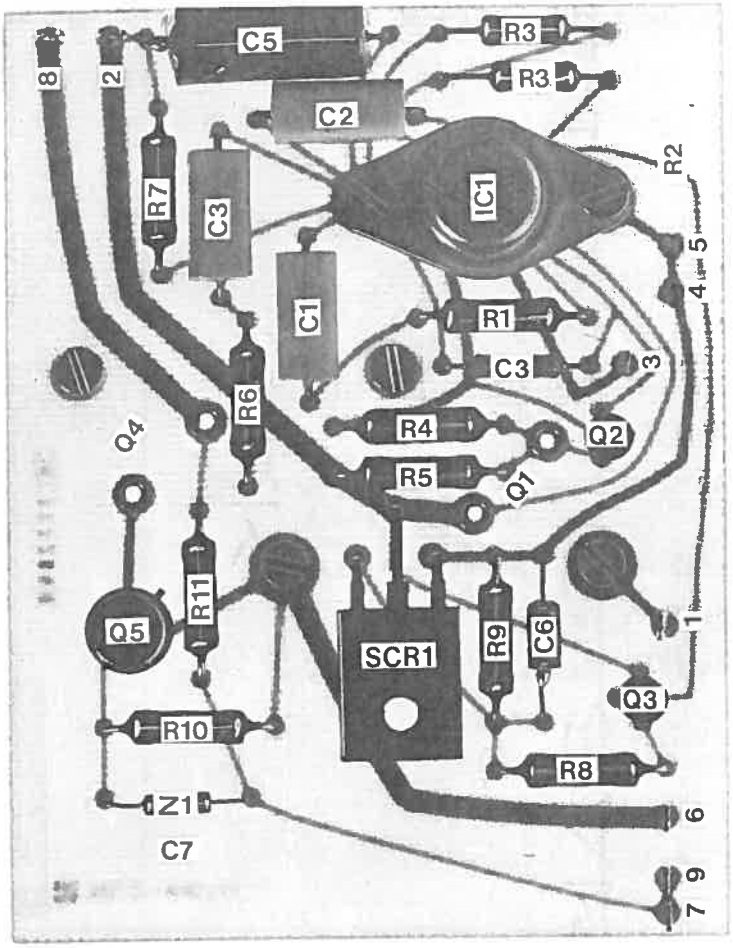
DF1-10003: RECTIFIER CIRCUIT.
Electrical parts list.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
C1-2 +4	3	MY2-23667	0,1 µF 10 % 250 V DC	Philips
C3	1	MY2-51571	4,7nF 5 % 63 V	Siemens
C5	1	MY2-23759	220 µF 20 % 10 V DC	Philips
C6	1	MY2-23969	2,2 µF - 20 V DC	-
C 7	1		1 uF - 35 V DC	-
SCR1	1	MY1-51189	MCR 406-1	Motorola
IC1	1	MY1-51117	MC. 1469R	-
Q1+Q4	2	MY1-51523	2N 3055	-
Q2	1	MY1-23466	2N 4124	-
Q3	1	MY1-23467	2N 4126	N.S.
Q5	1	MY1-23768	2N 1711	
R1+6	2	MY2-31505	10 Ω 5 % 1/3 W	Beyschlag
R5	1	MY2-31518	120 Ω - -	-
R7	1	MY2-31521	220 Ω - -	-
R8	1	MY2-31528	820 Ω - -	-
R9	1	MY2-31525	470 Ω - -	-
R10	1	MY2-31522	270 Ω - -	-
R11	1	MY2-31519	150 Ω	
R2	1	MY2-26271	3,0 kΩ 1 % 1/4 W	Vitrohm
R3	1	MY2-51565	5,8 kΩ - -	-
R4	1	MY2-26235	2,0 Ω 1 % 1 W	-
Z1	1	MY1-23587	ZP 8.2 5 % 1/4 W	ITT
	1	MY4-51510	Heatsink WA 111-1	Schaffner
	1	NL2-66711	Printed Circuit Board	Elmi

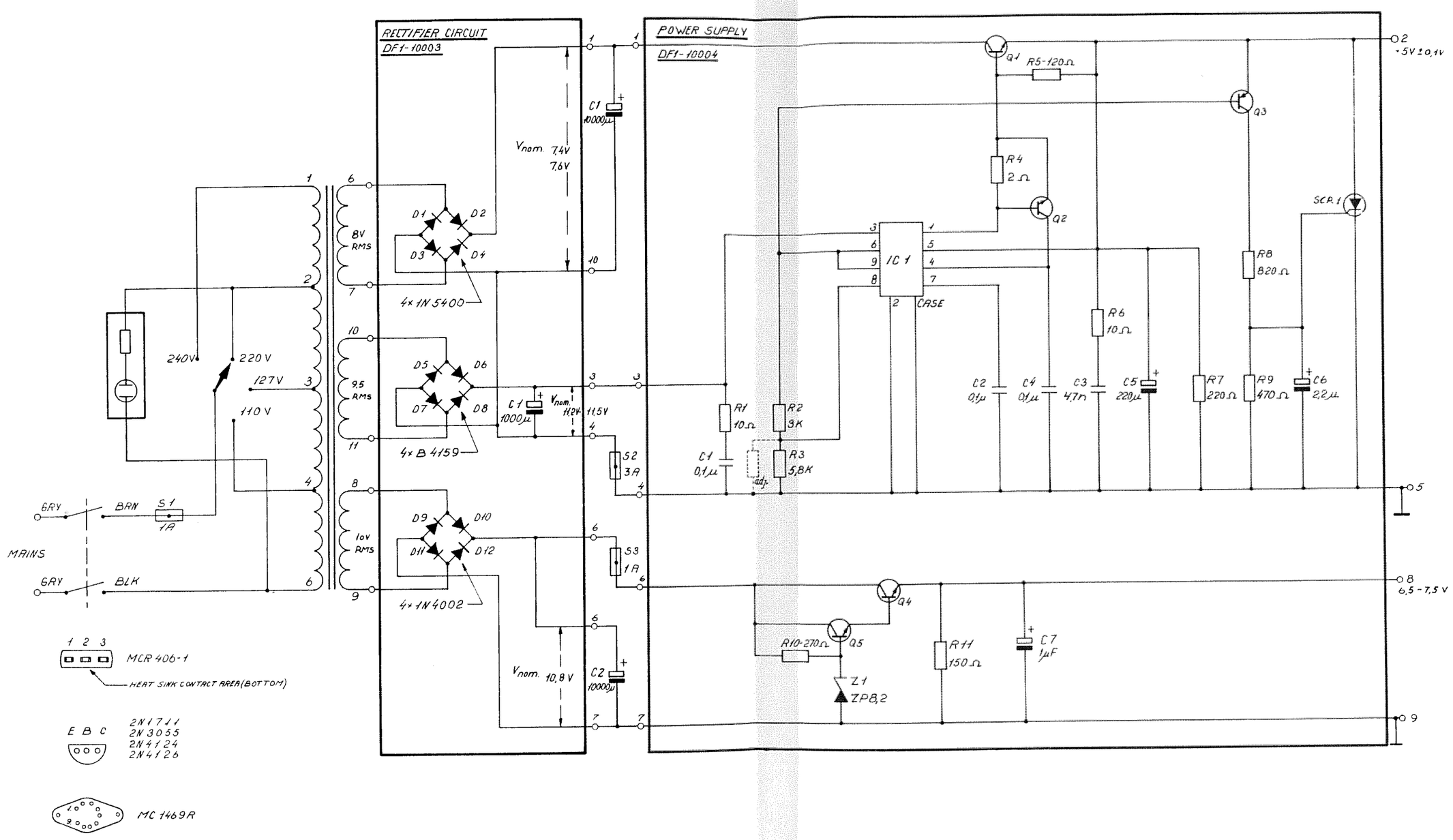
DF1-10004: POWER SUPPLY.
Electrical parts list.



DF1-10003: RECTIFIER CIRCUIT.
Electrical parts location.



DF1-10004: POWER SUPPLY.
Electrical parts location.



DF1-10003: RECTIFIER CIRCUIT and
DF1-10004: POWER SUPPLY.
Circuit diagram.

3.3.12 WIRING DIAGRAM PG 1 and PG 2

The complete wiring diagram breaks down into two separate diagrams.

PG 1/2 shows the cabling to the front-panel components. Individual component numbers and their functions are included in the interest of clearness. All lead destinations carry the designations of the cable bundles. A, B, C, D and E refer to the cable bundles going to the chassis section of the instrument.

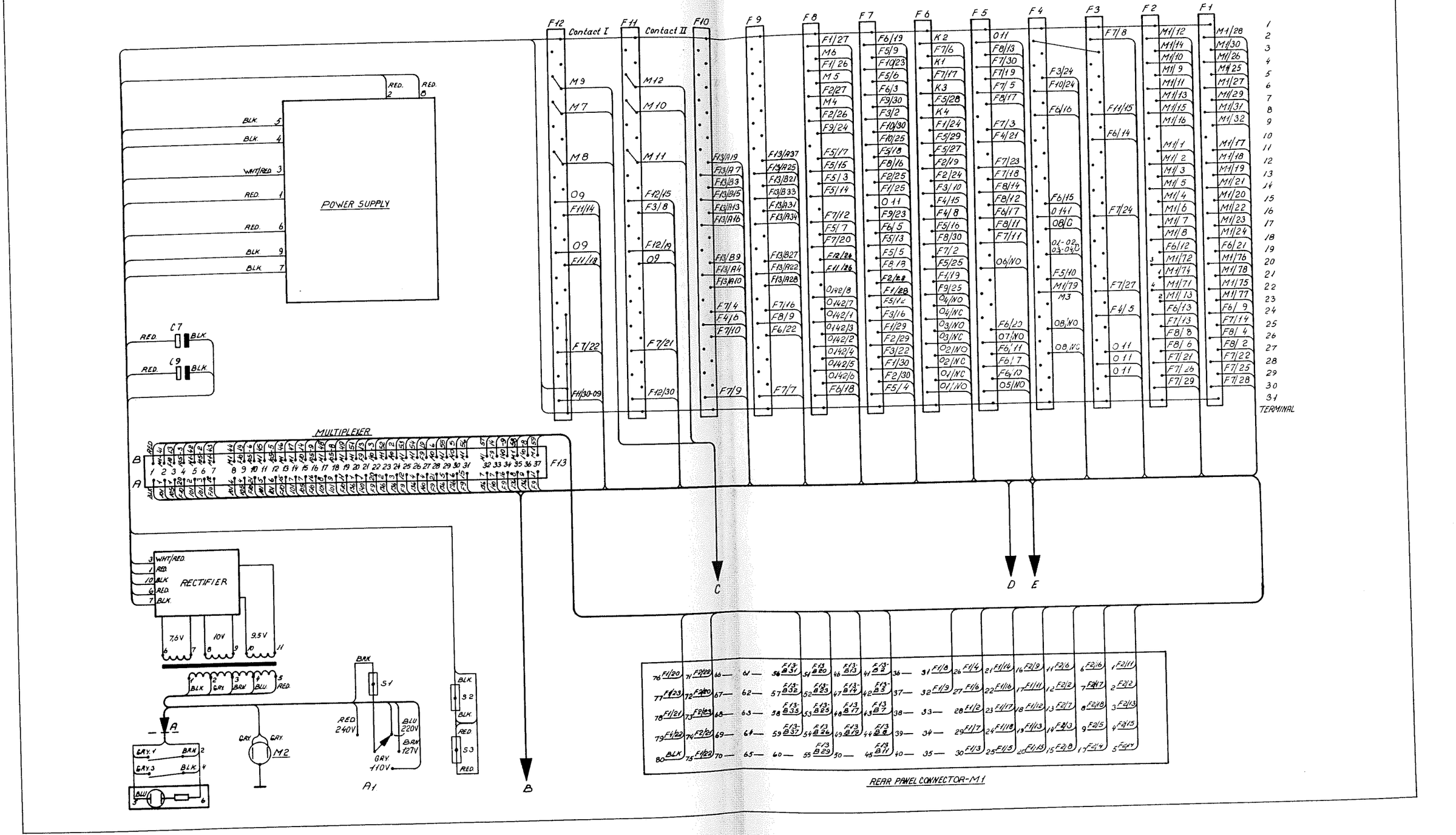
Wiring diagram PG 2/2 shows all wiring connections in the chassis section of the instrument. Here, too, all terminal destinations are listed.

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
F1-2	2	DR4-20003	Switch Driver	ELMI
F3	1	DN7-20001	Time Base Unit	-
F4	1	DN3-10001	Clock Oscillator	-
F5	1	DR4-20004	Basic Element Selector	-
F6	1	DR4-20002	Pulse Train Selector	-
F7	1	DR4-20001	Pulse/Pause Control	-
F8	1	DH1-20001	Trigger Pulse Generator	-
F9-10	2	DH2-20001	Counter	-
F11-12	2	DL3-10001	Contact Unit	-
F13	1	DR2-10001	Multiplexer	-
F14	1	DF1-10004	Power Supply	-
F15	1	DF1-10003	Rectifier	-

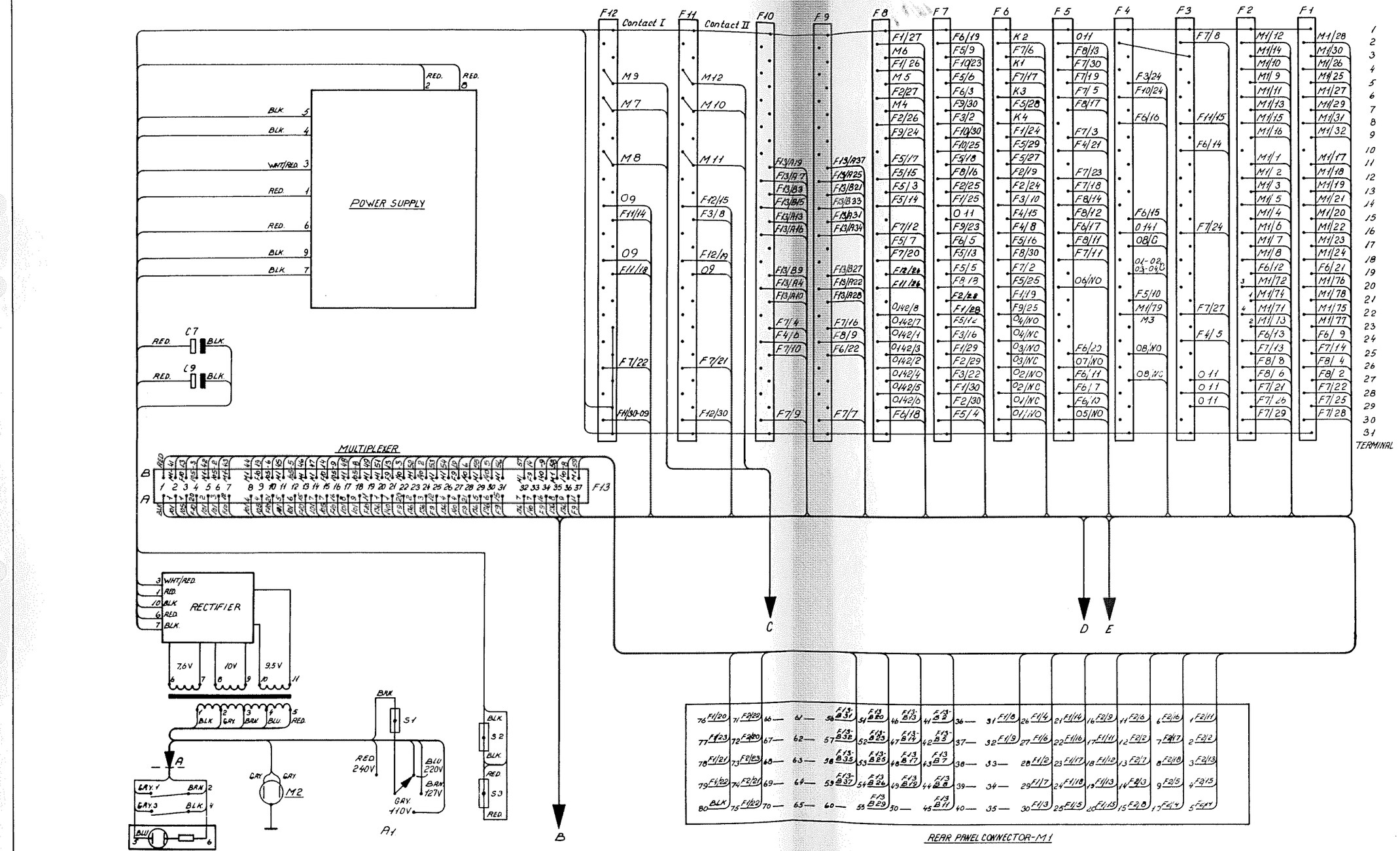
Wiring diagram.
Electrical parts list (1).

Cir. Ref.	Qty	Stock No.	Description	Manufacturer (Subject to change)
0101-0142	42	MY1-51534	Selector 10 pos. L10-01A	Cherry
	13	MY1-51535	End. cap. 009-0498	-
	13	MY1-51336	- - 009-0499	-
	16	MY4-51537	Mounting set 012-0150	-
	10	MY4-51538	- - 012-0148	-
R1-14	14	MY2-31509	22Ω 5 % 1/3 W	Beyschlag
	1	MY7-51559	Power Selector SWP 110-127-220-240 V	Schurter
	2	MY2-51568	Fuseholder 031-1001	Jørgensen&Co
	2	MY2-51569	Cap for 031-1001	-
S1	1	MY2-51020	Fuse 1A flink	Wickmann
S2	1	MY2-51570	- 3,15 A	-
S3	1	MY2-51022	- 1A træg	-
T1	1	MY1-51511	Transfer JS31,5 NO. 13733/2	J. Schou
W1	1	TK3-1500/90	Powercord	Elmi
A1	1	MY7-51526	Power Switch 23146 - 14241	D.A.V.
B1-4	4	MY7-51560	BNC Socket	Suhner
B5+7+8+10	4	MY7-23521/90	Socket PKI 10 black	Hirschmann
B6+9	2	- - /30	- - - red	-
C1+2	2	MY2-51505	10000 µF 16 V	Philips
J1	1	MY7-51518	Knob for 6 mm axle 021-441	Elma.
		MY7-51519	Pointer for 6 mm axle 041-402	-
		MY7-23442	Cap for do.	-
M1	1	X450999/106	80-way multi socket	LME
M2	1	MY7-23831	Power Connector StF 23	Kault+BUX
M3+14	12	MY7-23526	Connector frame 31 way	Siemens
01-09	9	MY1-51562	Pushbutton switch	LME
	18	MY2-6715/1	Lamps 6 V 40 mA T5,5	-
011	1	MY1-51561	Rotary Switch 03-2x5u	Elma

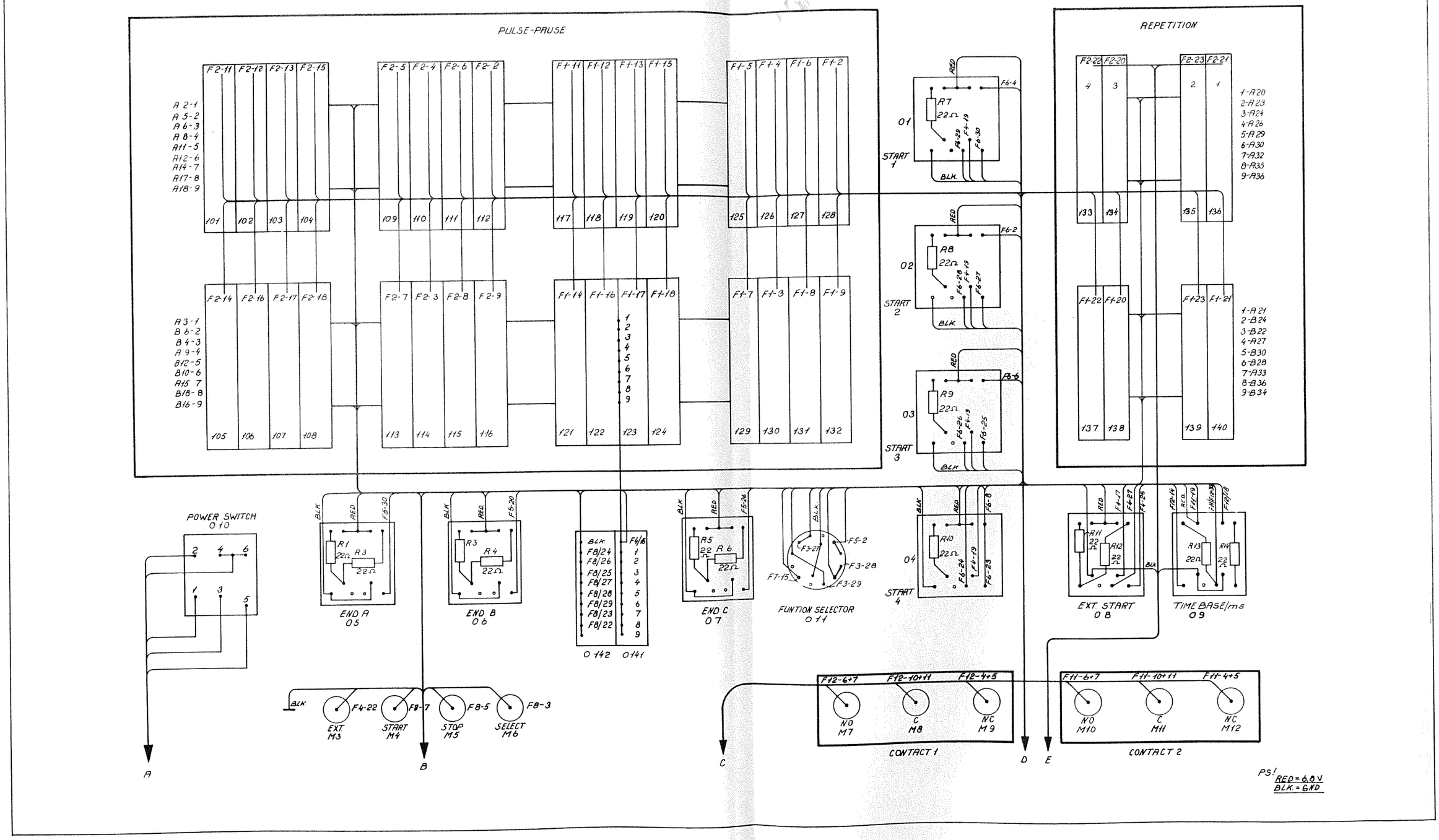
Wiring diagram.
Electrical parts list (2).



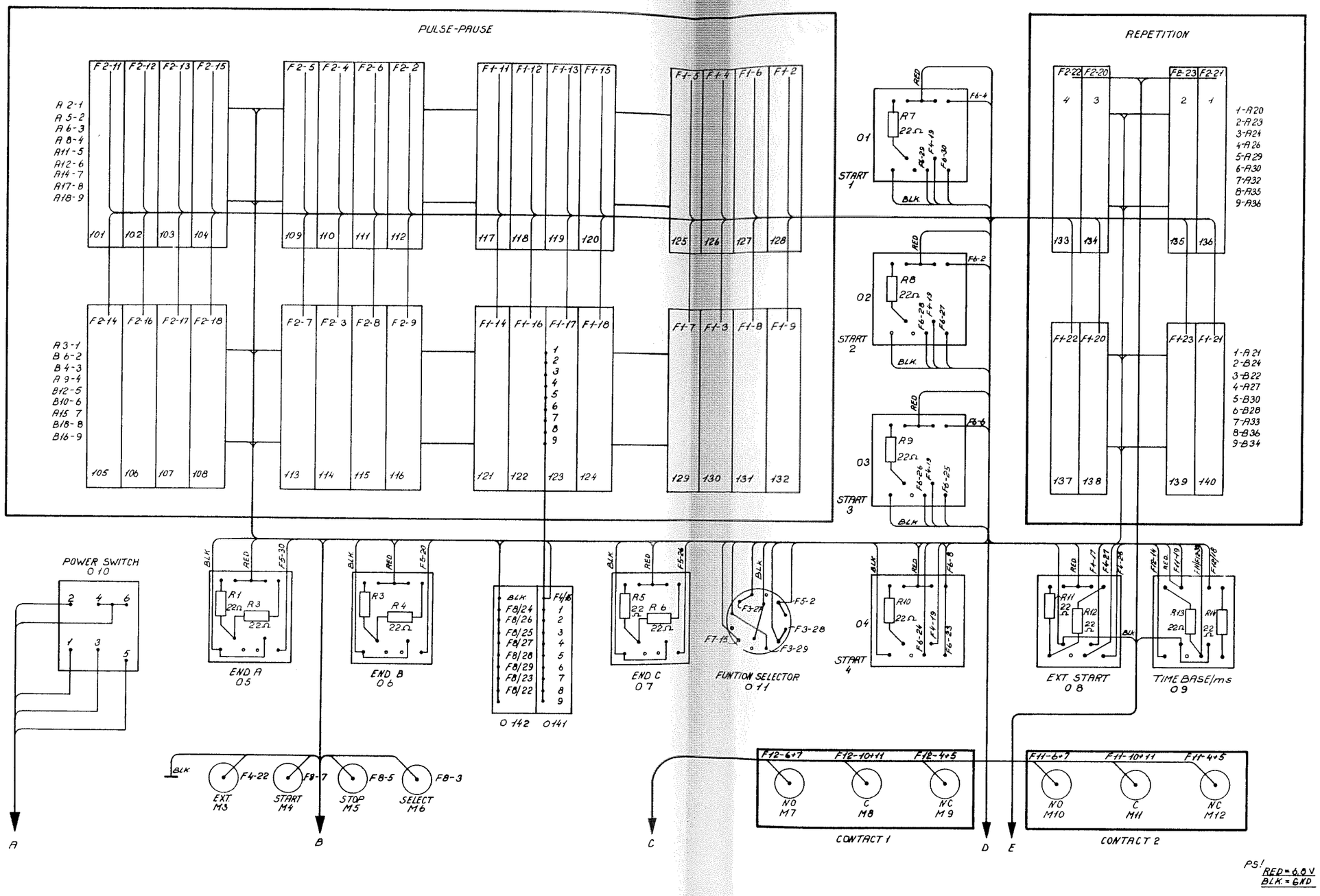
Wiring diagram PG 2/2.



Wiring diagram PG 2/2.



Wiring diagram PG 1/2.



Wiring diagram PG 1/2.

4. SERVICE AND MAINTENANCE

4.1 Introduction

The ZYHK-40101 PULSE TRAIN GENERATOR is an instrument of such design, that only skilled personnel should make any necessary repair.

In case of difficulties that cannot be overcome by the use of these service instructions, please write or phone to your ELMI-agent, giving full information about the trouble and steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

4.2 Mechanical Details

The test equipment can be removed from the cabinet by removing the power connecting cable and the four fixing screws along the edges of the front panel. Before removing the equipment from the cabinet switch off the mains voltage.

When servicing requires access to the switches or other components placed at the rear of the front panel, the latter can be removed from the chassis by unscrewing the four screws which secure the chassis to the connecting pieces between the chassis and the front panel.

4.3 Replacement of Indicator Lamps

The lamps can be replaced from the front-panel, by pulling off the push-button cover. Now the lamp can be removed by means of lamp pincers.

5. REPLACEABLE PARTS

5.1 Introduction

This section contains information for ordering replacement parts.

Component lists with numbers corresponding to type and serial number refer to parts in alphanumerical order of their reference designations. These component lists give the following information:

a) Component circuit designation in the diagram.

b) Component description.

c) Component manufacturer.

Specify the following information for each part:

a) Type and serial number of instrument.

b) Circuit reference.

c) Description.

To order a part not listed, give a complete description of the part and include its function and location.

5.2 Component Designation

A. Power Switches
C. Capacitors
D. Diodes
IC. Integrated Circuit
K. Indicator Lamps
L. Inductors
M. Sockets and Plugs
O. Selectors and Switches
P. Printed Circuit Boards
Q. Transistors
R. Resistors and Potentiometers
S. Fuses
T. Transformers
X. Crystals
Z. Zener Diodes
RE. Relays

5.3 How to Order Parts

To order replacement parts, address order or inquiry either to your authorized representative or to:

ELMI A/S
90, Kirkebjerg Alle
DK-2600 GLOSTRUP
Denmark

Phone: National: 02-45 42 11
International + 45 2 45 42 11

Telex: 33 423 ELMI DK

Cables: ELMIWORKS