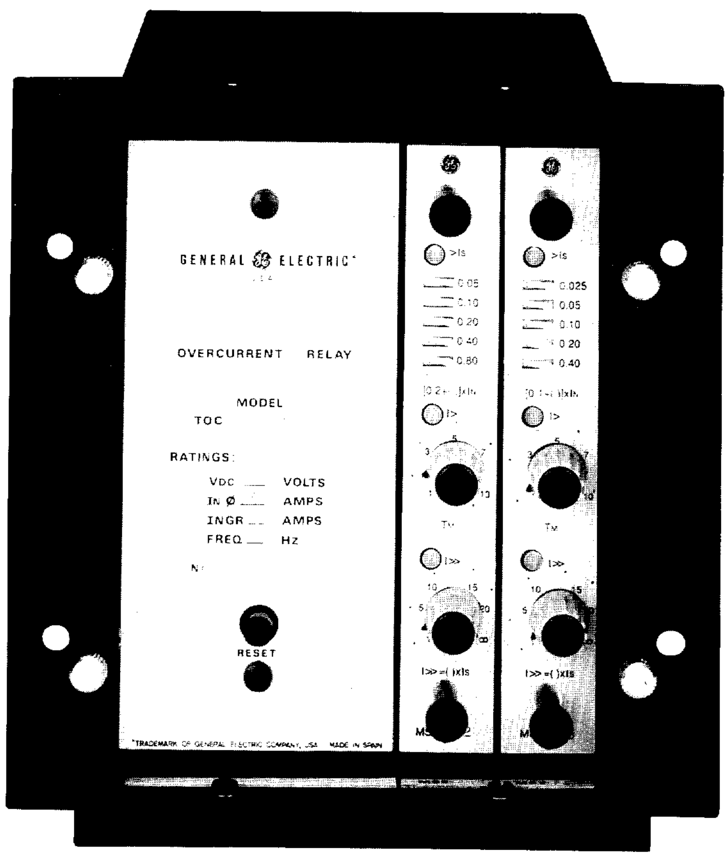
INSTRUCTIONS

GEK - 90551A

MODULAR OVERCURRENT RELAYS

TOC SERIES 1000S



GENERAL ELECTRIC

U. S. A.

INDEX

DESCRIPTION

The TOC series 1000S relays covered by these instructions are overcurrent non-directional relays with inverse time overcurrent units and instantaneous units (separate units or one common unit for all phases depending on the model) used to detect interphase and ground faults.

The TOC series 1000S relays are available with the inverse BS142, inverse ANSI, very inverse or extremely inverse time-current characteristic.

The relays are solid-state modular relays and are supplied in cases of 1/3, 1/2 and 1-19" rack containing one or several functions forming in this case complete protection systems.

MODEL LIST

Protection Functions		BASIC MODELS	
Phase	Ground	With independent measuring units for each phase	With common measuring unit for all phase
3x51	1x51N	TOC1000A	TOC8000A
3x50/51	1x50/51N	TOC1000B	TOC8000B
3x51	---	TOC4000A	TOC7000A
3x50/51	---	TOC4000B	TOC7000B
---	1x51N	TOC5000A	TOC5000A
2x51	1x51N	TOC6000A	TOC9000A
2x50/51	1x50/51N	TOC6000B	TOC9000B

These instructions do not purport to cover all details and variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the GENERAL ELECTRIC (USA) PROTECTION AND CONTROL EQUIPMENT, S.A.

Models TOC 1000 A are three-phase relays, with three independent inverse time overcurrent measuring units for the phases and one additional unit for detection of ground faults. Models TOC1000B include moreover three independent instantaneous units.

Models TOC 8000 A are three-phase relays, with one inverse time overcurrent measuring unit common for all three phase, and one additional unit for ground faults. Models TOC 8000 B include moreover two instantaneous units, one common for all three phases and the other for ground faults.

Models TOC4000A are three phase relays with three independent, inverse time overcurrent measuring units. Models TOC4000B include, moreover, three instantaneous units.

Models TOC7000A are three phase relays with one inverse time overcurrent measuring unit, common for all three phases. Models TOC7000B include moreover one instantaneous unit common for all three phases.

Models TOC5000A are single-phase relays, with one inverse time overcurrent measuring unit. Models TOC5000B include moreover one instantaneous unit.

Models TOC6000A are two phase and ground relays with three independent inverse time overcurrent measuring units, two for the phases and the other for ground. Models TOC6000B include, moreover, three independent instantaneous units, two for the phases and one for ground.

The type TOC9000A are two-phase and ground relays with two inverse time overcurrent measuring units, one common for both phase and the other for ground. Models TOC9000B include, moreover, two instantaneous units, one common for both phases and the other for ground.

CURRENT RANGES

Rated current (In)	Range of inverse time current (Is)	Instantaneous unit unit
5 A	1,5-13,125A	1 to 20 times Is
	0,5-4,375A	
1 A	0,3-2,625A	
	0,1-0,875A	

The operating value of the instantaneous units can be adjusted between 1 and 20 times the value selected for the inverse time unit.

In those models provided with instantaneous units, the operation of these units can be inhibited by placing its adjusting potentiometer in the position marked infinite.

The standard models are provided with an output relay common for all measuring units, with three normally open tripping contacts.

Optionally, these relays can be supplied with signalling contacts provided by two or four auxiliary relays (funtions 51, 51N, 50, 50N, depending on the model). In these cases, the number of available tripping contacts is two.

APPLICATION

The type TOC relays find a very wide application in all cases of alternating current circuits for example: feeder lines, machines, transformers and so on, where in addition to provide an efficient protection against overloads they perform also a fast detection of short - circuit faults. The model selection for a given application must be made in such a way that a correct selectivity is obtained so that only the part of the system where the fault has actually occurred be isolated. The type TOC relays offer the possibility of choosing within 4 families of operating curves.

The inverse time-current characteristic is used generally in applications where the level of fault current depends on the generation capacity of the system in the moment of fault occurrence. Figures 1 and 2 represent relays TOC with inverse time current characteristics according to B.S.142 and ANSI standards respectively.

The very inverse time-current characteristic is used generally in those applications where the amount of fault current depends substantially upon the system impedance between the generator point and the location of the relay, and very little or nothing at all, of the characteristics of the generating system. Figure 3 represents the relay type TOC with very inverse time current characteristic.

The extremely inverse time-current characteristic is used mainly in applications where a large value of current is brought about in the moment of connection, after the circuit has remained out of service for a long period. Feeder and distribution lines fall into these cases, taking into account that such extremely inverse time-current characteristics matches closely the curves of the power fuses. Figure 4 represents, relay model TOC with extremely inverse characteristic.

The operation times for models with independent measuring units, TOC1000/4000/5000/6000, are given in figures 1 to 4 for any type of fault.

The operation times for models with a common measuring unit for two or three phases, TOC8000/7000/9000, are indicated in figures 1 to 4 for single phase faults, whereas for two and three phase faults, the operation times are between 5% and 10% lower. Figures 5, 6, 7 and 8 represent typical external connection diagrams of the four basic families: TOC1000/8000, TOC4000/7000, TOC5000 and TOC6000/9000.

The pick-up of the TOC time unit should be chosen so that it will operate for all short-circuits that occur in the protected zone, and also provide back-up protection for short circuits in the inmediately adjacent zone. The time unit pick-up should be set low enough to ensure that the minimum fault current is at least 1.5 times the pick-up level.

The selected operating curve of the time unit must assure selectivity with the protection of the adjacent zones. The adjustment should be made for the condition which yields maximum fault current. The time margin to ensure selectivity between two adjacent sections is determined by the three following factors: the tripping time of the breaker in the section nearest to the fault, the type TOC relays have a negligible overtravel, the time margin between two adjacent sections reduces in practice to 0.2 sec.

Models TOC1000/8000B, TOC4000/7000B, TOC5000B, TOC6000/9000B include instantaneous overcurrent units that reduce substantially the clearing time of the fault current. These units are set to pick up on fault current only in the protected zone. Significant transient overreach can be experienced under certain conditions, and this must be taken into account by selecting a pick-up setting that is higher than that which would be dictated by the maximun fault current external to the protected zone.

The transient overreach characteristic for the instantaneous units of type TOC relays is shown in figure 9.

The operation of the instantaneous units if the TOC relays can be inhibited by setting the trimmer potentiometer in the position marked infinite. This possibility allows for a reduction in the models used as spare parts.

TECHNICAL SPECIFICATIONS

A. CURRENT CIRCUITS

Pick-up current

Inverse time unit: 1,1 times the selected tap value.
Instantaneous unit: 1 time the selected tap value

Reset

Current the same or higher than 90% of tap value.
Time: shorter than 50 msec.

Operating time

Inverse time unit: Four types of curves (see figures 1, 2, 3, 4)
Instantaneous unit: see figure 10.

Overtravel

Inverse time unit: shorter than 30 msec.
Instantaneous unit: shorter than 10 msec,

Thermal capacity

Continously: 2 In.
For 3 seconds: 50 In.
For 1 second: 100 In.

Burdens (in current circuits)

Range Amps.	Freq Hz.	Minim tap (A)	Burdens in Ohms for multiples of minimum operating current (pick-up)					
			At minimu Pick-up			3 times	10 times	20 times
			R	jK	Z	Z	Z	Z
1,5-13,125	50	1,5	0.04	0,01	0,04	0,04	0,04	0,04
0,5-4,375	50	0,5	0,05	0,025	0,055	0,055	0,055	0,055
0,3-2,625	50	0,3	0,3	0,1	0,33	0,33	0,33	0,33
0,1-0,875	50	0,1	0,35	0,2	0,4	0,4	0,4	0,4

B. D.C. POWER SUPPLY

Rated voltage V.dc.	Operating range V.dc.
48	38-58
110	88-132
125	100-150
220	176-264
250	200-300

MODEL	Consumption in mA		
	Normal	Tripped	tripped with auxiliary signaling relays
TOC1000A	200	245	265
TOC4000A/6000A	150	195	205/215
TOC5000A/7000A	50	95	105
TOC8000A/9000A	100	145	165
TOC1000B	200	245	285
TOC4000B/6000B	150	195	215/225
TOC5000B/7000B	50	95	115
TOC8000B/9000B	100	145	165

C. OUTPUT CONTACTS

Make and carry: 3000 W, resistive, for 0,2 sec. with a maximum of 30A and 300 V.dc.

Break: 50W, resistive, with a maximum of 2A and 300 V. Vdc.

Make and carry continuosly: 5A. with a maximum of 300 V.d.c.

D. ACCURACY

Operating value : +/- 5%

Operating time : +/- 5% or 0,025 seconds, whichever is greater.

Error class index E according to British Standard 142 assigned to operating values (currents) and operating times: class E-5.

E. FREQUENCY RANGES

Rated frequency : 50 or 60 Hz
Effective range : 47-51 Hz or 57-61 Hz
Operative range : 45-62 Hz.

F. TEMPERATURE RANGES

Effective range : -5 C to + 40 C.
Operative range : -20 C to + 55 C.
Storage range : -40 C to + 60 C.

G. AMBIENT HUMIDITY

Up to 95% provided that no condensation occurs.

H. INSULATION

Between any terminal and the chassis: 2000 V.a.c. for 1 minute at industrial frequency.

Between independent circuits: 2000 V.a.c. for 1 minute at industrial frequency.

Between each terminal of one open contact: 1000 V.a.c. for 1 minute at industrial frequency.

I. TYPE TESTS

Impulse test

Impulse voltage wave having a rise time of 1,2 usec. + 30% and a fall time of 50 usec. + 20%
Test per IEC Standards 255-4
Test voltage 5 KV (peak)

High frequency disturbance test

Damped oscillatory wave with envelope decaying to 50% of its peak value after 3 to 6 cycles.
Frequency 1 MHz + 10%
Repetition frequency : 400 times per second
Test per IEC standards: 255-4
Longitudinal mode peak voltage : 2,5 KV
Transverse mode peak voltage: 1 KV.

OPERATING PRINCIPLES

A. INPUT

Figure 11a and 11b show the block diagram of one measuring unit of models with one measuring unit for all phases and models with independent measuring units.

The current transformers of the protected circuit provide a secondary current which is applied to the input of the relay and then reduced by means of internal current transformers.

The secondary circuits of the internal current transformers of the relay are connected to one or several full-wave rectifiers depending upon relay model.

The output of the rectifier (rectifiers) feeds a setting stage by means of a potentiometer, this setting determines the pickup current of the relay. The voltage Vin generated in this potentiometer, represents the input current of the relay.

B. INVERSE TIME UNIT

The input signal Vin is controlled by the pickup current level detector circuit, which determines the primary current level at which the relay must give the delayed tripping order to the circuit breaker.

The funtion generator converts the Vin voltage into another Vf voltage, suitable to provide the operating characteristics of the relay, (inverse, very inverse or extremely inverse).

The linear ramp generator is a simple integrating circuit that integrates the Vf signal produced by the function generator. The time constants which provide the relay operating curves are obtained by means of the adjusting (trimmer) potentiometer. The operation of the linear ramp generator is controlled by the output of the pick-up current level detector in such a way that if the output voltage of the rectifier is lower than the pick-up level, no output ramp is generated.

The output of the ramp generator is applied to a level detector which has an adjustable thresold to calibrate the operation time.

Once this thresold is reached an output is generated; this output energizes the tripping relay and lights up the indicating LED located in the front plate.

C. INSTANTANEOUS UNIT

The instantaneous unit uses the same input signal as the inverse time unit. The operation of this unit gets under way when the input signal, rectified and filtered, gets over the selected threshold operating value. The performance thus obtained has a low transient overreach characteristic with short operating time. Figure 10 shows the operating time for the instantaneous unit (the times indicated in this figure do not include the operating time of the output relay, 8 msec., approximately).

Figure 11 shows the block diagram of the instantaneous unit. The voltage Vin is compared with a voltage reference Vr, which is adjustable between 1 and 20 times the operating level selected fir the inverse time unit. When the input to the comparator, Vin, is higher than the reference Vr, an output is produced which applies to a delay circuit to make sure that the signal remains long enough to operate the output circuitry.

CONSTRUCTION

CASE

The case of type TOC series 1000, relays is manufactured with steel plate. The general outline is shown in figures 29, 30, and 31.

The front cover id made up of plastic material and fits over the relay case making pressure over a rubber joint located around the enclosure, this produces a tight-proof sealing avoiding the provided in the rear part with socktes that serve as mechanical support and as electric connection elements, holding the modules tightly in their right position. Each module is provided whith two plastic guides, one upwards, and another downwards, that provide a perfect alignment.

ELECTRIC WIRING AND INTERNAL CONNECTIONS

The wiring of the external circuits is achieved by means of the three terminal blocks assembled on the rear side of the case. Each terminal block is provided with 7 terminals made up of a screw with 4 mm, diameter and threaded in a contact board. The connections of the printed circuit boards are made by means of 32 point connectors. The female connectors for the printed circuit boards are assembled on rear plates located to approximately 4 cm. from the case rear plate. The socket for normal connections and test connections (optional) is assembled on the relay front.

All the current inputs are connected on a terminal block, located in the rear side. This block has enough capacity to support the seconday currents of the current transformers. The internal input current carrying wires are of larger cross-section than the rest of the internal wiring. They have been designed to have as low a lenght as possible, to minimize the resistive load of the current transformers.

The connections are made with crimped terminals. The input current wires are grouped into braids, separated from the other groups, in order to minimize the coupling effect of magnetic fields, associated with input current, over the internal wires transmitting low level signals.

IDENTIFICATION

The complete relay model is indicated in the nameplate of the input transformer module.

In the up and down side of the case front there are two stripes stuch on it with the identification of the position which each module must occupy into the case. The terminal blocks are identified by means of a letter located in the rear plate, just over the left border of each block (looking at the relay from the backside). There are three terminal blocks in each case and each one has its own code (front A to C) to avoid mistakes when making the connection of the external wires.

In eah terminal block, the external studs (1 to 7) are identified on the upper part by engraved numbers.

PRINTED CIRCUIT BOARDS

Each modules consists of a printed circuit board with a front plate mounted on it through two supports. Over this plate, there are two elements which fit into two nuts on the box and that serve the purpose of pulling the module out of the rack, or conversely, pushing it into it. The electrical connections are made through a male connector which fits into a female connector located on the case. Each module has its corresponding module identification consisting of a three letter code followed by a three digit number, located in the down side of each front plate.

LOCATION OF CONTROLS AND TARGETS

Figure 12 represents the front plate of a printed circuit board including both, the inverse time and the instantaneous unit with all the controls and indicating signals identified by means of the followig numbers.

Model TOC 1000

Includes four printed circuit boards (3 for the phases and 1 for ground).

1 LED (light emitting diode) indicating the pick-up current of the inverse time unit.

2 Adjustment switches it select the current tap of the inverse time unit.

3 LED diode for indication of inverse time unit tripping.

4 Potentiometer for selecting the operation curve of the inverse time unit.

5 LED diode for indication of instantaneous unit tripping.

6 Adjustment potentiometer to select the current tap of the instantaneous unit.

Model TOC1000A

Includes four printed circuit boards (3 for phase and one for ground). Each pcb includes only following elements: 1, 2, 3 and 4.

Model TOC8000B

Includes two printed circuit boards (one common for all three phases and one for ground). Each pcb includes all elements 1 to 6. The elements of the pcb of the phases are common for all three phases.

Model TOC8000A

Includes two printed circuit boards (one common for all three phases and one for ground). Each pcb includes only elements 1 to 4. The elements of the pcb of the phases are common for all three phases.

Model TOC4000B

Includes three printed circuit boards, one for each phase. Each pcb includes all elements 1 to 6.

Model TOC4000A

Includes three printed circuits boards, one for each phase. Each pcb includes only elements 1 to 4.

Model TOC7000B

Includes one printed circuit board common for all three phases with all the elements 1 to 6.

Model TOC7000A

Includes one printed circuit boards common for all three phases with elements 1 to 4.

Model TOC5000B

Includes one printed circuit board with all elements 1 to 6.

Model TOC5000A

Includes one printed circuit board with elements 1 to 4.

Model TOC6000B

Includes three printed circuit boards (2 for the phases and one for ground). Each pcb includes all elements for 1 to 6.

Model TOC6000A

Includes three printed circuit boards (two for the phases and one for the ground). Each pcb includes only elements 1 to 4.

Model TOC9000B

Includes two printed circuit boards (one common for the two phases and the other for ground). Each pcb includes all elements 1 to 6. The elements of the pcb of the phases are common for the two phases.

Model TOC9000A

Includes two printed circuit boards (one common for the two phases and the other for ground). Each pcb includes only the elements 1 to 4. The elements of the pcb of the phases are common for the two phases.

NOTE. FIGS. 13 TO 19 SHOW ARRANGEMENT OF PCB FOR EACH MODEL AS WELL AS THE STANDARD CASE SIZES.

INTERNAL CONTROL AND TEST POINTS

Figure 20 shows their location in the relay. This arrangement is the same for the phase printed circuit boards as well as for the ground pcb's.

The relays are calibrated at the factory so that no subsequent adjustment is required by the customer. However, if for any reason it would become necessary to calibrate the relay, the identification of the internal controls for adjustment is given below:

P2 Pick-up current adjustment trimmer of the inverse time unit (or units) and of the instantaneous unit (or units).

P1 Operating time adjustment trimmer of the inverse time unit (or units).

RECEIVING, HANDLING AND STORAGE

The relays are supplied to the customer in a special packing unit that properly protects it during transportation, provided it is done under normal conditions.

Immediately after receiving the relay, the customer should check if there is any evidence of the relay having suffered damage during transportation, because of rough handling. If there is any sign in this sense, the transport company must be notified immediately in vritting, informing the factory of the fact.

To unpack the relay, it is necessary to take the normal precautions, taking care of nor losing the screws that are supplied inside the box.

If the relay is not going to be installed immediately, it is convenient to store it in its original packing, in a dry and dust free location.

It is important to check that the inscription on the nameplate matches the data or specifications handed over with the order.

ACCEPTANCE TESTS

It is recommendeed, once the relay is received, that a visual inspection and the tests given below be performed to make sure that the relay has not suffered any damage in transportation and the factory calibration has not been altered. If the checks or the test carried out show that a readjustment of the relay is necessary, see the section RELAY CALIBRATION.

These tests can be carried out as installation or acceptance tests, depending on the criteria of the user. Since most users have different procedures for installation and acceptance tests, this section explains all the tests that can be performed with these relays.

A. VISUAL INSPECTION

Check that the model indicated in the front plate matches the data given in the order. Unpack the relay and check there are no broken parts and no signs that the relay has suffered any damage durig transportation.

B. ELECTRIC TESTS

1. GENERAL CONSIDERATIONS ON THE POWER SUPPLY NETWORK

All devices operating with alternating current are affected by frequency. Since a non-sine wave shape is the result of a fundamental wave shape plus a series of harmonics of the fundamental wave, it is inferred that devices operating with alternating current (relay) are affected by the shape of the applied wave.

To properly test relays operating with alternating current, it is essential to use sine wave current and/or voltages. The purity of a sine wave (absence of harmonics) cannot be expressed in a specific form for a determined relay. However any relay which includes tuned circuits, R-L and R-C circuits or non linear elements (such as the inverse time overcurrent relays) will be affected by non-sine waveshapes.

Likewise, the relays having d-c power supply must be tested with d-c and not with rectified a-c power supply, because if this power supply is not properly smooth, it is possible the relays do not operate properly due to voltage dips in the power source.

Zener diodes, for example, may stop conducting because of power supply voltage drops. As general rule, the d.c. power supply must not have a ripple higher than 5%.

These relays respond to the current wave shape in a way different from most a.c. ammeters. If the power supply network used for tests contains very high amplitude harmonics, the response of the ammeter and the relay will be different.

The relays have been calibrated at the factory using a 50 or 60 Hz network with a minimum content of harmonics. When tests are performed on the relay, a network must be used with a wave shape free from harmonics. The ammeters and timers used to perform pick-up current and operation time tests with the relay must be calibrated and their accuracy must be better than that of the relay. The power supply used in the test must remain stable, especially near the level of the pick up (starring) current as well as during the operation time according to the curve that is being tested. It is important to point out that the accuracy with which the test is performed depends on the network and on the instruments that are used.

Funtional tests performed with unsuitable power supply network and instruments are useful to check that the relay operates properly and therefore its operating characteristic are verified in an approximate manner. However, if the relay would be calibrated in these conditions, its operational characteristics would be outside the tolerance range of values.

2. <u>INVERSE TIME UNIT</u>

a) <u>Pick-up current calibration check</u>

1. Connect the relay as indicated in figure 21. To apply current to the relay, use a 127 or 220 V -50 Hz, or 120 V-60Hz power source with an adjustable resistor in series.

2. Adjust the relay in the minimum tap.Place all the switches to the left (identified as 2 in figure 12.

0.3 ...... for relays of 1,5-13,125A and 0,3-2,625A range
0.1 ...... for relays of 0,5-4,375A and 0,1-0,875A range

The instantaneous unit must be adjusted in infinite position by means of potentiometer 6 of figure 12.

Relay range	Applied current (A)
1,5-12,125	1,567-1,732
0,5-4,375	0,522-0,577
0,3-2,625	0,313-0,346
0,1-0,875	0,104-0,116

Table 1

Apply current to the relay and check within the margins indicated in table 1, that the LED diode identified with 1 in figure 12 lights up, that the contact of the output relay closes and that afterwards the LED diode indicating the tripping of the inverse time unit ligths up; this diode is identified as 3 in figure 12.

With the contacts of the output relay closed, reduce the applied current, verifying that with the current values indicated in Table 2, the output relay resets and the LED identified by 1 in fig.12 turns off.

Relay range	Applied current (A)
1,5-13,125A	1,5
0,5-4,375A	0,5
0,3-2,625A	0,3
0,1-0,875A	0,1

Table 2

b) <u>Operating time check</u>

With the relay connected as indicated in section a), adjust it in curve number 5 by means of potentiometer indicated by 4 in figure 12 and adjust the inverse time unit in the minimum tap as indicated in a).

Apply successively currents of 2,5 and 10 times the minimum tap value checking that the operating time is within the margins indicated in tables 3, 4, 5 and 6.

TABLE 3. Relays with ANSI INVERSE characteristics

Times minimum current	Applied current (A)				Operating time for curve 5 in seconds
	range				
	1,5-13,12	0,5-4,37	0,3-2,62	0,1-0,87	
2	3	1	0,6	0,2	2,80 - 3,30
5	7,5	2,5	1,5	0,5	1,40 - 1,60
10	15	5	3	1	1,05 - 1,20

TABLE 4. Relays with VERY INVERSE characteristics

Times minimum current	Applied current (A)				Operating time for curve 5 in seconds
	range				
	1,5-13,12	0,5-4,37	0,3-2,62	0,1-0,87	
2	3	1	0,6	0,2	4,10 - 4,80
5	7,5	2,5	1,5	0,5	1,10 - 1,30
10	15	5	3	1	0,75 - 0,85

TABLE 5. Relays with EXTREMELY INVERSE characteristics

Times minimum current	Applied current (A)				Operating time for curve 5 in seconds
	current range				
	1,5-13,12	0,5-4,37	0,3-2,62	0,1-0,87	
2	3	1	0,6	0,2	3,90 - 4,55
5	7,5	2,5	1,5	0,5	0,55 - 0,65
10	15	5	3	1	0,20 - 0,25

TABLE 6. Relays with B.S.142 INVERSE characteristics

Times minimun current	Applied current (A) current range				Operating time for curve 5 in seconds
	1,5-13,12	0,5-4,37	0,3-2,62	0,1-0,87	
2	3	1	0,6	0,2	4,60 - 5,40
5	7,5	2,5	1,5	0,5	2,00 - 2,25
10	15	5	3	1	1,40 - 1,60

Adjust the relay in the minimum tap and applying a current 5 times the minimum tap (7,5A for 1,5-13,12A range; 2,5A for 0,5-4,37A; 1,5A for 0,3-2,62A and 0,5A for 0,1-0,87A) check that the operation time is within the margins indicated in table 7.

TABLE 7.

Curve	Time in seconds			
	ANSI invr.	Very inv.	Extrem.inv.	BS142 inv.
1	0,25 0,35	0,20 0,30	0,10 0,15	0,35 0,50
3	0,80 1,00	0,65 0,85	0,30 0,40	1,15 1,40
7	1,90 2,30	1,55 1,90	0,70 0,95	2,70 3,30
10	2,70 3,30	2,20 2,70	1,10 1,30	3,90 4,65

3. INSTANTANEOUS UNIT

a) Pick-up current check

1. Connect the relay as indicated in figure 21. To apply current to the relay use a power source of 127 or 220 V.-50Hz, or 120 V.-60Hz. with a variable resistor in series.

2.Adjust the relay in the minimum tap.Place all the switches to the left (identified as 2 in figure 12)

0,3	...... for relays	1,5-13,125A	and	0,3-2,625A range
0,1	...... for relays	0,5-4,375A	and	0,1-0,875A range

adjust the instantaneous unit 1 time the adjustment value of the inverse time unit by means of potentiometer 6 of figure 12.

3. Check that the operation of the instantaneous unit is within the margins indicated in table 8

Relay range	Applied current (A)
1,5-13,125	1,567-1,732
0,5-4,375	0,522-0,577
0,3-2,625	0,313-0,346
0,1-0,875	0,104-0,115

Table 8

NOTE: WHEN PERFORMING EACH TEST, THE CURRENT APPLIED TO THE RELAY MUST BE DISCONNECTED AFTER THE OPERATION OF THE RELAY, IN ORDER NOT TO EXCEED ITS THERMAL CAPACITY.

b) Operating time check

With the relay connected as indicated in section a), apply current to the relay according to table 9.

Relay range	Applied current (A)
1,5-13,125	7,5
0,5- 4,375	2,5
0,3- 2,625	1,5
0,1- 0,875	0,5

Table 9

checking that the operation time lies between 0,021 and 0,035 seconds.

INSTALLATION

A. INTRODUCTION

The place where the relay will be installed must be clean, dry, free of dust and vibrations and must also be well lit to ease the task of inspection and testing.

The relay must be mounted on a vertical surface. Figures 29,30 and 31 show the outline and drilling drawings.

The external and internal connection diagrams are shown in figures 5 to 8 22 to 28. If the inspection or test performed show the need for a readjustment of the relay, see section RELAY CALIBRATION.

B. GROUND CONNECTION FOR SURGE OVERVOLTAGE SUPPRESSION

Tap C7 of the relay must be connected to ground so that the surge suppression circuits provided within the relay operate properly.

This connection must be as short as possible to assure maximum protection level (preferibly 25 cm or less).

C. TAP ADJUSTMENT

1. INVERSE TIME UNIT

3.1.1.- Adjustment of the pick-up tap
It is carried out in all the models by means of the switches blocking identified as 2 in figure 12. The following expression appears beneath it:

$$Is = [0.1 + ()] *In$$
$$Is = [0.3 + ()].*In$$

depending on whether the plante is low or high range respectively.

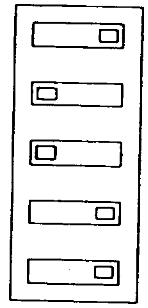
where:

Is Pick-up current in amps.
In Rated current of the tested unit (1 A or 5 A).
() Sum of the values indicated by the active switches (right hand switch).

The In rated current value is identified in the front plate by:

IN Phase rated current.
INGR Ground rated current.

For example, let's imagine that the switches at the relay's front (corresponding to the pick-up current selection) for a phase plate whose rated current is 5 A present the following configuration:



$$Is = [0.3 + ()] * In$$

The formula that must be applied to obtain the pick-up current is:

$$Is = [0.3 + ()] * In \text{ (given that it is a high range plate)}$$

In order to know the value to insert inside the brackets, the operation to carry out is the sum of the values indicated for the activated switches (right hand switch), in this case

$$() = 0.075 + 0.60 + 1.20 = 1.875$$

where

$$Is = [0.3 + 1.875] * 5 = 10.875 \text{ A}$$

b) <u>Adjustment of the time dial</u>

It is adjusted in all models by means of the potentiometer 4 of figure 12. By means of this element the relay operating curve is selected. The operating times depend upon the applied currents and are indicated in the curves of figures 1, 2, 3 and r, bearing in mind that the applied current is indicated in multiples of the pick-up tap, Is, selected in section a).

2. <u>INSTANTANEOUS UNIT</u>

In those models including the instantaneous unit, the adjustment is made by means of the potentiometer identified as 6 in figure 12. Under this element there is the expression:

$$I >> = (\ ) x Is$$

where:

- I is the instantaneous unit adjustment value
- ( ) is the value selected with the potentiometer 6, for example (15).
- Is is the pick-up current in amperes selected in section a), therefore, if potentiometer 6 has been adjusted with 15...(15), it results:

$$I >> = 15x4=60A$$

D. TEST

Since most users use different procedures in the installation tests, the section ACCEPTANCE TEST includes all the necessary test that can be performed as installation tests depending on the user criteria. Following the tests considered as minimum are given:

Inverse unit tests

Adjust the relay in the desired pick-up tap. Apply current to the relay and check that it operates between 1,05 and 1,15 times adjustment value.

The section ACCEPTANCE TEST includes a detailed explanation of the starting current tests for the inverse time unit.

Adjust the relay in the desired time curve. Check the operation time applying a current 5 times the value of the starting tap. Check once more the operating time applying currents of 2 and 10 times the starting tape value. The section ACCEPTANCE TESTS includes a detailed information about operation time for the inverse time unit.

Instantaneous unit tests

Adjust the instantaneous unit of the relay in the desired value and refer to the section ACCEPTANCE TESTS for starting current and operation time checking tests.

All tests described in the section INSTALLATION, must be performed in the moment in wich the relay is mounted.

If for any reason, the tests specified on the section ACCEPTANCE TESTS would have not bee performed in time, it is recommended they be carried out at the moment of installation.

RELAY CALIBRATION

If during tests it is found that the relay is out of tolerance (first of all make sure that the power source and the instruments used comply with the requirements specified in the section ACCEPTANCE TESTS) calibration can be made in the following way:

1) Calibration of pick-up current taps.

1. Connect the relay as indicated in figure 21. To apply current to the relay use a power source of 110/125V-50Hz or 120V-60Hz with a variable resistor in series.

2. Adjust the relay in the minimun tap . Place all the switches to the left (identified as 2 in figure 12).

0,3 ......for relays of 1,5-13,125A and 0,3-2,625A range
0,1 ......for relays of 0,5-4,375A and 0,1-0,875A range

the instantaneous unit will be adjusted in 1 time the value adjusted for the inverse time unit.

3. Apply gradually current to the relay from 0 to the value indicated in table 10. Check for 1 minute that this current is constant with a tolerance of +/-1%.

Relay range	Applied current (A)
1,5-13,125	1,65
0,5-4,375	0,55
0,3-2,625	0,33
0,1-0,875	0,11

Table 10

and operate potentiometer P2 of figure 20 until just the LED diodes identified by 1 and 5 in figure 12 are lit for the applied current, checking moreover the closing of the output contacts and that after some time the LED diode identified by 3 in figure 12 lights up.

4. Calibration for operating time

With the relay connected as in the above section, apply a current 5 times the tap values as indicated in table 11.

Relay range	Applied current (A)
1,5-13,125 0,5-4,375 0,3-2,625 0,1-0,875	7,5 2,5 1,5 0,5

Table 11

Operate potentiometer P1 of figure 20, until the operating time is that of the table 12.

TABLE 12

BS1442	ANSI INVERSE	VERY INVERSE	EXTREM.INVERSE
2.140	1,508	1,235	0,602

Once this time has been adjusted, check the operating times for several pick-up current taps and curves, such as indicated in tables 3, 4, 5 or 6.

PERIODIC TESTS AND MAINTENANCE

In view of the fundamental role of the protection relays in the operation of any installation, it is recommended to follow a program of a periodical tests. Since the interval between periodical tests varies for different types of relays, types of installations, as well as with the experience of the user on periodical tests, it is recommended that the points described under paragraph INSTALLATION be checked at intervals of 1 to 2 years.

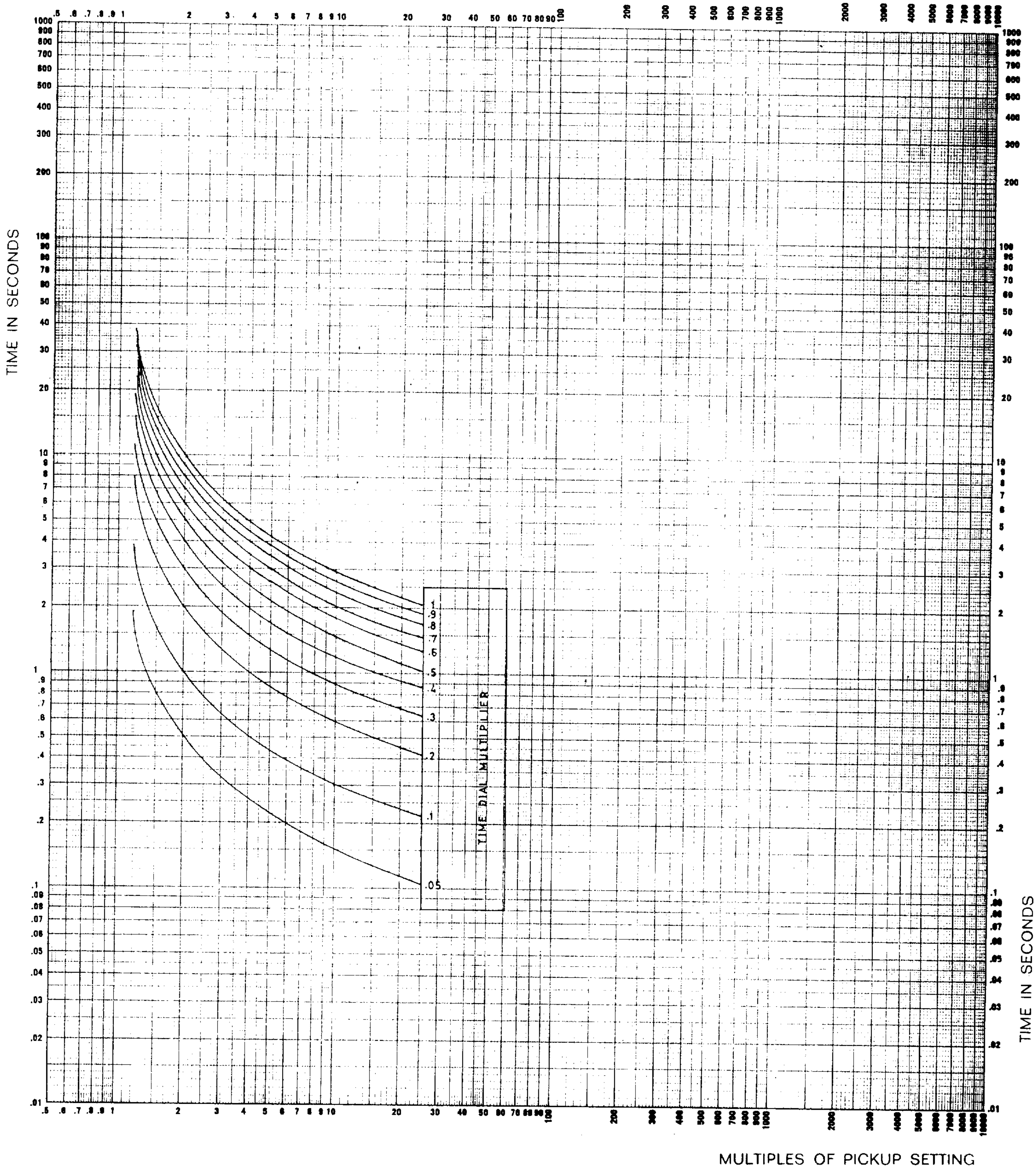


Fig. 1. Operating curves with BS 142 INVERSE characteristic

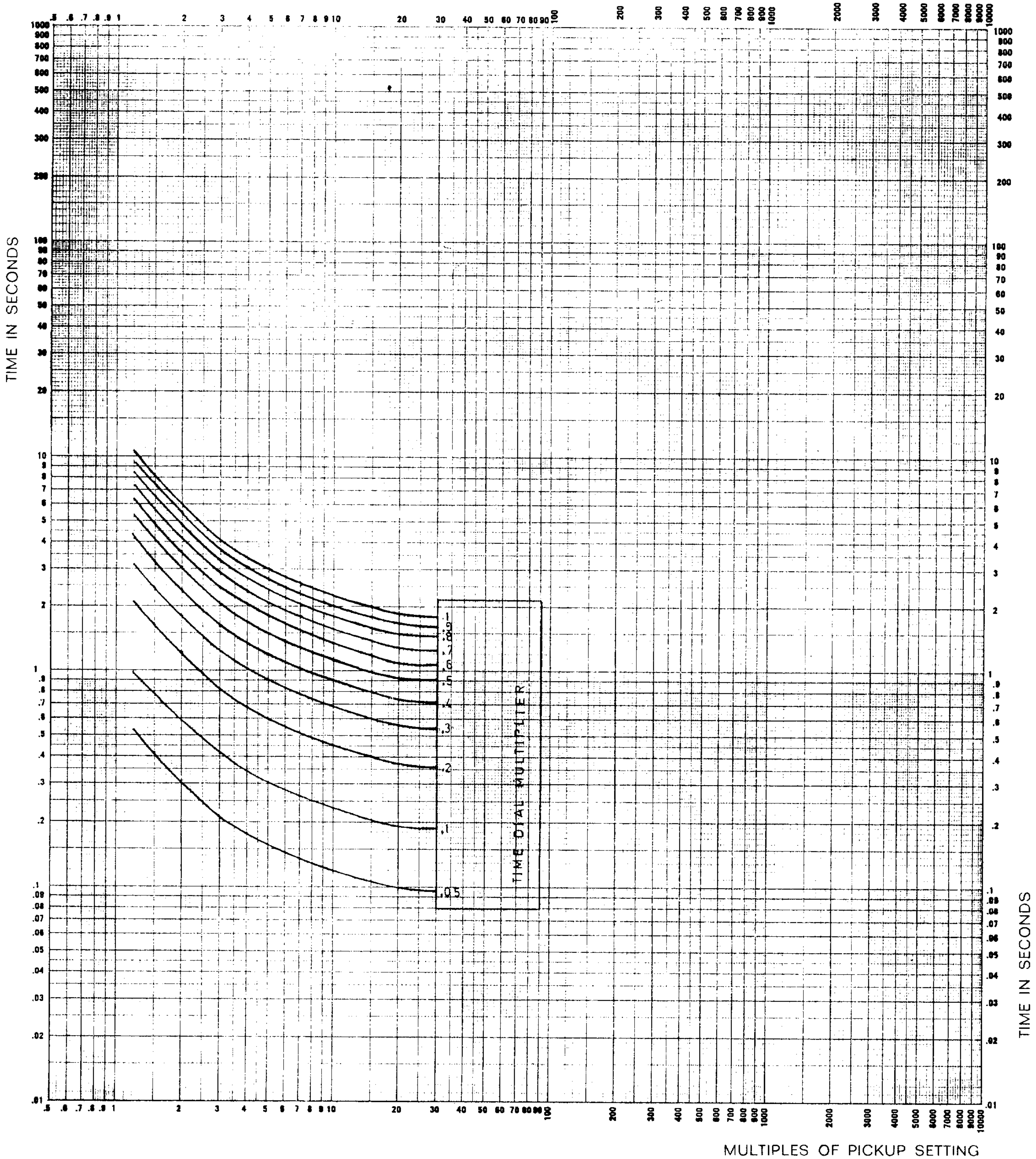


Fig. 2. Operating curves with ANSI INVERSE characteristic

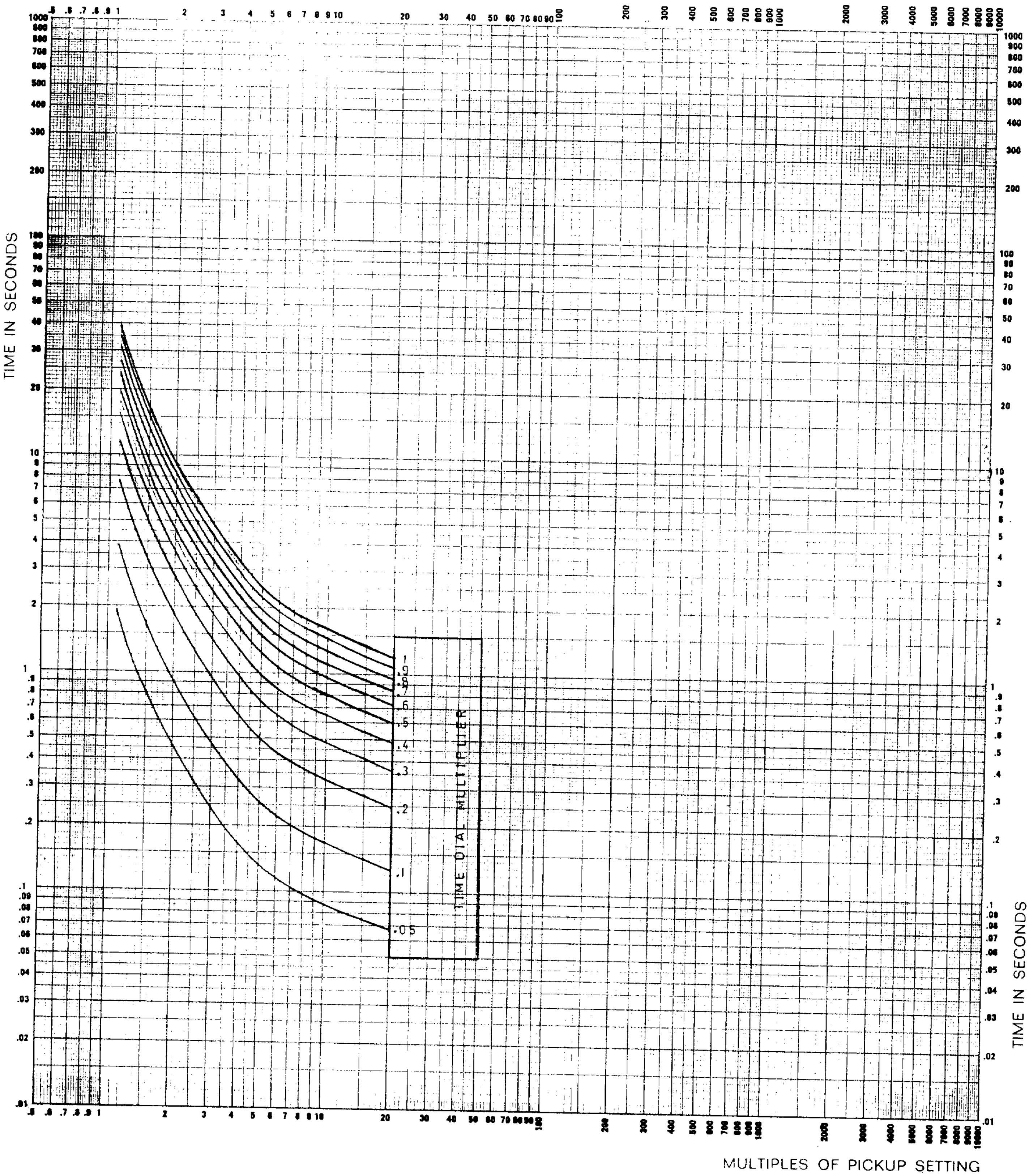


Fig. 3. Operating curves with VERY INVERSE characteristic

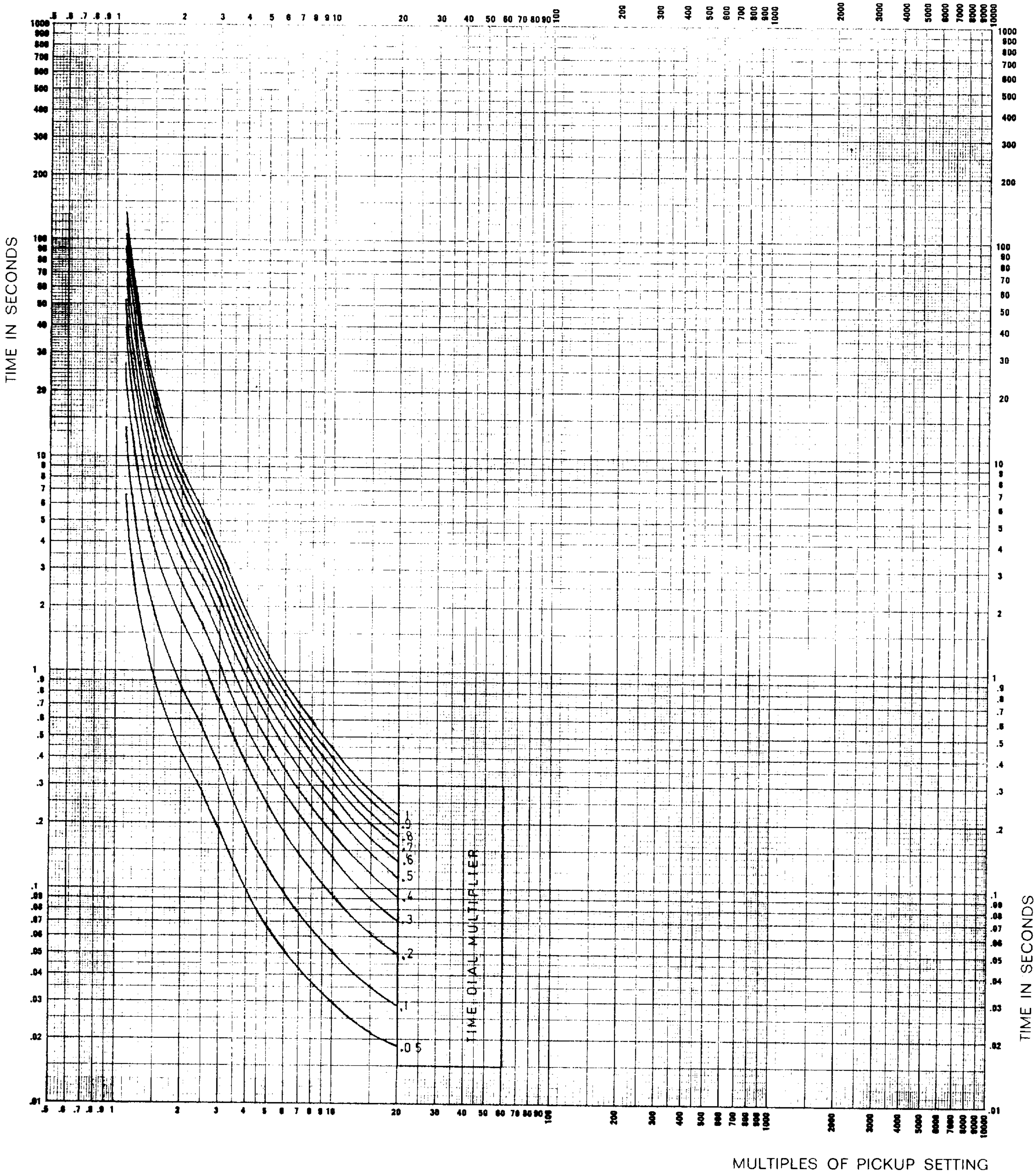


Fig. 4. Operating curves with EXTREMELY INVERSE characteristic

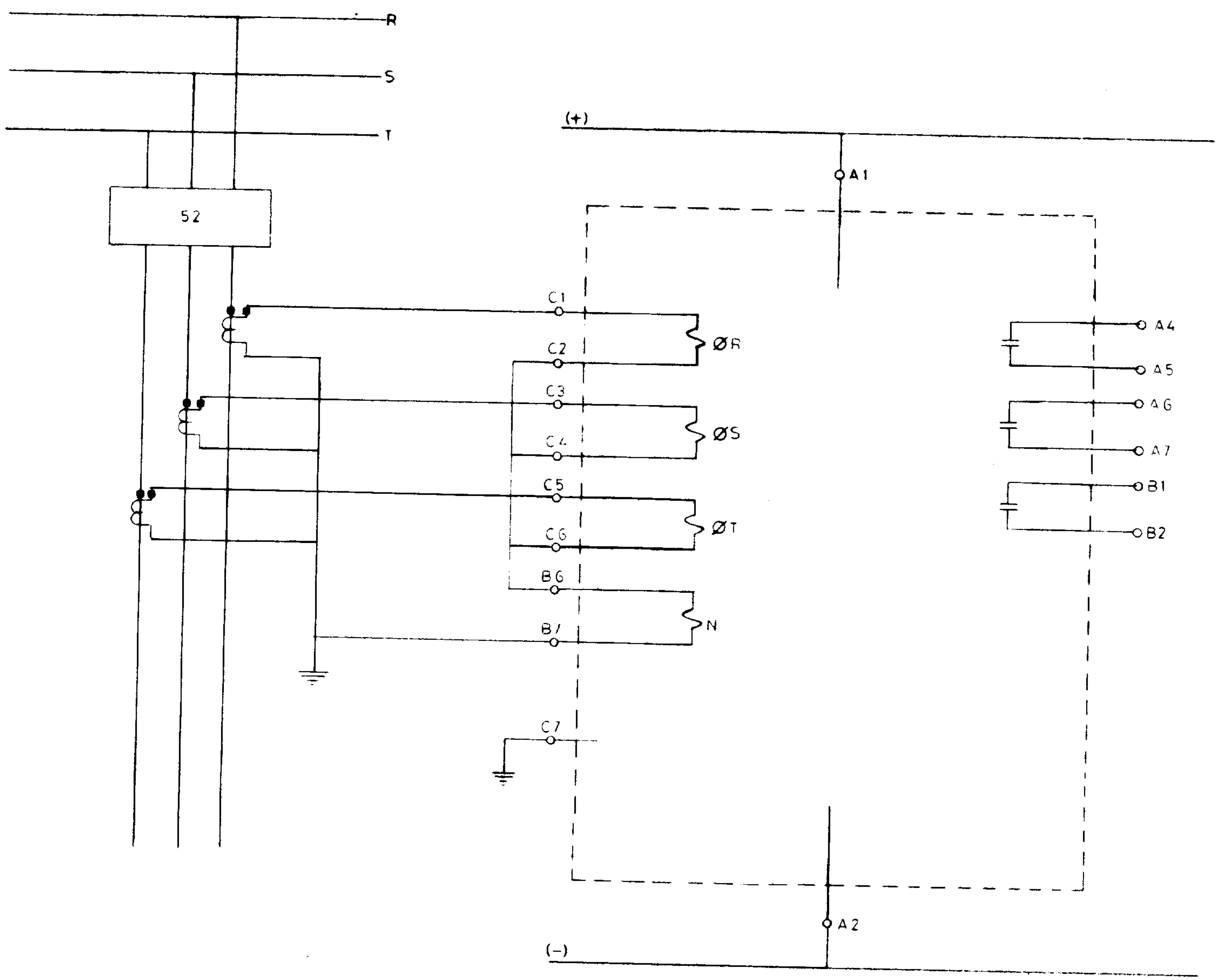


Fig. 5. External connection diagram TOC 1000/8000

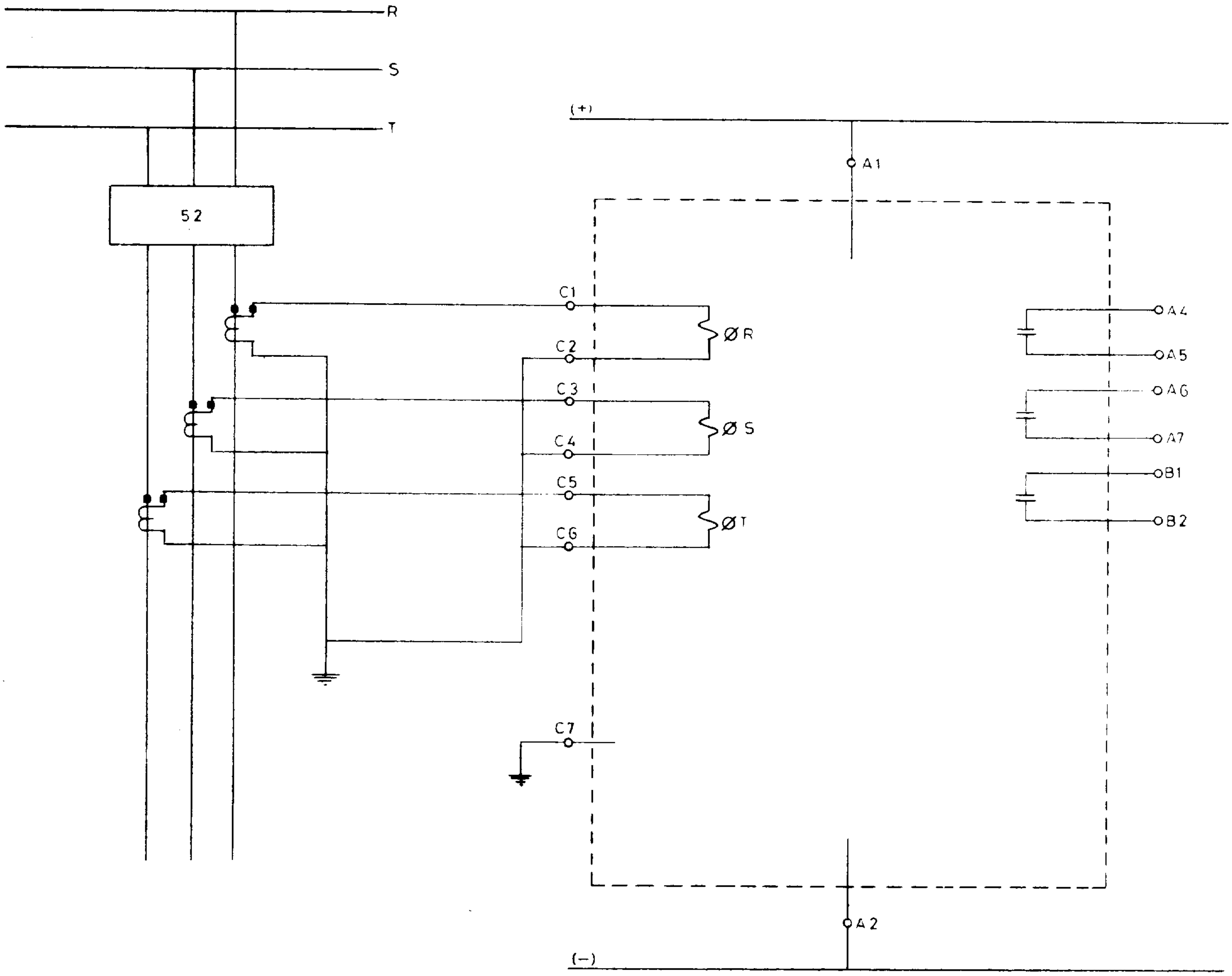
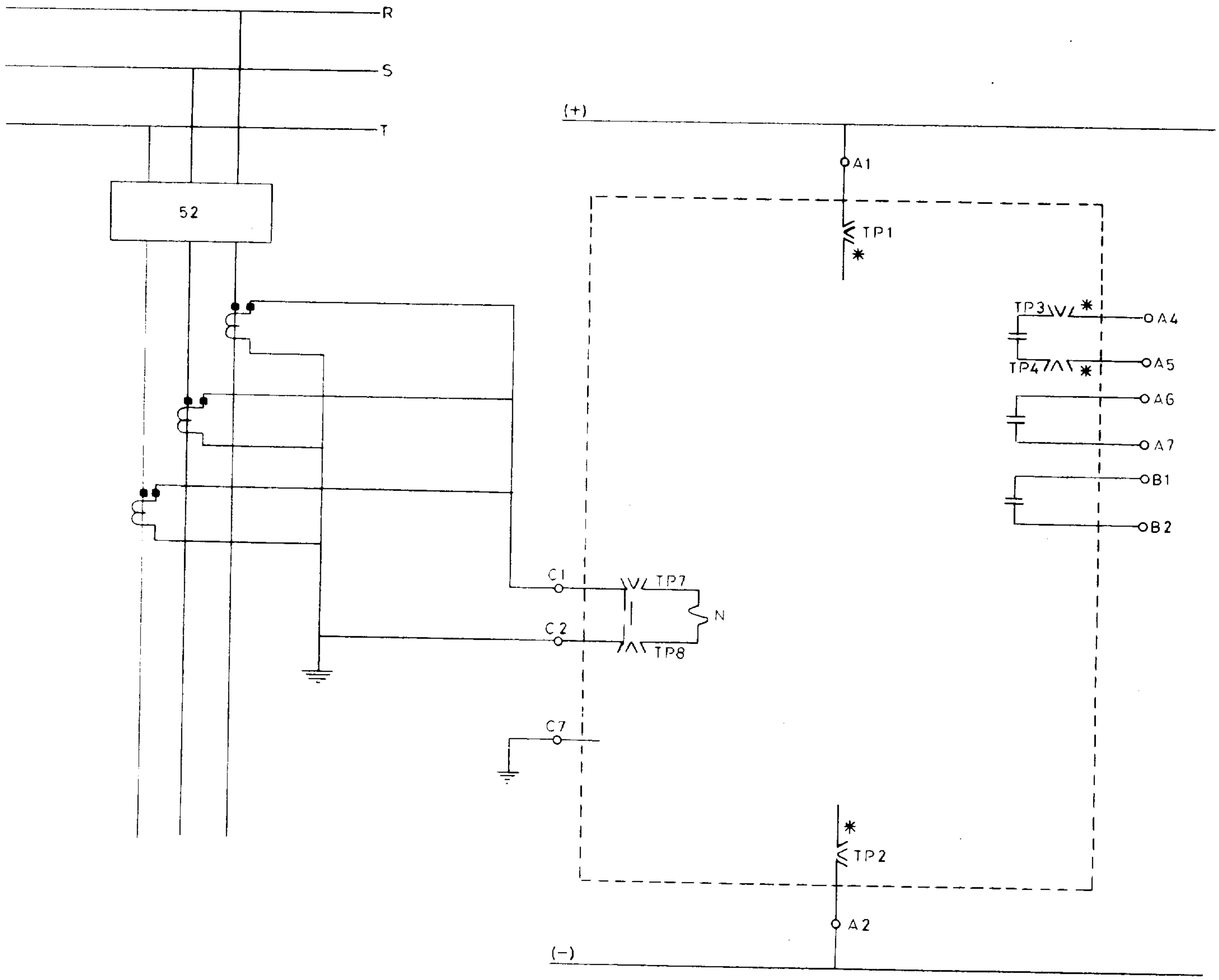


Fig. 6. External connection diagram TOC 4000/7000



✱ SHORT FINGERS

Fig. 7. External connection diagram TOC 5000

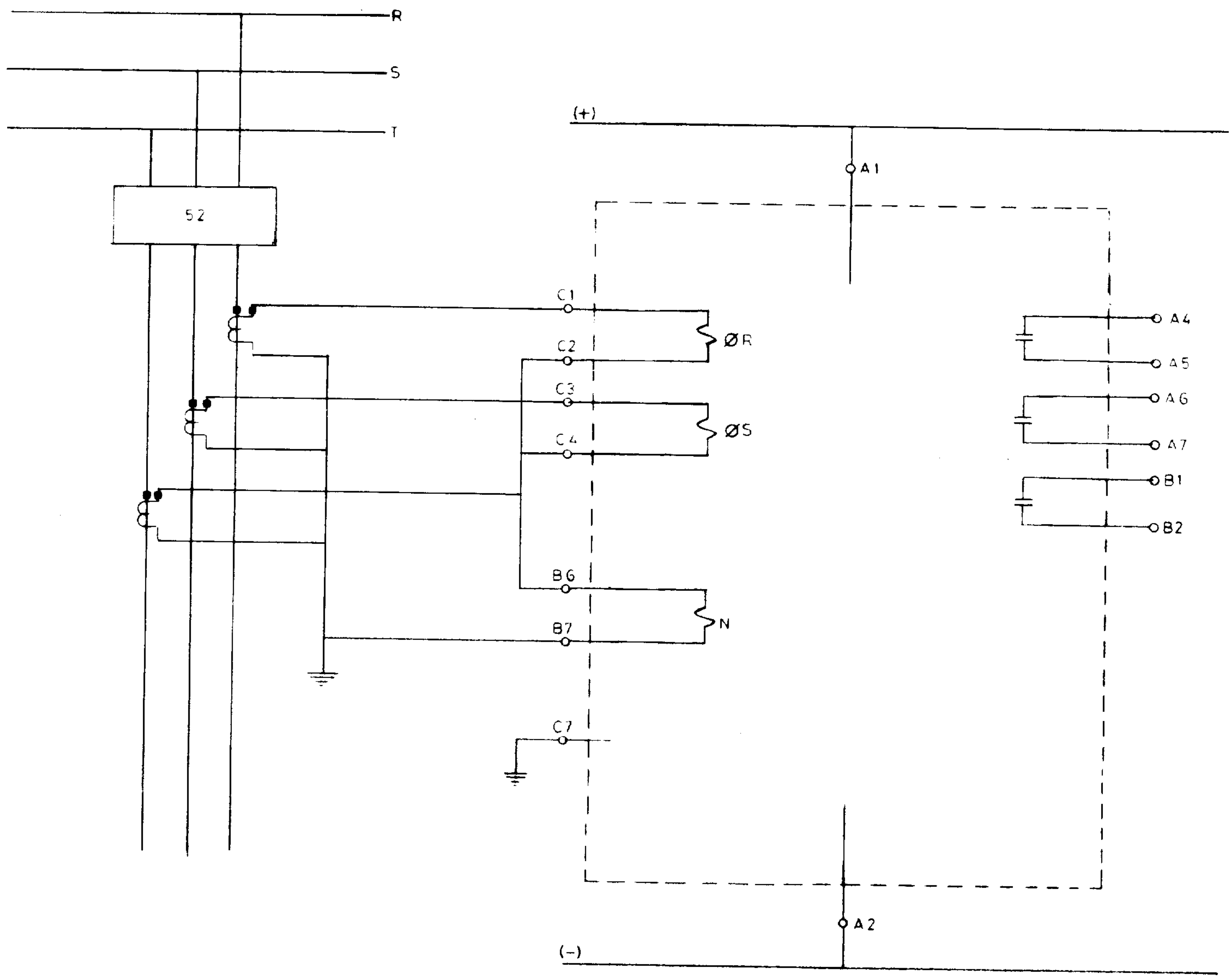


Fig. 8. External connection diagram TOC 6000/9000

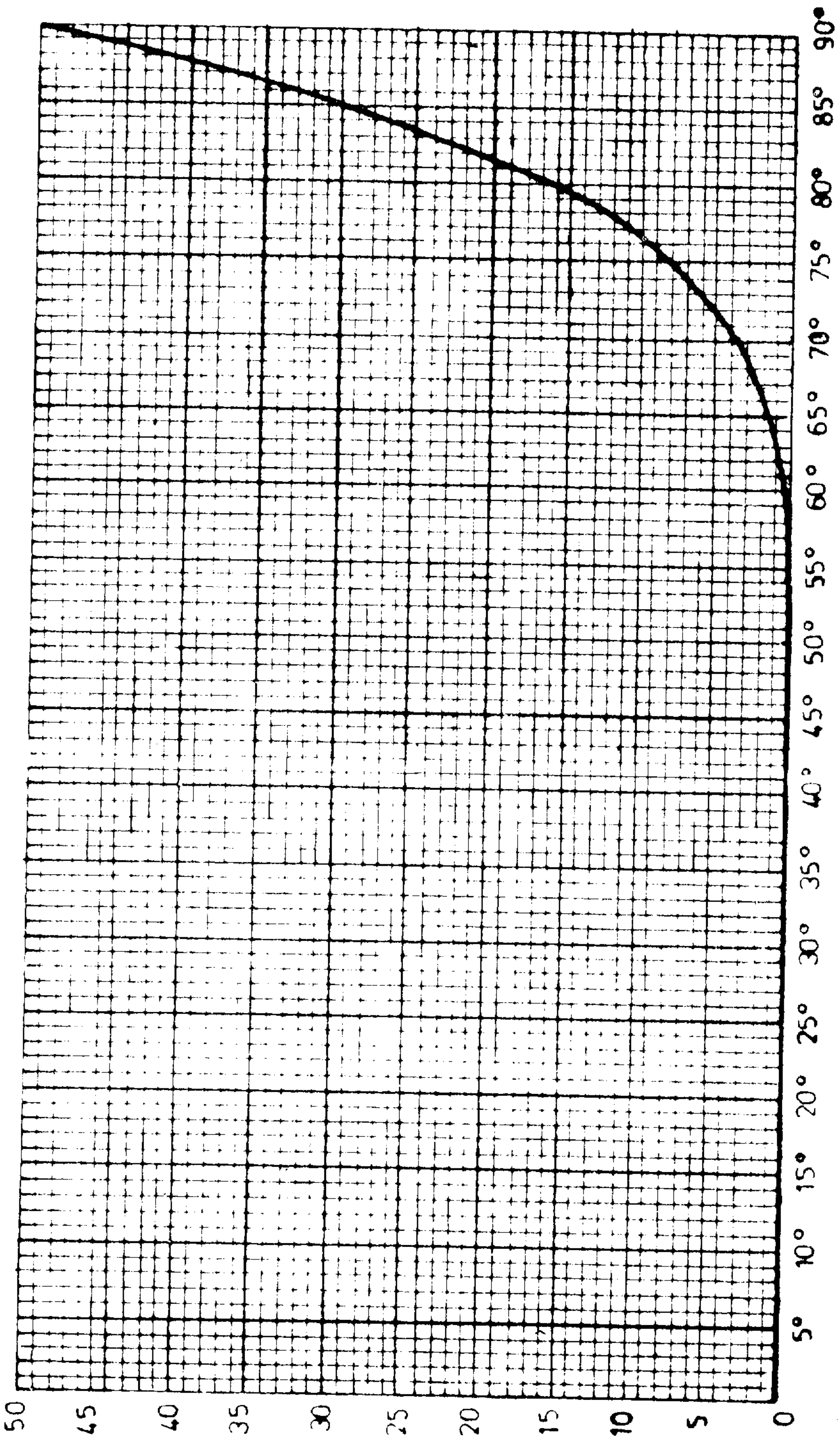


Fig. 9. Transient overreaching characteristic of the instantaneous unit

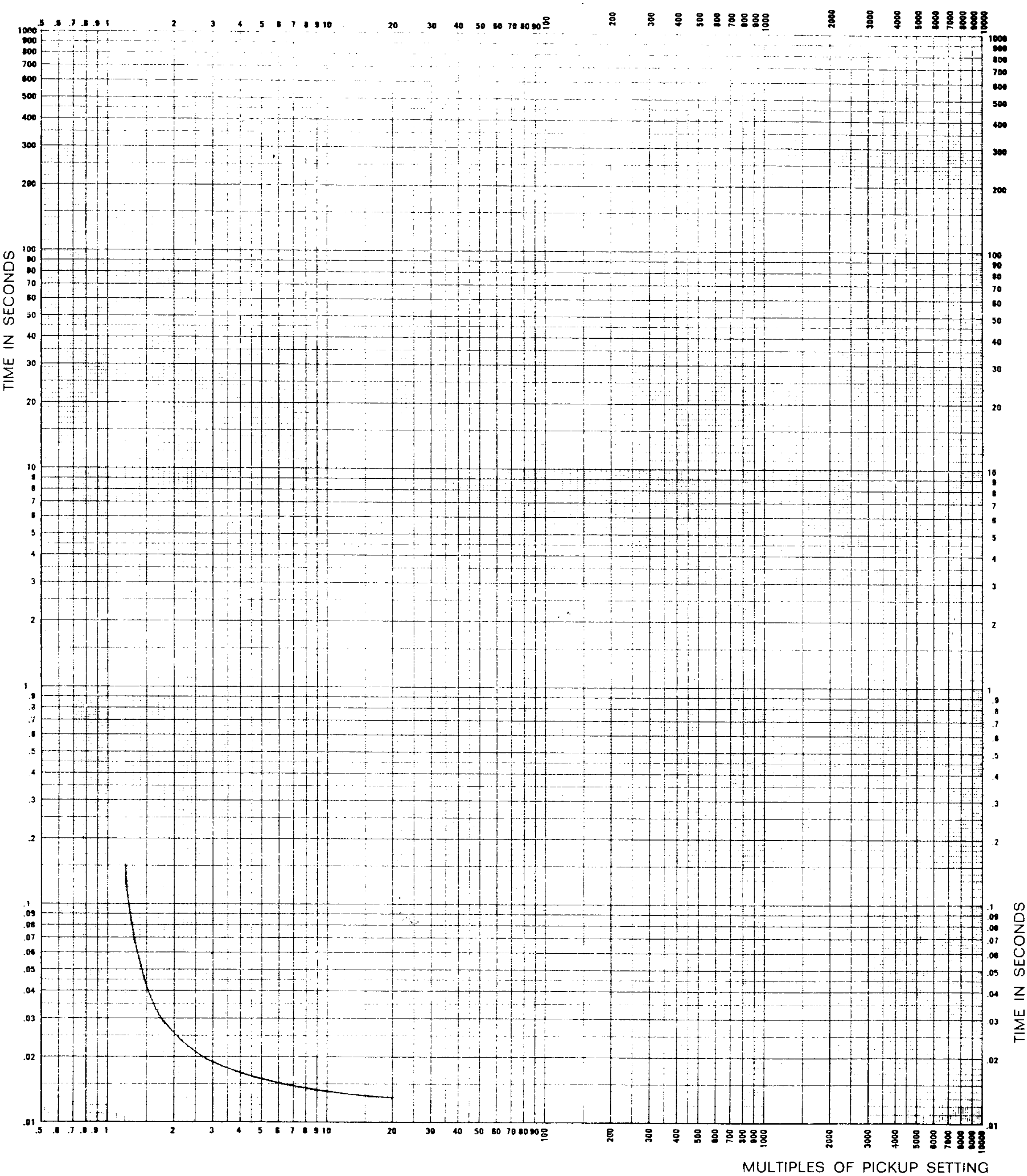


Fig. 10. Operating characteristic of the instantaneous unit

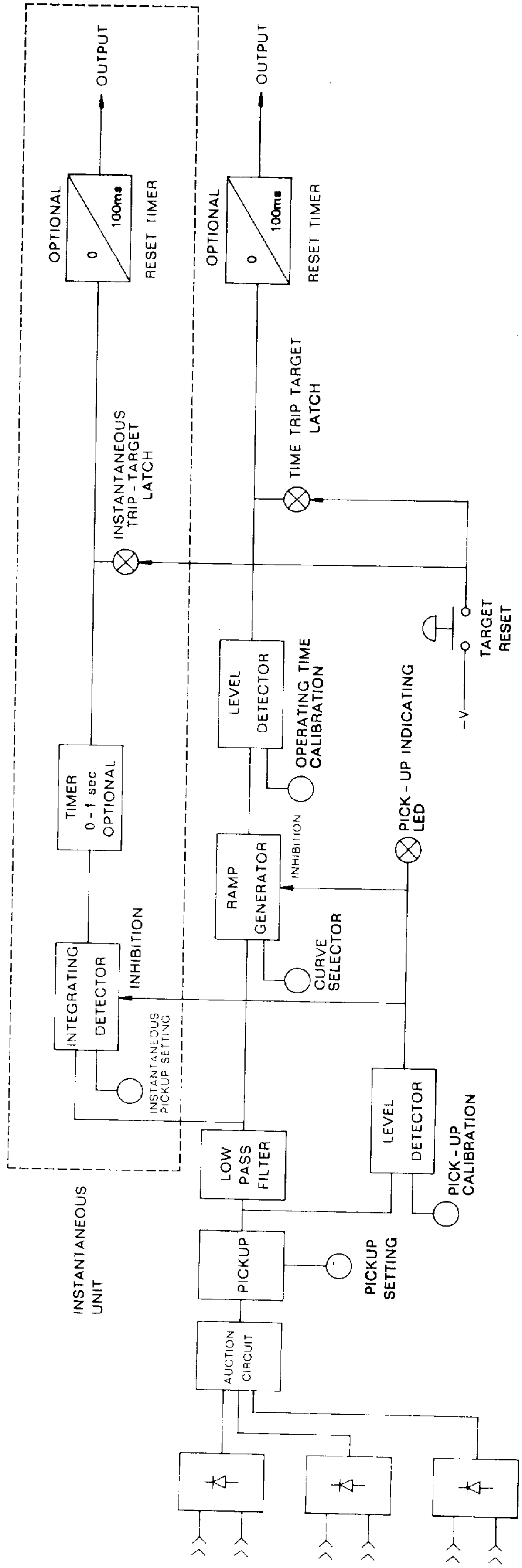


Fig. 11 a. Block diagram of a three phase board with common measuring unit

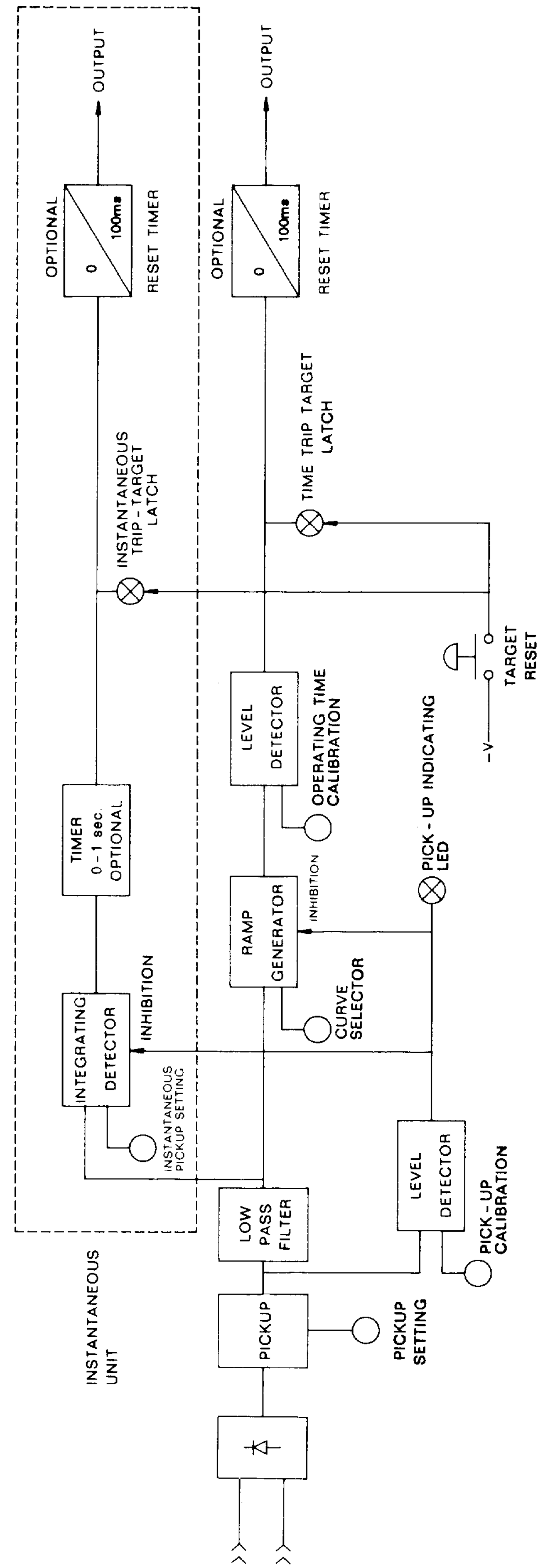


Fig. 11 b. Block diagram of a one phase board

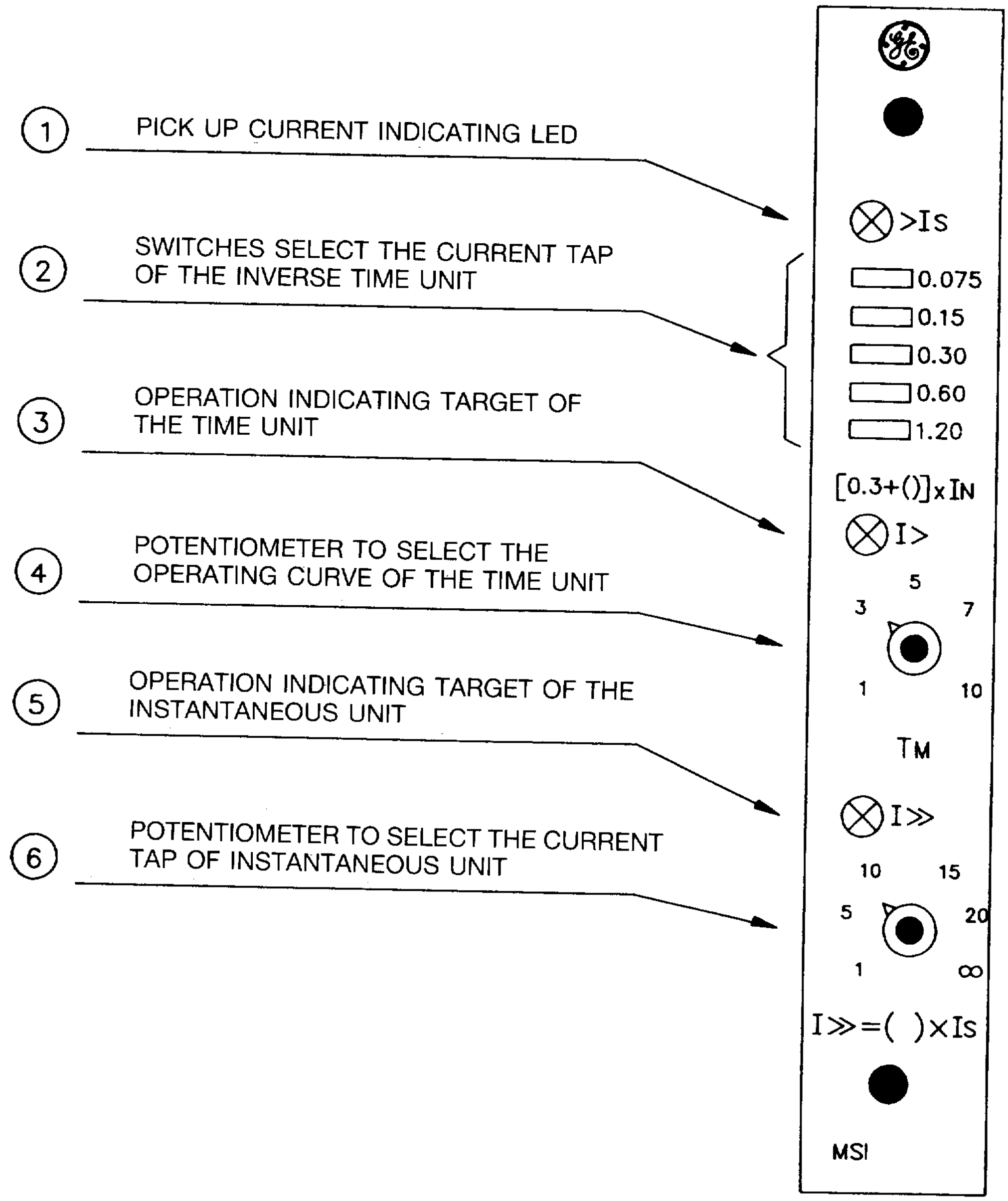
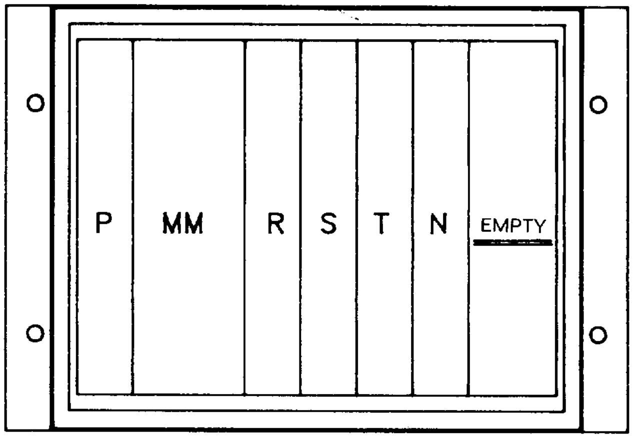
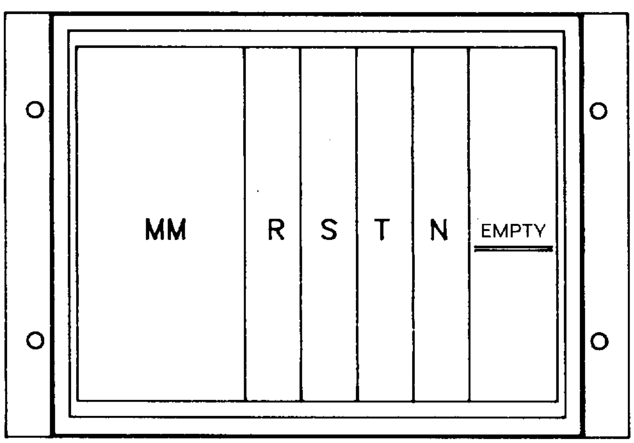


Fig. 12. Location of controls and targets



TOC 1100 A/B

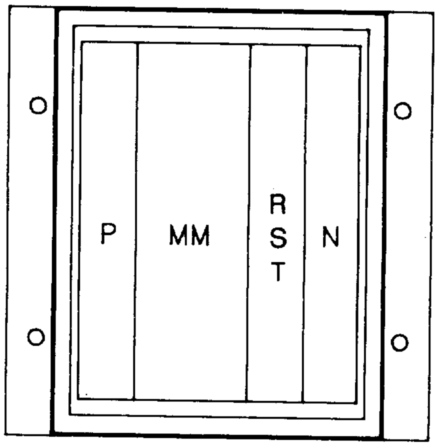
½ RACK STANDARD CASE



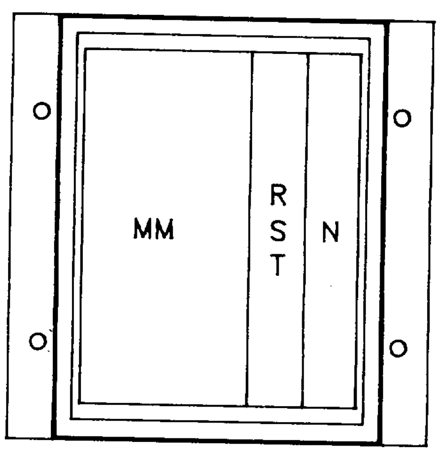
TOC 1000 A/B

½ RACK STANDARD CASE

Fig. 13. Module arrangement of TOC 1000/1100

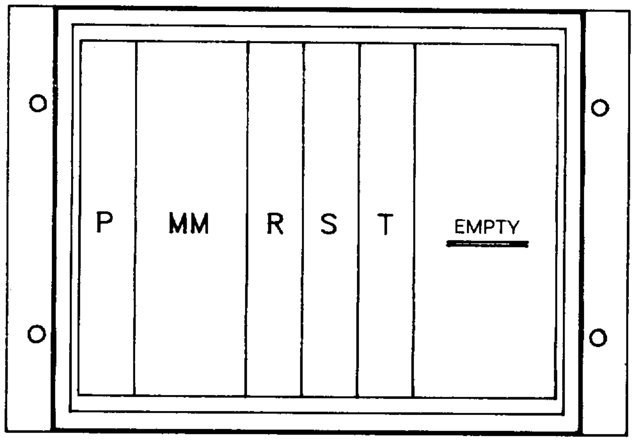


TOC 8100 A/B
1/3 RACK STANDARD CASE

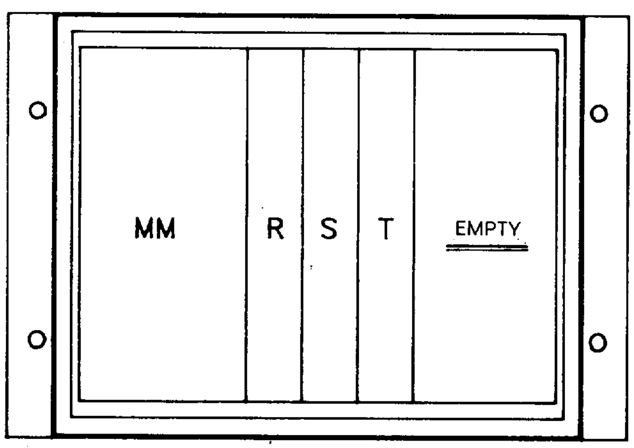


TOC 8000 A/B
1/3 RACK STANDARD CASE

Fig. 14. Module arrangement of TOC 8000/8100

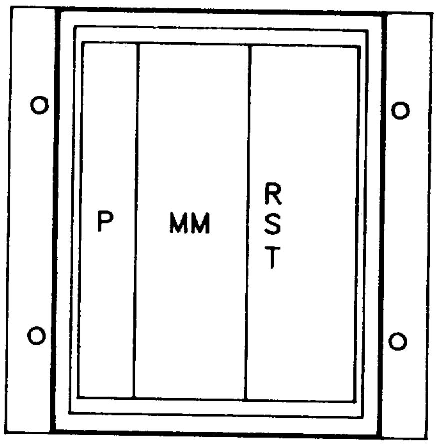


TOC 4100 A/B
1/2 RACK STANDARD CASE

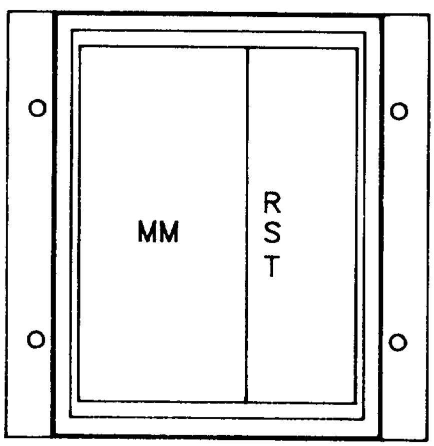


TOC 4000 A/B
1/2 RACK STANDARD CASE

Fig. 15. Module arrangement of TOC 4000/4100

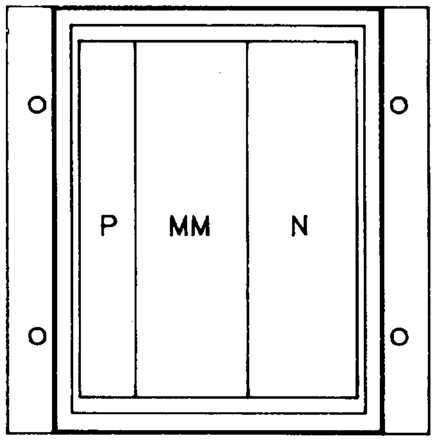


TOC 7100 A/B
1/3 RACK STANDARD CASE

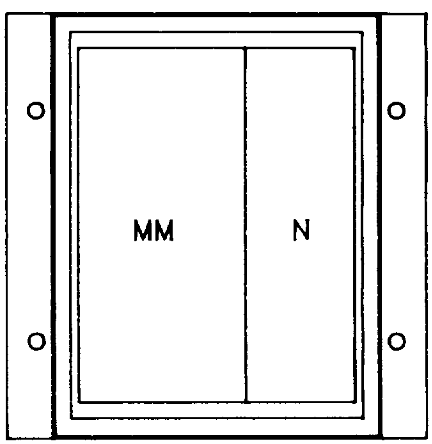


TOC 7000 A/B
1/3 RACK STANDARD CASE

Fig. 16. Module arrangement of TOC 7000/7100

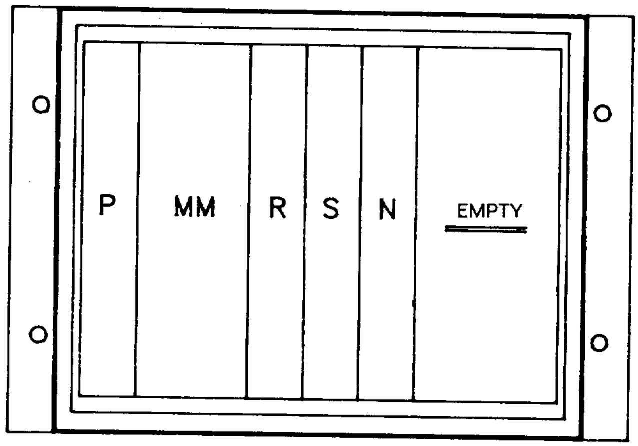


TOC 5100 A/B
1/3 RACK STANDARD CASE

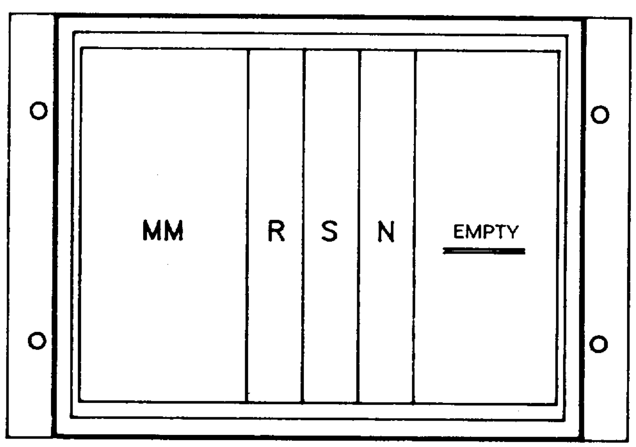


TOC 5000 A/B
1/3 RACK STANDARD CASE

Fig. 17. Module arrangement of TOC 5000/5100

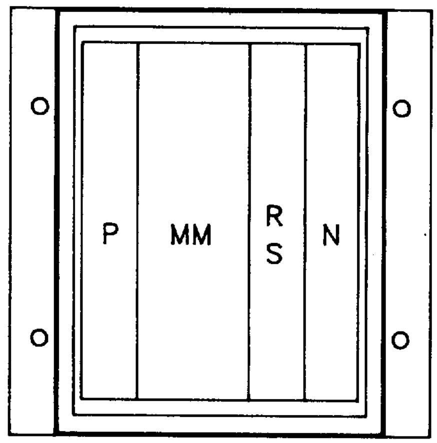


TOC 6100 A/B
½ RACK STANDARD CASE

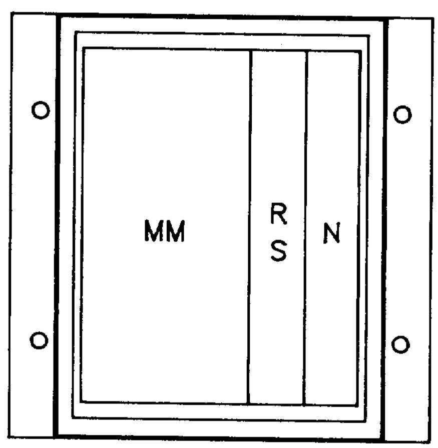


TOC 6000 A/B
½ RACK STANDARD CASE

Fig. 18. Module arrangement of TOC 6000/6100



TOC 9100 A/B
1/3 RACK STANDARD CASE



TOC 9000 A/B
1/3 RACK STANDARD CASE

Fig. 19. Module arrangement of TOC 9000/9100

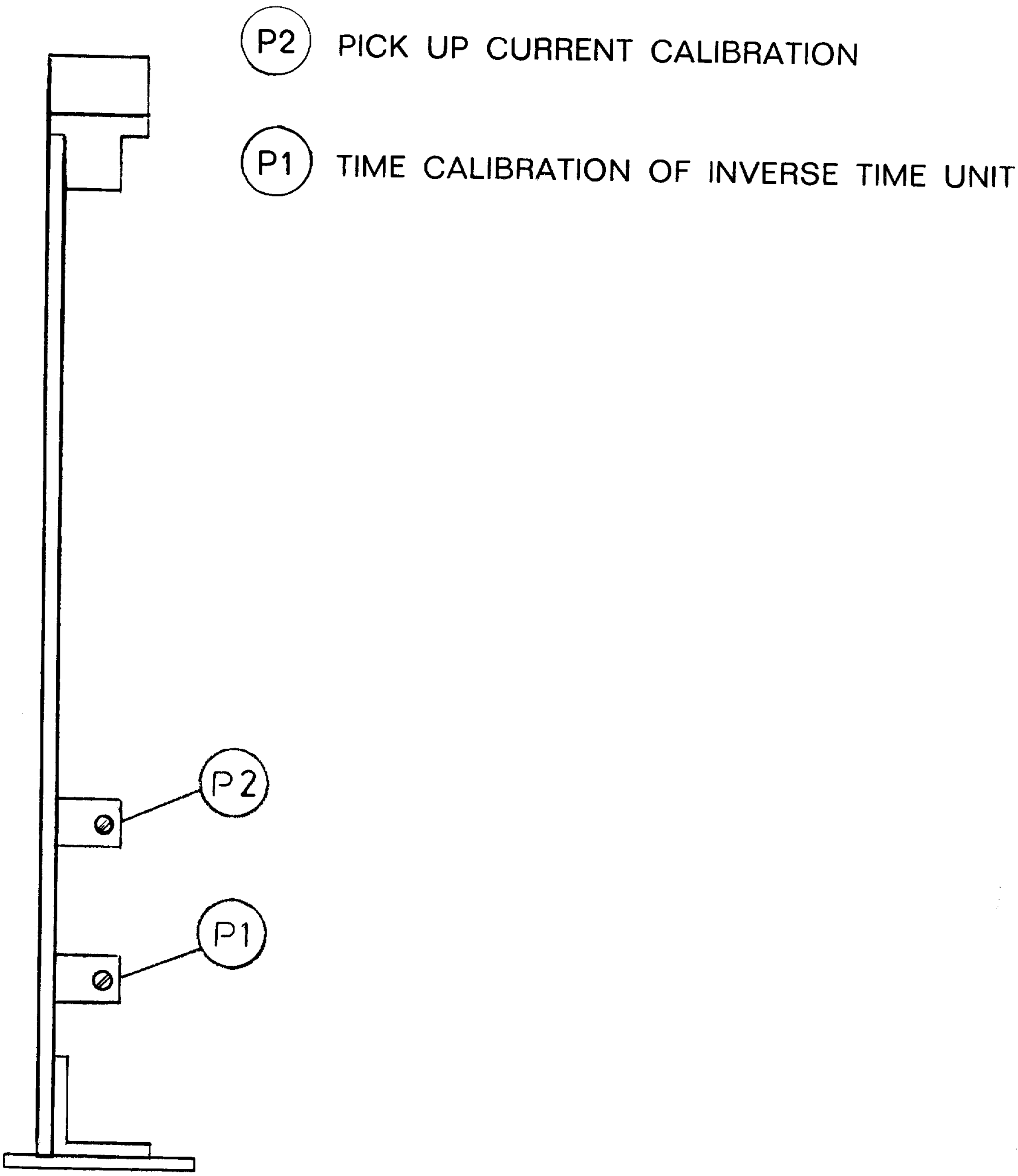
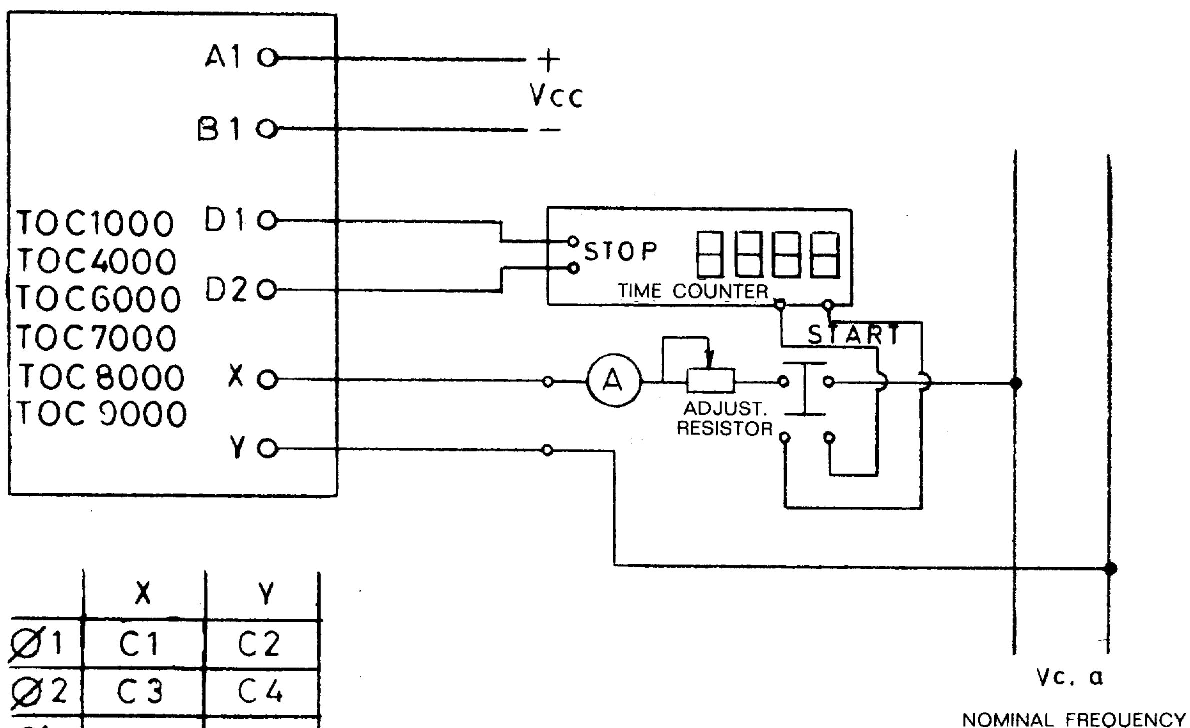


Fig. 20. Internal controls



	X	Y
Ø1	C1	C2
Ø2	C3	C4
Ø3	C5	C6
GR	B6	B7

Fig. 21 a. Test diagram TOC 1000/4000/6000/7000/8000/9000

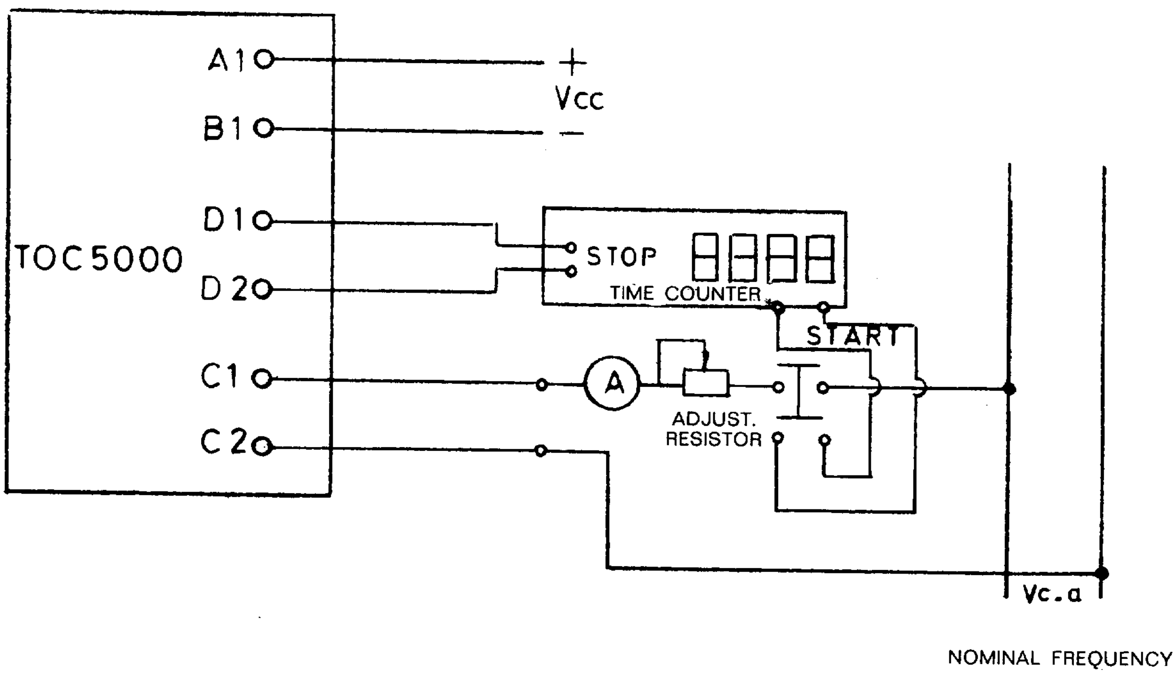


Fig. 21 b. Test diagram TOC 5000

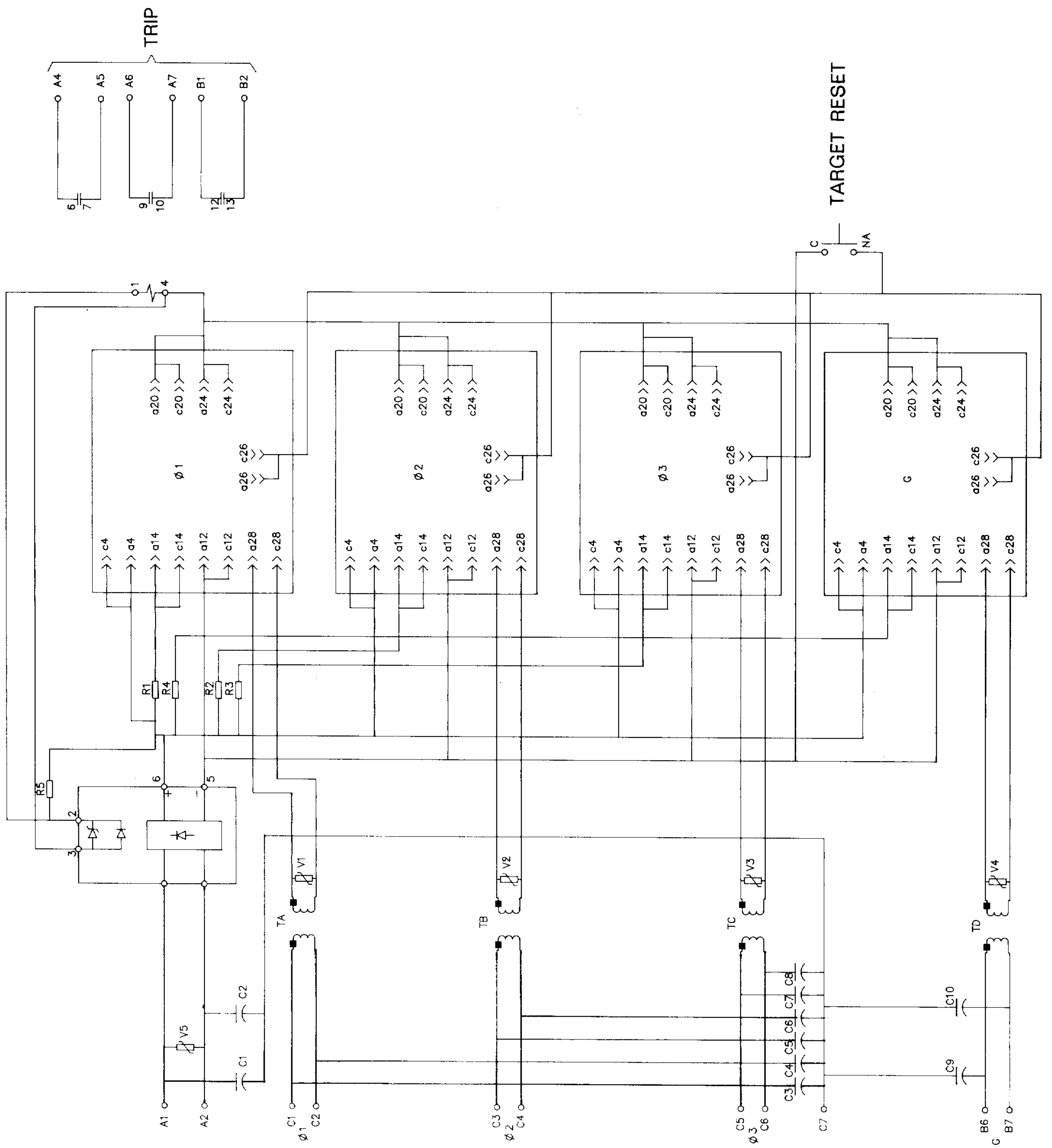


Fig. 22. Internal connection diagram of TOC 1000

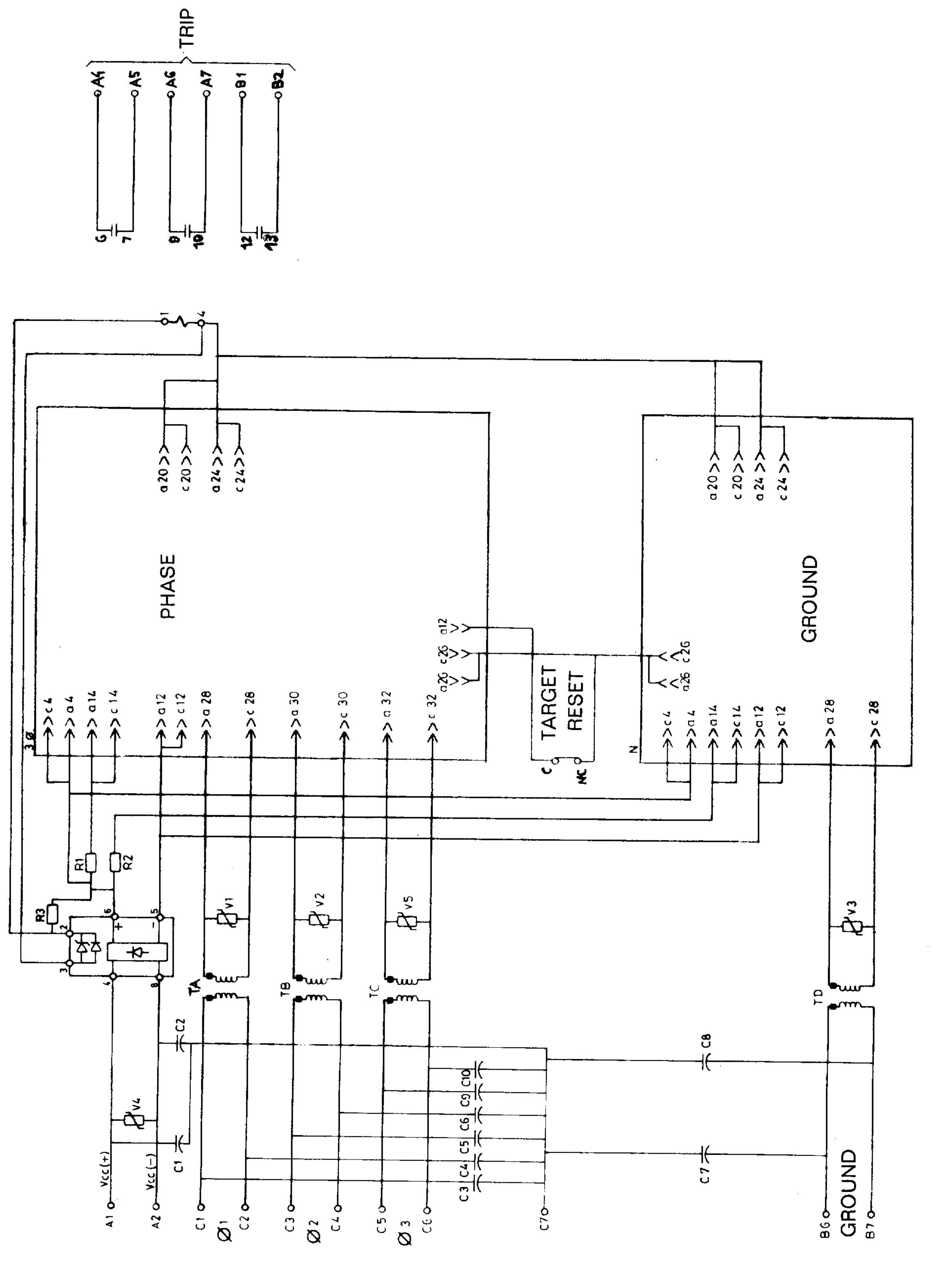


Fig. 23. Internal connection diagram of TOC 8000

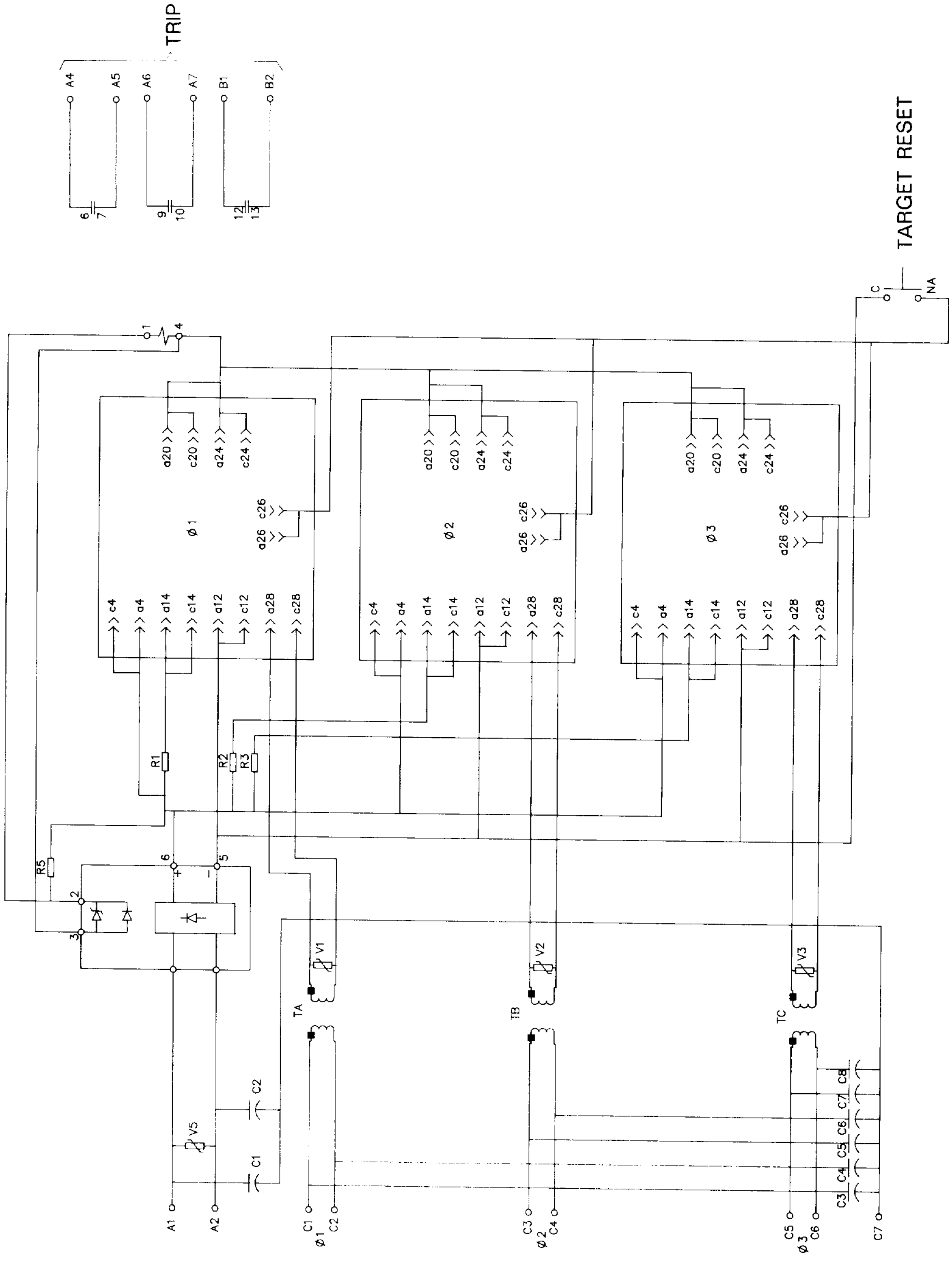


Fig. 24. Internal connection diagram TOC 4000

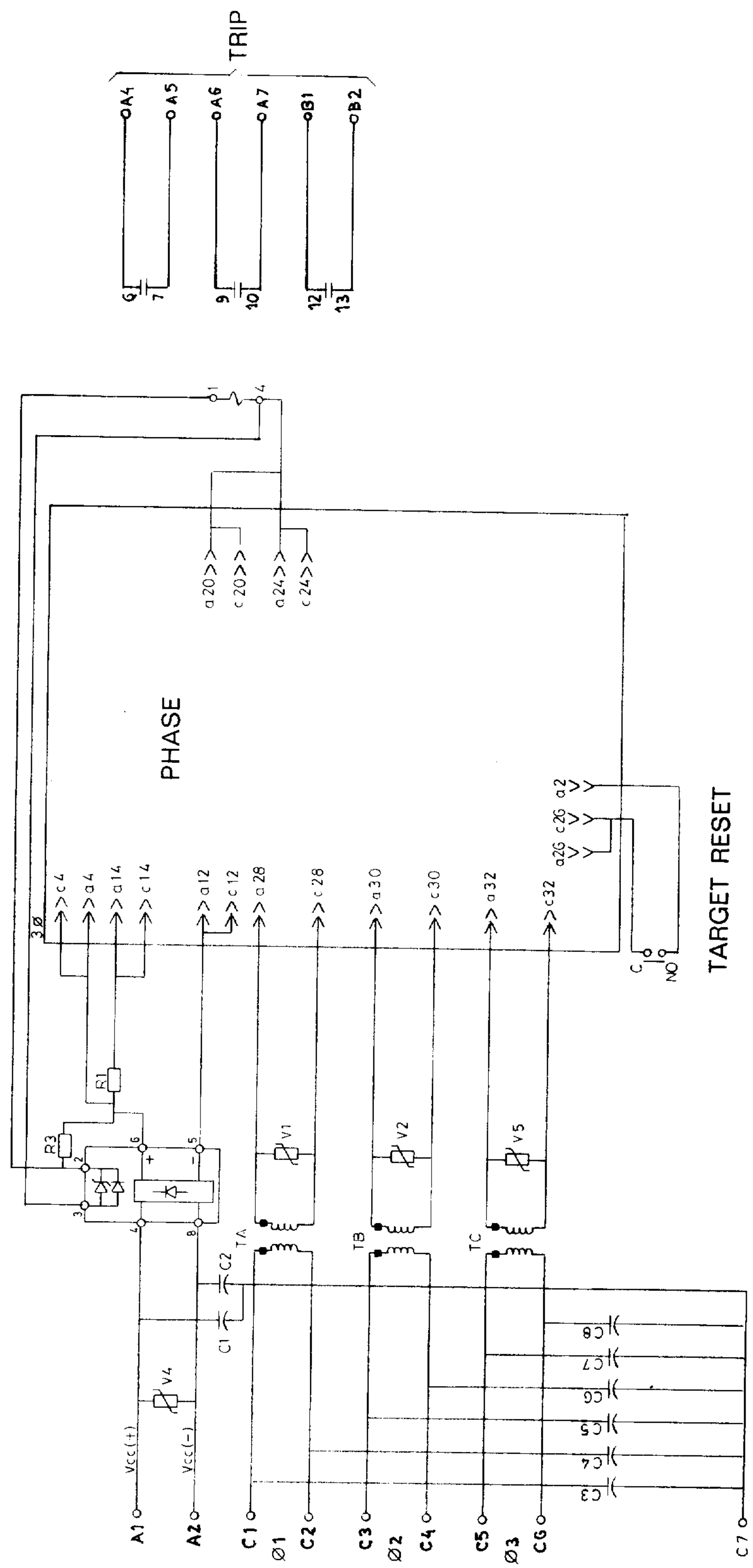


Fig. 25. Internal connection diagram TOC 7000

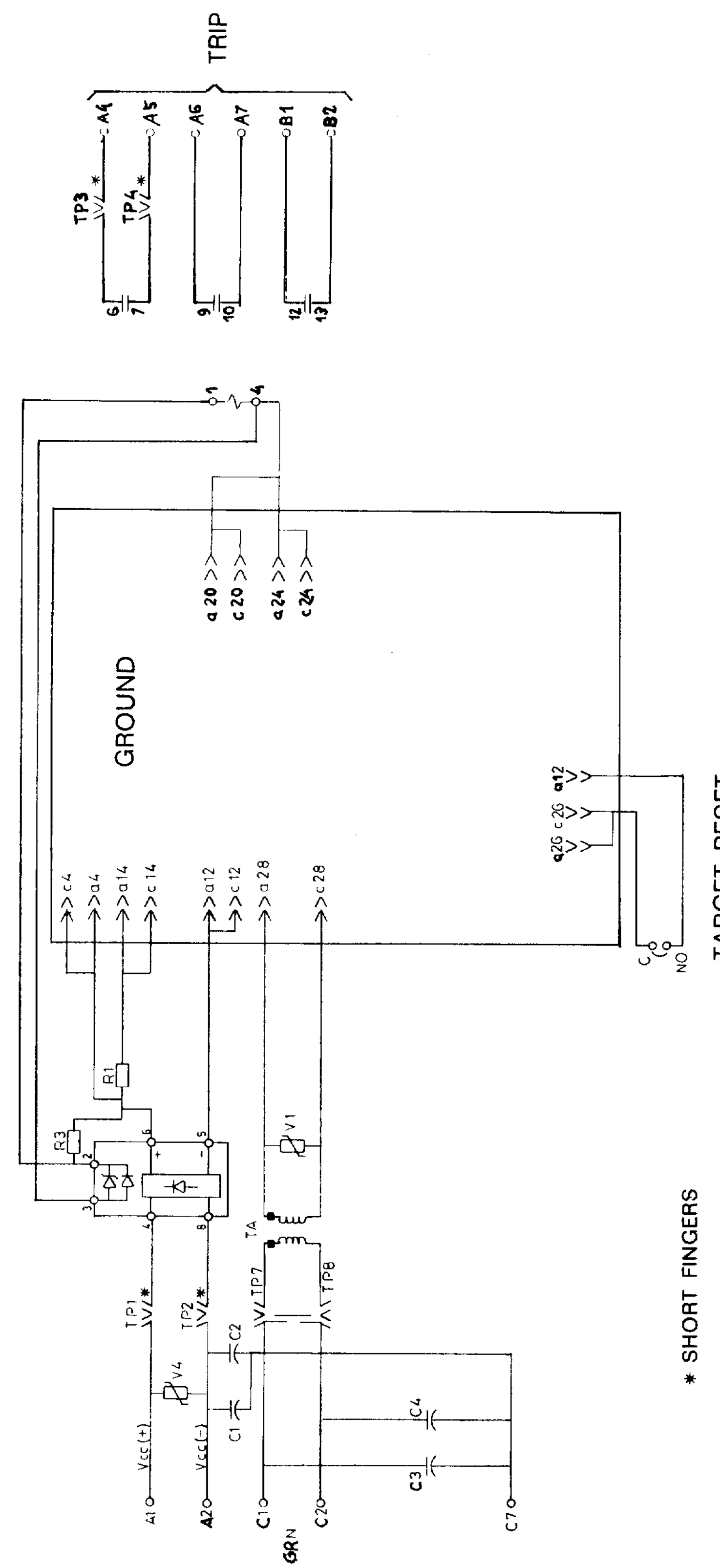


Fig. 26. Internal connection diagram TOC 5100

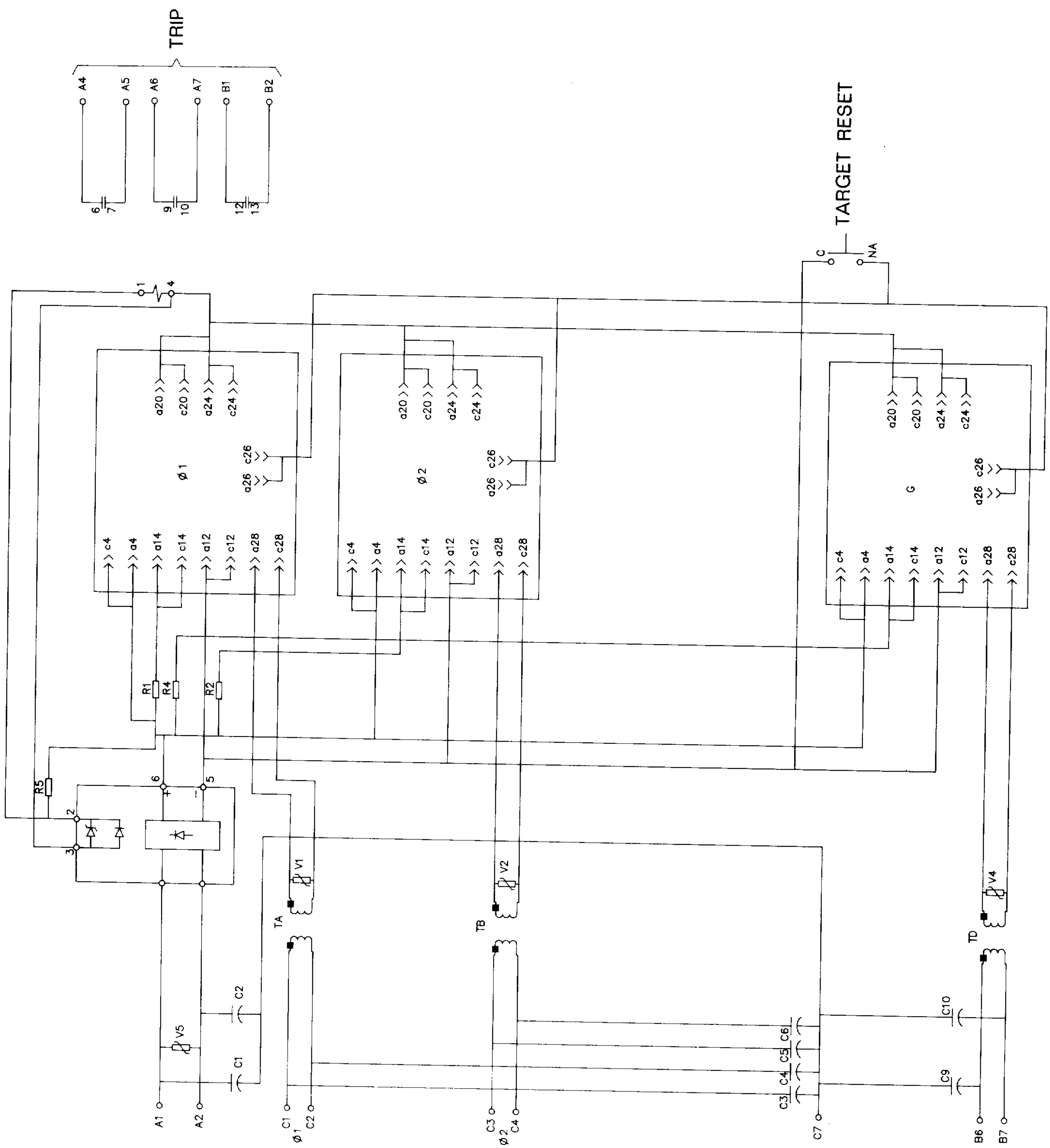


Fig. 27. Internal connection diagram TOC 6000

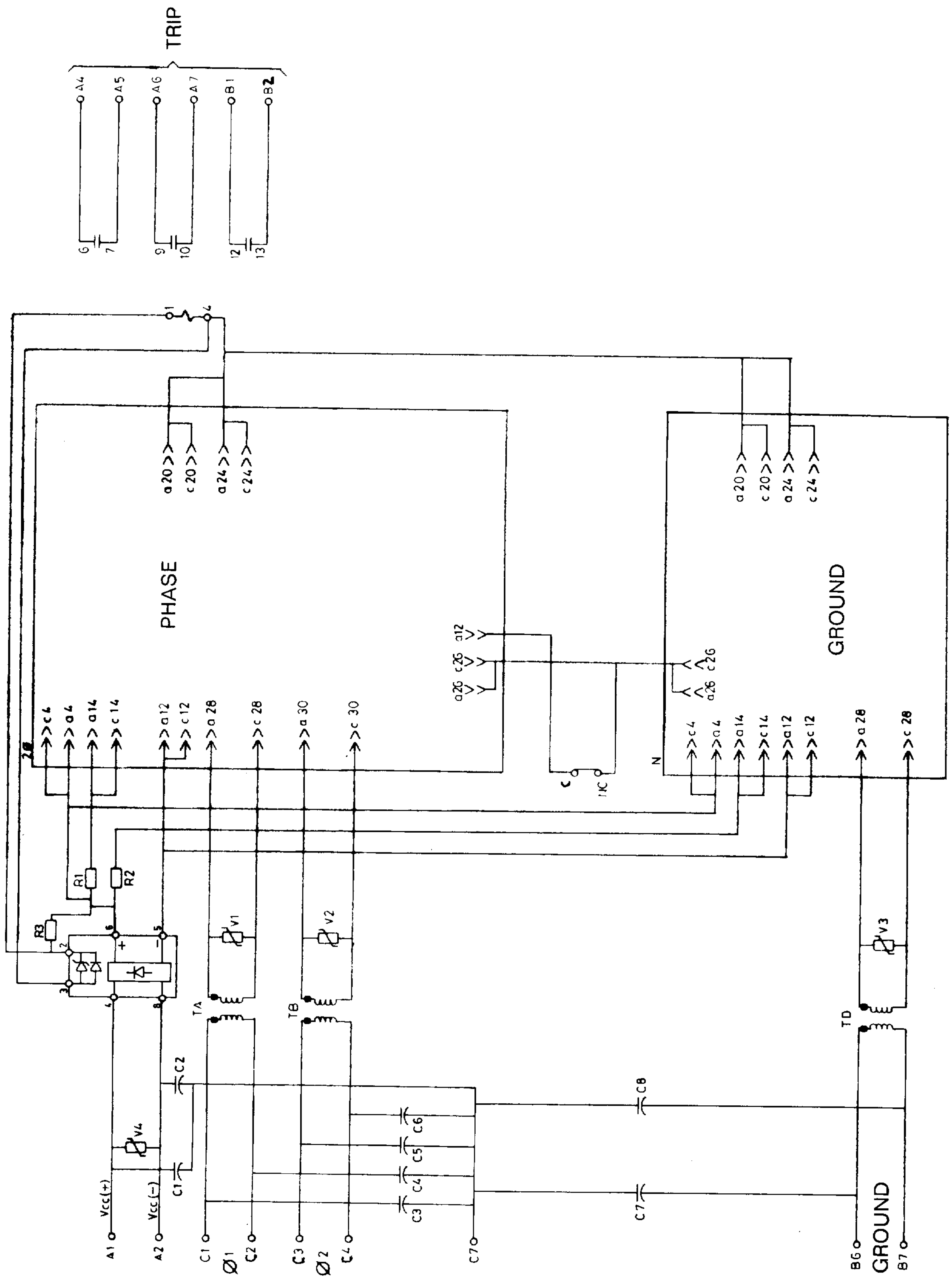


Fig. 28. Internal connection diagram TOC 9000

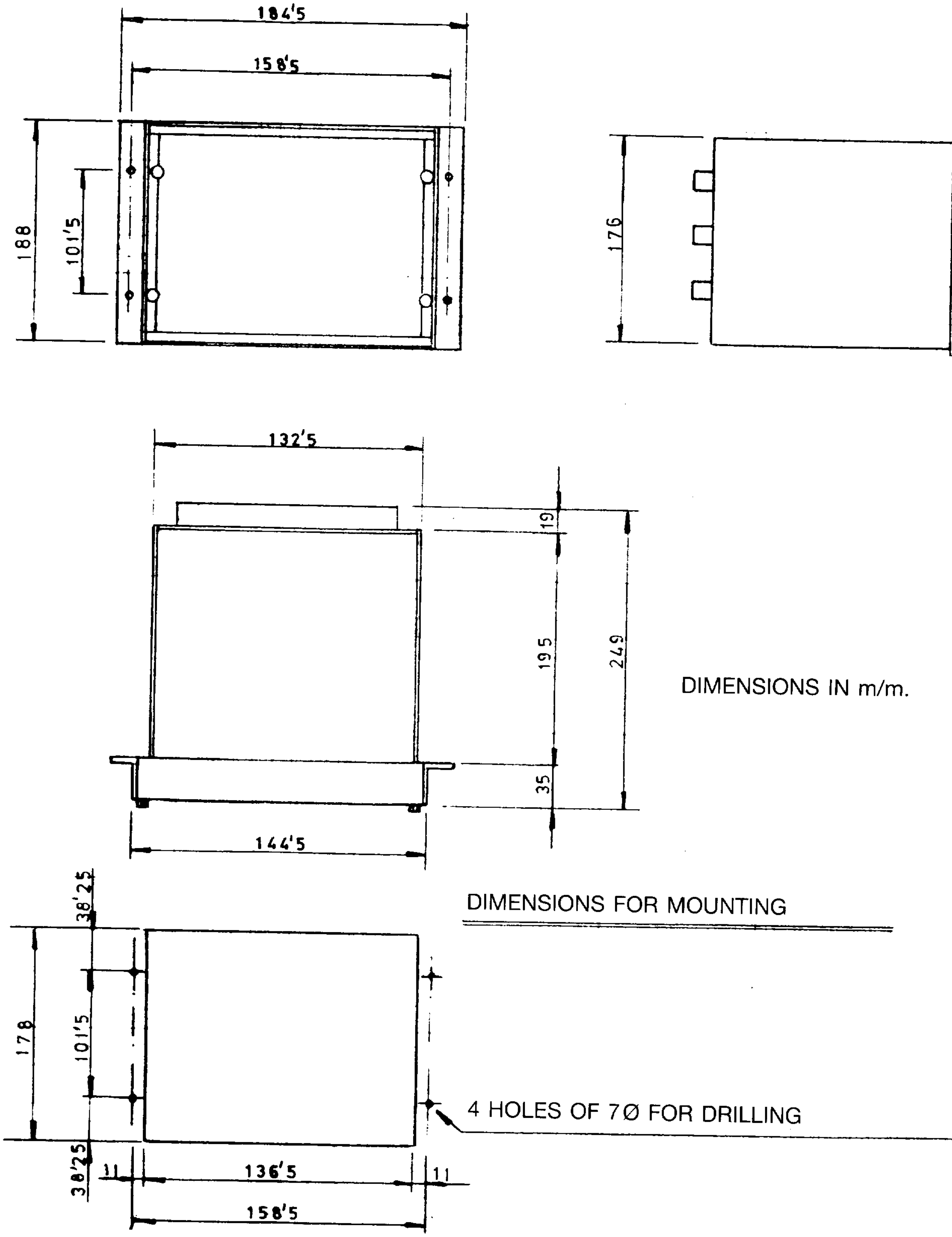


Fig. 29. Outline and panel drilling 1/3 rack case

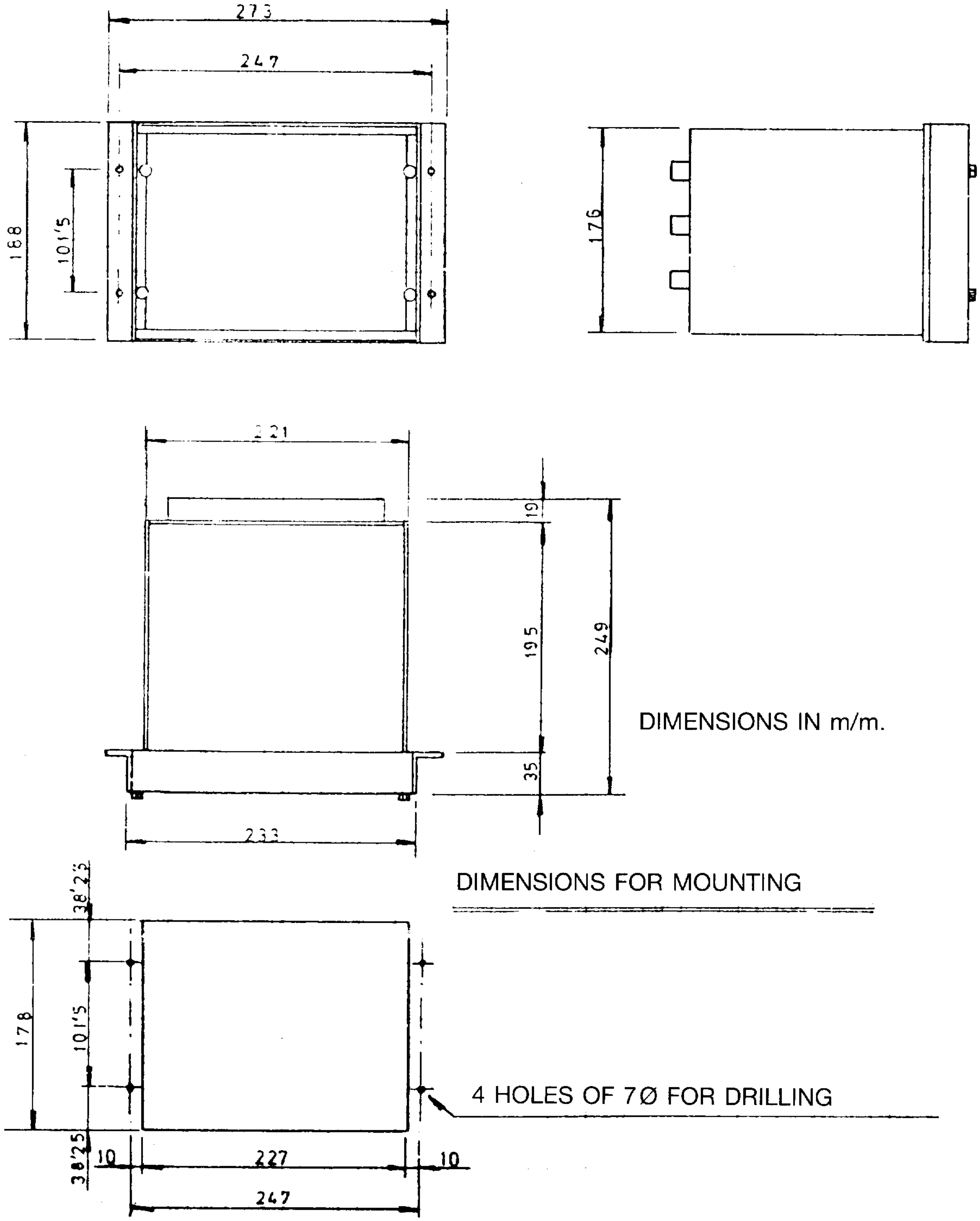


Fig. 30. Outline and panel drilling 1/2 rack case

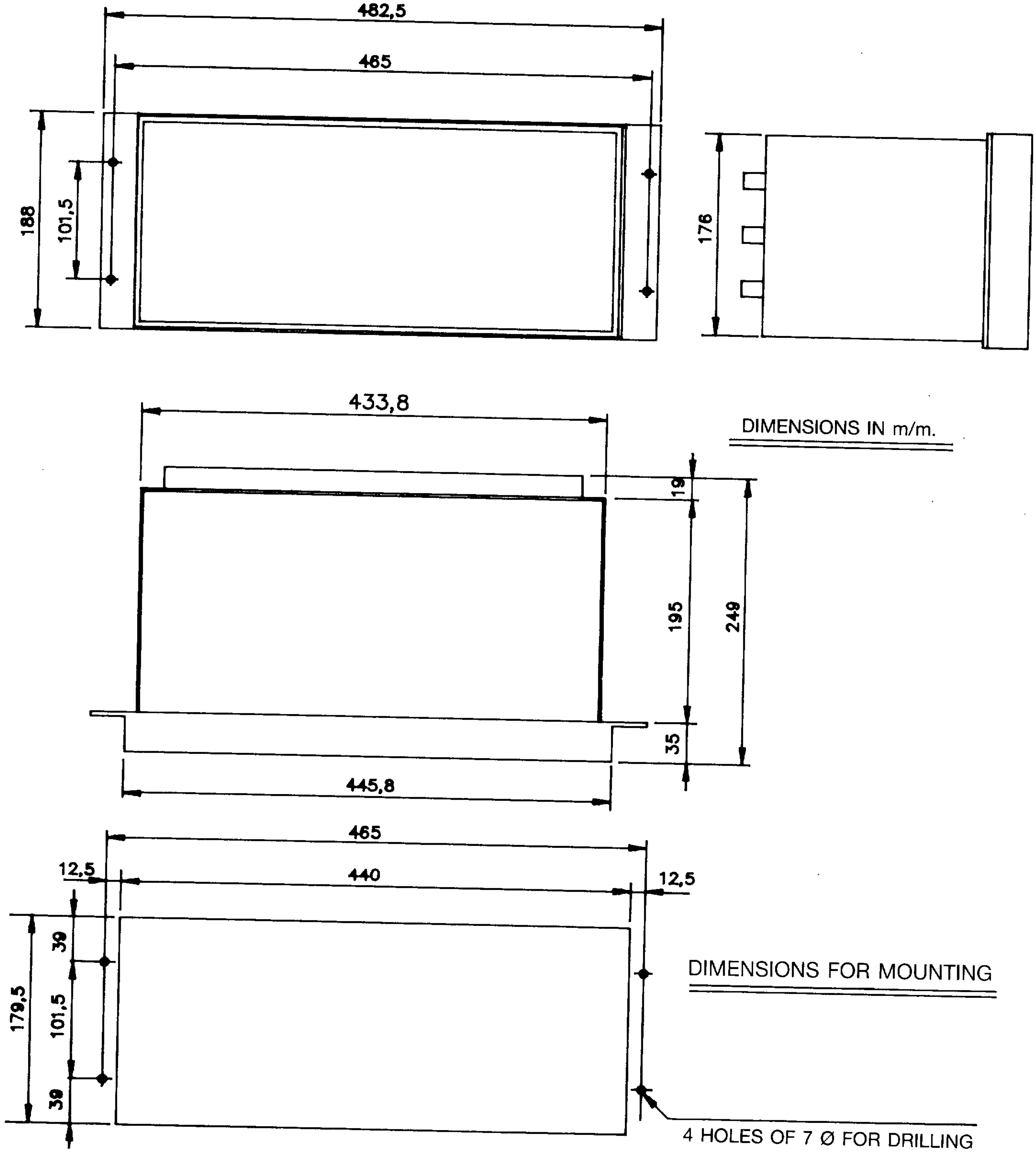


Fig. 31. Outline and panel drilling 1 rack case

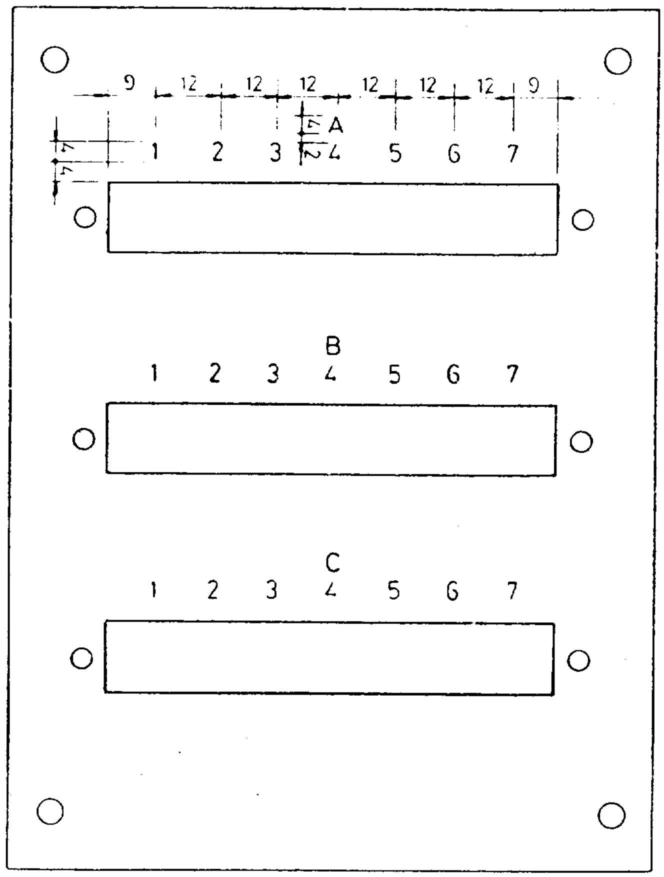


Fig. 32. Layount of terminal bloks on the rear side of the 1/3 rack case.

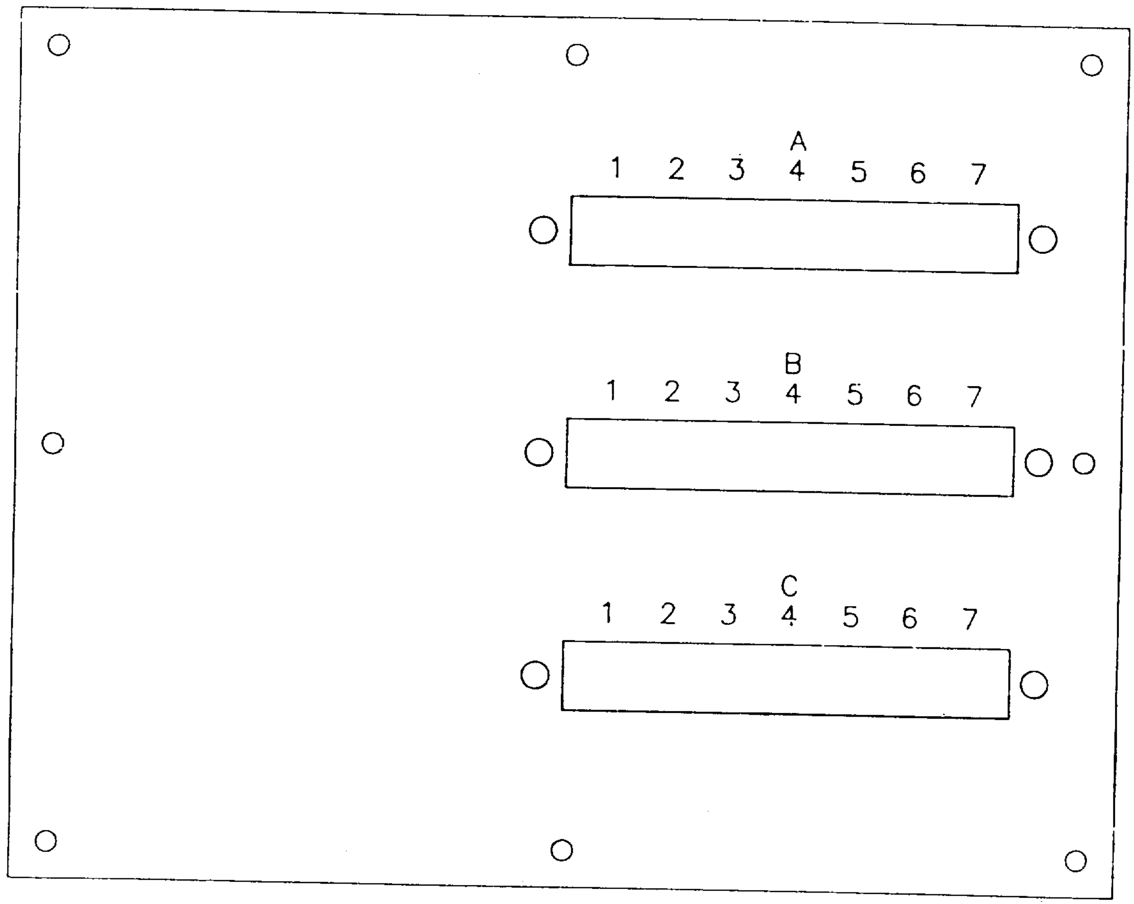


Fig. 33. Layount of the terminal bloks on the rear side of the 1/2 rack case.

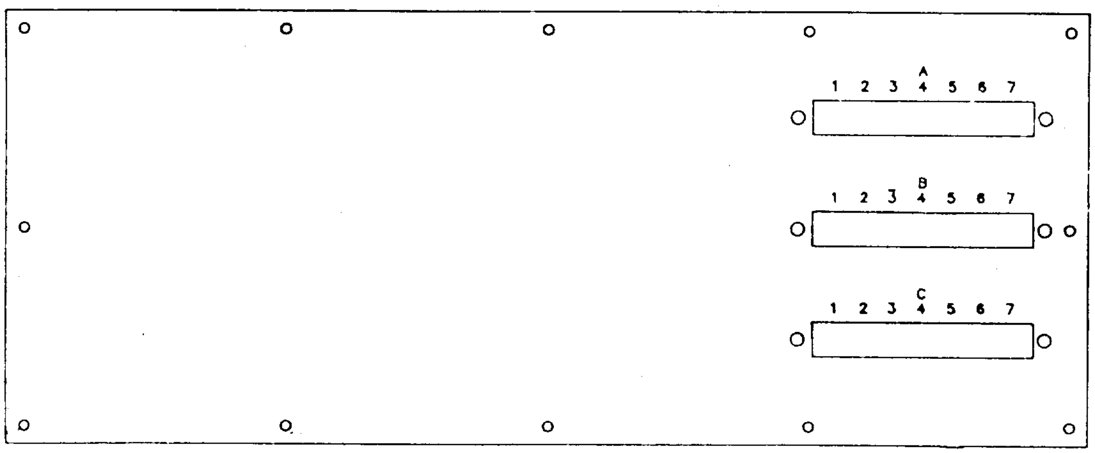


Fig. 34. Layount of terminal bloks on the rear side of the 19" rack case.

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