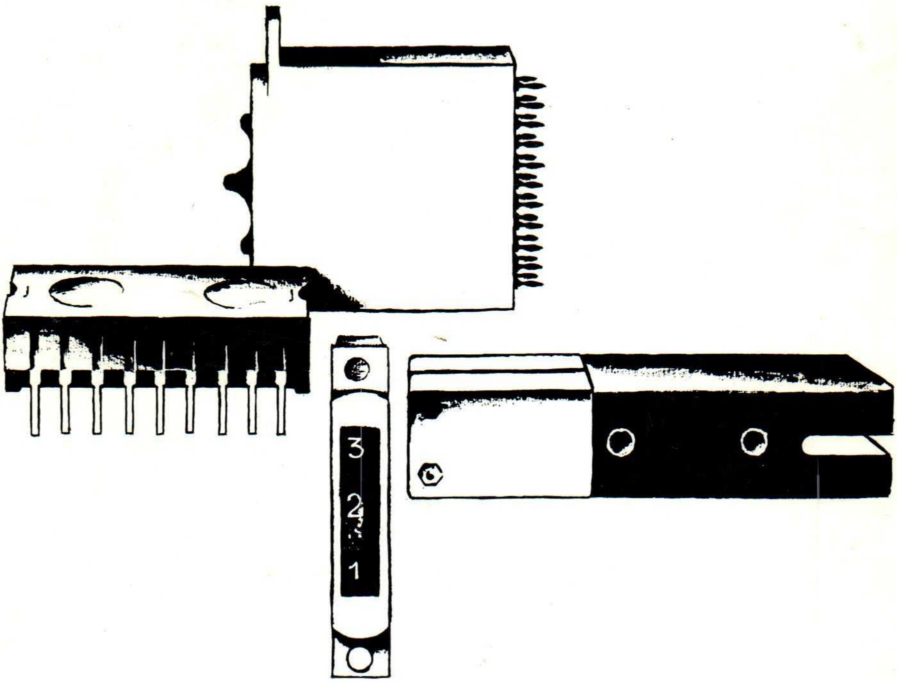
PHILIPS

PRODUCT DATA

PHILIPS ELECTRONIC COMPONENTS AND MATERIALS DIVISION

CIRCUIT BLOCKS 40-SERIES
NORBITS 60-SERIES,
INPUT/OUTPUT DEVICES

SEPTEMBER 1969



The contents of this booklet form an extract from the volume "Components and Materials" Part 1 entitled "Circuit blocks, Input/output devices", issued September 1969.

Circuit blocks

40-Series

OPERATIONAL AMPLIFIER

GENERAL

The DOA40 is a high gain, wide band, low drift d.c. differential amplifier. Input voltage offset can be externally corrected.
A 6 dB/octave roll-off network is built-in. Terminals are available to connect an external roll-off network.

This unit is developed for use with power supplies of +15 V. As many control systems use 12 V supplies, some data are given for use at these voltages at the end of the specification.

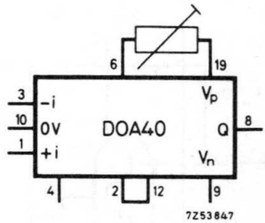


Fig.1. Drawing symbol

Dimensions in mm

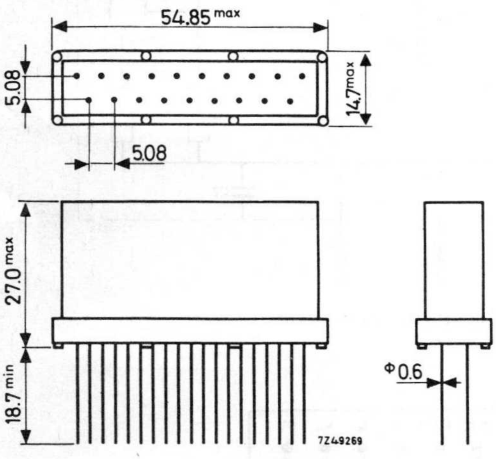


Fig.2.

The complete circuit is potted inside a metal can with 19 wire terminals. The can is internally connected to terminal 10 (0 V)

Circuit diagram and terminal location

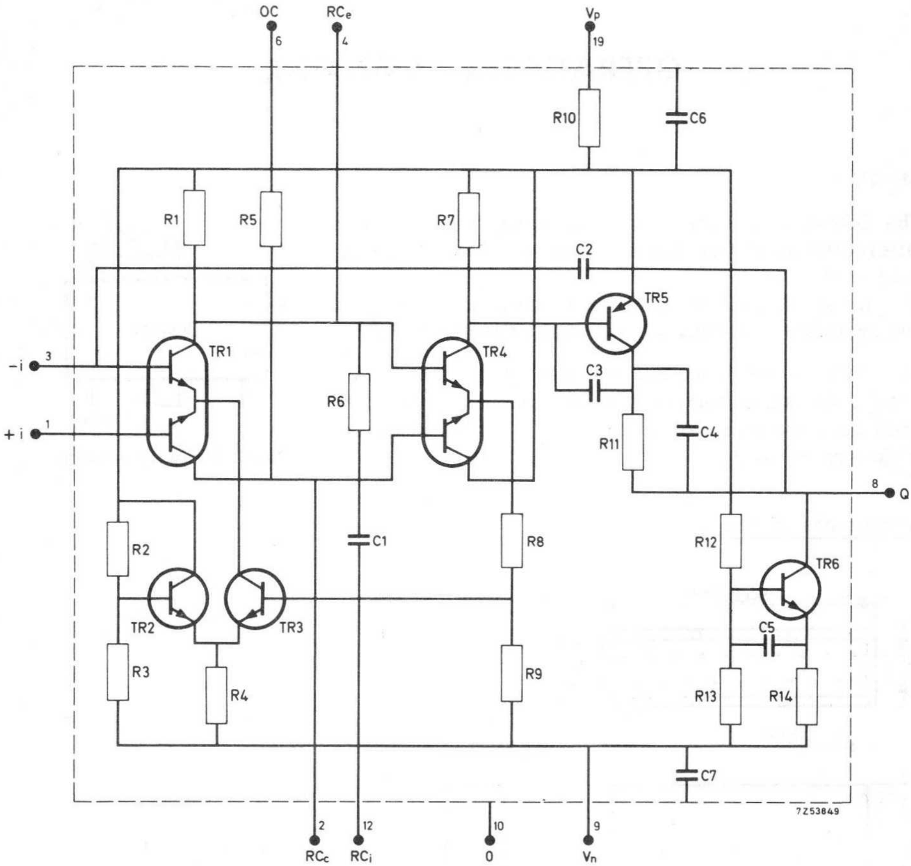


Fig.3. Circuit diagram

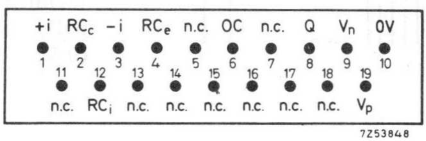


Fig.4. Terminal location

TECHNICAL PERFORMANCE

Ambient temperature range: operating	0 to +85 °C
storage	−40 to +85 °C
Max. case temperature	91 °C

Power supply

Supply voltages	V_P = +15 V ± 3% V_N = −15 V ± 3%
Supply currents	I_P = 10 mA + load current I_N = 10 mA + load current

Input data (ambient temperature +25 °C unless noted otherwise)

Open loop gain	minimum	typical
DC, max. load	25 000	60 000
DC, 100 kΩ load	100 000	150 000

Input voltage offset

Initial offset can be trimmed to zero by means of an external variable resistor of 15 kΩ between terminals OC and V_P

	maximum	typical
drift with temperature change (0 °C to +85 °C)	5 μV/deg C	3 μV/deg C
drift with supply voltage change		
for +15 V supply	7 μV/%	3 μV/%
for −15 V supply	3 μV/%	2 μV/%

Input current	maximum	typical
Each input: bias current	700 nA	300 nA
drift with temperature change (0 °C to +85 °C)	7 nA/deg C	3 nA/deg C
Differential: initial offset	35 nA	6 nA
drift with temperature change (0 °C to +85 °C)	1 nA/deg C	0.3 nA/deg C

Input impedance	minimum	typical
between inputs	75 kΩ	200 kΩ
common mode	60 MΩ	100 MΩ

Input voltage		
max. voltage between inputs	+5 and −5 V	
max. common mode voltage	+10 and −10 V	
common mode rejection	min. 20 000 typ. 60 000	
Voltage noise (16 Hz - 16 kHz)	3 μV (rms)	

Output data

Output voltage (at a load current of 6 mA)	min. +10 V to −10 V	
Load resistance	min. 1.67 kΩ	
Output resistance	< 5 kΩ	

Frequency response

Unity gain bandwidth (small signal)	min. 8.5 MHz	typ. 9.5 MHz
Full output response (20 V_{p-p})		
with 10 kΩ load	min. 40 kHz	typ. 60 kHz
with 1.67 kΩ load	min. 33 kHz	typ. 50 kHz
Slewing rate (R_{load} = 10 kΩ)	min. 2.5 V/μs	typ. 3.7 V/μs

Specifications for the DOA40 used with 12 V supply

If the DOA40 is used with 12 V supply, the specifications remain the same as those given for the 15 V supply, except those listed below.

Power supply voltages	V_P = +12 V ± 5% V_N = −12 V ± 5%
Power supply currents (load current and feedback current to be added)	I_P = 8 mA I_N = 8 mA
Input currents	multiply the data given for 15 V supply by 0.8
Common mode voltage	+8 V, −8 V
Output voltage at a load current of 5 mA	+9 V, −9 V
Load resistance	1.8 kΩ (min.)

APPLICATION INFORMATION

When used in a follower circuit, the DOA40 may exhibit instability. To avoid this, it is good practice to insert a 10 kΩ resistor between the signal source and the amplifier input.

The characteristics of the DOA40 are such that adaption circuitry is unnecessary for most applications. However, three special situations which are sometimes encountered - comparatively small input currents, comparatively large output capability, and the need to adjust input current to zero - can also be handled by the DOA40 with the simple adaption circuits described below.

Reduction of input current and increase of input impedance

The dual transistor BCY87 connected as an emitter-follower in the circuit of Fig.5 can be used to reduce the input current to 40 nA per input and increase the input impedance to 15 MΩ between inputs (typical values).

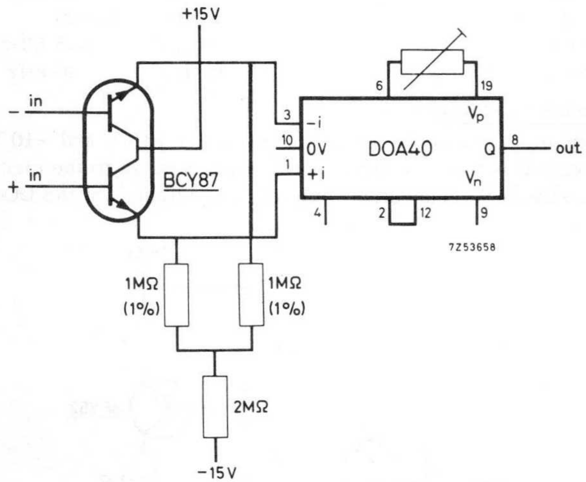


Fig.5. Configuration giving reduced input current and increased input impedance. The component values given are typical.

The characteristics of the circuit are given below. Other characteristics not listed are those of the DOA40 unit alone.

Supply voltage rejection (both supplies)	typical	80 μV/V
Input voltage, drift with temperature change	typical	5 μV/deg C
	maximum	10 μV/deg C
Input current / each input		
bias current	typical	40 nA
	maximum	60 nA
drift with temperature change	typical	0.25 nA/deg C
/ differential		
initial offset	typical	4 nA
	maximum	6 nA
drift with temperature change	typical	0.1 nA/deg C
Input impedance between inputs,	typical	15 MΩ
	minimum	10 MΩ
common mode	typical	600 MΩ
Common mode rejection	typical	10 000
Unity gain bandwidth	typical	6.5 MHz
Full output frequency (20 V_{p-p})	typical	40 kHz

Increase of the output capability

The circuit of Fig.6 is capable of delivering 50 mA at +10 V and -10 V. The output can be short-circuited momentarily without causing damage to the circuit. Feedback networks if used should be connected to the circuit output, not the DOA40 output.

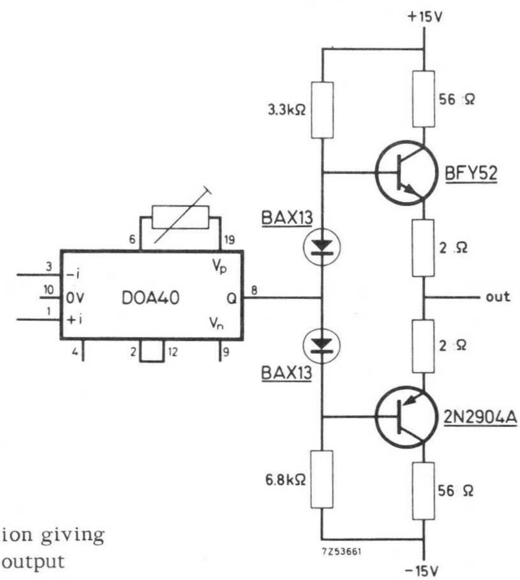


Fig.6. Configuration giving increased output capability.

Zero adjustment of input current

Each DOA40 input requires a bias current of 700 nA to give zero output voltage. By supplying this bias current from an external source, the DOA40 output can be made zero for a driving signal current equal to zero.

In Fig.7a the negative input (pin 3) is to be so adjusted. A 10 MΩ resistor should be connected between the output and pin 3, and the potentiometer R_2 adjusted so that the output voltage of the DOA40 becomes equal to zero (i.e., the current through R_1 becomes equal to the bias current of that input). The 10 MΩ resistor should then be removed.

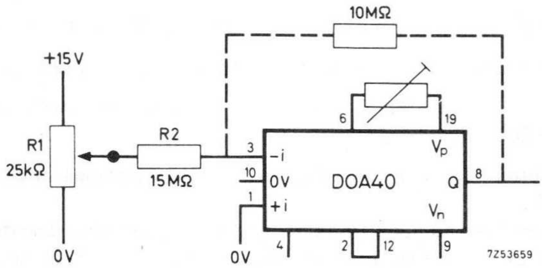


Fig.7a. External supply of bias current: adjustment of negative input.

The positive input (pin 1) may now be adjusted with the circuit of Fig.7b. Connect pin 3 to the DOA40 output, and the 10 MΩ resistor between pin 1 and ground. The potentiometer R_3 can now be adjusted so that the DOA40 output becomes zero. Disconnect the 10 MΩ resistor.

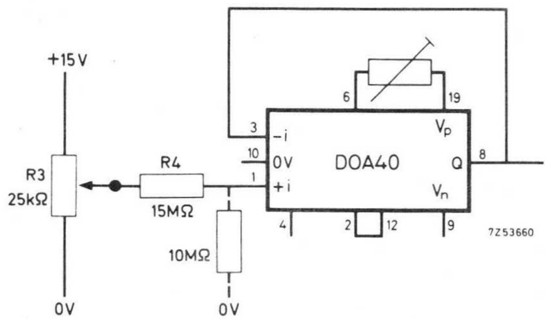


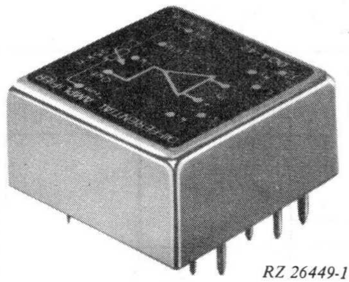
Fig.7b. External supply of bias current: adjustment of positive input.

Several publications are available which may be of further interest.

1. "Operational Amplifiers", Application Information.
   This publication gives an introduction to the use of operational amplifiers as engineering tools. The concepts and terminology of the general operational amplifier, and the properties and accuracy of a typical circuit are presented.
2. "Digital to Analogue and Analogue to Digital Conversion", Application Information. The publication gives detailed information on the construction of both types of converter.
3. "Flux Meter with Digital Read-out", Application Note (Print No. 9399 210 00601).
4. "Simple Process Control", Application Note (Print No. 9399 214 05501).
5. "Electronic Potentiometer", Application Note (Print No. 9399 260 00201).
6. "A level Detector Using the Operational Amplifier DOA40", Application Note (Print No. 9399 260 03101).

The Application Notes (3, 4, 5 and 6) give brief descriptions of practical applications of the DOA40.
Small discrepancies may be seen to exist in terminal location drawings in the above publications. The terminal locations as given in this Data Sheet are the ones to be followed.

DIFFERENTIAL AMPLIFIER



RZ 26449-1

GENERAL

The DOA42 is a high-gain, wideband, low-drift d.c. differential amplifier which may also be used as an operational amplifier. The input-voltage offset can be corrected externally.

A roll-off network is built in to ensure stable operation at feedback values between 100 and 60 dB (loop gain between 0 and 40 dB). Data on additional external compensating RC circuits to be used at lower gain values are given below under "Application information".

The unit, developed for use with power supplies producing +15 and −15 V, can also be operated from 12 V supplies if reduced output characteristics are acceptable. Some data are given for use at these voltages under "Technical Performance".

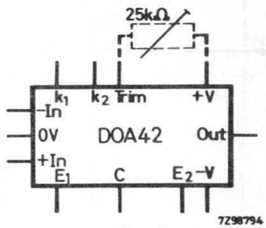


Fig.1
Drawing symbol

Dimensions (in mm) and terminal identification

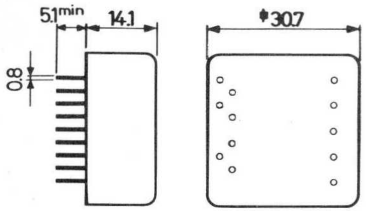
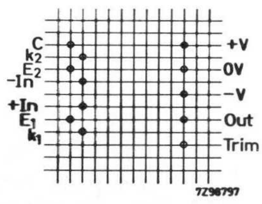


Fig.2



+V	=	positive supply voltage
−V	=	negative supply voltage
0 V	=	earth and housing
+In	=	non-inverting input
−In	=	inverting input
k_1, k_2	=	terminals for external freq. compensation
Trim	=	for external offset correction
Out	=	amplifier output terminal
E_1	=	emitter 1
E_2	=	emitter 2
C	=	collector

Fig.3. Terminal location (bottom view) on 0.1 in grid

Circuit diagram

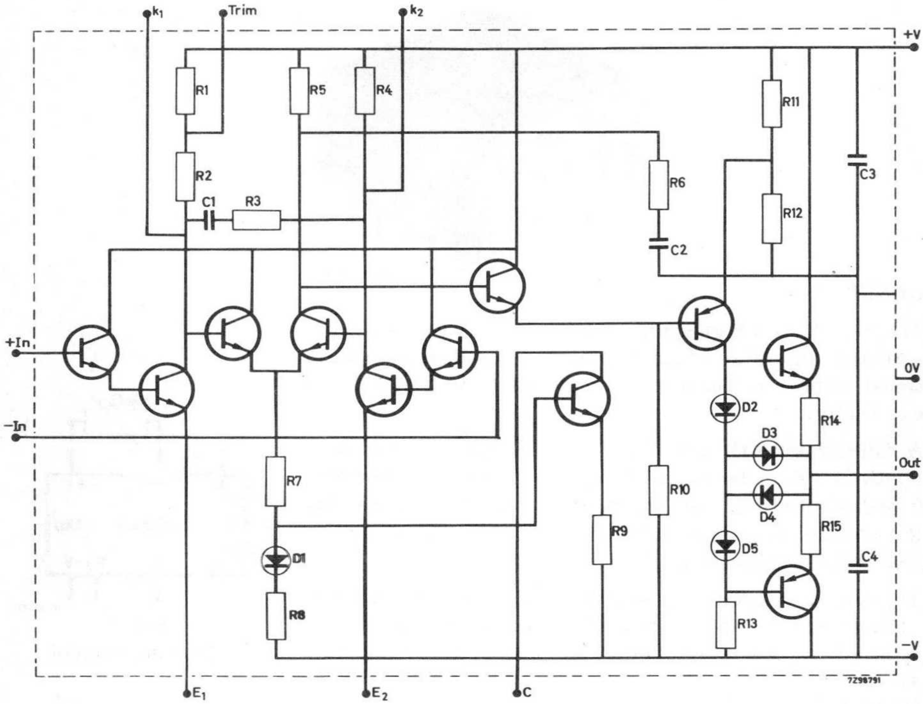


Fig.4

TECHNICAL PERFORMANCE

Ambient temperature range: operating	−25 °C to +85 °C
storage	−55 °C to +85 °C
Max. case temperature	85 °C
Power supply	+15 V ±3%, 3.7 mA (typ.)+load current −15 V ±3%, 1 mA (typ.)+load current

Input data (ambient temperature +25 °C unless stated otherwise)

Open loop gain	minimum	typical
DC, max. load		106 dB
DC, 10 kΩ load	100 dB	106 dB

Input voltage offset

Initial offset can be trimmed to zero by means of an external variable resistor of 25 kΩ between terminals Trim and +V.

	maximum	typical
Drift with temperature change (0 °C to +85 °C)		7 μV/degC
Drift with supply voltage change		
for +15 V supply	± 20 μV/V	± 10 μV/V
for −15 V supply	± 20 μV/V	± 10 μV/V

Input current	maximum	typical
Each input: bias current	20 nA	5 nA
drift with temperature change (0 °C to +85 °C)	0.5 nA/degC	0.1 nA/degC
Differential: initial offset	4 nA	1 nA
drift with temperature change (0 °C to +85 °C)	100 pA/deg C	30 pA/degC

Input impedance	minimum	typical
between inputs	5 MΩ	20 MΩ
common mode		1000 MΩ

Input voltage

Max. voltage between inputs	+5 and −5 V	
Max. common mode voltage	+5 and −5 V	
Common mode rejection	min. 80 dB	typ. 100 dB
Voltage noise (0 - 10 kHz)	max. 15μV (rms)	typ. 8 μV (rms)

Output data

Output voltage (total current 5 mA)	min. +10 V to −10 V
Load resistance	min. 2 kΩ (short circuit proof)
Output resistance	typ. 150 Ω

Frequency response

Unity gain bandwidth (small signal)	typ. 5 MHz
Full output response (20 V_{p-p})	
with 10 kΩ load	typ. 45 kHz
with 2 kΩ load	typ. 40 kHz
Slewing rate (R_{load} = 10 kΩ)	typ. 2.5 V/μs

Specifications for the DOA42 used with 12 V supply.

If the DOA42 is used with a 12 V supply the specifications remain the same as those given for a 15 V supply except for the data given below:

Power supply	V_P = +12 V ± 5%, 2.9 mA(typ.)+ load current V_N = -12 V ± 5%, 0.8 mA(typ.)+ load current
Input currents	multiply the data given for 15 V supply by 0.8
Max. common mode voltage	+4 V, −4 V
Output voltage at a load current of 4 mA	+9 V, −9 V
Load resistance	min. 2.25 kΩ

APPLICATION INFORMATION

– Fig.5 gives the frequency response for various gain levels. When the amplifier is applied with a closed loop gain of less than 40 dB external compensation RC series circuits have to be connected between the pins k_1 and k_2.
The corresponding external correction networks are given in Fig. 6.

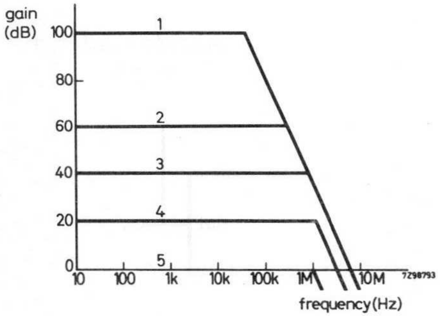


Fig.5

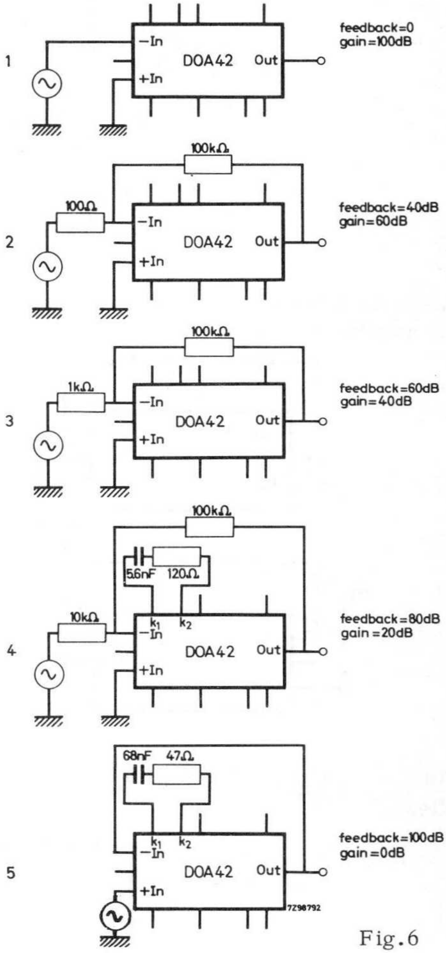


Fig.6

– Use as an operational amplifier.

For use as an operational amplifier the terminals E_1, E_2 and C should be interconnected directly across the pins.

- Use as a differential amplifier with a high input impedance.

Operational amplifiers used as differential amplifiers have a rather low input impedance, because the input impedance of the negative input is equal to R1 (see Fig.7), which is limited.

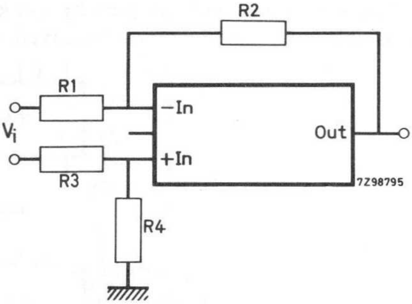


Fig.7

Resistors R3 and R4 give symmetry to the input. For high input impedance differential amplifiers a set-up with 3 operational amplifiers is often used (Fig.8).

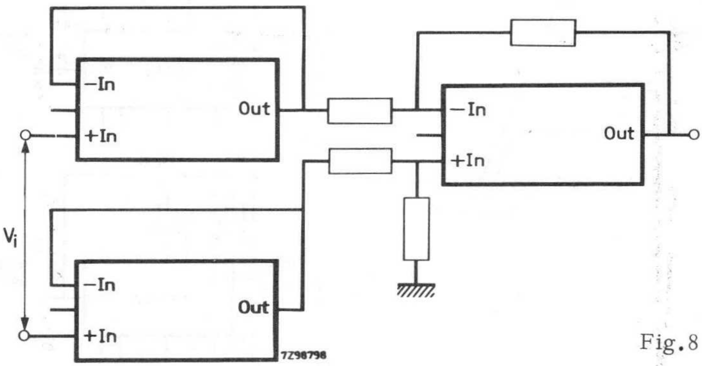


Fig.8

With one DOA42 a high input impedance differential amplifier can be obtained as follows:

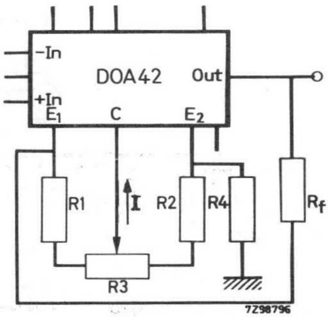


Fig.9

The input impedance is high for both inputs. The transfer formula then is:

$$\frac{V_{out}}{V_{in}} = \left\{ \frac{1}{2} \left(1 + \frac{R_f}{R4}\right) + \frac{2R_f}{R1 + R2} \right\} - \frac{R_f\,(R1 - R2)}{R1 + R2} \cdot \frac{I}{V_{in}} + \left(\frac{R_f}{R4} - 1\right) \frac{V_{cm} - V_{be}}{V_{in}}$$

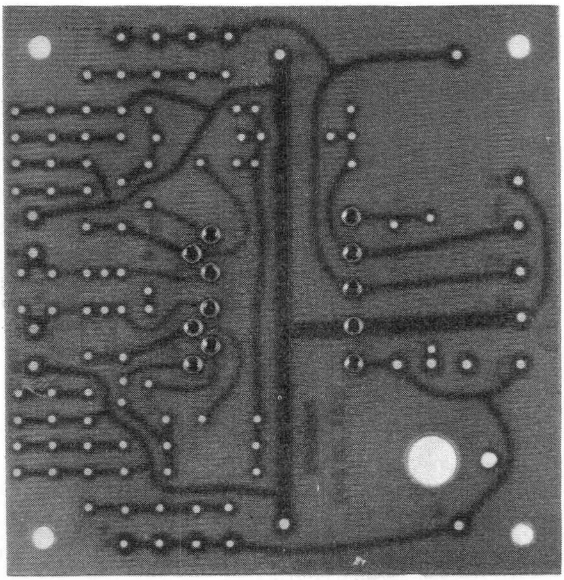
where V_{cm} = common mode voltage, R_f = feedback resistance, V_{be} = base-emitter voltage.

Thus, for R2 = R1 and R4 = R_f $\quad \frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R1}$

The input impedance of this circuit is equal to the input impedance (min. 5 MΩ) of the normal DOA42 configuration without feedback (E1, E2, C shortcircuited). In those cases where a high input impedance differential amplifier is required, the DOA42 offers a unique solution.

ACCESSORIES

A printed-wiring board (see photograph) providing plug-in facilities for the DOA42 can be ordered separately.
This board will also accommodate a trimming potentiometer.



RZ 26423-5

DIFFERENTIAL ZERO DETECTOR

GENERAL

This unit can be used as a zero detector, voltage comparator, polarity detector, adjustable discriminator or differential amplifier.
Its feature of offering compatible signals for digital systems (e.g. composed of circuit blocks of the 10- or 20- Series) makes this unit a natural interface in hybrid systems.
The DZD 40 has been used succesfully in a wide range of instruments and control systems:

- digital to analogue and analogue to digital converters
- flux meter with digital read out
- automatic pH control system
- electronic potentiometer
- voice or no-voice detector
- automatic frequency characteristic testing
- over and under voltage detection
- over-dissipation switch in transmitter power stage
- servo control
- gas leak detector.

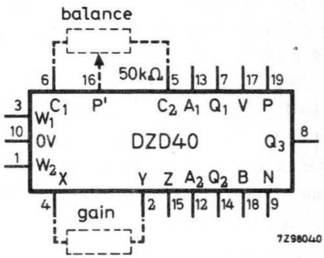
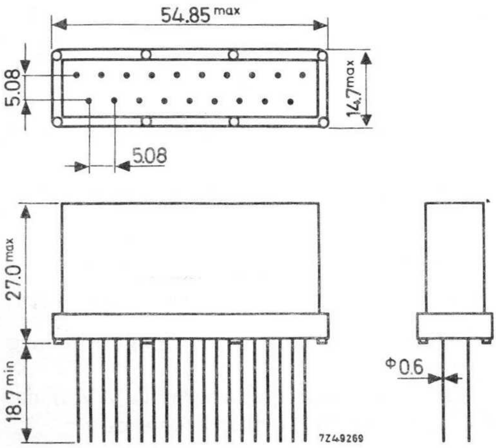


Fig.1 Drawing symbol

Dimensions in mm



The complete circuit is potted inside a metal can with 19 wire terminals.
The can is internally connected to the 0V supply (terminal 10).

Fig.2

Ambient temperature range

	operating	0 to 70 °C
	storage	-40 to +85 °C

Power supply

Supply voltages: $V_P = +12V \pm 5\%$, $V_N = -12V \pm 5\%$
or $V_P = +15V \pm 1\%$, $V_N = -15V \pm 1\%$
($V_V = V_B = V_{P'} =$ approx. V_P)

Nominal consumed current at nominal values of V_P and V_N: $I_P = 6$ mA, $I_N = 8.3$ mA

CIRCUIT DESCRIPTION

The differential zero detector comprises a two stage d.c. - coupled differential amplifier followed by an OR-gate and an inverting amplifier.
A voltage difference between the input terminals W_1 and W_2 is amplified about 1000 x by the two stage complementary differential amplifier (TR_1, TR_2, TR_3, TR_4). This amplified voltage difference is applied to the bases of TR_6 and TR_7.
As long as $| V_{A1} - V_{A2} |$ is less than a certain voltage, TR_5 is conducting.
If this voltage is exceeded TR_6 or TR_7 becomes conducting, the base current of TR_5 (via R_{10}) diminishes, the voltage across R_{14} goes up and TR_5 is cut off. So if the input voltage difference between W_1 and W_2 has a certain value either TR_6 or TR_7 are conducting (depending upon the polarity of $| V_{W_1} - V_{W_2} |$) and TR_5 is not conducting. From this it can be seen that V_{Q_1} and V_{Q_2} are in phase opposition with regards to V_{W_1} and V_{W_2}.

Truth table

inputs		outputs		
W_1	W_2	Q_1	Q_2	Q_3
high	high	high	high	low
high	low	low	high	high
low	low	high	high	low
low	high	high	low	high

High-high and low-low in the input rows indicate that signals applied to the inputs differ less than the trip value.

High-low and low-high in the input rows indicate that the voltage difference applied to the input exceeds the trip value.

In the output columns, high stands for +12 V and low for 0 V approximately.

It will be noticed that only one output terminal will be low for any input combination.

Current mode switching (no bottoming of transistors) is used to obtain high switching speeds and to reduce loading of the amplifier.
For this reason the terminals Q_1 and Q_2 should be connected to terminal 0 V if not used and they should be clamped with diodes (as for TR_5) if they are used.

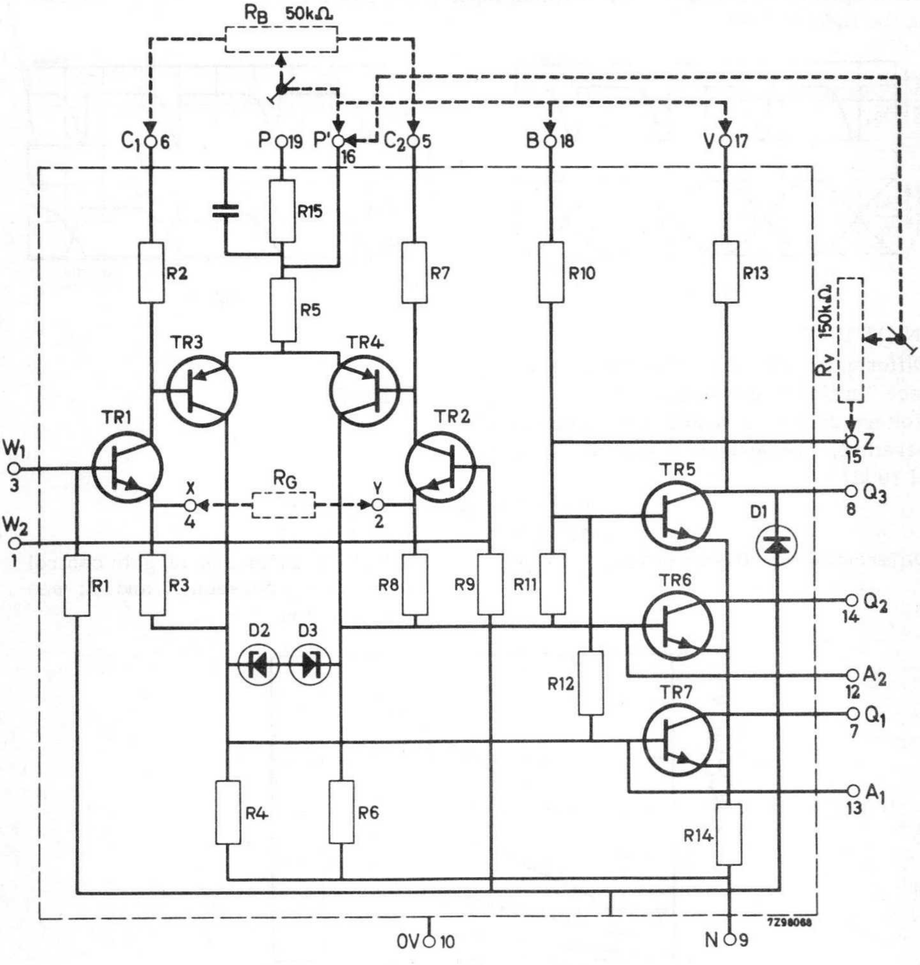


Fig.3. Circuit diagram

Terminal P' should be connected to terminal B for fixed bias or to variable resistor R_V for fine-gain adjustment.

Avoid a shortcircuit between terminals Q_3 and N, as this will damage diode D_1.

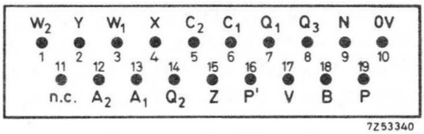


Fig.4. Terminal location

Oscillograms of some voltages with an input voltage of 8 mV_{p-p}, 100 kHz, are shown in the figures below.

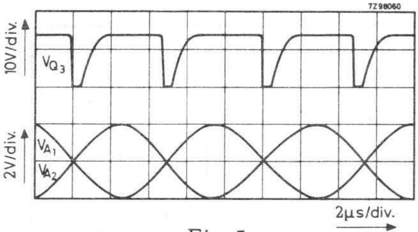


Fig.5

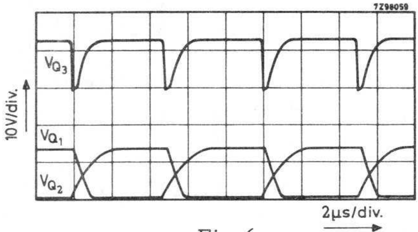


Fig.6

INPUT DATA

Differential off-set voltage after balancing (see "Initial adjustments")	0.1 mV
Voltage drift as a result of a change in temperature, measured at a source impedance of 10 kΩ	
typical value	3 µV / deg C
maximum value	5 µV / deg C
Differential sensitivity ($\lvert V_{W_1} - V_{W_2} \rvert$)	adjustable by means of gain control resistor R_G between X and Y; see graphs below

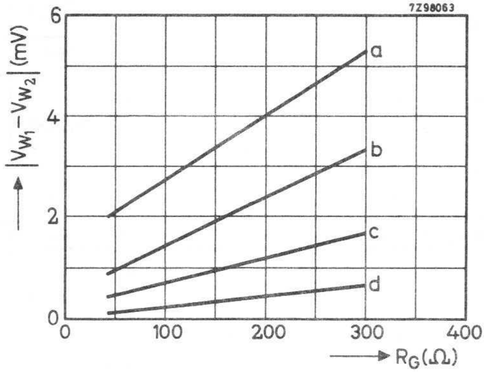


Fig. 7

The curves a and d are worst case limits at T_{amb} = 0 °C.
Curve a applies to the minimum input signal at which TR_5 or TR_6 is conducting (V_{Q1} or V_{Q2} is low) and TR_7 is not conducting (V_{Q3} is high).
Curve d applies to the maximum input signal at which TR_5 or TR_6 is not conducting (V_{Q_1} and V_{Q_2} are high) and TR_7 is conducting (V_{Q_3} is low).
The curves b and c give typical values at T_{amb} = 25 °C.
Curve b : as a.
Curve c : as d.

η = input requirement factor for frequencies over 100 kHz (1.8 at 200 kHz, 1 up to 100 kHz)

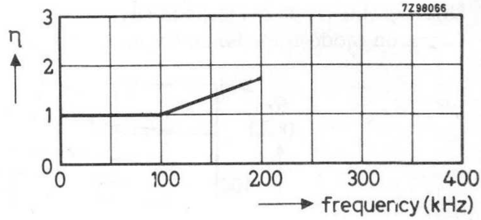


Fig.8

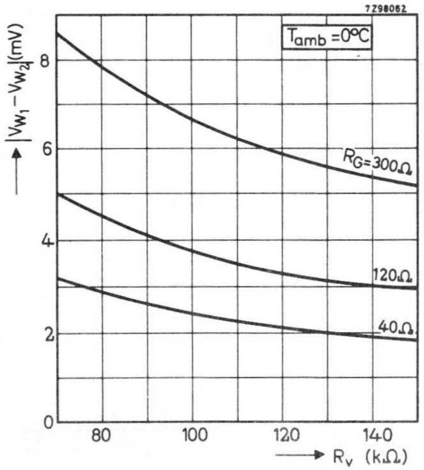


Fig. 9

The curves apply to the minimum input signal at which TR_5 or TR_6 is conducting (V_{Q1} or V_{Q2} is low) and TR_7 is not conducting (V_{Q3} is high).

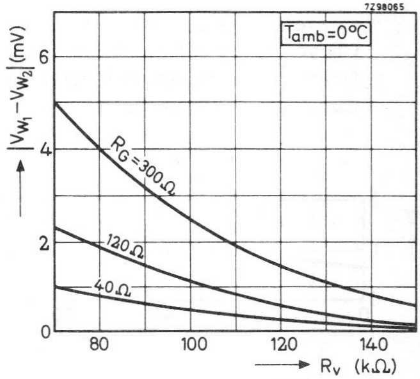


Fig. 10

The curves apply to the maximum input signal at which TR_5 and TR_6 are not conducting (V_{Q1} and V_{Q2} are high) and TR_7 is conducting (V_{Q3} is low).

Maximum value of $\|V_{W_1} - V_{W_2}\|$ to avoid extra delays	700 mV
Maximum voltage between input terminals	5 V
Frequency range	0-200 kHz. From 100 to 200 kHz the differential sensitivity reduces; the input voltage must be multiplied by the factor η (see Fig.8)
Maximum common mode voltage	$\pm$ 2V
Common mode rejection $\|V_{A1} - V_{A2}\|$ (typical value)	80 dB
Differential off-set current	< 30 nA
Current drift as a result of a change in temperature (typical value)	1 nA / deg C

Differential input resistance (R_i) — see Figs.11 and 12
Common mode impedance (typical value) — 1.2 MΩ

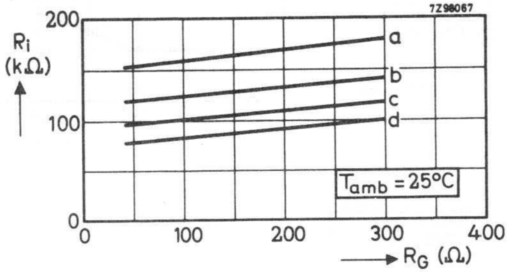


Fig.11

Curve a : typical differential input resistance
Curve b : typical input resistance between each input and 0 V
Curve c : minimum differential input resistance
Curve d : minimum input resistance between each input and 0 V

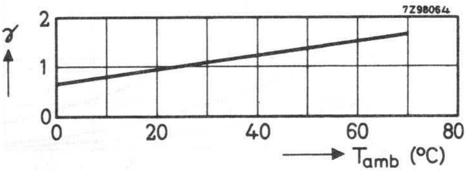


Fig.12. $\gamma = \frac{R_i \text{ at } T_{amb}}{R_i \text{ at } T_{amb} = 25\ ^oC}$

OUTPUT DATA

Outputs A_1 and A_2

Voltage gain	see Fig. 13
Maximum undistorted voltage $V_{A_1} = -V_{A_2}$	1 V
Band width at 3 dB	0 - 150 kHz
Minimum load resistance	100 kΩ

Outputs Q_1 and Q_2 *)

Maximum current at $V_Q > 0V$ **)	3.5 mA
Load resistance	3.6 kΩ

Output Q_3

	V and P' interconnected	V and P' not interconnected
Maximum current	2.5 mA	3.5 mA
Load resistance	5 k Ω	3.6 k Ω

*) If the outputs Q_1 and Q_2 are not used these terminals should be connected to terminal 0 V.

**) Clamp diodes (e.g.BAX13, BAY38, 1N4009) must be externally connected to Q_1 and Q_2.

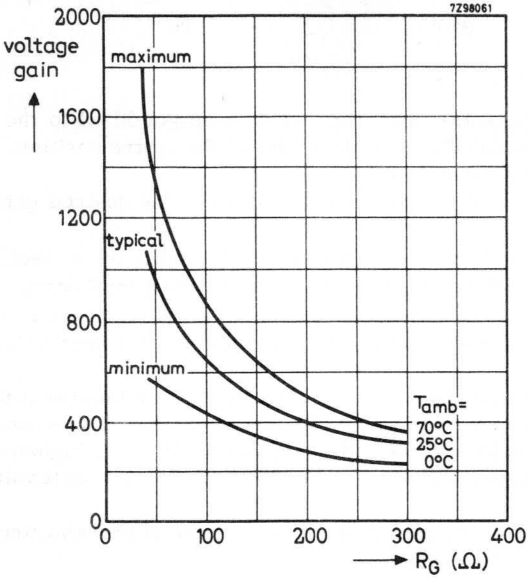


Fig.13

APPLICATION INFORMATION

Application hints

1. Avoid a shortcircuit between the terminals Q_3 and N as diode D_1 (see diagram) will be damaged.
2. In order to avoid instabilities due to transient switching voltages arising on supply lead inductance, the supply terminals N and P should be decoupled directly to terminal 0 V by means of low inductance capacitors.
3. For slowly diminishing voltages below the trip level the dv/dt of the zero going output at Q_3 will be approximately 10000 times as that of the input signal.
   In case a faster dv/dt is required, the voltage at Q_3 should be applied to a pulse shaper (e.g. PS10, PS20).
4. The terminals Q_1 and Q_2 provide signals that can in most cases directly be used to trigger units of the 10- and 20- Series or logic circuits having similar input requirements.
5. In circuits where high voltages might be detrimental, it is good practice to protect the inputs by an antiparallel diode circuit, thereby limiting the voltage.
6. If possible, arrange the circuit so as to avoid common mode voltage presence on inputs.
7. With a.c. input signals of over 10 kHz a capacitor of 2200 pF should be connected to the terminals Z and 0 V. Then only d.c. common mode voltage is allowed.
8. If terminal V is left unconnected the resistance load on Q_3 can be 3.6 kΩ.

Initial adjustments

Minimum off-set voltage

Connect a trimming potentiometer (R_B, see diagram) of 50 kΩ to the terminals C1 and C_2, slider to terminal P'. Place the slider in the centre position.
Short circuit the input terminals W_1 and W_2.
Connect a resistor to the terminals X and Y to obtain the desired gain (see "Sensitivity", next section).
Connect a d.c. millivoltmeter with high input impedance or an oscilloscope to the terminals A_1 and A_2; the meter or the oscilloscope must be floating.
Apply the supply voltages; allow a few minutes for block temperature distribution to reach a stable value of reading of the amplified off-set voltage on the millivoltmeter.
Correct the off-set voltage by turning the slider of the trimming potentiometer in such a way that minimum reading on the meter or the oscilloscope is obtained. When reading comes below 20% of full-scale value, switch to higher meter sensitivity. A correct adjustment will show a final value of a few millivolts, depending upon the actual gain.
Observe the voltmeter or oscilloscope for some time after balancing has been obtained; the reading should be stable.
Remove the shortcircuit of the input terminals and remove the voltmeter or the oscilloscope. Leave the slider of the potentiometer in optimum position.

Notes - In case no particular requirement for balance is to be met, the trimming potentiometer can be replaced by resistors having the value found during the balance procedure.

Un-balance will give unequal output wave shapes on Q_1 and Q_2 as well as an alternation of two forms on Q_3 with a sinusoidal input voltage.

Sensitivity

Coarse adjustment can be done by connecting a resistor (R_G, see diagram) to the terminals X and Y; if a trimming potentiometer of 500 Ω is used for this purpose the gain can be set over a wide range. The terminals P' and B must be interconnected. For the correct value of R_G, see Fig. 7. After the resistor between the terminals X and Y has been adjusted, fine adjustment can be done by disconnecting terminal P' from terminal B and by connecting a variable resistor (R_V) of 150 kΩ to the terminals Z and P' (without influencing the input impedance).

APPLICATION SUGGESTIONS

Low voltage zero detector giving zero output at zero input

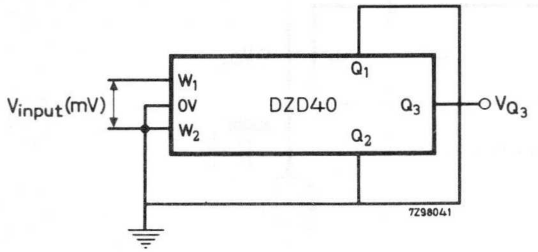


Fig.14

$V_{input} \ll 5\ V_{P\text{-}P}$ or $5\ V_{dc}$
$V_{Q3} = +V_{supply}$ as long as V_{input} is higher than the trip level.
$V_{Q3} = 0$ V as V_{input} has reached the trip level.
If V_{input} is an a.c. signal V_{Q3} will be high apart from the zero crossing points i.e. the unit acts as a bidirectional pulse shaper, see Fig.15.

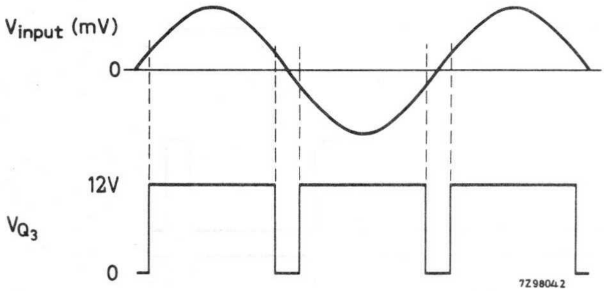


Fig.15

High voltage zero detector giving zero output at zero input

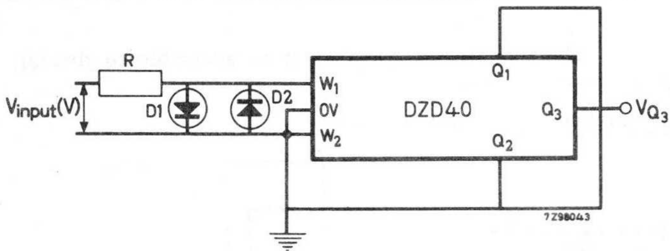


Fig.16

$V_{Q3} = +V_{supply}$ as long as V_{input} is higher than the trip level. $V_{Q3} = 0$ V as V_{input} has reached the trip level. If V_{input} is an a.c. signal V_{Q3} will be high apart from the zero crossing points i.e. the unit acts as a bi-directional pulse shaper (see Fig.15). D_1 and D_2 limit the input voltage to W_1 and W_2. R serves to stay safely within diode current limits and loading of signal source possibilities.
If input frequency exceeds 10 kHz a capacitor of 2200 pF should be connected to the terminals Z and P'.

Low voltage zero detector giving complementary outputs

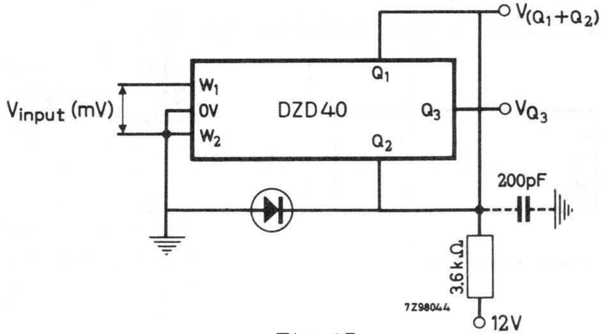


Fig. 17

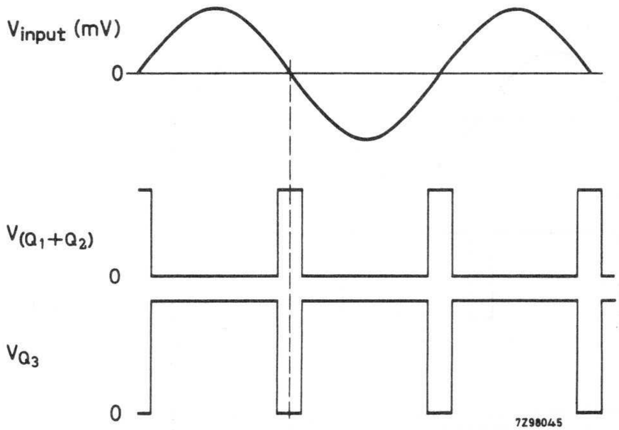


Fig. 18

V_{Q_3} may be obtained as well with this circuit, but then it is advisable to give Q_1 and Q_2 a capacitive load of 200 pF or more.

High voltage zero detector giving complementary outputs

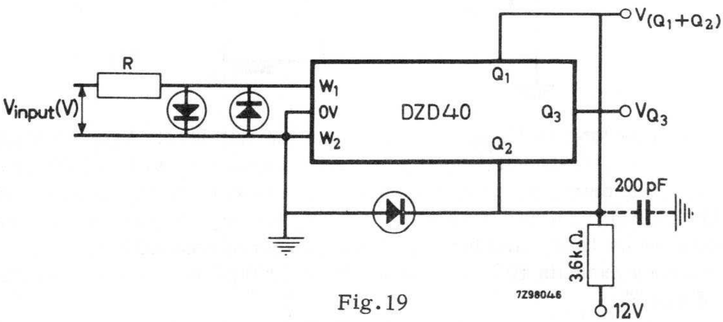


Fig.19

Low voltage comparator giving zero output at zero difference input

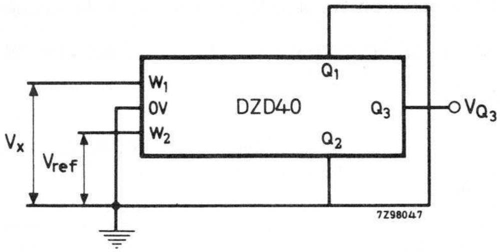


Fig. 20

V_x and $V_{ref} < 1$ V

$V_{Q_3} \approx 0$ V, if $|V_x - V_{ref}| <$ trip level

Low voltage comparator giving high output at zero difference input

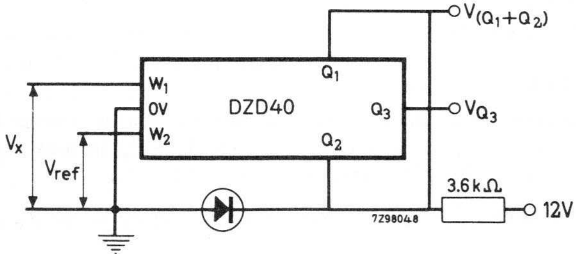


Fig. 21

$V_{(Q_1 + Q_2)}$ = high if $|V_x - V_{ref}| = 0$ V.

High voltage comparator for d.c. voltages

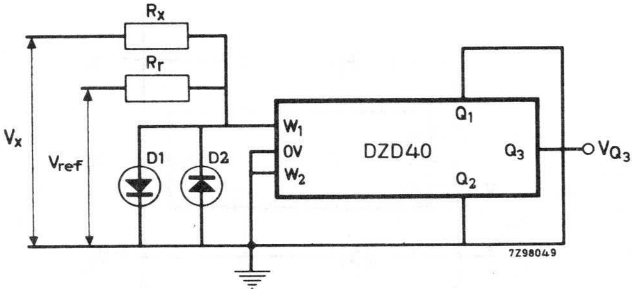


Fig. 22

The outputs can also be arranged as in Fig. 21.

This circuit avoids common mode difficulties. The clamping diodes D_1 and D_2 are to be used if the voltage between W_1 and W_2 could possibly exceed 5 V.

Note - V_{ref} and V_x are to be operating in series (i.e. not opposition).

Calculation of R_x and R_r.

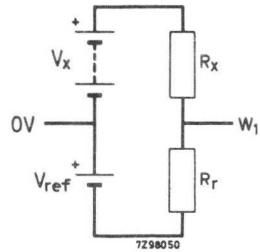


Fig. 23

The voltage between the terminals 0V and W_1 will be zero if

$$\frac{V_x}{V_{ref}} = \frac{R_x}{R_r}$$

R_x and R_r can be selected taking into account the loading of the sources V_r and V_x.

Example - V_x is a potential between + 60 and + 95V with respect to the 0V line. V_r is a properly connected reference source of 5 V. Both sources can be loaded with 1mA max.

It is desired to produce a positive output signal whenever V_x = 80 V. As $V_x$max = 95V, the total voltage across $R_x + R_r$ is max. 100V. To stay within loading $R_x + R_r$ must be approx. 100 kΩ.

Furthermore $\frac{R_x}{R_r} = \frac{80}{5}$ for zero detection at 80 V, so $R_x = 16\ R_r$.

When R_r = 6.8 kΩ a trimming potentiometer of 150 kΩ can be used for R_x. The output can be taken from $(Q_1 + Q_2)$ as in Fig. 21.

Polarity detector

Use is made of the terminals Q_1 and Q_2, if desired terminal Q_3 can be used to indicate zero difference input.

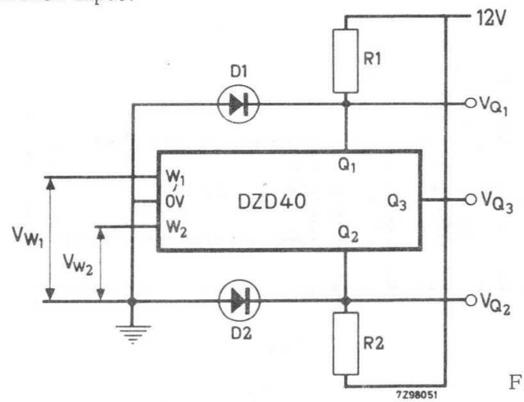


Fig. 24

V_{Q_1} is low, if W_1 is high
V_{Q_2} is low, if W_2 is high

Clamping diodes across the inputs can be omitted if the input voltages are $< 1\ V_p$.

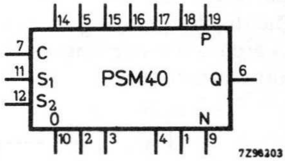
This circuit is extremely useful in servo control, direction determination and tolerance automation.

To avoid common mode influence V_{W_1} and V_{W_2} should be made lower than 2V (resistive step down).

PHASE SHIFT MODULE

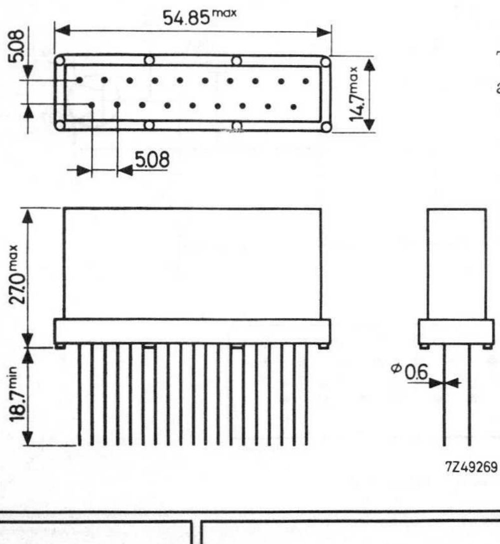
GENERAL

This phase shift module is designed for use in conjunction with a trigger source (e.g. TTM) for the control of the conduction angle of thyristors.
It can be used in single-phase, half- or full-wave applications for control of thyristors operating with an a.c. supply of 15 to 10 000 Hz. The control range is better than 10 to 170°. Three PSM's can be synchronised for 3-phase full-wave control.
An important feature is that one can make a choice between two operation modes, i.e. either linear control of conduction angle by means of a control voltage or linear control of the average voltage across the thyristor load (cosinusoidal control). In the latter case the average thyristor load voltage can be made independent of the a.c. supply voltage (see "CONTROL FACILITIES").



Drawing symbol

Dimensions in mm



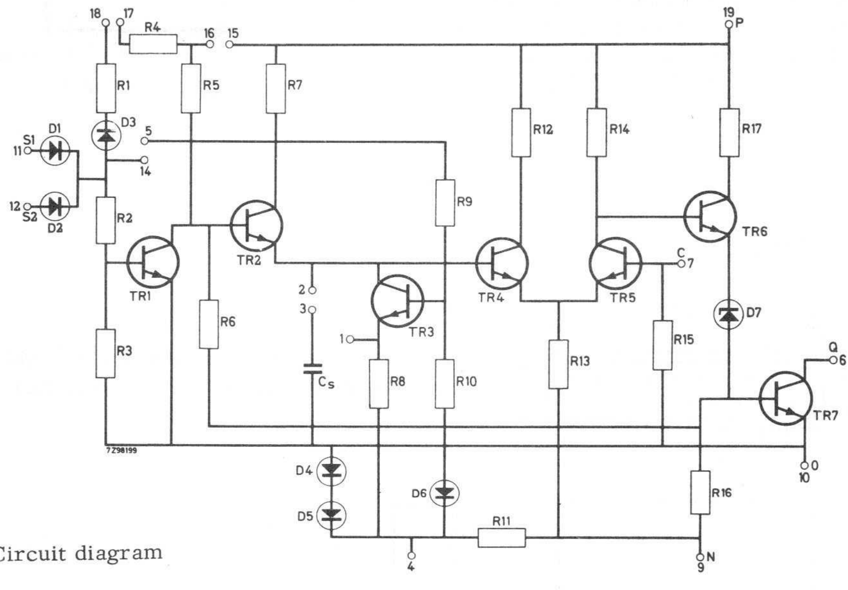
The complete circuit is potted inside a metal can with 19 wire terminals.

CIRCUIT DESCRIPTION

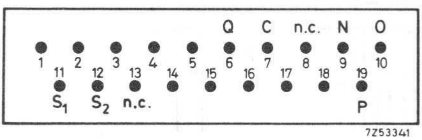
For operation on 50 Hz, terminals 2 and 3 have to be interconnected. Transistor TR_1 is conducting during most of the period that the synchronization voltages are present on S1 and S2. Thereby the collector of TR_1 will be at a low voltage, therefore TR_2 will be non conducting during the time that TR_1 conducts. As soon as the value of the synchronization voltage becomes lower than the diode forward voltage drop (around the zero crossing of the synchronization signal) TR_1 ceases to conduct, TR_2 rapidly charges C_s. A few electrical degrees after synchronization zero TR_1 becomes conducting again, TR_2 cuts off.

TR_3 discharges C_s during the half cycle to zero volts. TR_4 and TR_5 constitute a long tailed pair comparator. As long as the voltage to the base of TR_4 exceeds that applied to TR_5, TR_4 is conducting and TR_5 is off. Consequently base current will flow to TR_6 through R_{14} and TR_6 will conduct. The emitter current of TR_6 drives TR_7 into saturation so that the output Q will be at a low potential for the time that the voltage on point 2 is higher than that applied to the control input terminal C.

The discharge of C_s as a function of time can be made linear by means of TR_3 acting as a constant current discharger or cosinusoidal discharger by using different circuit connections.



Circuit diagram



Terminal location

TECHNICAL PERFORMANCE

Operating temperature range	-25 to $+85$ °C
Storage temperature range	-40 to $+85$ °C

Power supply

Supply voltage	$V_p = +12$ V ± 5%, $V_N = -12$ V ± 5% or $V_p = +12$ V + 10%, $V_N = -12$ V + 10% or $V_p = +12$ V − 10%, $V_N = -12$ V − 10%
Consumed current	$I_p = I_N$ = approximately 10 mA (excluding load current)

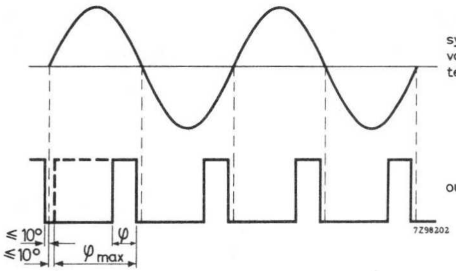
Note - As the output voltage V_Q is dependent upon switch on sequence and rise time of the supply voltages, it is recommended to short circuit terminal Q temporarily to terminal 0 when switching on.

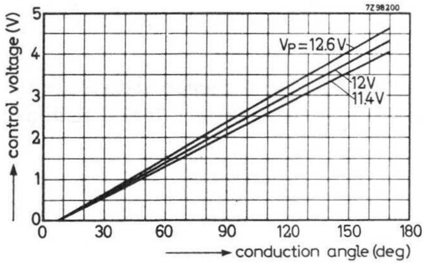
Input data

Control voltage (V_c)	
absolute maximum	5 V
absolute minimum	0 V
Control current (I_c)	0.5 to 0.33 mA
Maximum wiring capacitance at the control input (terminal C)	200 pF

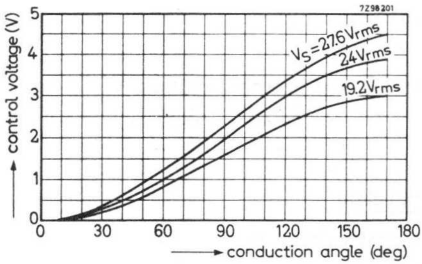
Output data

Output voltage (V_Q)	
high level (TR_7 non conducting)	max. 15 V
low level (TR_7 conducting)	max. 0.5 V min. 0 V
Output current (I_Q)	max. 25 mA at V_Q = max. 0.5 V ($T_{amb} = -25$ °C)
Minimum control range of conduction angle (φ)	10 − 170°





Linear control



Cosinusoidal control

Synchronization

Synchronization voltage (V_S)	24 V_{rms}, + 15%, -20%
Nominal synchronization current (I_S)	
at linear control	approx. 4 mA
at cosinusoidal control	approx. 8 mA

The synchronization voltage can be supplied by a transformer with or without a center tap and preferably provided with an electrostatic screen between the primary and the synchronization winding to avoid capacitive zero shift.
When a transformer with a center tap is used the outputs of the transformer have to be connected to the terminals S_1 and S_2, whereas the center tap is connected to terminal 0.
When a transformer without a center tap is used the outputs of the transformer have to be connected to the terminals S_1 and S_2. Furthermore two diodes OA200 or an equivalent type, have to be connected with the cathode to the terminals S_1 and S_2, whereas the anodes of these diodes have to be connected to terminal 0.

Synchronization frequency range 15 to 10 000 Hz

When the terminals 2 and 3 are interconnected the unit can be used at a synchronization frequency of 50 Hz.
For frequencies higher or lower than 50 Hz the terminals 2 and 3 have to be left disconnected and an external capacitor has to be connected between the terminals 2 and 0.
Capacitance as a function of the frequency: $C = \frac{11}{f}\ \mu F$

CONTROL FACILITIES

Linear conduction angle control

The conduction angle is proportional to the control voltage. The terminals 5, 15 and 16 have to be interconnected. The terminals 15 and 16 can also be interconnected by means of an adjustable resistor, in case of multi-phase operation.
The conduction angle can be controlled by a voltage level on the control input (terminal C).
When the control voltage is derived by a potentiometer from the d.c. voltage which supplies the conduction angle determining part of the circuit (terminal 16) the variations of the conduction angle, caused by supply voltage variations, are greatly reduced.

Cosinusoidal control of the conduction angle

The course of the conduction angle (φ) as a function of the control voltage (V_C) is given in the formula:
$\varphi = \arccos\,(1 - aV_C)$, in which

$a = \text{approx.}\ \frac{11}{V_{s_{rms}}}$

At a constant value of the control voltage the variations of the average voltage across the thyristor load, caused by the mains voltage variations, can be greatly reduced as follows.
The conduction angle determining part of the circuit has to be supplied by a full-wave rectified voltage (proportional to the mains voltage) and by a smoothed voltage derived from the mentioned voltage.
Therefore the terminals 14 and 5 have to be interconnected and the terminals 17 and 18 have to be interconnected directly or by means of an adjustable resistor (multi-phase operation). Furthermore an electrolytic capacitor of 100 μF, 40 V has to be connected between terminals 18 and 0.

ADJUSTMENT

1. Single-phase operation

To obtain a conduction angle of 0° at a control voltage of 0 V, a resistor has to be connected between terminals 1 and 4. For determining its value the following procedure has to be done.
Connect an adjustable resistor with a control range up to 47 kΩ between the terminals 1 and 4, a resistor of 1 kΩ between the terminals Q and P and a d.c. voltmeter between the terminals Q and 0. The control input terminal C has to be connected to terminal 0. Furthermore the necessary interconnections for linear or cosinusoidal control have to be made. Apply the synchronization and d.c. supply voltages.
The output voltage will be about 0 V when the adjustable resistor has its maximum value. This resistor has to be decreased until the moment the output voltage starts to increase. The conduction angle is now close to 0° at a control voltage of 0 V.
The unit is ready for use after the resistor of 1 kΩ and the voltmeter are removed.

Note - After the resistance value has been determined the variable resistor may be replaced by a fixed resistor of the same value as the inherent stability is such that no readjustment will be required.
Typical value of the resistor for linear control: 10 kΩ, for cosinusoidal control: 33 kΩ.

2. Multi-phase operation

To obtain equal conduction angles of two or more PSM's at a common control voltage within the whole control range the following has to be done.

a. Linear control

Interconnect the terminals 5, 15 and 16. Apply the d.c. supply voltages; the synchronization voltage is not applied. Measure the voltage on terminal 2. This voltage should be equal for all PSM's. If there is a difference between the voltages on terminals 2 a resistor has to be inserted between the terminals 17 and 18 of the unit with the highest voltage on terminal 2. The value of this resistor is approximately 1 Ω per mV voltage difference. For further adjustment, see 2c.

b. Cosinusoidal control

Connect terminal 5 to 15 and terminal 17 to 18. Apply the d.c. supply voltages to the terminals P and N and a d.c. voltage of 30 V to terminal 18; the synchronization voltage is not applied. The same measurements have to be done as for linear control.
If there is a difference between the voltages on terminal 2 of two PSM's a resistor has to be inserted between the terminals 17 and 18 of the unit with the highest voltage on terminal 2. The value of this resistor is approximately 3 Ω per mV voltage difference. For further adjustment, see 2c.

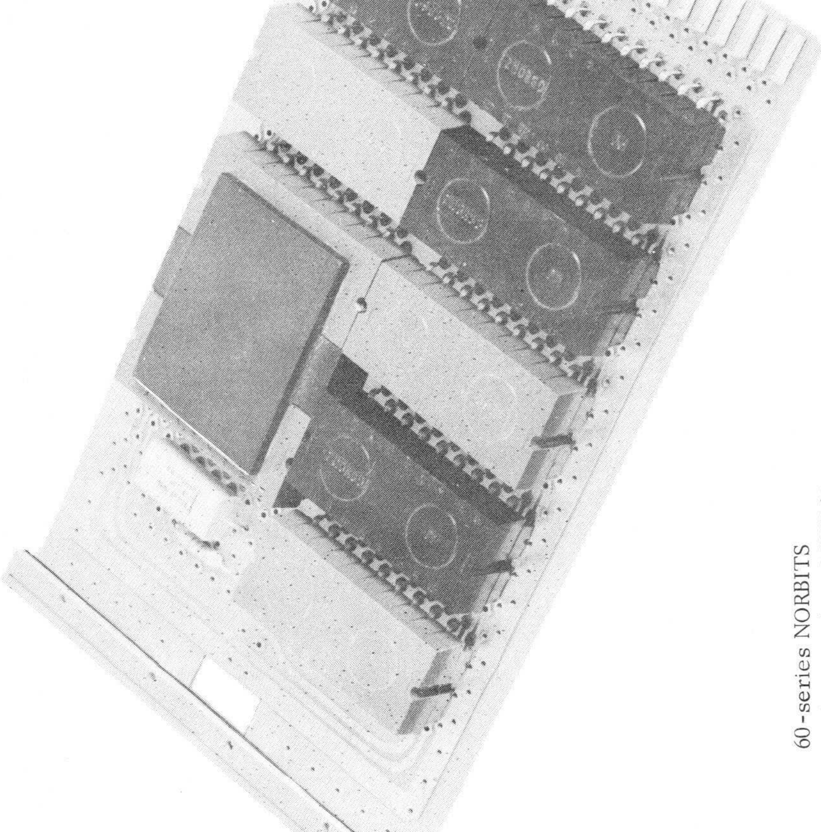
c. With the adjustments described in 2a and 2b the conduction angles of the units will be equal at high values of the control voltage (> 4 V). To obtain equal conduction angles at low values of the control voltage the following has to be done.

The units have to be connected for the desired mode of operation.

Adjust one unit so that a conduction angle of 0° at a control voltage of 0 V is obtained (see 1).

Apply a control voltage of 1 V to all units. Connect a d.c. voltmeter between output Q of the unit which has been adjusted and output Q of the unit to be adjusted. These outputs have to be connected via a resistor of 1 kΩ to terminal P. Vary the value of the resistor between the terminals 1 and 4 of the unit to be adjusted, until minimum reading on the voltmeter has been obtained. Now the conduction angles of both units will be equal within the whole control range.

60-Series NORBITS



RZ 23458

60-series NORBITS
on printed-wiring board PWB61

INTRODUCTION

The 60 series, which uses NOR logic as a basis of operation, represents an important advance in static switching devices for industrial control systems. It comprises 7 circuit blocks having the following features in common:

- Single rail 24 V ± 25% supply, allowing the use of an inexpensive power supply - which helps to keep the cost down, particularly in small systems.
- Transfer moulded cases, giving optimum protection.
- Rigid terminals spaced at 0.2 in. pitch, permitting a variety of interconnection methods to be used (dip soldering, hand soldering, miniwire wrapping).
- Exceptionally good noise immunity.
- Easy to understand level logic, making it possible to carry out system tests with only a d.c. voltmeter.
- Silicon semiconductors throughout, ensuring reliable operation down to $-10\ ^{o}C$ and up to $+70\ ^{o}C$.
- Low price.

Compatible input and output devices as well as a full range of mounting accessories are available.

The 60 series comprises the following types:

2.NOR 60	Dual 4-input NOR gate
4.NOR 60	Quadruple 2x2 + 2x3 input NOR gate
2.IA 60	Dual Inverter Amplifier
2.LPA 60	Dual Low Power Amplifier
TU 60	Timer Unit
2.SF 60	Dual input Switch Filter
PA 60	Power Amplifier

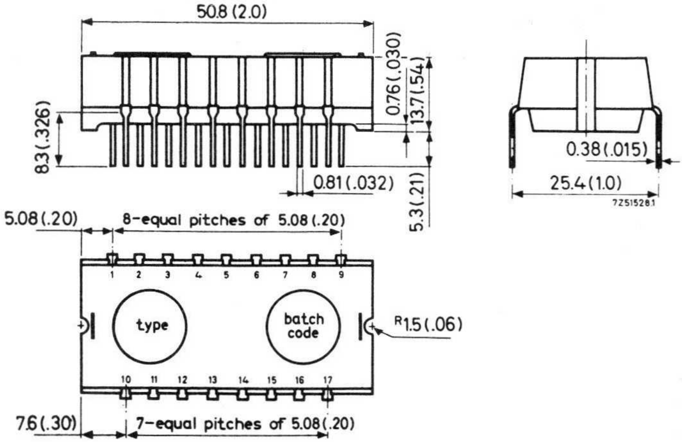
CONSTRUCTION

The circuit elements are housed in a transfer moulded encapsulation. The dimensions are as shown below. The pin connections for each unit are shown on the relevant data sheets. Pin numbering is moulded on both top and bottom of the unit. All pins are also accessible from the top of the unit to facilitate test requirements.

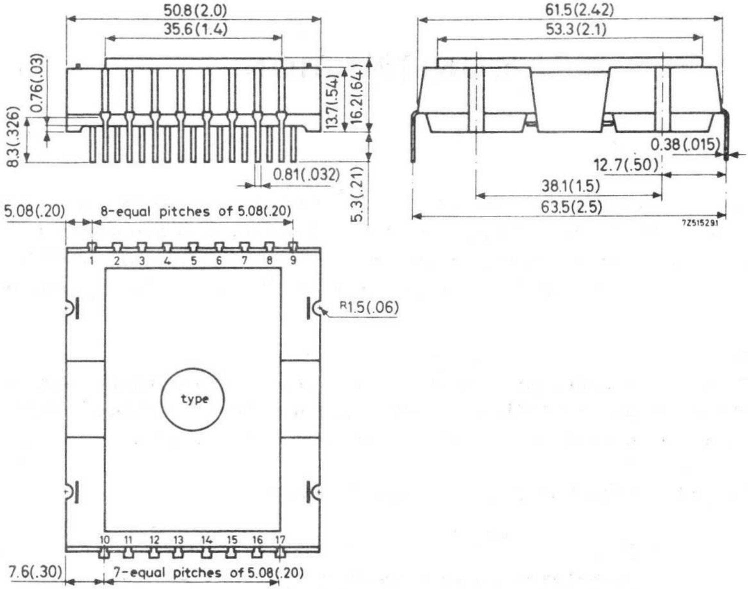
Mounting

The units may be mounted on printed-wiring boards, and a range of these is available with suitable metal mounting chassis. They may also be clamped in the moulded Universal Mounting Chassis UMC 60 or fixed with 3 mm screws.

Dimensions in mm (inch equivalents within brackets)



Size A (types 2.NOR 60, 4.NOR 60, 2.IA 60, 2.LPA 60, 2.SF 60, TU 60)



Size B (type PA 60)

Terminals	suitable for soldering and Miniwrap
Wrap tool	Gardner Denver, bit number 506633
Wrap wire size	0.3 mm (0.012" = 28 U.S. gauge = 30 s.w.g.)
Weight, size A	30 g approx.
size B	85 g approx.
Colour coding	see data sheets of the units

TEST SPECIFICATIONS

TEST SPECIFICATIONS

All units meet the following test specifications: ←

Test	IEC 68	MIL-STD-202C
Dry heat life test	56 days at max. diss. max. temp. check at: 0-10/14d-56d.	Meth. 108A, Cond. D; check at 0-10/ 14d-56d.
Long-term damp heat non operating	Test C, 56 days check at 0-10/14d-56d.	Meth. 103B, Cond. D; check at 0-10/ 14d-56d.
Long-term damp heat operating	Test C, 56d. min., diss., check at 0-10/14d-56d.	ditto
Temp. cycle-test	Test Na, 30 min., 2-3 min in between; preferred: -40 °C; +85 °C and +125 °C.	Meth. 107B, Cond. A: moderate temp.
Vibration	Test Fb; 10-500-10 Hz 1 octave/min ; ampl. 0.75 mm max.; 10 g max. 3 x 3 hrs.	Meth. 204A, Cond. A: 10-500-10 Hz: 15 min ampl. 0.75 max; 10 g max., 3 x 3 hrs.
Shock	-	Meth. 202B, 3 blows 50 g.
Robustness of terminations	Test $U_A + U_B$	Meth. 211A + (B or C)
Solderability + solder heat	Test T; at 0 hr and at 56d; no electr. test	Meth. 210, at 0 hr and at 56d; no electr. test

CHARACTERISTICS AND DEFINITIONS

AMBIENT TEMPERATURE LIMITS

Storage	T_{amb} = -40 °C to +85 °C
Operating	T_{amb} = -10 °C to +70 °C

SUPPLY VOLTAGE (V_S)

Single rail, +24 $V_{d.c.}$ ± 25% (18 to 30 V) or
+12 $V_{d.c.}$ ± 5% (11.4 to 12.6 V) at reduced ratings

LOCIG LEVELS

The operation of the "60"-series is based on positive logic, i.e. "1" level is a positive voltage that is more positive than "0" level, and "0" level is independent of supply voltage.
Logic "1" depends upon supply and loading of the output of the logic functional block.

Levels with V_S = 24 V ± 25%	Levels with V_S = 12 V ± 5%
0 V < "0" < +0.3 V	0 V < "0" < +0.3 V
11.4 V < "1" < V_S	8.3 V < "1" < V_S

D.C. NOISE IMMUNITY

"0" level Immunity: A d.c. voltage of +1 V with respect to the 0-volt line, applied to any one input (the other inputs floating) will not cause a change of output voltage.

"1" level Immunity:

a. With a supply voltage of 24 V ± 25%:
A variation of 2 V of the "1" input level will not cause a unit to change its output voltage.

b. With a supply voltage of 12 V ± 5%:
A variation of 0.25 V of the "1" input level will not cause a unit to change its output voltage.

DRIVE UNIT: Drive required on one input of a NOR 60 (with all other inputs returned to 0-volt line) to bring the output at "0" level (less than +0.3 V).

FAN OUT: Number of drive units that can be delivered by a logic function without exceeding the "1" level limits as defined above.
The fan out actually indicates the number of NOR gates that can be driven into saturation (thereby bringing the respective outputs at "0" level).

INPUT AND OUTPUT DATA

EXTENSION OF THE DRIVE UNIT CONCEPT

System design is greatly simplified by expression of the input requirements and fan out capabilities of the various units in integral multiples of the D.U. To check that the loadability of a particular unit is not exceeded, simply add the number of D.U.'s present at its output.

LOADING TABLE

The loading table shows the input requirements and output capability of the various units expressed in D.U.'s.

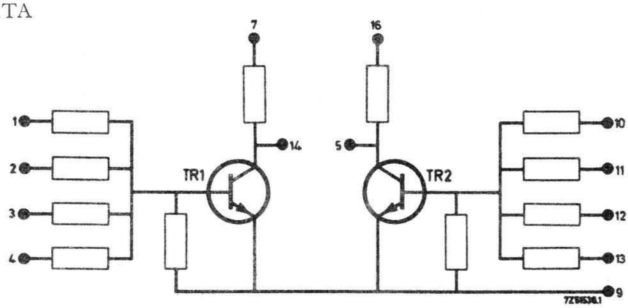
unit	input	V_s = 24 V ±25% output	V_s = 12 V ±5% output
2.NOR 60, per function	1 D.U.	6 D.U.	4 D.U.
4.NOR 60, per function	1 D.U.	6 D.U.	4 D.U.
2.IA 60, per function	2 D.U.	20 D.U.	13 D.U.
2.IA 60, connected as Low Power Amp.	2 D.U.	$R_{load} \geq 300\ \Omega$	$R_{load} \geq 150\ \Omega$
2.LPA 60 per function	2.D.U.	$R_{load} \geq 300\ \Omega$	$R_{load} \geq 150\ \Omega$
PA 60	1 D.U.	$R_{load} \geq 30\ \Omega$	$R_{load} \geq 13\ \Omega$
TU 60	1 D.U.	5 D.U.	3 D.U.
2.SF 60, per filter	100 $V_{d.c.}$	2 D.U.	2 D.U.

For matching non standard input signals to 60-series inputs as well as matching non standard loads, the data sheets of the units give impedances and current requirements.

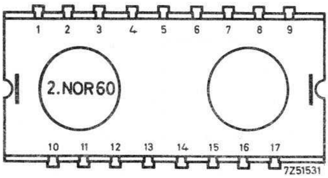
DUAL FOUR INPUT NOR GATE

Function	dual NOR (positive logic)
Case	size: A; colour: black

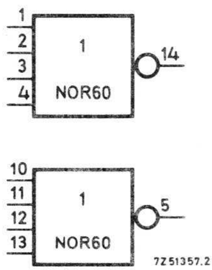
CIRCUIT DATA



Circuit diagram



Terminal location



Drawing symbols

1, 2, 3, 4	= input NOR 1
5	= output NOR 2
6	= n.c.
7	= for supply NOR 1 (V_S)
8	= n.c.
9	= 0 V common
10, 11, 12, 13	= input NOR 2
14	= output NOR 1
15	= n.c.
16	= for supply NOR 2 (V_S)
17	= n.c.

The unit contains two identical transistor-resistor NOR circuits. Each circuit has 4 inputs. If any input of a NOR is at "1" level the output of that NOR will be at "0" level.

CHARACTERISTICS

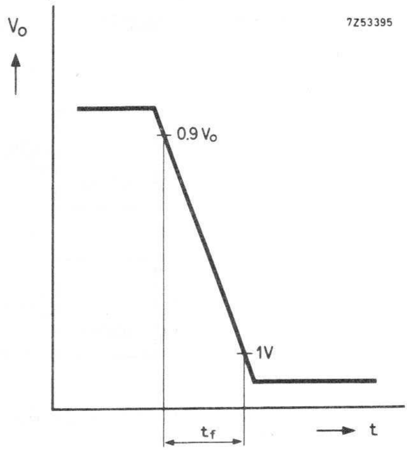
	at V_S = 24 V ±25%	at V_S = 12 V ±5%
Supply current at $V_{S\,nom}$	3.2 mA	1.6 mA
at $V_{S\,max}$	≤ 4.2 mA	≤ 1.8 mA
Input requirement	1 D.U.	1 D.U.
Output capability	6 D.U.	4 D.U.

	single input	two paralleled inputs	three paralleled inputs	four paralleled inputs
Input impedance [1]	100 kΩ	62 kΩ	40 kΩ	30 kΩ
Input current for "0" output [1] [2]	0.13 mA	0.125 mA	0.11 mA	0.1 mA

→ Switching speed

Fall time defined below $t_f \leq 1.25\ \mu s$

Fall delay time defined below $t_{fd} \leq 6\ \mu s$



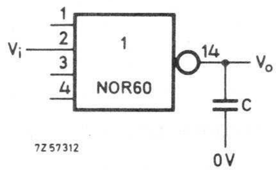


Fig.A

The fall time t_f is defined as the time required for the output voltage V_O to change from 90% of its full value to 1 V after application of a step input, the output being loaded with C = 200 pF (see Fig.A).

[1] Not used inputs returned to 0-volt line.

[2] At V_S = 30 V.

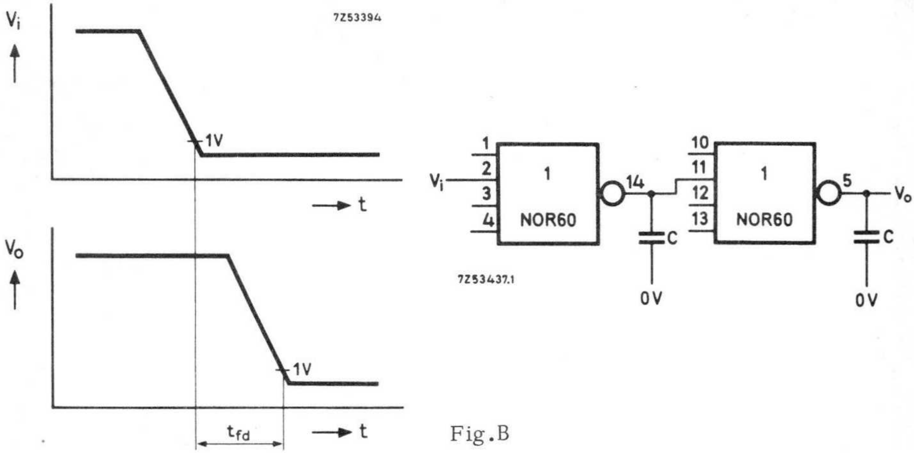


Fig.B

The fall delay time t_{fd} is defined as the time between the 1 V points of the negative-going input and output voltages of two cascaded NORs, each being loaded with C = 200 pF (see Fig.B).

LIMITING VALUES (Destruction may occur when these values are exceeded)

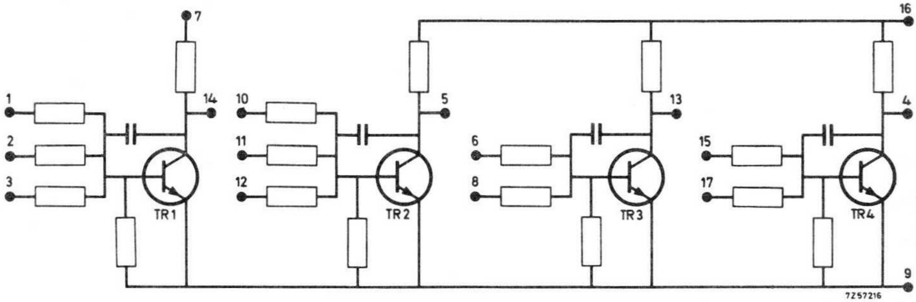
Supply voltage	V_S	max.	30	$V_{d.c.}$
		min.	0	V
Positive transient on V_S		max.	10	V during 10 μs
Positive input voltage	$+V_i$	max.	90	V
Negative input voltage	$-V_i$	max.	18	V

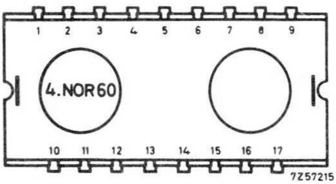
QUADRUPLE 2×2 + 2×3 INPUT NOR GATE

Function — quadruple NOR (positive logic)

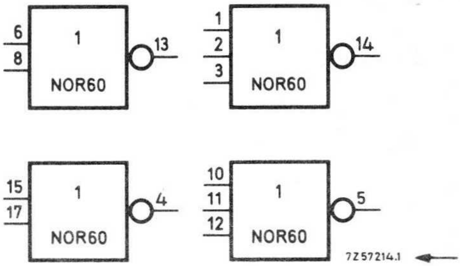
Case — size: A; colour: black

CIRCUIT DATA





Terminal location



Drawing symbols

1, 2, 3	= input NOR 1
4	= output NOR 4
5	= output NOR 2
6, 8	= input NOR 3
7	= for supply NOR 1 (V_S)
9	= 0 V common
10, 11, 12	= input NOR 2
13	= output NOR 3
14	= output NOR 1
15, 17	= input NOR 4
16	= for supply NOR 2, 3, 4 (V_S)

The unit contains two identical 2-input and two identical 3-input NOR circuits. If any input of a NOR is at "1" level the output of that NOR will be at "0" level.

CHARACTERISTICS

	at V_S = 24 V ±25%	at V_S = 12 V ±5%
Supply current at $V_{S\,nom}$	3.2 mA	1.6 mA
at $V_{S\,max}$	≤ 4.2 mA	≤ 1.8 mA
Input requirement	1 D.U.	1 D.U.
Output capability	6 D.U.	4 D.U.

	single input	two paralleled inputs	three paralleled inputs
Input impedance [1]	90 kΩ	50 kΩ	35 kΩ
Input current for "0" output [1][2]	0.13 mA	0.125 mA	0.11 mA
Switching speed	to be established		

LIMITING VALUES (Destruction may occur when these values are exceeded)

Supply voltage	V_S	max. min.	30 0	$V_{d.c.}$ V
Positive transient on V_S		max.	10	V during 10 μs
Positive input voltage	$+V_i$	max.	90	V
Negative input voltage	$-V_i$	max.	24	V

[1]) Not used inputs returned to 0-volt line.

[2]) At V_S = 30 V.

DUAL INVERTER AMPLIFIER

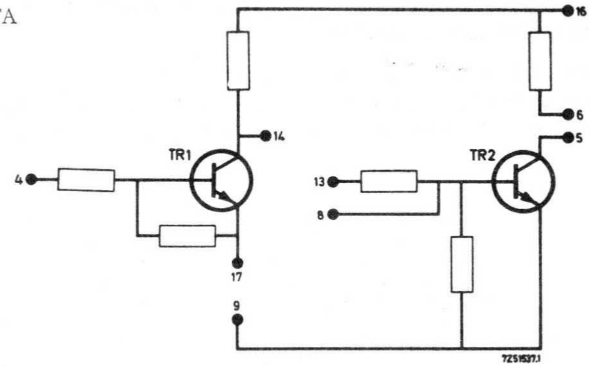
Function

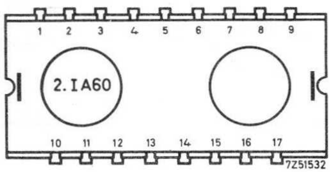
The unit comprises two identical Inverter Amplifiers. Use as a single inverting Low Power Amplifier is feasible.

Case

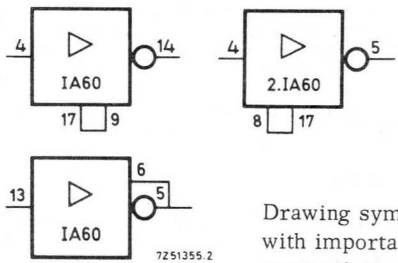
Size:A; colour: blue

CIRCUIT DATA





Terminal location



Drawing symbols with important connections

1, 2, 3 = n.c.
4 = input IA 1
5 = output IA 2
6 = collector resistor IA 2
7 = n.c.
8 = base of IA 2 transistor
9 = 0 V common
10, 11, 12 = n.c.
13 = input IA 2
14 = output IA 1
15 = n.c.
16 = for supply (V_S)
17 = emitter of IA 1 transistor

To obtain the dual I.A., pin 17 should be connected to pin 9 and pin 6 to pin 5.
A "1" level input (pin 4 or 13) will cause a "0" level output (pin 14 or 5-6 respectively).
To obtain the inverting L.P.A., pin 17 should be connected to pin 8 and the load connected between pins 5 and 16. When pin 4 is at "1" level, pin 5 will be at "0" level.

Notes to the load of the L.P.A.

1. Care should be taken that the value of a varying load should not drop below the specified minimum.
2. Incandescent lamps have a "cold" resistance that is only a fraction of the value calculated from nominal voltage and current, so that turning on of the lamp may cause a surge current. It is advisable to use a pre-heating quiescent current to eliminate destructive surge currents.
3. Inductive loads will cause large voltage peaks upon switching off. To avoid destruction the load should be provided with a flywheeling diode, type BY126. The anode should be connected to pin 5, the cathode to pin 16 (positive supply).

CHARACTERISTICS

	at V_S = 24 V ±25%		at V_S = 12 V ±5%	
	per I.A.	as L.P.A.	per I.A.	as L.P.A.
Supply current at $V_{S\,nom}$	10.9 mA	10.9 mA I_{load} = 0 mA	5.5 mA	5.5 mA I_{load} = 0 mA
Supply current at $V_{S\,max}$ and "1" input	≤ 14.0 mA	≤ 114 mA R_{load} = 300 Ω	≤ 5.9 mA	≤ 89.9 mA R_{load} = 150 Ω
Input requirement	2 D.U.	2 D.U.	2 D.U.	2 D.U.
Output capability	20 D.U.	140 D.U. [1]	13 D.U.	
Minimum load resistance		300 Ω [1]		150 Ω [1]

Input impedance		45 kΩ
Input current for "0" output of I.A. at V_S = 30 V		0.285 mA
Switching speed		
Fall time defined below	t_f	≤ 1 μs
Fall delay time defined below	t_{fd}	≤ 3 μs

[1]) This load is permissible only if the input switched between "0" and "1" levels by a preceding 60 Series unit or other true digital input, avoiding excessive dissipation during transitions.

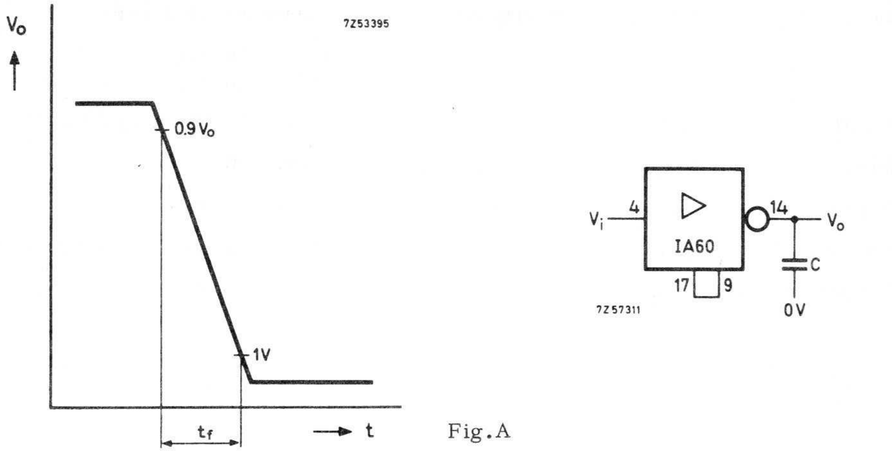


Fig.A

The fall time t_f is defined as the time required for the output voltage V_o to change from 90% of its full value to 1 V, after application of a step input, the output being loaded with C = 200 pF (see Fig.A).

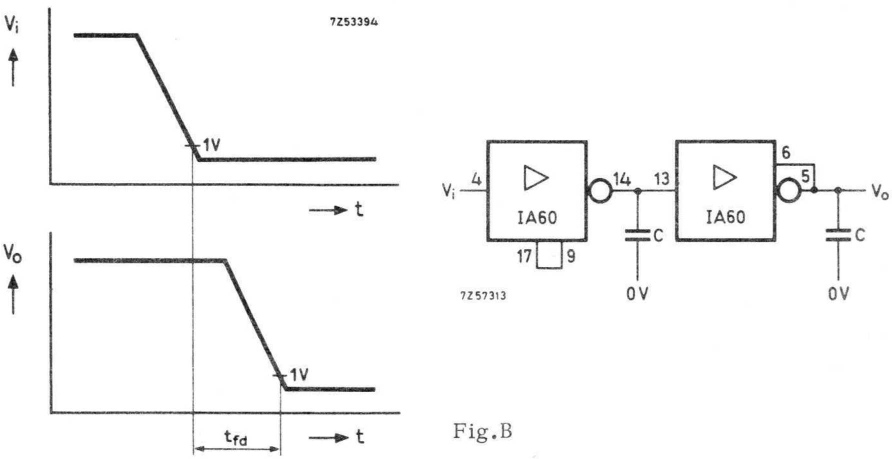


Fig.B

The fall delay time t_{fd} is defined as the time between the 1 V points of the negative-going input and output voltages of two cascaded Inverter Amplifiers, each being loaded with 200 pF (see Fig.B).

LIMITING VALUES (Destruction may occur if these values are exceeded)

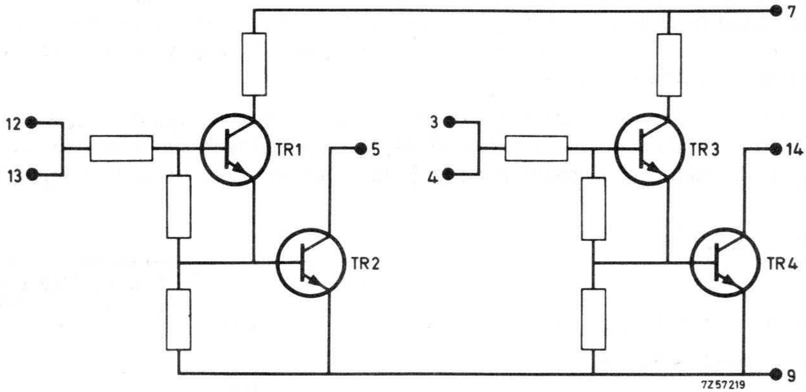
Supply voltage	V_S	max.	30	$V_{d.c.}$
		min.	0	V
Positive transient on V_S		max.	10	V during 10 μs
Positive input voltage	$+V_4$, $+V_{13}$	max.	70	V
Negative input voltage	$-V_4$, $-V_{13}$	max.	16	V
Positive voltage at pin 8	$+V_8$	max.	1	V via min. 500 Ω
Negative voltage at pin 8	$-V_8$	max.	5	V

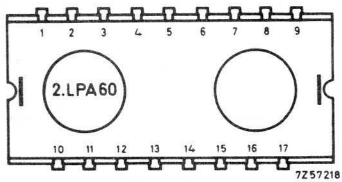
DUAL LOW POWER AMPLIFIER

Function — The unit comprises two identical inverting Low Power Amplifiers

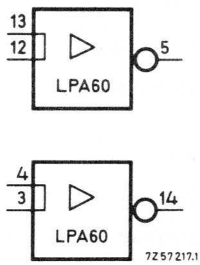
Case — size: A; colour: blue

CIRCUIT DATA





Terminal location



Drawing symbols

1, 2	= n.c.
3, 4	= input LPA2
5	= output LPA1
6	= n.c.
7	= for supply (V_S)
8	= n.c.
9	= 0 V common
10, 11	= n.c.
12, 13	= input LPA1
14	= output LPA2
15, 16, 17	= n.c.

The load should be connected between pins 5 and 7 for LPA1 and between pins 14 and 7 for LPA2.
When the input (12/13 or 3/4) is at "1" level, the output (5 or 14) will be at less than 1 V. This being no true "0" level, it is not recommended to use an LPA as a logic operator.

Notes to the loading

1. Care should be taken that the value of a varying load should not drop below the specified minimum.
2. Incandescent lamps have a "cold" resistance that is only a fraction of the value calculated from nominal voltage and current, so that turning on of the lamp may cause a surge current. It is advisable to use a pre-heating quiescent current to eliminate destructive surge currents.
3. Inductive loads will cause large voltage peaks upon switching off. To avoid destruction the load should be provided with a flywheeling diode, type BAX12. The anode should be connected to pin 5 (14), the cathode to pin 7 (positive supply).

CHARACTERISTICS

	at V_S = 24 V ±25%	at V_S = 12 V ±5%
Supply current at $V_{S\,nom}$, I_{load} = 0 mA	8 mA	4 mA
Supply current at $V_{S\,max}$ and "1" input,		
R_{load} = 300 Ω	≤ 108 mA	–
R_{load} = 150 Ω	–	≤ 89.9 mA
Input requirement	2 D.U.	2 D.U.
Output capability	100 mA	80 mA
Min. load resistance	300 Ω	150 Ω

Input impedance	45 kΩ
Input current for "0" output at V_S = 30 V	0.285 mA
Output voltage at "1" input	< 1 V
Switching speed	to be established

LIMITING VALUES (Destruction may occur if these values are exceeded)

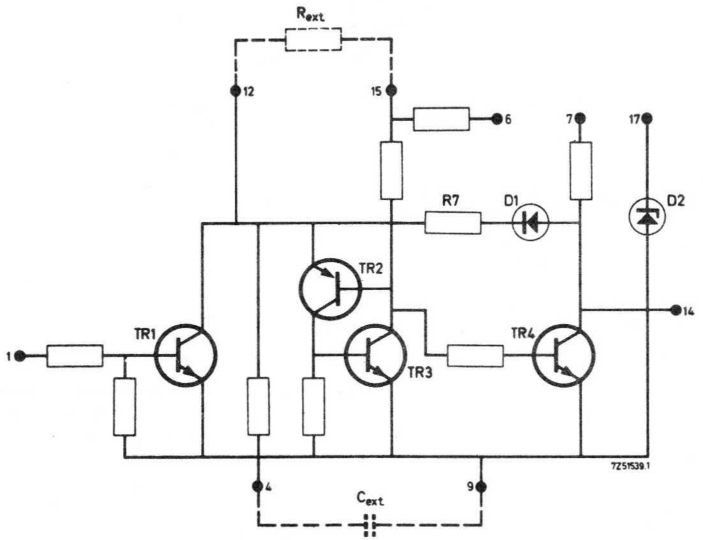
Supply voltage	V_S	max.	30	$V_{d.c.}$
		min.	0	V
Positive transient on V_S		max.	10	V during 10 μs
Positive input voltage	$+V_i$	max.	70	V
Negative input voltage	$-V_i$	max.	16	V

TIMER

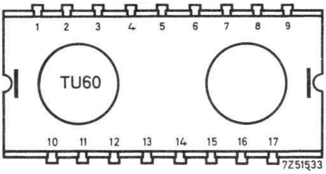
Function — Gives an inverted output. The output of a "1" is delayed following a "0" input. No delay occurs when the input returns to "1"

Case — Size: A; colour: red

CIRCUIT DATA

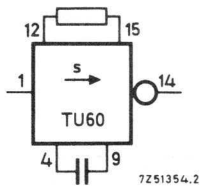


With the input at "1" the capacitor (C_{ext}) is discharged. When the input goes to "0", TR_1 ceases to conduct so that the capacitor is allowed to slowly charge until the base potential of TR_2 is exceeded. TR_2 starts to conduct and provides base current for TR_3, which speeds the turn-on of TR_2. TR_4 ceases to conduct and the output level changes from "0" to "1". Positive feedback is provided via D_1 and R_7.



Terminal location

- 1 = input
- 2, 3 = n.c.
- 4 = for external capacitor
- 5 = n.c.
- 6 = see instructions below
- 7 = positive supply
- 8 = n.c.
- 9 = 0 V common
- 10, 11 = n.c.
- 12 = for external resistor
- 13 = n.c.
- 14 = output
- 15 = for external resistor
- 16 = n.c.
- 17 = see instructions below



→ Drawing symbol with significant connections

Instructions for connection of the supply

When V_S = 24 V ±25% : connect 6 and 7, connect 15 and 17.

When V_S = 12 V ±5% : connect 15 and 7, do not connect 6 and 17.

CHARACTERISTICS

	at V_S = 24 V ±25%	at V_S = 12 V ±5%
Supply current at $V_{S\,nom}$	6.9 mA	1.9 mA
at $V_{S\,max}$	10.1 mA	2.1 mA
Input requirement	1 D.U.	1 D.U.
Output capability	5 D.U.	3 D.U.

Input impedance — 90 kΩ

Input current for "0" output, at V_S = 30 V — 0.125 mA

External resistance — R_{ext} min. 100 kΩ, max. 1 MΩ

External capacitance — C_{ext} requirement: leakage current max. 100 nA at 10 V (or leakage resistance min. 100 MΩ at 10 V)

Delay time (see Fig.A)	t_{delay}	about R_{ext} C_{ext} seconds (MΩ x μF)
Max. change of delay time with temperature		-0.14 %/deg C
Switching speed		
Fall time as defined below	t_f	≤ 1 μs
Rise time as defined below	t_r	≤ 6 μs
Timing requirements (see Fig.A)		
Set time	t_{set}	min. 11.9 C_{ext} ms (C_{ext} in μF)
Recovery time	t_{sec}	min. 11.9 C_{ext} ms
Start inhibit before end of delay	$t_{st\ inh}$	min. 18.9 C_{ext} ms
Inhibit duration	t_{inh}	min. 18.9 C_{ext} ms (A shorter t_{inh} gives a shorter delay)

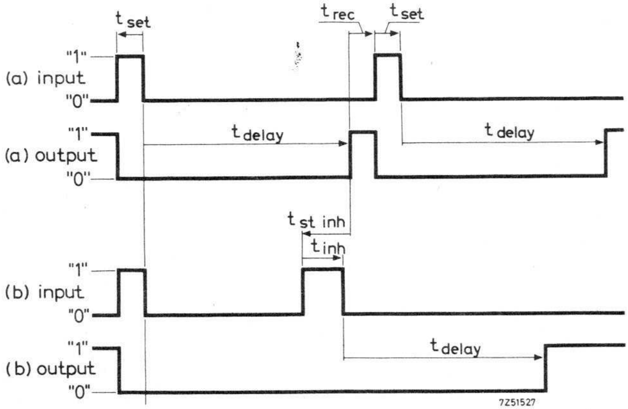


Fig.A

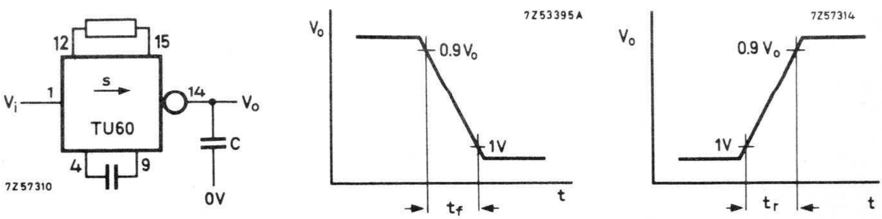


Fig.B

The fall time t_f is defined as the time required for the output voltage V_o to change from 90% of its full value to 1 V, after application of a step input and being loaded with C = 200 pF (see Fig.B).

The rise time t_r is defined as the time required for the output voltage V_o to change from 1 V to 90% of its full value, after application of a step input and being loaded with C = 200 pF (see Fig.B).

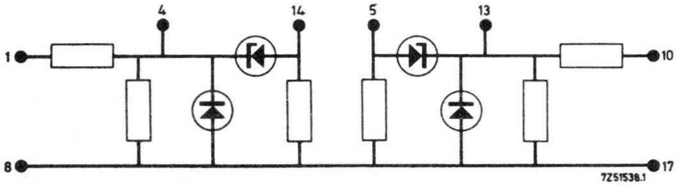
LIMITING VALUES (Destruction may occur if these values are exceeded)

Supply	V_s	max. min.	30 $V_{d.c.}$ 0 V
Positive transient on V_s		max.	10 V during 10 μs
Positive input voltage	$+V_1$	max.	70 V
Negative input voltage	$-V_1$	max.	16 V

DUAL SWITCH FILTER

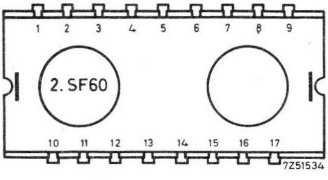
Function	Dual switch filter for eliminating the effects of contact bounce of mechanical switches
Case	size: A; colour: green

CIRCUIT DATA



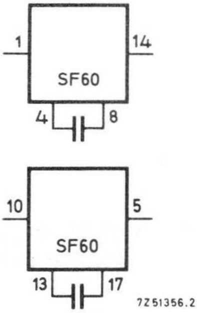
The circuit consists of two identical filters for minimising the effects of contact bounce and spurious interference on long leads between switch and system input. The switch filter also has the facility that 100 V are applied across the switch contacts, thus ensuring reliable switching.

The voltage divider enables the input to be presented with a high impedance load whilst the internal circuitry is presented with a lower impedance source. The time for which contact bounce is eliminated is determined by an external capacitor. The zener diode provides a threshold. The diode prevents that excessive base current is drawn from any driven NORBIT if a large negative voltage appears on the filter input. It also prevents that a reverse voltage is presented to the capacitor, which thus may be of a polarised type.



Terminal location

1	= input SF1	10	= input SF2
2, 3	= n.c.	11, 12	= n.c.
4	= for external capacitor of SF1	13	= for external capacitor of SF2
5	= output SF2	14	= output SF1
6, 7	= n.c.	15, 16	= n.c.
8	= 0 V common	17	= 0 V common (to be taken to central earth point)
9	= n.c.		



Drawing symbols with capacitor

Instructions

a. Capacitor working voltage ≥ 100 $V_{d.c.}$

b. Mount the unit as close as possible to the logic system input.

c. The common 0-volt line (8 or 17) must be returned to the central earth point of the system to avoid common impedance coupling.

CHARACTERISTICS (per filter)

Input voltage for "1" out	+100 V ±25%
Input current	< 3.3 mA
Input surge current peak	< 4.8 mA
Output capability	2 D.U.
Contact bounce elimination time	1.7 C ms (C in μF)

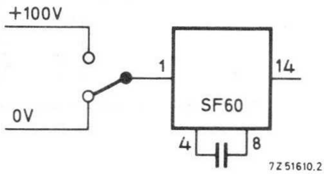


Fig.a

→

Switching speed (C in μF):

Turn-on time	41 C ms
Max. operating frequency with 1 : 1 mark to space ratio for circuit Fig.a	$\frac{6.3}{C}$ Hz
Ditto for Fig.b	$\frac{11.08}{C}$ Hz

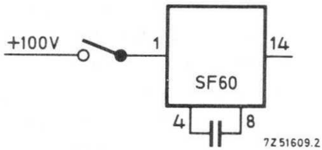


Fig.b

LIMITING VALUES (Destruction may occur if these values are exceeded)

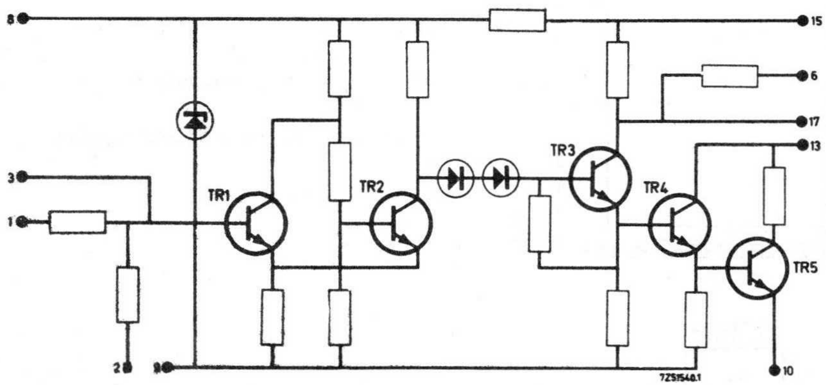
Positive input voltage	$+V_1$, $+V_{10}$	max. 125 V
Negative input voltage	$-V_1$, $-V_{10}$	max. 100 V

POWER AMPLIFIER

Function — Power amplifier for load switching

Case — size: B; colour: blue

CIRCUIT DATA



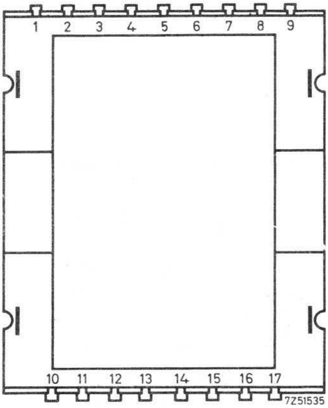
The power amplifier consists of a Schmitt trigger followed by a buffer + driver stage, which provides adequate drive to the power transistor under all conditions of permissible supply voltage and input signal. The load should be connected between pin 13 and + of power supply. A "1" input will switch on the load current.

Notes

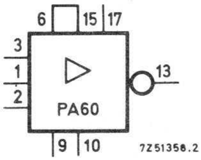
1. Observe rules for $R_{load\,min}$.
2. Incandescent lamps have a "cold" resistance that is only a fraction of the value calculated from voltage and current so that turning on of a lamp may cause a current surge. It is often advisable to use a preheating quiescent current to eliminate destructive surge currents.
3. Inductive loads will cause large voltage peaks at switching off. To avoid destruction of the output transistor the load should be shunted by a damping diode. By using diode type BAX12 a max. current of 1 A at 30 V in a load of 10 H can be switched off while secondary breakdown is avoided.
(Connection of the diode: anode to pin 13, cathode to supply).

4. Pin 10 facilitates the connection of a 0 V load supply line which is separated from the 0 V logic supply line up to the power supply unit, by which means common wire impedance is avoided. Also, if a second power supply unit is used for the PA 60, common impedance with the 0 V logic supply line should be avoided in the connecting wire necessary between pin 9 (0 V logic supply) and pin 10 (0 V supply of PA 60).

Terminal location



1 = input
2 = base resistor of input transistor
3 = base of input transistor
4, 5 = n.c.
6 = + supply, connect to 15
7 = n.c.
8 = zener diode
9 = 0 V common
10 = 0 V output stage, see note 4
11, 12 = n.c.
13 = output (load between 13 and supply)
14 = n.c.
15 = + supply, connect to 6
16 = n.c.
17 = collector of TR3



Drawing symbol with one of the necessary connections

Additional instructions

a. If the input (pin 1) is driven by a standard "1" level from NOR 60, etc., connect pins 2 and 9.

b. If the supply voltage is 12 V ±5%, connect a resistor of 330 Ω between pin 6 and 8, and a resistor of 1.5 kΩ between 15 and 17; both resistors ±5%, $\frac{1}{4}$ W.

c. The metal centre part of the case is a heatsink connected to the collector of TR5; it should not be touched by electrical conductors.

CHARACTERISTICS	at V_S = 24 V ±25%	at V_S = 12 V ±5%
Supply current at $V_{S\,nom}$ excluding I_{load}	18.8 mA	15.1 mA
Supply current at $V_{S\,max}$ excluding I_{load}	< 26.2 mA	< 28.8 mA
Required load resistance	> 30 Ω	> 13 Ω
Required input	1 D.U.	1 D.U.

For switching on load current	at pin 1	at pin 3
input voltage	8 V	1.6 V 1)
input current, 2-9 connected	75 μA	75 μA
2-9 not connected	-	30 μA
For switching off load current		
input voltage	< 2.5 V	< 0.65 V
On-off input voltage difference, R_{source} < 56 kΩ	-	> 0.32 V

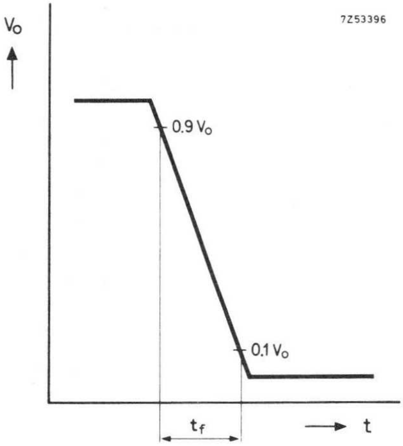
Switching speed

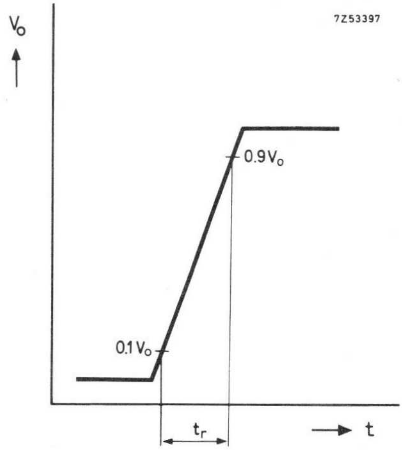
Fall time as defined below	$t_f \leq 1\ \mu s$
Rise time as defined below	$t_r \leq 5\ \mu s$

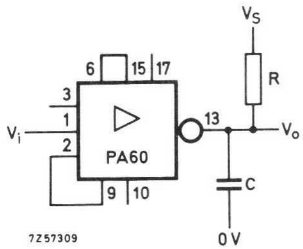
The fall time t_f is defined as the time required for the output voltage to change from 90% to 10% of its full value, after application of a step input, at a supply voltage V_S = 30 V and a load resistance R = 30 Ω shunted by C = 200 pF (see Figure).

The rise time t_r is defined as the time required for the output voltage to change from 10% to 90% of its full value, after application of a step input, at a supply voltage V_S = 30 V and a load resistance R = 30 Ω shunted by C = 200 pF (see Figure).

1) Via min. 500 Ω.







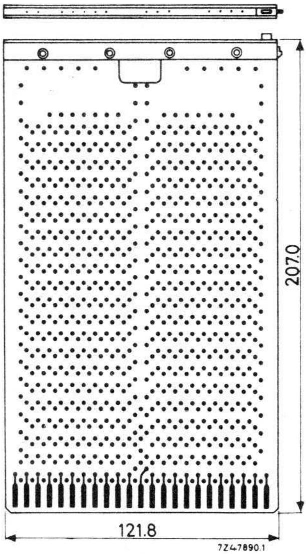
LIMITING VALUES (Destruction may occur if these values are exceeded)

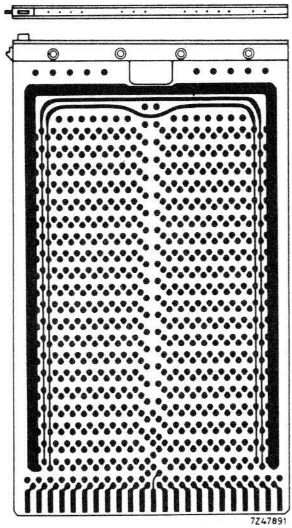
Supply voltage(s)	V_S	max.	30 $V_{d.c.}$
		min.	0 V
Positive transient on V_S driver stage		max.	10 V during 10 μs
Positive transient on V_S power stage		max.	5 V during 10 μs
Voltage at pin 1 (pins 2 and 9 connected)			
positive	$+V_1$	max.	100 V
negative	$-V_1$	max.	15 V
Voltage at pin 3			
positive	$+V_3$	max.	5 V via min. 500 Ω
negative	$-V_3$	max.	4.5 V

ACCESSORIES FOR CIRCUIT BLOCKS
60-SERIES

EXPERIMENTERS' PRINTED-WIRING BOARD

Experimenters' printed-wiring board (with extractor) with plated-through holes suitable for 60-series NORBITS. It fits mounting chassis 4322 026 38240.





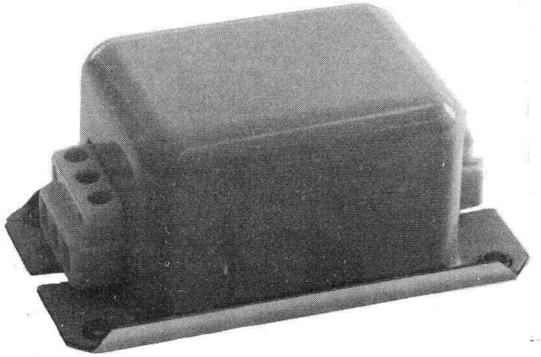
Accommodation of NORBITS

size A	+ size B (PA 60)
10	0
8	1
6	2
3	3
0	4

Material of version GPB 60	glass-epoxy
of version GPB 60/P	phenol paper
Hole diameter	1.2 mm
Contacts	2x23, gold plated, pitch 0.2"
Mating connector	2422 020 52591 (type F045)

For more information, see Application Note "Printed-wiring boards for 60-series Norbit Assemblies", No. 32/522/BE.

0.5 A MAINS FILTER



RZ 22748-2

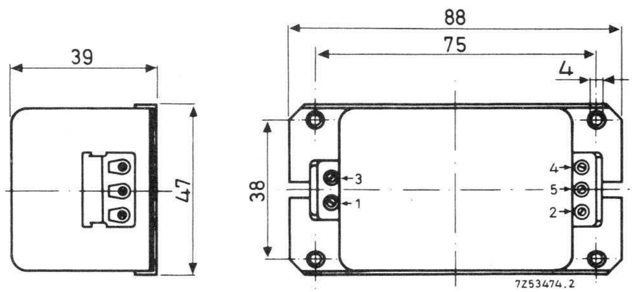
APPLICATION

This mains filter is intended for use between mains supply connection terminals and the mains inputs of control systems consuming less than 0.5 Amp. to provide an attenuation of minimum 50 dB for frequencies between 100 kHz and 10 MHz.

CONSTRUCTION

Unit is potted in a metal housing.

Dimensions in mm

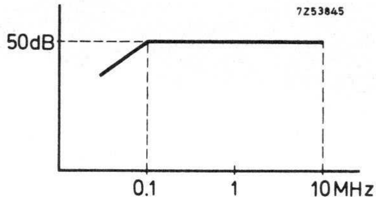


Weight: 280 g

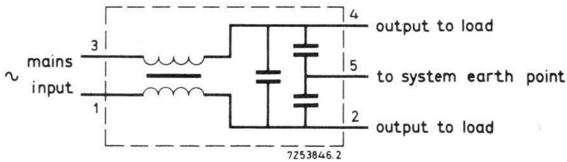
TECHNICAL PERFORMANCE

Attenuation	≥ 50 dB
Maximum a.c. input voltage	250 V
Maximum a.c. input current	0.5 A
Test voltage for 1 min	
a) across input terminals	2 kV
b) across input terminal and case	2 kV
Operating temperature range	−25 to +70 °C
Storage temperature range	−40 to +85 °C

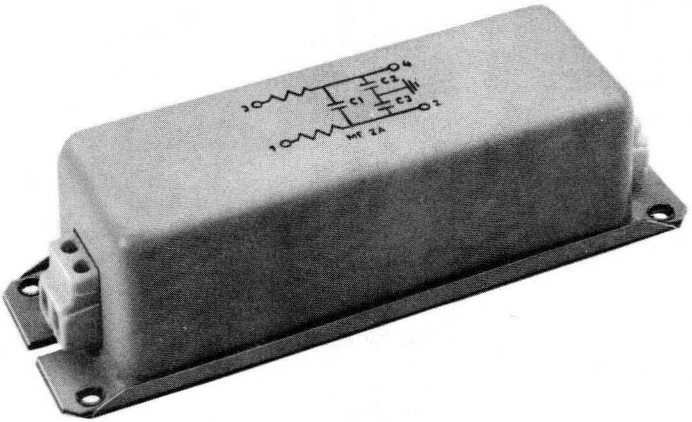
Minimum attenuation



Circuit diagram



2A MAINS FILTER



RZ 27208-8

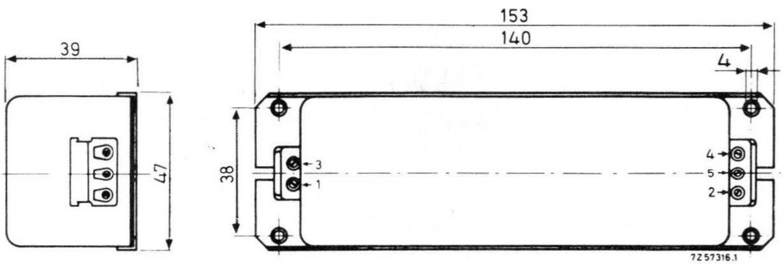
APPLICATION

This mains filter is intended for use between mains supply connection terminals and the mains inputs of control systems consuming less than 2 A to provide an attenua - of minimum 50 dB for frequencies between 300 kHz and 15 MHz.

CONSTRUCTION

Unit is potted in a metal housing.

Dimensions in mm

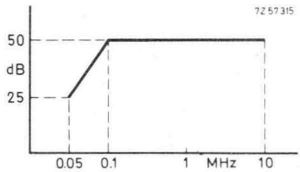


Weight: 570 g

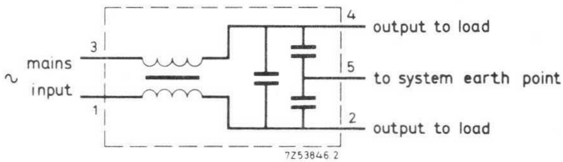
TECHNICAL PERFORMANCE

Attenuation	$\geq$ 50 dB
Maximum a.c. input voltage	250 V
Maximum a.c. input current	2 A
Test voltage for 1 min	
a) across input terminals	2 kV
b) across input terminals and case	2 kV
Operating temperature range	−25 to +70 °C
Storage temperature range	−25 to +85 °C

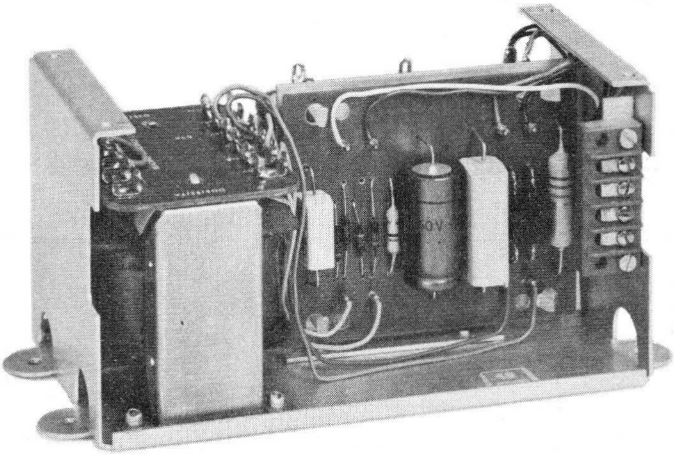
Minimum attenuation



Circuit diagram

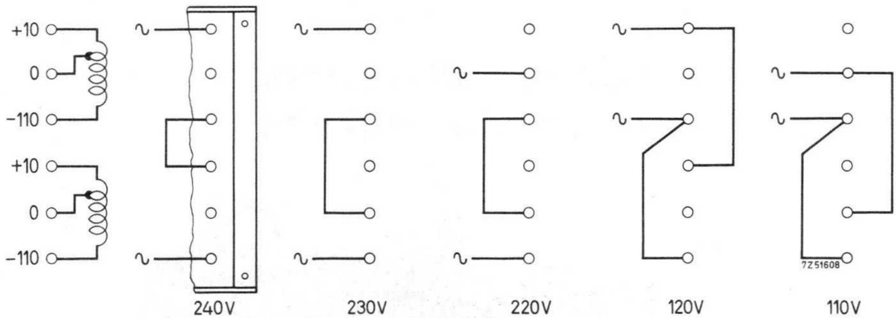


POWER SUPPLY UNITS for 60-series NORBITS

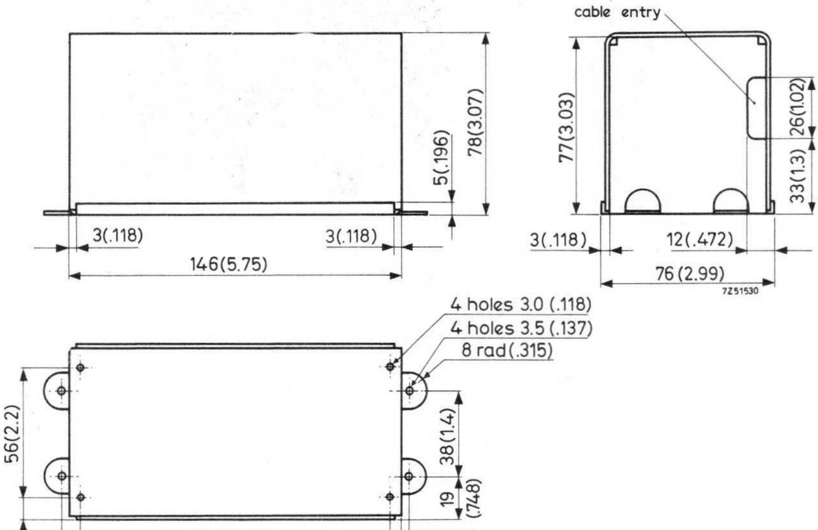


(Cap removed from unit.) RZ 23469-1

Input voltage	240, 230, 220, 120 or 100 V_{ac}, +10%, -15%
Input frequency	47 to 440 Hz
Output	$<$ 30 V at 0 mA, $>$ 18 V at 500 mA (for logic supply)
Additional output PSU 61	+100 V $\pm$25% at 0 to 25 mA (for Switch Filters)
Operating ambient temperature	-10 to +60 ^{o}C



Input facilities of mains transformer

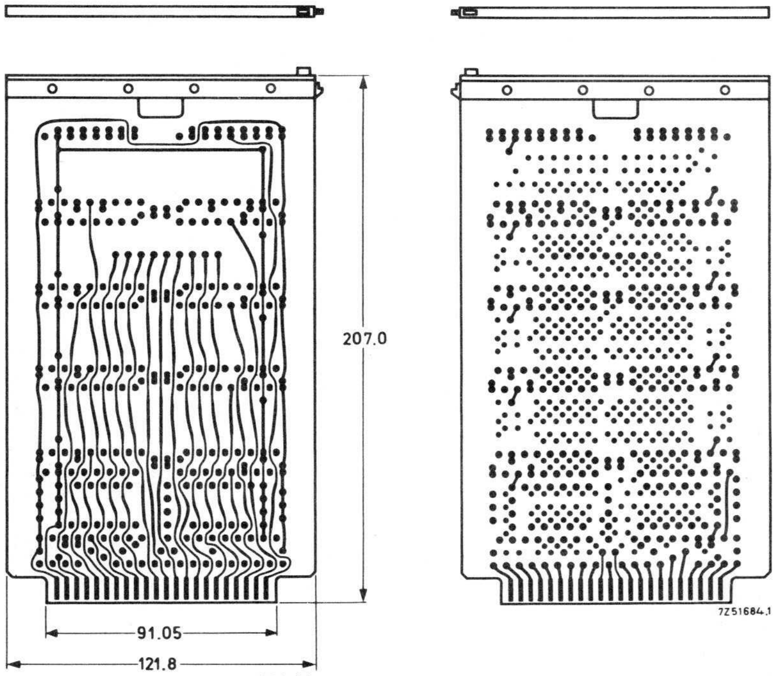


Dimensions in mm, inch values between brackets.

Case: aluminium

EXPERIMENTERS' PRINTED-WIRING BOARDS for 60-series NORBITS

Experimenters' printed-wiring boards (with extractor) with plated-through holes, and 0-volt supply line tracks for pins 9 and 16. They fit mounting chassis 4322 026 38230.

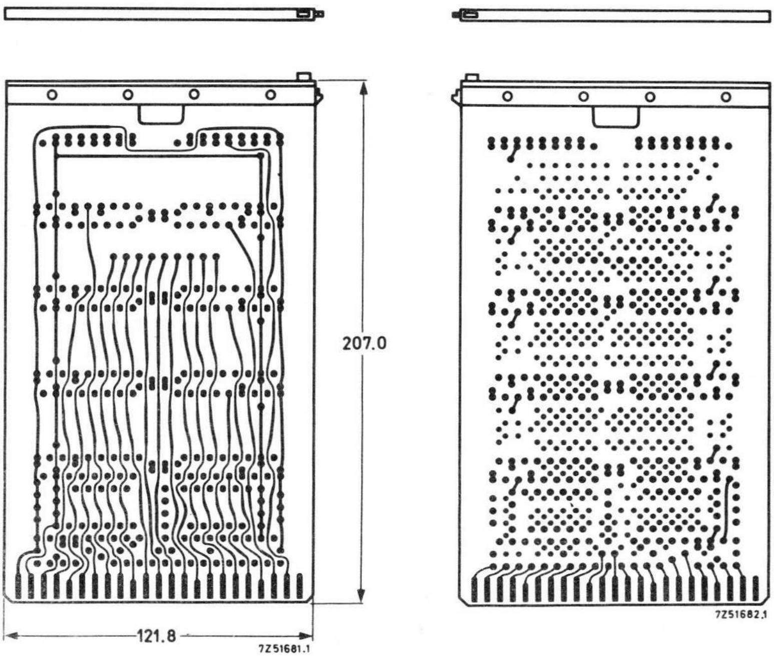


Accommodation	ten blocks size A
Material of version 4322 026 38790	glass-epoxy (PWB 60)
of version 4322 026 38800	phenol paper (PWB 60/P)
Hole diameter	1.3 mm
Contacts	2x22, gold plated, pitch 0.156"
Mating connector	types F047, F050, F053

For more information, see Application Note "Printed-wiring boards for 60-series Norbit Assemblies", No. 32/522/BE.

EXPERIMENTERS' PRINTED-WIRING BOARDS for 60-series NORBITS

Experimenters' printed-wiring boards (with extractor) with plated-through holes, and 0-volt supply line tracks for pins 9 and 16. They fit mounting chassis 4322 026 38240.

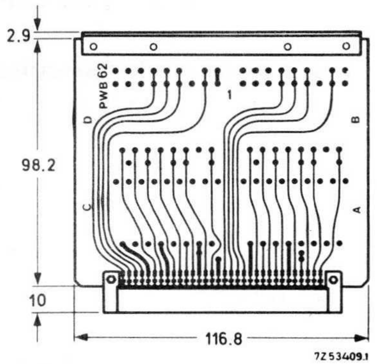


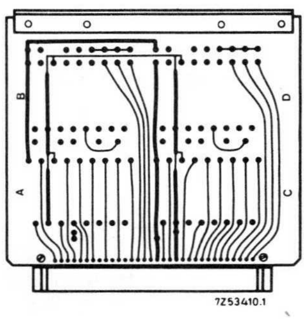
Accommodation	ten blocks size A
Material of version 4322 026 38810	glass-epoxy (PWB 61)
of version 4322 026 38820	phenol paper (PWB 61/P)
Hole diameter	1.3 mm
Contacts	2x23, gold plated, pitch 0.2"
Mating connector	2422 020 52591 (type F045)

For more information, see Application Note "Printed-wiring boards for 60-series Norbit Assemblies", No. 32/522/BE.

PRINTED–WIRING BOARD
for 60–series NORBITS

Printed-wiring board with plated-through holes, extractor and complete F054 connector, of which the female part has been soldered to the board. All terminals of any Norbit mounted on the board are brought out. The 0-volt pins and the positive supply pins have been tracked together for all Norbits.
The board fits the miniature mounting chassis 4322 026 38250.
The board is especially useful for systems where a small number of types (board + blocks) is essential with a view to replacement.





Accommodation: size A + size B (PA60)

size A	size B
4	0
2	1
0	2

Material	glass-epoxy
Hole diameter	1.2 mm
Connector	
type	F054 (2422 025 89082)
contacts	2 x 32
contact pitch	2.54 mm (0.1")
terminations	suitable for mini wire-wrapping

INTERCONNECTION DIAGRAM

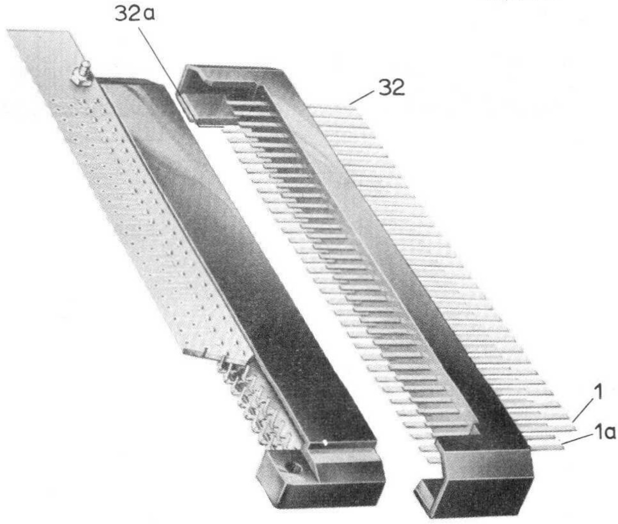
The designer of an electronic circuit with Norbits mounted on PWB62 boards, can easily derive the necessary connecting instructions from the diagram depicted on the next page. With this diagram he can indicate the connections that are to be made. The diagram gives the numbers of the terminals of the circuit block, its position on the PWB62 and the numbers of the connector terminals (see photograph below).
The thin lines in the diagram represent the tracks of the printed circuit on the PWB62, so they indicate the interconnections between the Norbit terminals, and the connector pins.

All the designer has to do is to draw the connections which should be made by the wire man (see thick lines on the second diagram).

As an example we give an alarm circuit of which the designer has drawn the diagram in the upper part, and has indicated for the wire man on the lower part the external interconnections to be made. Moreover, outside the diagram the necessary connections to be made the supply with unit, the oscillator, switches, and so on, are indicated by the arrows.

In this way the design engineer can draw the electronic circuit and the associated assembly instructions in one diagram.

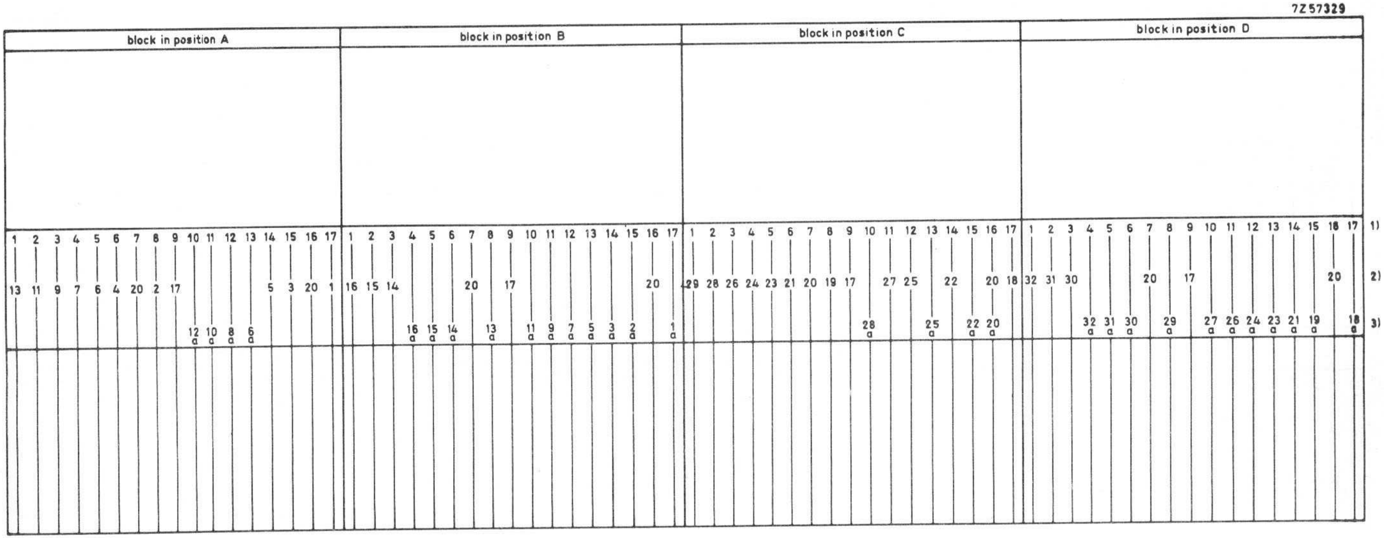
A 50744-1



Connector pin numbering as used in Interconnection Diagram.

Interconnection diagram (containing track data)

See example next page.

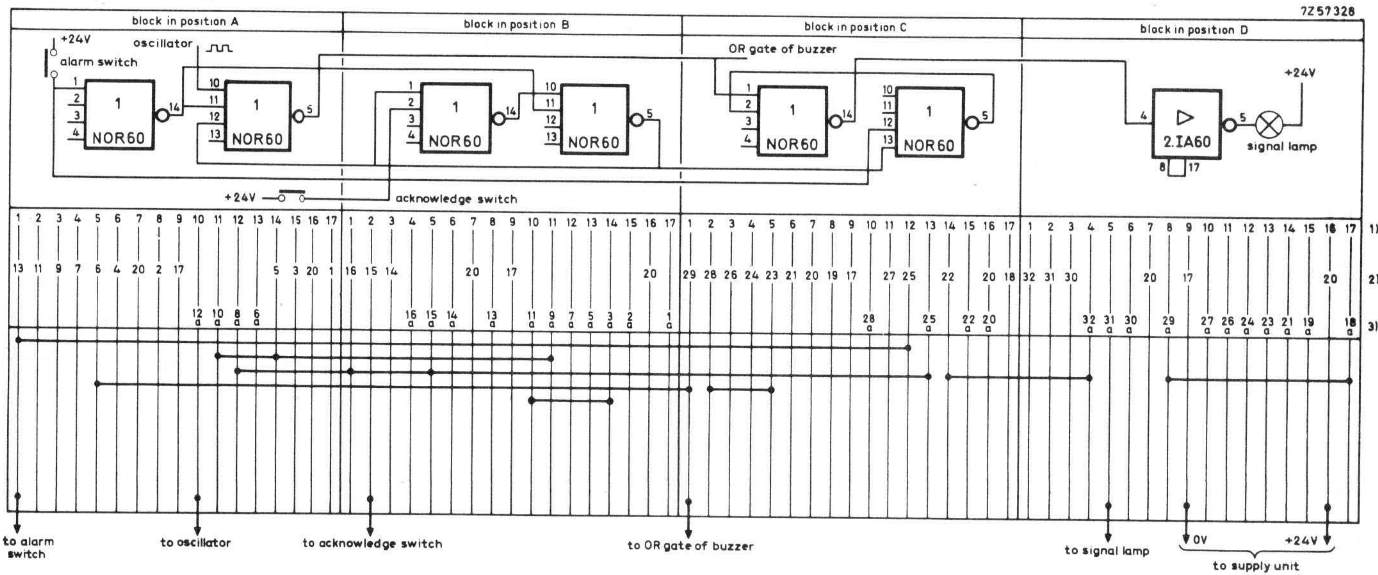


1) Terminal number of circuit block inserted in PWB62

2) Pin number of male F054 connector (see photograph) to which track on the "solder side" (bearing no type number) is connected.

3) Pin number of male F054 connector (see photograph) to which track on the "components side" (bearing type number) is connected.

Example

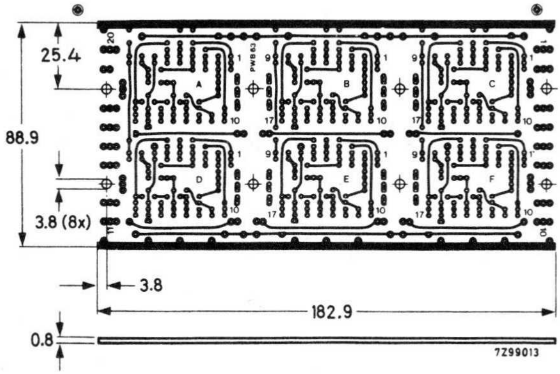


1) Terminal number of circuit block inserted in PWB62

2) Pin number of male F054 connector (se photograph) to which track on the "solder side" (bearing no type number) is connected

3) Pin number of male F054 connector (see photograph) to which track on the "components side" (bearing type number) is connected.

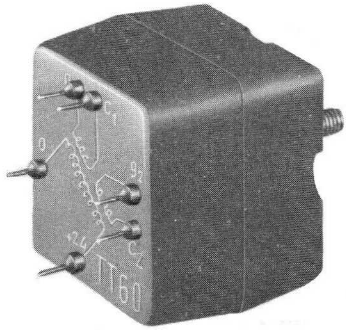
PRINTED-WIRING BOARD for UMC60



Single-sided printed-wiring board (with holes) intended for use in a Universal Mounting Chassis UMC 60.
Tracks have been laid such that only short jumpers need be used to obtain all kinds of logic functions with Norbits.

Accommodation (60-series blocks)	6 size A
	or 4 size A + 1 size B (PA60)
	or 2 size A + 2 size B
	or 3 size B
Material	glass-epoxy
Board thickness	0.8 mm
Hole diameter	1.2 mm

THYRISTOR TRIGGER TRANSFORMER



A 51993

APPLICATION

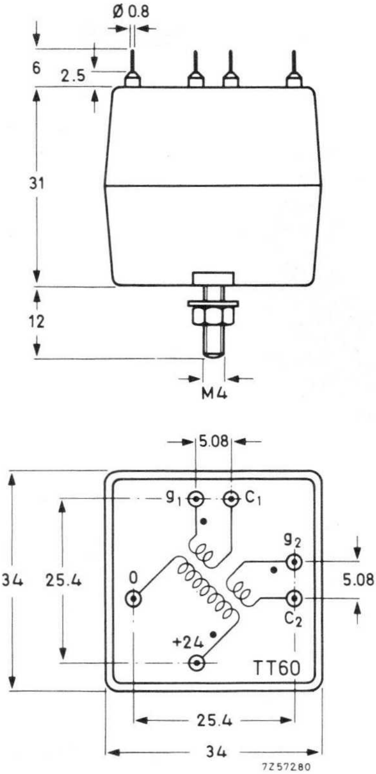
The TT60 can produce, in conjunction with the power amplifier PA60, two pulse currents of up to 400 mA. This is sufficient gate current to trigger a pair of practically any type of thyristor.

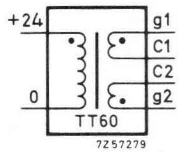
DESCRIPTION

The transformer has been encapsulated in a mould.
A threaded stud permits the unit to be fixed to a support (This may be the thyristor heat sink, to obtain short gate and cathode leads).

For the hand soldering of wires to the pins 7 wire spirals, catal.No. 4022 220 64781, are packed with the transformer.

Dimensions in mm





Drawing symbol

Weight: 80 g approx.

TECHNICAL PERFORMANCE

Turns ratio primary : sec_1 : sec_2	3 : 1 : 1
Inductance of primary winding	$\geq$ 6 mH
Leakage inductance referred to primary (both secondaries short-circuited)	$\leq$ 18 μH
Primary winding resistance at T_{amb} = 25 ^{o}C	$\leq$ 0.5 Ω
Secondary winding resistance at T_{amb} = 25 ^{o}C	$\leq$ 0.1 Ω
Test voltage between the windings for 1 minute	5 kV

Output pulse in response to step input,
circuit of Fig.A, R_{eq} = 13 Ω:

rise time	≤ 0.75 μs
pulse duration	≥ 20 μs
Operating ambient temperature	-10 to +85 °C
Storage temperature	-40 to +85 °C

APPLICATION INFORMATION

Pulse amplifier circuit

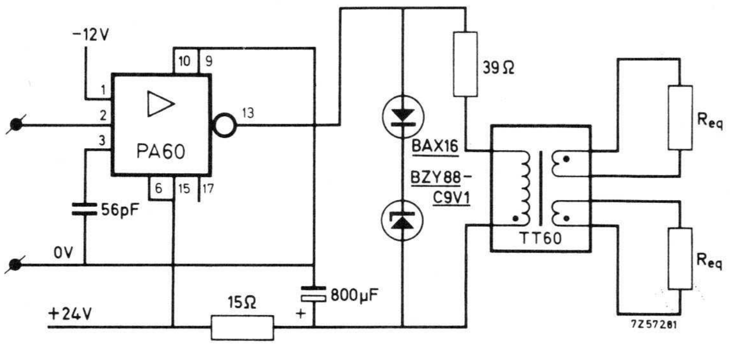


Fig.A

Note that terminal 2 of the PA60 is used for the pulse input.

Relaxation oscillator circuit

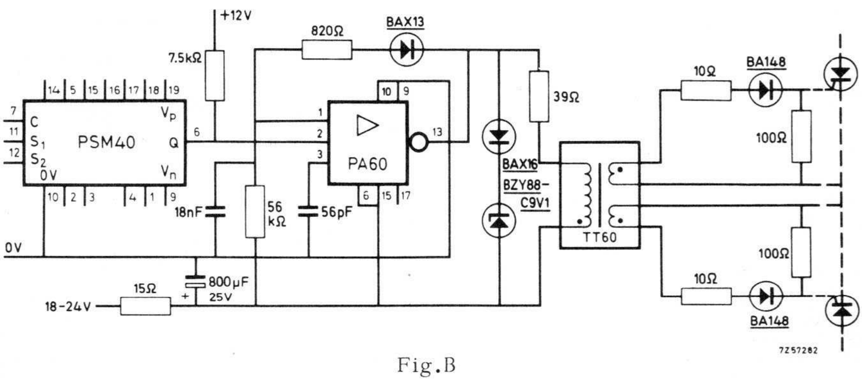
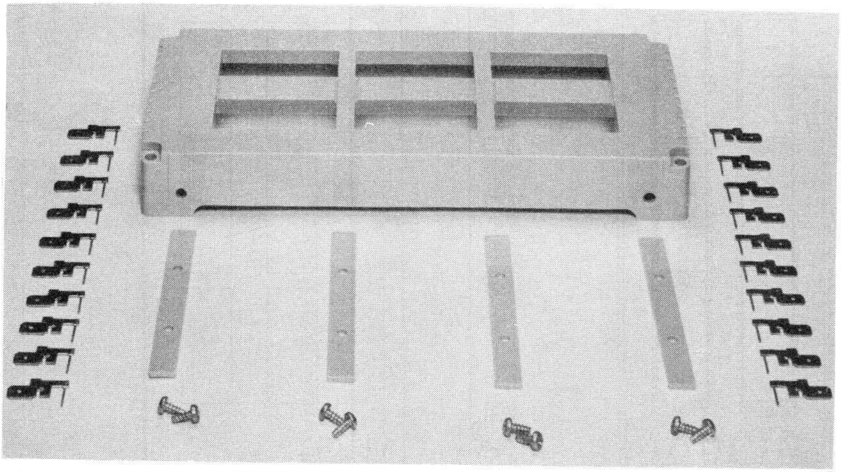


Fig.B

Fig.B shows the PA60 as a 10 kHz oscillator controlled by phase shift module PSM40. Oscillation commences with the level "high" (+12 V) on terminal 2 of the PA60, ceasing when it becomes "low" (0 V).

UNIVERSAL MOUNTING CHASSIS
for 60-series NORBITS



RZ 26441-7

APPLICATION

Low cost mounting facility for:

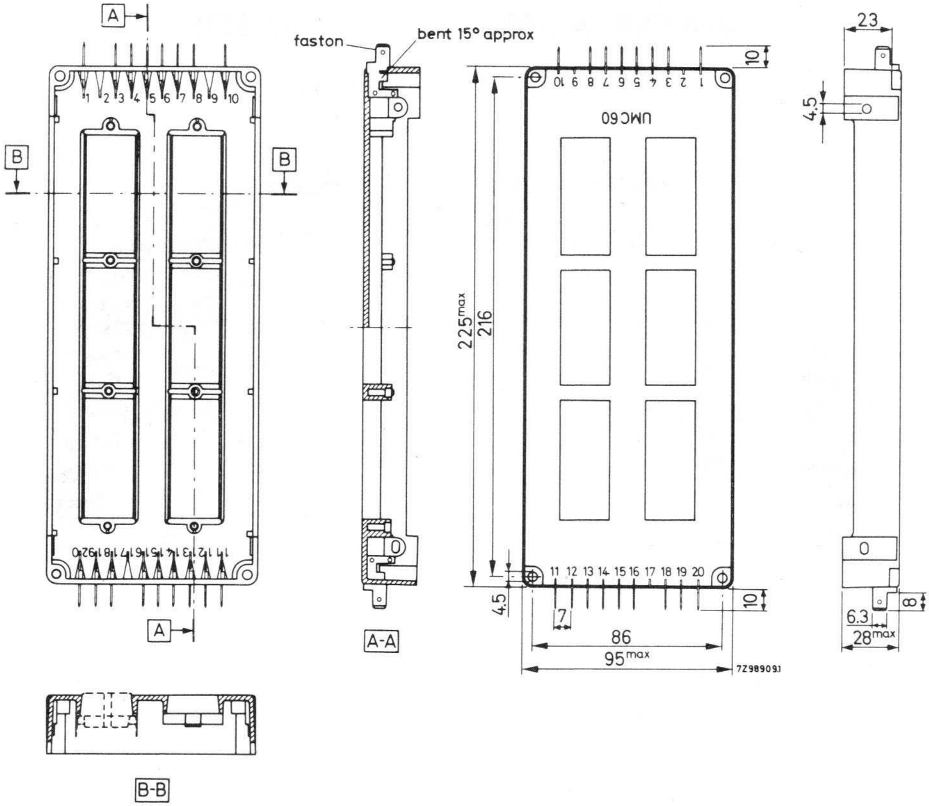
6 size A blocks,
or 4 size A blocks and 1 size B block (PA 60)
or 2 size A blocks and 2 size B blocks
or 3 size B blocks.

The chassis provides an alternative for mounting 60-series blocks on a printed-wiring board with connector.
Chassis can be bolted together side by side (Fig.4); they may also be stacked (Fig.5 and Fig.6) or hinged.

DESCRIPTION

The delivery includes a moulded polycarbonate chassis body, 4 moulded polycarbonate strips, 8 self-tapping screws and 20 standard 0.25 inch Fastons. Strips and screws are for clamping the circuit blocks into the holes in the chassis. The Fastons are for connections to the circuitry in the chassis.

To accommodate a size B block, it is necessary to remove the material between two size A holes, see Fig.1.
Interconnections between the terminal pins of the circuit blocks can be made by means of hand soldering or mini wire-wrapping; it is also feasible to use printed-wiring board PWB63 (catal. No. 4322 026 73750) in the chassis (see Fig.3).



Colour: grey

Weight: 150 g approx.

Dimensions in mm

ASSEMBLY AND USE

The Fastons are brought in from the outside of a chassis and then fixed by bending the slotted part on the inside over about 15°

The blocks are clamped into the chassis with the strips and the self-tapping screws.

For fixing two or more chassis together, 4 mm bolts and nuts may be used.

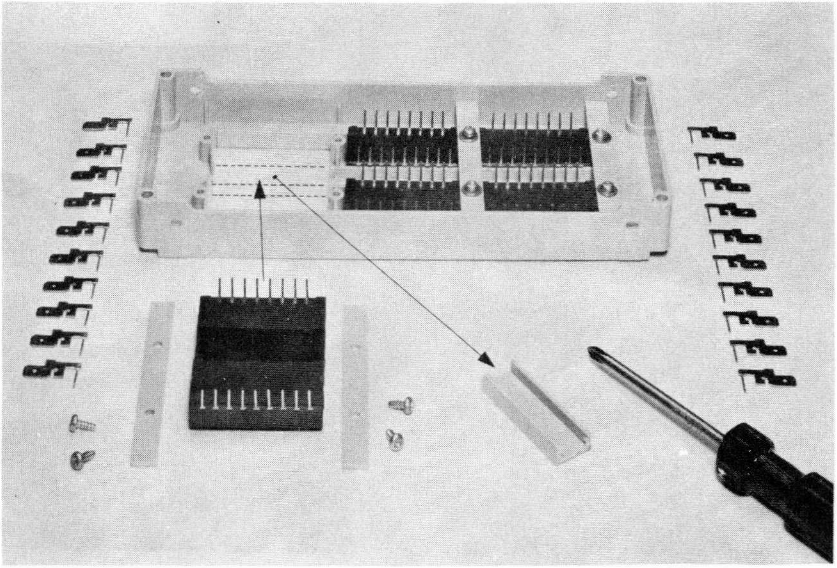


Fig.1

RZ 26441-6

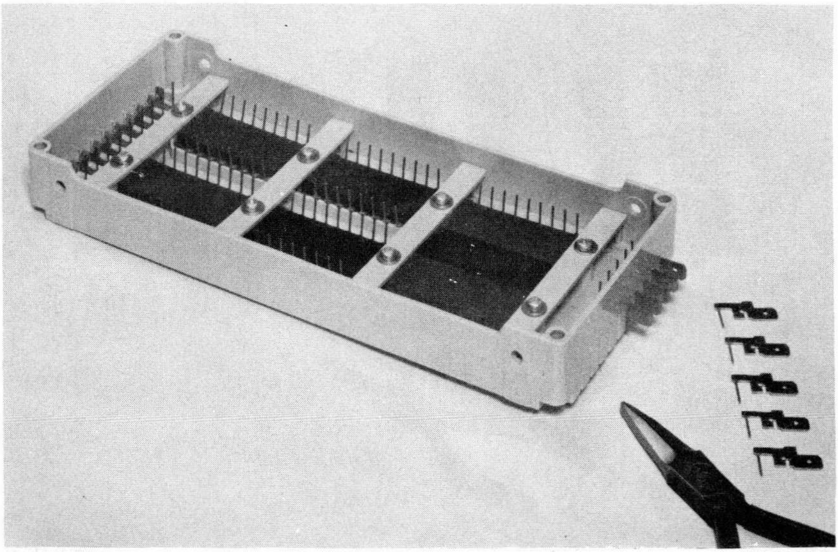


Fig.2

RZ 26441-3

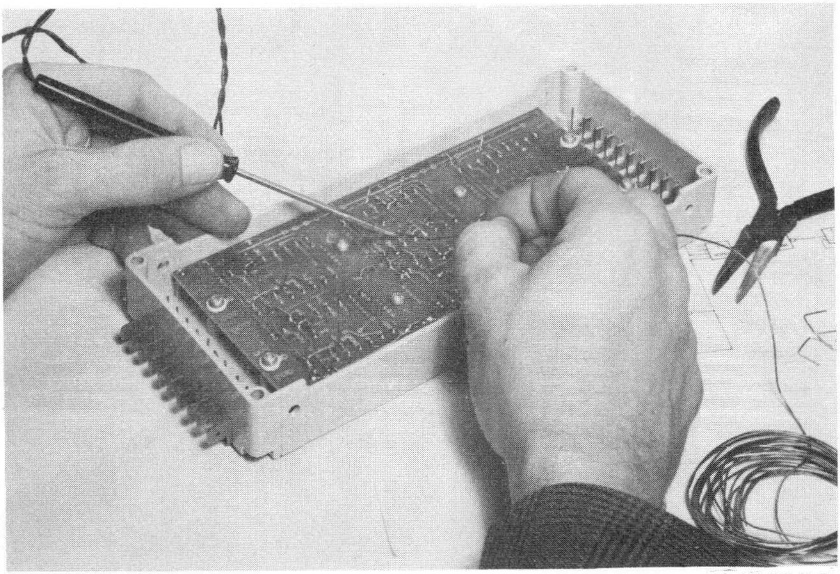


Fig.3

RZ 26441-8

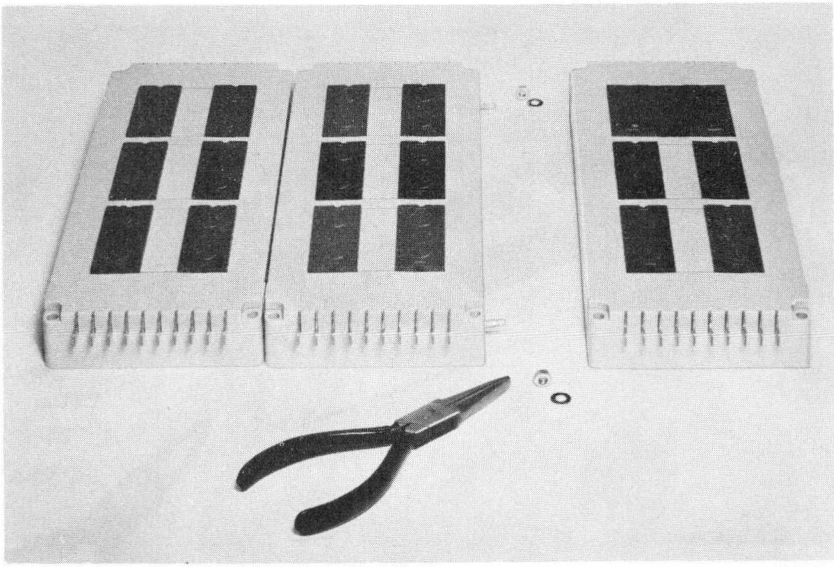


Fig.4

RZ 26441-4

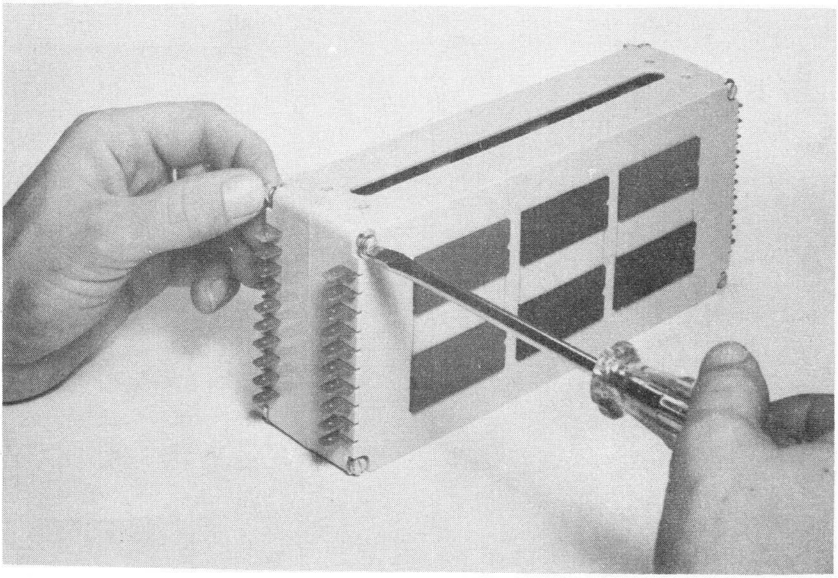


Fig.5

RZ 26441-9

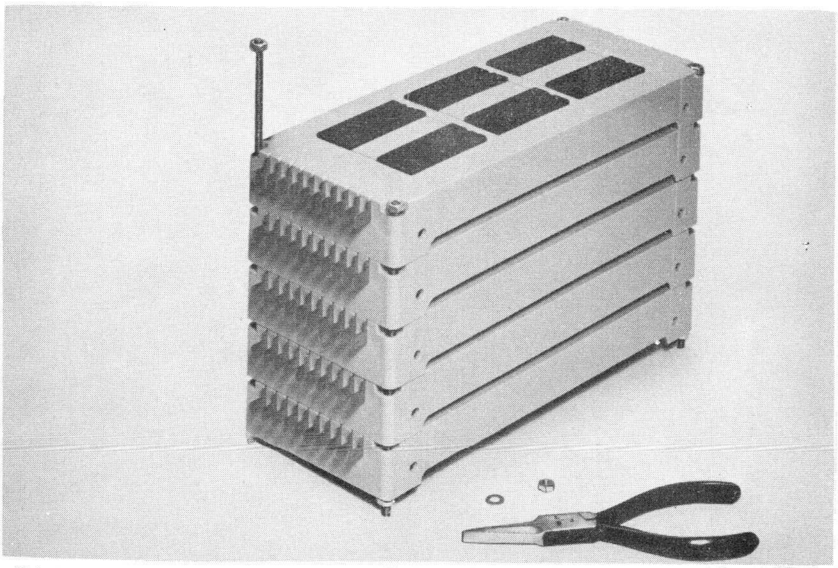
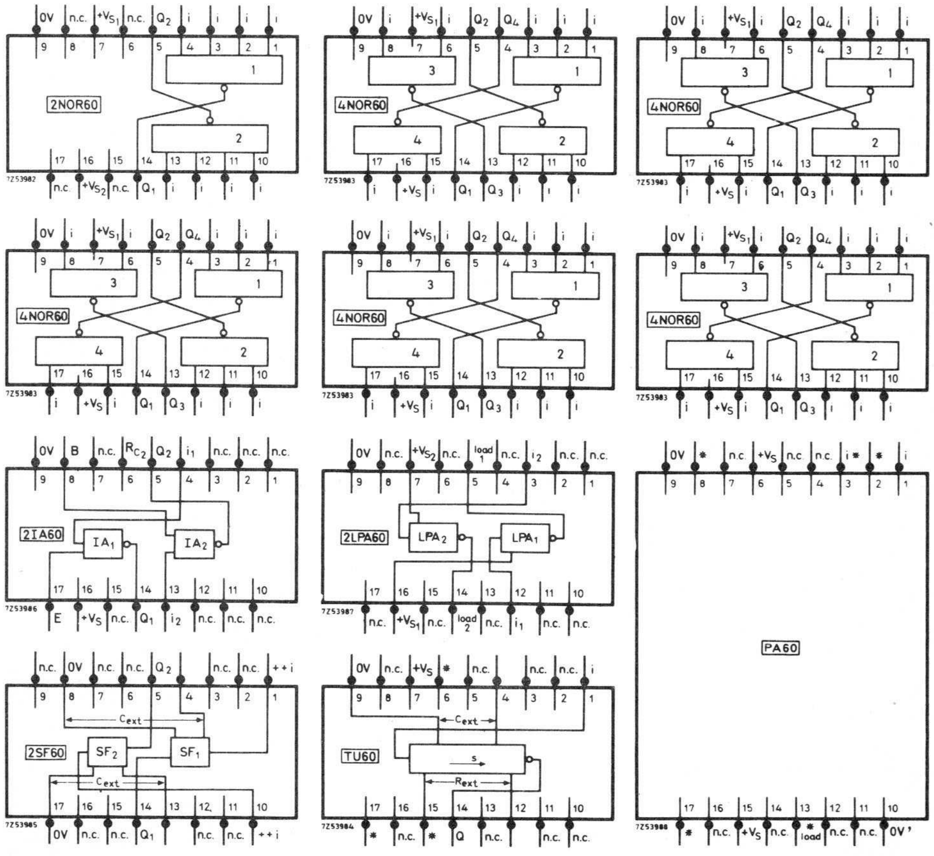


Fig.6

RZ 26441-10

WIRING LAYOUT STICKERS
for the 60-series NORBITS

These are drawing symbols of 60-series blocks printed on self-adhesive, transparent material. They can be used for fast preparation of wiring layouts. All pin distances are actual size.
The stickers are available in sheets, each containing the arrangement of drawing symbols shown below. Each sticker can be separately detached from the sheet, without cutting. Catalog number for 50 sheets: 9399 269 11001.



Input/output devices

INTRODUCTION

Input devices

Industrial control systems require compatible input devices that are capable of deriving signals representative of controlled or otherwise pertinent conditions. Though the information to be dealt with may take a variety of forms - e.g. presence, position, movement, rotation etc. - many different situations can be covered by a comparitively small selection of input devices.
The requirements of each situation determine the physical principle to be employed in the input device.
For reasons of speed and reliability it is preferable to avoid mechanical contact in deriving the input signal, and often an all-static method of derivation is required. Experience with input devices has made it clear that skilful use of them can greatly improve machine output and reliability.

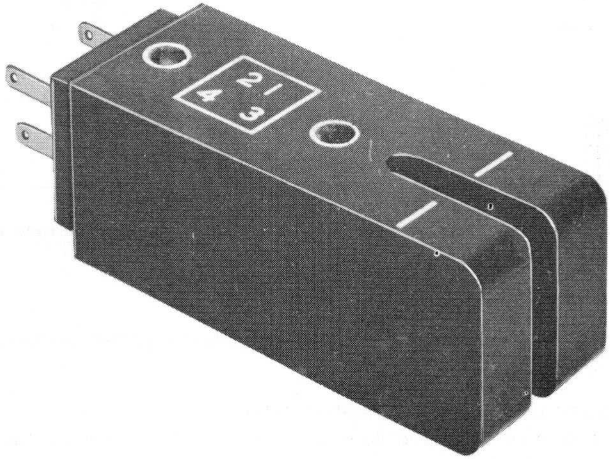
Output devices

At the output of a control system signals will often have to be amplified to obtain the necessary power for certain operations. In this respect the Thyristor Trigger Module will provide a useful way of bridging the gap from low signal voltage to high mains voltages. In connection with a Phase Shift Module PSM40 it makes possible a wide range of output control facilities.

In this series the following units are available:

VANE SWITCHED OSCILLATOR

RZ 19213-1



Supply voltage	12 V_{dc}
Operating-temperature range	-25 to +85 ^{o}C

APPLICATION

The vane switched oscillator can be applied as a static switching device, the switching action being determined by the position of a vane. For the vane any metal can be used.

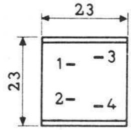
CONSTRUCTION

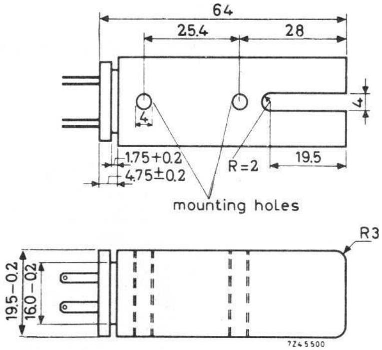
The vane switched oscillator consists of an oscillator and a diode rectifier. The latter is connected to a separate coupling winding of the oscillator coil, thus providing an isolated d.c. output.
The lay-out of the oscillator is such that upon inserting a suitable piece of metal (vane) in a gap between the oscillator coil windings, the oscillation stops and the d.c. output of the unit will drop to zero.
The complete circuit is encapsulated in epoxy resin.

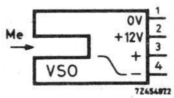
1 = - } supply
2 = + }

3 = + } output
4 = - }

Terminal location







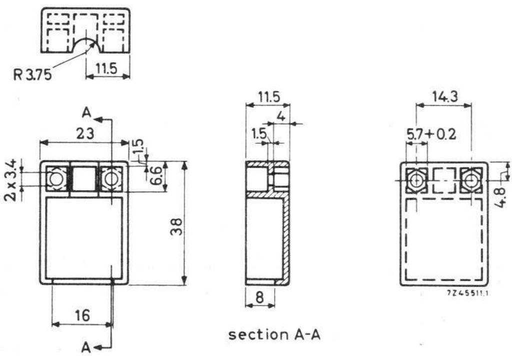
Drawing symbol

Dimensions in mm

The weight (without cable anchoring cover) is 42 g.

The unit may be mounted in any position. Two mounting holes allow the use of 4 mm bolts. Stacking of units is permitted.

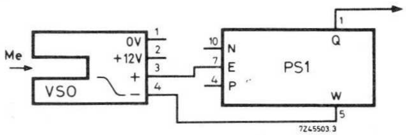
Connection can be made by 0.110 Fastons or by soldering.
A cable anchoring cover, consisting of two equal caps (as shown in the figure below), is supplied with each VSO.

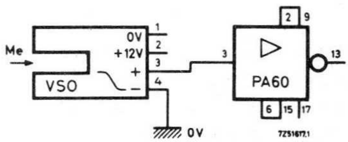


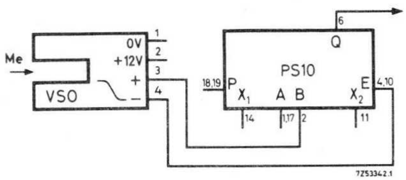
Cable anchoring cover

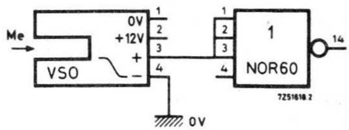
ELECTRICAL DATA

Supply voltage	12 V_{dc} ± 10% or +6 V_{dc} ± 10% and −6 V_{dc} ± 10% (with common 0 V)
Consumed current (in both oscillating and non-oscillating condition)	12 mA ± 10%
Output voltage	5.75 V ± 15% open circuit , isolated from the supply. Maximum permissible voltage between 1-2 and 3-4 is 100 V_p. Suited for driving the pulse shaper types PS 1* and PS 10**, and for driving the Norbit PA60 and 2.NOR60 if three inputs are connected in parallel.









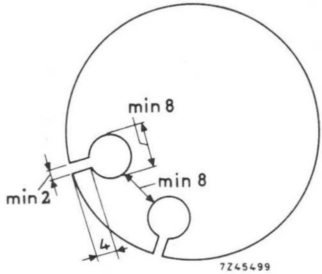
Output impedance (without vane)	4.1 kΩ ± 10%
Maximum detection frequency	1 kHz
Noise (over supply lines)	< 100 mV_{p-p}
Ambient temperature range	
operating	−25 to +85 °C
storage	−40 to +85 °C

* circuit block 100 kHz series, catalog number 2722 001 11001
** circuit block 10-series , catalog number 2722 004 11001

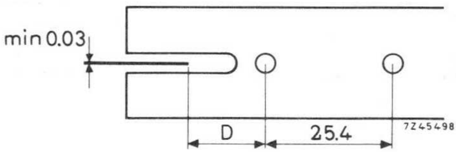
APPLICATION INFORMATION (typical values)

Vane material	any metal
Vane dimensions for aluminium:	
minimum width for a thickness of 2 mm	8 mm
minimum thickness	0.03 mm

Instead of a vane a disc with holes of indicated dimensions may be used.



The data given below are based on a movement of an aluminium vane 50 x 50 x 2 mm in longitudinal direction.
The operating distance D (see figure below) is the distance at which the output just drops to zero (measured from the centre of the hole nearest to the gap).
Hysteresis is defined as the distance between the vane position at which oscillation ceases and that at which oscillation starts.

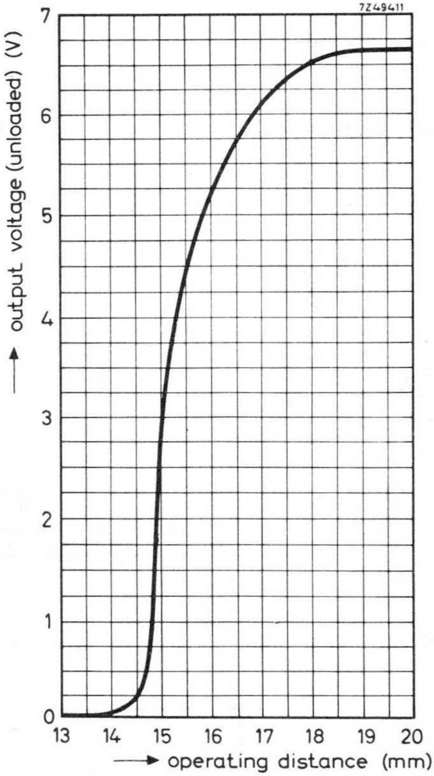


Operating distance D	
open circuit	14.6 ± 1.5 mm
with PS 1 or PS 10 (0 to 1)	15.3 ± 1 mm
Hysteresis	
open circuit	< 1 mm
with PS 1	0.03 mm
with PS 10	0.6 mm

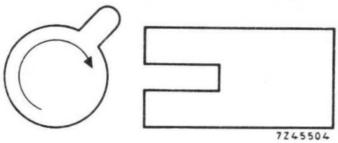
Variation of D with supply voltage

supply voltage	operating distance (mm)
nominal	D
nominal -5%	D +0.06
nominal +5%	D -0.06

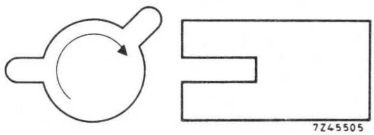
Variation of D with temperature (from −25 to +85 °C)	< 2.7 mm D is maximum at −25 °C
Variation of D with time (at T_{amb} = 25 °C and V_{supply} = 12 V ± 1%, reference point is half the unloaded output voltage of VSO without vane)	< 0.02 mm
Variation of output voltage with D	see typical curve, figure below. From the steep curve it can be seen that a switching point will be kept within very narrow mechanical tolerances.



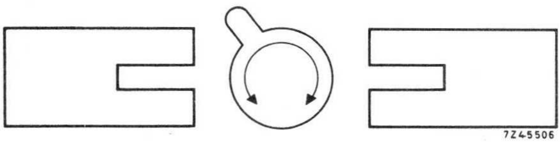
APPLICATION SUGGESTIONS



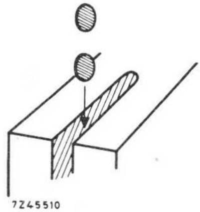
counting of revolutions



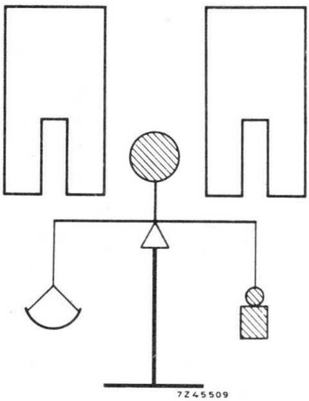
angular position switching (programming)



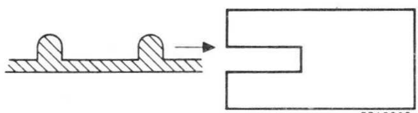
bidirectional counting



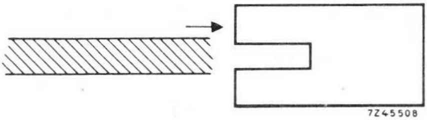
counting of small objects



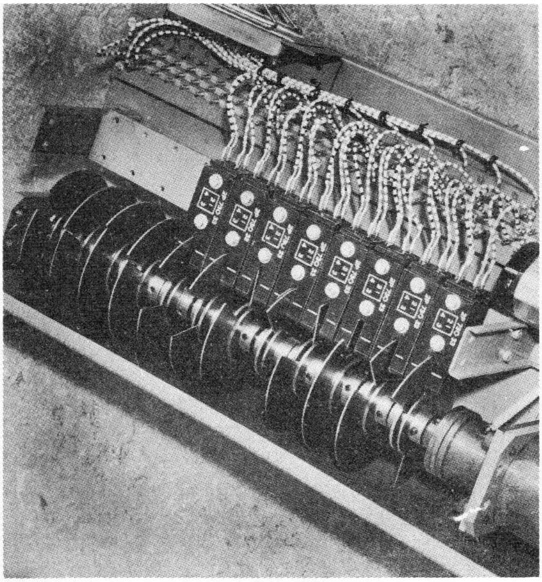
weighing or dosing



linear position switching (programming)

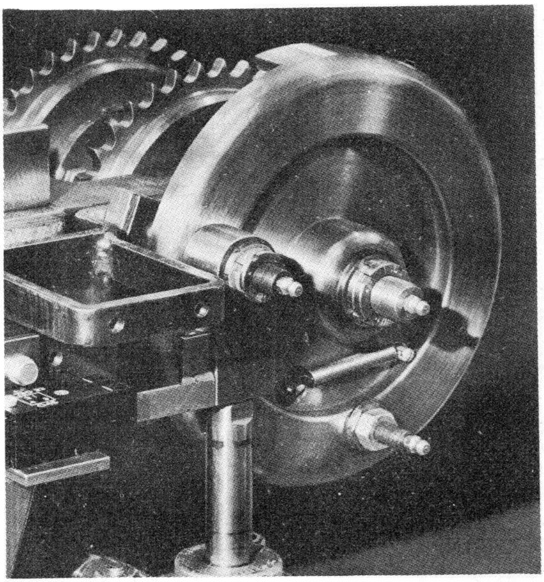


foil continuity check



RK 9230-4

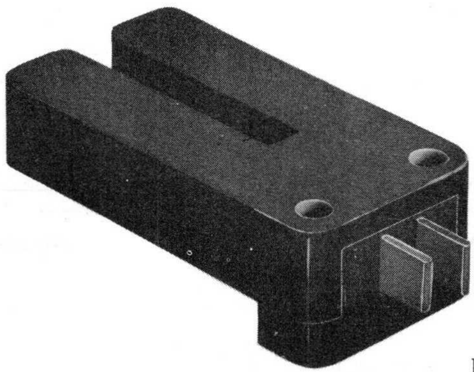
Eight VSO's used in a disc programmer for control of a metal-working machine.



VSO control of pneumatic metal-forming machine.

RK 9230-5

IRON VANE SWITCHED REED



RZ 21773-3

Maximum switching frequency	100 Hz
Operating-temperature range	−25 to +70 °C

APPLICATION

The iron vane switched reed can be applied as a limit switch, position indicator or as a signal source for low counting speeds.
In conjunction with d.c. amplifiers or with the thyristor trigger module (TTM), the IVSR can be used for power switching.
As the IVSR is free from most of the difficulties encountered with mechanical switches, it can succesfully replace micro switches.

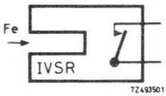
CONSTRUCTION

The IVSR consists of a magnet and a reed switch encapsulated in an U-shaped plastic housing.
When there is no piece of iron (vane) in the gap between the reed switch and the magnet, the reed switch is closed. Inserting a piece of iron of suitable dimensions in the gap reduces the magnetic flux through the reed to such an extent that the reed switch opens.
In this way it is possible to obtain signals that indicate the position of the iron vane.

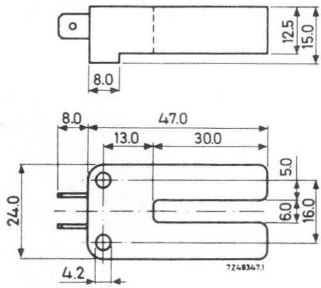
The weight is approximately 20 g.

The IVSR can be mounted in any position. Two mounting holes allow the use of 4 mm bolts. When IVSR's are mounted on a common support, the minimum distance between the housings is 36 mm, to avoid interaction. For mounting IVSR's over each other, this distance is 60 mm.

Connection can be made by means of 0.250" Fastons or by soldering.



Drawing symbol



Dimensions in mm

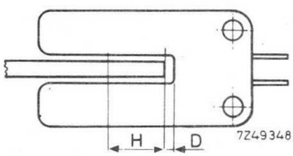
TECHNICAL PERFORMANCE

Load switching capacity (non inductive)	≤ 1.2 VA
Voltage switching capacity	≤ 32 V_{dc}
	≤ 50 V_{ac}
Current switching capacity (non inductive)	≤ 0.1 A_{dc}
Switching frequency	≤ 100 Hz
Contact resistance, measured at 10 mV at open circuit	< 150 mΩ
Contact capacitance	≤ 5 pF
Insulation resistance, measured at 250 V_{dc} at open circuit	≥ 10^8 Ω
Test voltage, measured at open circuit for 1 min	500 V_{dc}
Permissible operating-temperature range	-25 to +70 °C
Permissible storage-temperature range	-40 to +85 °C

APPLICATION INFORMATION (typical values)

Vane material	mild steel

The data given are based upon a movement of a mild steel vane 30 x 10 x 4 mm, placed centrally in the gap, in longitudinal direction.



The operating distance (D) is the distance between the front edge of the vane and the rear of the gap at which the reed switch opens.
The hysteresis (H) is defined as the distance between the vane position at which the reed switch opens and that at which the reed switch closes.

Operating distance	4 ± 3 mm
Hysteresis	10 ± 3 mm

APPLICATION SUGGESTIONS

As the reed switch is normally closed, the following two modes of operation can be distinguished:

- output voltage is present when there is no vane in the gap (Fig.a)
- output voltage is present when there is a vane in the gap (Fig.b)

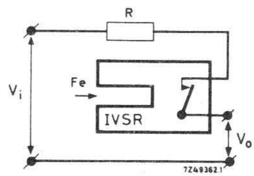


Fig.a

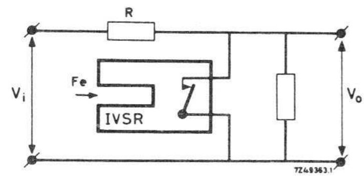
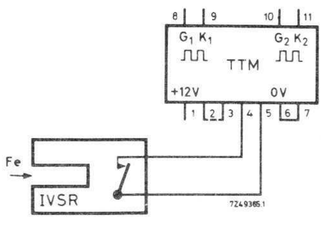
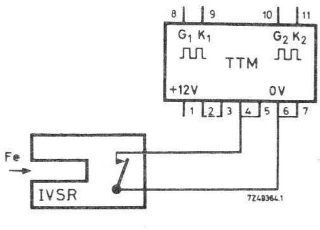


Fig.b

IVSR in conjunction with the thyristor trigger module (TTM)



Trigger pulses from the TTM only if there is no vane in the gap of the IVSR



Trigger pulses from the TTM only if there is a vane in the gap of the IVSR

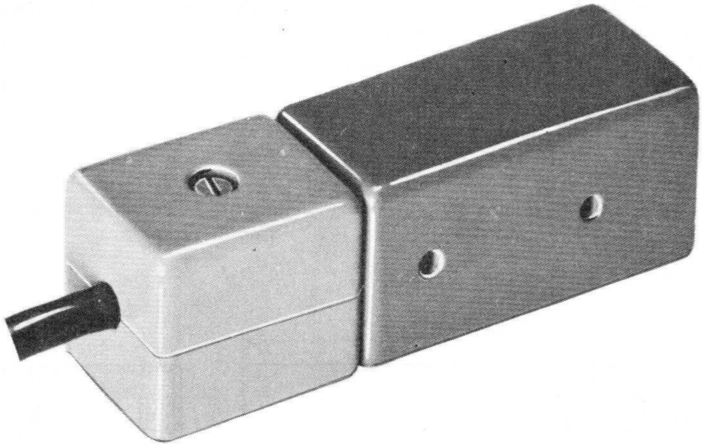
Notes

It is obvious that the IVSR should not be used in environments where iron dust or scraps might impair its operation.

It should be realised that capacitance directly across the switch terminals can be the cause of high currents through the switch at the moment of closing the contacts. This should be avoided by having sufficient resistance in the proper contact circuit.

In case the switch is used with electronic circuitry in which bounce might give rise to malfunctioning of the equipment, appropriate circuitry should be added to get rid of the bounce effect. The safe way out is the use of a one shot multivibrator.
Another solution that sometimes can be used, is applying a low pass RC network between the IVSR and the input of the equipment.

ELECTRONIC PROXIMITY DETECTOR



Supply voltage	12 V_{dc}
Maximum detection frequency	1 kHz
Operating-temperature range	-25 to +85 ^{o}C

GENERAL

The electronic proximity detector is a static switching device, the switching action being determined by the presence of a metallic object. The metal can be any electrically conducting material of rather arbitrary shape.
It can be applied as a detector for the presence, passage or position of metal parts and is a versatile tool in various industrial automation set-ups.

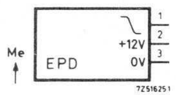
The EPD contains an oscillator which is link coupled to a detector. The detector is followed by an amplifier.
The oscillator coils and the coupling link are placed in a potcore half. In this way a well-defined field is set up in front of the open side of the potcore, located at the front side of the EPD. Bringing a piece of metal in this field the oscillator output and subsequently the output of the amplifier decreases, due to the loading effect of the eddy current losses in the metal.
When no piece of metal is near, the output voltage of the EPD is approximately 12 V. It will decrease in proportion to the reduction of the oscillator output, resulting from a metal object coming nearer.

The complete circuit is epoxy encapsulated in a polycarbonate housing.

The weight is approximately 120 g.

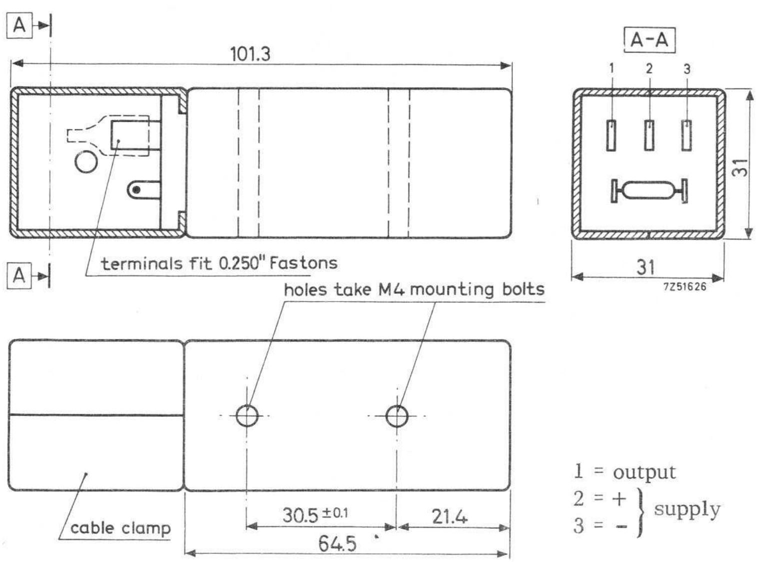
The unit may be mounted in any position. Two mounting holes allow the use of 4 mm bolts.

Connection can be made by 0.250" Fastons or by soldering. A cable clamp consisting of two equal caps is supplied with each EPD. This clamp permits either end or top entrance of a 3-core cable of 7 mm diameter.



Drawing symbol

Dimensions in mm



1 = output
2 = + } supply
3 = - }

Note

The resistor between the two 0.110" Fastons is an adjustment resistor for the oscillator loop gain; it should not be changed.

TECHNICAL PERFORMANCE

Supply voltage (V_S)	12 V_{dc} ±5% or +6 V_{dc} ±5% and −6 V_{dc} ±5% (with common 0 V) or 24 V_{dc} via series resistor and 12 V zener diode, giving a stabilised supply voltage of 12 V. (See also APPLICATION SUGGESTIONS.)
limiting value	abs. max. 15 V *) (destructive at $T_{amb} \geq 40$ °C)
Consumed current (nominal value)	16 mA
Output voltage, no object being detected	approximately V_S − 0.5 V
Output resistance	
no object being detected	680 Ω ±10%
object being detected	3.3 kΩ
Hysteresis for output voltages of 100 mV − 11 V	0 mm
Minimum load	1 kΩ
Maximum detection frequency	1 kHz
Noise (over supply lines)	< 10 mV
Ambient temperature range	
operating	−25 to +85 °C
storage	−40 to +85 °C

APPLICATION INFORMATION (typical values)

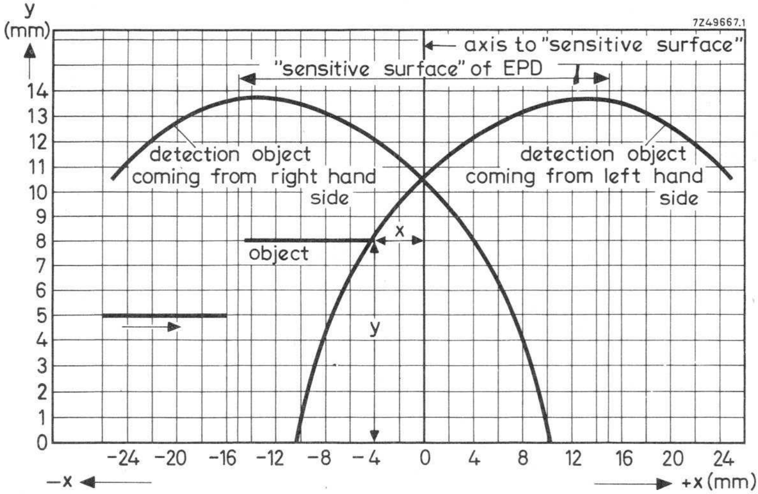
Detection graphs

Detection of a rectangular mild steel reference object, 50 x 25 x 1 mm

Sensitive surface	surface of 31 x 31 mm at the opposite end of the EPD to the terminals
Axis	line perpendicular to the centre of the sensitive surface
Operating point	point at which the output voltage of the EPD is reduced to 100 mV (moment of detection)

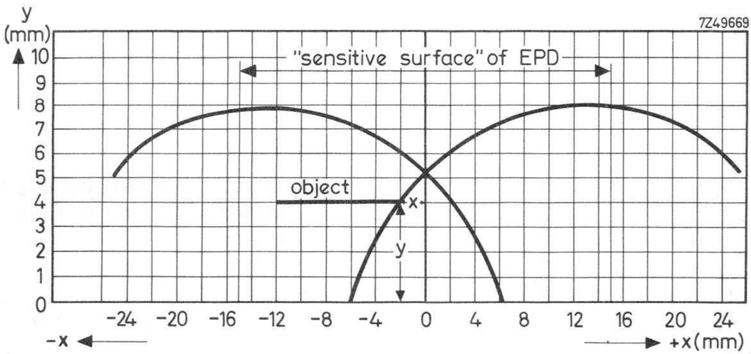
*) Reversal of supply voltage will damage the detector.

Operating distance	distance of the leading edge of the reference object to the axis at the operating point (x-operating distance)
Detection range	distance of the reference object to the sensitive surface (y-operating distance)



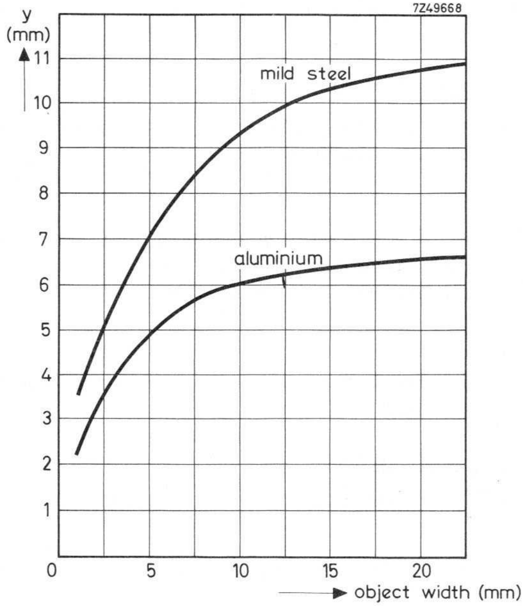
From the graph it can be seen that the object is detected before the axis is reached if it passes at a distance of < 10 mm from the sensitive surface. If it passes at a distance of e.g. 13.5 mm, the object is detected after the axis has been passed.

Detection of a rectangular aluminium reference object, 50 x 25 x 1 mm

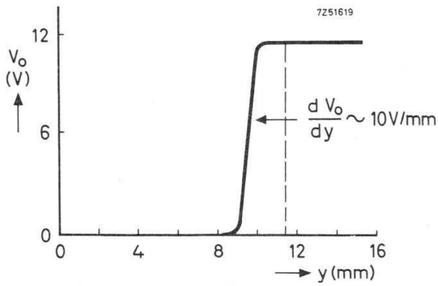


Detection of rectangular mild steel and aluminium reference objects (50 x 1 mm) with different widths

Object approaches the centre of the sensitive surface perpendicularly from in front.



Output voltage as a function of the position of a rectangular mild steel reference object, 50 x 25 x 1 mm



Upon frontal approach of the object to the sensitive surface, the output voltage of the EPD will change from over 11 V to 100 mV within 1 mm from the position in which the output voltage starts to change.
This characteristic is extremely important when the EPD is used as a position detector.

Notes:

The detection graphs may differ slightly from unit to unit.

Quite small objects can be detected when brought close to the sensitive surface. Thickness is relatively unimportant as eddy currents occur in penetration layer only.

Influence of supply voltage variations

A supply voltage variation of ±5% produces a change of ±0.1 mm in y-operating distance, at 10 mm from the sensitive surface.

Influence of temperature

With the reference object at a y-operating distance of 10 mm (at −25 °C) a change in temperature of both EPD and object will cause the y-operating distance to change less than 2 mm over the range from −25° to +85 °C.

Direction of approach

As the exterior field is rotation symmetrical the path along which the detection position is reached is immaterial.

Distance from metallic surroundings

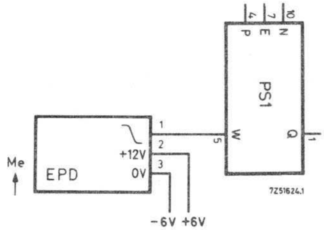
Clearance from metallic surrounding: 30 mm (this applies for sensitive front part of unit).

Spacing required between two detector axes with sensitive surface in the same plane: 60 mm.

Spacing required between two reference objects to give discrete detection: 50 mm. (This property can be put to use in feeder systems, a gap being used to initiate part supply restart.)

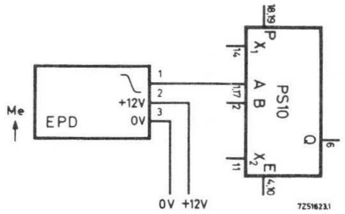
APPLICATION SUGGESTIONS *)

EPD in conjunction with 100 kHz-Series circuit blocks

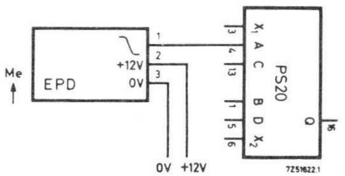


*) With long cables between EPD and subsequent electronics RC decoupling of interference can be employed.

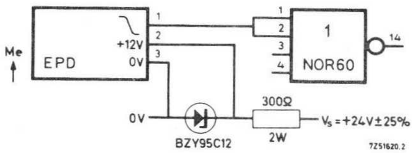
EPD in conjunction with 10-Series circuit blocks

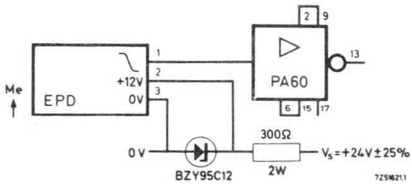


EPD in conjunction with 20-Series circuit blocks



EPD in conjunction with 60-Series Norbits





MINIATURE ELECTRONIC PROXIMITY DETECTOR

development sample data

Green Binder, Tab 2

The photograph shows two EPD60's together with a microswitch.

Supply voltage: 24 Vdc ± 25 %
or
12 Vdc ± 5 %

Max. detection frequency: 1 kHz

Operating temperature: -25°C to +70°C

APPLICATION:

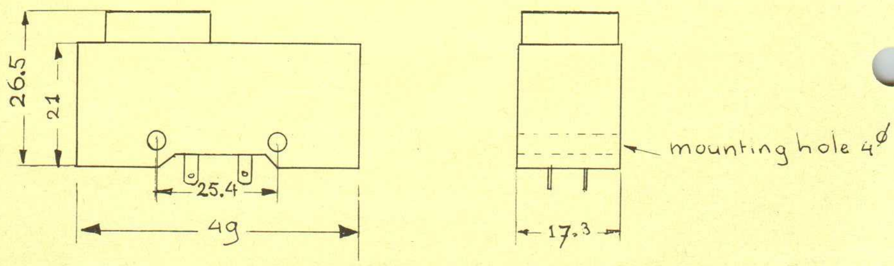
The Miniature Electronic Proximity Detector EPD 60 can be applied as a static switching device, the switching action being determined by the position of a metal object.
In this way a non contacting static equivalent for the well known micro switch is obtained.

CONSTRUCTION:

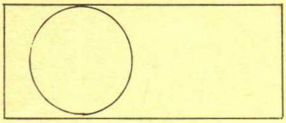
The unit is potted in a high grade synthetic resin housing, the dimensions of which are compatible with standard micro switch housings.
The circuit consists of an oscillator followed by a detector and an amplifier.
The oscillator coils, placed in a pot core half located in the cylindrical part,set up a well defined field.
By means of a metal object the loading on the oscillator and hence the output of the unit can be controlled.
The normal output of the unit (i.e. without a metal object close to the sensitive coil area) is low, 0-0,3 V.
If an object of adequate size is brought far enough into the field, the output of the unit will go "high".
Connection to the unit can be made by means of 0.110" Fastons supplied with the unit.

MECHANICAL DATA:

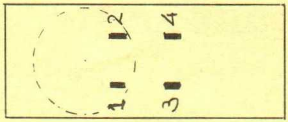
Dimensions in mm.



Top view



Bottom view



Terminals:

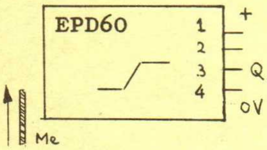
1 = +24Vdc supply

2 = +12Vdc(connect with 1)

3 = Output Q

4 = OV common

Drawing symbol



Colour: Red

Weight: 30 grams (approximately)

Stacking units side by side is permissible.

ENVIRONMENTAL SPECIFICATIONS:

Temperature range

Operating:	-25°	to	+70°C
	-40°	to	+85°C

Dry heat	tbi
Long term damp heat	tbi
Vibration	tbi
Shock	tbi
Robustness of terminals	tbi
Solderability and solder heat	tbi

ELECTRICAL DATA:

Max. supply voltage limit: +35V for 1 sec.

Supply voltage: +24Vdc ± 25% to terminal 1,
OV from supply to terminal 4

or

+12Vdc + 5% to terminal 1
(interconnect 2 and 1),
OV from supply to terminal 4

Supply current: 15 mA nominal

OUTPUT DATA:

	Vsupply = 24V	Vsupply = 12V
Output low	VQ max. =+0.3V at IQ = 0 mA Output resist.: 3 kOhm typical	VQ max. = +0.3V at IQ = 0 mA Output resist.: 3 kOhm typical
Output high	VQ min.= +11.4V at -IQ = 0.41 mA and Vsupply min. (18V) (loading is eq. to 3 DU in 24V nom. 60 Series operation) VQ max. = V supply max. Output resist.: 15 kOhm.	VQ min.= +8.3V at -IQ = 0.2 mA and Vsupply min. (11.4V) (loading is eq. to 2 DU in 12V nom. 60 Series operation) VQ max. = V supply max. Output resist.: 15 kOhm.

Max. detection frequency: 1 kHz

Hysteresis for output
voltages of (0.3V - Vsupply V) : tbi

MS type 902 FS2

Electrical. Dale. See pag 7.

APPLICATION INFORMATION: (Typical values)

General.

The EPD60 can be switched by bringing either a ferrous or non ferrous metal object in the sensitive area in front of the coil.
The object may have rather arbitrary size and form. It should be understood that losses introduced to the oscillator will for ferrous objects in general be proportional to volume of the object introduced in the field. For non ferrous materials the amount of losses will be determined by the conductivity of the material i.e. a perfect conductor would not introduce losses and hence preclude detection.

This indicates that a good conductor will be detected only if they are sufficiently thin and brought close to the sensing area.

For definition purpose the following standard objects have been chosen:

Object A : mild steel, circular disc.
diameter 10 mm, thickness 0.2 mm.

Object B : copper circular disc.
diameter 10 mm, thickness 0.04 mm.

Operating distance : The distance of the standard object (center to the center of the sensitive area) that just causes the output Q to go high.

Object A: X = 2.5 mm
tolerances tbi

Object B: X = 1.25 mm
tolerances tbi

Influence of temperature: Δ X/°C for temperatures from 25°C - 70°C = /um/°C

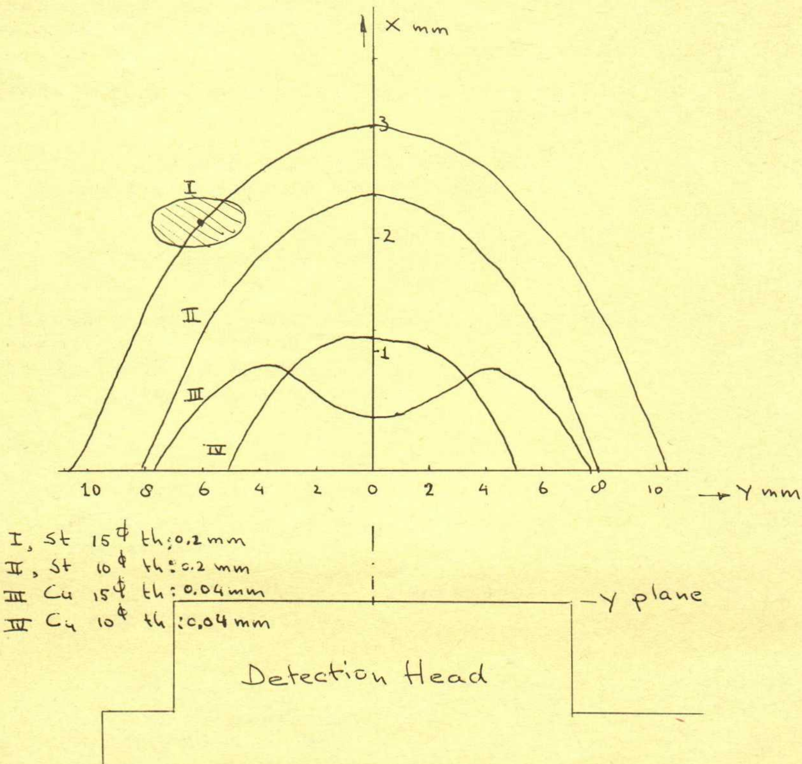
Δ X/°C for temperatures from -25°C - 25°C = /um/°C

Influence of supply voltage
at V supply nom. = 24V for
18 ≤ Vsupply ≤ 30V ≤ µm/V

Detection graphs.

The graphs give the loci of the centres of the reference objects with respect to the sensitive area for operation of the detector (output going "high").

The reference object being passed at varying distance, x



Type: Q02 FS2.

Supply voltage: + 24 V dc ± 5 %.

Supply current: 15 mA.

Output Low VQ min = ca +0,5 V

" High VQ min = ?

VQ max = +23 V en VQ max supply +24 Volt.

Max. detection frequency: 1 kc.

Hysteresis = 0,5 m.m.

Schakel afstand.

2 m.m.

MAGNETIC PROXIMITY DETECTOR

RZ 24323-1

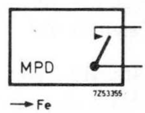
Maximum switching frequency	100 Hz
Operating temperature range	-25 to + 70 ^{o}C

GENERAL

The magnetic proximity detector can be applied as a detector for the presence, passage or position of ferreous parts. It is a versatile tool in industrial automation set-ups.

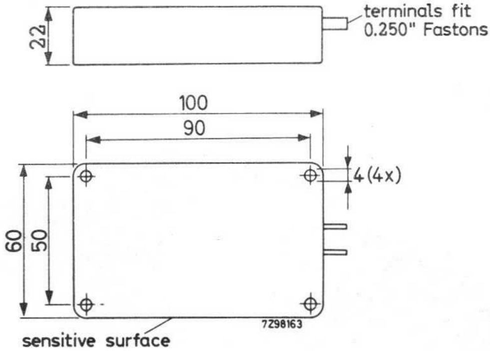
The MPD consists of two magnets and a reed switch, which are mounted in a high grade plastic housing. The reed switch is mounted between the magnets at a position where their fields are balanced (contacts normally open).
As a ferreous object approaches the sensitive surface of the MPD, unbalance occurs between the magnetic fields and the reed switches on. As the ferreous object is withdrawn the reed switches off.

Connection can be made by 0.250" Fastons. The terminals of the MPD are provided with receptacles and insulating covers.



Drawing symbol

Dimensions in mm



TECHNICAL PERFORMANCE

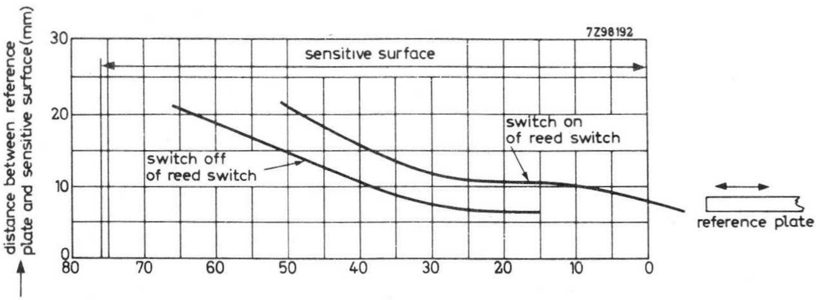
Load switching capacity	$\leq$ 25 W
Voltage switching capacity	$\leq$ 200 V_{dc}
Current switching capacity	$\leq$ 1 A_{dc}
Switching frequency	$\leq$ 100 Hz
Contact resistance, initially	$\leq$ 100 mΩ
Operating temperature range	-25 to + 70 °C
Storage temperature range	-25 to + 85 °C

APPLICATION INFORMATION

The data given below are based upon the position of a mild steel (free cutting quality) reference plate 76 x 76 x 1.9 mm.

Detection range = distance between sensitive surface and front face of reference plate, at frontal approach	$\geq$ 17 mm at 20 °C
Hysteresis = distance between "switch on" and "switch off" points, at frontal approach	< 6 mm at 20 °C
Repeatability with a supply voltage of 30V and a current of 7.5 mA flowing through the unit when the reed contacts are closed	
after 10 000 operations	detection range and hysteresis unchanged
after one million operations	detection range and hysteresis may decrease by approximately 0.4 mm

Change of "switch on" point with a temperature variation from +25 to +70 °C	≤ 0.5 mm
Change of hysteresis with a temperature variation from + 25 to + 70 °C	≤ 0.75 mm

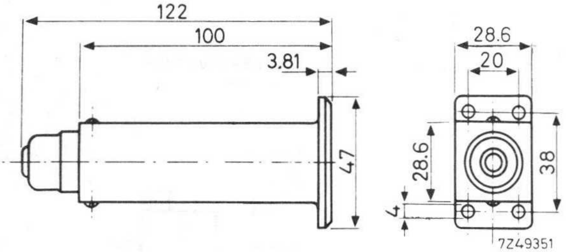


Typical detection graphs for passage of reference plate.
With the reference plate approaching from opposite end, the results are the same and the curves a mirror image of those shown.

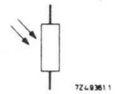
MOUNTING

Distance of ferreous metals from any point of the unit in order to avoid altering the detection range by more than 0.1 mm	≥ 200 mm
Distance between two units, mounted side by side giving a change in detection range of 0.1 mm	
sensitive surfaces in same direction	170 mm
sensitive surfaces in opposite direction	155 mm

PHOTO-ELECTRIC DETECTOR



Dimensions in mm



Drawing symbol

APPLICATION

This photo-electric detector has been developed to be used as an Input Device for systems composed of digital circuit blocks. However, it can also be used for other applications, see "APPLICATION SUGGESTIONS" on next page.
It is intended for use in conjunction with the lamp unit 1 MLU.
It can also be combined with other light sources, that meet the requirements of the particular situation.

CONSTRUCTION

The housing has been moulded of black acryl butyl styrene. In the housing a cadmium sulfide cell has been mounted. At the front side is a lens with a focal distance of 43.5 mm. The lens is protected by a glass disc. Connection to the circuitry can be made after unscrewing the cap at the rear.
The photo-electric detector can be mounted in any position by means of four bolts and nuts.

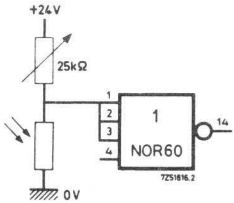
TECHNICAL PERFORMANCE

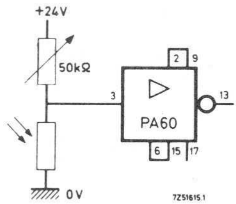
Dark value, measured in total darkness	> 10 MΩ
Light value, measured at 1000 lux	< 300 Ω
Recovery rate at falling light intensity	> 200 kΩ/s
Maximum permissible voltage	150 V_p
Maximum dissipation at 40 °C	0.2 W
Maximum capacitance	6 pF
Maximum switching frequency	6 Hz (typical value)
Maximum operating distance when used with the lamp unit 1 MLU	1 m

Permissible operating-temperature range	−10 to +40 °C For higher temperatures up to +50 °C, the maximum dissipation is 0.1 W
Permissible storage-temperature range	−20 to +60 °C
Weight	approximately 130 g

APPLICATION SUGGESTIONS (typical values)

a. Photo-electric detector CSPD in conjunction with 60-series Norbits.

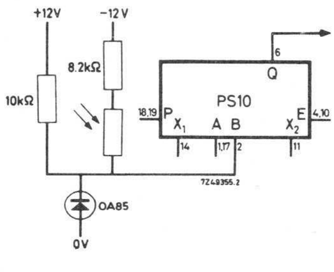


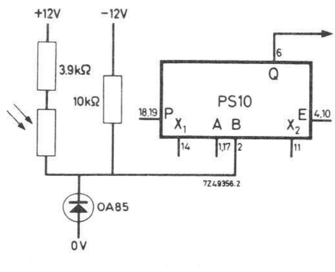


Output level state "1", when detector is illuminated

Output current is flowing, when detector is not illuminated.

b. Photo-electric detector CSPD in conjunction with 10-series circuit blocks.

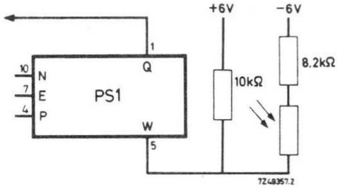


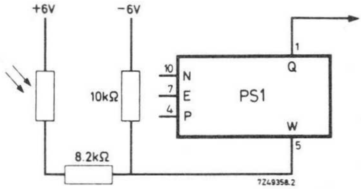


Output level state "1", when detector is illuminated

Output level state "1", when detector is not illuminated

c. Photo-electric detector CSPD in conjunction with 100 kHz-series circuit blocks.





Output level state "0", when detector is illuminated

Output level state "0", when detector is not illuminated

d. Twilight switch

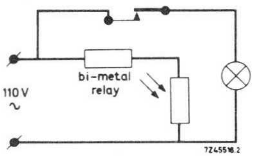
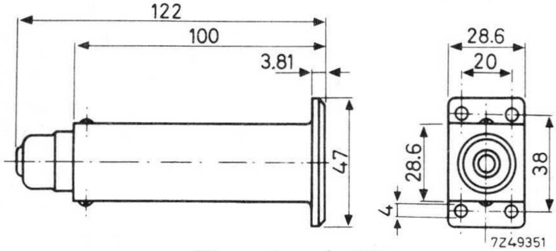
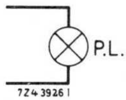


Photo-electric detector CSPD operates with a bi-metal relay so that incident light flashes have no influence.

LAMP UNIT



Dimensions in mm



Drawing symbol

APPLICATION

This lamp unit is intended for use in conjunction with the photo-electric detector CSPD

CONSTRUCTION

The housing has been moulded of black acryl butyl styrene. A 6 V, 3 W-lamp with bayonet base (type of lamp socket B15d) has been mounted inside the housing. At the front side is a lens with a focal distance of 43.5 mm. The lens is protected by a glass disc.
Connection to the supply voltage can be made after unscrewing the cap at the rear. The unit can be mounted in any position by means of four bolts and nuts.

TECHNICAL PERFORMANCE

Maximum supply voltage	6 V_{ac} or 6 V_{dc} For maximum life of the lamp it is advisable to use an a.c. or d.c. supply voltage of 5.4 V (I = 0.5 A). Variant supply voltages can be used for other lamps, provided the power consumption does not exceed 3 W.
Maximum operating distance when used with the photo-electric detector CSPD	1 m
Permissible operating-temperature range	-10 to +40 ^{o}C
Permissible storage-temperature range	-20 to +60 ^{o}C
Weight	approximately 130 g

LIGHT INTERRUPTION PROBE

3328

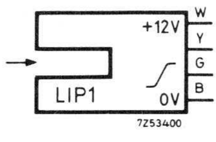
APPLICATIONS

The Light Interruption Probe can be used to detect the presence or passage of small objects. Major applications are envisaged in the field of machine tool control (accurate positioning and revolution counting).

DESCRIPTION

The unit houses a novel optical system, a lamp, a photo element, and an emitter follower output stage.

The light coming from the lamp is guided through an optical glass rod. The end of this glass rod at the probe side has been cut and polished at an angle of 45° to the axis of the rod. This provides a combination of a converging lens and prism, forming a focal line in the centre of the gap at the end of the probe. By means of a similar optical system the light that has passed the gap is guided to the photo element in the cylindrical housing.



Drawing symbol

The photo element has a low resistance when illuminated, thereby draining the base current to the emitter follower.

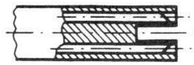
As a consequence the output of the unit will be a 'low' voltage. On the other hand if the light emerging from the lamp-side rod is intercepted the output of the unit will be a 'high' voltage.

As only a small object is necessary to intercept the light at the location of the focal line a high resolution is obtained. Though the unit essentially behaves in an analogue way only data pertaining to digital applications will be given.

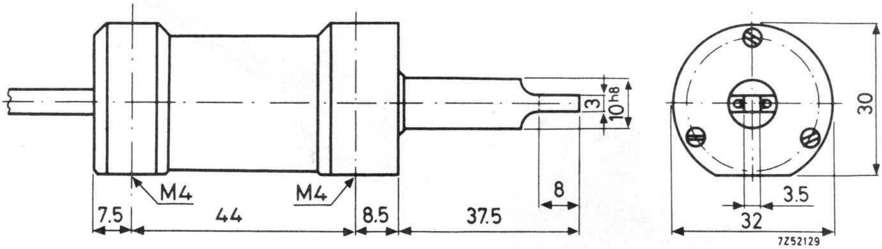
Electrical connections are made by means of a 4-core colour-coded shielded cable with a length of 2 m.

MECHANICAL DATA

Dimensions in mm



Housing material: brass
Finish: black

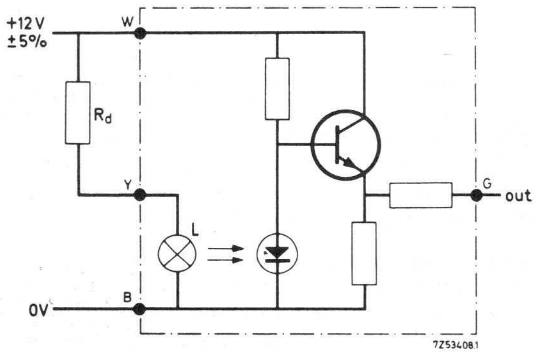


Weight: 170 g (ex cable)

Mounting

The unit can be mounted in any position either by means of two M4 bolts and a supporting bracket, or by entering the probe part into a 10 mm bore cylindrical hole.

CIRCUIT DATA



R_d = 36 Ω ± 2% (cat. no. 2112 100 10538) is supplied with unit,
L = 6 V, 1 W (cat. no. 9237 246 10181).
Cable shield is connected to probe housing.

Connections

W = white lead, to be connected to +12 V
Y = yellow lead, to be connected via R_d to +12 V
B = brown lead, common 0 V for power supply and load
G = green lead, to be connected to load.
Cable shield to be connected to system shield or to central earth point depending on system lay-out.

Notes

Interconnecting 0 volt and shield arbitrarily may cause difficulties as this introduces the possibility of feeding shield interference pick-up to the 0 volt line.

When the LIP is attached to a machine, which will generally have some earth connecnection provided for its metal structure, it is recommended that the probe housing and cable shield be properly insulated from the machine to eliminate extra interference pick-up due to capacitive and inductive coupling.

When considering to connect the load terminal to the input of a subsequent unit which is positive with respect to the 0 volt line, make sure that the LIP 1 output voltage is not raised as a result.

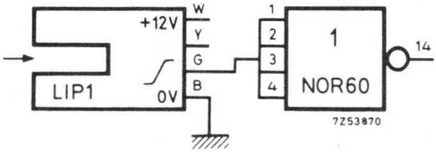
TECHNICAL PERFORMANCE

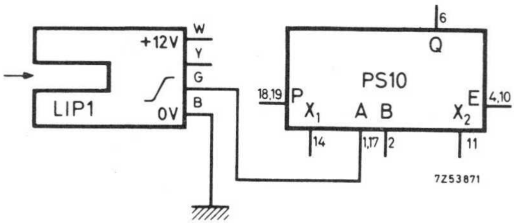
Ambient temperature range		
operating		0 to +50 °C
storage		−10 to +70 °C
Power supply	voltage (V_s)	+12 V_{dc} ± 5%
	current	180 mA
Output, unloaded 1)		
max. '0' level (no object)		+1.25 V
min. '0' level (no object)		0 V
min. '1' level (with object)		+4.8 V
max. '1' level (with object)		+ V_s
Output impedance, no object		max. 2.1 kΩ
, complete interception		max. 1.1 kΩ
Output is short circuit proof against 0 volt line		
Max. detection frequency		> 10 kHz
Lamp life		> 1000 h (spare lamp is supplied with the unit)

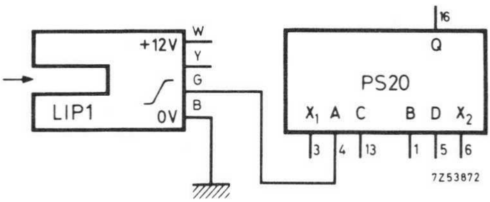
1) For specification purposes use is made of a glass disc carrying a (chromium) mark and space pattern.
Mark width and space width are each 1 mm.
Marks are arranged radially and have a length of 5 mm.
Disc is located in gap so as to bring mark in center of gap.
Actual length of focal line is 2 mm approximately.

APPLICATION INFORMATION

Connecting to circuit blocks







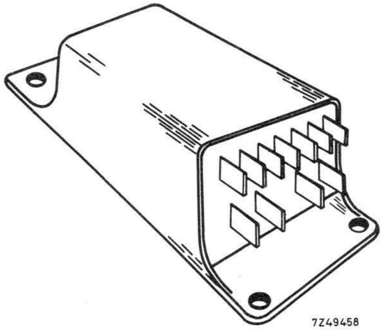
Application Suggestions

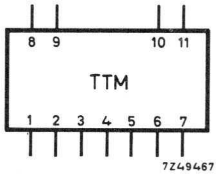
Revolution counting
Angular positioning
Digital Tachos
Analogue Tachos
Weighing

Angular programming

Linear programming

THYRISTOR TRIGGER MODULE





drawing symbol

Supply voltage	12 V_{dc}
Number of outputs	2, isolated (output voltages in phase)

GENERAL

The thyristor trigger module is intended for use as a supply of repetitive gate trigger pulses for one or two thyristors.

It can be applied in a variety of circuits.

The possibility of logic control (e.g. in conjunction with 60-series Norbits or with circuit blocks of the 10-series or 20-series) makes it well adapted for automation and control systems. In conjunction with a phase shift module PSM 40 (catalog number 2722 010 02001), linear conduction angle control over 10 to 170^o is possible.
With three TTM's 3-phase operation of thyristors can be achieved.
For further applications, see section "APPLICATION SUGGESTIONS".

CONSTRUCTION

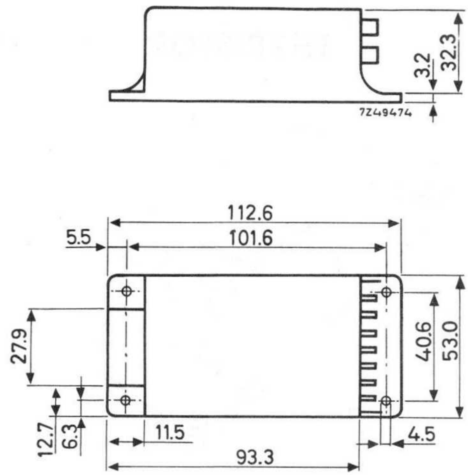
The TTM comprises a blocking oscillator circuit, which is potted in epoxy resin. The whole is contained in a high grade plastic housing.

Four holes in the base allow the use of 4 mm bolts for mounting.
As the maximum operating temperature of the TTM is 85 ^{o}C, bolting the unit directly to the heatsink of the thyristor will in many cases be feasible.
If the gate and cathode connection leads have considerable length it is recommended to twist them as a pair for each thyristor.

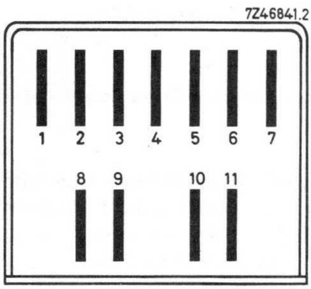
Connection can be made by 0.250 Fastons supplied with the TTM.

The weight is approximately 280 g.

Dimensions in mm



Terminal location

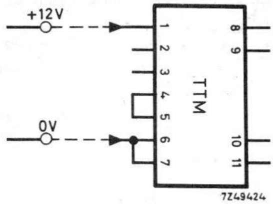


1 = supply + 12V
2 = } interconnected, except for on-off control and conduction angle control with a potentiometer or a control voltage
3 =
4 = } interconnected, except for control
5 = with a switch which is normally open
6 = supply 0V
7 = safety-catch input
8 = gate thyristor 1
9 = cathode thyristor 1
10 = gate thyristor 2
11 = cathode thyristor 2

TECHNICAL DATA

Operating-temperature range	- 25 to + 85 °C
Storage-temperature range	- 40 to + 85 °C
Power supply	
Supply voltage	$12\ V_{dc} \pm 5\%$ Loss of supply voltage does not cause inadvertent trigger pulses.
Nominal consumed current	35 mA

12 V_{dc} ± 5%, filtered, obtained from e.g. power supply unit 2722 151 00021.



Input requirements

Current from control terminals (typical values)

4/5 to 6	1.5 mA
7 to 6	35 mA (I_{peak} = 57 mA)

See further section "INPUT CONTROL POSSIBILITIES".

Output data *

Number of outputs	2, isolated. Output voltages are in phase.
Isolation of outputs	rated at 500 V_{rms} operation
Voltage	≤ 10 V_{dc}
Current (one output loaded with 16 Ω, the other output short-circuited)	250 mA. Short-circuiting of both outputs will not impair the reliability of the TTM and will not damage the power supply.
Impedance (both outputs or one output loaded with 16 Ω)	25 Ω
Nominal pulse frequency (both outputs loaded with 16 Ω)	2.3 kHz
Pulse width at 3 V (both outputs loaded with 16 Ω)	> 20 μs (see Fig. a)
Pulse rise time	< 0.5 μs (see Fig. a)

Shape of voltage pulse (both outputs loaded with 16 Ω)

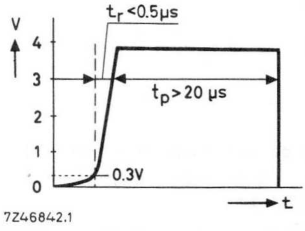


Fig. a

Shape of current pulse (both outputs loaded with 16 Ω)

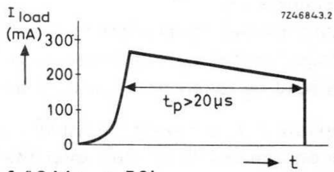
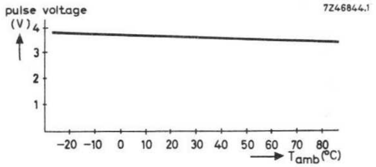


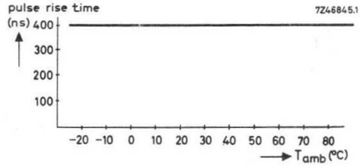
Fig. b

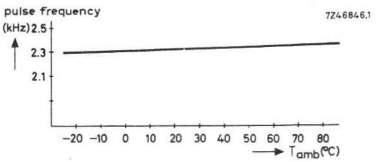
* The data given apply to a supply voltage of 12 V_{dc} ± 5%

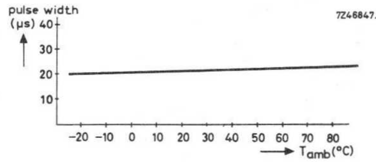
Temperature dependence of the pulse (both outputs loaded with 16 Ω)

see typical curves below



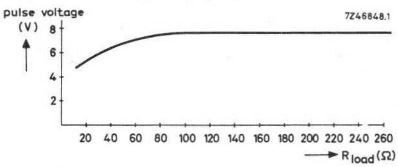


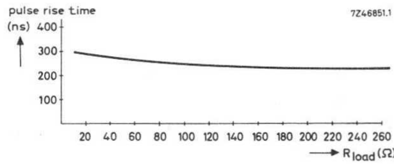


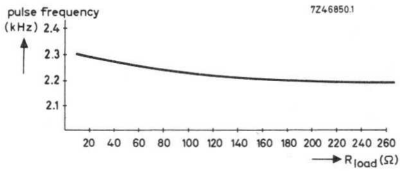


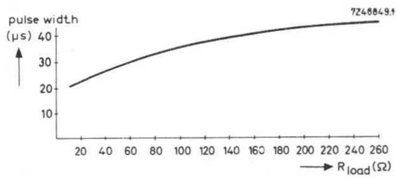
Load dependence of the pulse (one output loaded with 16 Ω, the other output with a variable load)

see typical curves below









→ The TTM can be used with thyristors of the following types (or other types having similar gate input requirements): BTX 12, BTX 13, **BTY 79**, **BTY 80**, **BTY 81**, **BTY 87**, BTY 91, BTY 95 **and BTY 99.**

Any two thyristors can be triggered simultaneously either in series, parallel or inverse parallel connection.

All precautions and restrictions to ensure operation within the limits of the thyristor e.g. voltage/current sharing as well as voltage and current derating for series/parallel circuits should be taken from the relevant thyristor data sheets.

Triggering into conduction of thyristors with highly inductive loads will only be possible if the current builds up well over the latching value within 20 μs.

Appropriate means of external circuitry (e.g. fly wheeling diode or resistive shunting of the load) can be adopted in situations that require these additions.

The low mark to space ratio of the pulse train (approximately 1 : 20) permits positive gate voltage during the negative half wave of the a.c. supply to the thyristor with a very slight derating of the permissible temperature of the thyristor stud.
Data sheets of the thyristors used, have to be consulted to evaluate the influence of additional reverse current losses in the actual circuit and the applicable derating.

Note: The output transformer has been designed to meet the recommendations according to B.S. 3188, viz. 3.1 kV_p for 1 min. This test voltage may only be applied to the transformer when the semiconductors are short-circuited or when they are removed from the circuit (e.g. prior to potting).

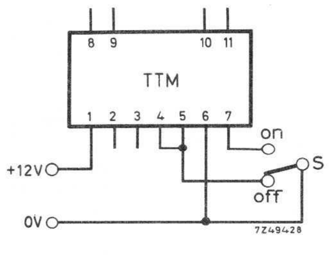
INPUT CONTROL POSSIBILITIES

Safety-catch operation

As the TTM has been supplied with a safety-catch input (terminal 7), for some applications use can be made of safety-catch operation, which gives a safeguarding against spurious trigger pulses.
If safety-catch operation is employed the TTM is controlled via two control terminals requiring phase opposition of the control voltages.
When an interference pulse will attack both control lines in phase, inadvertently triggering will be eliminated to a very large extent.
It should be noted that the employment of safety-catch operation gives a switching-time delay of the TTM of approximately 400 µs.

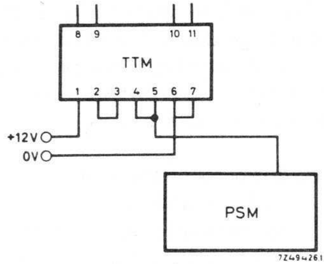
On-off control with safety-catch operation

Supply: 12 V_{dc} power supply unit
Maximum required switching capacity of the switch: 50 mA



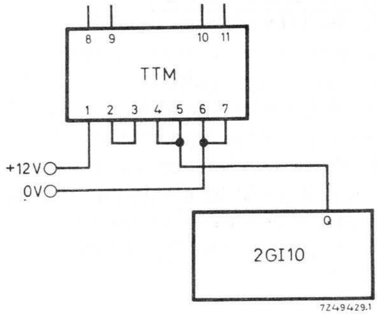
Conduction-angle control (10 - 170 °) with a phase shift module PSM, catalog number 2722 010 02001

Supply: 12 V_{dc} power supply unit



On-off control with a dual positive gate inverter 2GI 10 *

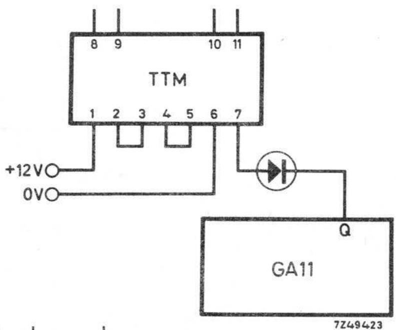
Supply: 12 V_{dc} power supply unit.
The TTM delivers trigger pulses only when the output level of the 2GI 10 is at "positive high".



Instead of the dual positive gate inverter 2GI 10, e.g. the flip-flops FF 10, FF 11, FF 12 or the pulse shaper PS 10 can be used.

On-off control with a gate amplifier GA 11

Supply: 12 V_{dc} power supply unit
Switching-time delay: 400 μs

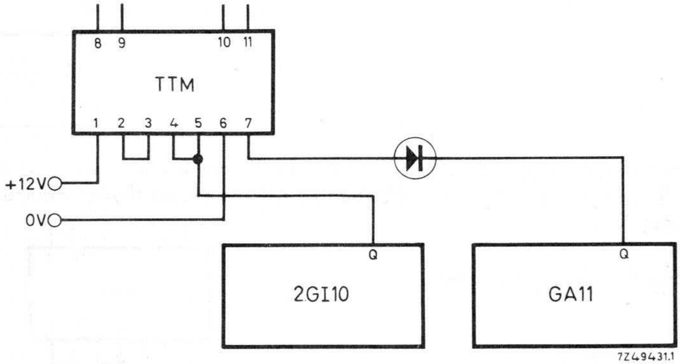


* Similar circuit block of the 20-series can also be used.

The TTM delivers trigger pulses only when the output level of the GA 11 is at "positive low".

On-off control with a dual positive gate inverter 2GI 10* and a gate amplifier GA 11, safety-catch operation

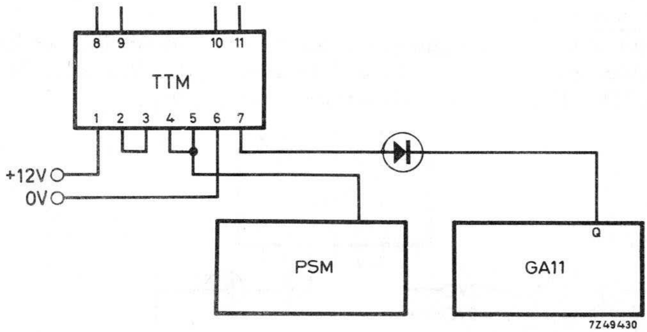
Supply: 12 V_{dc} power supply unit



The TTM delivers trigger pulses only when the output level of the 2GI 10 is at "positive high" and at the same time that of the GA 11 is at "positive low".

Conduction-angle control (10-170°) with a phase shift module PSM, and a gate amplifier GA 11, safety-catch operation

Supply: 12 V_{dc} power supply unit

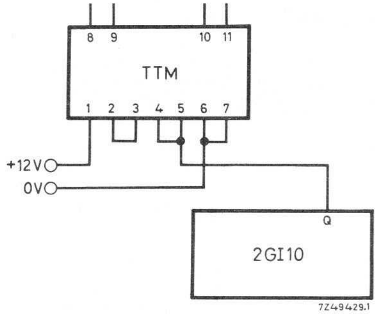


The TTM delivers trigger pulses only when the output of the GA 11 is at "positive low".

* Similar circuit block of the 20-series can also be used.

Electronic fusing facility with a dual positive gate inverter 2GI 10 *

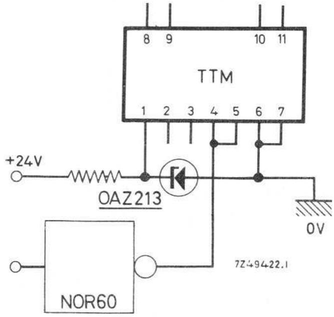
Supply: 12 V_{dc} power supply unit



As the TTM delivers trigger pulses only when the output level of the 2GI 10 (FF 10, etc.) is at "positive high", fusing is obtained by making excess thyristor current switch 2GI 10 output to zero.

On-off control with a 2.NOR 60

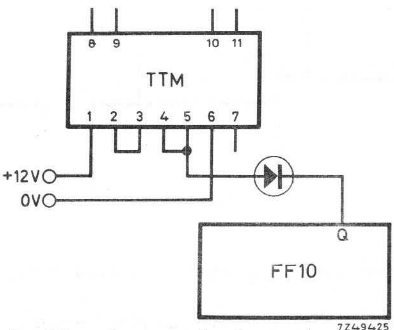
Supply: Norbit supply unit



The TTM delivers trigger pulses only when the output level of the 2.NOR 60 is high.

Single pulse output

For some applications single trigger pulse facility is of interest. This can be achieved when a suitable negative transient is available to reset a flip-flop e.g. FF 10 thereby stopping the TTM. The recovery time is approximately 500 μs.



* Similar circuit block of the 20-series can also be used.

Control during a number of a.c. mains cycles

A feature in some power dosing applications can be obtained by having the output level of the 2GI 10, FF 10 etc. at "positive high" for a number of mains cycles only. This can be achieved by counting the mains "zero crossings" in a preset counter. Up on reaching the preset number, a negative going transient stops the TTM.

APPLICATION SUGGESTIONS

Automatic proportional speed control of an a.c. motor (see the figure on next page).

A metal disc, which has been attached to the motor shaft turns through the gap of a vane switched oscillator (VSO). In this way a pulse shaped voltage is obtained from the VSO of which the repetition frequency will be proportional to the motor speed. The output signal of the VSO drives a one-shot multivibrator (OS 11) via a pulse shaper (PS 10).

The outputs of the OS 11 give pulses with a duration of 150 μs and with a repetition frequency which is proportional to the motor speed. If this signal is integrated in the proper way the voltage level will be proportional to the frequency and so to the motor speed. The integrated signal of output Q_2 of the OS 11 gives a positive voltage level. If this voltage level is higher than a certain value preset with the potentiometer of 2.5 kΩ, the transistor ASY 27 will be cut off.

This transistor is capable to charge the external capacitor (220 nF) of the timer unit (TU 10) quickly.

The delay time of the TU 10 can vary between 1 and 11 ms, dependent on the value of the collector current of the ASY 27.

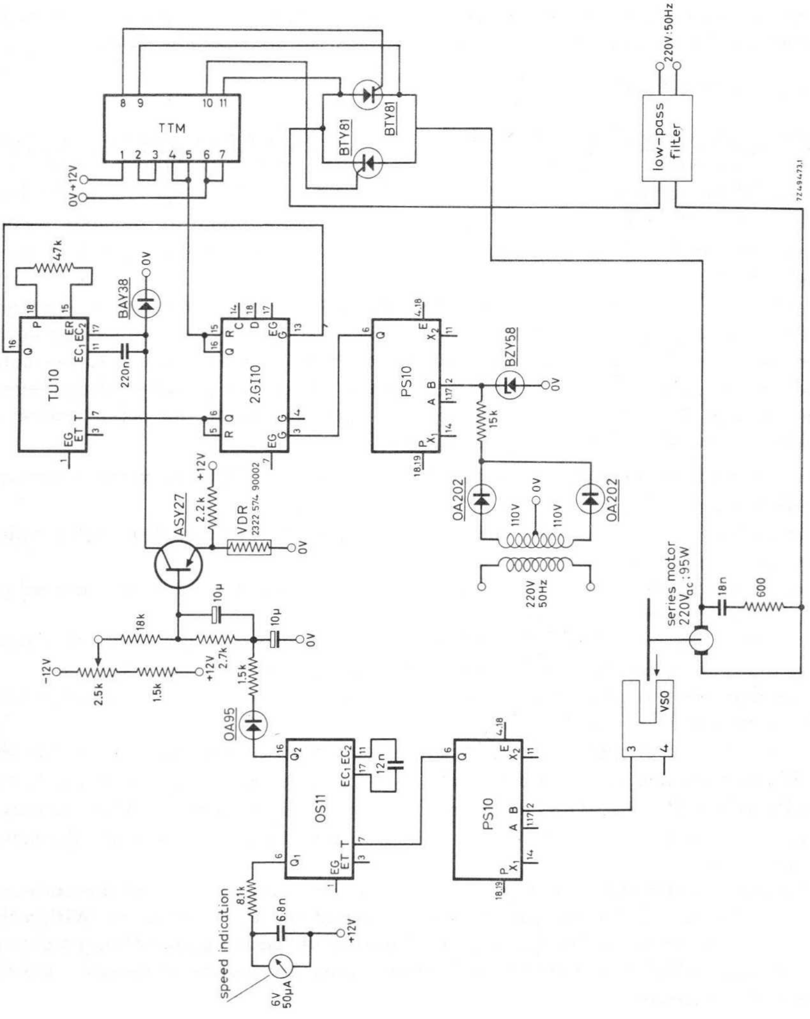
At the moment of the zero crossings of the mains voltage the TU 10 is triggered (so every 10 ms if the mains frequency is 50 Hz).

The thyristor trigger module (TTM) drives the two thyristors in the conducting state during the time the output level of the TU 10 is at "positive low" (0 V).

(Via the dual positive gate inverter 2GI 10 this gives a "positive high" signal, + 12V, at the terminals 4 and 5 of the TTM).

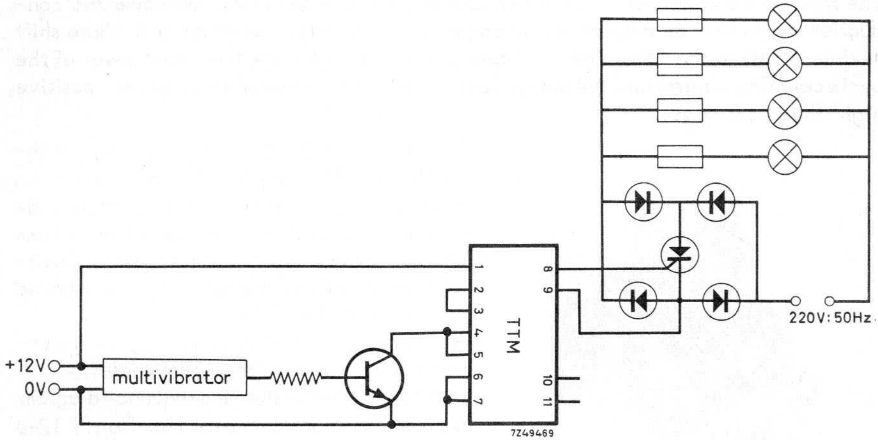
In the case the motor speed is lower than the required value the base current of the ASY 27 increases and in turn the collector current increases too, so that the external capacitor of the TU 10 will be charged quickly. The delay time of the TU 10 decreases through which the thyristors are driven in the conducting state sooner and the motor will run faster.

Is the motor speed higher than the required value, the base current and the collector current of the ASY 27 decrease and the delay time of the TU 10 increases. Within the period of 10 ms the output level of the TU 10 will be at "positive low" during a shorter time, through which the thyristors will come in the conducting state later and the motor will run slower.


TTM
BTY81
BTY81
0V
+12V
220V:50Hz
low-pass filter
TU10
47k
BAY38
220n
2.GI10
PS10
BZY58
15k
OA202
OA202
110V
110V
220V 50Hz
ASY27
2.2 k
VDR
2322 574 90002
10µ
10µ
18k
2.7k
2.5k
1.5k
1.5k
-12V
+12V
OA95
OS11
12n
PS10
VSO
series motor
220Vac:95W
18n
600
8.1k
6.8n
speed indication
6V
50µA

On-off control of traffic light flasher

The multivibrator switches the TTM on and off. The switching frequency is determined by the circuit constants of the multivibrator.

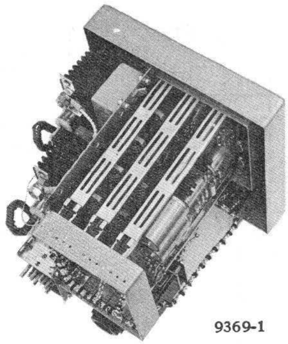


Cycle counting control for spotwelding

In the spotwelding technique it is necessary to dose accurately the energy put into the weld, especially when handling small pieces of work.

With this cycle counting control it is possible to set the welding time to 1, 2, 3 or 4 cycles of the mains.

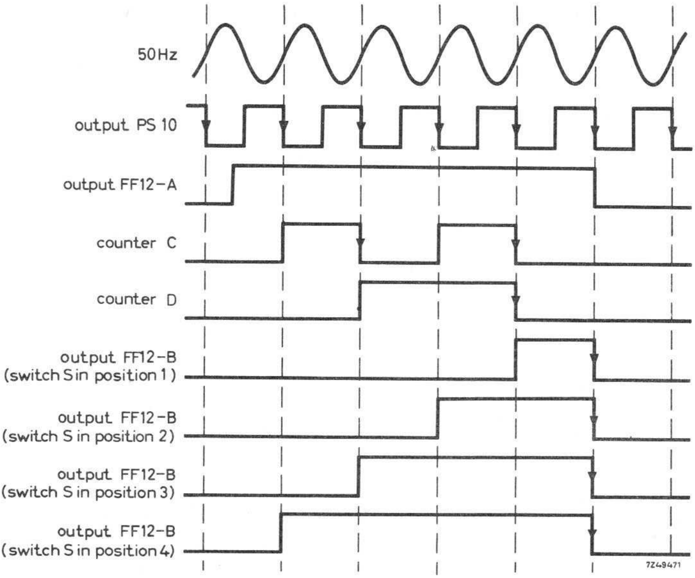
The thyristors are controlled by a thyristor trigger module (TTM), moreover the conduction angle can be determined by connecting the output terminal of a phase shift module (PSM) to the TTM. The thyristors are conducting when the output level of the cycle counting control and the output level of the PSM are simultaneously at "positive high" (See next page).

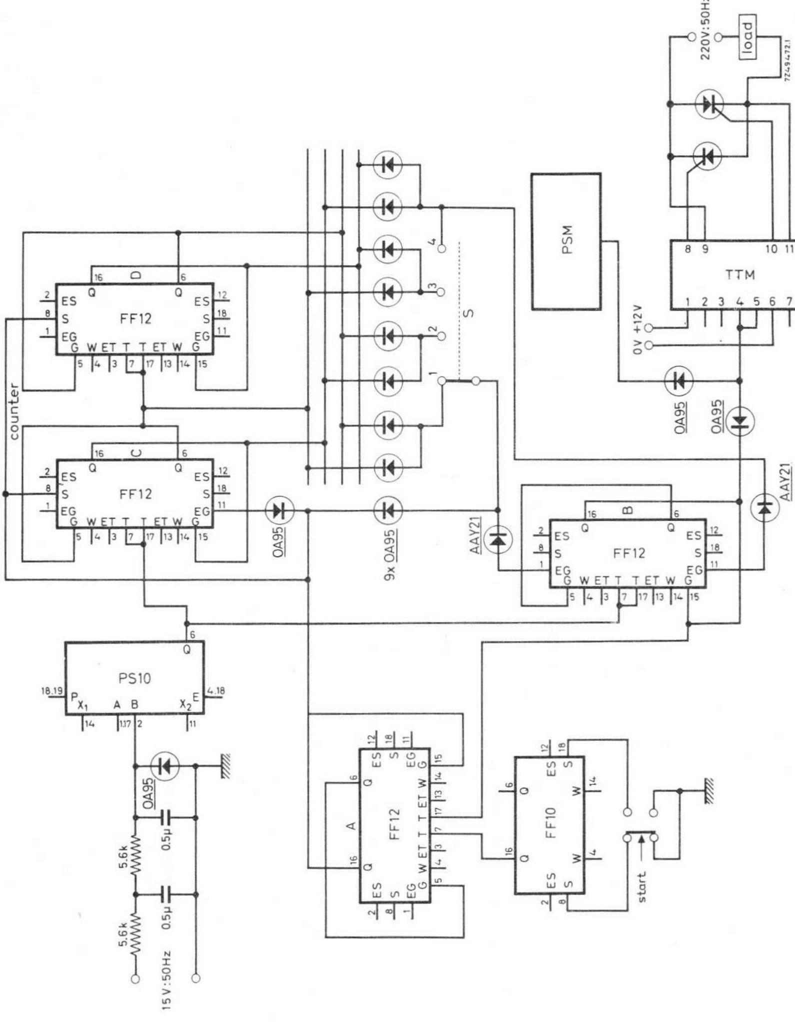

9369-1

The circuit can be started by pressing a push-botton. The flip-flop FF 10 is used to prevent the bouncing of the contacts influencing the circuit. The 50 Hz pulses are obtained from an a.c. voltage (15 V, 50 Hz), which is half-wave rectified and subsequently pulse shaped by the pulse shaper PS 10.

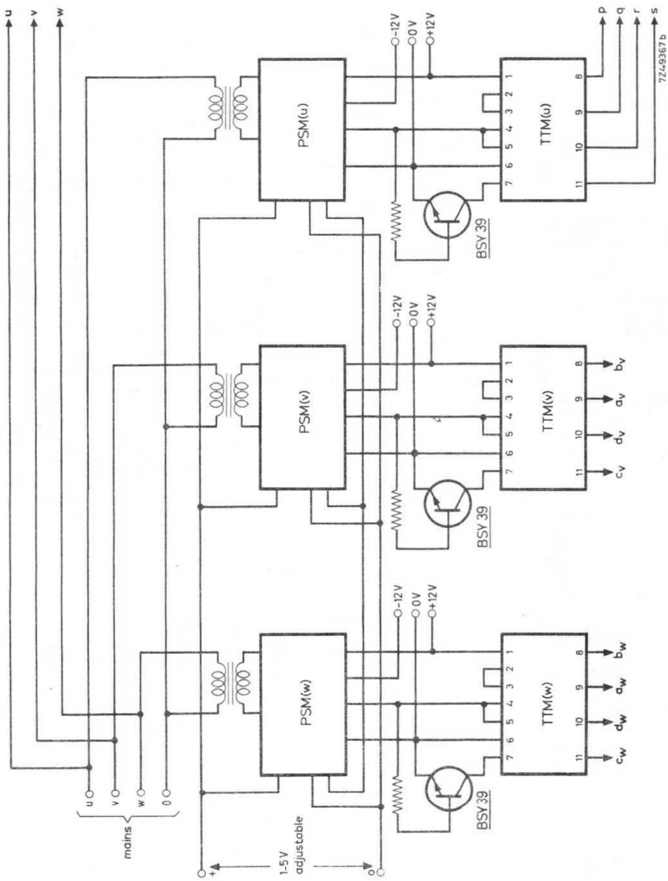
A low-pass filter is used to suppress interference signals of higher frequencies.

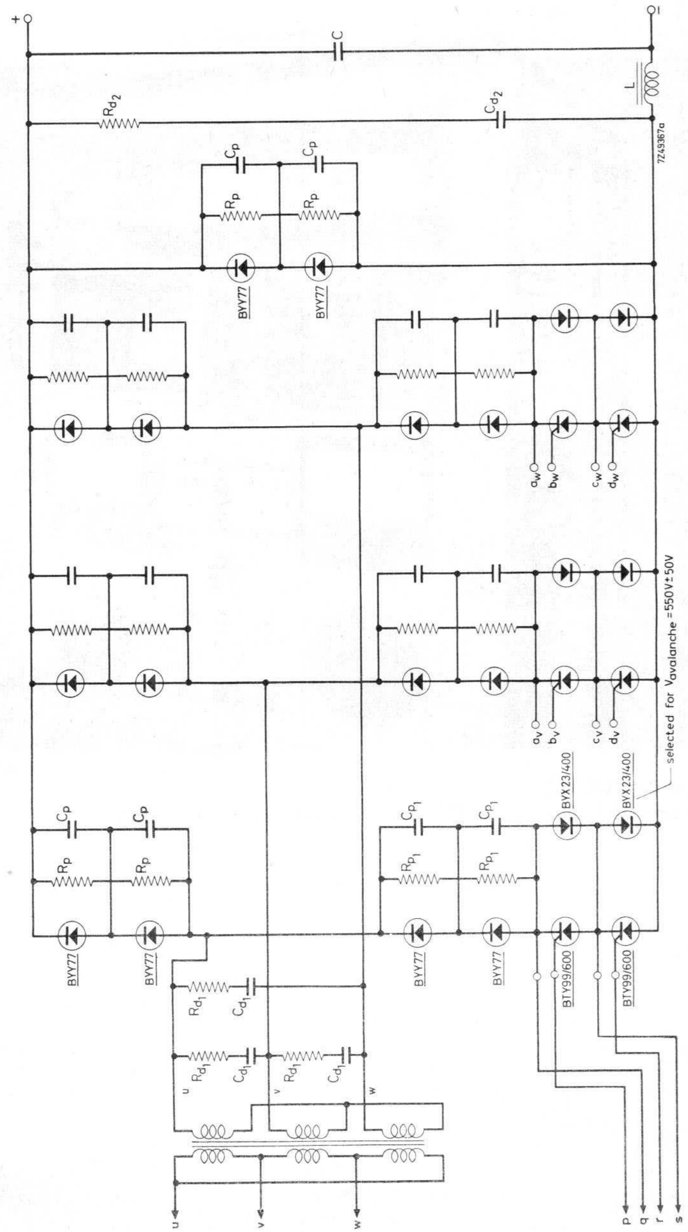
In the figure below the time sequence diagram is given. The output level of flip-flop FF 12-B is at "positive high" during 1, 2, 3 or 4 cycles when the switch is in the position 1, 2, 3 or 4 **respectively.**

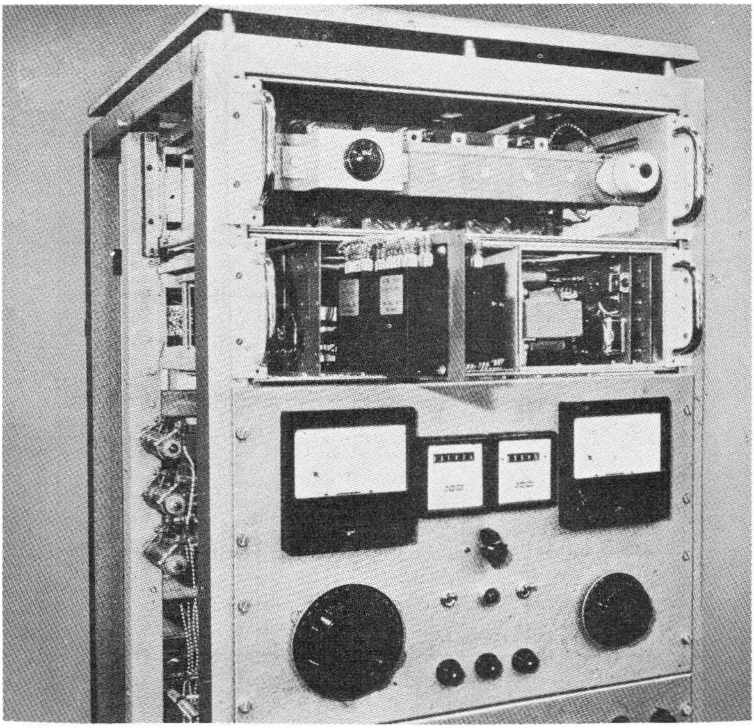



220V:50Hz
load
7Z49472.1
PSM
TTM
0V +12V
OA95
AAY21
FF12
D
C
B
A
counter
9x OA95
S
PS10
FF10
start
5.6k
0.5μ
15V:50Hz

Power supply for transmitter, 800 V_{dc}, 8.5 A



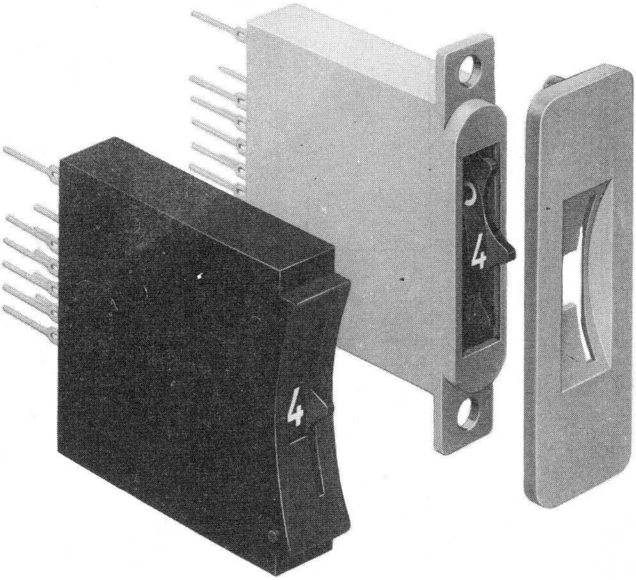

+
−
C
L
R_{d_2}
C_{d_2}
7Z49367a
C_p
R_p
BYY77
a_w b_w c_w d_w
a_v b_v c_v d_v
selected for $V_{avalanche}$ = 550 V ± 50 V
BYX23/400
C_{p_1}
R_{p_1}
BTY99/600
R_{d_1}
C_{d_1}
u v w
p q r s



A 48839-2

Power control unit.
Thyristors triggered by 4 TTM's are used for mains switching.

THUMBWHEEL SWITCHES



2428A

Contact resistance	≤ 50 mΩ
Operating temperature range	-25 to +85 °C.

APPLICATION

These thumbwheel switches have been developed to be used as pre-set devices in digital control systems in which numerical information is handled.

CONSTRUCTION

Housing	shock resistant polycarbonate colour: grey (facade mounting) black (block mounting)
Contact springs	heat-treated copper beryllium
Contact surface	721 rolled alloy (70% gold, 20% silver, 10% copper)
Terminals	tinplated brass suited for soldering or mini wire-wrap
Thumbwheel	high grade plastic, colour black; provided with white figures or signs
Thumbwheel detent	copper beryllium spring with low wear molybdenum bisulfide doped snap
Printed wiring boards	glass-epoxy; goldplated tracks
Type identification	catalog number is given on the closing strip at the rear, type abbreviation on housing

Dimensions in mm

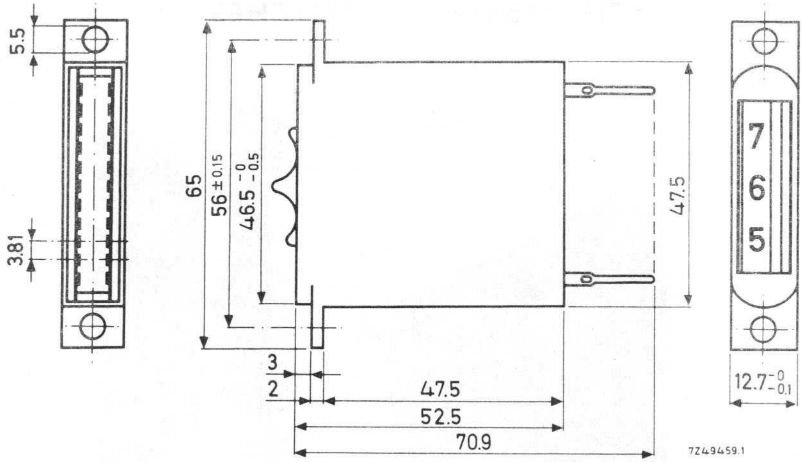


Fig. 1. Switch for facade mounting.

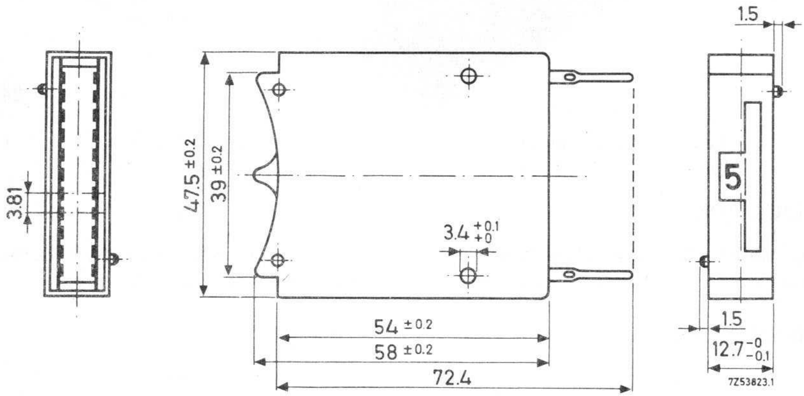


Fig. 2. Switch for block mounting.

TECHNICAL PERFORMANCE

Working voltage	50 V_{dc}
Test voltage for 1 min *)	500 V_{dc}
Insulation resistance, measured at 100 V_{dc} *)	$\geq 10^8\ \Omega$
Current switching capacity in purely resistive circuits	0.1 A_{dc}

*) Between any pair of terminals and between any terminal and all others connected together.

Maximum current carrying capacity	0.5 A_{dc}
Contact resistance measured at 20 mV, 0.1 A, 1 kHz	$\leq$ 50 mΩ
Losses (tan δ), measured at 1 MHz between any terminal and all others connected together to earth	$\leq 25.10^{-4}$
Capacitance, measured at 1 MHz between any pair of terminals and between any terminal and all others connected together to earth	$\leq$ 15 pF
Operating temperature range	-25° to 85 °C
Storage temperature range	-40° to 85 °C
Humidity	in conformity with IEC 68, test C, 21 days
Life	in excess of 100 000 complete rotations, at a rate of 1 step/ s
Operating torque	250 to 750 gcm
ater 20 000 rotations	150 to 650 gcm
Dimensions of the figures on the thumbwheel	6 x 4 mm, line thickness 0.8 mm
Weight	approximately 30 g

FACADE MOUNTING

The switches can be mounted in panels with a thickness up to 4 mm by means of mounting façades and the screws and washers supplied (see Fig.3.) When the panel thickness is less than 4 mm, additional washers must be used between the panel and the switch. The following mounting façades, giving facilities for mounting up to 10 switches, are available (Fig.4).

mounting façade	number of switches	catalog number
FMF 1	1	4311 027 80598
FMF 2	2	4311 027 80608
FMF 3	3	4311 027 80618
FMF 4	4	4311 027 80628
FMF 5	5	4311 027 80638
FMF 6	6	4311 027 80648
FMF 7	7	4311 027 81163
FMF 8	8	4311 027 81173
FMF 9	9	4311 027 81183
FMF10	10	4311 027 81193

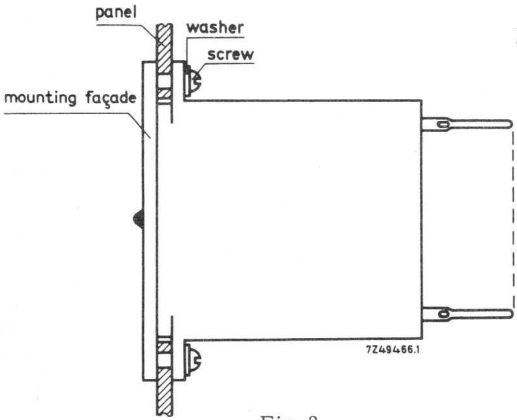


Fig.3.

2428B

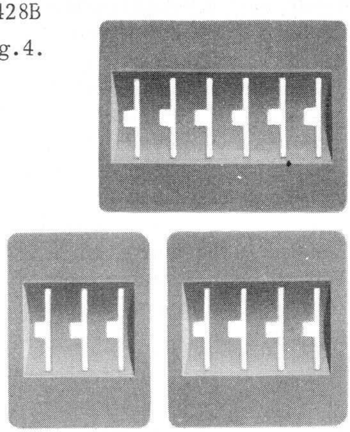


Fig.4.

The dimensions of the necessary panel holes are indicated in Fig. 5; the outline of the mounting façade is indicated by a dash line.

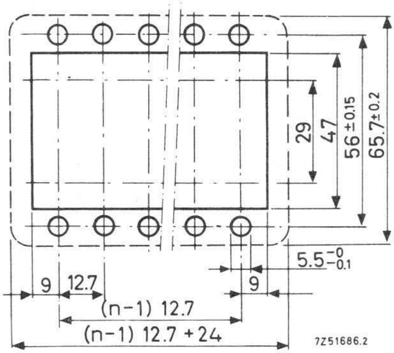


Fig.5. (n = number of switches)

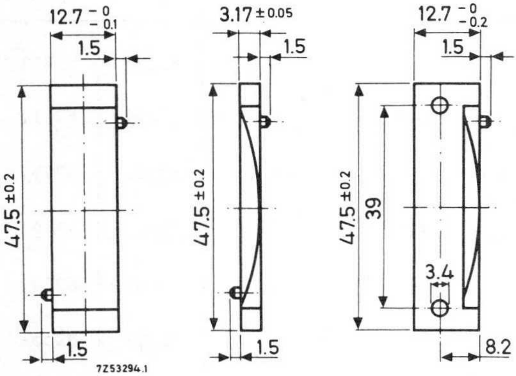
BLOCK MOUNTING

Type BM switches, which do not require a front façade, can be "block mounted" by means of mounting brackets and 3 mm tie rods, and can be supplied coupled in master-slave arrangements. Accessories include:

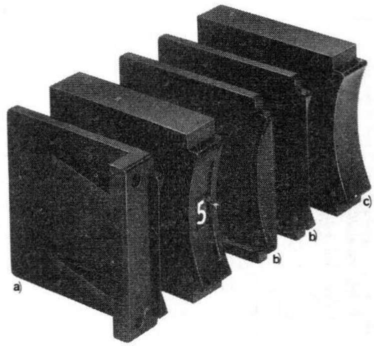
a) BM CLO, catalog number 4311 027 82141
(a blank housing suitable as distance piece for future extension, for housing slave switches or ancillary circuits, or for engraving)

b) BM SEP, catalog number 4311 027 82161
(a spacer suitable for left and right hand mounting)

c) BM EXT, catalog number 4311 027 82151
(end piece suitable for left and right hand mounting)

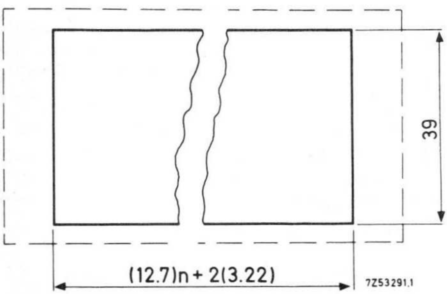


(a) (b) (c)



2428C

Fig.6. Spacers and end piece



(n = number of switches)

Fig.7. Panel cut-out

SURVEY OF TYPES

	description	abbreviation	index	catalog no. 4311 027 . . . . . facade mounting	block mounting
decimal and 2 position switches	10 position 2 pole switch	10P2C	0 - 9	82201	82521
	10 position 1 pole switch	10P1C	0 - 9	82321	82401
	2 position 4 pole sign switch	2P4+ -	+, -	82231	82641
	2 position 2 pole sign switch	2P2+ -	+, -	82341	82601
	2 position 4 pole sign switch	2P4x ÷	x, ÷	82311	82651
	2 position 2 pole sign switch	2P2x ÷	x, ÷	82351	82611
	2 position 4 pole sign switch	2P401	0.1	82281	82661
	2 position 2 pole sign switch	2P201	0.1	82361	82501
	2 position 4 pole sign switch	2P4MA	M, A *)	82291	82671
	2 position 2 pole sign switch	2P2MA	M, A *)	82371	82621
	2 position 4 pole sign switch	2P4AvAr	Av, Ar **)	82301	82681
	2 position 2 pole sign switch	2P2AvAr	Av, Ar **)	82381	82631
binary decoding switches (including 4 diodes BAX13 and a resistor of 12 kΩ)	decoding switch 1248 negative logic	1248N	0 - 9	82221	82391
	decoding switch 1248 positive logic	1248P	0 - 9	82251	82411
	decoding switch 1242 (jump at 8) negative logic (Berkeley code)	1242N	0 - 9	82211	82711
	decoding switch 1242 (jump at 8) positive logic (Berkeley code)	1242P	0 - 9	82241	82721
	decoding switch 1248 negative logic ***)	1248N/C	0 - 9	82451	82541
	decoding switch 1248 positive logic ***)	1248P/C	0 - 9	82431	82551
	decoding switch 1242 (jump at 8) negative logic ***)	1242N/C	0 - 9	82441	82571
	decoding switch 1242 (jump at 8) positive logic ***)	1242P/C	0 - 9	82421	82581
	decoding switch 2 out of 5 + 2 out of 2	2522	0 - 9 plus blank		82771
binary coding switches	coding switch 1248	1248C	0 - 9	82271	82531
	coding switch 1242 (jump at 8)	1242C	0 - 9	82261	82701
	coding switch 1248 ****)	1248C/C	0 - 9	82471	82561
	coding switch 1242 (jump at 8)****)	1242C/C	0 - 9	82461	82591
	coding switch 1248	1248S	0 - 9		82511

Note: The contacts of all switches break before make.

*) "Start" and "Stop" for latin-based languages.
**) "Forward" and "Reverse" for latin-based languages.
***) Switch decodes 9-complement of decimal digit on thumbwheel.
****) Switch encodes 9-complement of decimal digit on thumbwheel.

DIAGRAMS AND TERMINAL LOCATION

10P2C

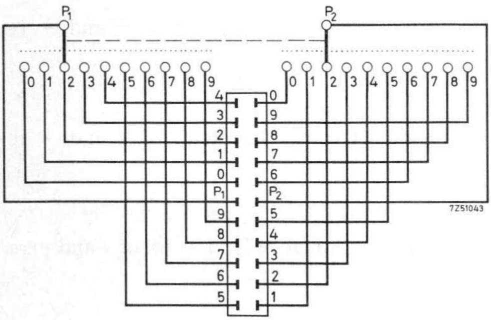


Fig. 9

10P1C

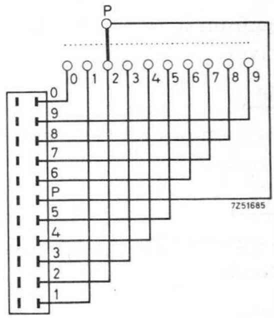


Fig. 10

2P4 + -

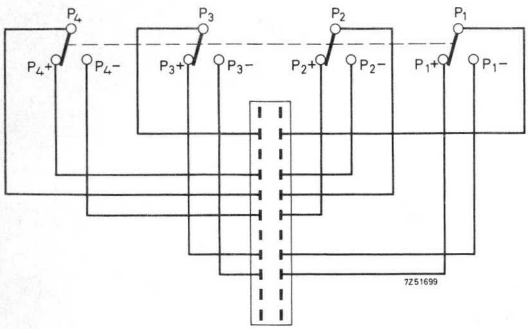


Fig. 11

2P2 + -

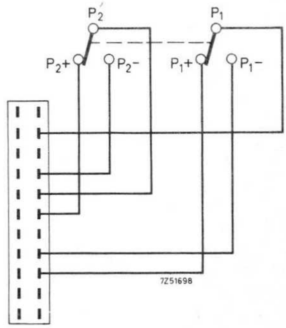


Fig. 12

2P4 x ÷

As diagram of Fig. 11 but with x and ÷ instead of + and - respectively.

2P2 x ÷

As diagram of Fig. 12 but with x and ÷ instead of + and - respectively.

2P401

As diagram of Fig. 11 but with 0 and 1 instead of + and - respectively.

2P201

As diagram of Fig. 12 but with 0 and 1 instead of + and - respectively.

2P4MA

As diagram of Fig. 11 but with M ("marche") and A ("arrêt") instead of + and - respectively.

2P2MA

As diagram of Fig. 12 but with M ("marche") and A ("arrêt") instead of + and - respectively.

2P4AvAr

As diagram of Fig. 11 but with Av ("avant") and Ar ("arrière") instead of +and - respectively.

2P2AvAr

As diagram of Fig. 12 but with Av ("avant") and Ar (arrière") instead of + and - respectively.

1248N

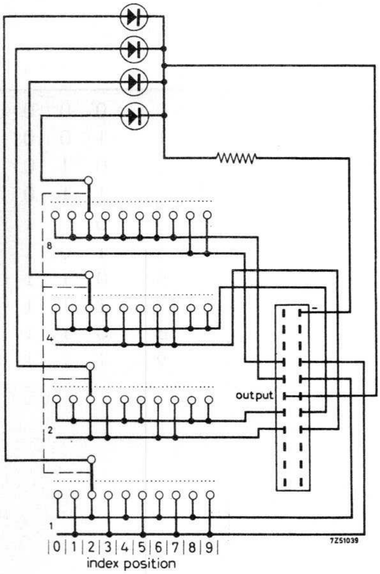


Fig. 13

Truth table

Index	1	2	4	8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

1248P

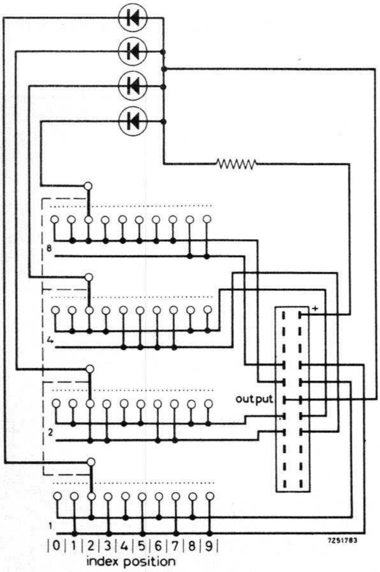


Fig. 14

For truth table, see above

1242N

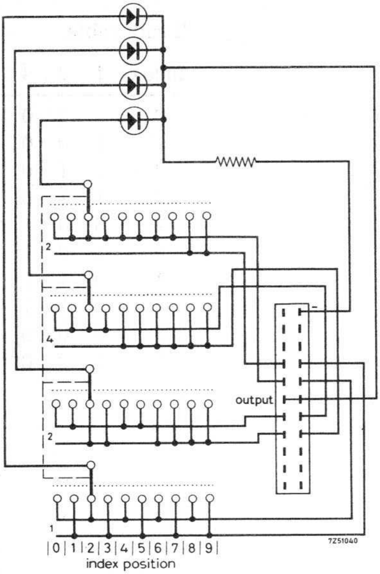


Fig.15

Truth table

Index	1	2	4	2
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	1	1	1
9	1	1	1	1

1242P

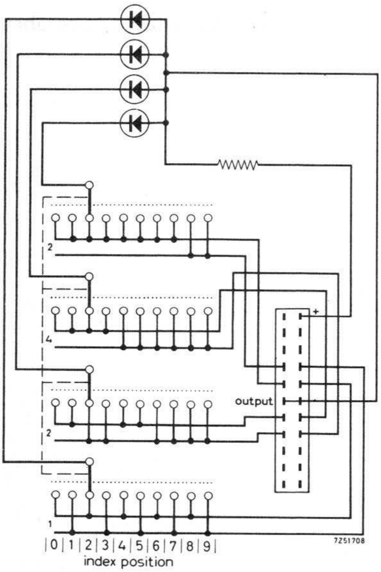


Fig.16

For truth table, see above

1248N/C

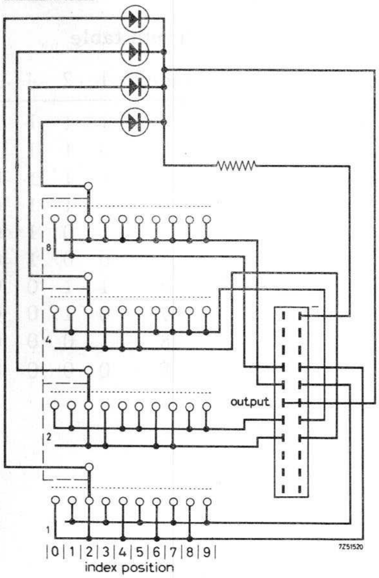


Fig.17

Truth table

Index	1	2	4	8
0	1	0	0	1
1	0	0	0	1
2	1	1	1	0
3	0	1	1	0
4	1	0	1	0
5	0	0	1	0
6	1	1	0	0
7	0	1	0	0
8	1	0	0	0
9	0	0	0	0

1248P/C

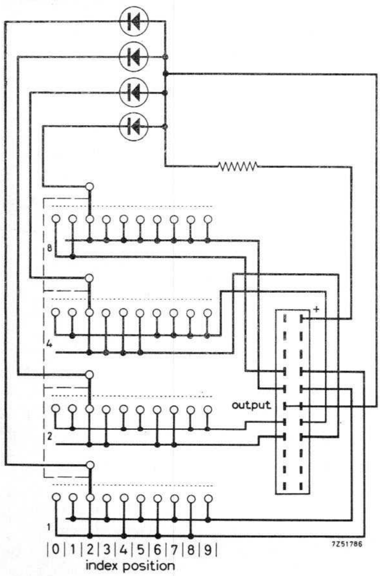


Fig.18

For truth table, see above

1242N/C

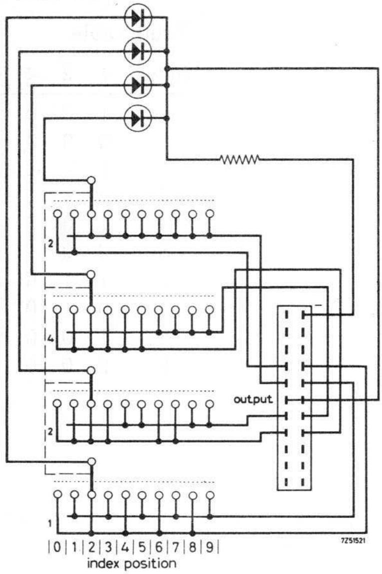


Fig. 19

Truth table

Index	1	2	4	2
0	1	1	1	1
1	0	1	1	1
2	1	1	1	0
3	0	1	1	0
4	1	0	1	0
5	0	0	1	0
6	1	1	0	0
7	0	1	0	0
8	1	0	0	0
9	0	0	0	0

1242P/C

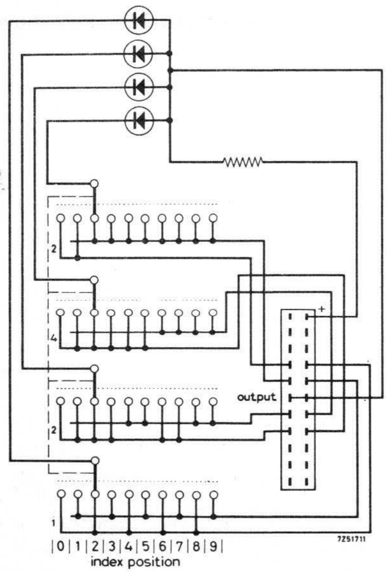


Fig. 20

For truth table, see above

2522

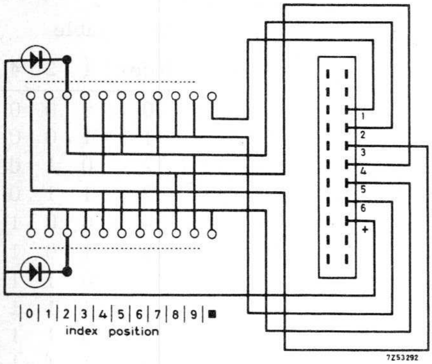


Fig.21

Truth table

Index	5	4	2	6	3	1	+
0	1	0	0	0	1	0	0
1	1	1	0	0	0	0	0
2	1	0	1	0	0	0	0
3	1	0	0	1	0	0	0
4	0	1	0	0	1	0	0
5	0	0	1	0	1	0	0
6	0	0	0	1	1	0	0
7	0	1	1	0	0	0	0
8	0	1	0	1	0	0	0
9	0	0	1	1	0	0	0
■	1	0	0	0	0	1	0

1248C

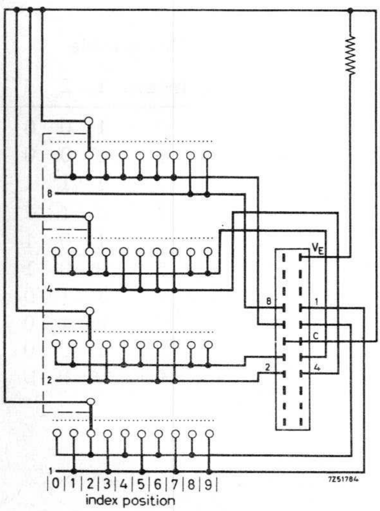


Fig.22

Truth table

Index	1	2	4	8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

1242C

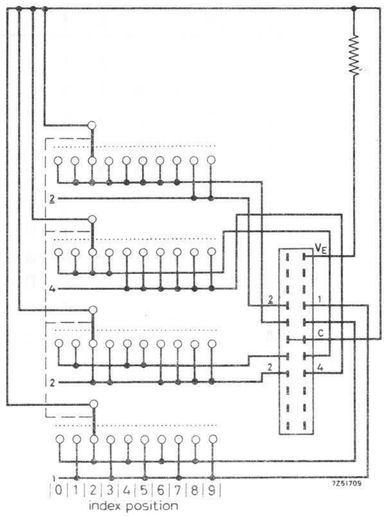


Fig.23

Truth table

Index	1	2	4	2
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	1	1	1
9	1	1	1	1

1248C/C

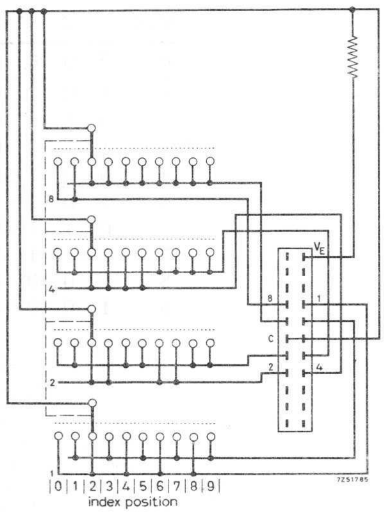


Fig.24

Truth table

Index	1	2	4	8
0	1	0	0	1
1	0	0	0	1
2	1	1	1	0
3	0	1	1	0
4	1	0	1	0
5	0	0	1	0
6	1	1	0	0
7	0	1	0	0
8	1	0	0	0
9	0	0	0	0

1242C/C

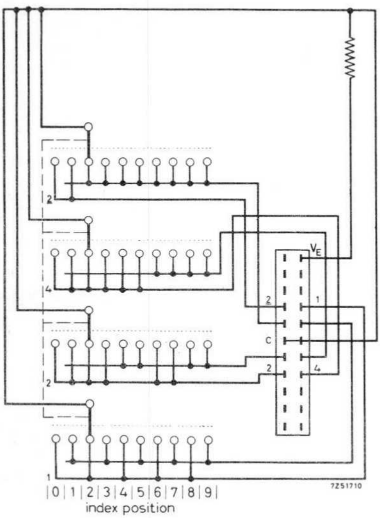


Fig.25

Truth table

Index	1	2	4	2
0	1	1	1	1
1	0	1	1	1
2	1	1	1	0
3	0	1	1	0
4	1	0	1	0
5	0	0	1	0
6	1	1	0	0
7	0	1	0	0
8	1	0	0	0
9	0	0	0	0

1248 S

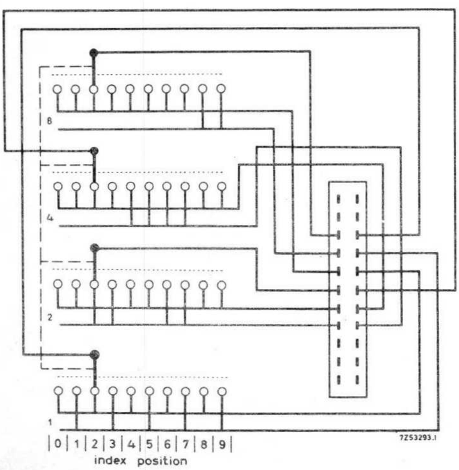


Fig.26

Truth table

Index	1	2	4	8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

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