TIME PROPORTIONAL TRIAC TRIGGER — TDA1023

GENERAL DESCRIPTION

The TDA1023 is a bipolar integrated circuit for controlling triacs in the time proportional or burst firing mode. It permits very precise temperature control of heating equipment and is especially suited for the control of panel heaters. The circuit generates positive-going trigger pulses and complies with the regulations on radio interference and mains distortion.

Special features are:

- adjustable proportional range width
- adjustable hysteresis
- adjustable trigger pulse width
- adjustable firing burst repetition time
- control range translation facility
- failsafe operation
- supplied from the mains
- provides supply for external temperature bridge

QUICK REFERENCE DATA

Supply voltage (derived from mains voltage)	V_{CC}	typ.	13.7	V
Stabilized supply voltage for temperature bridge	V_Z	typ.	8	V
Supply current (average value)	$I_{16(AV)}$	typ.	10	mA
Trigger pulse width	t_w	typ.	200	μs
Firing burst repetition time at C_T = 68 μF	T_b	typ.	41	s
Output current	$-I_{OH}$*	max.	150	mA
Operating ambient temperature range	T_{amb}		−20 to + 75	°C

* Negative current is defined as conventional current flow out of a device. A negative output current is suited for positive triac triggering.

PACKAGE OUTLINE

16-lead DIL; plastic (SOT-38).

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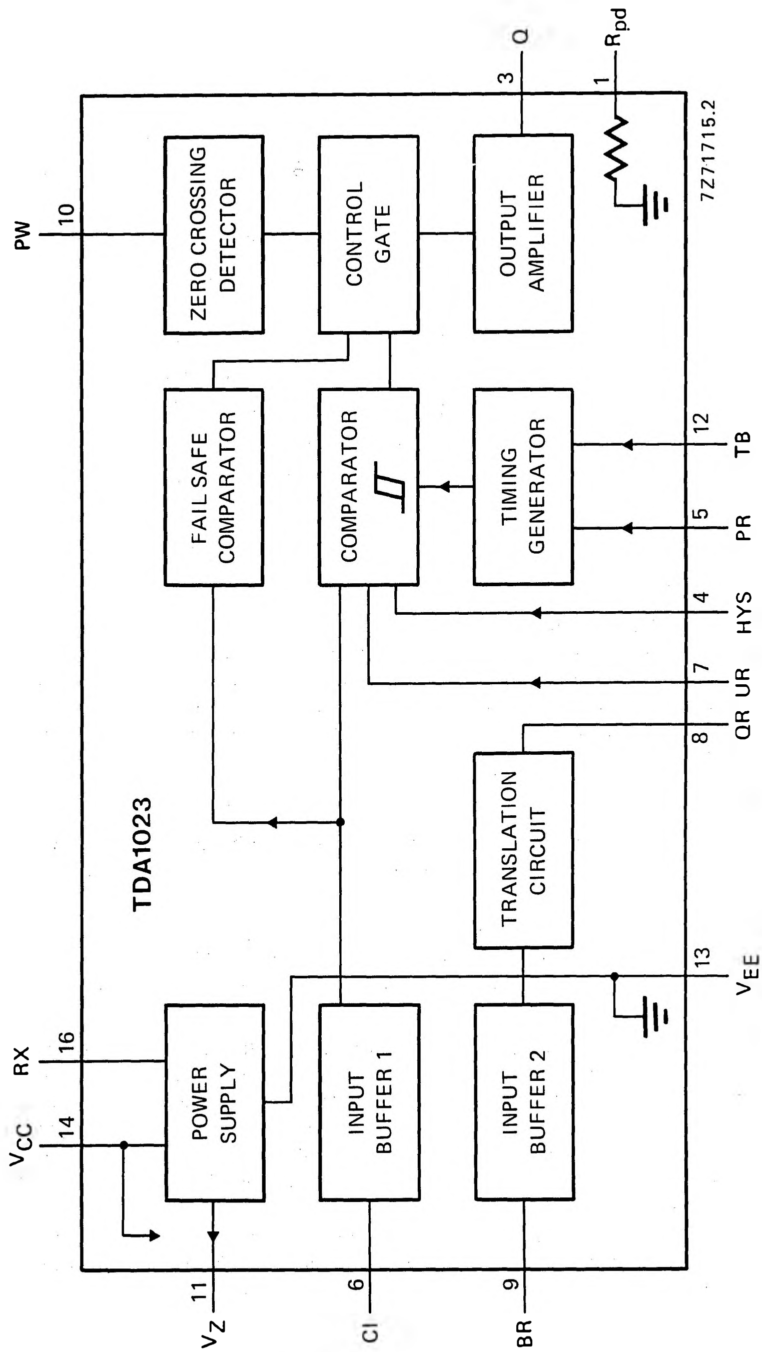

Fig. 1 Block diagram.

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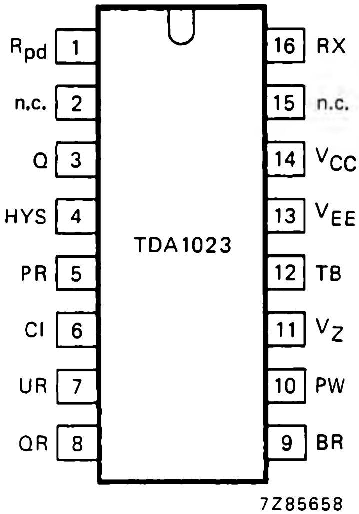

Fig. 2 Pinning diagram.

PINNING

1	R_{pd}	internal pull-down resistor connection
2	n.c.	not connected
3	Q	output
4	HYS	hysteresis control input
5	PR	proportional range control input
6	CI	Control input
7	UR	unbuffered reference input
8	QR	output of reference buffer
9	BR	buffered reference input
10	PW	pulse width control input
11	V_Z	reference supply output
12	TB	firing burst repetition time control input
13	V_{EE}	ground connection
14	V_{CC}	positive supply connection
15	n.c.	not connected
16	RX	external resistor connection

FUNCTIONAL DESCRIPTION

The TDA1023 generates pulses to trigger a triac. These trigger pulses coincide with the zero crossings of the mains voltage. This minimizes r.f. interference and transients on the mains supply. The trigger pulses come in bursts, with the net effect that the load is periodically switched on and off. This further minimizes mains pollution. The average power in the load is varied by varying the duration of the trigger pulse burst, in accordance with the voltage difference between the control input CI and the reference input, either UR or BR.

Power supply: V_{CC}, RX and V_Z (pins 14, 16 and 11)

The TDA1023 is supplied from the a.c. mains via a resistor R_D to the RX connection (pin 16); the V_{EE} connection (pin 13) is connected to the neutral line (see Fig. 4a). A smoothing capacitor C_S has to be connected between the V_{CC} and V_{EE} connections.

The circuit contains a string of stabilizer diodes between the RX and V_{EE} connections that limit the d.c. supply voltage, and a rectifier diode between the RX and V_{CC} connections (see Fig. 3).

At pin 11 the device provides a stabilized reference voltage V_Z for an external temperature sensing bridge.

The operation of the supply arrangement is as follows. During the positive half of the mains cycles the current through external voltage dropping resistor R_D charges the external smoothing capacitor C_S until RX reaches the stabilizing voltage of the internal stabilizer diodes. R_D should be chosen such that it can supply the current I_{CC} for the TDA1023 itself plus the average output current $I_{3(AV)}$ plus the current required from the V_Z connection for an external temperature bridge, and recharge the smoothing capacitor C_S (see Figs 9 to 12). Any excess current is bypassed by the internal stabilizer diodes. Note that the maximum rated supply current must not be exceeded.

During the negative half of the mains cycles external smoothing capacitor C_S has to supply the sum of the currents mentioned above. Its capacitance must be high enough to maintain the supply voltage above the minimum specified limit.

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FUNCTIONAL DESCRIPTION (continued)

Dissipation in resistor R_D is halved by connecting a diode in series (see Fig. 4b and 9 to 12).

A further reduction of dissipation is possible by using a high-quality voltage dropping capacitor C_D in series with a resistor R_{SD} (see Figs 4c and 14). Asuitable VDR connected across the mains provides protection of the TDA1023 and of the triac against mains-borne transients.

Control and reference inputs CI, BR and UR (pins 6, 9 and 7)

For room temperature control (5 °C to 30 °C) the best performance is obtained by using the translation circuit. The buffered reference input BR (pin 9) is used as a reference input, and the output of the reference buffer QR (pin 8) is connected to the unbuffered reference input UR (pin 7). In this arrangement the translation circuit ensures that most of the potentiometer rotation can be used to cover the room temperature range. This provides an accurate temperature setting and a linear temperature scale.

If the translation circuit is not required, the unbuffered reference input UR (pin 7) is used as a reference input. The buffered reference input BR (pin 9) must be connected to the reference supply output V_Z (pin 11).

For proportional power control the unbuffered reference input UR (pin 7) must be connected to the firing burst repetition time control input TB (pin 12) and the buffered reference input BR (pin 9), which is inactive now, must be connected to the reference supply output V_Z (pin 11).

In all arrangements the train of output pulses becomes longer when the voltage at the control input CI (pin 6) becomes lower.

Proportional range control input PR (pin 5)

With the proportional range control input PR open the output duty factor changes from 0% to 100% by a variation of 80 mV at the control input CI (pin 6). For temperature control this corresponds with a temperature difference of only 1 K.

This range may be increased to 400 mV, i.e. 5 K, by connecting the proportional range control input PR (pin 5) to ground. Intermediate values are obtained by connecting the PR input to ground via a resistor R5, see Table 1.

Hysteresis control input HYS (pin 4)

With the hysteresis control input HYS (pin 4) open the device has a built-in hysteresis of 20 mV. For temperature control this corresponds with 0.25 K.

Hysteresis is increased to 320 mV, corresponding with 4 K, by grounding HYS (pin 4). Intermediate values are obtained by connecting pin 4 to ground via a resistor R4. See Table 1 for a set of values for R4 and R5 giving a fixed ratio between hysteresis and proportional range.

Trigger pulse width control input PW (pin 10)

The trigger pulse width may be adjusted to the value required for the triac by choosing the value of the external synchronization resistor R_S between the trigger pulse width control input PW (pin 10) and the a.c. mains. The pulse width is inversely proportional to the input current (see Fig. 13).

Output Q (pin 3)

Since the circuit has an open-emitter output, it is capable of sourcing current, i.e. supplying a current out of the output. Therefore it is especially suited for generating positive-going trigger pulses. The output is current-limited and protected against short-circuits. The maximum output current is 150 mA and the output pulses are stabilized at 10 V for output currents up to that value.

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FUNCTIONAL DESCRIPTION (continued)

A gate resistor R_G must be connected between the output Q and the triac gate to limit the output current to the minimum required by the triac (see Figs 5 to 8). This minimizes the total supply current and the power dissipation.

Pull-down resistor R_{pd} (pin 1)

The TDA1023 includes a 1.5 kΩ pull-down resistor R_{pd} between pins 1 and 13 (V_{EE}, ground connection), intended for use with sensitive triacs.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage, d.c.	V_{CC}	max.	16	V
Supply current				
average	$I_{16(AV)}$	max.	30	mA
repetitive peak	$I_{16(RM)}$	max.	100	mA
non-repetitive peak	$I_{16(SM)}$	max.	2	A
Input voltage, all inputs	V_I	max.	16	V
Input current, CI, UR, BR, PW input	$I_{6;\,7;\,9;\,10}$	max.	10	mA
Voltage on R_{pd} connection	V_1	max.	16	V
Output voltage, Q, QR, V_Z output	$V_{3;\,8;\,11}$	max.	16	V
Output current				
average	$-I_{OH(AV)}$	max.	30	mA
peak, max. 300 μs	$-I_{OH(M)}$	max.	700	mA
Total power dissipation	P_{tot}	max.	500	mW
Storage temperature range	T_{stg}	−55 to	+ 150	°C
Operating ambient temperature range	T_{amb}	−20 to	+ 75	°C

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CHARACTERISTICS

V_{CC} = 11 to 16 V; T_{amb} = −20 to + 75 °C unless otherwise specified

	symbol	min.	typ.	max.	unit
Supply: V_{CC} and RX (pins 14 and 16)					
Internally stabilized supply voltage at I_{16} = 10 mA	V_{CC}	12	13.7	15	V
Variation with I_{16}	$\Delta V_{CC}/\Delta I_{16}$	–	30	–	mV/mA
Supply current at $V_{16\text{-}13}$ = 11 to 16 V; I_{10} = 1 mA; f = 50 Hz; pin 11 open; $V_{6\text{-}13} > V_{7\text{-}13}$; pins 4 and 5 open	I_{16}	–	–	6	mA
pins 4 and 5 grounded	I_{16}	–	–	7.1	mA
Reference supply output V_Z (pin 11) for external temperature bridge					
Output voltage	$V_{11\text{-}13}$	–	8	–	V
Output current	$-I_{11}$	–	–	1	mA
Control and reference inputs CI, BR and UR (pins 6, 9 and 7)					
Input voltage to inhibit the output	$V_{6\text{-}13}$	–	7.6	–	V
Input current at V_I = 4 V	$I_{6;7;9}$	–	–	2	μA
Hysteresis control input HYS (pin 4)					
Hysteresis, pin 4 open	ΔV_6	9	20	40	mV
pin 4 grounded	ΔV_6	–	320	–	mV
Proportional range control input PR (pin 5)					
Proportional range, pin 5 open	ΔV_6	50	80	130	mV
pin 5 grounded	ΔV_6	–	400	–	mV
Pulse width control input PW (pin 10)					
Pulse width at $I_{10(RMS)}$ = 1 mA; f = 50 Hz	t_w	100	200	300	μs
Firing burst repetition time control input TB (pin 12)					
Firing burst repetition time, ratio to capacitor C_T	T_b/C_T	320	600	960	ms/μF
Output of reference buffer QR (pin 8)					
Output voltage at input voltage $V_{9\text{-}13}$ = 1.6 V	$V_{8\text{-}13}$	–	3.2	–	V
$V_{9\text{-}13}$ = 4.8 V	$V_{8\text{-}13}$	–	4.8	–	V
$V_{9\text{-}13}$ = 8 V	$V_{8\text{-}13}$	–	6.4	–	V

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	symbol	min.	typ.	max.	unit
Output Q (pin 3)					
Output voltage HIGH at $-I_{OH}$ = 150 mA	V_{OH}	10	–	–	V
Output current HIGH	$-I_{OH}$	–	–	150	mA
Internal pull-down resistor R_{pd} (pin 1)					
Resistance to V_{EE}	R_{pd}	1	1.5	3	kΩ

Table 1. Adjustment of proportional range and hysteresis.
Combinations of resistor values giving hysteresis > ¼ proportional range.

proportional range mV	proportional range resistor R5 kΩ	minimum hysteresis mV	maximum hysteresis resistor R4 kΩ
80	open	20	open
160	3.3	40	9.1
240	1.1	60	4.3
320	0.43	80	2.7
400	0	100	1.8

Table 2. Timing capacitor C_T values.

effective d.c. value	marked a.c. specification		catalogue number*
μF	μF	V	
68	47	25	2222 016 90129
47	33	40	– – 90131
33	22	25	– 015 90102
22	15	40	– – 90101
15	10	25	– – 90099
10	6.8	40	– – 90098

* Special electrolytic capacitors recommended for use with TDA1023.

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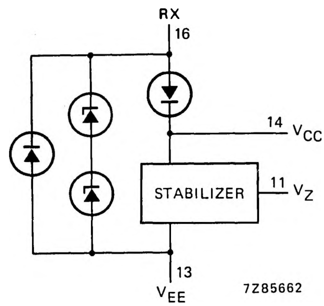

Fig. 3 Internal supply connections.

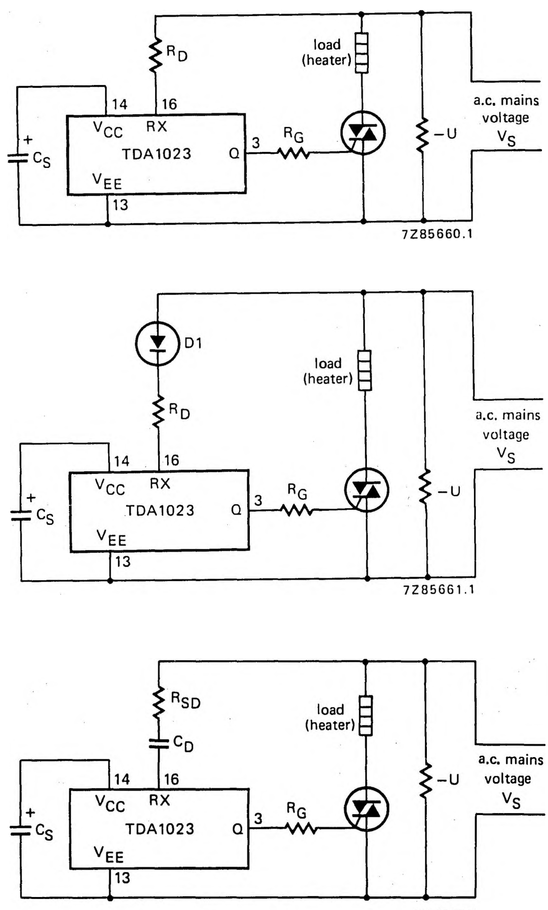

Fig. 4 Alternative supply arrangements.

TIME PROPORTIONAL TRIAC TRIGGER

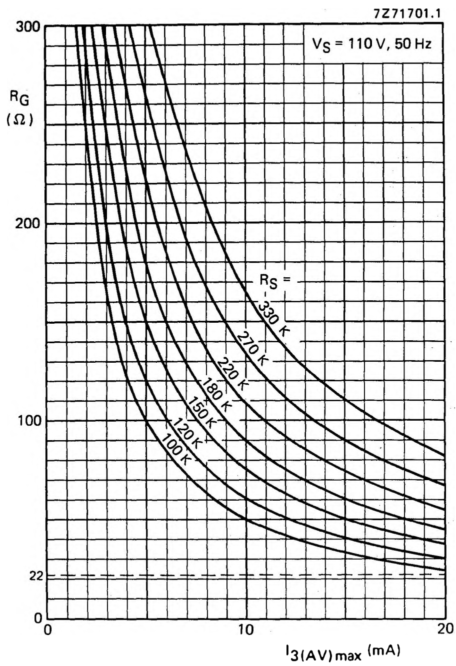

Fig. 5.

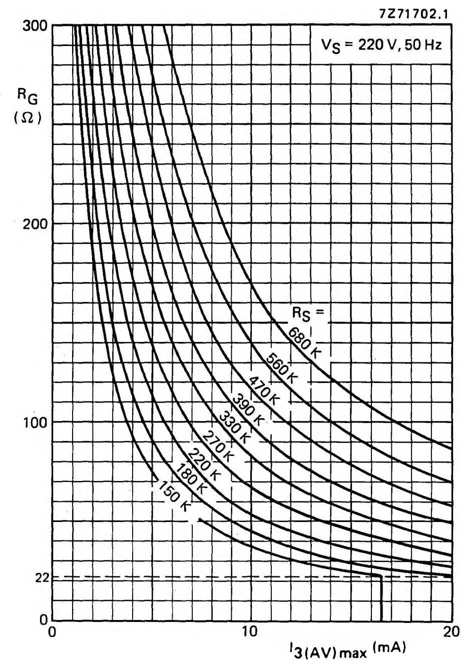

Fig. 6.

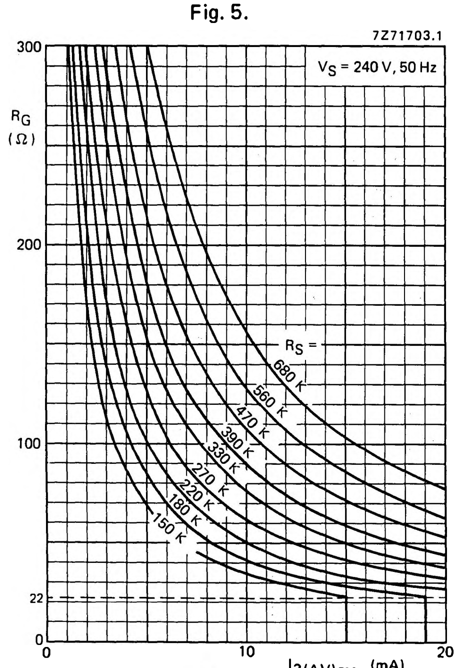

Fig. 7.

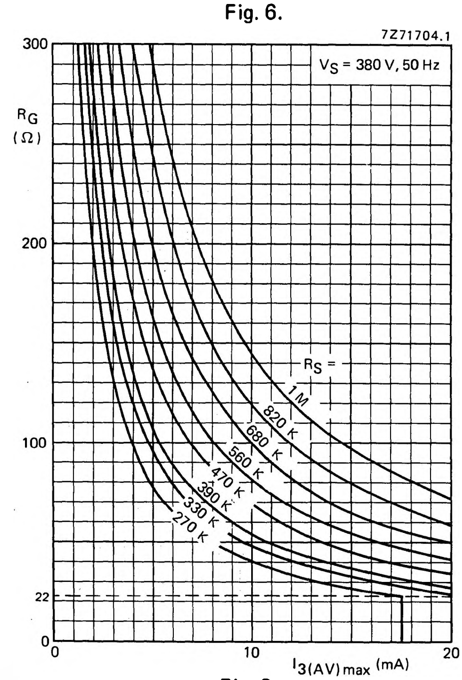

Fig. 8.

TIME PROPORTIONAL TRIAC TRIGGER TDA1023

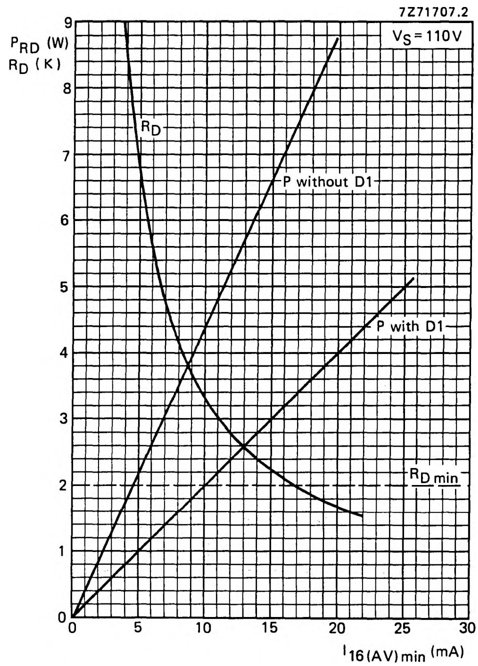

Fig. 9.

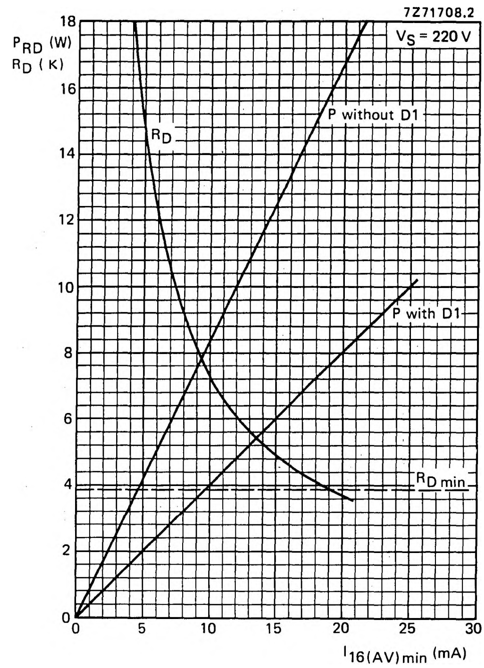

Fig. 10.

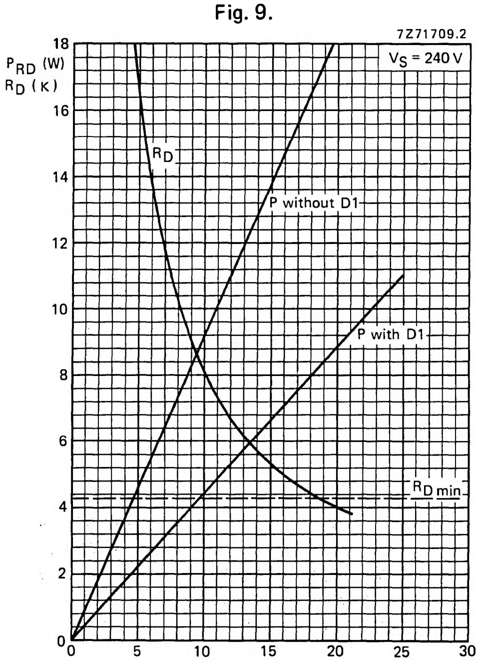

Fig. 11.

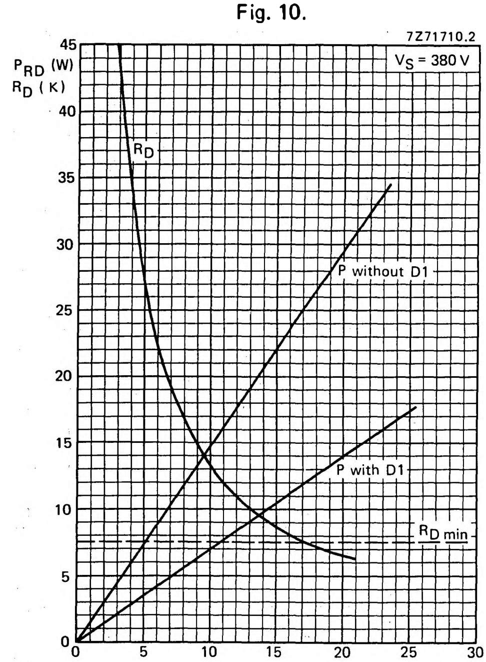

Fig. 12.

TIME PROPORTIONAL TRIAC TRIGGER TDA1023

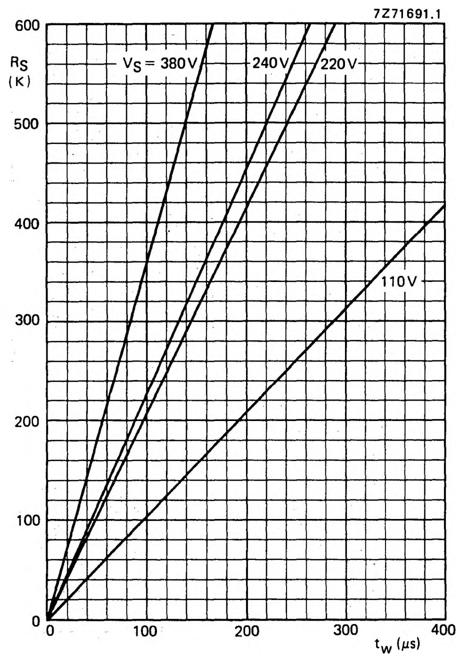

Fig. 13 Synchronization resistor R_S as a function of required trigger pulse width t_w with mains voltage V_S as a parameter.

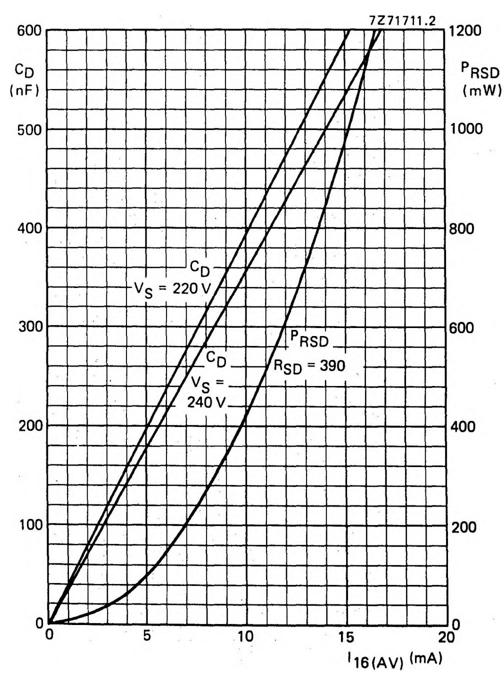

Fig. 14 Nominal value of voltage dropping capacitor C_D and power P_{RSD} dissipated in voltage dropping resistor R_{SD} as a function of the average supply current $I_{16(AV)}$ with the mains supply voltage V_S as a parameter.

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APPLICATION INFORMATION

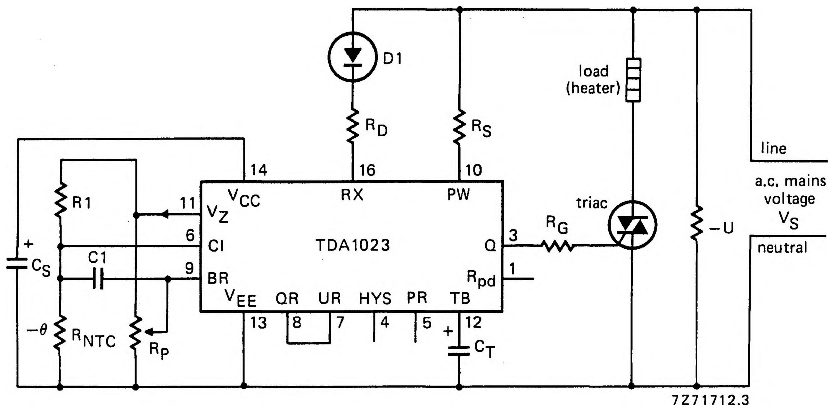

Fig. 15 The TDA1023 used in a 1200 to 2000 W heater with triac BT139. For component values see Table 3.

Conditions

Mains supply: V_S = 220 V

Temperature range = 5 to 30 °C

BT139 data: $V_{GT} < 1.5$ V; $I_{GT} > 70$ mA; $I_L < 60$ mA — at $T_j = 25$ °C

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Table 3. Temperature controller component values (see Fig. 15).

parameter	symbol	value	remarks
Trigger pulse width	t_W	75 μs	see BT139 data sheet
Synchronization resistor	R_S	180 kΩ	see Fig. 13
Gate resistor	R_G	110 Ω	see Fig. 6
Max. average gate current	$I_{3(AV)}$	4.1 mA	see Fig. 8
Hysteresis resistor	R4	n.c.	see Table 1
Proportional band resistor	R5	n.c.	see Table 1
Min. required supply current	$I_{16(AV)}$	11.1 mA	
Mains dropping resistor	R_D	6.2 kΩ	see Fig. 10
Power dissipated in R_D	P_{RD}	4.6 W	see Fig. 10
Timing capacitor (eff. value)	C_T	68 μF	see Table 2
Voltage dependent resistor	VDR	250 V a.c.	cat. no. 2322 593 62512
Rectifier diode	D1	BYW56	
Resistor to pin 11	R1	18.7 kΩ	1% tolerance
NTC thermistor (at 25 °C)	R_{NTC}	22 kΩ	B = 4200 K cat. no. 2322 642 12223
Potentiometer	R_P	22 kΩ	
Capacitor between pins 6 and 9	C1	47 nF	
Smoothing capacitor	C_S	220 μF; 16 V	
If R_D and D1 are replaced by C_D and R_{SD}			
Mains dropping capacitor	C_D	470 nF	see Fig. 14
Series dropping resistor	R_{SD}	390 Ω	see Fig. 14
Power dissipated in R_{SD}	P_{RSD}	0.6 W	see Fig. 14
Voltage dependent resistor	VDR	250 V a.c.	cat. no. 2322 594 62512

Notes

1. ON/OFF control: pin 12 connected to pin 13.
2. If translation circuit is not required: slider of R_P to pin 7; pin 8 open; pin 9 connected to pin 11.

APPLICATION INFORMATION SUPPLIED ON REQUEST