ZERO CROSSING TRIAC TRIGGER — TDA1024

GENERAL DESCRIPTION

The TDA1024 is a bipolar integrated circuit delivering positive pulses for triggering a triac or a thyristor. It is primarily intended for use as a static switch to replace mechanical thermostats that switch resistive loads, such as:

- central heating installations
- washing machine heaters
- water heaters
- smoothing irons

The TDA1024 provides its own d.c. supply and will supply an external circuit, e.g. a temperature sensing bridge. The circuit complies with the regulations on radio interference and mains distortion.

Its main features are:

- adjustable trigger pulse width
- adjustable hysteresis
- supplied from the mains
- provides supply for external temperature bridge
- protected inputs and output
- low supply current, low dissipation

QUICK REFERENCE DATA

Supply voltage (d.c.) (internally derived from mains voltage)	V_{CC}	typ.	6.5	V
Supply current (average value, unloaded)	$I_{RX(AV)}$	max.	1.8	mA
Output current HIGH	$-I_{OH}$*	max.	100	mA
Output pulse width	t_w	typ.	195	μs
Power dissipation (unloaded)	P	typ.	12	mW
Operating ambient temperature range	T_{amb}		−20 to +80	^oC

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

PACKAGE OUTLINE

8-lead DIL; plastic (SOT-97A).

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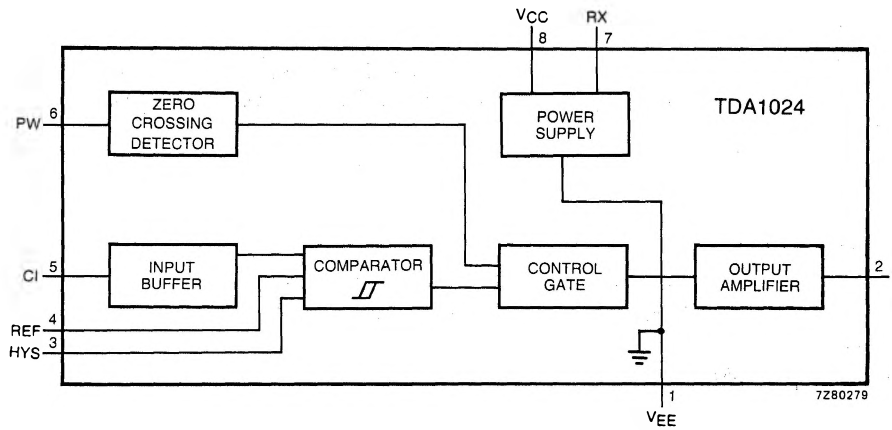

Fig. 1 Block diagram.

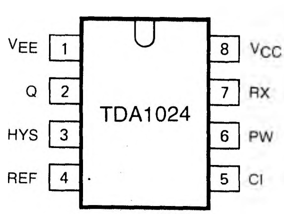

Fig. 2 Pinning diagram.

PINNING

1	V_{EE}	ground
2	Q	output
3	HYS	hysteresis control input
4	REF	reference input
5	CI	control input
6	PW	pulse width control input
7	RX	external resistor
8	V_{CC}	positive supply

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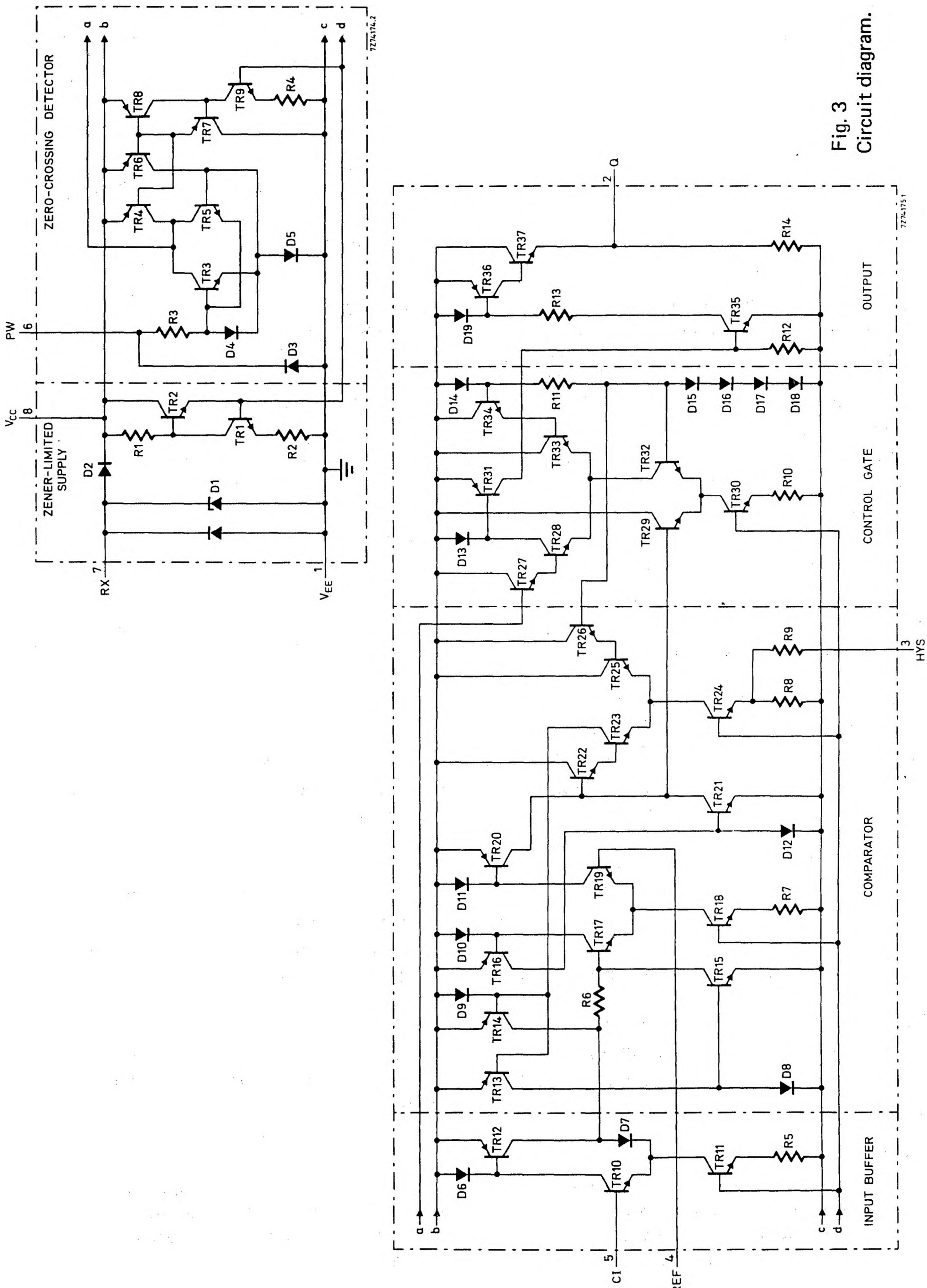

Fig. 3
Circuit diagram.

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FUNCTIONAL DESCRIPTION

The TDA1024 generates positive-going output 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.

Supply: V_{CC} and RX (pins 8 and 7)

The TDA1024 may be supplied by an external d.c. power supply connected to V_{CC} (pin 8), but usually it is supplied directly from the mains voltage. For this purpose the circuit contains a stabilizer diode between RX and V_{EE} that limits the d.c. supply voltage (see Fig. 4). An external resistor R_D has to be connected from the mains to RX (pin 7); V_{EE} is connected to the neutral line (see Fig. 5a). A smoothing capacitor C_S has to be connected between V_{CC} and V_{EE}.

During the positive half of the mains cycles the current through external voltage-dropping resistor R_D charges the external smoothing capacitor C_S up to the stabilizing voltage of the internal stabilizer diodes. R_D should be chosen such that it can supply the current I_{CC} for the TDA1024 itself plus the average output current $-I_{Q(AV)}$, and recharge the smoothing capacitor C_S. Any excess current is bypassed by the internal stabilizer diode. Note that the maximum rated supply current must not be exceeded.

During the negative half of the mains cycles external smoothing capacitor C_S supplies the circuit. Its capacitance must be high enough to maintain the supply voltage above 5 V, the minimum specified limit (see Fig. 10).

Dissipation in resistor R_D is halved by connecting a diode in series (see Figs 5b and 11).

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 5c and 12).

A suitable VDR connected across the mains provides protection of the TDA1024 and of the triac against mains-borne transients.

Control and reference inputs CI and REF (pins 5 and 4)

The TDA1024 produces output pulses when the CI input is at a higher potential than the REF input. For power control as a function of temperature the inputs may be connected as shown in Fig. 14.

An input buffer circuit at the CI input gives a high input impedance and a low output impedance. This makes the hysteresis of the circuit independent of the input voltage.

Hysteresis control input HYS (pin 3)

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

Hysteresis is increased to 300 mV, corresponding with a temperature difference of 4 K, by grounding HYS. Intermediate values are obtained by connecting HYS to ground via a resistor.

Pulse width control input PW (pin 6)

The output 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 pulse width control input PW and the a.c. mains. The pulse width is inversely proportional to the input current (see Fig. 13).

Output Q (pin 2)

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 100 mA and the output pulses are stabilized at 4 V for output currents up to that value.

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FUNCTIONAL DESCRIPTION (continued)

Output Q (pin 2) (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 6 to 9). This minimizes the total supply current and the power dissipation.

RATINGS

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

Supply voltage (d.c.)	V_{CC}	max.	8	V
Supply current				
average	$I_{RX(AV)}$	max.	30	mA
repetitive peak	$I_{RX(RM)}$	max.	80	mA
non-repetitive peak ($t < 50\ \mu s$)	$I_{RX(SM)}$	max.	2	A
Input voltage (all inputs)	V_I	max.	8	V
Input current (CI, REF, PW)	I_{CI}; I_{REF}; $\pm I_{PW}$	max.	10	mA
Output voltage HIGH	V_Q	max.	8	V
Output current				
average	$-I_{OH(AV)}$	max.	30	mA
peak, max. 300 μs	$-I_{OH(M)}$	max.	400	mA
Total power dissipation	P_{tot}	max.	225	mW
Storage temperature range	T_{stg}	−55 to	+125	°C
Operating ambient temperature range	T_{amb}	−20 to	+80	°C

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CHARACTERISTICS

V_{CC} = 5 to 8 V; T_{amb} = −20 to +80 °C unless otherwise specified.

	symbol	min.	typ.	max.	unit
Supply: V_{CC} and RX (pins 8 and 7)					
Internally stabilized supply voltage at $I_{RX(AV)}$ = 10 mA	V_{CC}	5.5	6.5	7.5	V
variation with I_{RX}	$\Delta V_{CC}/\Delta I_{RX}$	–	15	–	mV/mA
Supply current at V_{CC} = 5.5 V; unloaded; f = 50 Hz; $V_{CI} > V_{REF}$ pin 3 open (minimum hysteresis)	$I_{RX(AV)}$	–	–	1.8	mA
Supply current increase pin 3 grounded (maximum hysteresis)	$\Delta I_{RX(AV)}$	–	1.4	–	mA
Control and reference inputs CI and REF (pins 5 and 4)					
Input current, CI input, at $V_{CI} > V_{REF}$	I_{CI}	–	–	5	μA
Input current, REF input, at $V_{REF} > V_{CI}$	I_{REF}	–	–	5	μA
Hysteresis control input HYS (pin 3)					
Hysteresis, pin 3 open (minimum hysteresis)	$\Delta V_{CI\text{-}REF}$	10	20	30	mV
pin 3 grounded (maximum hysteresis)	$\Delta V_{CI\text{-}REF}$	150	300	500	mV
Pulse width control input PW (pin 6)					
Pulse width at $I_{PW(RMS)}$ = 1 mA; V_{CC} = 5.5 V; f = 50 Hz	t_w	130	195	265	μs
Output Q (pin 2)					
Output voltage HIGH at $-I_{OH}$ = 100 mA	V_{OH}	4	–	–	V
at $-I_{OH}$ = 1 mA	V_{OH}	1	–	–	V
Output current HIGH	$-I_{OH}$	–	–	100	mA

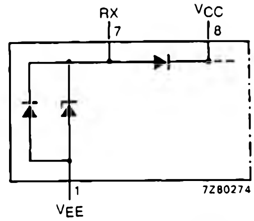
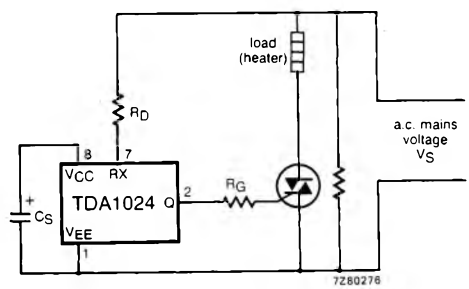
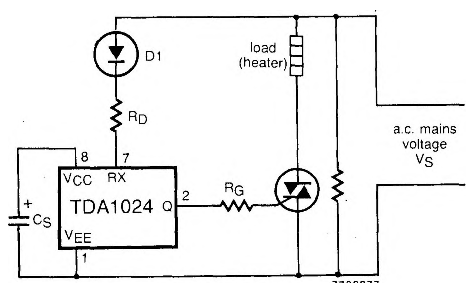


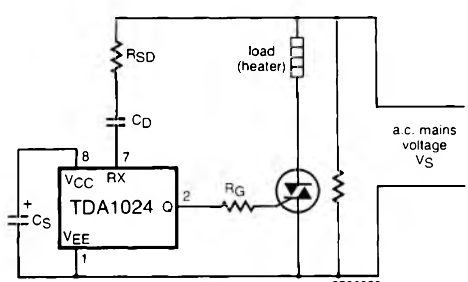
Fig. 4 Internal supply connections.



(a)



(b)



(c)

Fig. 5 Alternative supply arrangements.

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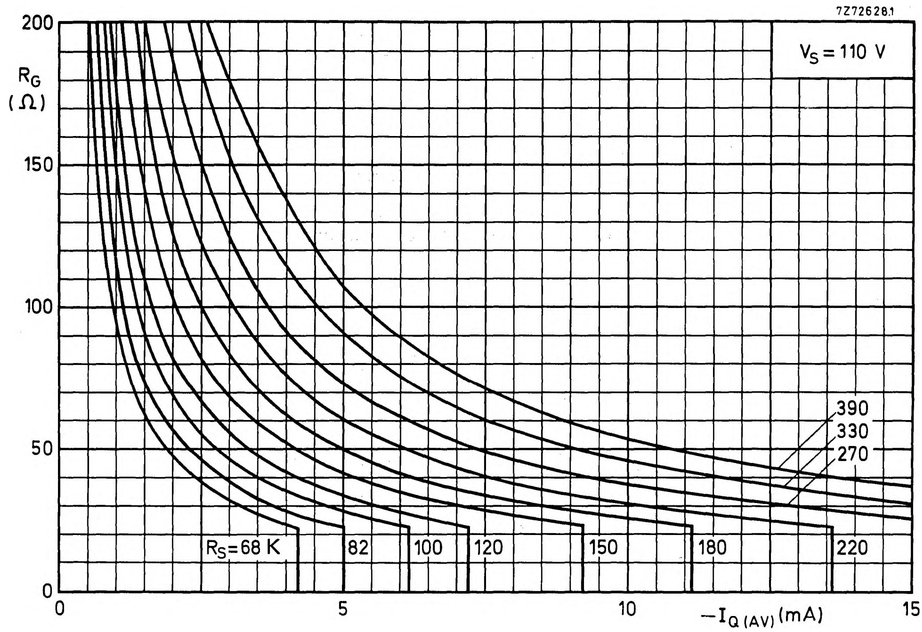

Fig. 6.

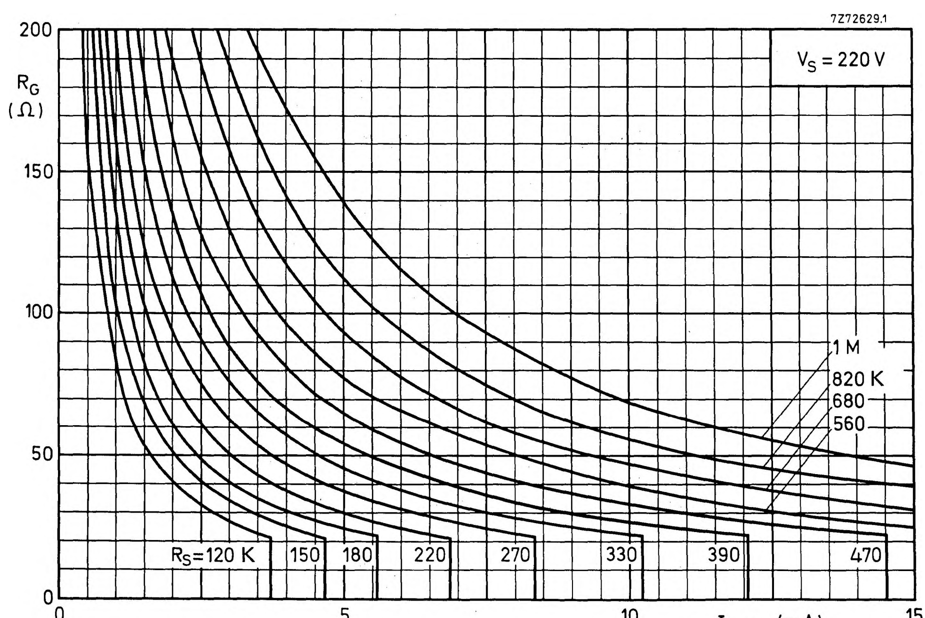

Fig. 7.

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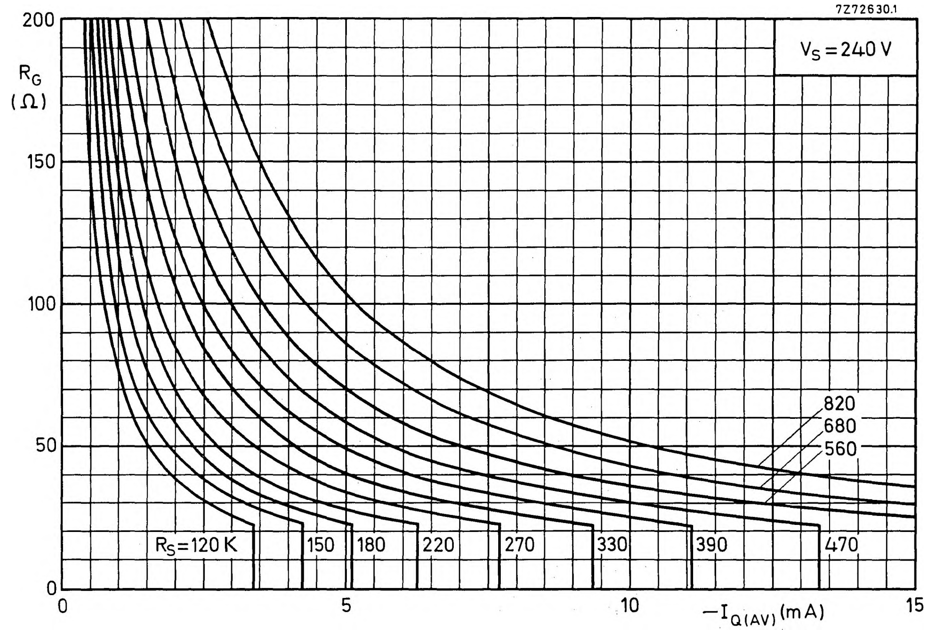

Fig. 8.

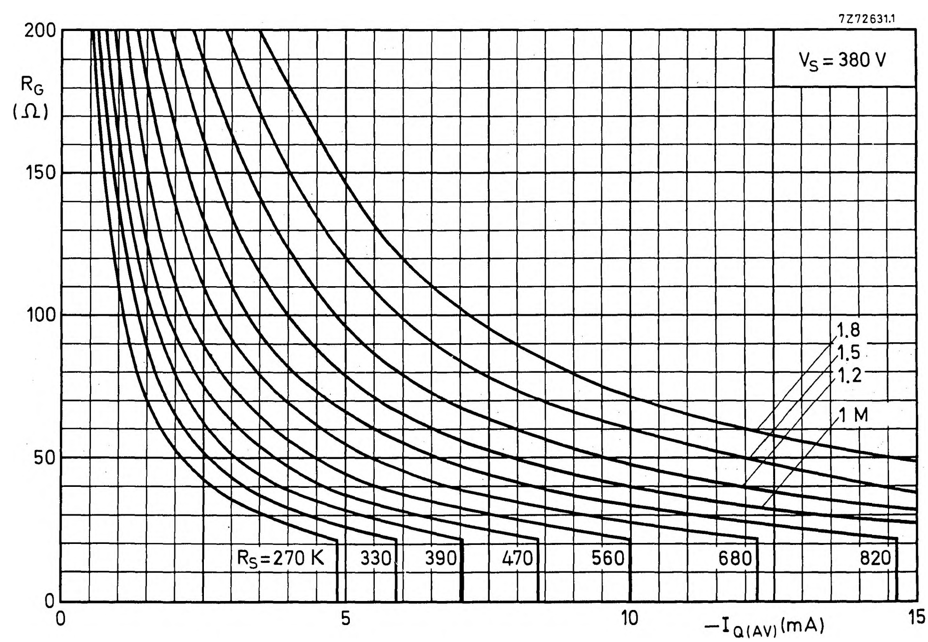

Fig. 9.

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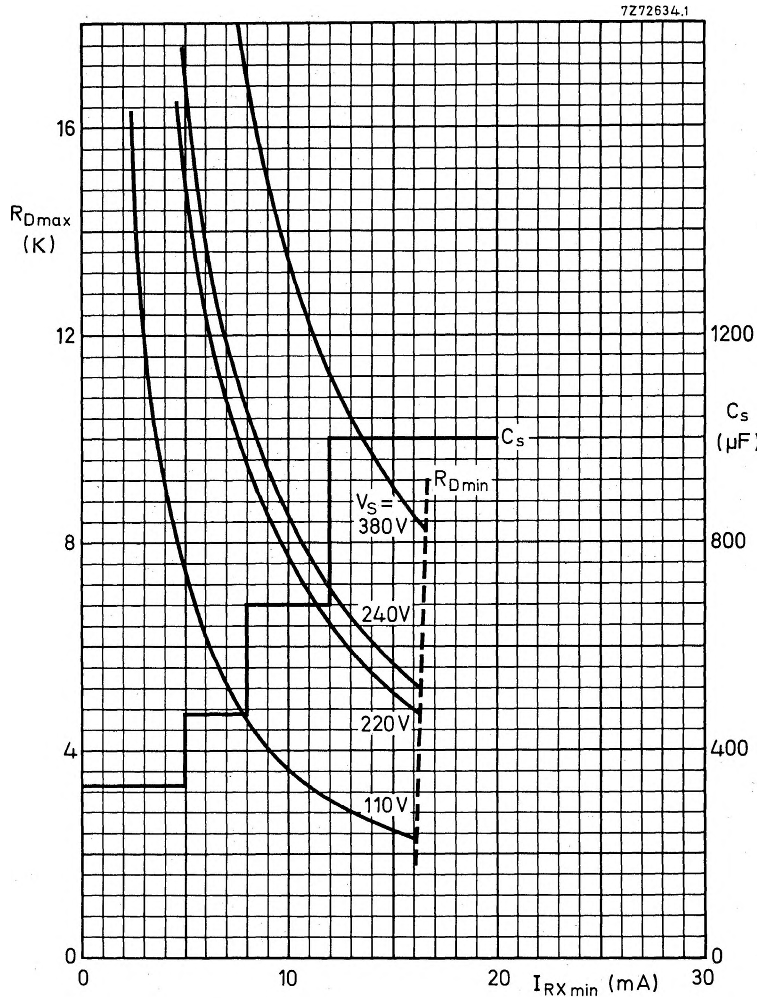

Fig. 10 Maximum value of voltage-dropping resistor R_D as a function of minimum value of the current into RX with the mains supply voltage V_S as a parameter for the supply arrangements of Figs 5a and 5b, and recommended value of smoothing capacitor C_S as a function of the current into RX for all three supply arrangements of Fig. 5. When V_{CC} is used to supply external circuitry such as a temperature-sensing bridge, the current required by that external circuitry should be added to I_{RXmin}.

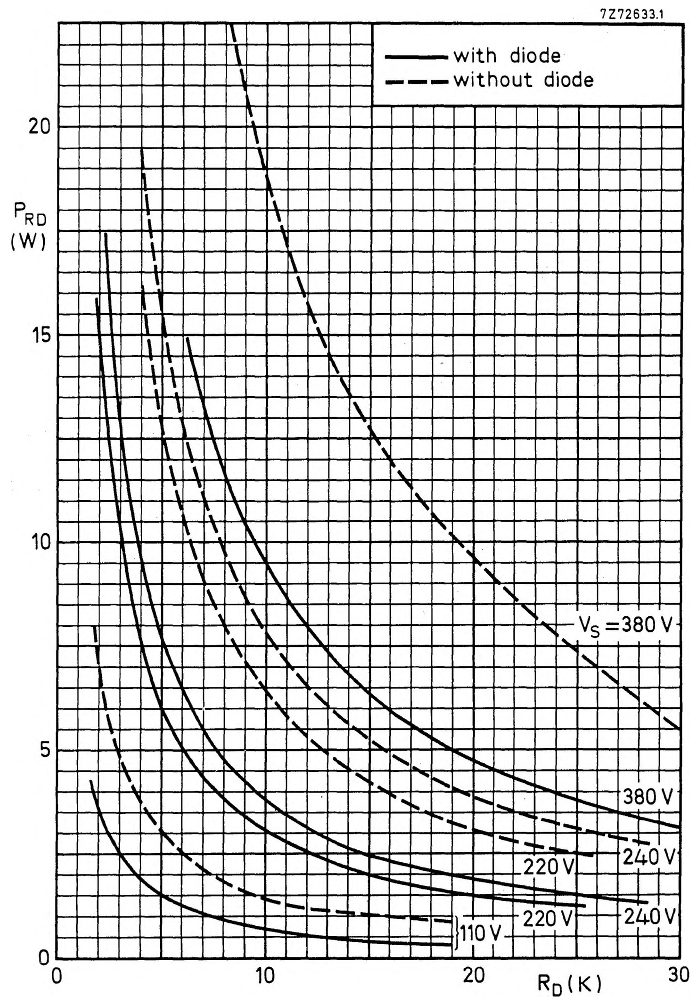

Fig. 11 Power dissipated in voltage-dropping resistor R_D as a function of its value with the mains supply voltage V_S as a parameter, for the supply arrangements of Figs 5a and 5b.

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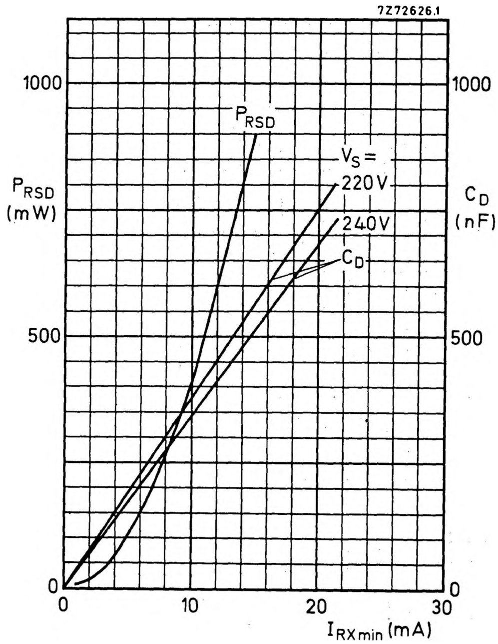

Fig. 12 Power dissipated in voltage-dropping resistor R_{SD} and dropping capacitor C_D as a function of the minimum current into RX with the mains supply voltage V_S as a parameter, for the supply arrangement of Fig. 5c. When V_{CC} is used to supply external circuitry such as a temperature-sensing bridge, the current required by that external circuitry should be added to I_{RXmin}.

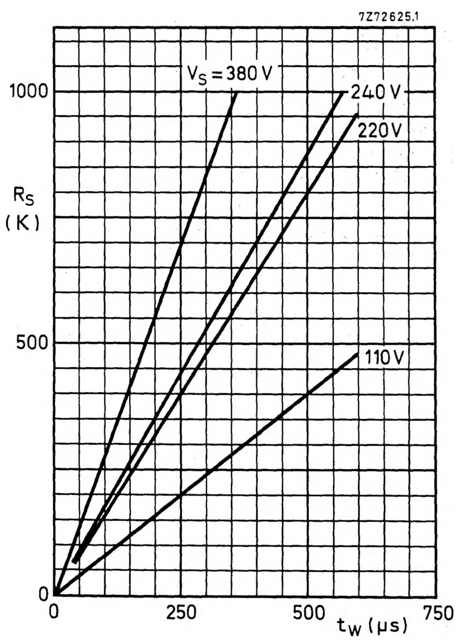

Fig. 13 Synchronization resistor R_S as a function of required trigger pulse width t_W with mains supply voltage V_S as a parameter.

APPLICATION INFORMATION

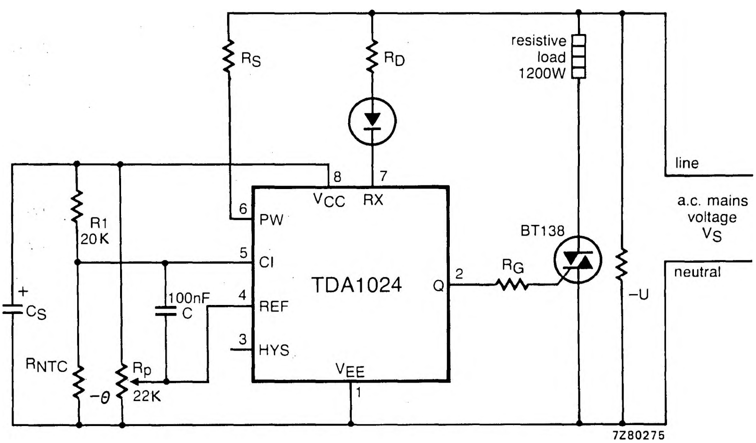

Fig. 14 Typical application of the TDA1024 in a 1200 W thermostat covering the temperature range 5 to 30 °C. For component values see Table 1.

Conditions

Mains supply voltage $V_{S(RMS)} = 220$ V

Temperature range: 5 to 30 °C

BT138 data: $V_{GT} < 1.5$ V, $I_{GT} > 70$ mA, $I_L < 60$ mA at $T_j = 25$ °C

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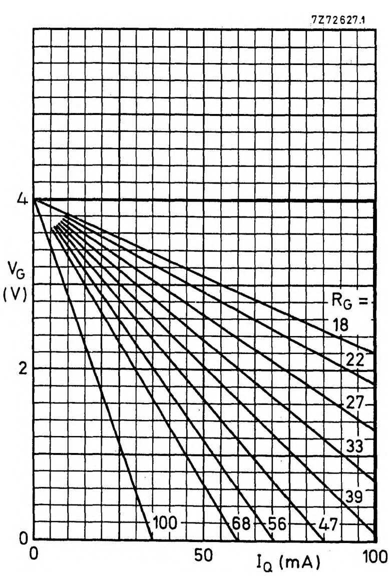
Table 1

Temperature controller component values (see Fig. 14)

parameter	symbol	value	remarks
Trigger pulse width	t_W	105 μs	see BT138 data sheet
Synchronization resistor	R_S	180 kΩ	see Fig. 13
Gate resistor	R_G	33 Ω	see Fig. 7
Average output current	$I_{Q(AV)}$	3.7 mA	
Min. required supply current	$I_{RX(AV)}$	6.5 mA	
Voltage-dropping resistor	R_D	10 kΩ	see Fig. 10
Power dissipated in R_D	P_{RD}	3.2 W	see Fig. 11
Voltage dependent resistor	VDR	250 V a.c.	cat. no. 2322 593 62512
Rectifier diode	D1	BYW56	
NTC thermistor (at 25 °C)	R_{NTC}	22 kΩ	B = 4200 K cat. no. 2322 642 12223
Smoothing capacitor	C_S	220 μF; 16 V	
If R_D and D1 are replaced by C_D and R_{SD}			
Voltage-dropping capacitor	C_D	270 nF	
Series dropping resistor	R_{SD}	390 Ω	
Power dissipated in R_{SD}	P_{RSD}	190 mW	
Voltage dependent resistor	VDR	250 V a.c.	cat. no. 2322 594 62512



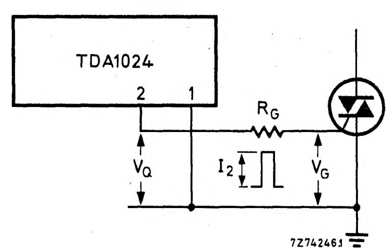


Fig. 15 Gate voltage (V_G) as a function of trigger current (I_Q) with gate resistor (R_G) load lines.