

GENERAL PURPOSE TRIGGER CIRCUIT

TCA280A

GENERAL DESCRIPTION

The TCA280A is a bipolar integrated circuit delivering positive pulses for triggering a triac or a thyristor. The flexibility of the circuit makes it suited for a great variety of applications, such as:

- synchronous on/off switching
- phase control
- time-proportional control
- temperature control
- motor speed control

Features

- adjustable proportional range
- adjustable hysteresis
- adjustable firing burst repetition time
- adjustable pulse width
- supplied from the mains
- provides supply for external temperature bridge
- low supply current, low dissipation

QUICK REFERENCE DATA

Supply voltage, d.c. (derived from mains voltage)	V _{CC}	typ.	14,4 V
Supply current (average value)	I _{CC}	typ.	1 mA
Output current	−I _{OH} *	max.	200 mA
Output pulse width	t _w	typ.	190 μs
Power dissipation, unloaded	P	typ.	15 mW
Operating ambient temperature range	T _{amb}	−20 to + 80 °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).

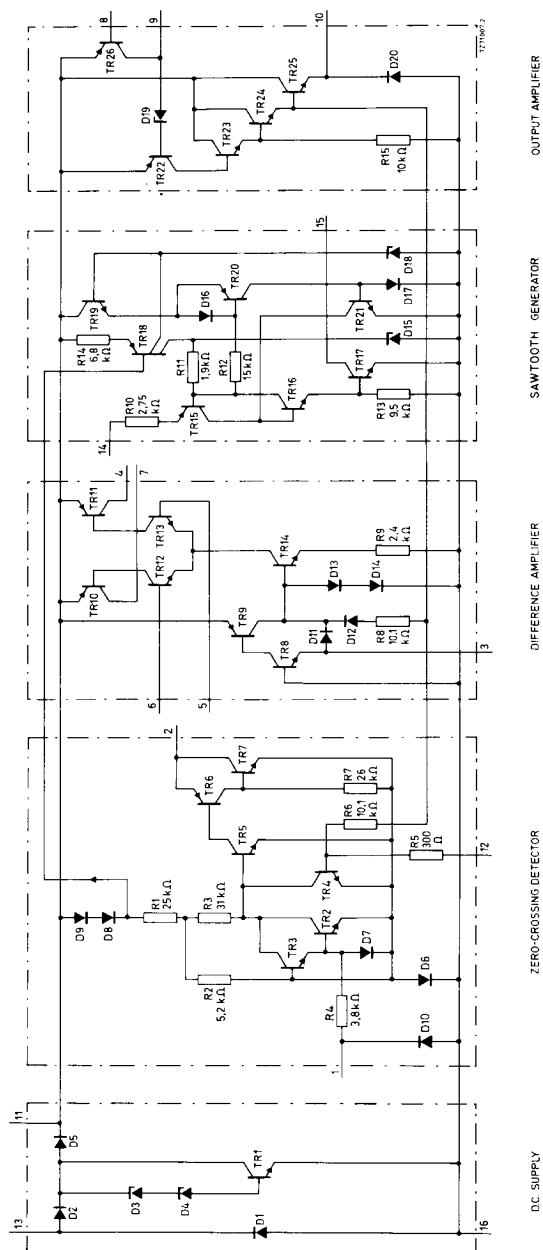


Fig. 1 Circuit diagram.

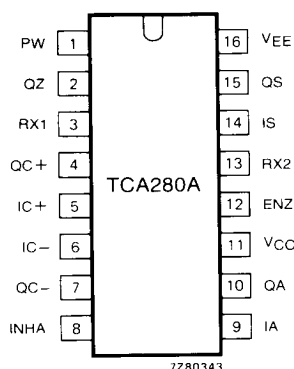


Fig. 2 Pinning diagram.

PINNING

1	PW	pulse width control input
2	QZ	zero-crossing detector output
3	RX1	external resistor
4	QC+	comparator non-inverting output
5	IC+	comparator non-inverting input
6	IC-	comparator inverting input
7	QC-	comparator inverting output
8	INHA	output stage inhibiting input
9	IA	output stage input
10	QA	output stage output
11	VCC	positive supply
12	ENZ	enable input, zero crossing detector
13	RX2	external resistor
14	IS	sawtooth generator trigger input
15	QS	sawtooth generator output
16	VEE	ground

FUNCTIONAL DESCRIPTION

The TCA280A contains four circuits that may be interconnected externally to perform the function required, and a supply part. The four circuits are a zero-crossing detector, a differential amplifier, a sawtooth generator and an output stage.

Supply: VCC and RX2 (pins 11 and 13)

The TCA280A may be supplied by an external d.c. power supply connected to VCC (pin 11), but usually it is supplied directly from the mains voltage. For this purpose the circuit contains a string of stabilizer diodes between VCC and VEE that limit the d.c. supply voltage. An external resistor R_d has to be connected from the mains to RX2; VEE is connected to the neutral line (see Figs 5 and 6). A smoothing capacitor C1 has to be connected between VCC and VEE. The circuit produces a positive supply voltage at VCC; this may be used to supply an external circuit such as a temperature sensing bridge.

During the positive half of the mains cycles the current through external voltage dropping resistor R_d charges the external smoothing capacitor C1 to the stabilizing voltage of the internal stabilizer diodes. R_d should be chosen such that it can supply the current for the TCA280A itself (see Fig. 4) plus any current taken up by an external (peripheral) circuit connected to VCC, and recharge the smoothing capacitor C1. 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 C1 supplies the circuit. Its capacitance must be high enough to maintain the supply voltage above the minimum specified limit. For values of R_d and C1 see Figs 5 and 6.

Dissipation in resistor R_d is halved by connecting a diode in series (see Figs 7 and 8). For phase control applications this arrangement should always be used.

A suitable VDR connected across the mains provides protection of the TCA280A and of the triac against mains-borne transients.

FUNCTIONAL DESCRIPTION (continued)**Zero-crossing detector**

The TCA280A contains a zero-crossing detector intended to produce pulses that coincide with the zero crossings of the mains voltage for minimum r.f. interference and transients on the mains supply.

The pulse width control input PW (pin 1) permits adjustment of the pulse width at output QZ (pin 2) to the value required for the triac by choosing the value of the external synchronization resistor R_S between PW and the a.c. mains. The pulse width is inversely proportional to the input current and to the mains frequency.

The zero-crossing detector is inhibited when the ENZ input (pin 12) is HIGH, and it is enabled when ENZ is LOW, e.g. connected to V_{EE} .

Output QZ is an n-p-n open-collector output requiring an external collector resistor to V_{CC} . QZ produces negative-going output pulses.

Comparator

IC+ and IC− (pins 5 and 6) are differential inputs of a comparator or difference amplifier, with QC+ and QC− (pins 4 and 7) as complementary outputs. QC+ and QC− are p-n-p open-collector outputs requiring external collector resistors to V_{EE} . QC+ will be HIGH and QC− will be LOW when IC+ is higher than IC−.

The comparator contains a long-tailed pair with a current source in its tail. The tail current is activated by a current into RX1 (pin 3). When an inductive load is driven with phase control the trigger pulse may be terminated at the instant of firing of the thyristor or triac. This may be achieved by connecting RX1 via a resistor to the anode of the thyristor or triac.

Sawtooth generator

The sawtooth generator may be used to produce bursts of trigger pulses, with the net effect that the load is periodically switched on and off.

The heart of the sawtooth generator is a thyristor arrangement. The firing burst repetition time is usually determined by an external resistor and capacitor connected to the sawtooth generator trigger input IS (pin 14). The repetition time is typ. $0.7 \times RC$.

The output QS (pin 15) is an n-p-n open-collector output. During the flyback of the sawtooth the transistor is ON and is capable of sinking current.

Output stage

The output stage is driven by a current drawn out of input IA (pin 9). This drive may be inhibited by drawing a current out of inhibiting input INHA (pin 8). Hence the output will be HIGH only if current is drawn out of IA and no current is drawn out of INHA i.e. if inhibiting input INHA (pin 8) is HIGH and input IA (pin 9) is LOW. Both inputs may be used as a single input provided the other one is suitably biased.

The output QA (pin 10) is an n-p-n open-emitter output capable of sourcing an output current, i.e. conventional current flow out of the circuit.

A gate resistor R_G should be connected between the output QA and the triac or thyristor gate to limit the output current to the minimum required by the triac or thyristor. This minimizes the total supply current and the power dissipation. Output QA is protected with a diode to V_{EE} (pin 16) against damage by undershoot of the output voltage, e.g. caused by an inductive load.

RATINGS

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

Supply voltage (voltage source)	V_{CC}	max.	17 V
Supply current (current source)			
average	$I_{RX2(AV)}$	max.	30 mA
repetitive peak	$I_{RX2(RM)}$	max.	80 mA
non-repetitive peak ($t < 10 \mu s$)	$I_{RX2(SM)}$	max.	2 A
Input voltage, all inputs	V_I	max.	17 V
Differential input voltage between IC+ and IC-	V_{ID}	max.	7 V
Input current, all inputs	I_I	max.	10 mA
Output current			
average	$-I_{QA(AV)}$	max.	30 mA
non-repetitive peak ($t < 300 \mu s$)	$-I_{QA(SM)}$	max.	600 mA
Total power dissipation	P_{tot}	see Fig. 3	
Storage temperature range	T_{stg}	-55 to +125 °C	
Operating ambient temperature range	T_{amb}	-20 to +80 °C	

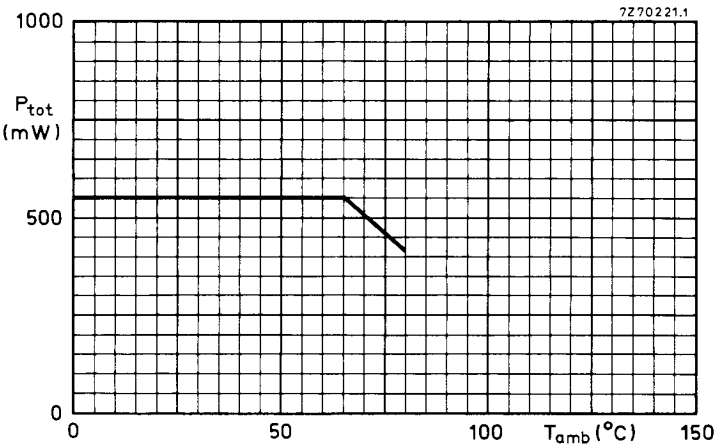


Fig. 3 Power derating curve.

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CHARACTERISTICS

$V_{CC} = 11$ to 17 V; $V_{EE} = 0$ V; $I_{RX1} = 10 \mu\text{A}$ or $-I_{RX1} = 30 \mu\text{A}$; $T_{amb} = 25^\circ\text{C}$ unless otherwise specified.

parameter	symbol	min.	typ.	max.	unit
Supply					
Supply voltage, external	V_{CC}	11	—	17	V
Supply voltage, internally generated, at $I_{RX2}(\text{RMS}) = 5 \text{ mA}$, unloaded	V_{CC}	11	14,3	15	V
Supply current, unloaded	I_{CC}	0,3	—	0,75	mA
Variation with supply voltage	$\Delta I_{CC}/\Delta V_{CC}$	—	—	0,03	mA/V
Pulse width control input PW (pin 1)					
Input voltage					
at $I_{PW} = 100 \mu\text{A}$	V_{PW}	—	—	1,9	V
at $-I_{PW} = 100 \mu\text{A}$	$-V_{PW}$	—	—	0,25	V
Input current at $I_{QZ} = 0,5 \text{ mA}$	$I_{PW}(\text{RMS})$	30	—	50	μA
Pulse width at $I_{PW}(\text{RMS}) = 1 \text{ mA}$; $f = 50 \text{ Hz}$ (at pin 2)	t_w	—	190	—	μs
Variation with supply voltage	$\Delta t/\Delta V$	—	27	—	$\mu\text{s/V}$
Zero crossing detector enable input ENZ (pin 12)					
Input voltage					
HIGH (inhibit)	V_{ENZH}	1,2	—	—	V
LOW (enable)	V_{ENZL}	—	—	0	V
Zero crossing detector output QZ (pin 2)					
Output current					
HIGH	I_{QZH}	—	—	1	μA
LOW	I_{QZL}	—	—	40	mA
Comparator input IC+ and IC— (pins 5 and 6)					
Differential input voltage	$\pm V_{ID}$	—	—	7	V
Input bias current					
at $V_{IC+} > V_{IC-} + 1 \text{ V}$	I_{IC+}	—	5	10	μA
at $V_{IC-} > V_{IC+} + 1 \text{ V}$	I_{IC-}	—	5	10	μA
Comparator outputs QC+ and QC— (pins 4 and 7)					
Output voltage at $-I_{OH} = 0,3 \text{ mA}$	V_{OH}	$V_{CC} - 1,5$	—	—	V
Output current					
HIGH	$-I_{OH}$	—	—	0,3	mA
LOW	$-I_{OL}$	—	—	90	nA

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CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
Sawtooth generator trigger input IS (pin 14)					
Input trigger voltage	V_{ISH}	7	—	8,3	V
Input trigger current	I_{ISH}	—	—	3	μA
Thyristor holding voltage	V_{ISL}	1,8	—	2,8	V
Thyristor holding current	I_{ISL}	95	—	210	μA
Sawtooth generator output QS (pin 15)					
Output current					
LOW	I_{QSL}	—	—	5	mA
HIGH	I_{QSH}	—	—	100	nA
Output stage inhibiting input INHA (pin 8)					
Input current at $-I_{IA} = 100 \mu A$	$-I_{INHA}$	20	—	50	μA
Input voltage at $-I_{IA} = 100 \mu A$	V_{INHA}	—	$V_{CC}-2$	—	V
Output stage input IA (pin 9)					
Input current at $-I_{QA} = 200 \text{ mA}$	$-I_{IA}$	15	—	—	μA
Input voltage at $-I_{IA} = 50 \mu A$	V_{IA}	$V_{CC}-8,3$	—	$V_{CC}-7$	V
Output stage output QA (pin 10)					
Output voltage HIGH at $-I_{QAH} = 200 \text{ mA}$; $V_{CC} = 13 \text{ V}$; INHA open	V_{QAH}	$V_{CC}-2,8$	—	—	V
Output current					
HIGH	$-I_{QAH}$	—	—	200	mA
LOW at $V_{QA} = 0$	I_{QAL}	—	—	1	μA

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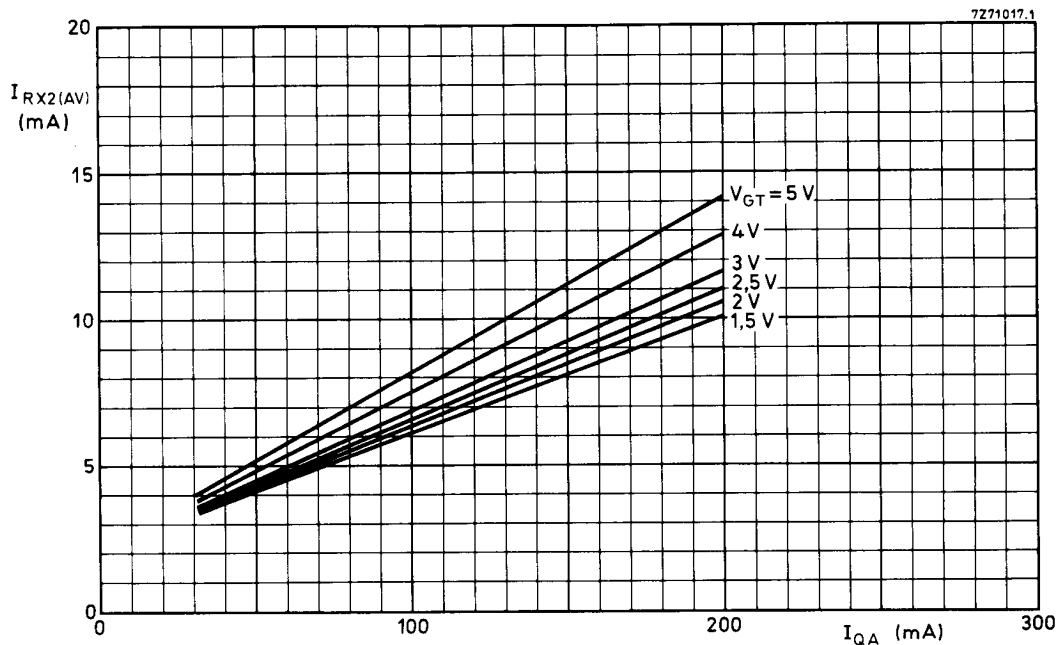


Fig. 4 Average supply current $I_{RX2(AV)}$ as a function of output current I_{QA} with triac gate trigger voltage V_{GT} as a parameter; typical performance.

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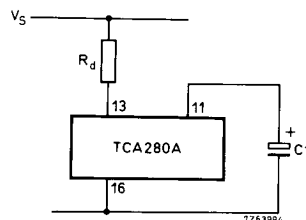
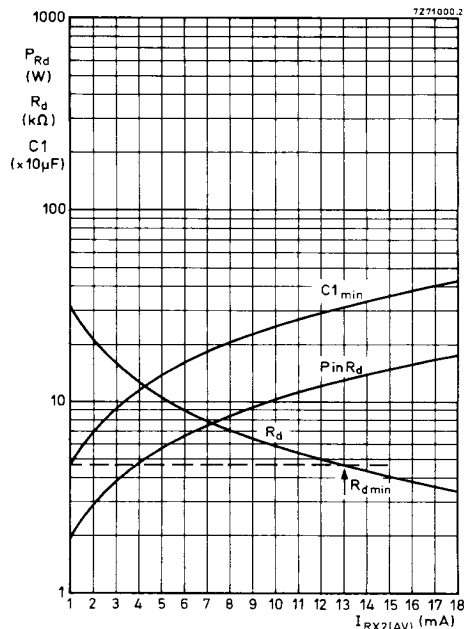


Fig. 5 Voltage dropping resistor R_d , dissipation P_{Rd} in this resistor, and recommended minimum value of smoothing capacitor $C1$ as a function of average supply current $I_{RX2(AV)}$, for the supply arrangement without series diode. Note that the supply current $I_{RX2(AV)}$ includes the supply current of any external (peripheral) circuit supplied from V_{CC} ; typical performance.

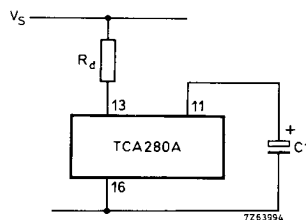
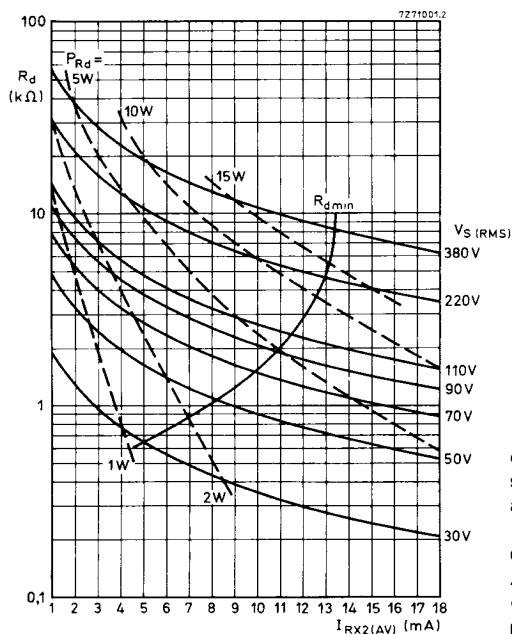


Fig. 6 Voltage dropping resistor R_d and power dissipation P_{Rd} in this resistor as a function of supply current $I_{RX2(AV)}$, for the supply arrangement without series diode. Note that $I_{RX2(AV)}$ includes the supply current of any external (peripheral) circuit supplied from V_{CC} . Also shown is the r.m.s. mains supply voltage ($V_S(RMS)$) as a function of $I_{RX2(AV)}$; typical performance.

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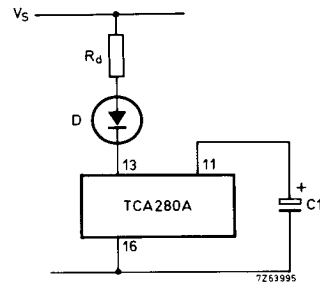
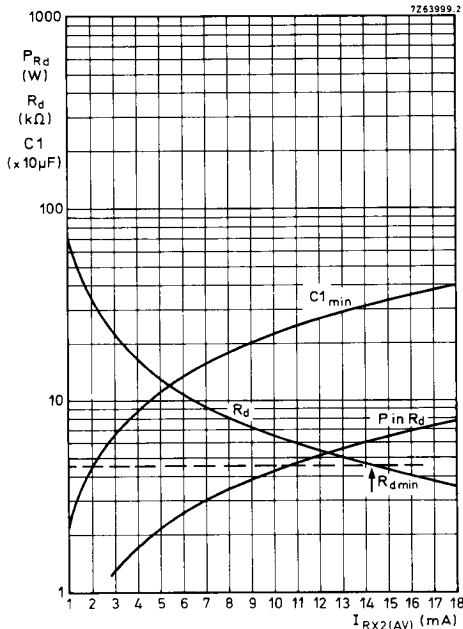


Fig. 7 Voltage dropping resistor R_d , dissipation P_{Rd} in this resistor, and recommended minimum value of smoothing capacitor $C1$ as a function of average supply current $I_{RX2(AV)}$, for the supply arrangement with series diode D . $I_{RX2(AV)}$ includes the supply current of any external (peripheral) circuit supplied from V_{CC} . It should be noted that certain applications like the time proportional controller require a value of the smoothing capacitor $C1$ that is up to three times higher; typical performance.

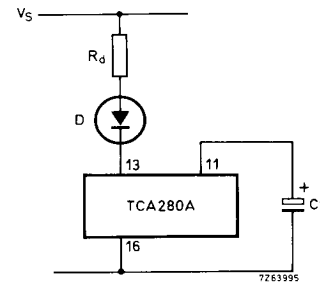
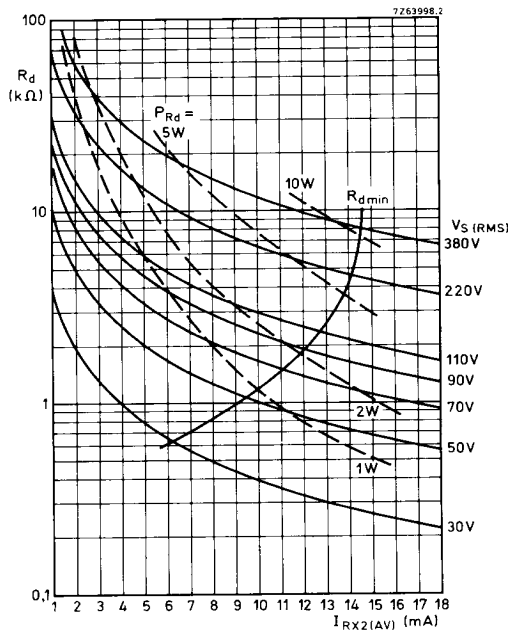


Fig. 8 Voltage dropping resistor R_d and power dissipation P_{Rd} in this resistor as a function of supply current $I_{RX2(AV)}$, for the supply arrangement with series diode. Note that $I_{RX2(AV)}$ includes the supply current of any external (peripheral) circuit supplied from V_{CC} . Also shown is the r.m.s. mains supply voltage (V_S (RMS)) as a function of $I_{RX2(AV)}$; typical performance.

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APPLICATION INFORMATION

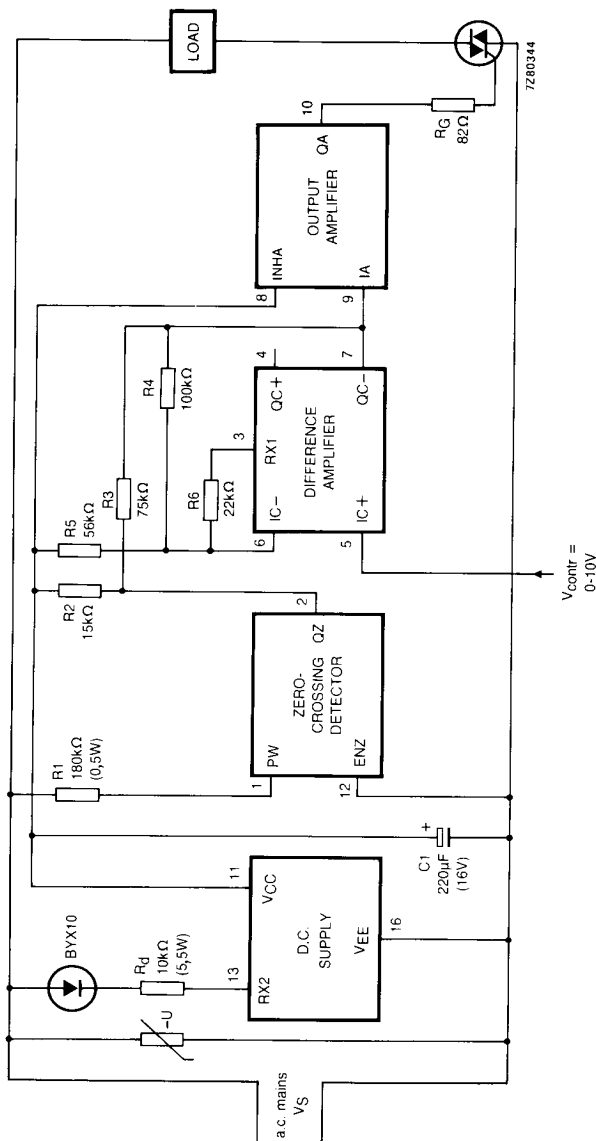


Fig. 9 Typical application of the TCA280A as a static switch for resistive loads. The arrangement gives triggering around the zero crossings of the mains voltage. The values shown for R_d , R_G and C_1 give a gate current $I_{GT} = 100$ mA typical at $V_{GT} = 2.5$ V and a trigger pulse duration $t_w = 160$ μ s typical.

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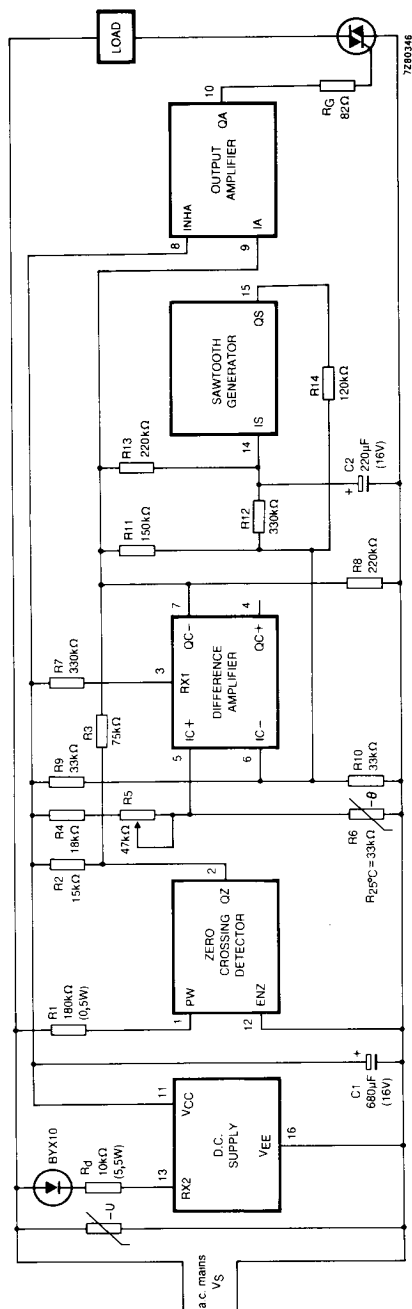


Fig. 10 Typical application of the TCA280A as a time proportional temperature controller. The arrangement gives triggering around the zero crossings of the mains voltage as long as the voltage produced by the temperature bridge connected to IC+ (pin 5) is higher than the voltage on IC- (pin 6). The voltage on IC- is a sawtooth superimposed on a d.c. reference voltage. The sawtooth has a repetition time of about 30 s; this can be determined by C2. The proportional band is determined by the amplitude of the sawtooth; this can be chosen by the value of R12. The values shown for R_d , R_G and C1 give a gate current $I_{GT} = 100$ mA typ. at $V_G = 2.5$ V and a trigger pulse duration $t_{wT} = 160$ μ s typ.

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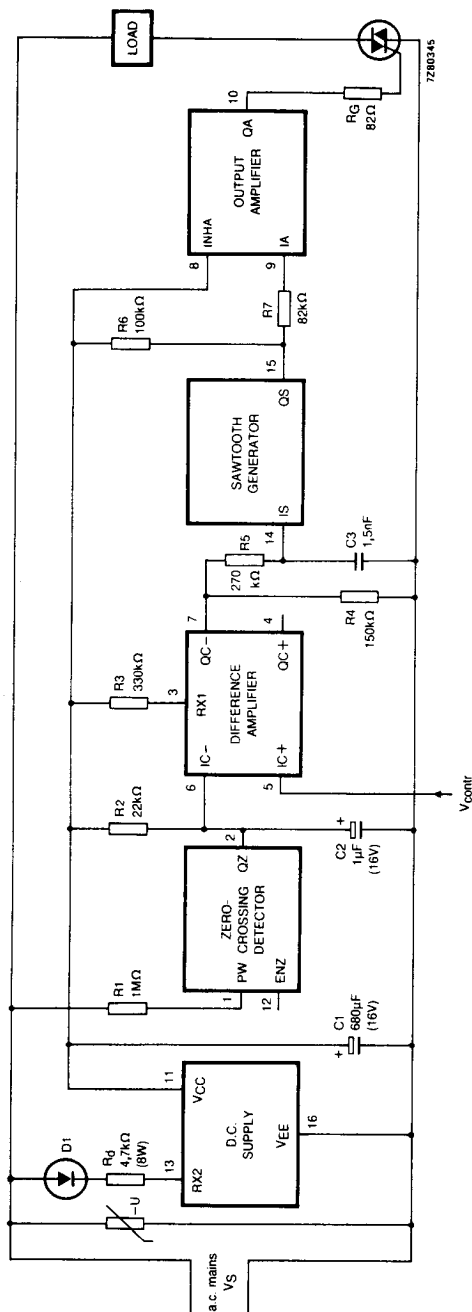


Fig. 11 Typical application of the TCA280A as a single-phase control circuit. The circuit produces bursts of trigger pulses at the gate of the triac or thyristor. The pulses coincide with the zero crossings of the mains voltage. The arrangement forms a full-wave a.c. controller when used with a triac, and a controlled half-wave rectifier when used with a thyristor.