General-purpose triggering circuit　　TCA280B

GENERAL DESCRIPTION

The TCA280B is a bipolar integrated circuit delivering positive pulses for triggering a triac or a thyristor. The flexibility of the circuit makes it suitable for a 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

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage (derived from mains voltage)	-	14	-	V
I_{CC}	supply current (average value)	-	1	-	mA
$-I_{QAH}$*	output current	-	-	200	mA
t_W	output pulse width	-	190	-	µs
P_{tot}	total power dissipation, unloaded	-	15	-	mW
T_{amb}	operating ambient temperature range	−20	-	+80	°C

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

ORDERING AND PACKAGE INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TCA280B	16	DIL	plastic	SOT38

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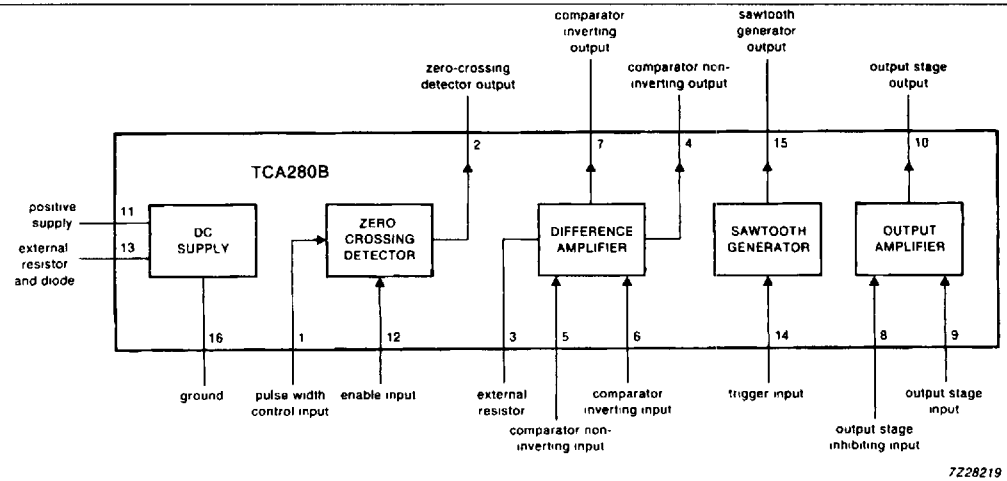


Fig.1 Block diagram.

PINNING

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

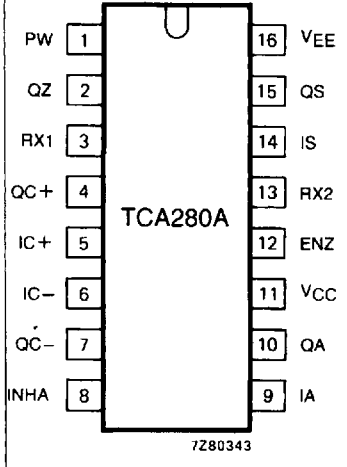


Fig.2 Pin configuration.

FUNCTION DESCRIPTION

The TCA280B contains four circuits, that may be interconnected to perform the functions required, and a supply section. The four circuits are a zero-crossing detector, a differential amplifier, a sawtooth generator and an output stage.

Supply: V_{CC} and RX2 (pins 11 and 13)

The TCA280B may be supplied by an external DC power supply connected to V_{CC} (pin 11), but can be supplied directly from the mains voltage. For this purpose the circuit contains a number of stabilizer diodes, and a transistor connected between V_{CC} and V_{EE}, that limit the DC supply voltage. An external resistor R_d and an external diode (mains voltage rated) has to be connected from the mains to R_{X2}; V_{EE} is connected to the neutral line (see Figs 5 and 6). A smoothing capacitor C1 has to be connected between V_{CC} and V_{EE}. The circuit produces a positive supply voltage at V_{CC}, this may be used to supply an external circuit such as a temperature sensing bridge.

An external diode in series with the resistor R_d must be included (see Figs 5 and 6). The maximum reverse current (10 μA) through pin 13 must not be exceeded or circuit operation cannot be guaranteed. Note that the diode also reduces the required power rating of resistor R_d by nearly 50%.

During the positive half of the mains cycle the current through the external voltage dropping resistor R_d charges the external smoothing capacitor C1 to the stabilizing voltage of the internal stabilizer diodes/transistor network. The value of R_d should be chosen such that it can supply the current for the TCA280B (see Fig.4) plus any current drawn by an external (peripheral) circuit connected to V_{CC} and recharge the smoothing capacitor C1. Any excess current is bypassed by the internal diode/transistor stabilizing network. The maximum rated current must not be exceeded.
During the negative half of the mains cycle the external smoothing capacitor 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.

A suitable VDR connected across the mains provides protection for the TCA280B and the triac against mains-borne transients.

Zero-crossing detector

The TCA280B contains a zero-crossing detector to produce pulses that coincide with the zero crossings of the mains voltage for minimum RF interference and transients on the mains supply.

The pulse width control input PW (pin 1) allows 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 AC 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 enabled when ENZ is LOW, e.g. connected to V_{EE}.

Output QZ, which produces negative-going output pulses, is an n-p-n open-collector output that requires an external resistor connected to V_{CC}.

Comparator

IC+ and IC– (pins 5 and 6) are differential inputs of a comparator or differential 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 thryristor 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 typical 0.7 x RC.

FUNCTIONAL DESCRIPTION

(continued)

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

Output stage

The output stage is driven by current drawn from input IA (pin 9). This drive may be inhibited by drawing current from inhibiting input INHA (pin 8). Hence the output will be HIGH only if current is drawn from IA and no current is from 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.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage (voltage source) supply current (current source)		-	17	V
$I_{RX2(AV)}$	average		-	17	mA
$I_{RX2(RM)}$	repetitive peak		-	80	mA
$I_{RX2(SM)}$	non-repetitive peak	$t < 10\,\mu s$	-	2	A
$I_{RX2(RV)}$	reverse		-	−10	μA
V_I	input voltage, all inputs		-	17	V
V_{ID}	differential input voltage between IC+ and IC−		-	7	V
I_I	input current, all inputs		-	10	mA
	output current				
$I_{QA(AV)}$	average		−30	-	mA
$I_{QA(SM)}$	non-repetitive peak	$t < 300\,\mu s$	−600	-	mA
P_{tot}	total power dissipation	see Fig.3			
T_{stg}	storage temperature range		−55	+125	°C
T_{amb}	operating ambient temperature range		−20	+80	°C

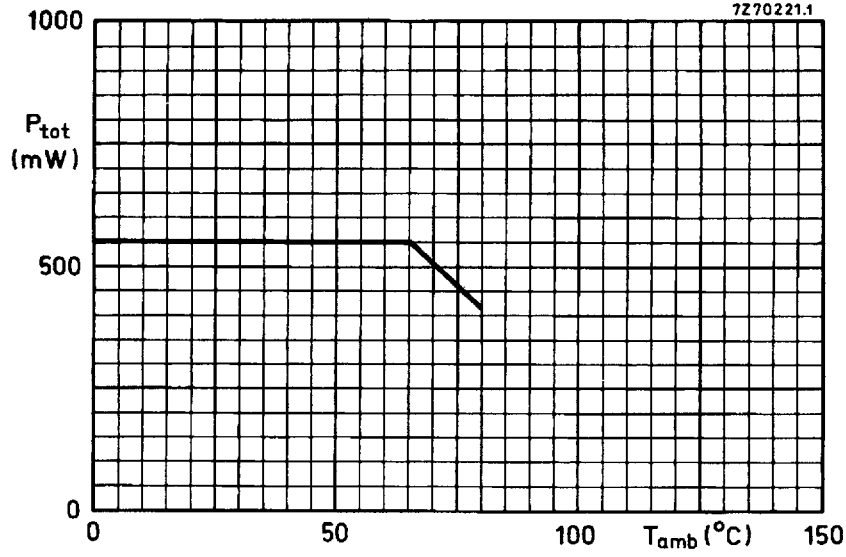


Fig.3 Power derating curve.

CHARACTERISTICS

V_{CC} = 11 to 17 V; V_{EE} = 0 V; I_{RX1} = 10 µA or I_{RX1} = −30 µA;
T_{amb} = 25 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{CC}	supply voltage, external		11	-	17	V
V_{CC}	supply voltage, internally generated	$I_{RX2(RMS)}$ = 5 mA, unloaded	11.0	14.3	15.0	V
I_{CC}	supply current, unloaded		0.3	-	0.75	mA
$\Delta I_{CC}/\Delta V_{CC}$	variation with supply voltage		-	-	0.03	mA/V
Pulse width control input PW (pin 1)						
V_{PW}	input voltage	I_{PW} = 100 µA	-	-	1.9	V
V_{PW}		I_{PW} = −100 µA	−0.25	-	-	V
$I_{PW(RMS)}$	input current(RMS value)	I_{QZ} = 0.5 mA	30	-	50	µA
t_w	pulse width	$I_{PW(RMS)}$ f = 50 Hz (at pin 2)	-	190	-	µs
$\Delta t/\Delta V$	variation with supply voltage		-	27	-	µs/V
Zero crossing detector enable input ENZ (pin 12)						
V_{ENZH}	input voltage HIGH	inhibit	1.2	-	-	V
V_{ENZL}	input voltage LOW	enable	-	-	0	V

CHARACTERISTICS (continued)

Zero crossing detector output QZ (pin 2)						
I_{QZH}	output current HIGH		–1	-	-	µA
I_{QZL}	output current LOW		-	-	–40	mA
Comparator input IC+ and IC– (pins 5 and 6)						
$\pm V_{ID}$	differential input voltage		-	-	7	V
I_{IC+}	input bias current	$V_{IC+} > V_{IC-} + 1$ V	-	5	10	µA
I_{IC-}		$V_{IC-} > V_{IC+} + 1$ V	-	5	10	µA
Comparator outputs QC+ and QC– (pins 4 and 7)						
V_{OH}	output voltage	$I_{OH} = -0.3$ mA	$V_{CC}-1.5$	-	-	V
I_{OH}	output current HIGH		-	-	–0.3	mA
I_{OL}	output current LOW		–90	-	-	nA
Sawtooth generator trigger input IS (pin 14)						
V_{ISH}	input trigger voltage		7.0	-	8.3	V
I_{ISH}	input trigger current		-	-	3	µA
V_{ISL}	thyristor holding voltage		1.8	-	2.8	V
I_{ISL}	thyristor holding current		95	-	210	µA
Sawtooth generator output QS (pin 15)						
I_{QSL}	output current LOW		-	-	–5	mA
I_{QSH}	output current HIGH		–100	-	-	nA
Output stage inhibiting input INHA (pin 8)						
I_{INHA}	input current	$I_{IA} = -100$ µA	–50	-	–20	µA
V_{INHA}	input voltage	$I_{IA} = -100$ µA	-	$V_{CC}-2$	-	V
Output stage input IA (pin 9)						
I_{IA}	input current	$I_{QA} = -200$ mA	-	-	15	µA
V_{IA}	input voltage	$I_{IA} = -50$ µA	$V_{CC}-8.3$	-	$V_{CC}-7$	V
Output stage output (pin 10)						
V_{QAH}	output voltage HIGH	$I_{QAH} = -200$ MA $V_{CC} = 13$ V INHA open-circuit	$V_{CC}-2.8$	-	-	V
I_{QAH}	output current HIGH		–200	-	-	mA
I_{QAL}	output current LOW		-	-	1	µA

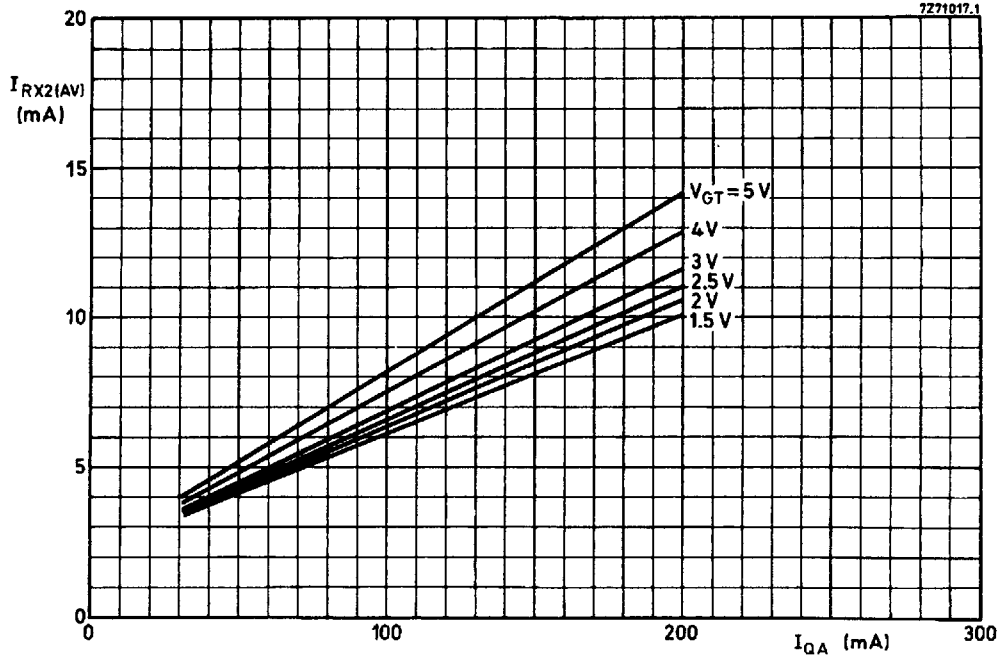
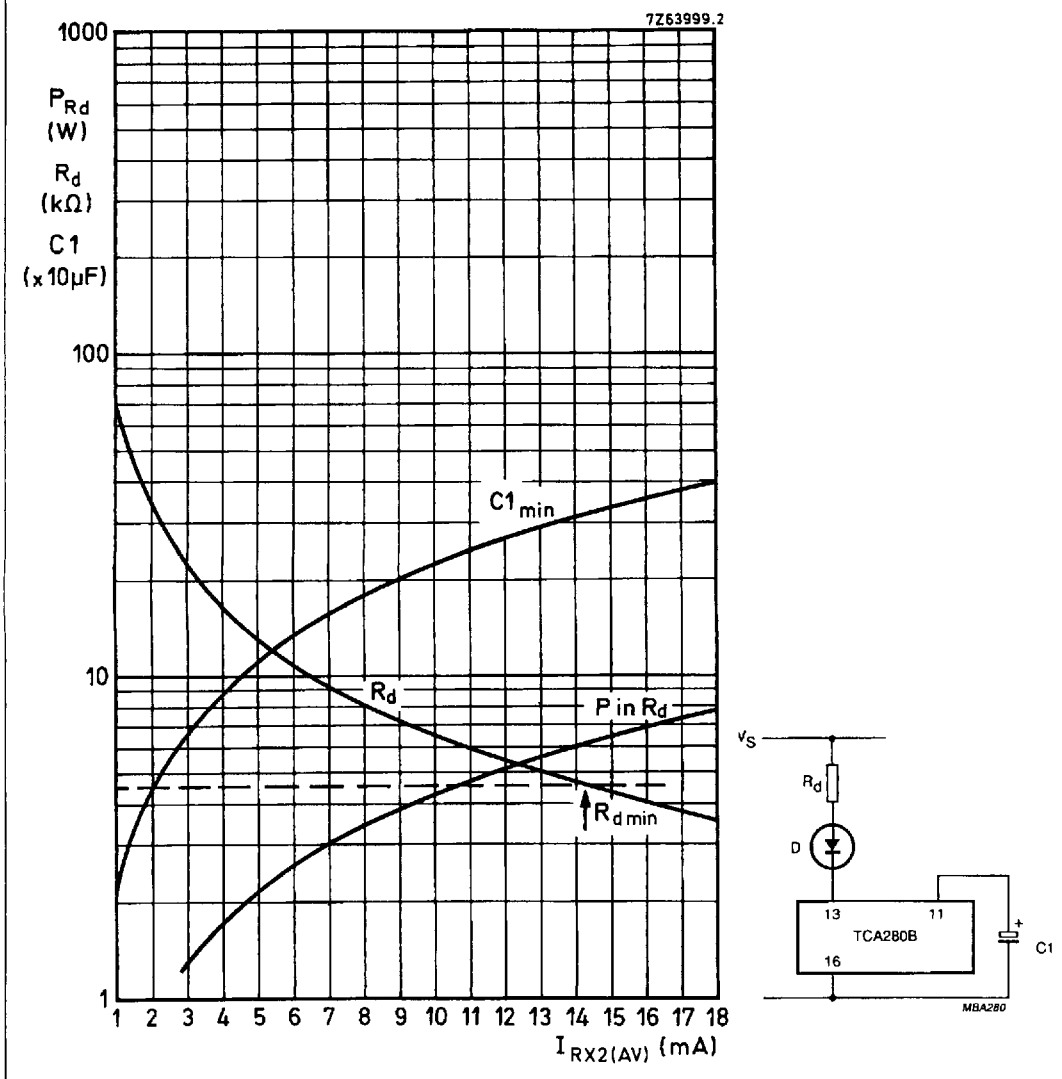
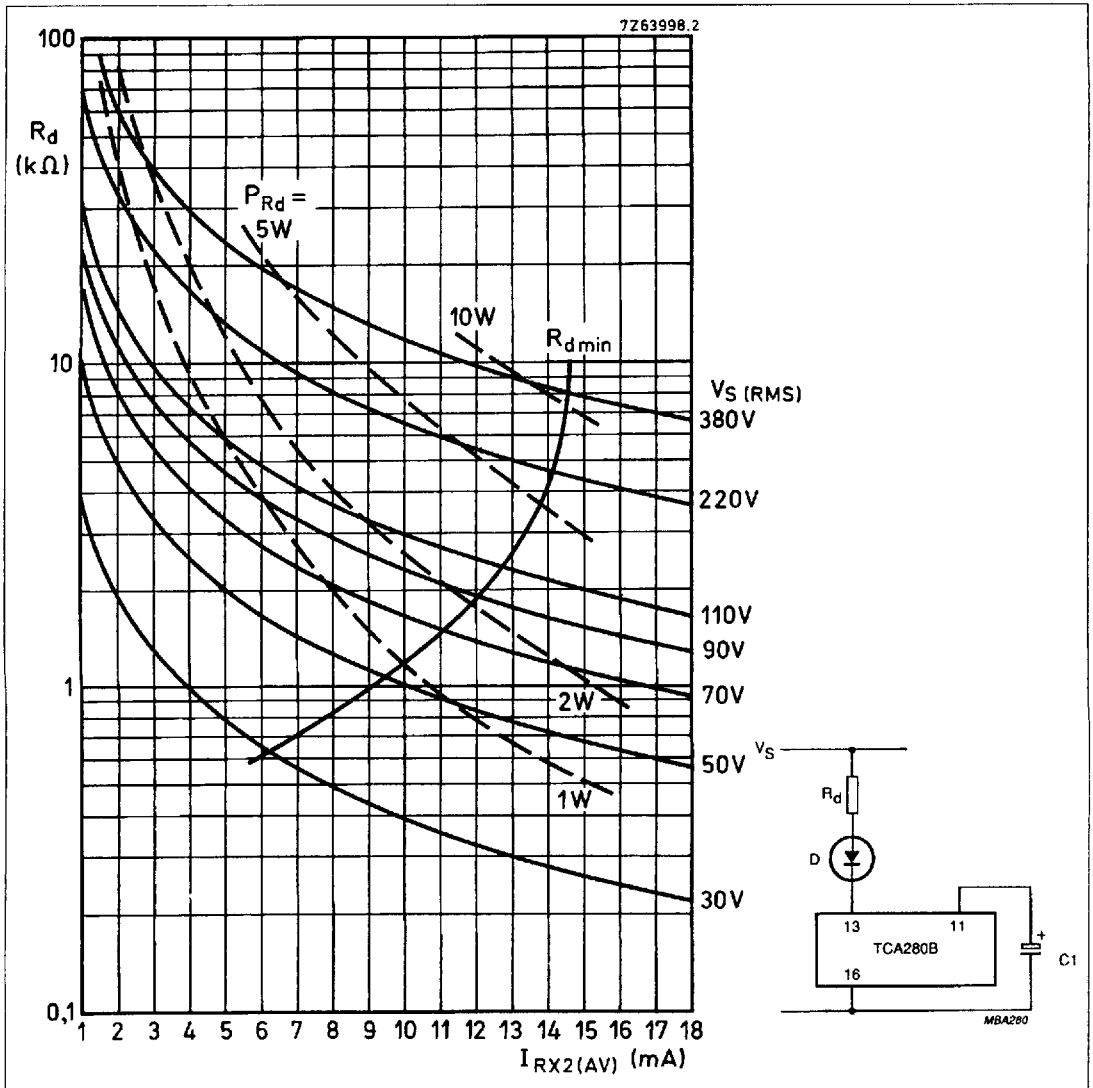


Fig.4 Average supply current $I_{RX2(AV)}$ as a function of output current I_{QA} with triac gate trigger voltage V_{GT} as a parameter; typical performance.



Note: In certain applications the time proportional controller requires a value of smoothing capacitor (C1) three times higher; typical performance.

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 with series diode D. $I_{RX2(AV)}$ includes the supply of any external (peripheral) circuit supplied from V_{CC}.



Note: $I_{RX2(AV)}$ includes the supply current of any external (peripheral) circuit supplied from V_{CC}.

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 with series diode. Also shown is the RMS mains supply voltage ($V_{S(RMS)}$) as a function of $I_{RX2(AV)}$; typical performance.

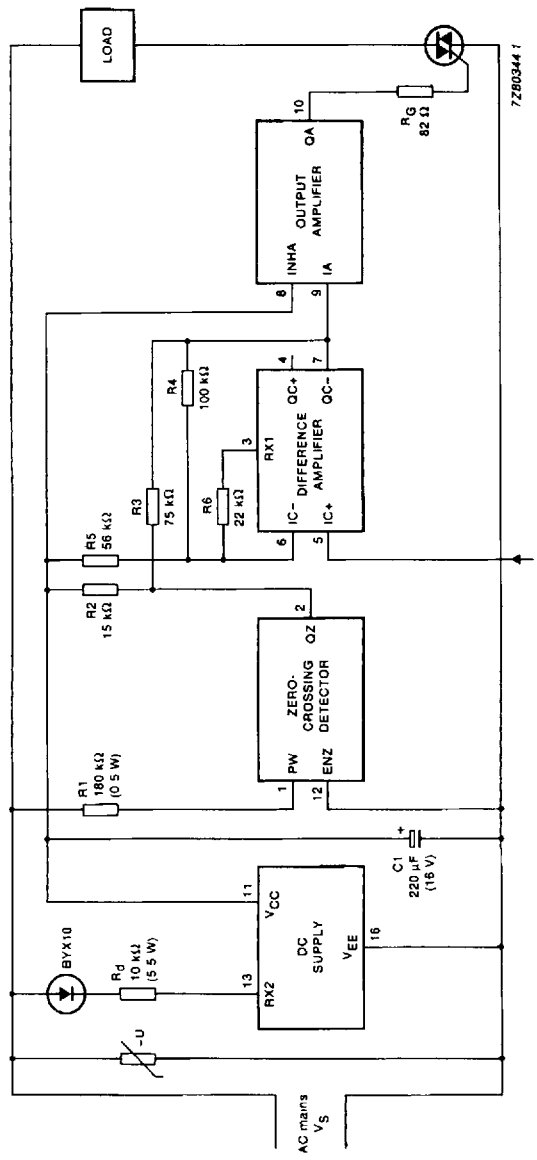


Fig.7 Typical application of the TCA280B as a static switch for resistive loads. The arrangement gives triggering around the zero crossings of the mains voltage. The values shown for R_d, R_G and C1 give a gate current I_{GT} = 100 mA typical at V_{GT} = 2.5 V and a trigger pulse duration t_w = 160 µs typical.

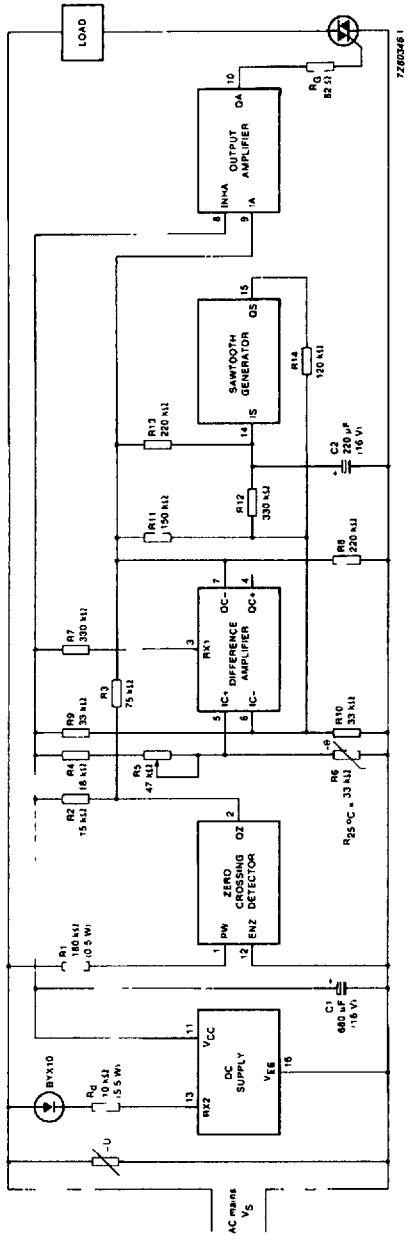


Fig.8 Typical application of the TCA280B as a time proportional temperature controller. The arrangement gives triggering around the zero crossings of the mains voltage as long as the voltage produced by the temperature bridge connected to IC+ (pin 5) is higher than the voltage on IC− (pin 6). The voltage on IC− is a sawtooth superimposed on a DC reference voltage. The sawtooth has a repetition time of approximately 30 s; this time is 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_W = 160 µs typ.

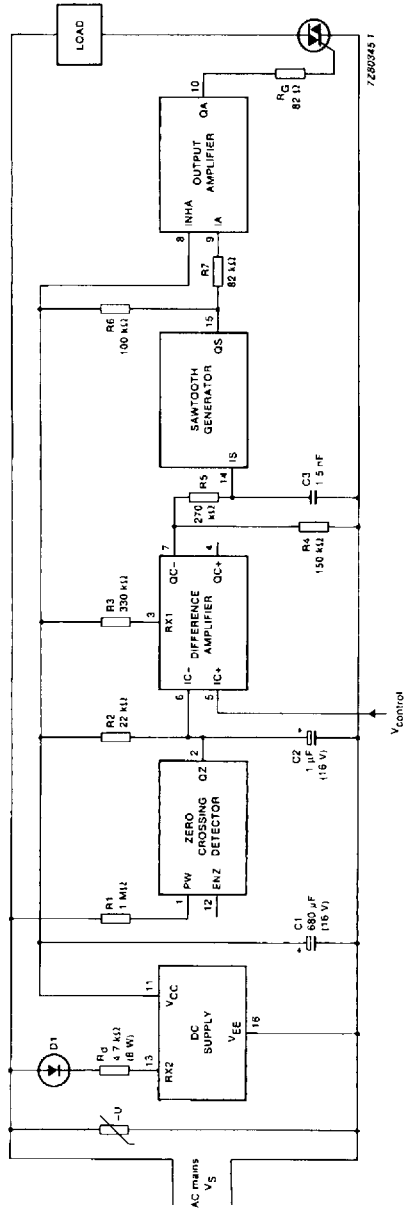


Fig.9 Typical application of the TCA280B as a single-phase control circuit. The circuit produces bursts of trigger pulses at the gate of the triac of thyristor. The pulses coincide with the zero crossings of the mains voltage. The arrangement forms a full-wave AC controller when used with a triac, and a controlled half-wave rectifier when used with a thyristor.