

### Zero Voltage Switch / Temperature Control for General Applications

**Technology:** Bipolar

#### Features

- Direct supply from the mains
- Current consumption  $\leq 0.5$  mA
- Very few external components
- Full wave drive – no d.c. current component in the load circuit
- Negative output current pulse typ. 100 mA – short circuit protected
- Simple power control
- Ramp generator
- Reference voltage

**Case:** DIP 8, SO 8

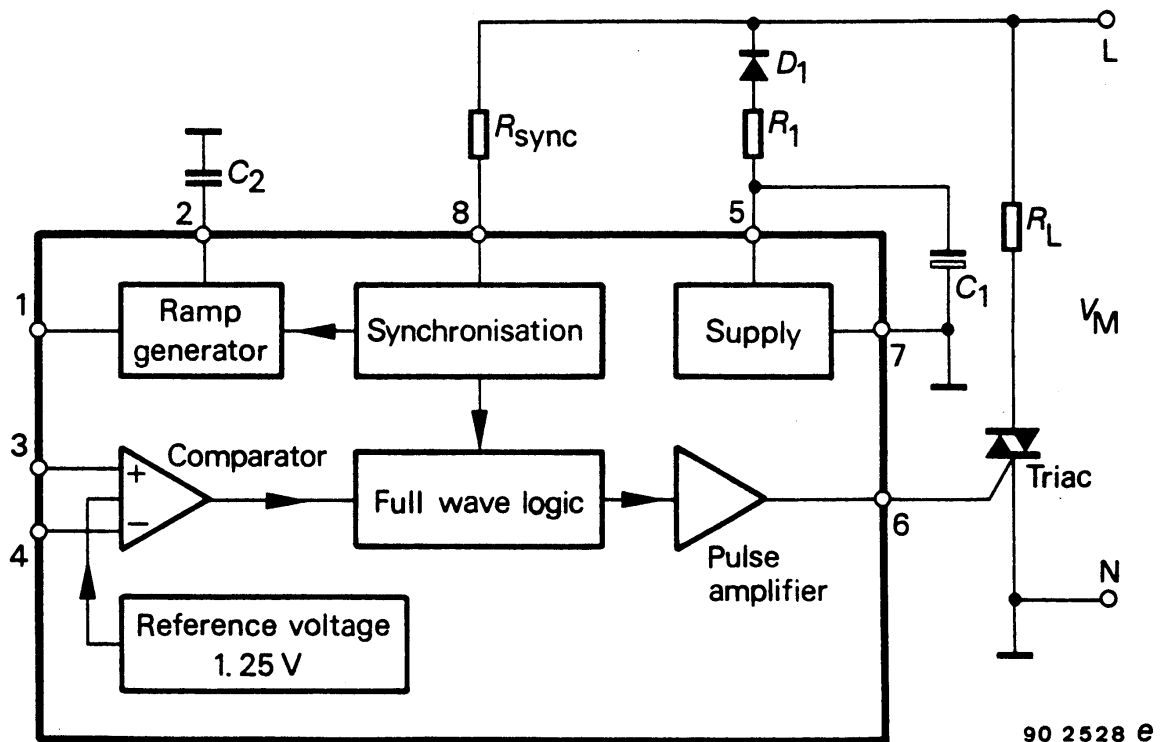


Figure 1 Block diagram and pin connections

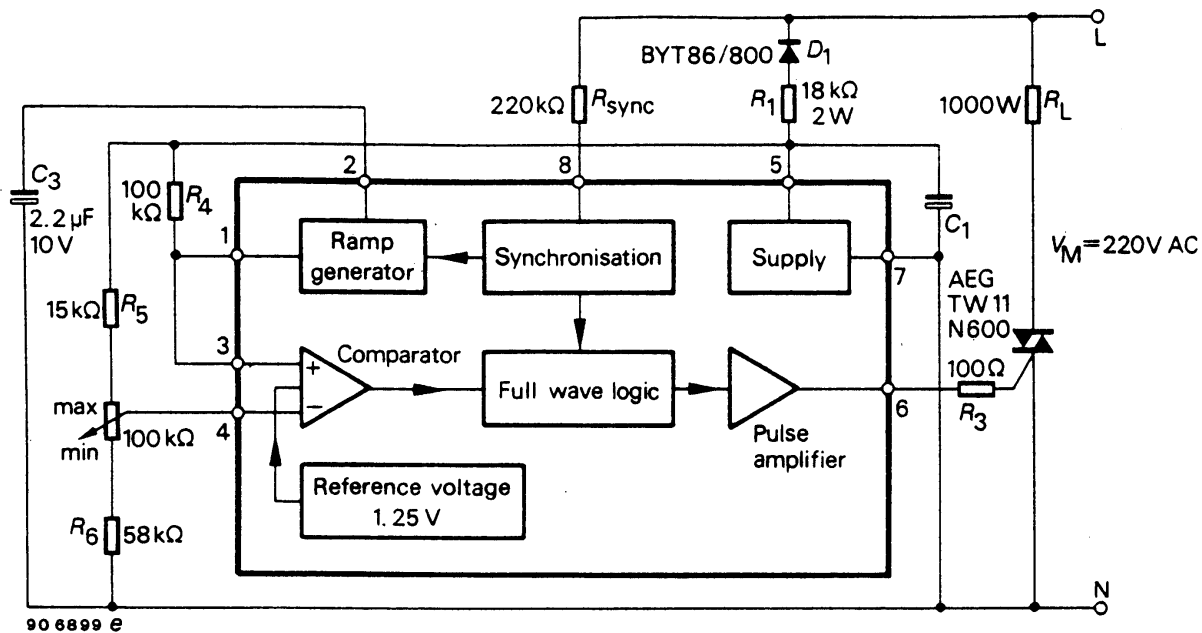


Figure 2 Typical circuit — Period group control 0 ... 100 %

## General Description

Integrated circuit, U 217 B, is a triac controller for zero crossing mode. It is meant to control power in switching resistive loads of mains supply.

Informations regarding supply sync. is provided at Pin 8 via resistor  $R_{Sync}$ .

To avoid d.c. load on the mains, full wave logic guarantee that complete mains cycles are used for load switching.

Fire pulse is released, when the inverted input of the comparator is negative (Pin 4) with respect to the non-inverted input (Pin 3) and internal reference voltage.

A ramp generator with free selectable duration is possible with capacitor  $C_2$  at Pin 2, which provides not only symmetrical pulse burst control (Figure 3) but also control with superimposed proportional band (Figure 10). Ramp voltage available at capacitor  $C_2$  is decoupled across emitter follower at Pin 1. To maintain the lamp flicker specification, ramp duration is adjusted according to the controlling load. In practice interference should be avoided

(temperature control), therefore in such cases a two point control is preferred to proportional control. One can use internal reference voltage for simple applications, in that case Pin 3 is inactive and connected to Pin 7 (GND), Figure 9.

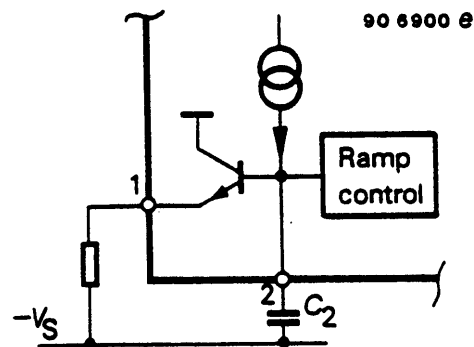


Figure 3 Pin 1 internal network

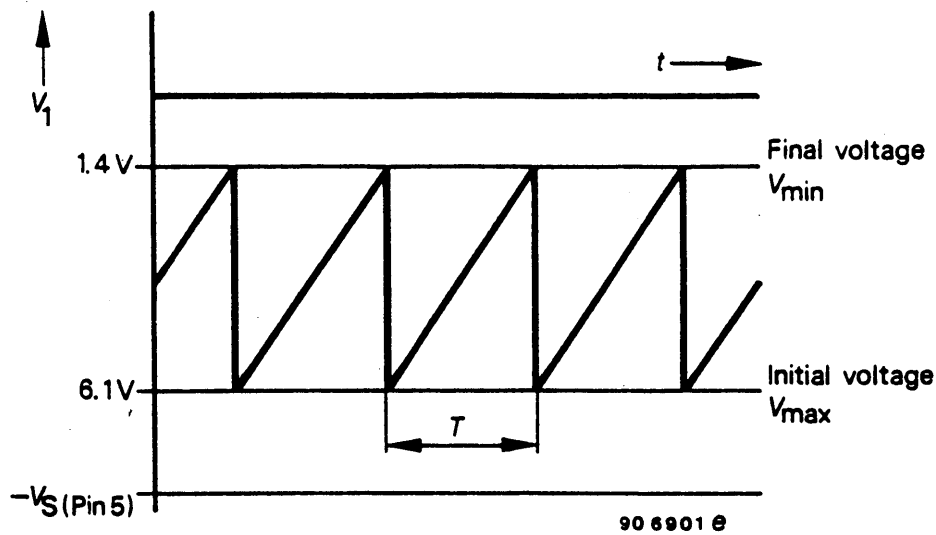


Figure 4

### Firing Pulse Width $t_p$ , Figure 5

It depends on the latching current of the triac and its load current. Firing pulse width is determined by the zero crossing identification which can be influenced with the help of sync. resistance ( $R_{sync}$ ), (Figure 6).

$$t_p = \frac{2}{\omega} \arcsin \left( \frac{I_L \times V_M}{P \sqrt{2}} \right)$$

whereas

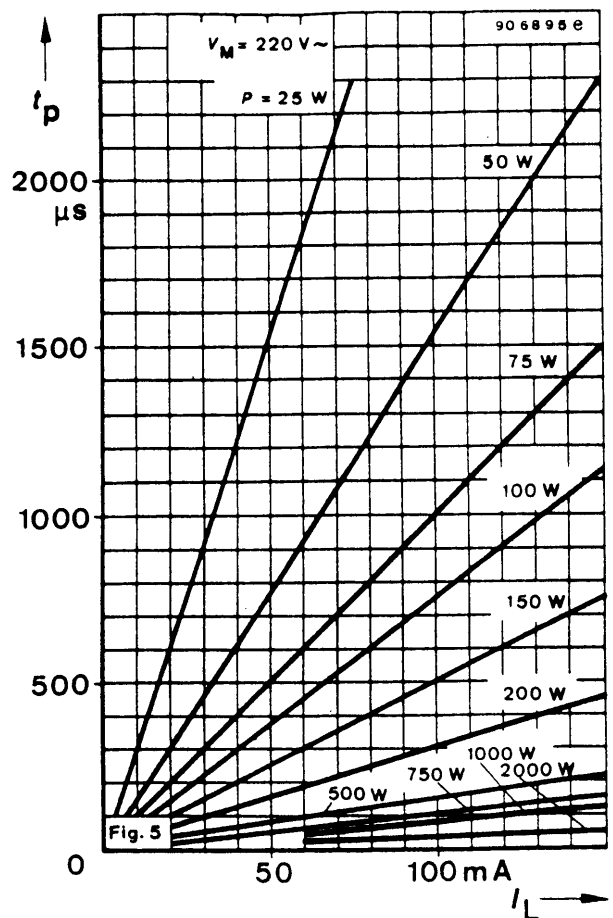
$I_L$  = Latching current of the triac

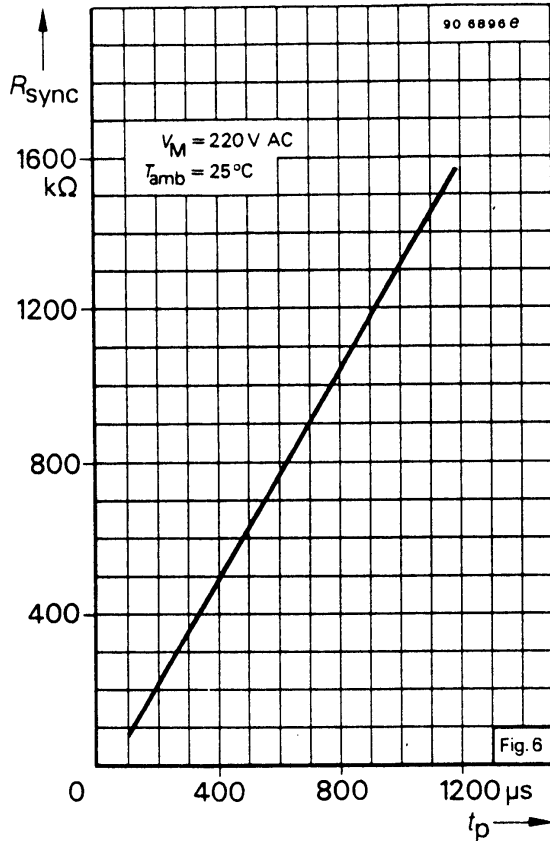
$V_M$  = Mains supply, effective

$P$  = Power load (user's power)

Total current consumption is influenced by firing pulse width, which can be calculated as follows:

$$R_{sync} = \frac{V_M \sqrt{2} \sin \left( \omega \times \frac{t_p}{2} \right) - 0.6 \text{ V}}{3.5 \times 10^{-5} \text{ A}} - 49 \text{ k}\Omega$$





### Triac Firing Current (Pulse)

It depends on the triac requirement. It can be limited with gate series resistance, which is calculated as follows:

$$R_{Gmax} \approx \frac{7.5 \text{ V} - V_{Gmax}}{I_{Gmax}} - 36 \Omega;$$

$$I_p = \frac{I_{Gmax}}{T} \times t_p$$

whereas:  $V_G$  = Gate voltage  
 $I_{Gmax}$  = Max. gate current  
 $I_p$  = Average gate current  
 $t_p$  = Max. gate current  
 $T$  = Mains period duration

### Supply Voltage

The integrated circuit U 217 B which also contains internal voltage limiting, can be connected via diode (D1) and resistor (R1) with the mains supply. An internal climb circuit limits the voltage between Pin 5 and 7 to a typical value of 9.25 V.

Series resistance  $R_1$  can be calculated (Figures 7 and 8) as follows:

$$R_{1max} = 0.85 \frac{V_{min} - V_{Smax}}{2 I_{tot}} ; P_{(R1)} = \frac{(V_M - V_S)^2}{2 R_1}$$

$I_{tot} = I_S + I_p + I_x$  whereas

$V_M$  = Mains voltage

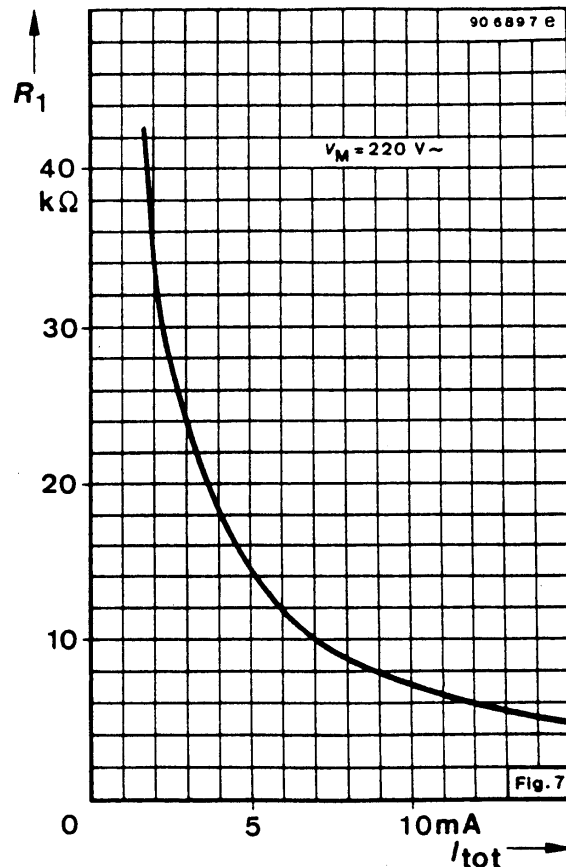
$V_S$  = Limiting voltage of the IC

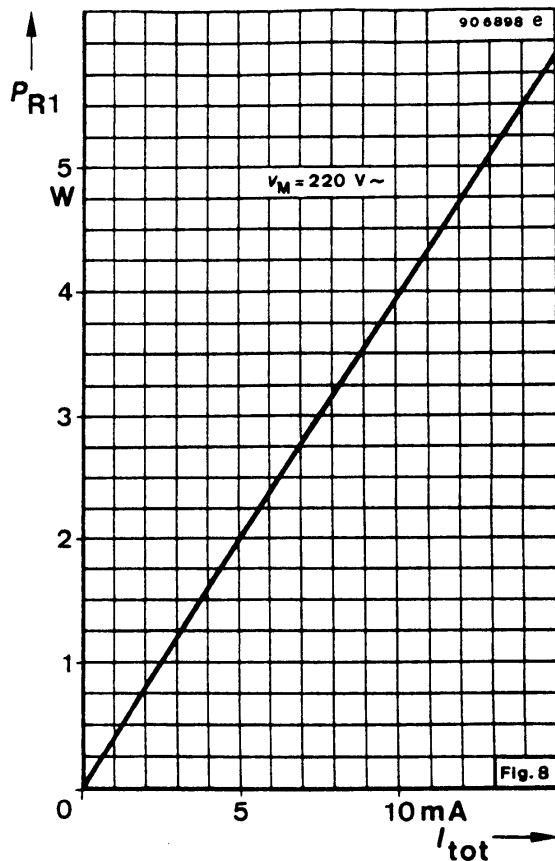
$I_{tot}$  = Total current consumption

$I_S$  = Current requirement of the IC (without load)

$I$  = Current requirement of other peripheral components

$P_{(R1)}$  = Power dissipation at  $R_1$





### Absolute Maximum Ratings

Reference point Pin 7

Parameters	Symbol	Value	Unit
Supply current Pin 5	$-I_S$	30	mA
Sync. current Pin 8	$I_{Sync.}$	5	mA
Output current ramp generator Pin 1	$I_O$	3	mA
Input voltages Pin 1, 3, 4, 6 Pin 2 Pin 8	$-V_I$	$\leq V_S$	V
	$_V_I$	$2 \dots V_S$	V
	$\pm V_I$	$\leq 7.3$	V
Power dissipation			
$T_{amb} = 45^\circ C$	$P_{tot}$	400	mW
$T_{amb} = 100^\circ C$	$P_{tot}$	125	mW
Junction temperature	$T_j$	125	$^\circ C$
Operating-ambient temperature range	$T_{amb}$	0 ... 100	$^\circ C$
Storage temperature range	$T_{stg}$	-40 ... + 125	$^\circ C$

### Thermal Resistance

Parameters	Symbol	Maximum	Unit
Junction ambient	$R_{thJA}$	200	K/W

### Electrical Characteristics

$-V_S = 8\text{ V}$ ,  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ , reference point Pin 7, unless otherwise specified

Parameters	Test Conditions / Pin	Symbol	Min	Typ	Max	Unit
Supply voltage limitation	$-I_S = 5\text{ mA}$ Pin 5	$-V_S$	8.6	9.25	9.9	V
Supply current	Pin 5	$-I_S$			500	$\mu\text{A}$
Voltage limitation	$I_8 = \pm 1\text{ mA}$ Pin 8	$\pm V_I$	7.5		8.7	V
Synchronous current	Pin 8	$\pm I_{\text{Sync}}$	0.12			mA
Zero detector		$\pm I_{\text{Sync}}$		35		$\mu\text{A}$
Output pulse width	$V_M = 220\text{ V}$ , $R_{\text{Sync}} = 220\text{ k}\Omega$ $R_{\text{Sync}} = 470\text{ k}\Omega$	$t_p$ $t_p$		260 460		$\mu\text{s}$ $\mu\text{s}$
Output pulse current	$V_6 = 0\text{ V}$ Pin 6	$-I_O$	100			mA
<b>Comparator</b>						
Input offset voltage	Pin 3,4	$V_{IO}$		5	15	mV
Input bias current	Pin 4	$I_{IB}$			1	$\mu\text{A}$
Common mode input range	Pin 3,4	$-V_{IC}$	1		$(V_{S-1})$	V
Threshold internal reference	$V_3 = 0\text{ V}$ Pin 4	$-V_T$		1.25		V
<b>Ramp generator</b> , reference point Pin 5 ( $-V_S$ ) Period, Figure 13	$-I_S = 1\text{ mA}$ , $I_{\text{Sync}} = 1\text{ mA}$ , $C_1 = 100\text{ }\mu\text{F}$ , $C_2 = 1\text{ }\mu\text{F}$ , $R_4 = 120\text{ k}\Omega$ Pin 1	T		0.78		s
Initial voltage	Pin 1	$V_1$	0.9	1.40	1.80	V
Final voltage	Pin 1	$V_1$	5.7	6.1	6.70	V
Charge current	$V_2 = 0\text{ V}$ , $I_8 = -1\text{ mA}$ Pin 2	$-I_2$		17	20	$\mu\text{A}$

### Applications

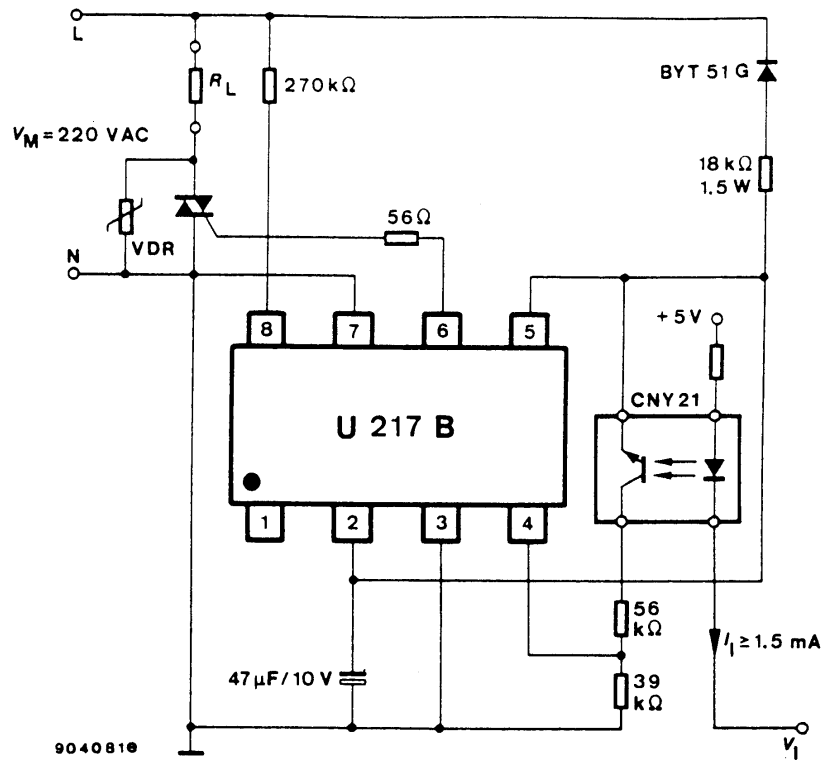


Figure 9 Power switch

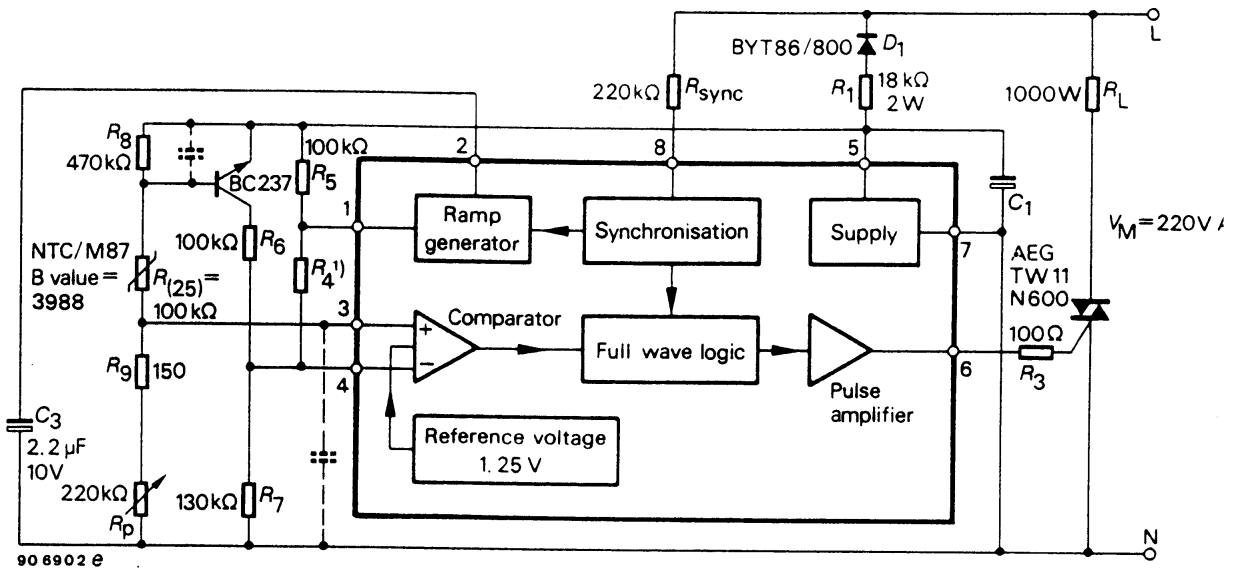


Figure 10 Temperature control 15 °C ... 35 °C with sensor monitoring  
NTC-Sensor M 87 Fabr. Siemens

$$R_{(25)} = 100 \text{ k}\Omega / \text{B} = 3988 \Rightarrow \begin{matrix} R_{(15)} = 159 \text{ k}\Omega \\ R_{(35)} = 64.5 \text{ k}\Omega \end{matrix} \quad R_4^{1)} \text{ determines the proportional range}$$

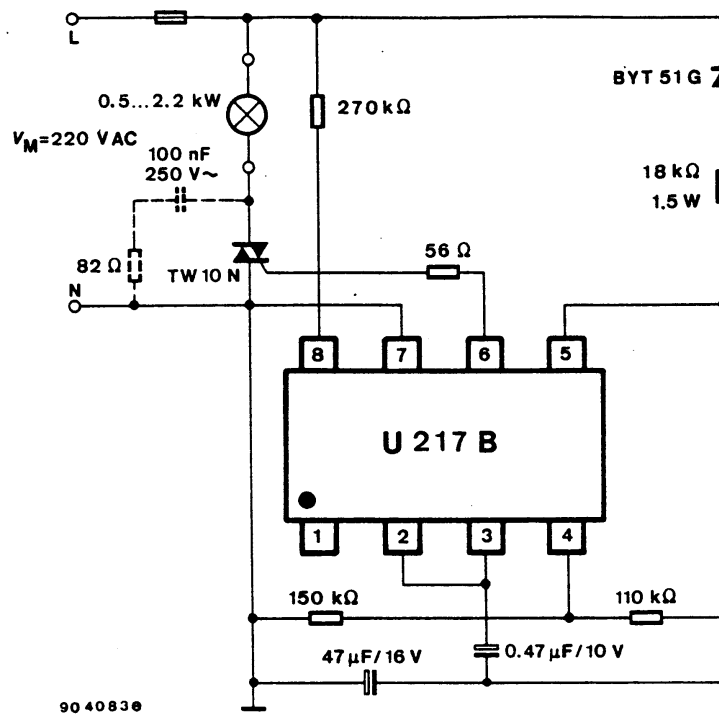


Figure 11 Power blinking switch with  $f \approx 2.7$  Hz, duty cycle 1:1, power range 0.5 ... 2.2 kW

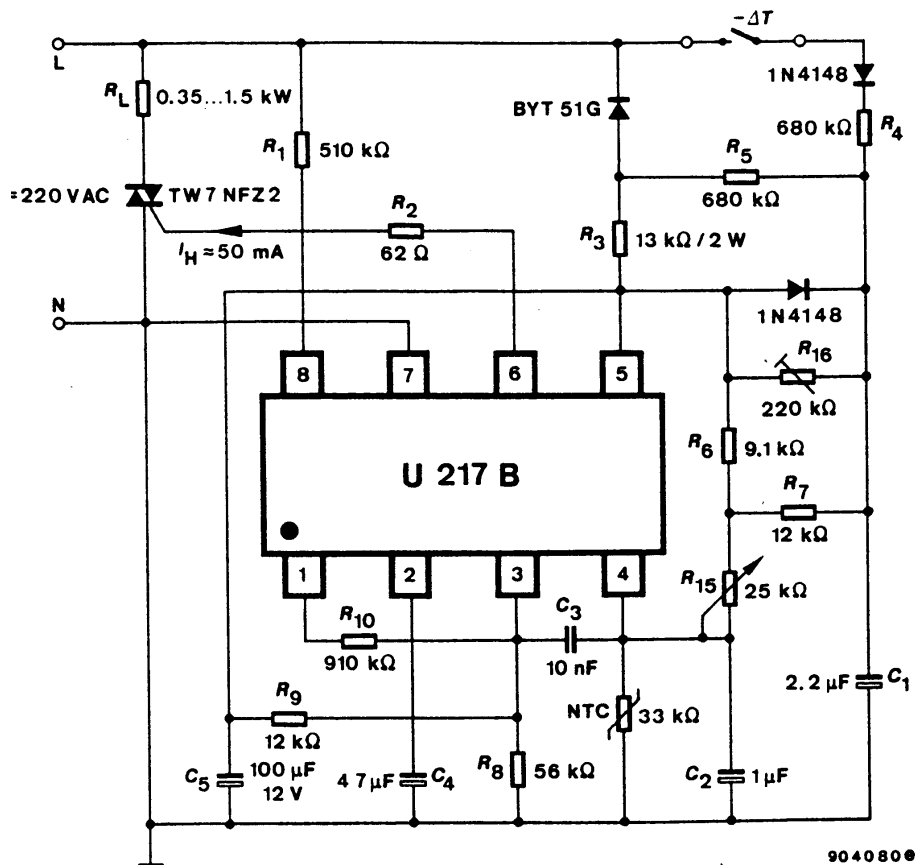


Figure 12 Room temperature control with definite reduction (remote control) for a temperature range 5 ... 30 °C



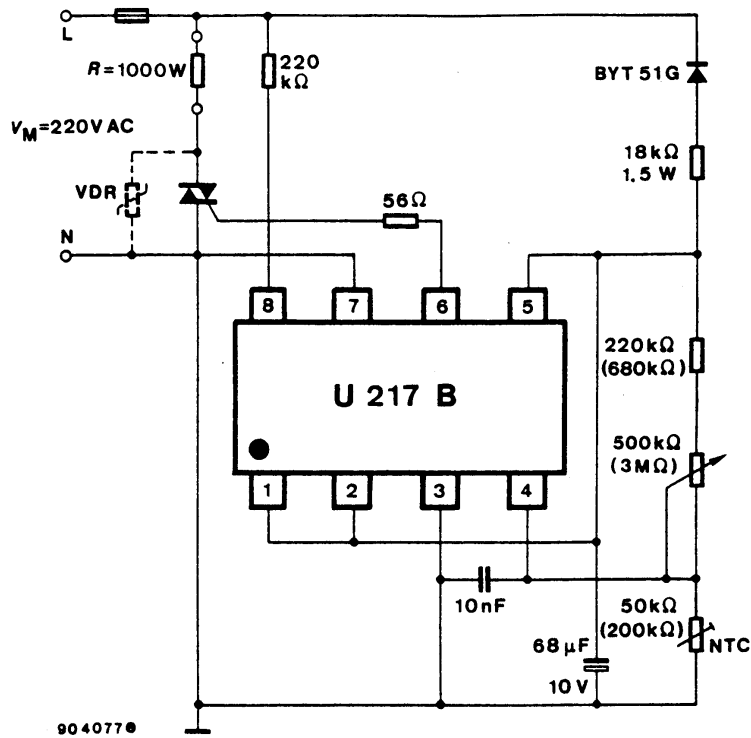


Figure 13 Two-point temperature control for a temperature range 15 ... 30 °C

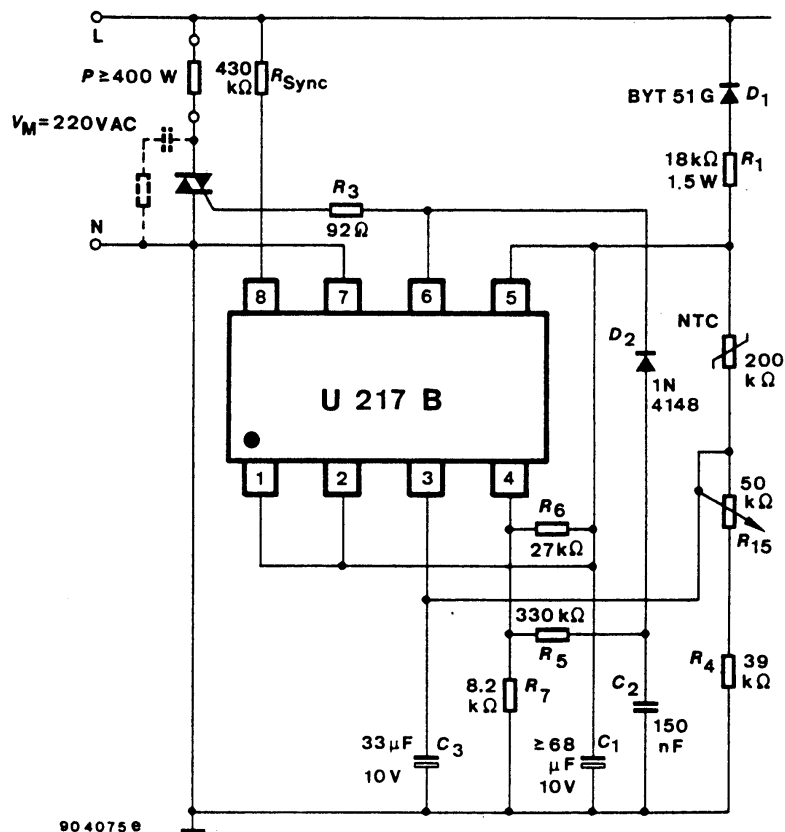


Figure 14 Two-point temperature control for a temperature range 18 ... 32 °C and hysteresis of ± 0.5 °C at 25 °C

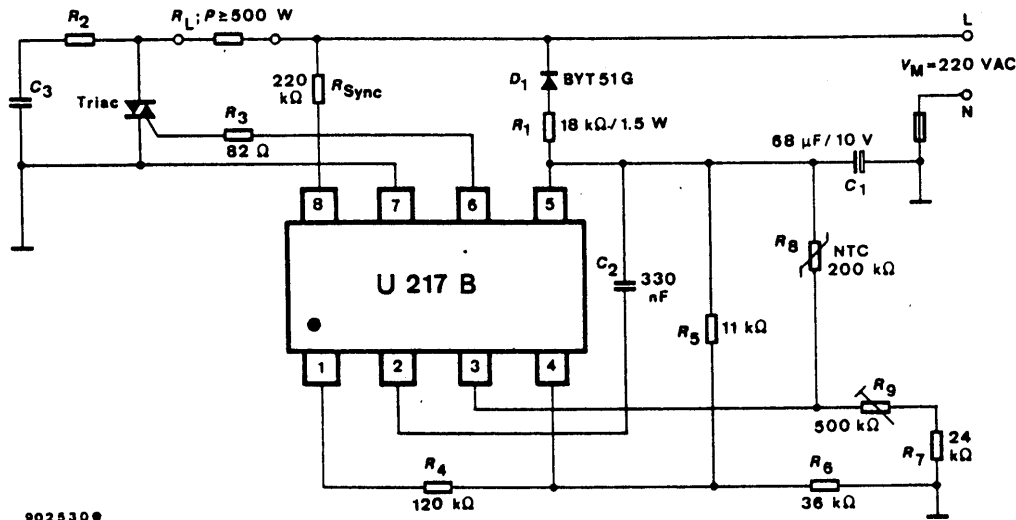


Figure 15 Two-point temperature control with superimposed proportional behaviour for temperature range 40 ... 120 °C

The circuit described here is a two-step temperature controller with superimposed proportional behaviour. The temperature can be continuously set from 40 °C to 120 °C. The proportional quantity was dimensioned in such a way that it becomes effective in the tolerance range of  $\pm 5$  °C at a temperature of 60 °C. The period of the proportional action control working in accordance with the period group method, was set so that, with loads up to 500 W, the flicker standard is adhered to.

With a low periphery expenditure, control can be realized with the monolithically integrated zero voltage switch U 217 B. Temperature measurement takes place via a high resistance NTC arranged in a bridge circuit. In this way, an

excessive bridge current is avoided. The set values can be varied with the potentiometer  $R_9$ . The bridge voltage is led to the internal comparator. Triac control pulses can only be generated if Pin 3 is positive with respect to Pin 4. A ramp generator connected via resistor  $R_4$  to Pin 4 causes the circuit's proportional behaviour. The proportional influence can be varied by altering the resistor  $R_4$ . The capacitor  $C_2$  determines the generator frequency. To obtain good control behaviour, a high generator frequency is necessary. However, there is a load-dependent frequency limitation for adherence to the above mentioned flicker standard. Zero voltage synchronization and adjustment of the output pulse width takes place at Pin 8 via the resistor  $R$ . The circuit is fed directly from the mains via resistor  $R_2$ .



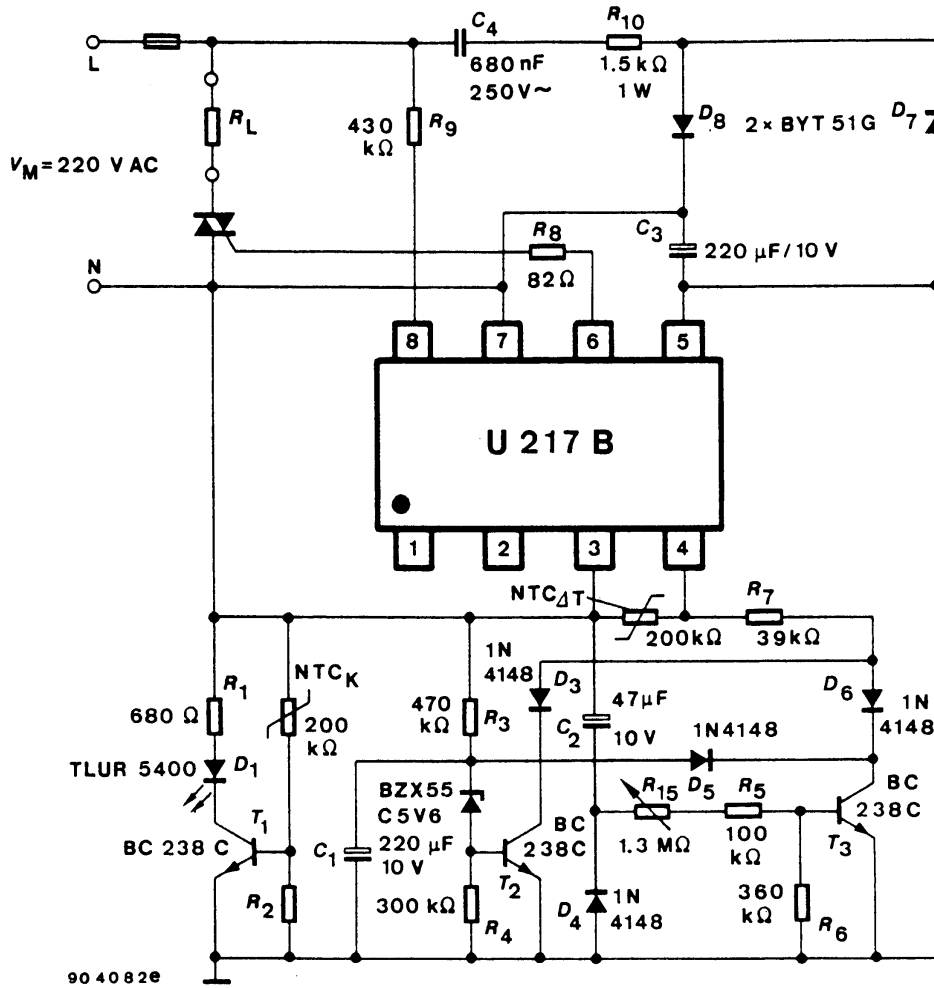


Figure 18 Coffee machine temperature control with boiling temperature automatic and calcareous deposit indicator

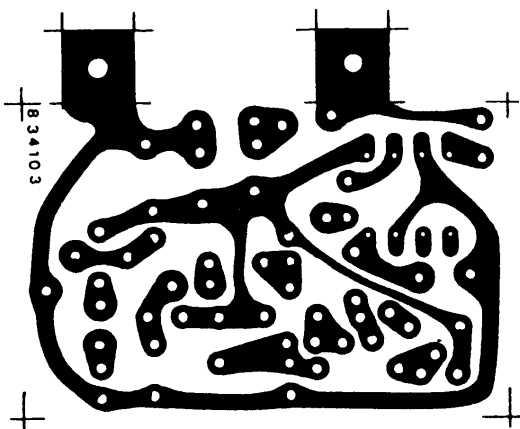


Figure 19 Printed board

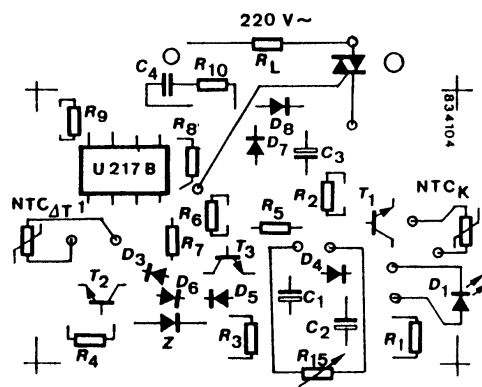
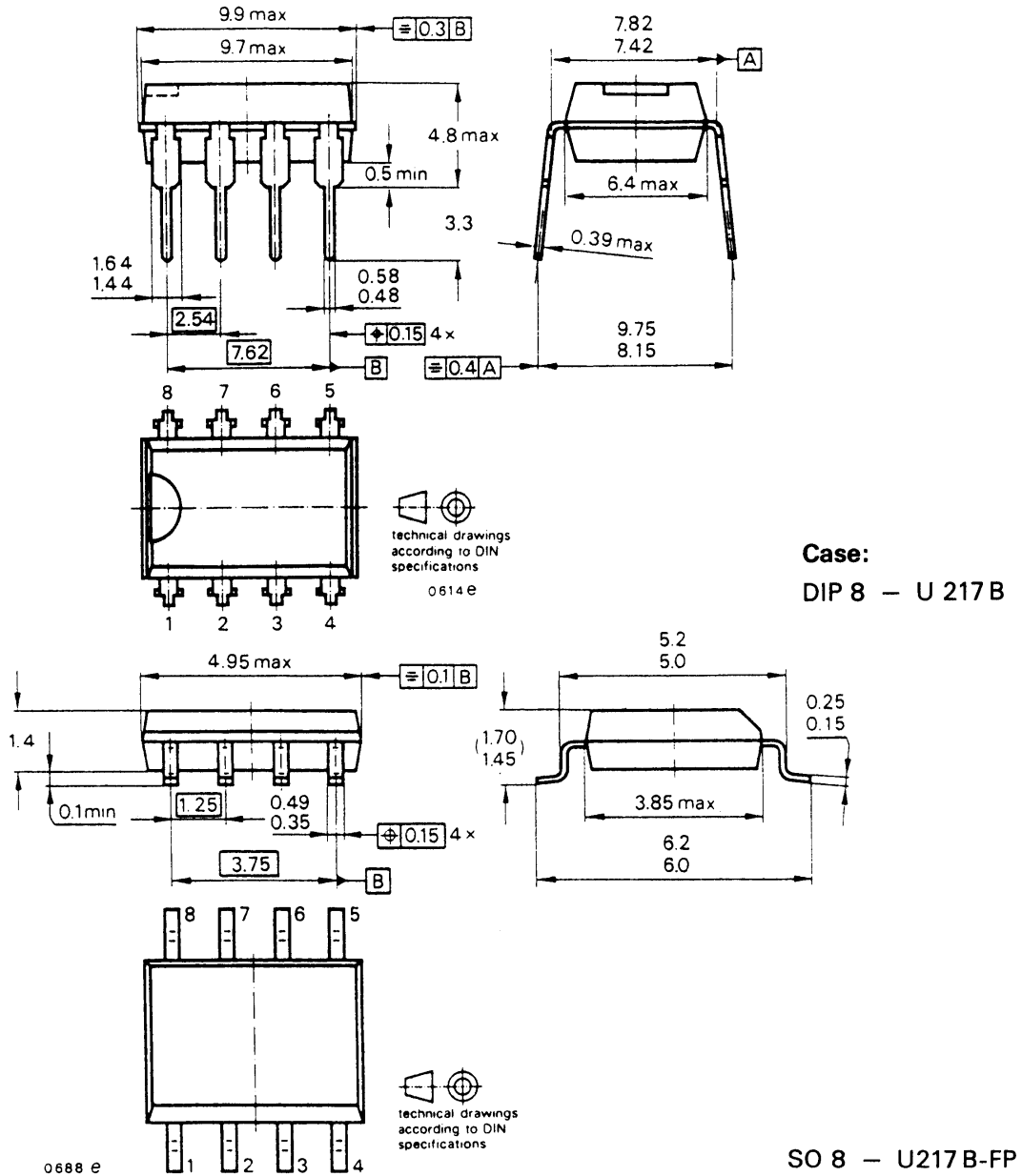


Figure 20 Printed board with components

### Dimension in mm



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Of particular concern is the control or elimination of releases into the atmosphere of those substances which are known as ozone depleting substances (ODSs).

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2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA and
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

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