Zero Voltage Switch / Temperature Control for General Applications

Technology: Bipolar

Features

- Direct supply from the mains
- Current consumption ≤ 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

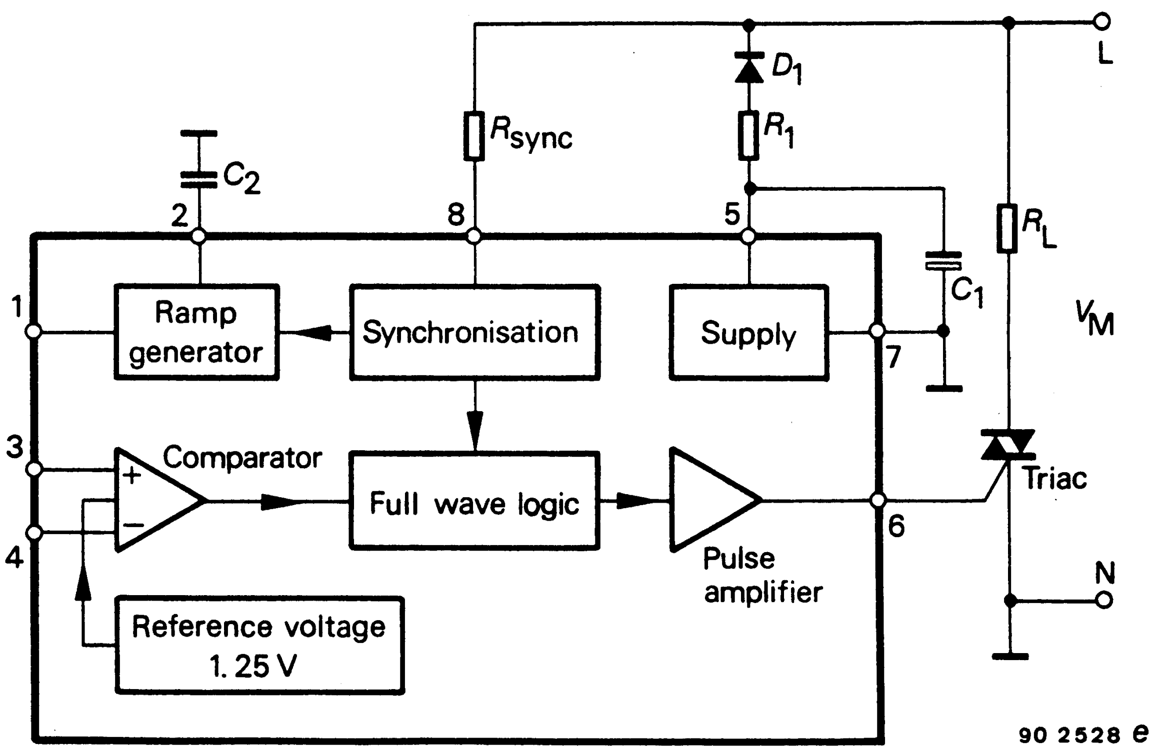


Figure 1 Block diagram and pin connections

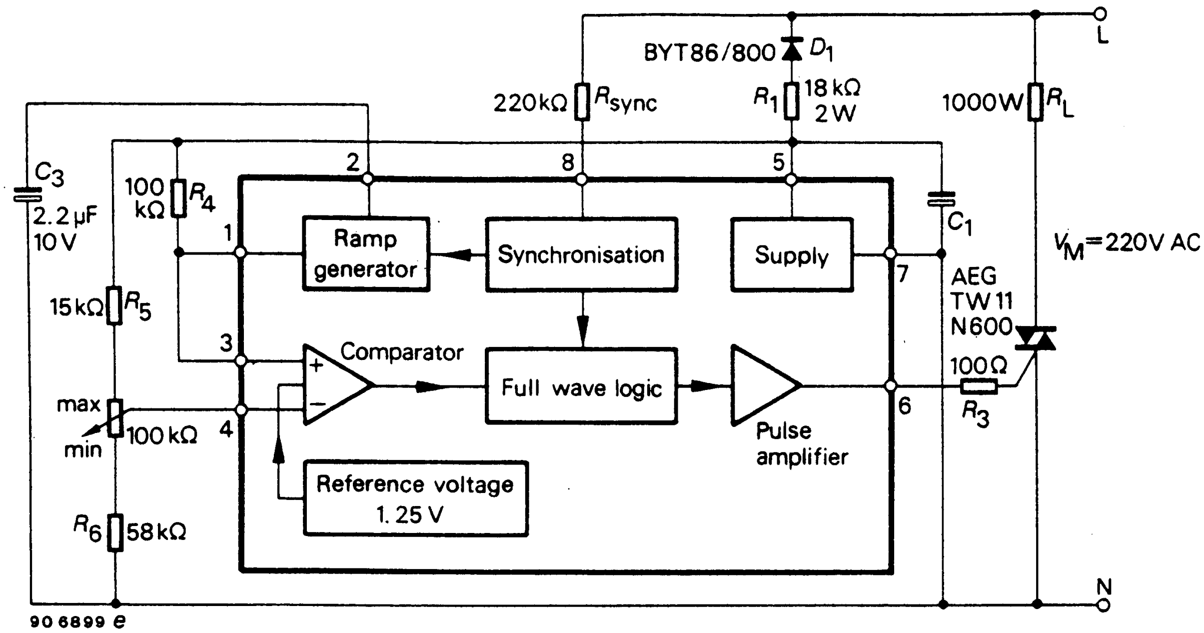


Figure 2 Typical circuit — Period group control 0 ... 100 %

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 l. 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.

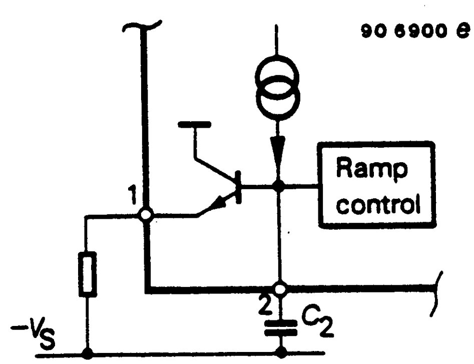


Figure 3 Pin 1 internal network

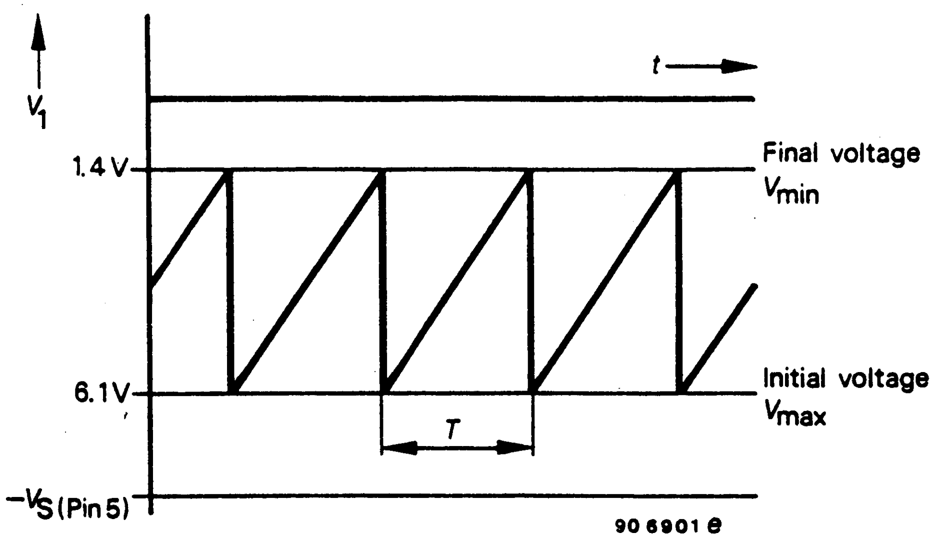


Figure 4

Firing Pulse Width t_p, Figure 5

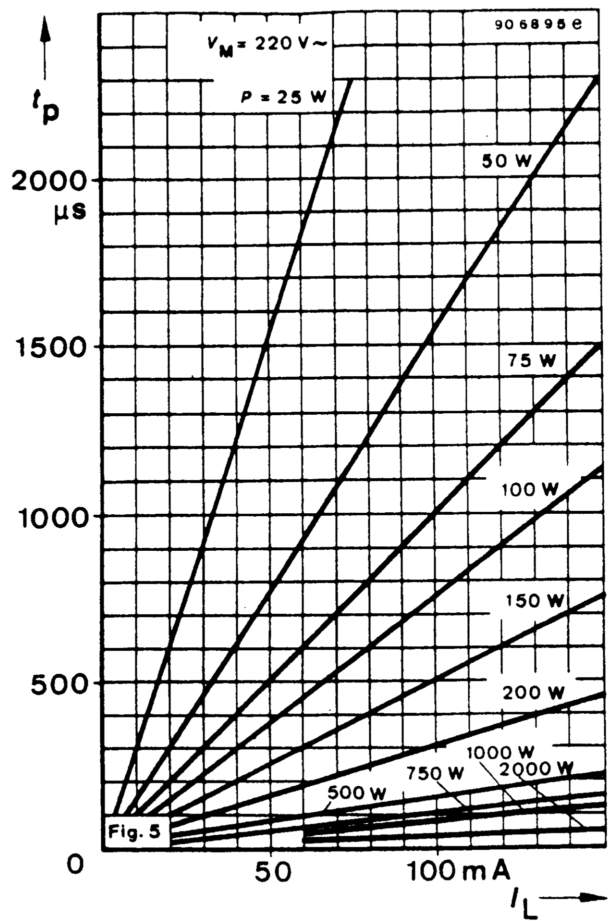
It depends on the latching current of the triac and its load current. Firing pulse width is determined by the zero crossing identification which can be influenced with the help of sync. resistance (R_{sync}), (Figure 6).

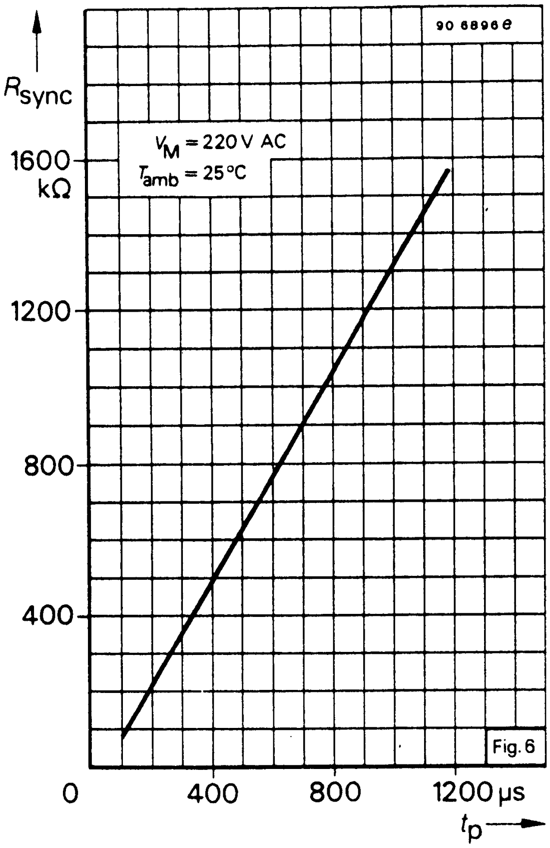
$$t_p = \frac{2}{\omega}\ \text{arc. sin}\left(\frac{I_L \times V_M}{P\sqrt{2}}\right)$$

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:

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





Triac Firing Current (Pulse)

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

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

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

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

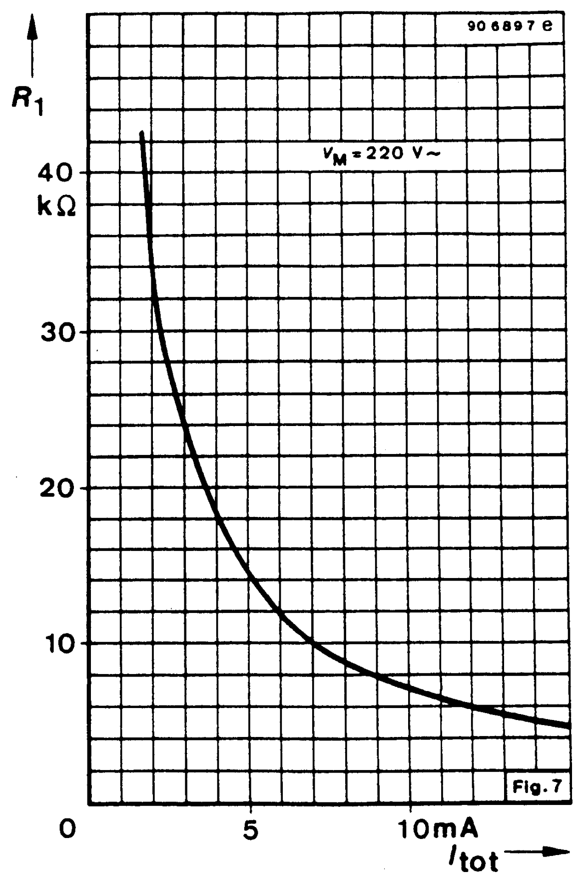
Supply Voltage

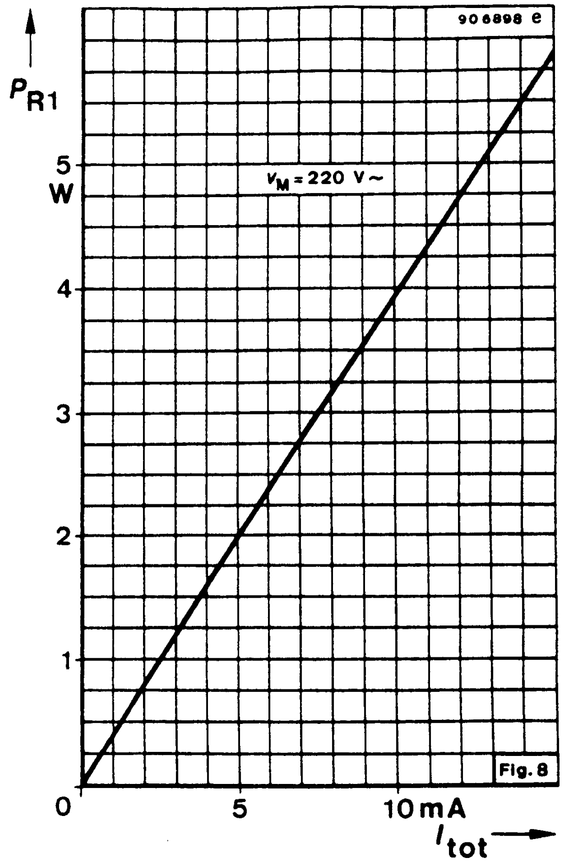
The integrated circuit U 217 B which also contains internal voltage limiting, can be connected via diode (D1) and resistor (R1) with the mains supply. An internal climb circuit limits the voltage between Pin 5 and 7 to a typical value of 9.25 V.

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	$-V_I$ $_{-}V_I$ $\pm V_I$	$\leq V_S$ 2 ... V_S $\leq$ 7.3	V V V
Power dissipation				
T_{amb} = 45 °C		P_{tot}	400	mW
$T_{amb\,=}$ 100 °C		P_{tot}	125	mW
Junction temperature		T_j	125	°C
Operating–ambient temperature range		T_{amb}	0 ... 100	°C
Storage temperature range		T_{stg}	–40 ... + 125	°C

Thermal Resistance

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

Electrical Characteristics

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

Parameters	Test Conditions / Pin	Symbol	Min	Typ	Max	Unit
Supply voltage limitation	$-I_S$ = 5 mA Pin 5	$-V_S$	8.6	9.25	9.9	V
Supply current	Pin 5	$-I_S$			500	µA
Voltage limitation	I_8 = ± 1 mA Pin 8	$\pm V_I$	7.5		8.7	V
Synchronous current	Pin 8	$\pm I_{Sync}$	0.12			mA
Zero detector		$\pm I_{Sync}$		35		µA
Output pulse width	V_M= 220 V∼, R_{Sync} = 220 kΩ R_{Sync} = 470 kΩ	 t_P t_P		 260 460		 µs µs
Output pulse current	V_6 = 0 V Pin 6	$-I_O$	100			mA
Comparator						
Input offset voltage	Pin 3,4	V_{I0}		5	15	mV
Input bias current	Pin 4	I_{IB}			1	µA
Common mode input range	Pin 3,4	$-V_{IC}$	1		(V_{S-1})	V
Threshold internal reference	V_3 = 0 V Pin 4	$-V_T$		1.25		V
Ramp generator, reference point Pin 5 ($-V_S$) Period, Figure 13	$-I_S$= 1 mA, I_{Sync} =1 mA, C_1 = 100 µF, C_2 = 1 µF, R_4= 120 kΩ 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 V, I_8 = –1 mA Pin 2	$-I_2$		17	20	µA

Applications

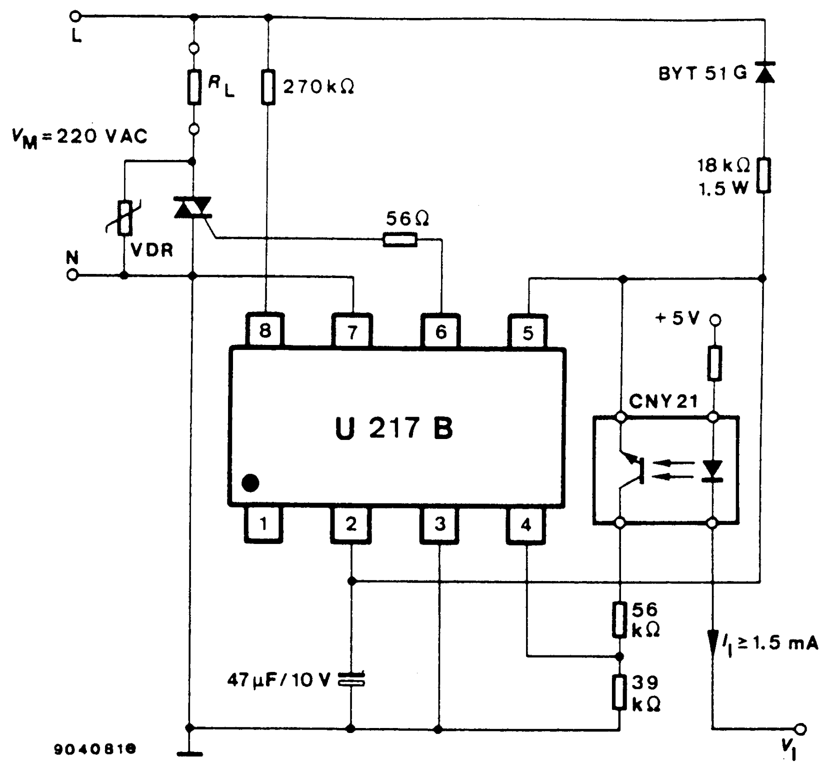


Figure 9 Power switch

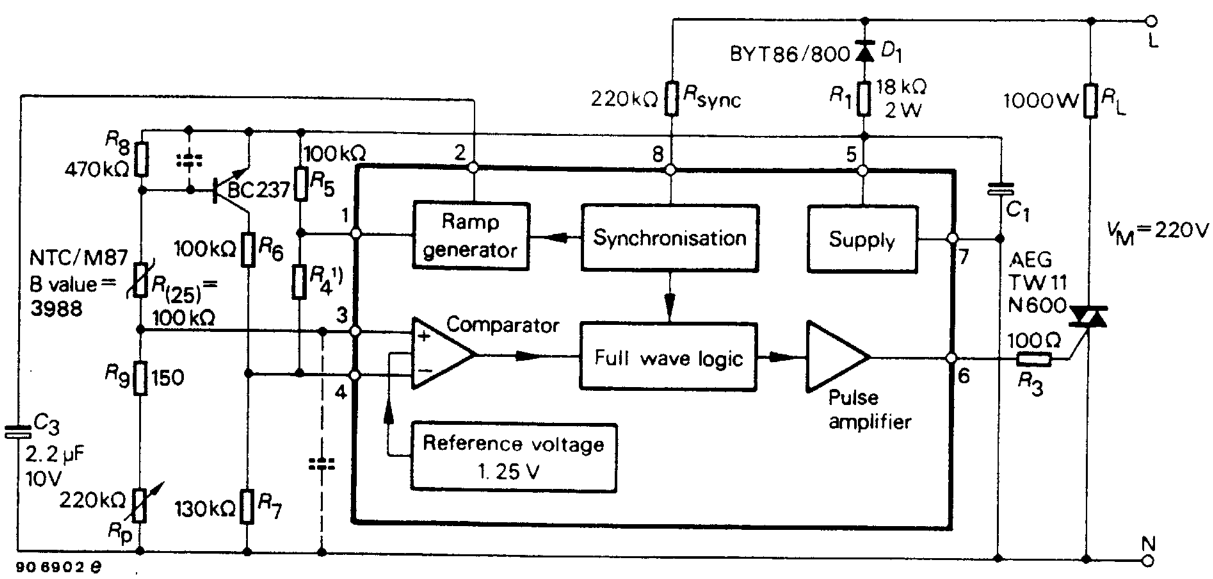


Figure 10 Temperature control 15 °C ... 35 °C with sensor monitoring
NTC–Sensor M 87 Fabr. Siemens

$R_{(25)}$ = 100 kΩ/B = 3988 ⇒ $R_{(15)}$ = 159 kΩ
$R_{(35)}$ = 64.5 kΩ

R_4[1)] determines the proportional range

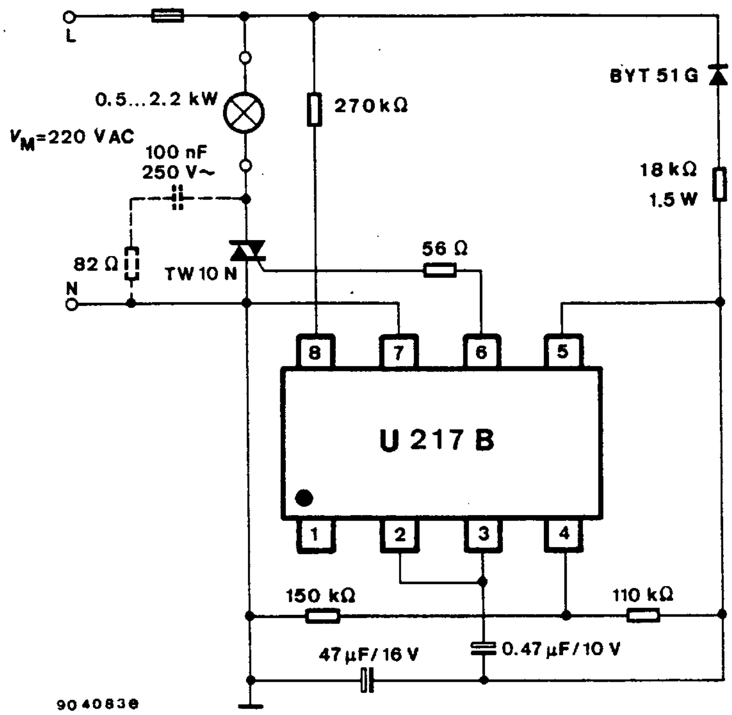


Figure 11 Power blinking switch with f ≈ 2.7 Hz, duty cycle 1:1, power range 0.5 ... 2.2 kW

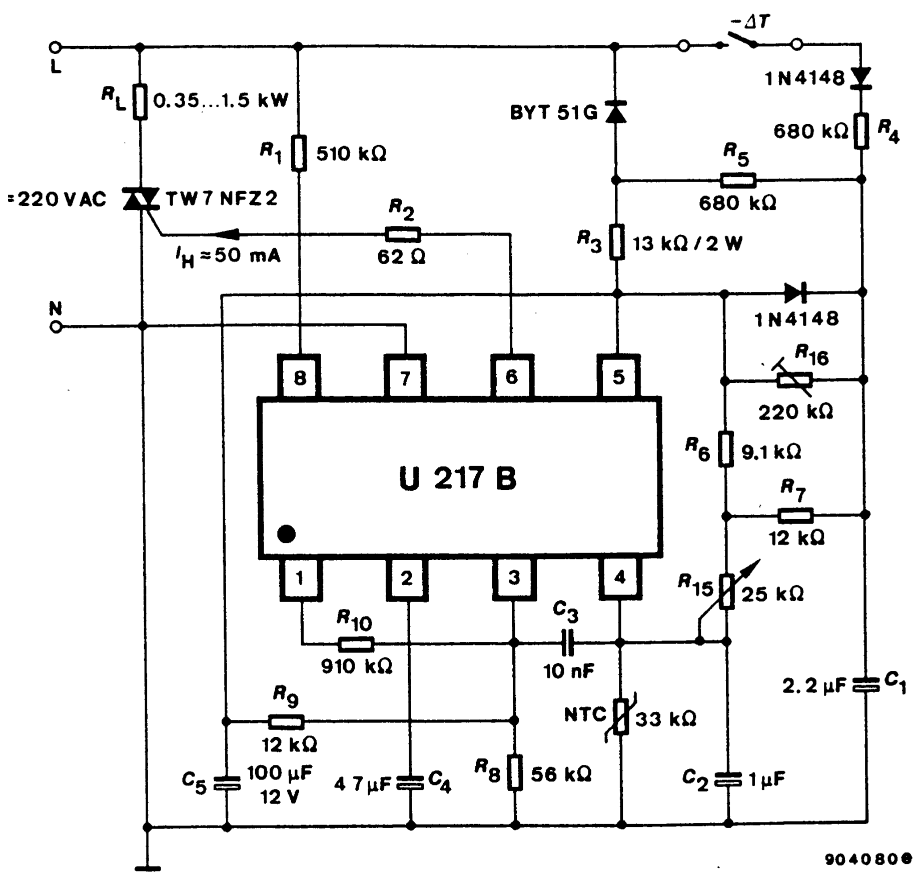


Figure 12 Room temperature control with definite reduction (remote control) for a temperature range 5 ... 30 °C

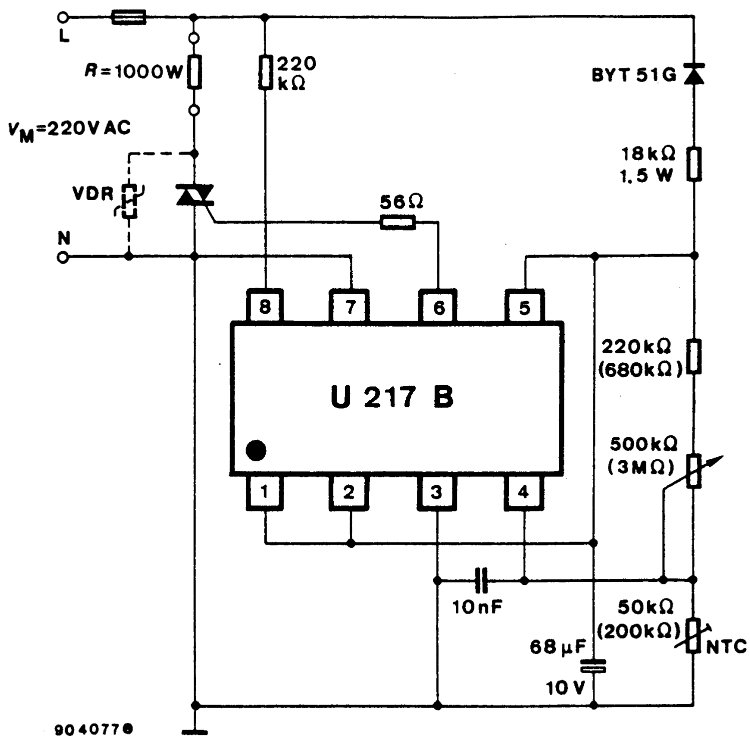


Figure 13 Two–point temperature control for a temperature range 15 ... 30 °C

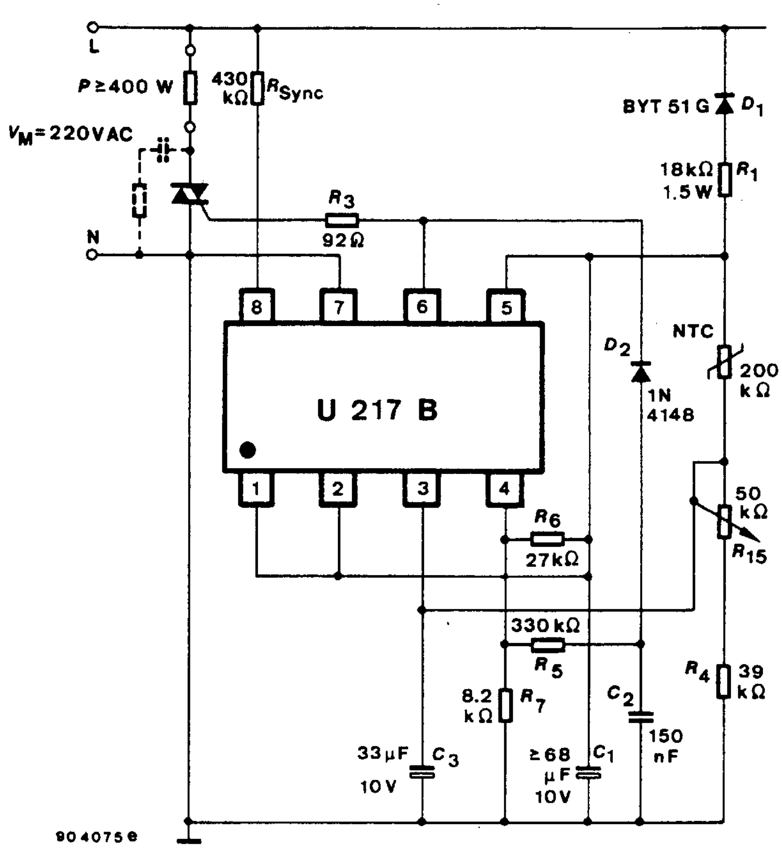


Figure 14 Two–point temperature control for a temperature range 18 ... 32 °C and hysteresis of ± 0.5 °C at 25 °C

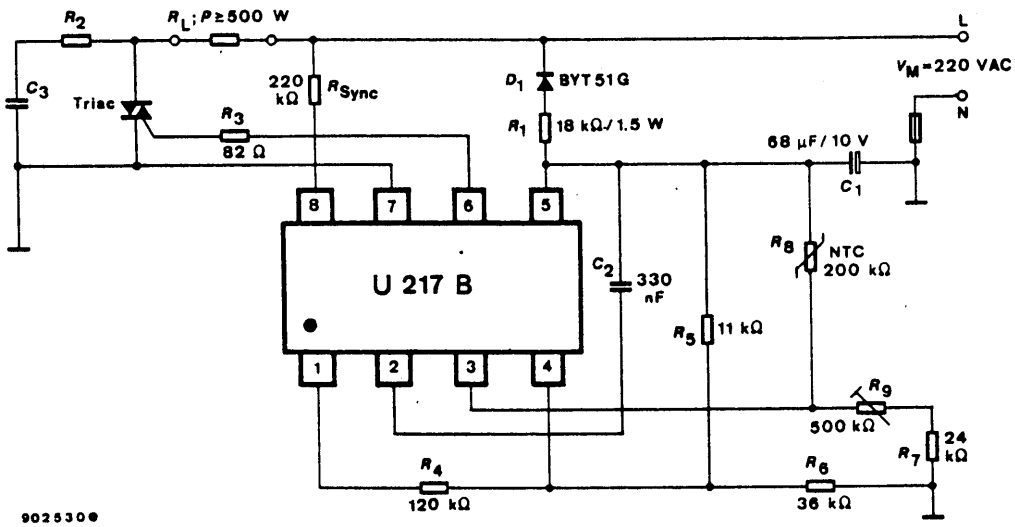


Figure 15 Two–point temperature control with superimposed proportional behaviour for temperature range 40 ... 120 °C

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 ± 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 monoIithically 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 circuits 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.

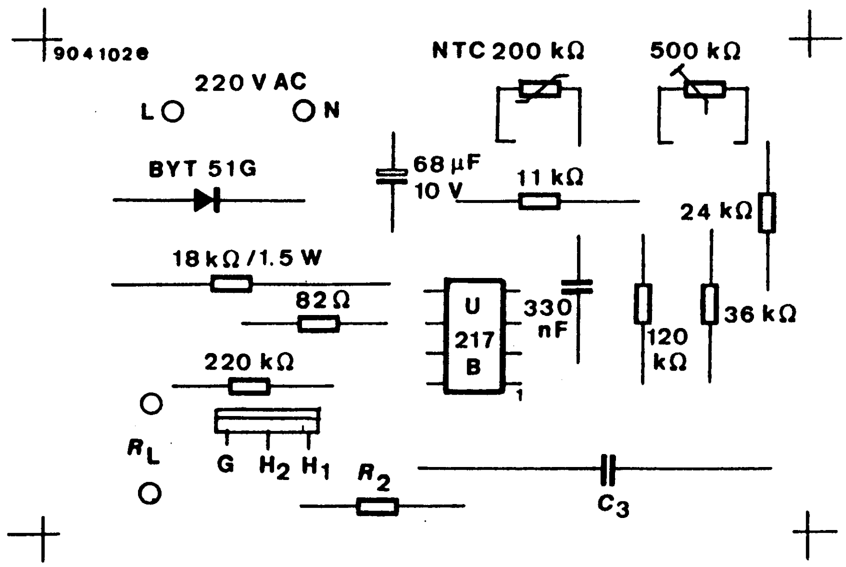


Figure 16 Printed board with components

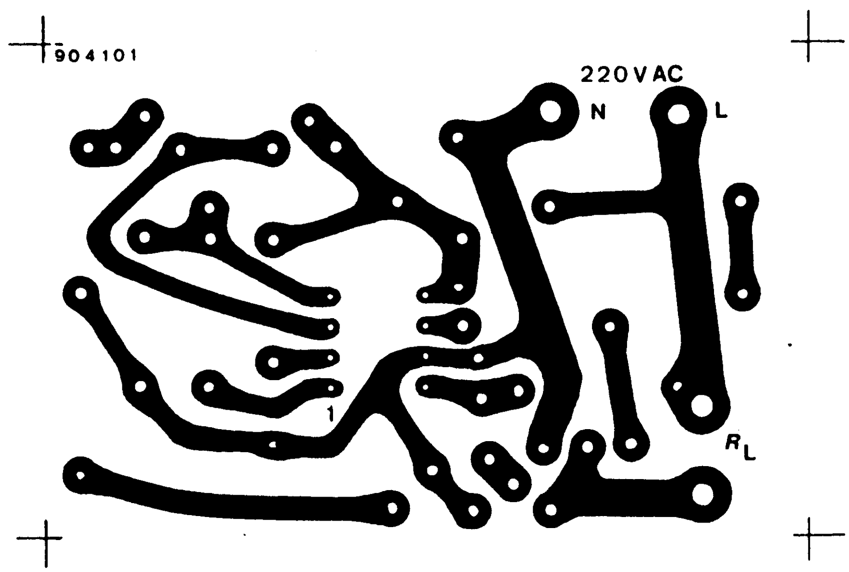


Figure 17 Printed board layout for circuit from Figure 15

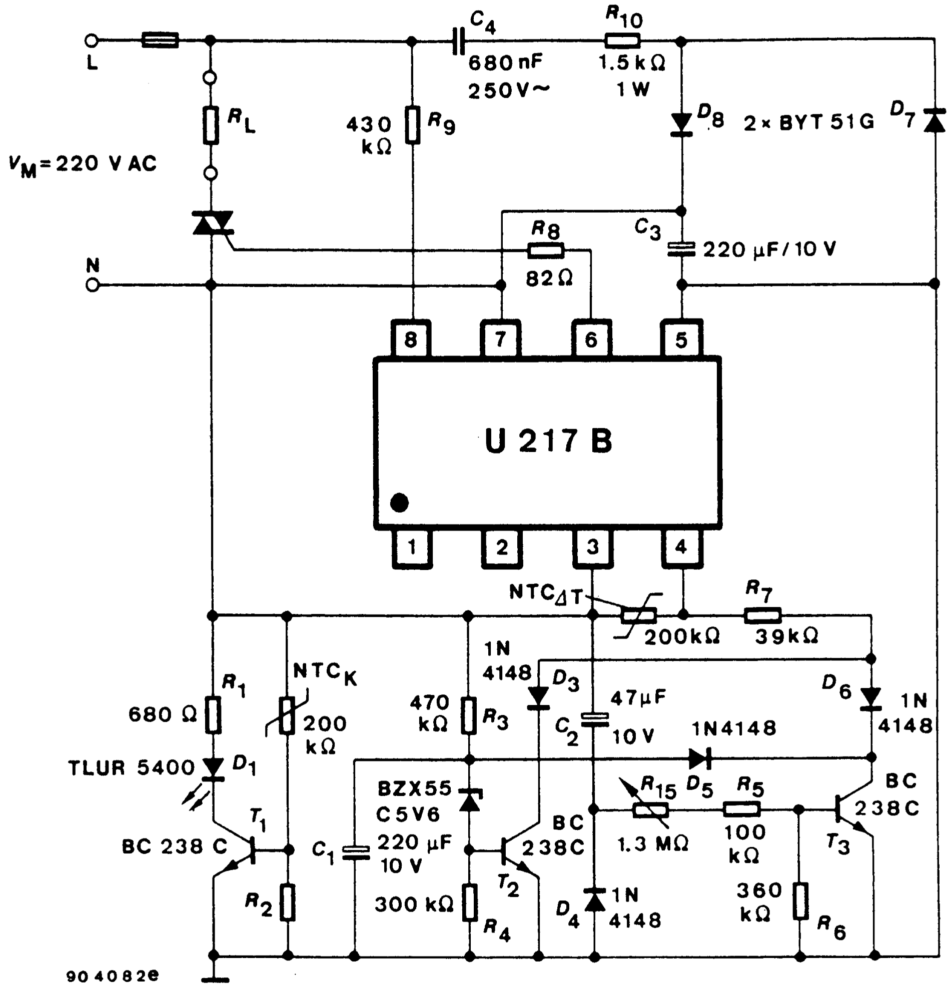


Figure 18 Coffee machine temperature control with boiling temperature automatic and calcareous deposit indicator

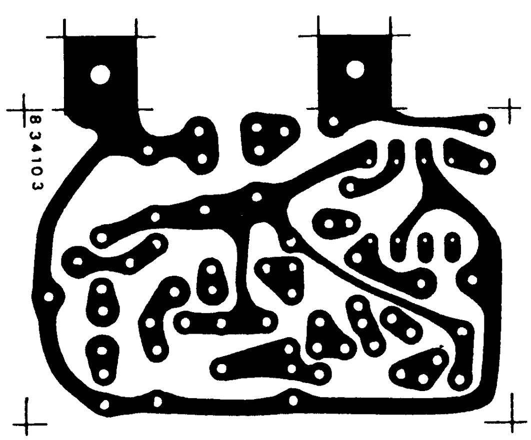


Figure 19 Printed board

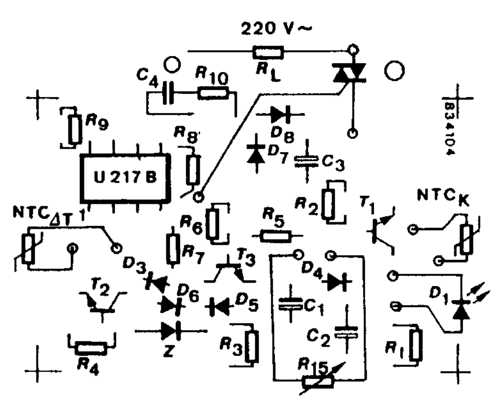
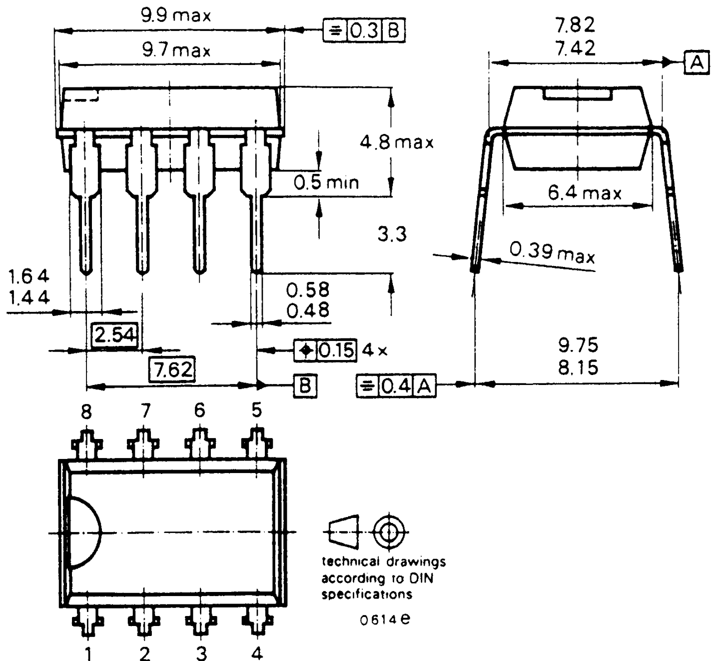


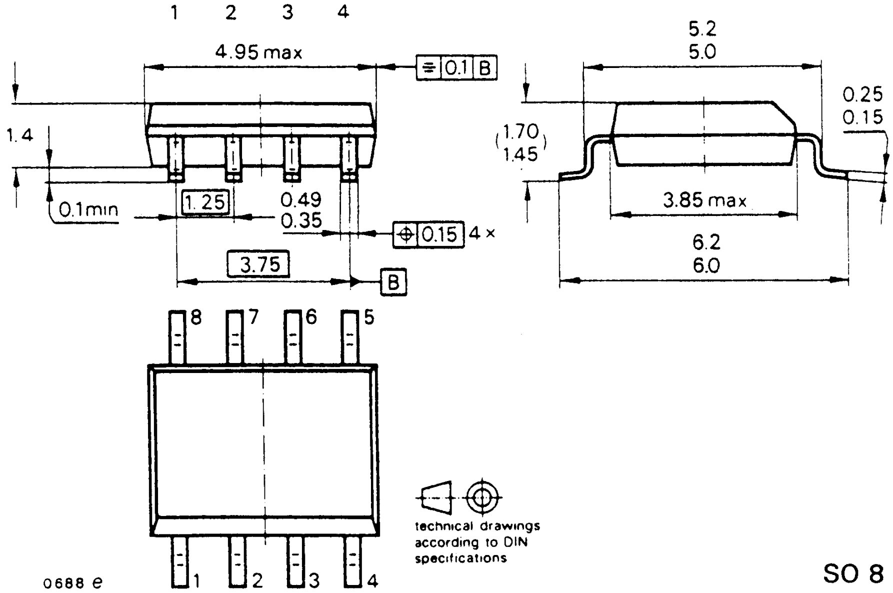
Figure 20 Printed board with components

Dimension in mm



Case:

DIP 8 – U 217 B



SO 8 – U217 B-FP

OZONE DEPLETING SUBSTANCES POLICY STATEMENT

It is the policy of **TEMIC TELEFUNKEN microelectronic GmbH** to

1. Meet all present and future national and international statutory requirements and

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

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

The Montreal Protocol (1987) and its London Amendments (1990) will soon severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

TEMIC TELEFUNKEN microelectronic GmbH semiconductor division has been able to use its policy of continuous improvements to eliminate the use of any ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

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.

TEMIC can certify that our semiconductors are not manufactured with and do not contain ozone depleting substances.

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