

Zero-Voltage Switch with Adjustable Ramp

Description

The integrated circuit, U217B, is designed as a zero-voltage switch in bipolar technology. It is used to control resistive loads at mains by a triac in zero-crossing mode.

A ramp generator allows power control function by period group control, whereas full-wave logic guarantees that full mains cycles are used for load switching.

Features

- Direct supply from the mains
- Current consumption ≤ 0.5 mA
- Very few external components
- Full-wave drive – no DC current component in the load circuit
- Negative output current pulse typ. 100 mA – short-circuit protected

- Simple power control
- Ramp generator
- Reference voltage

Applications

- Full-wave power control
- Temperature regulation
- Power blinking switch

Block Diagram

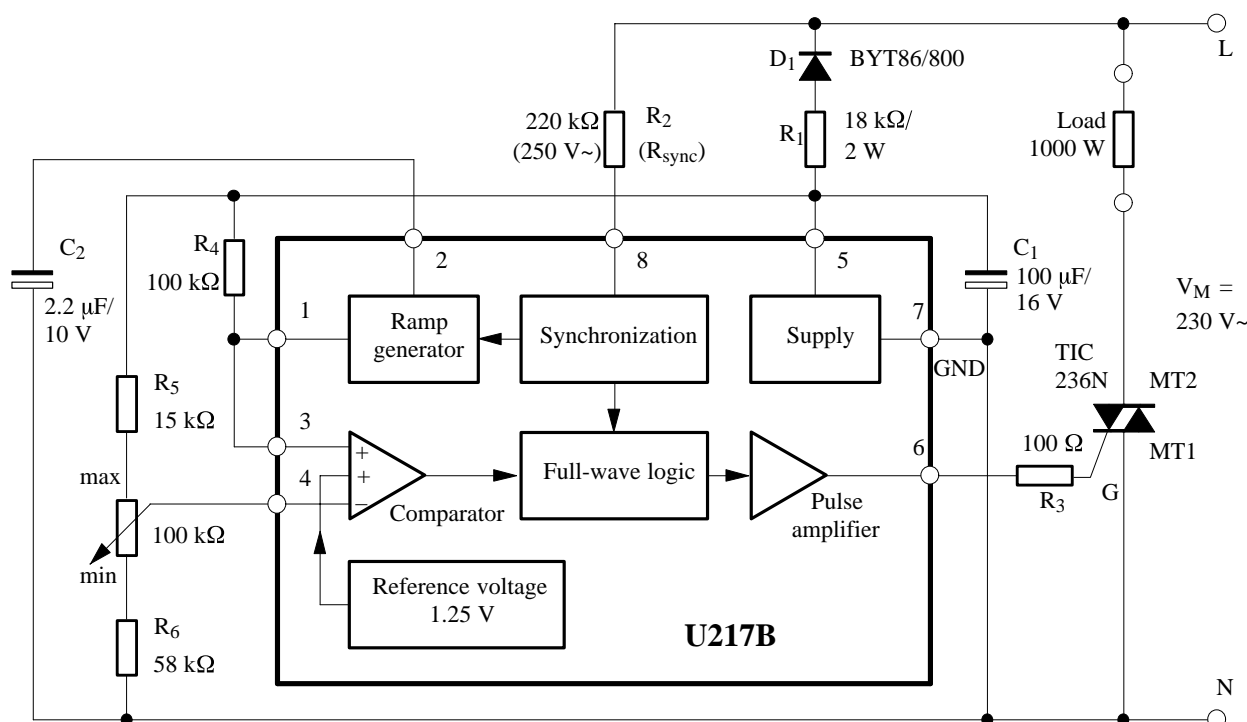


Figure 1. Block diagram with typical circuit, period group control 0 to 100%

Order Information

| Extended Type Number | Package | Remarks |
|----------------------|---------|------------------|
| U217B-x | DIP8 | Tube |
| U217B-xFP | SO8 | Tube |
| U217B-xFPG3 | SO8 | Taped and reeled |

Pin Description

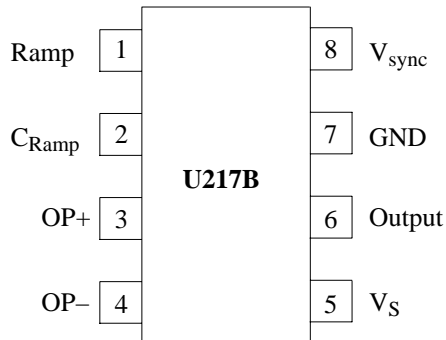


Figure 2. Pinning

| Pin | Symbol | Function |
|-----|--------|-------------------------|
| 1 | Ramp | Ramp output |
| 2 | CRamp | Ramp capacitor |
| 3 | OP+ | OP non-inverting input |
| 4 | OP- | OP inverting input |
| 5 | VS | Supply voltage |
| 6 | Output | Trigger pulse output |
| 7 | GND | Ground |
| 8 | Vsync | Voltage synchronization |

General Description

The integrated circuit U217B is a triac controller for zero-crossing mode. It is designed to control power in switching resistive loads of mains supplies.

Information regarding supply sync. is provided at Pin 8 via resistor R_{sync} .

To avoid DC load on the mains, the full-wave logic guarantees that complete mains cycles are used for load switching.

A 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 can be performed by capacitor C_2 at Pin 2. The ramp function is used for open-loop control (figure 4), but also for application with proportional band regulation (figure 11). Ramp voltage available at capacitor C_2 is decoupled across the 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, 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), see figure 13.

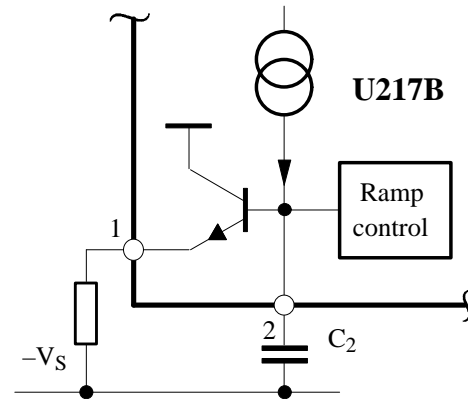


Figure 3. Pin 1 internal network

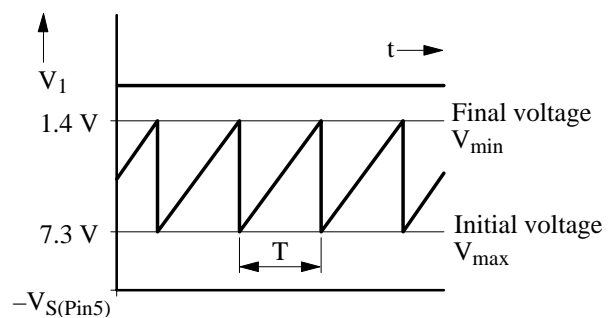


Figure 4. Threshold voltage of the ramp

Triac Firing Current (Pulse)

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

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

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

where:

- V_G = Gate voltage
- I_{Gmax} = Maximum gate current
- I_p = Average gate current
- t_p = Firing pulse width
- T = Mains period duration

Firing Pulse Width t_p (Figure 5)

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

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

whereby:

I_L = Latching current of the triac
 V_M = Mains supply, effective
 P = Power load (user's power)

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

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

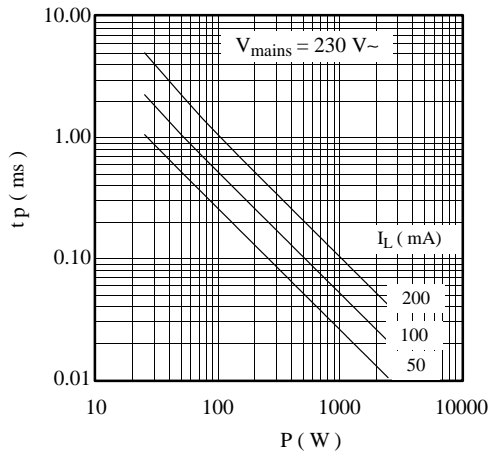


Figure 5. Output pulse width

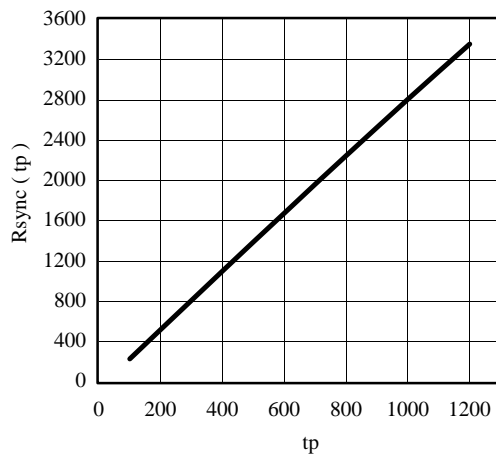


Figure 6. Synchronization resistance

Supply Voltage

The integrated circuit U217B (which also contains internal voltage limiting) can be connected via the diode (D_1) and the resistor (R_1) with the mains supply. An internal climb circuit limits the voltage between Pin 5 and 7 to a typical value of 9.25 V.

The series resistance R_1 can be calculated (figures 7 and 8) as follows:

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

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

whereby:

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_x = Current requirement of other peripheral components
 $P_{(R1)}$ = Power dissipation at R_1

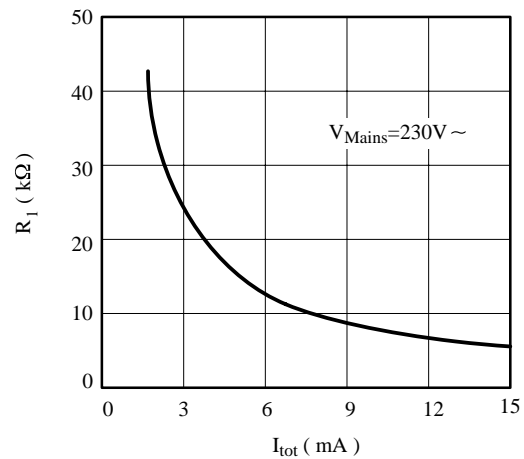


Figure 7. Maximum resistance of R_1

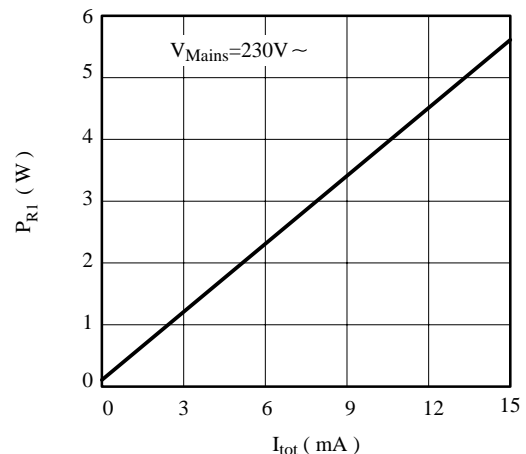


Figure 8. Power dissipation of R_1 according to current consumption

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 | $-V_I$ | $\leq V_S$ | V |
| Pin 2 | $-V_I$ | 2 to V_S | V |
| Pin 8 | $\pm V_I$ | ≤ 7.3 | V |
| Power dissipation $T_{amb} = 45^\circ\text{C}$ $T_{amb} = 100^\circ\text{C}$ | P_{tot} P_{tot} | 400 125 | mW mW |
| Junction temperature | T_j | 125 | $^\circ\text{C}$ |
| Operating ambient temperature range | T_{amb} | 0 to 100 | $^\circ\text{C}$ |
| Storage temperature range | T_{stg} | -40 to + 125 | $^\circ\text{C}$ |

Thermal Resistance

| Parameters | Symbol | Value | Unit |
|------------------|------------|-------|------|
| Junction ambient | R_{thJA} | 200 | K/W |

Electrical Characteristics

$-V_S = 8.5\text{ V}$, $T_{amb} = 25^\circ\text{C}$, 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 | μA |
| Voltage limitation | $I_8 = \pm 1\text{ mA}$ 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 | $V_M = 230\text{ V}$, $R_{sync} = 220\text{ k}\Omega$ $R_{sync} = 470\text{ k}\Omega$ | t_p t_p | | 260 460 | | μs μs |
| Output pulse current | $V_6 = 0\text{ V}$ Pin 6 | $-I_O$ | 100 | | | mA |
| Comparator | | | | | | |
| Input offset voltage | Pin 3,4 | V_{IO} | | 5 | 15 | mV |
| Input bias current | Pin 4 | I_{IB} | | | 1 | μA |
| Common-mode input voltage | 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 |
| Ramp generator, Pin 1, figure 1 | | | | | | |
| Period | $-I_S = 1\text{ mA}$, $I_{sync} = 1\text{ mA}$, $C_1 = 100\text{ }\mu\text{F}$, $C_2 = 1\text{ }\mu\text{F}$, $R_4 = 100\text{ k}\Omega$ | T | | 1.5 | | s |
| Final voltage | | V_1 | 0.9 | 1.40 | 1.80 | V |
| Initial voltage | | V_1 | 6.8 | 7.3 | 7.8 | V |
| Charge current | $V_2 = 0\text{ V}$, $I_8 = -1\text{ mA}$ Pin 2 | $-I_2$ | 13 | 17 | 26 | μA |

Applications

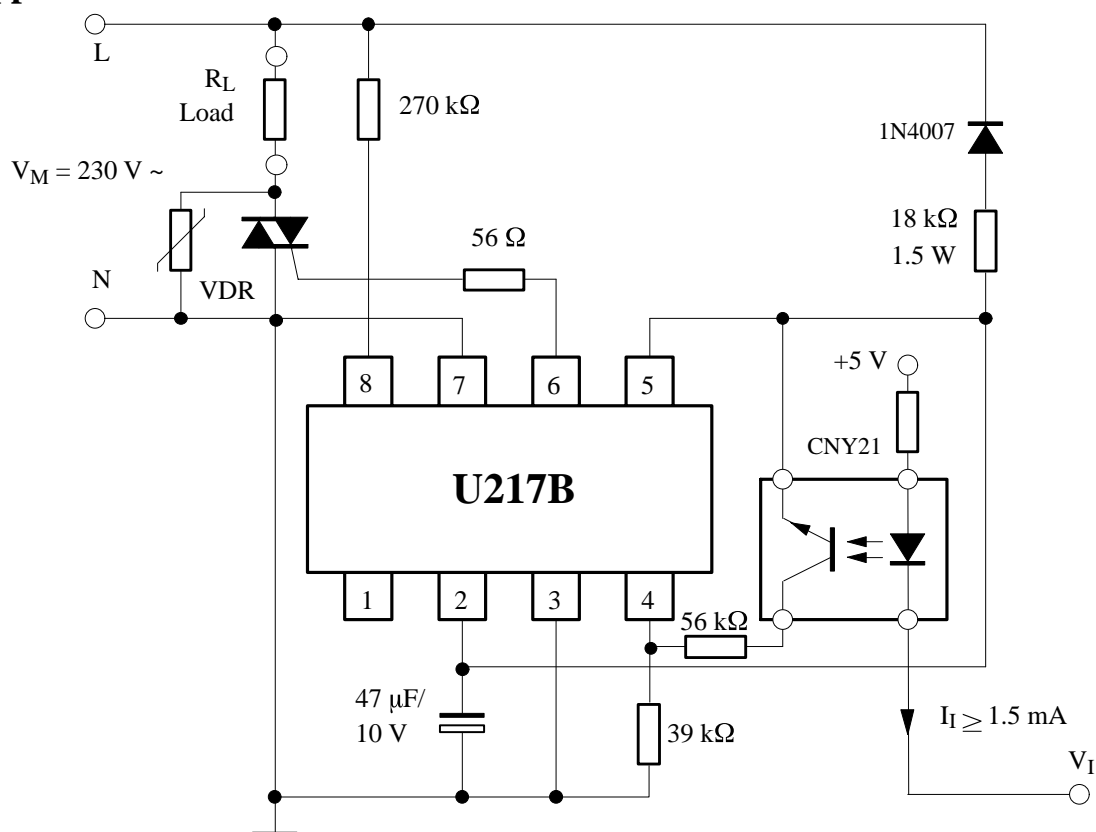


Figure 9. Power switch

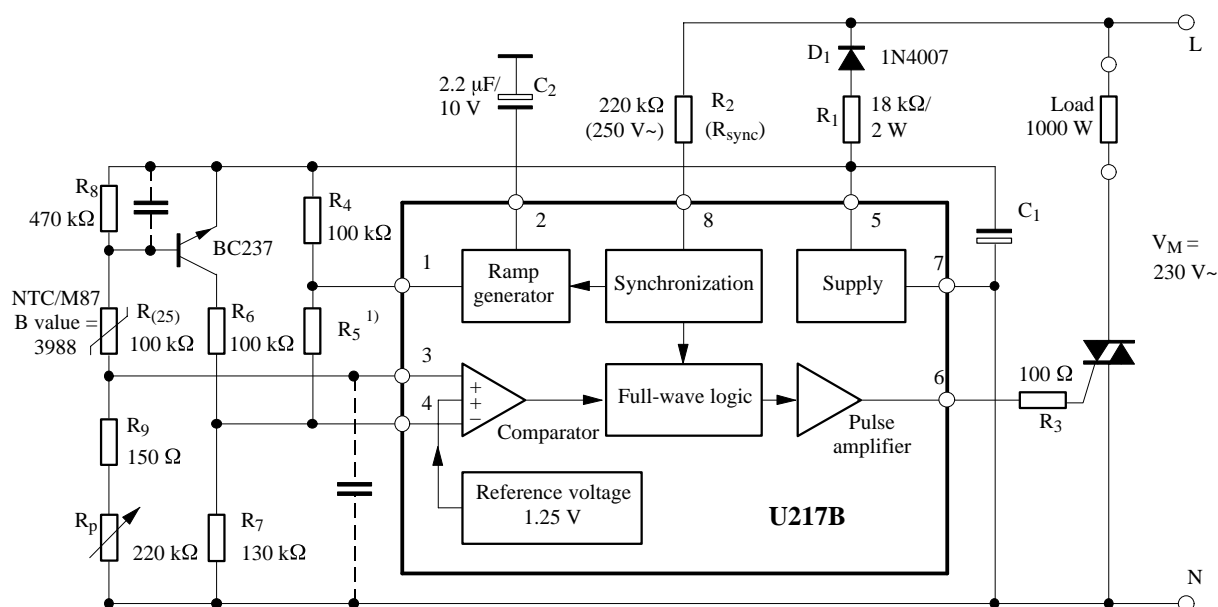


Figure 10. Temperature control 15 to 35°C with sensor monitoring

NTC-Sensor M 87 Fabr. Siemens

$$R_{(25)} = 100 \text{ k}\Omega / B = 3988 \Rightarrow R_{(15)} = 159 \text{ k}\Omega$$

$$R_{(35)} = 64.5 \text{ k}\Omega$$

$R_5^{1)}$ determines the proportional range

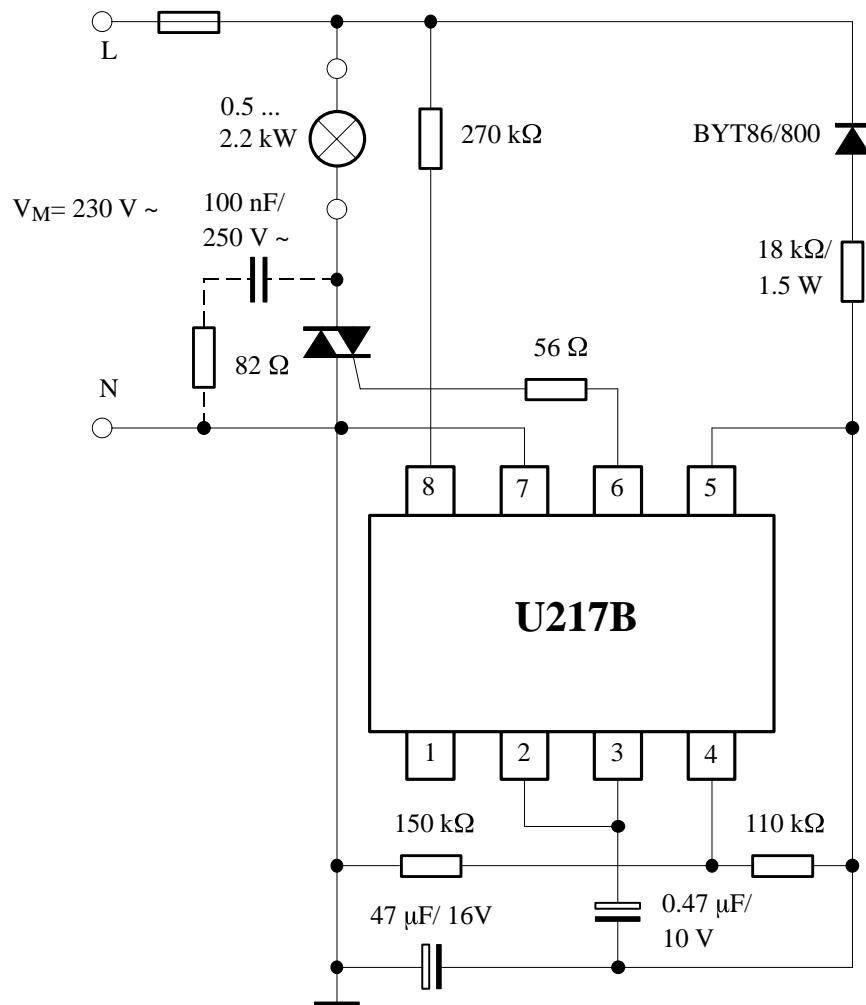


Figure 11. Power blinking switch with $f \approx 2.7\text{ Hz}$, duty cycle 1:1, power range 0.5 to 2.2 kW

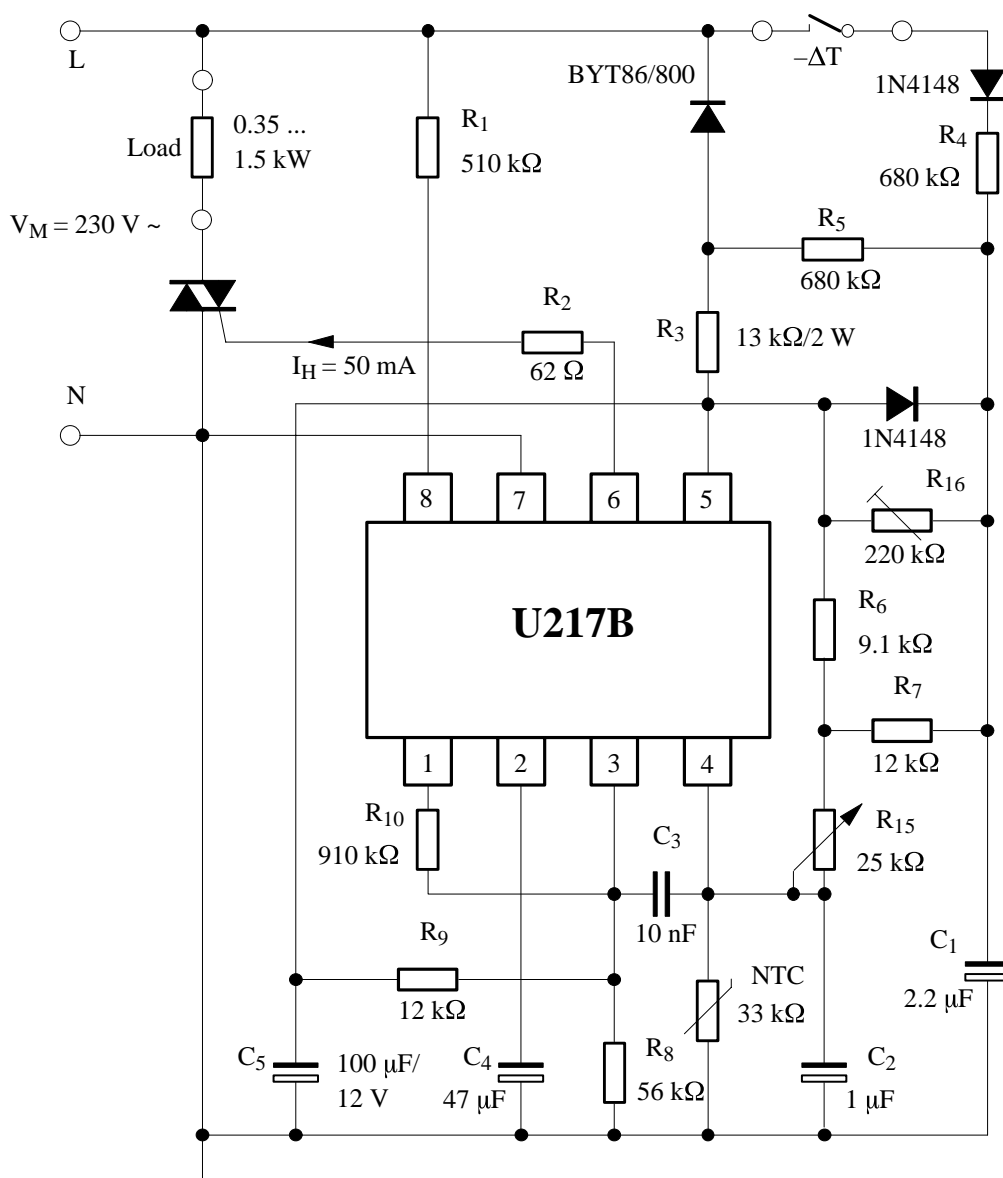


Figure 12. Room temperature control with definite reduction (remote control) for a temperature range of 5 to 30°C

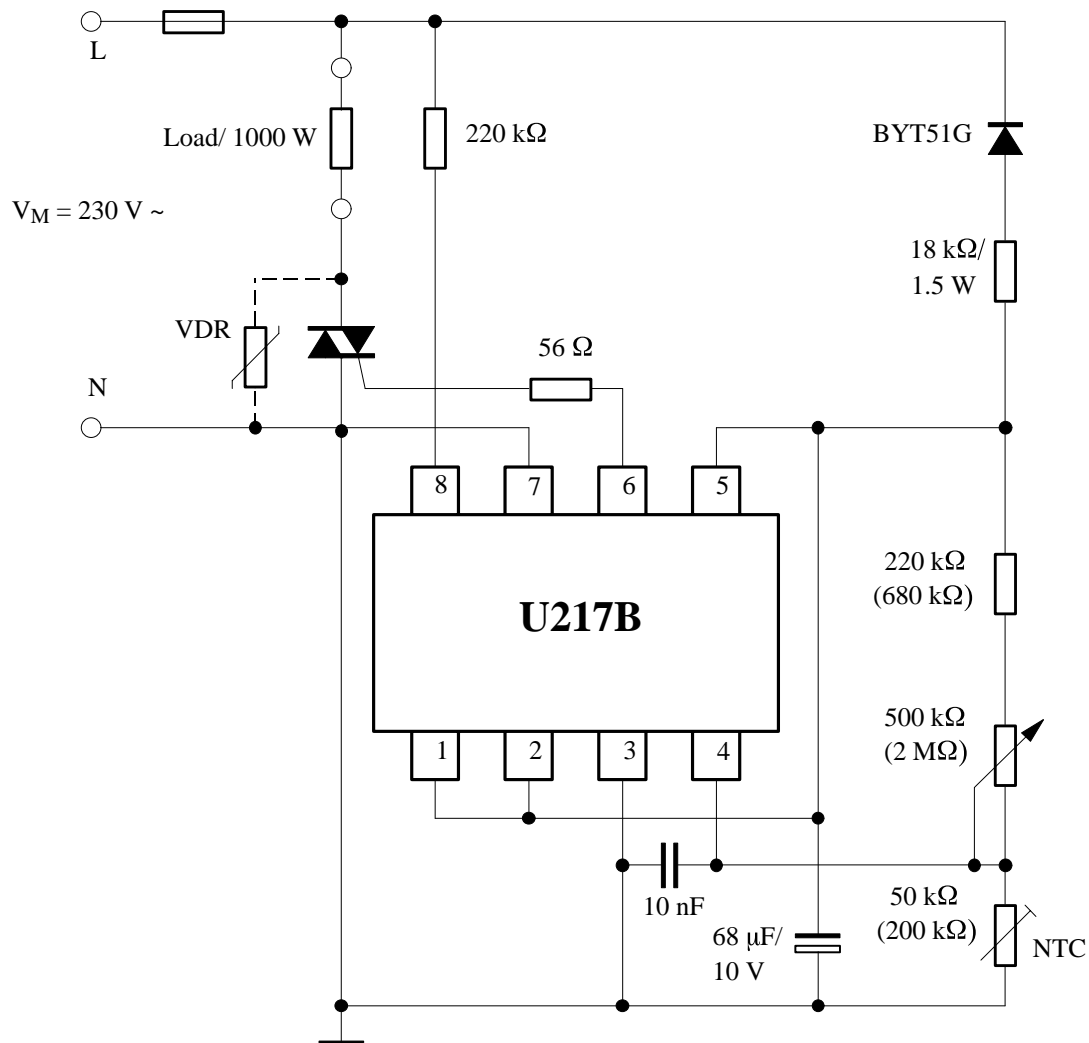


Figure 13. Two-point temperature control for a temperature range of 15 to 30°C

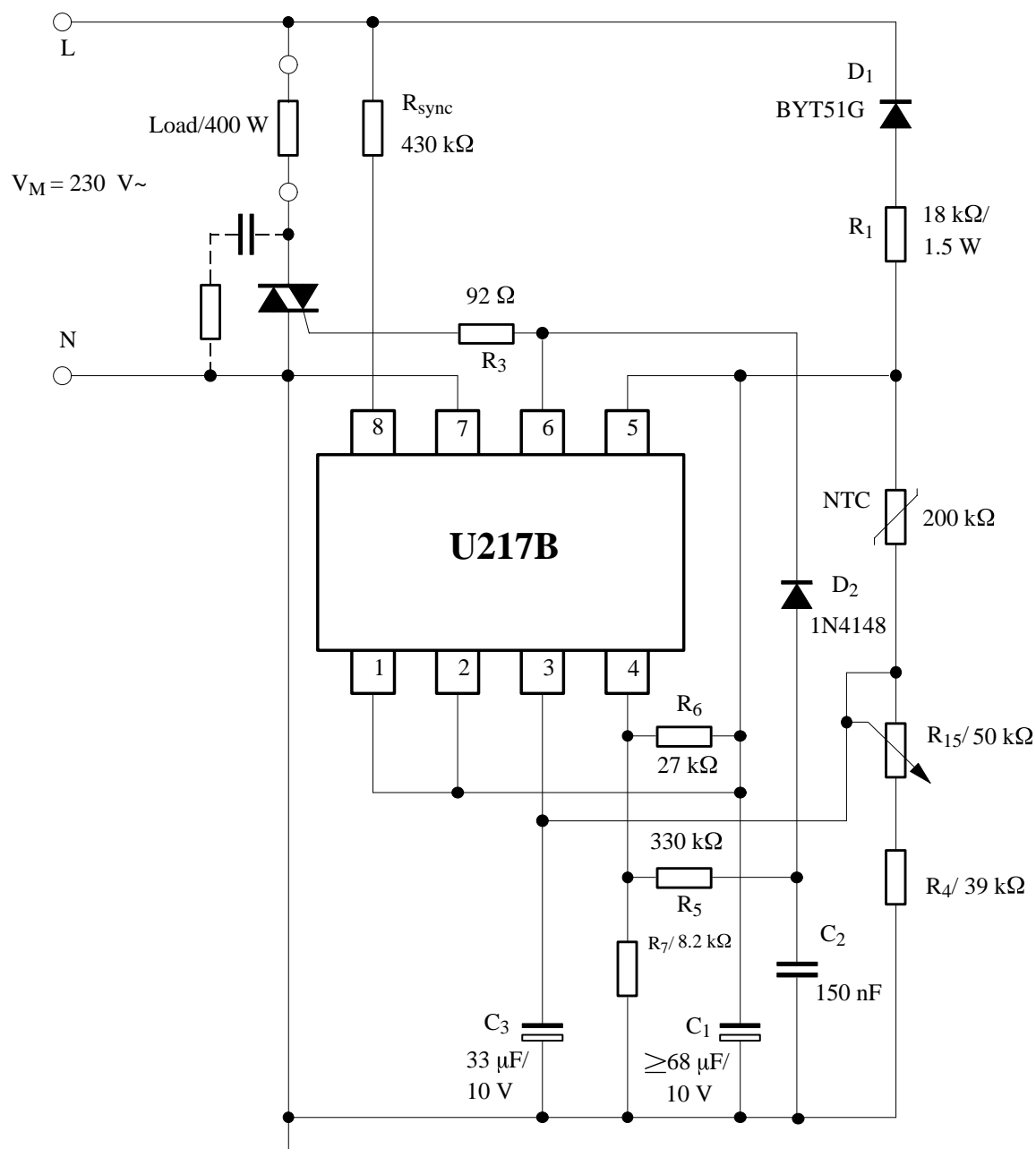
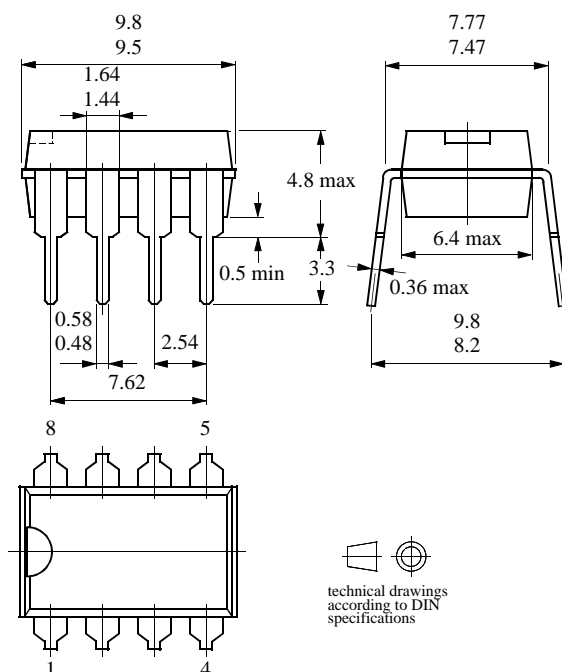


Figure 14. Two-point temperature control for a temperature range of 18 to 32°C and a hysteresis of $\pm 0.5^\circ\text{C}$ at 25°C

Package Information

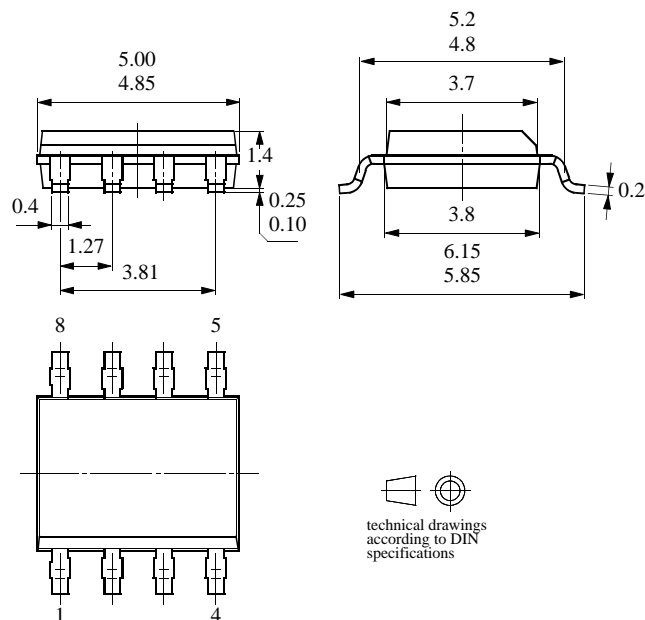
Package DIP8

Dimensions in mm



Package SO8

Dimensions in mm



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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.

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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
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

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