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## Features

- Direct Supply from the Mains
- Current Consumption  $\leq 0.5$  mA
- Very Few External Components
- Full-wave Drive – No DC Current Component in the Load Circuit
- Negative Output Current Pulse Typically 100 mA – Short-circuit Protected
- Simple Power Control
- Ramp Generator
- Reference Voltage

## Applications

- Full-wave Power Control
- Temperature Regulation
- Power Blinking Switch

## Description

The integrated circuit, T2117, 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.



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## Zero-voltage Switch with Adjustable Ramp

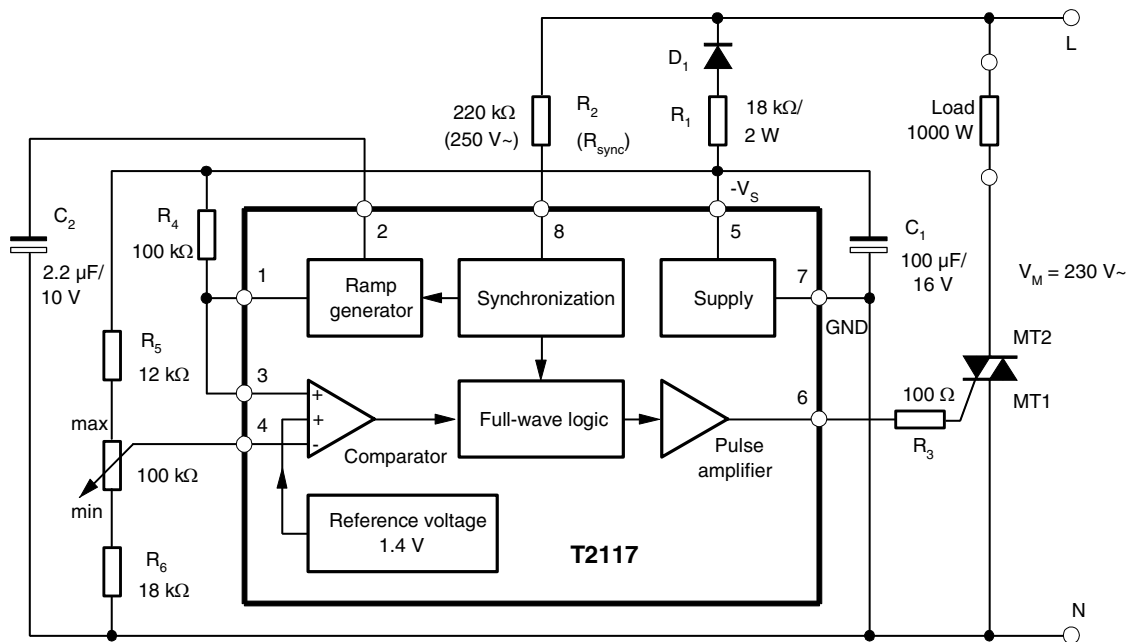
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**T2117**

Rev. 4768A–INDCO–11/03

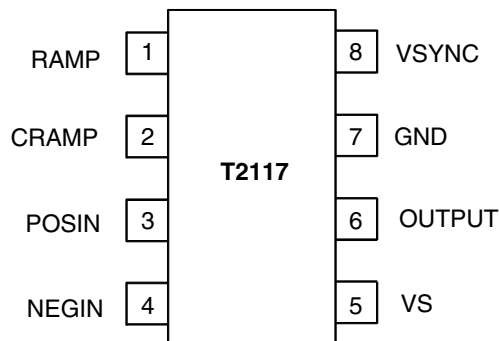


**Figure 1.** Block Diagram with Typical Circuit, Period Group Control 0 to 100%



## Pin Configuration

**Figure 2.** Pinning DIP8/SO8



## Pin Description

| Pin | Symbol | Function                       |
|-----|--------|--------------------------------|
| 1   | RAMP   | Ramp output                    |
| 2   | CRAMP  | Ramp capacitor                 |
| 3   | POSIN  | Non-inverting comparator input |
| 4   | NEGIN  | Inverting comparator input     |
| 5   | VS     | Supply voltage                 |
| 6   | OUTPUT | Trigger pulse output           |
| 7   | GND    | Ground                         |
| 8   | VSYNC  | Voltage synchronization        |

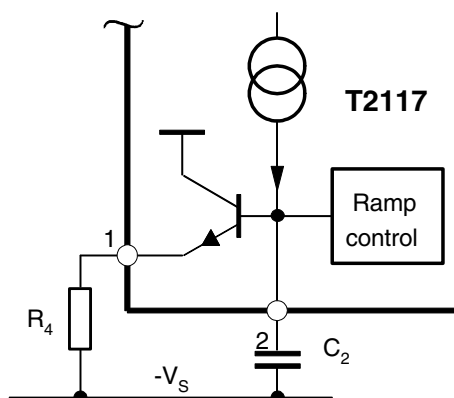
## General Description

The integrated circuit T2117 is a triac controller for zero-crossing mode. It is designed to control power in switching resistive loads of mains supplies.

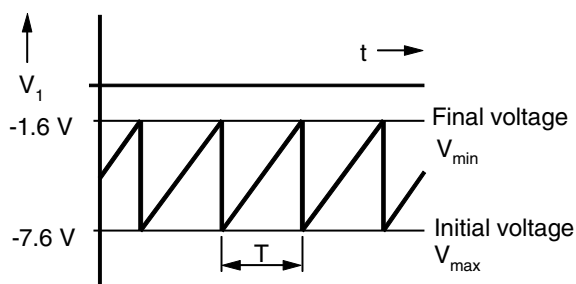
Information regarding synchronous supply is provided at pin 8 via resistor  $R_{\text{Sync}}$ . To avoid a DC load on the mains, the full-wave logic guarantees that complete mains cycles are used for load switching.

A fire pulse is released when the inverting input of the comparator is negative (pin 4) with respect to the non-inverting input (pin 3) and internal reference voltage. A ramp generator with freely 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 applications with proportional band regulation (Figure 11 on page 9). Ramp voltage available at capacitor  $C_2$  is decoupled across the emitter follower at pin 1. To maintain the lamp flicker specification, the ramp duration is adjusted according to the controlling load. 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 on page 11.

**Figure 3.** Pin 1 Internal Network



**Figure 4.** Threshold Voltage of the Ramp at  $V_S = -8.8 \text{ V}$



## Triac Firing Current (Pulse)

This depends on the triac requirement. It can be limited by the 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 $t_p$

This depends on the latching current of the triac and its load current. The firing pulse width is determined by the zero-crossing detection which can be influenced by the synchronous resistance,  $R_{sync}$ , (see Figure 6 on page 5).

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

where

- $I_L$  = Latching current of the triac
- $V_M$  = Mains supply, effective
- $P$  = Load power

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

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

Figure 5. Output Pulse Width

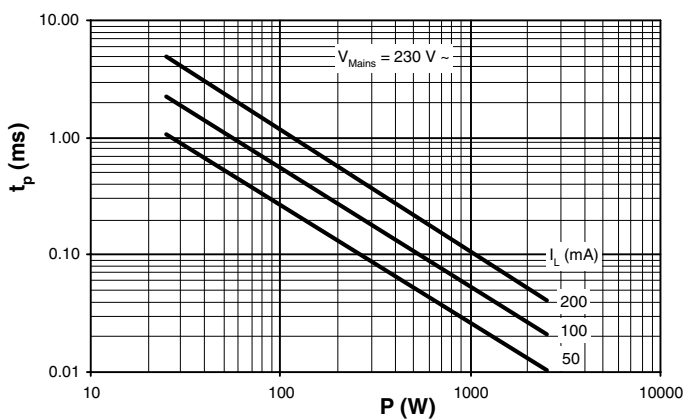
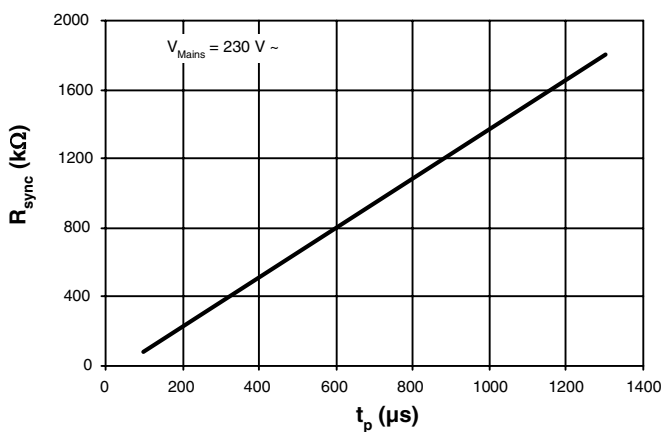


Figure 6. Synchronization Resistance



## Supply Voltage

The T2117 contains a voltage limiting function and can be connected with the mains supply via the diode  $D_1$  and the resistor  $R_1$ . The supply voltage between pin 5 and 7 is limited to a typical value of 9.5 V.

The series resistance  $R_1$  can be calculated as follows (Figure 7 on page 6 and Figure 8 on page 6):

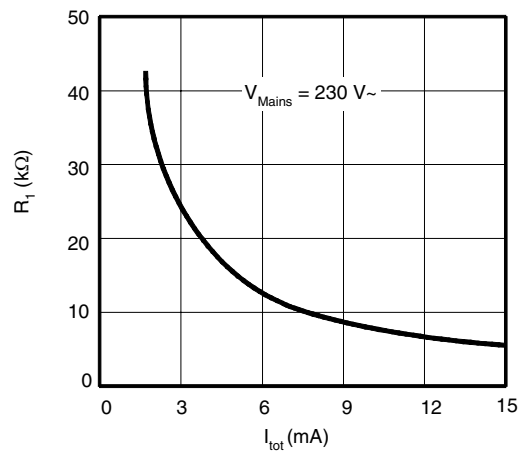
$$R_{1\max} = 0.85 \frac{V_{M\min} - V_{S\max}}{2 I_{\text{tot}}}; P_{(R1)} = \frac{(V_M - V_S)^2}{2 R_1}$$

$$I_{\text{tot}} = I_S + I_P + I_x$$

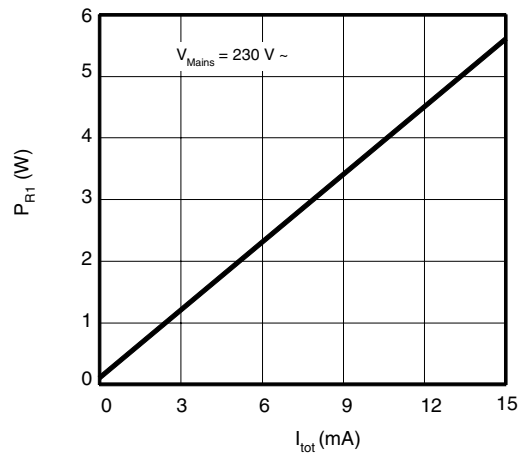
where

- $V_M$  = 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

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Parameters                                                                         | Pin                  | Symbol                        | Value                                  | Unit             |
|------------------------------------------------------------------------------------|----------------------|-------------------------------|----------------------------------------|------------------|
| Supply current                                                                     | 5                    | $-I_S$                        | 30                                     | mA               |
| Synchronous current                                                                | 8                    | $I_{sync}$                    | 5                                      | mA               |
| Output current ramp generator                                                      | 1                    | $I_O$                         | 3                                      | mA               |
| Input voltages                                                                     | 1, 3, 4, 6<br>2<br>8 | $-V_I$<br>$-V_I$<br>$\pm V_I$ | $\leq V_S$<br>2 to $V_S$<br>$\leq 7.3$ | V<br>V<br>V      |
| Power dissipation<br>$T_{amb} = 45^\circ\text{C}$<br>$T_{amb} = 100^\circ\text{C}$ |                      | $P_{tot}$<br>$P_{tot}$        | 400<br>125                             | mW<br>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 SO8  | $R_{thJA}$ | 200   | K/W  |
| Junction ambient DIP8 | $R_{thJA}$ | 110   | K/W  |

## Electrical Characteristics

$-V_S = 8.8\text{ V}$ ,  $T_{amb} = 25^\circ\text{C}$ , reference point pin 7, unless otherwise specified

| Parameters                | Test Conditions                                                                                 | Pin    | Symbol           | Min.       | Typ.       | Max.         | Unit                           |
|---------------------------|-------------------------------------------------------------------------------------------------|--------|------------------|------------|------------|--------------|--------------------------------|
| Supply-voltage limitation | $-I_S = 1\text{ mA}$<br>$-I_S = 10\text{ mA}$                                                   | 5      | $-V_S$<br>$-V_S$ | 9.0<br>9.1 | 9.5<br>9.6 | 10.0<br>10.1 | V<br>V                         |
| Supply current            |                                                                                                 | 5      | $-I_S$           |            |            | 500          | $\mu\text{A}$                  |
| Voltage limitation        | $I_8 = \pm 1\text{ mA}$                                                                         | 8      | $\pm V_I$        | 7.7        | 8.2        | 8.7          | V                              |
| Synchronization current   |                                                                                                 | 8      | $\pm I_{sync}$   | 0.12       |            |              | mA                             |
| Zero detector             |                                                                                                 | 8      | $\pm I_{sync}$   |            | 35         |              | $\mu\text{A}$                  |
| Output pulse width        | $V_M = 230\text{ V} \sim$<br>$R_{sync} = 220\text{ k}\Omega$<br>$R_{sync} = 470\text{ k}\Omega$ | 6<br>6 | $t_P$<br>$t_P$   |            | 260<br>460 |              | $\mu\text{s}$<br>$\mu\text{s}$ |
| Output pulse current      | $V_6 = 0\text{ V}$                                                                              | 6      | $-I_O$           | 100        |            |              | mA                             |
| <b>Comparator</b>         |                                                                                                 |        |                  |            |            |              |                                |
| Input offset voltage      |                                                                                                 | 3, 4   | $\pm V_{IO}$     |            |            | 15           | mV                             |
| Input bias current        |                                                                                                 | 4      | $I_{IB}$         |            |            | 1            | $\mu\text{A}$                  |
| Common-mode input voltage |                                                                                                 | 3, 4   | $-V_{IC}$        | 1          |            | $(V_S - 1)$  | V                              |

## Electrical Characteristics (Continued)

$-V_S = 8.8 \text{ V}$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ , reference point pin 7, unless otherwise specified

| Parameters                                | Test Conditions                                                                                                                                | Pin | Symbol            | Min. | Typ. | Max. | Unit          |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------|------|------|------|---------------|
| Threshold internal reference              | $V_3 = 0 \text{ V}$                                                                                                                            | 4   | $-V_{\text{Ref}}$ |      | 1.4  |      | V             |
| <b>Ramp Generator, Figure 1 on page 2</b> |                                                                                                                                                |     |                   |      |      |      |               |
| Period                                    | $-I_S = 1 \text{ mA}$<br>$I_{\text{sync}} = 1 \text{ mA}$<br>$C_1 = 100 \mu\text{F}$<br>$C_2 = 2.2 \mu\text{F}$<br>$R_4 = 100 \text{ k}\Omega$ | 1   | T                 |      | 1.5  |      | s             |
| Final voltage                             |                                                                                                                                                | 1   | $-V_1$            | 1.2  | 1.6  | 2.0  | V             |
| Initial voltage                           |                                                                                                                                                | 1   | $-V_1$            | 7.2  | 7.6  | 8.0  | V             |
| Charge current                            | $V_2 = -V_S$ , $I_8 = -1 \text{ mA}$                                                                                                           | 2   | $-I_2$            | 14   | 20   | 26   | $\mu\text{A}$ |

## Applications

**Figure 9.** Power Blinking Switch with  $f \approx 2.7 \text{ Hz}$ , Duty Cycle 1:1, Power Range 0.5 to 2.2 kW

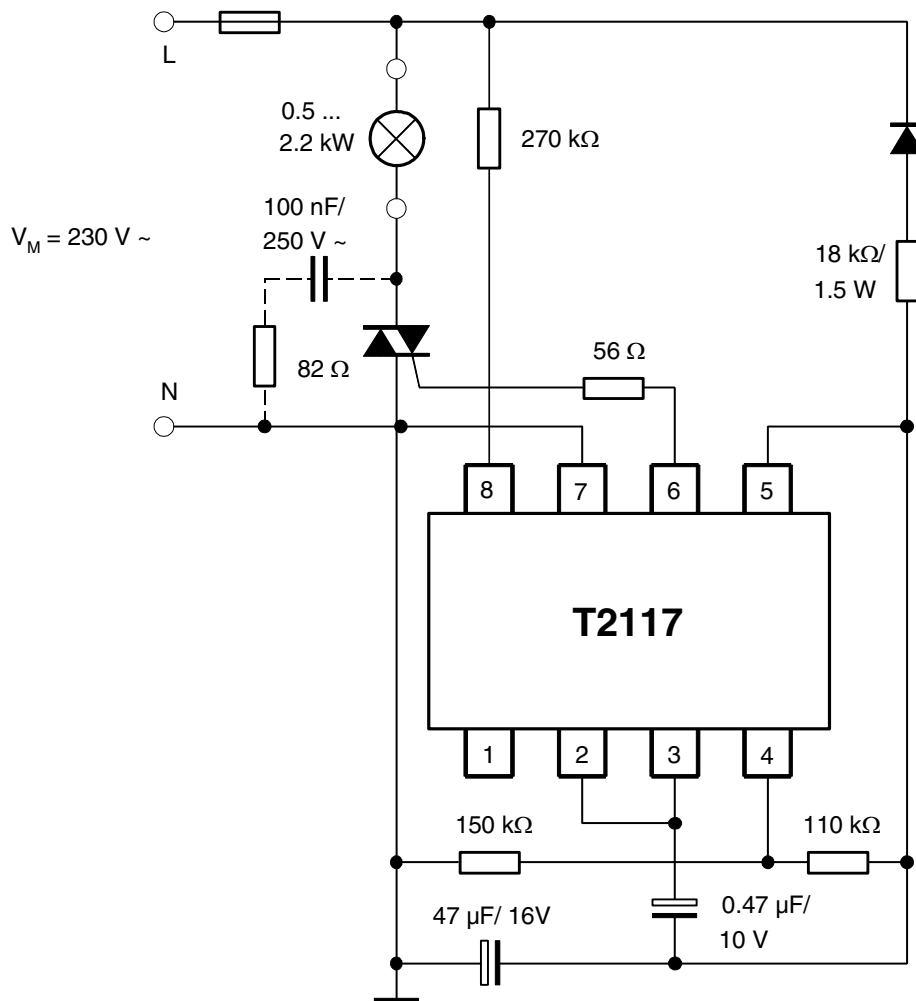




Figure 10. Power Switch

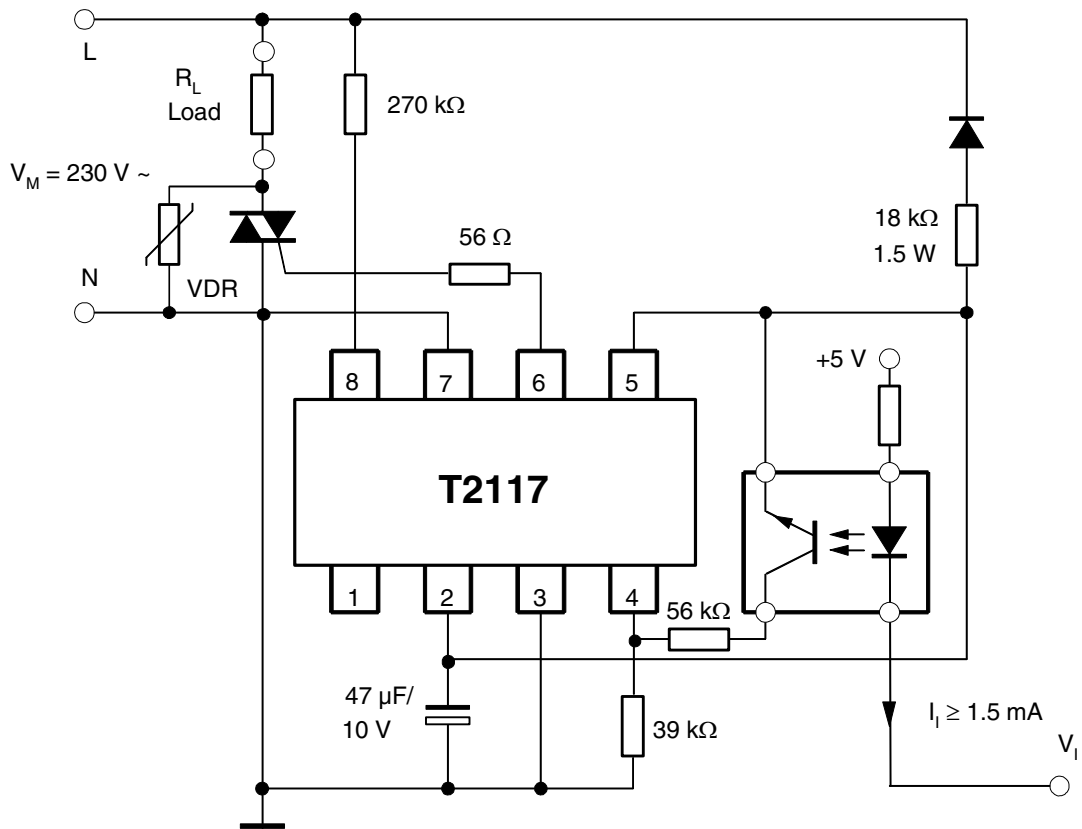
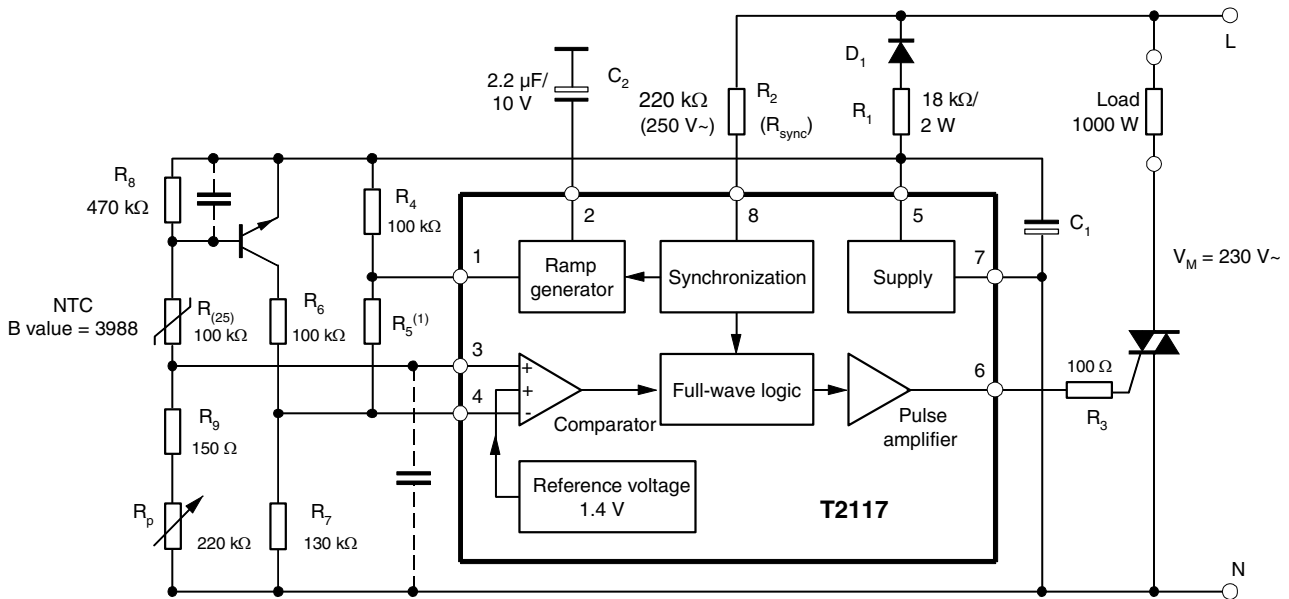
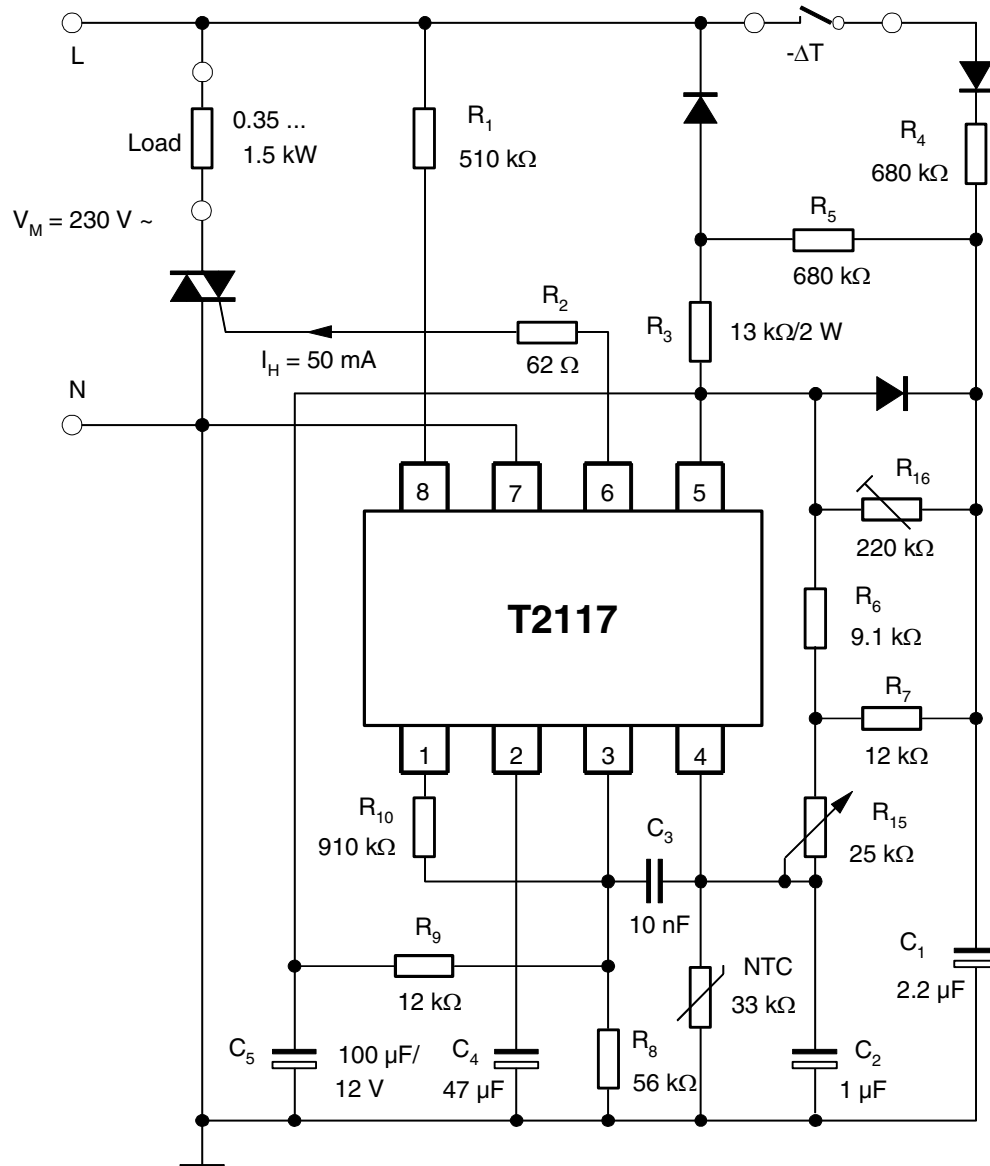


Figure 11. Temperature Control 15°C to 35°C with Sensor Monitoring

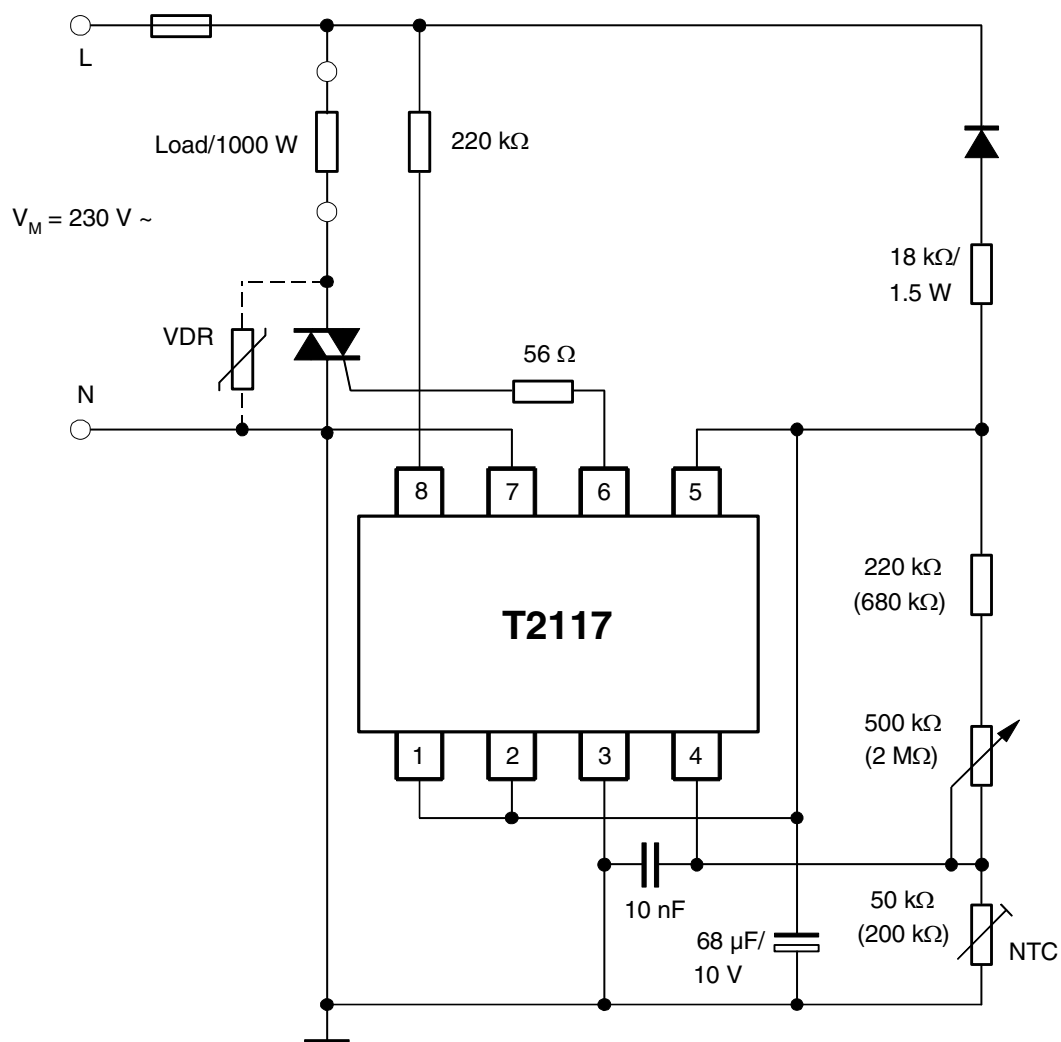


$R_{(25)} = 100 \text{ k}\Omega / B = 3988 \rightarrow R_{(15)} = 159 \text{ k}\Omega$ ,  $R_{(35)} = 64.5 \text{ k}\Omega$ ,  $R_5^{(1)}$  determines the proportional range.

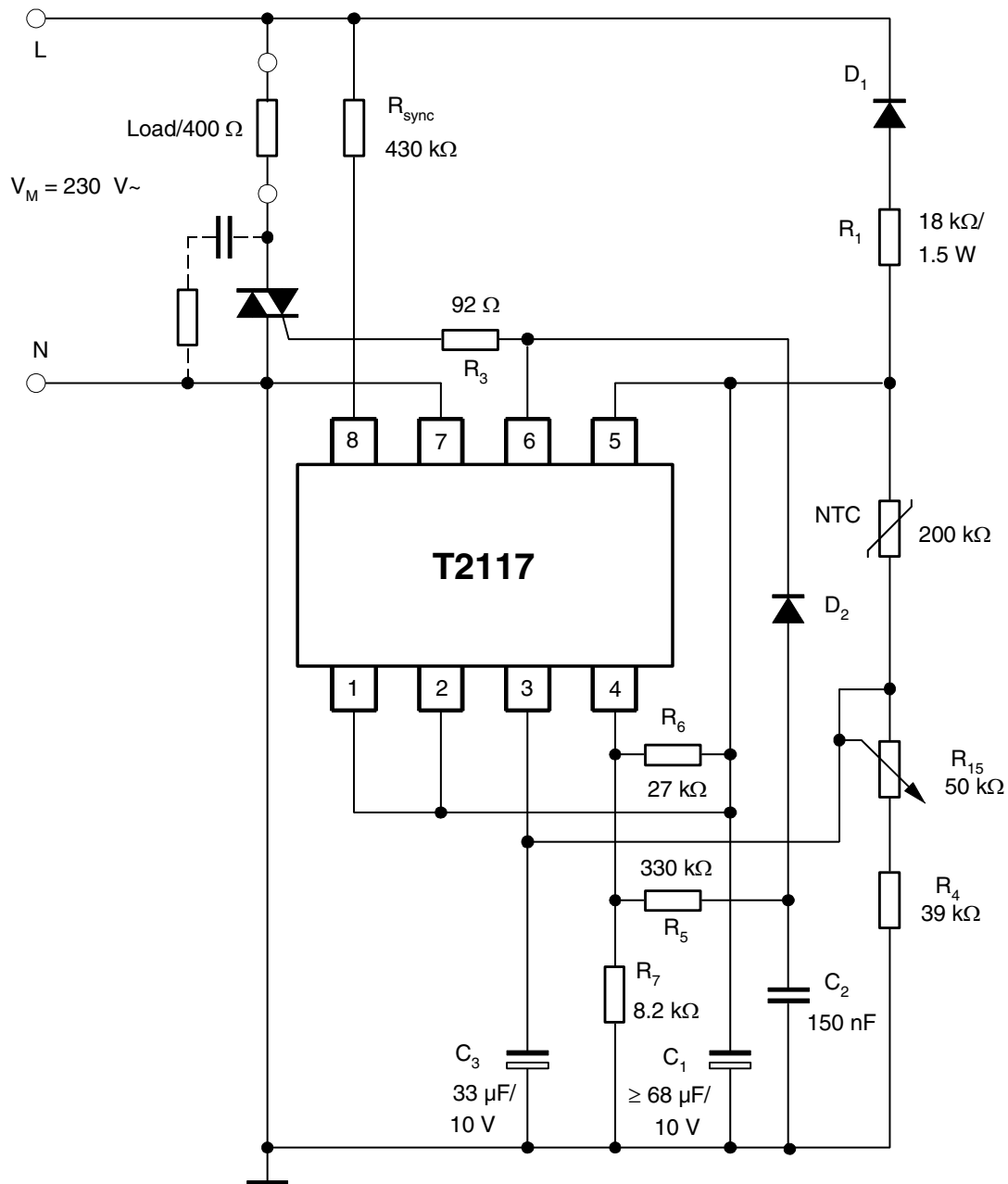
**Figure 12.** Room Temperature Control with Definite Reduction (Remote Control) for a Temperature Range of 5 to 30°C



**Figure 13.** Two-point Temperature Control for a Temperature Range of 15°C to 30°C



**Figure 14.** Two-point Temperature Control for a Temperature of 18°C to 32°C and a Hysteresis of  $\pm 0.5^\circ\text{C}$  at 25°C



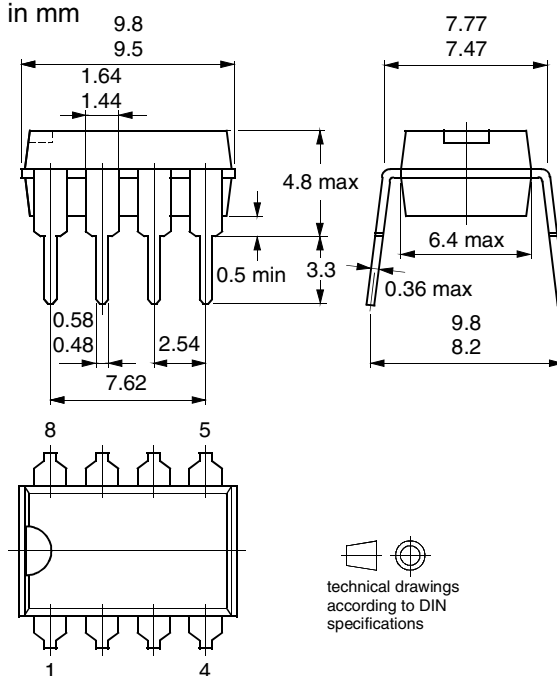
## Ordering Information

| Extended Type Number | Package | Remarks          |
|----------------------|---------|------------------|
| T2117-3AS            | DIP8    | Tube             |
| T2117-TAS            | SO8     | Tube             |
| T2117-TAQ            | SO8     | Taped and reeled |

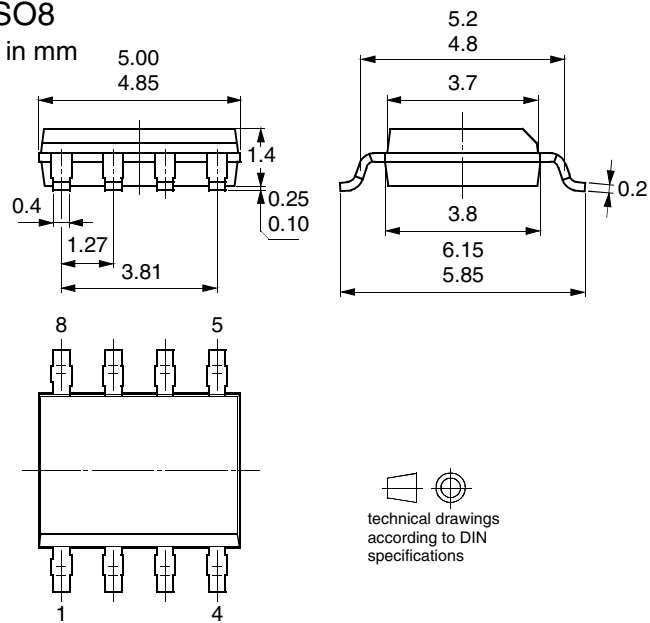
## Package Information

### Package DIP8

Dimensions in mm



# Package SO8 Dimensions in mm





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