Zero-Voltage Switch with Adjustable Ramp

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.

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

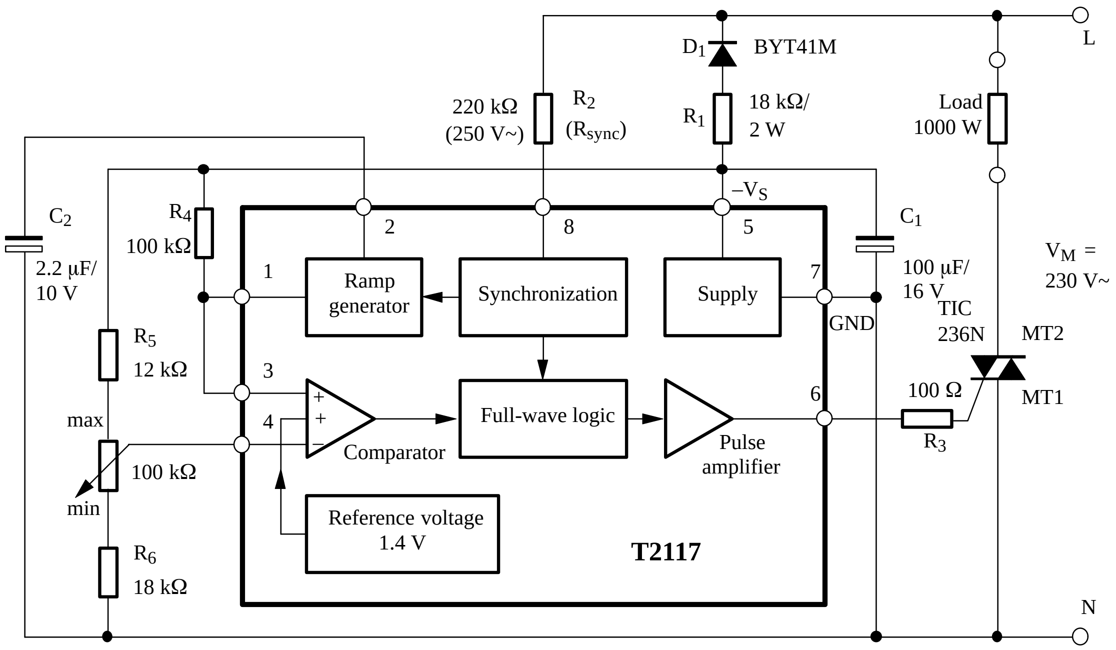


Figure 1. Block diagram with typical circuit, period group control 0 to 100%

Ordering Information

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

Pin Description

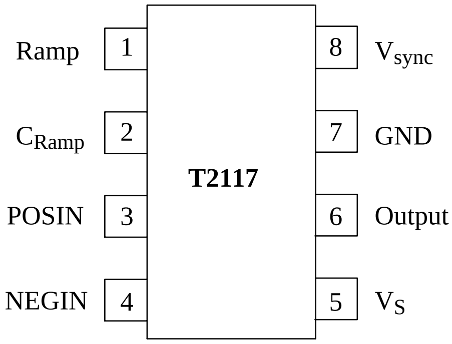


Figure 2. Pinning

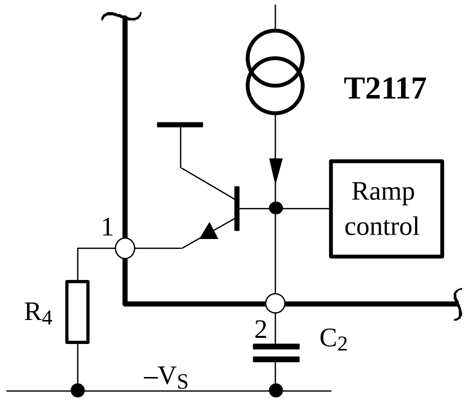


Figure 3. Pin 1 internal network

Pin	Symbol	Function
1	Ramp	Ramp output
2	C_{Ramp}	Ramp capacitor
3	POSIN	Non-inverting comparator input
4	NEGIN	Inverting comparator input
5	V_S	Supply voltage
6	Output	Trigger pulse output
7	GND	Ground
8	V_{sync}	Voltage synchronization

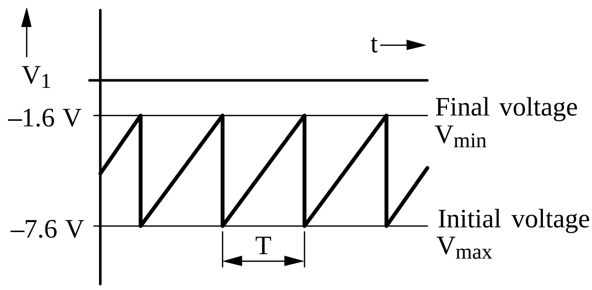


Figure 4. Threshold voltage of the ramp at V_S = –8.8 V

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 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 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 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 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, 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.

Triac Firing Current (Pulse)

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

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

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

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 detection which can be influenced with the help of sync. resistance, R_{sync}, (figure 6).

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

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:

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

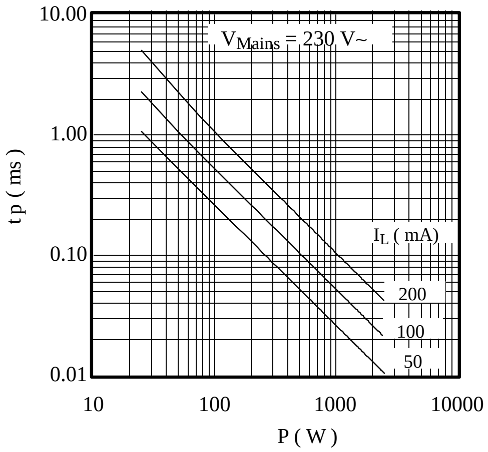


Figure 5. Output pulse width

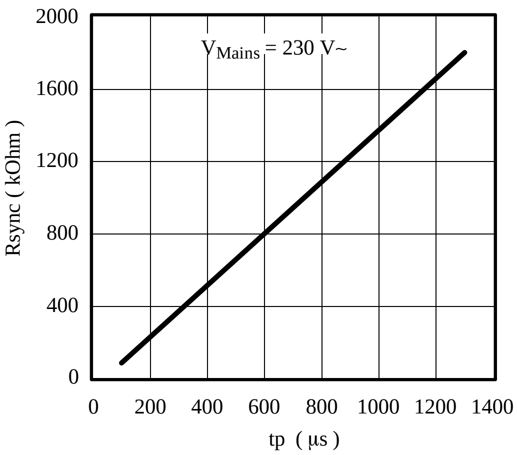


Figure 6. Synchronization resistance

Supply Voltage

The T2117 contains voltage limiting and can be connected with the mains supply via the diode D_1 and the resistor R_1. 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 (figures 7 and 8) as follows:

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

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

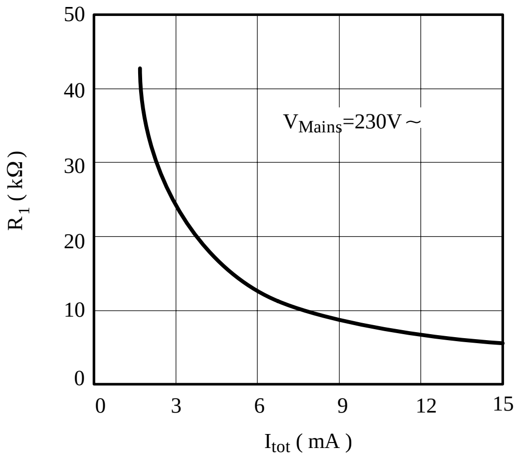


Figure 7. Maximum resistance of R_1

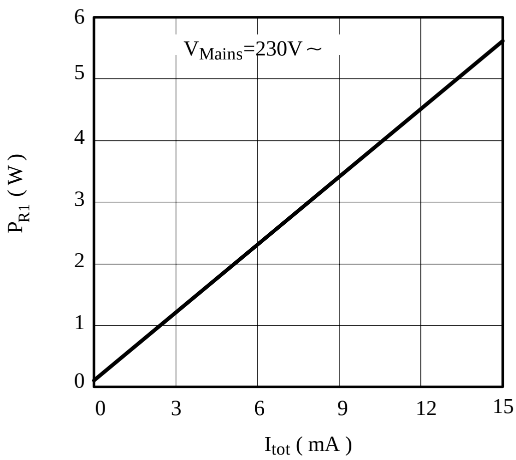


Figure 8. Power dissipation of R_1 according to current consumption

Absolute Maximum Ratings

Parameter		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 to V_S ≤ 7.3	V V V
Power dissipation	T_{amb} = 45°C T_{amb} = 100°C	P_{tot} P_{tot}	400 125	mW mW
Junction temperature		T_j	125	°C
Operating ambient temperature range		T_{amb}	0 to 100	°C
Storage temperature range		T_{stg}	–40 to + 125	°C

Thermal Resistance

Parameter		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 V, T_{amb} = 25°C, reference point Pin 7, unless otherwise specified

Parameter	Test Conditions / Pins		Symbol	Min.	Typ.	Max.	Unit
Supply-voltage limitation	$-I_S$ = 1 mA $-I_S$ = 10 mA	Pin 5 Pin 5	$-V_S$ $-V_S$	9.0 9.1	9.5 9.6	10.0 10.1	V V
Supply current		Pin 5	$-I_S$			500	µA
Voltage limitation	I_8 = ± 1 mA	Pin 8	$\pm V_I$	7.7	8.2	8.7	V
Synchronization current		Pin 8	$\pm I_{sync}$	0.12			mA
Zero detector		Pin 8	$\pm I_{sync}$		35		µA
Output pulse width	V_M= 230 V∼, R_{sync} = 220 kΩ R_{sync} = 470 kΩ	 Pin 6 Pin 6	 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	$\pm V_{I0}$			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 V	Pin 4	$-V_{Ref}$		1.4		V

Electrical Characteristics (continued)

$-V_S$ = 8.8 V, T_{amb} = 25°C, reference point Pin 7, unless otherwise specified

Parameter	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Ramp generator, figure 1						
Period	$-I_S$= 1 mA, i_{sync} =1 mA, C_1 = 100 µF, C_2 = 2.2 µF, R_4= 100 kΩ Pin 1	T		1.5		s
Final voltage	Pin 1	$-V_1$	1.2	1.6	2.0	V
Initial voltage	Pin 1	$-V_1$	7.2	7.6	8.0	V
Charge current	$V_2 = -V_S$, I_8 = –1 mA, Pin 2	$-I_2$	14	20	26	µA

Applications

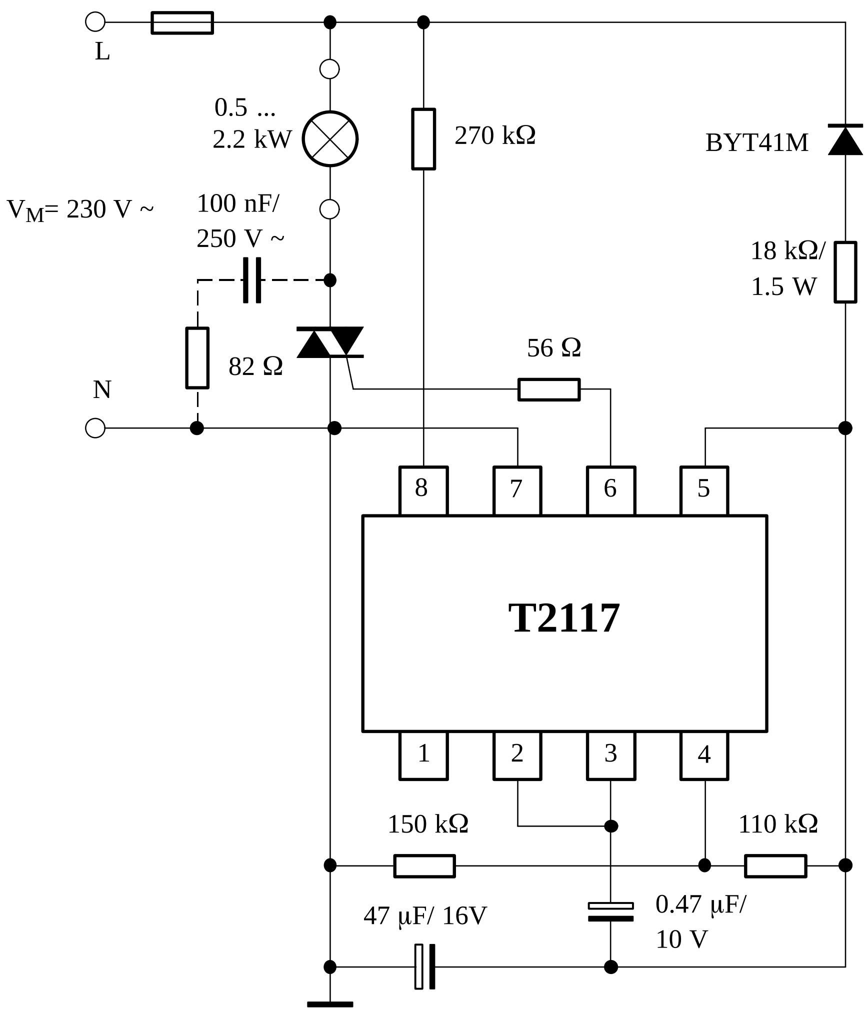


Figure 9. Power blinking switch with f ≈ 2.7 Hz, duty cycle 1:1, power range 0.5 to 2.2 kW

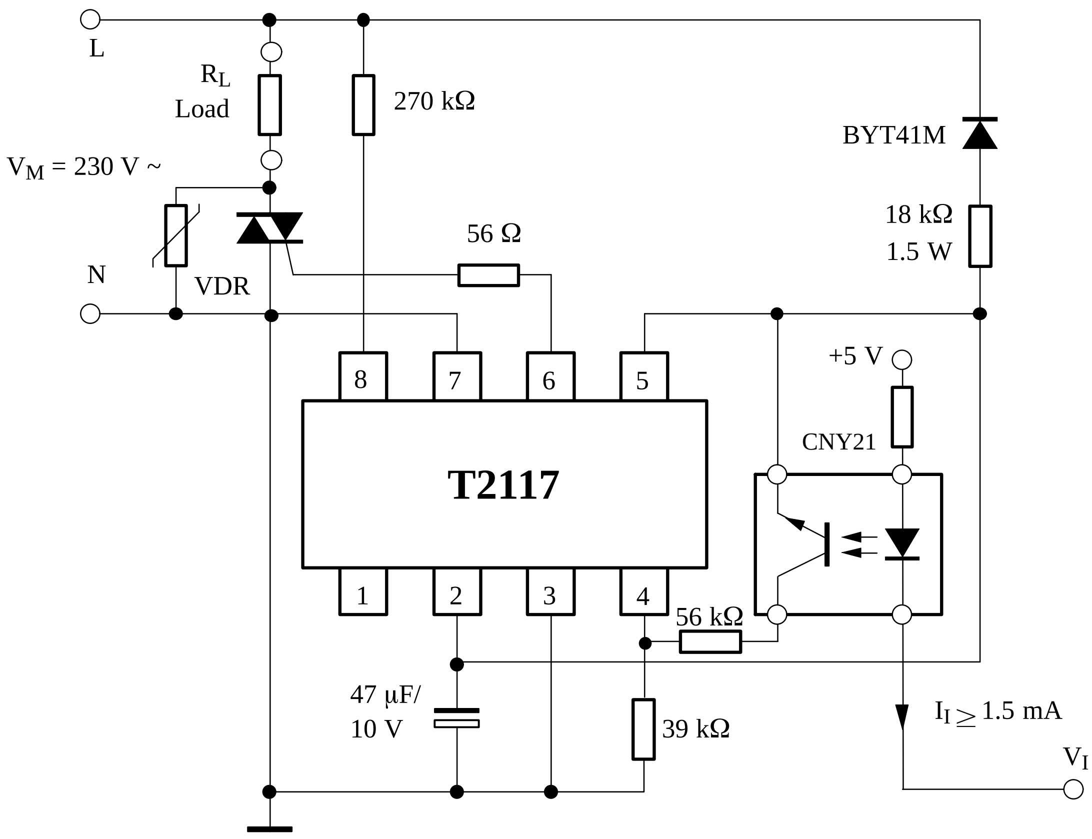


Figure 10. Power switch

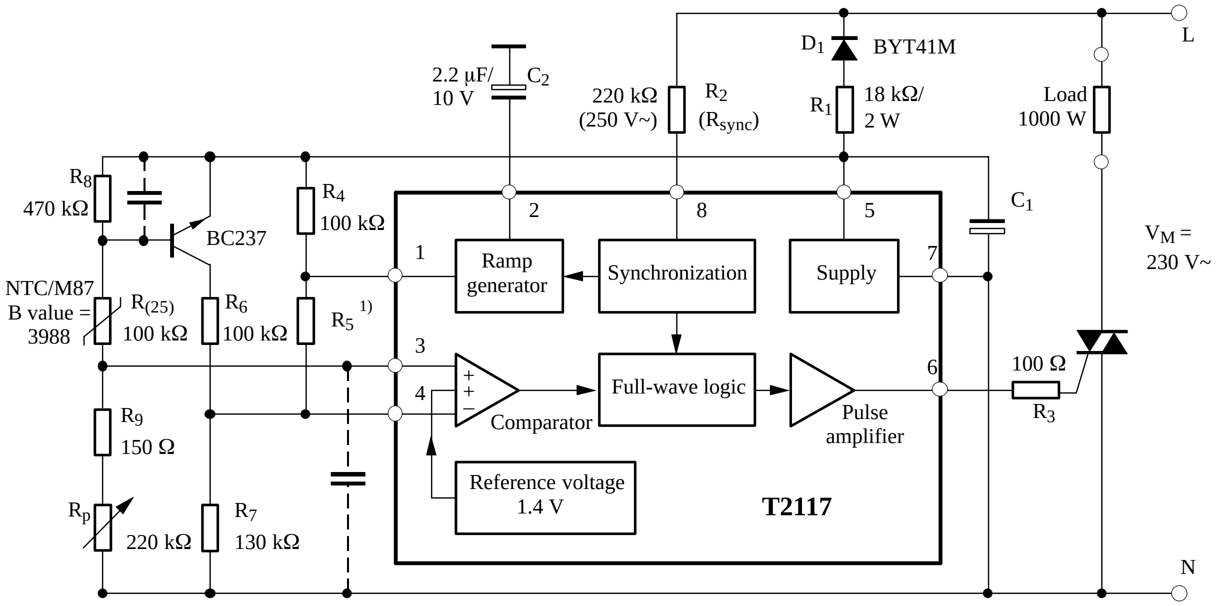


Figure 11. Temperature control 15 to 35°C with sensor monitoring
NTC–Sensor M 87 Fabr. Siemens

$R_{(25)}$ =100 kΩ/B =3988 ⇒ $R_{(15)}$ = 159 kΩ R_5[1)] determines the proportional range
$R_{(35)}$ = 64.5 kΩ

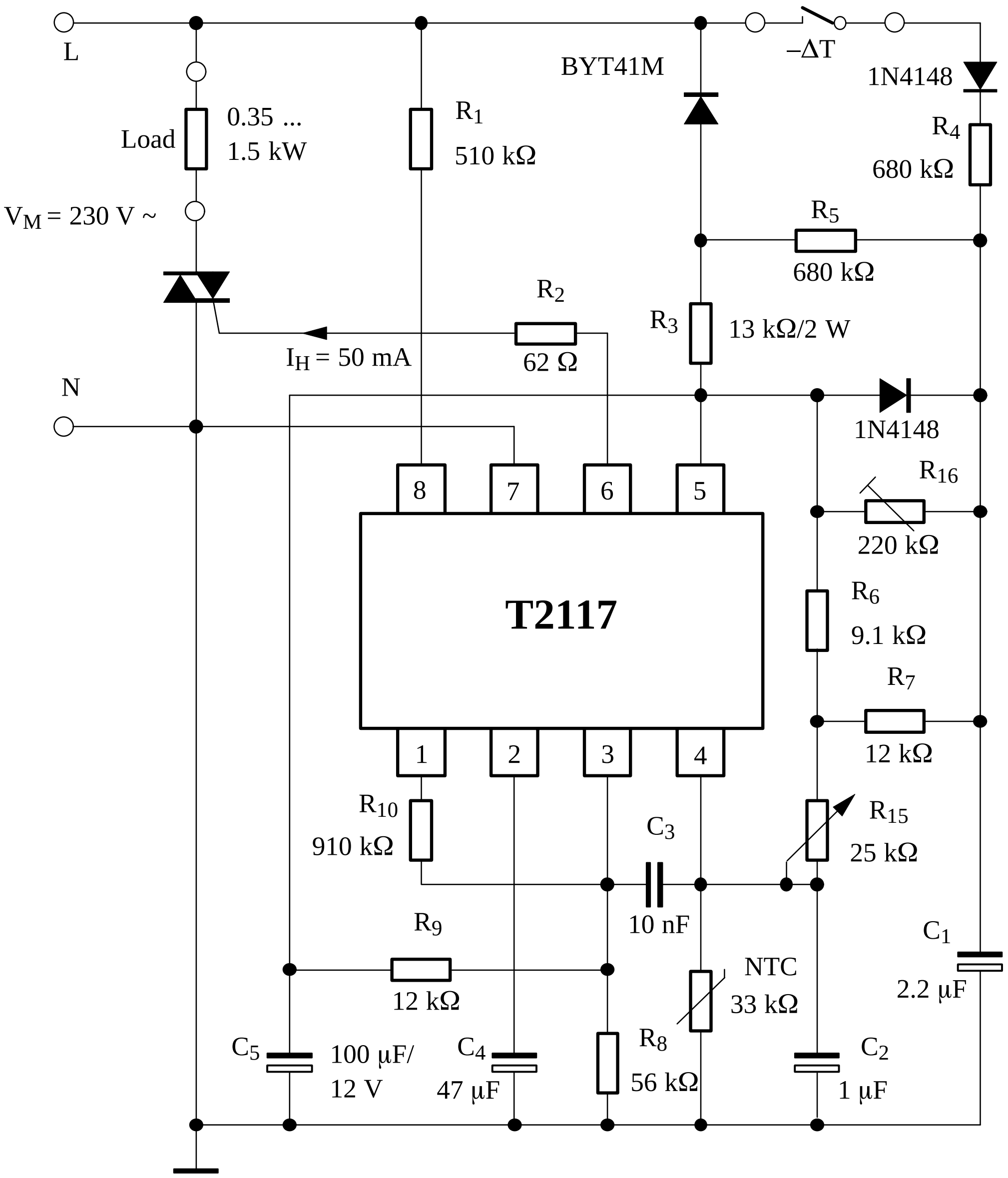


Figure 12. Room temperature control with definite reduction (remote control) for a temperature range of 5 to 30°C

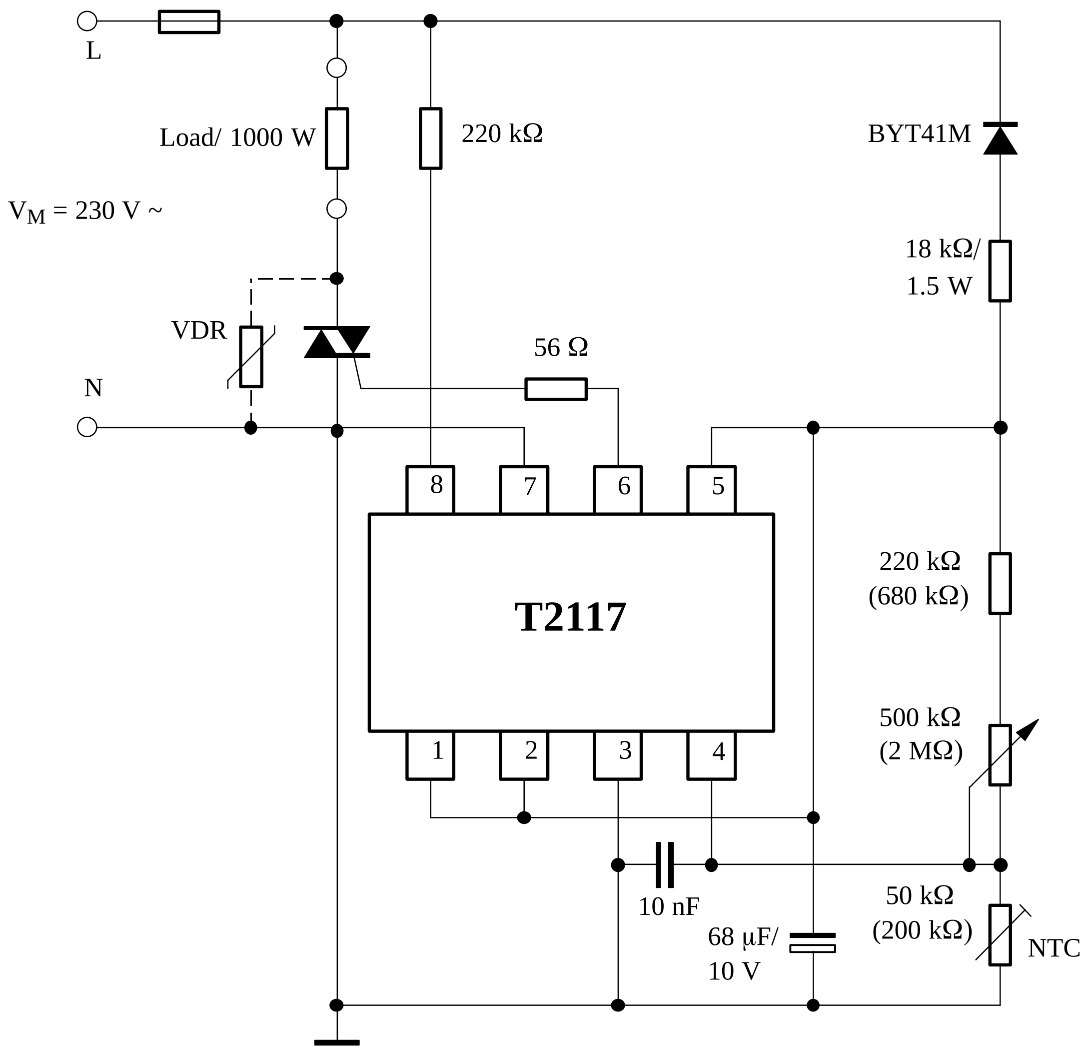


Figure 13. Two–point temperature control for a temperature range of 15 to 30°C

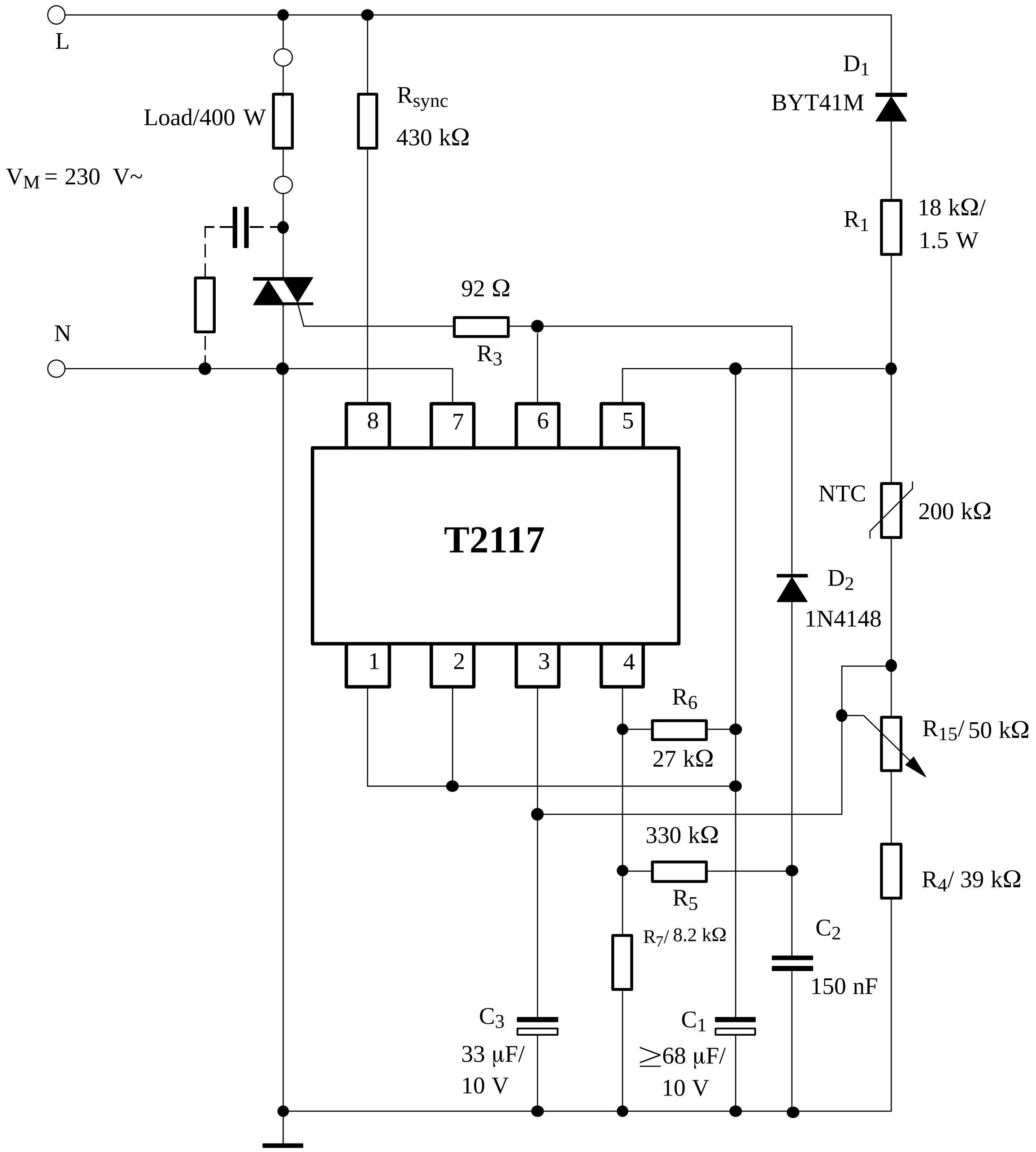
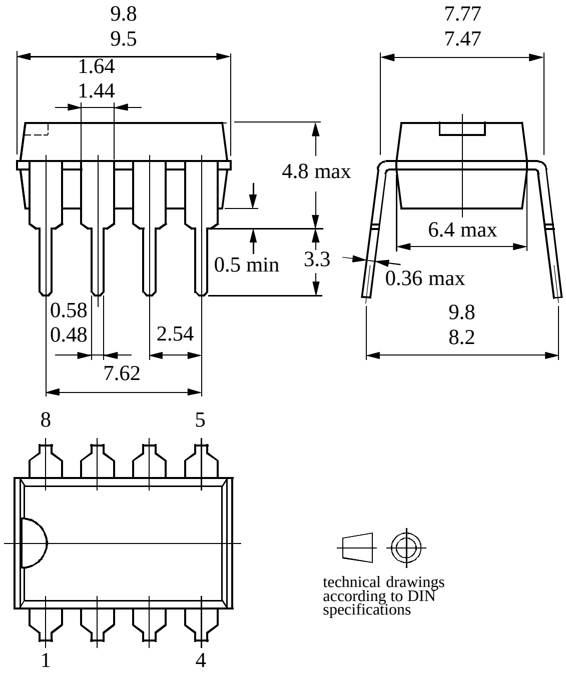


Figure 14. Two-point temperature control for a temperature range of 18 to 32°C and a hysteresis of ± 0.5°C at 25°C

Package Information

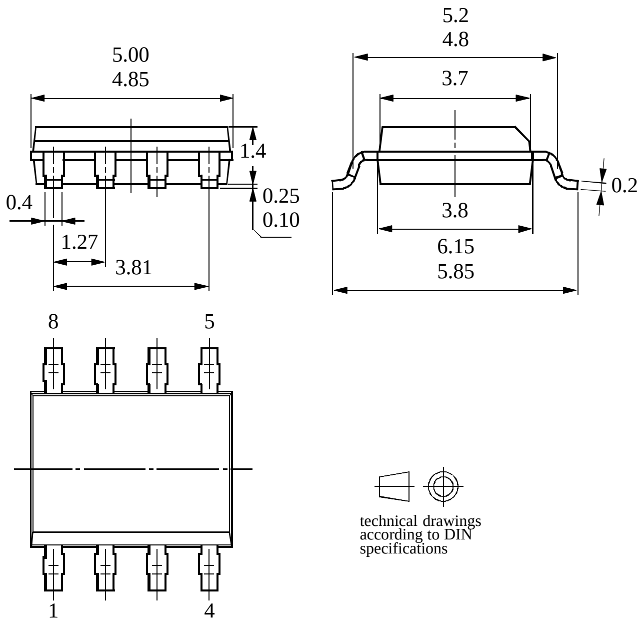
Package DIP8

Dimensions in mm



Package SO8

Dimensions in mm



Ozone Depleting Substances Policy Statement

It is the policy of **Atmel Germany GmbH** to

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

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

The Montreal Protocol (1987) and its London Amendments (1990) intend to 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.

Atmel Germany GmbH has been able to use its policy of continuous improvements to eliminate the use of 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
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

Atmel Germany GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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