

## Zero Voltage Switch with Fixed Ramp

### Description

The monolithic integrated bipolar circuit, TEA1024/TEA1124 is a zero voltage switch for triac control in domestic equipments. It offers not only the control of a triac in zero crossing mode but also the possibility of power control. This is why the IC contains a mains

synchronized ramp generator with 640 ms (1280 ms) duration (50 Hz). It is suitable for a typical load of 750 W (1000 W) meeting the Flicker Standard. (values in brackets relate to TEA1124.)

### Features

- Direct supply from the mains
- Definite IC switching characteristics
- Very few external components
- Full wave drive – no dc component in the load circuit
- Current consumption  $\leq 1.5$  mA
- Output short circuit protected

- Simple power control
- Integrated ramp generator
- Reference voltage variable by external resistance
- Pulse position optimization

**Package:** DIP8

### Block Diagram

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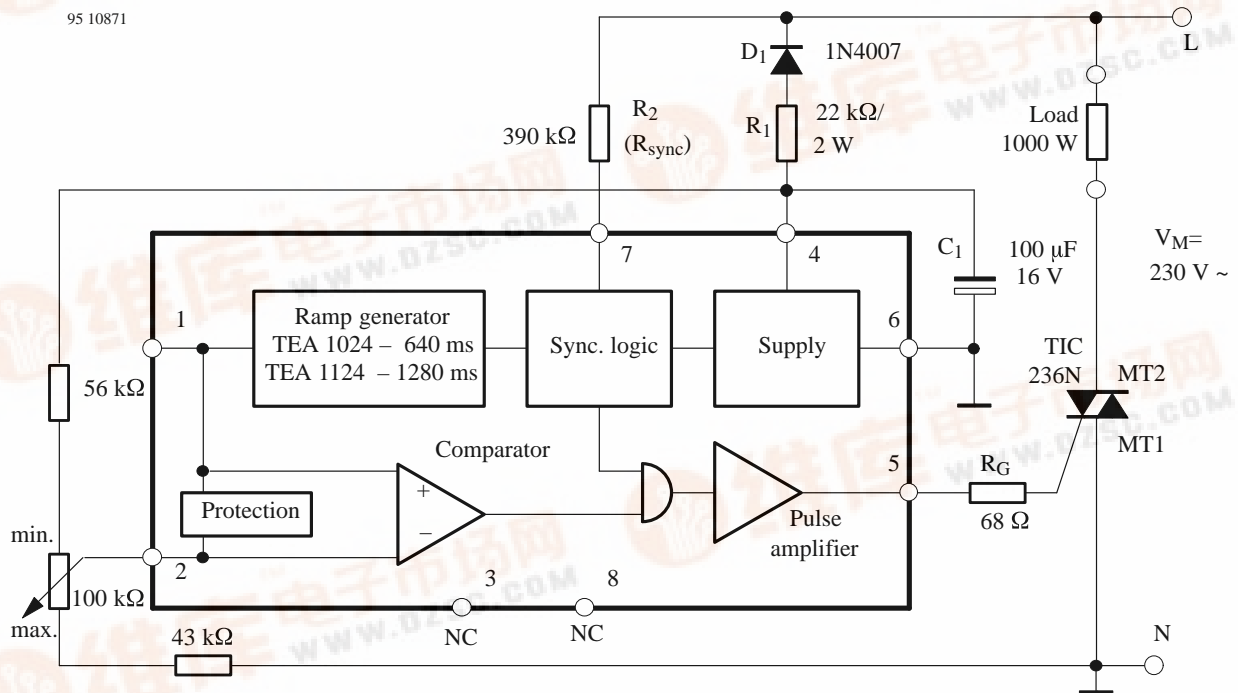


Figure 1. Typical block diagram – open loop power control

## Power Supply and its Limitations

The voltage limitation contained in the IC allows it to be powered from mains via series resistance  $R_1$  and rectifying diode  $D_1$  between Pin 6 (+ Pol/  $\perp$ ) and Pin 4 ( $-V_S$ ). The capacitor  $C_1$  smooths the supply voltage (see figure 1).

An internal temperature-compensated limiting circuit protects the module from random peaks of voltage on the mains, and delivers a defined reference voltage during the negative half-cycle.

## Synchronization

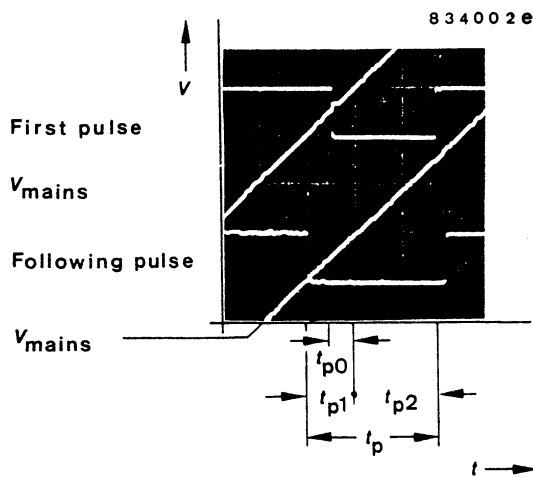


Figure 2. Pulse position optimization

The logic function is synchronized by means of a separate resistance  $R_2$  connected between Pin 7 and phase (voltage-synchronization). The width of the pulse can be varied between wide limits by choice of  $R_{sync}$ . The larger the value chosen, the wider the output pulse is on Pin 5. Automatic optimization of the phase of the pulse is necessary, since the latching current of the triac exceeds the steady current by a factor of 3.

The phase of the pulse is chosen so that ca. 1/3 of the pulse width appears before the transition through null and 2/3 after it (see electrical characteristics and figure 2).

In order to avoid phase-clipping after the switch-on the first third of the first pulse is automatically suppressed.

## Full-Wave Logic

The full-wave logic ensures that only pairs of pulses can be released, and that these always begin with the positive  $dv/dt$ . The load is thus switched on for a minimum of one complete mains cycle. This means that the triac receives a minimum of two driving pulses, so that the unwanted d.c. component in the load circuit is definitely eliminated.

## Pulse Amplifier

The pulse amplifier connected to the output of the full-wave logic circuit, is proof against continuous short-circuits, and delivers negative output pulses of typ. 75 mA, via an integrated limiting resistance, to Pin 5.

## Ramp Generator (Figures 3, 4)

Ramp voltage which is generated in the IC is available not only at reference Pin 1, but also at the non-inverted input of the comparator.

The current sink which is controlled by D/A converter influences the internal reference voltage at Pin 1 specified by voltage divider. The current sink is turned-off in the reset state of the D/A converter so that the voltage at Pin 1 is primarily specified via the internal voltage divider (ramp starting voltage).

In the maximum state of the 4 stage (5 stage – TEA1124) D/A converter, the current sink overtakes the maximum current, whereby the ramp's final (end) voltage has reached. External resistance  $R_x$ ,  $R_y$  shown in figure 4 are in position to influence the initial ramp voltage as well as the ramp amplitude. If the external resistances ratio  $R_x$ ,  $R_y$  is the same as that of the internal ratio, the ramp voltage at the beginning remains maintained (constant), only the amplitude is compressed.

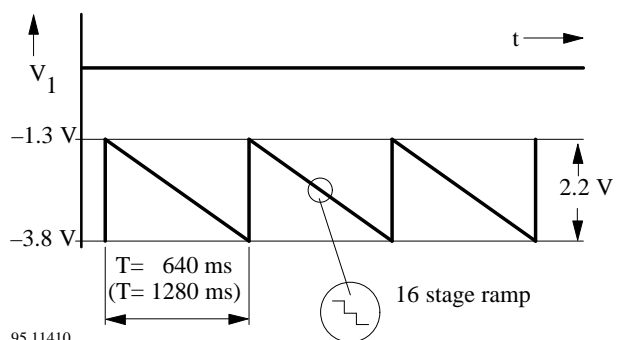


Figure 3. Ramp diagram without external circuit

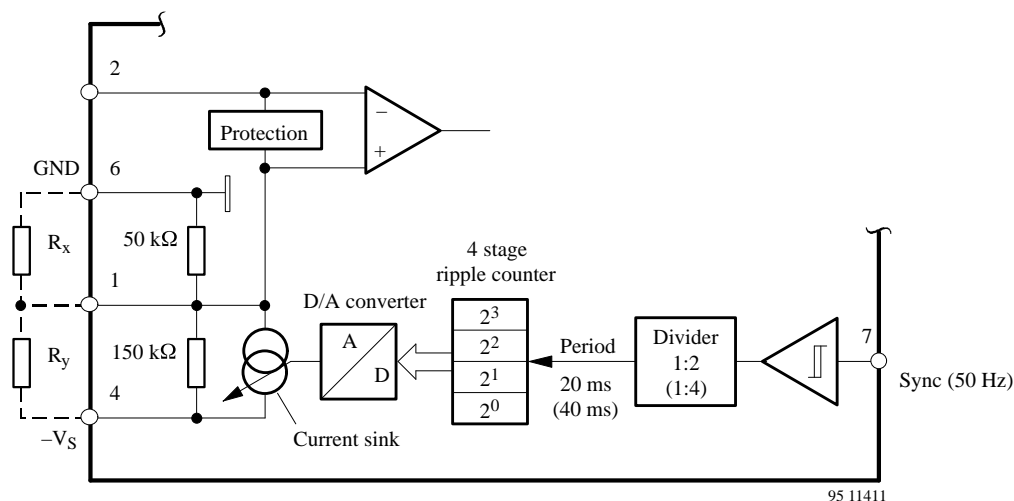


Figure 4. Principle diagram – Generation and evaluation of ramp

### Period

1. The time required for one complete cycle of a regular, repeating signal, function, or series of emends.
2. The tune between two consecutive transients of the pointer or indicating means of an electrical indicating instrument in the same disdain the rest position. Something called periodic fine.

### Comparator

The comparison of set value and measured value is carried out via the two comparator inputs Pin 1 and Pin 2. Here Pin 2 is the inverting input and has a circuit protecting it against interference spikes. Figure 5 shows the protective circuit of the comparator. Pin 1 is the non-inverting input.

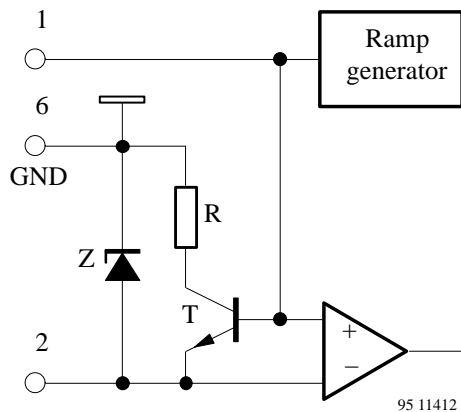


Figure 5. Protective circuit of the comparator

### Firing Pulse Width (Figures 6, 7)

It depends on the latching current as well as on the load current of the used triacs.

$$t_p [s] = \frac{3}{4 \pi f} \arcsin \frac{I_L \times V_M}{P \times \sqrt{2}}$$

whereas  $I_L [A]$  = Latching current of the triac  
 $V_M [V]$  = Mains voltage, effective  
 $P [W]$  = Power load  
 $f [1/s]$  = Mains frequency

Firing pulse width is specified through the zero cross over identification which can be influenced by the sync. resistance.

$$R_{sync} [\Omega] = \frac{V_M \sqrt{2} \sin \left( \frac{2}{3} \times \omega \times t_p \right) - 0.6}{2.5 \times 10^{-5}} - 1.4 \times 10^3$$

where  
 $t_p [s]$  = required ignition pulse width

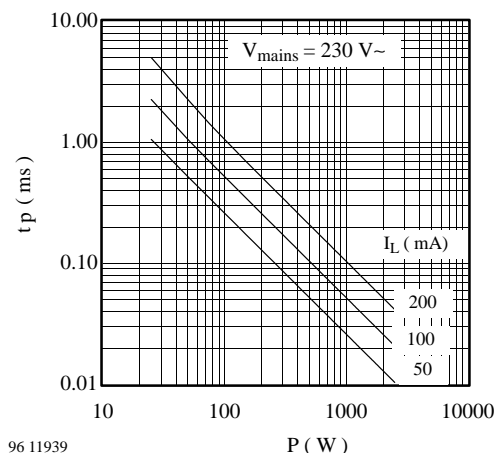


Figure 6.

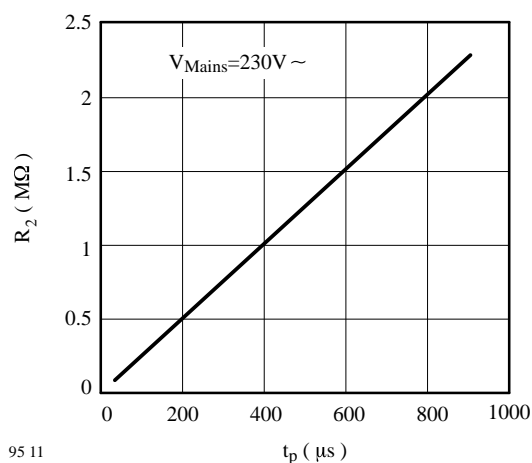


Figure 7.

## Ignition (Firing) Current

The necessary ignition current depends on the specified triac. With the help of a resistance, it is possible to limit its value:

$$R_{Gmax} [\Omega] \approx \frac{5.7 \text{ V} - V_{Gmax}}{I_{Gmax}} - 25 \Omega$$

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

- whereas  $V_G[V]$  = Gate voltage of the triac
- $I_G[A]$  = Max. gate current
- $I_p[A]$  = Average gate current requirement
- $t_p[s]$  = Ignition pulse width
- $T[s]$  = Duration (of mains frequency)

## Supply Voltage

Due to higher trigger sensitivity of the triac it is supplied with negative signal. It can be supplied via diode and series resistance from the negative half wave of the mains. An internal parallel controller limits the voltage between Pin 5 and 7 to a typical value of 6.55 V.

## Dimensioning of the Series Resistance $R_1$ (Figures 8, 9)

$$R_{1max} = 0.85 \frac{V_{Mmin} - V_{Smax}}{2 I_{tot}} - 65 \Omega$$

$$I_{tot} = I_S + I_P + I_X \quad P(R_1) = \frac{(V_M - V_S)^2}{2 R_1}$$

- $V_M$  = Mains supply
- $V_S$  = Limiting voltage of the IC
- $I_{tot}$  = Total current requirement
- $I_X$  = Current requirement for external circuit

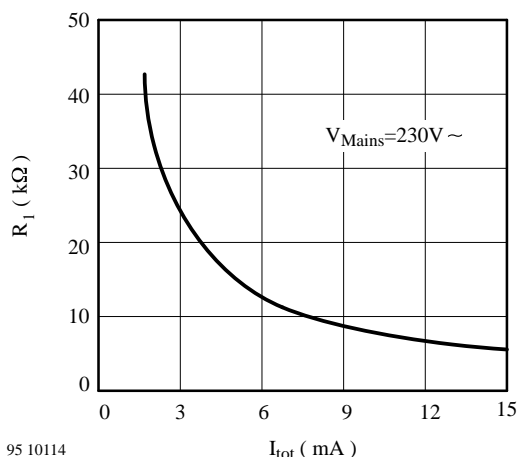


Figure 8.

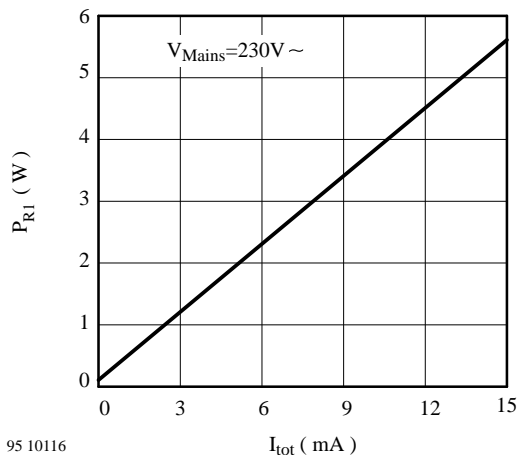


Figure 9.

## Absolute Maximum Ratings

Reference point Pin 6

Parameters	Symbol	Value	Unit
Current consumption $t \leq 10 \mu\text{s}$	Pin 4 $-I_S$ $i_s$	30 150	mA
Sync. current $t \leq 10 \mu\text{s}$	Pin 7 $I_{\text{Sync}}$ $i_{\text{Sync}}$	5 40	mA
Comparator input current	Pin 2 $\pm I_I$	1	mA
Input voltages	Pin 1,4,5 Pin 5 $-V_I$ $+V_I$	$\leq V_S$ $\leq 0.5$	V
Power dissipation $T_{\text{amb}} = 45^\circ\text{C}$ $T_{\text{amb}} = 100^\circ\text{C}$	$P_{\text{tot}}$	400 125	mW
Junction temperature	$T_j$	125	$^\circ\text{C}$
Ambient temperature range	$T_{\text{amb}}$	0 to 100	$^\circ\text{C}$
Storage temperature range	$T_{\text{stg}}$	-40 to + 125	$^\circ\text{C}$

## Thermal Resistance

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

## Electrical Characteristics

Supply voltage  $-V_S = 5.6 \text{ V}$ ,  $T_{\text{amb}} = 25^\circ\text{C}$ ,  $f = 50 \text{ Hz}$ , reference point Pin 6, unless otherwise specified

Parameters	Test Conditions / Pins	Symbol	Min	Typ	Max	Unit
Supply voltage limitation	$-I_4 = 1 \text{ mA}$ Pin 4	$-V_S$	5.7		7.4	V
Current consumption	Pos. half, cycle Pin 4	$-I_S$			1	mA
	Zero cross over (Pin 5 open) Pin 4	$-I_S$			1	
	neg. half cycle Pin 4	$-I_S$			1.8	
<b>Synchronization</b> Pin 7						
Voltage limitation	$\pm I_7 = 1 \text{ mA}$	$\pm V_I$	1.0		1.8	V
Synchronization current		$\pm I_{\text{Sync}}$	0.15			mA
Zero cross detection		$\pm I_{\text{Sync}}$		25		$\mu\text{A}$
<b>Comparator, figure 5</b>						
Input zero voltage	Pin 1, 2	$V_{I0}$		10		mV
Input quiescent current	Pin 2	$I_B$			1	$\mu\text{A}$
Common mode input range	Pin 1, 2	$-V_{IC}$	1	$(V_S - 1.6)$		V

# TEA1024/ TEA1124

Parameters	Test Conditions / Pins	Symbol	Min	Typ	Max	Unit
<b>Ramp generator, figures 3, 4</b>		Pin 1				
Period	TEA1024	T		640		ms
	TEA1124			1280		
Step number		n		16		
Initial voltage		$-V_1$	1.2	1.4	1.6	V
Final voltage		$-V_1$	3.3	3.6	3.9	V
Internal reference				$\left( \frac{V_s + 2.5\%}{4-7.5\%} \right)$		V
Temperature coefficient of internal reference		$\pm TC_{Ref}$		1.2		mV/K
<b>Pulse amplifier</b>		Pin 5				
Output pulse current	$V_G \leq 1.5 \text{ V}$	$-I_O$	50		100	mA
Output pulse width	$V_{Sync} = 230 \text{ V} \sim$ , $R_2 = 220 \text{ k}\Omega$	$t_0$		33		$\mu\text{s}$
		$t_1$		65		
		$t_2$		110		

## Applications

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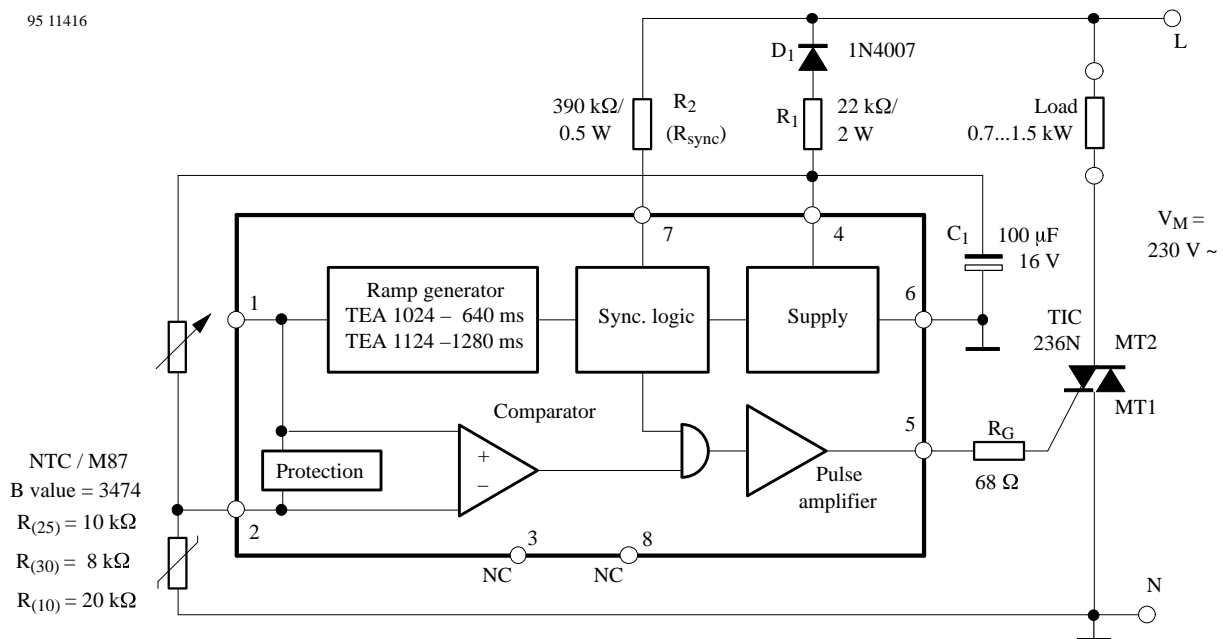


Figure 10. Simple temperature regulation with maximum proportional range

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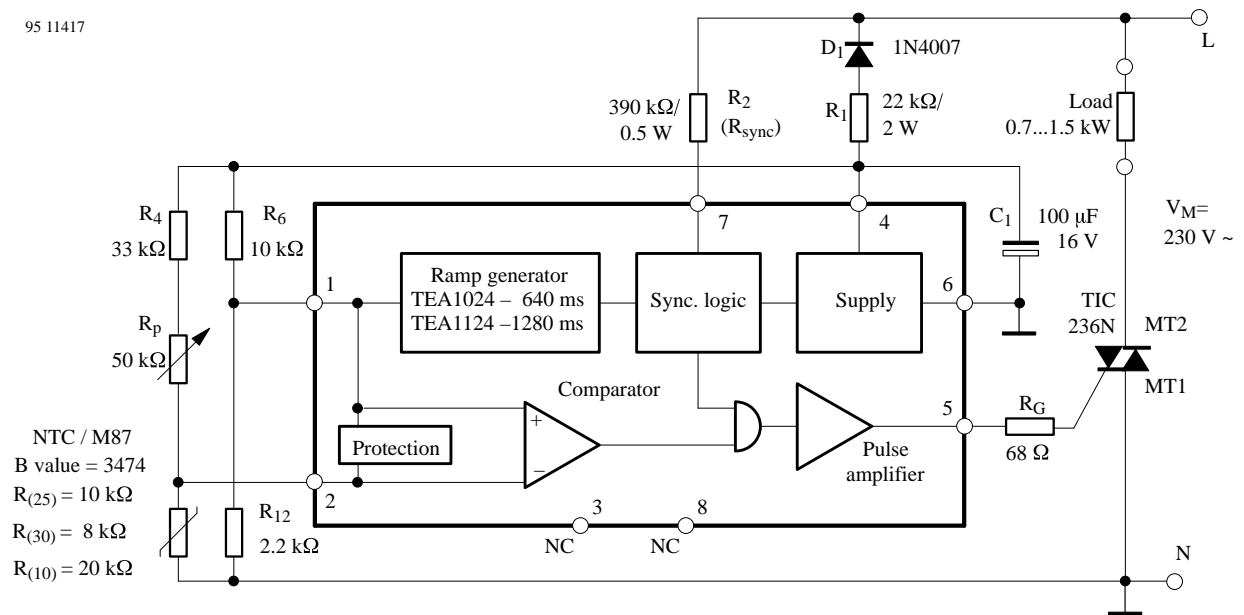
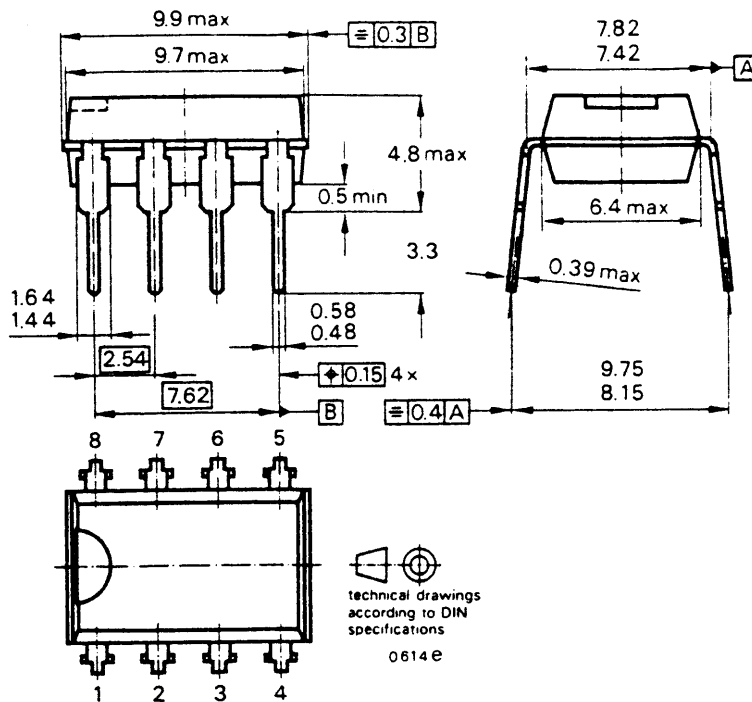


Figure 11. Temperature regulation with proportional range, 10 to 30 °C/ 640 ms ramp cycle

## Dimensions in mm

Package: DIP8



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

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