# SIEMENS

Programmable Digital Timer | SAB 0529

Features

Bipolar IC

- Direct operation from AC line or DC supply possible
- Time base is 50 Hz line frequency
- Triac triggering with voltage synchronization for resistive loads, or with current synchronization for resistive, inductive and capacitive loads
- Triac gate trigger current up to 100 mA
- Continuous output current to relay actuation max. 100 mA
- 8 overlapping timing periods between 1 second and 31 1/2 hours (at 50 Hz)
- 2 operating modes: momentary switching or switch off delay, both are retriggerable
- Upon request, delay times can be adjusted to customer's specification, requiring only minimum external components. This is possible through mask programming, but is based on minimum order quantities.
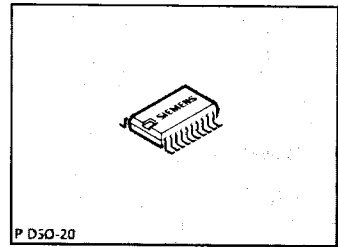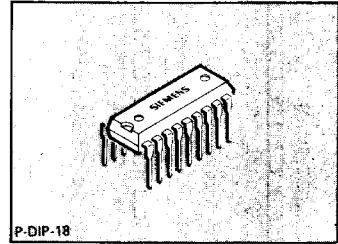
P-DIP-18

P DSO-20

Type	Ordering Code	Package
⑤ ■ SAB 0529	Q67000–H2176	P-DIP-18
⑤ ■ SAB 0529 G	Q67000–H2952	P-DSO-20 (SMD)

■ Not for new design.

With the digital timer SAB 0529, delay times between 1 second and 31 1/2 hours can be set. Time base is the 50 Hz line frequency. A triac may be triggered by the SAB 0529 IC.

The SAB 0529 can be programmed to two operating modes: "momentary switching" and "switch-off delay" (according to DIN 46120). In the first mode, a rising edge at the start input activates the triac and starts the timing period. In the switch-off delay mode, the rising edge at the start input activates the triac; but the falling edge starts the timing period.

The versatile IC SAB 0529 covers a great variety of applications, e.g. electronic timers, cooking equipment control, espresso machines, hand-driers, coin changing machines and slot machines, stairwell-light time switches, industrial controls, developing systems for photographic labs, automatic starters (to preheat car engines), and operating-hours counters.
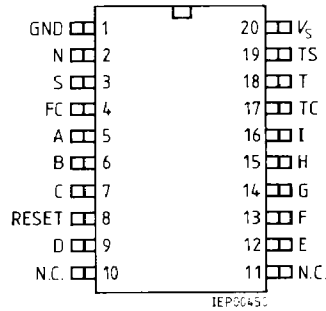
Pin Configurations
(top view)

SAB 0529
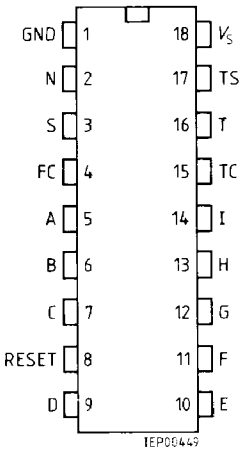

SAB 0529 G

Pin Definitions and Functions

SAB 0529 Pin	SAB 0529 G Pin	Symbol	Function
1	1	GND	Circuit ground
2	2	N	Line voltage via series resistor
3	3	S	Start
4	4	FC	Function changeover
5	5	A	Programming of basic timing unit
6	6	B	Programming of basic timing unit
7	7	C	Programming of basic timing unit
8	8	R	Reset
9	9	D	Basic timing unit x 1
10	12	E	Basic timing unit x 2
11	13	F	Basic timing unit x 4
12	14	G	Basic timing unit x 8
13	15	H	Basic timing unit x 16
14	16	I	Basic timing unit x 32
15	17	TC	Triac operation mode setting
16	18	T	Triac triggering
17	19	TS	Triac synchronization
18	20	V_S	Positive supply voltage

These values apply to the standard SAB 0529 version. By mask programming, each of those pins may be assigned a value between 1 and 63.

With the P-DSO-20-package (SAB 0529 G), pins 10 and 11 are not connected.

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Block Diagram

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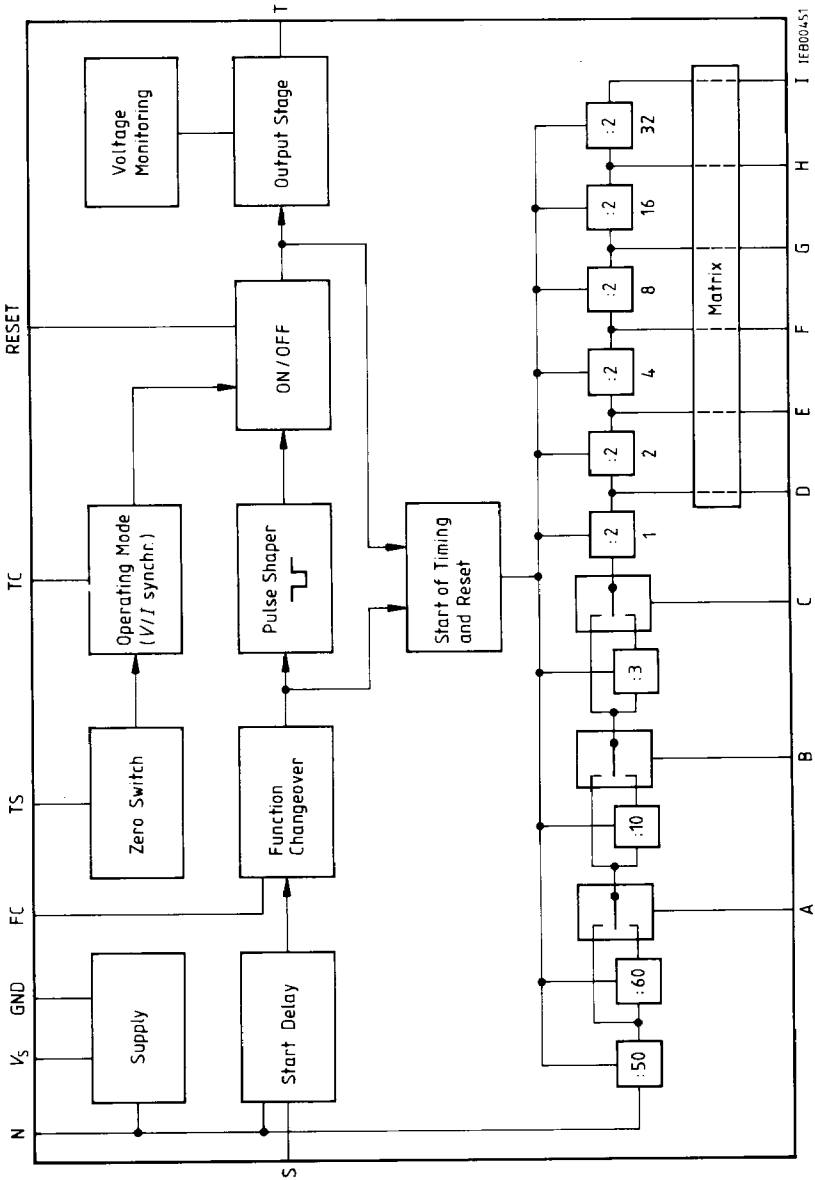
Absolute Maximum Ratings

Parameter	Symbol	Limit Values min.	Limit Values max.	Unit	Notes
Supply voltage at impressed dc voltage	V_S	−0.3	5.5	V	
Peak current at N	I_{Np}	−35	35	mA	50 Hz operation
DC from N (rms)	$-I_{Nrms}$		12.5	mA	with $V_S \le 7.5$ V
AC at N with impressed current	I_{Nrms}		25	mA	50 Hz operation with $V_S \le 7.5$ V
Voltage at S, FC, A, B, C, R	V	−0.3	7.5	V	
Voltage at N, with N utilized as clock input	V_{NT}	−0.3	V_S	V	
Voltage at TC	V_{TC}	−0.3	V_S	V	
Current at TS	I_{TS}	−4	4	mA	
Voltage at T	V_T	−0.3	7.5	V	
Peak current in T	I_{Tp}		150	mA	1 ms (10 ms interval)
Continuous current in T	I_T		100	mA	
Current in D, E, F, G, H, I	I		0.5	mA	D, E, F, G, H, I on-state
Voltage at D, E, F, G, H, I	V	−0.3	7.5	V	D, E, F, G, H, I off-state
Short-term peak current at N	I_{Np}	−350	350	mA	0.3 ms (100 ms interval) with $C_{ch} > 40$ μF
Junction temperature	T_j		150	°C	
Storage temperature	T_{stg}	−55	125	°C	
Thermal resistance system – air SAB 0529	$R_{th\,SA}$		70	K/W	
SAB 0529 G	$R_{th\,SA}$		105	K/W	

All voltages are referred to pin 0, unless otherwise specified.

Operating Range

Parameter	Symbol	min.	max.	Unit	Notes
Supply voltage at impressed DC voltage Impressed DC or impressed AC at N[2]	V_S	4.5	5.5	V	Voltage between pin 0 and V_S
DC supply from N (rms)	$-I_N$	2,5[1]	12.5	mA	see application circuit
AC supply at N (rms)	I_{Nrms}	5[1]	25	mA	see application circuit
Ambient temperature	T_A	0	70	°C	

[1] Only the supply current for the IC, i.e. without triac gate current. The rms gate current additionally flows through N. (The IC may be operated with DC or AC; see also application circuits).

[2] The voltage between 0 and V_S is between 5.5 V and 7.0 V for impressed AC and between 6.0 V and 7.5 V for impressed DC. Operation, however, is also assured if V_S falls to 4.5 V (e.g. due to ripple at V_S with DC supply).

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Characteristics

$V_S = 4.5$ V to ≤ 5.5 V (7.5 V)[1]), $T_A = 0\,°C$ to $70\,°C$

Parameter	Symbol	Limit Values			Unit	Test Conditions
		min.	typ.	max.		
Supply current at V_S and/or N	I_S		1.4	2.5	mA	$I_S = -I_N$
V_S with impressed current at N:						
Impressed ac	V_S	5.5	6.2	7.0	V	$I_{N\,rms} = 5$ mA
Impressed dc	V_S	6.0	6.8	7.5	V	$-I_N = 2.5$ mA
Switching threshold at:						
A, B, C, S, FC, R	$V_{A...}$	0.3	0.6	1	V	
N (if N is clock input)	V_N	0.6	1.2	2	V	
TC	V_{TC}		3.5	4.5	V	
TS (for voltages $> V_S$)	$V_{TS}+$		$V_S+1.3$		V	
TS (for voltages $< V_S$)	$V_{TS}-$		$V_S-1.3$		V	
L-input current at:						
A, B, C, S, FC, R	$-I_{IL}$			20	µA	$V_{A...} = 0$ V
N (if N is clock input)	$-I_{INL}$			40	µA	$V_N = 0$ V
H-input current at:						
A, B, C, S, FC, R	I_{IH}			20	µA	$V_{A...} = V_S \leq 5.5$ V
N (if N is clock input)	I_{INH}			10	µA	$V_N = V_S$
TC	I_{ITCH}			50	µA	4.5 V $\leq V_{TC} \leq V_S$
Pos. switching current at TS	$I_{TS}+$	27	45	81	µA	$V_{TS} = V_{TS}+$
Neg. switching current at TS	$I_{TS}-$	18	30	54	µA	$V_{TS} = V_{TS}-$
L-voltage at D, E, F, G, H, I	V_L			0.3	V	$I_L = 0.5$ mA
Reverse current at D, E, F, G, H, I	I_H			1	µA	
L-output voltage at T	$V_{Q\,TL}$		1.5	1.8	V	$I_T = 1$ mA
			1.6	2	V	$I_T = 10$ mA
			1.8	2.3	V	$I_T = 100$ mA

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[1]) with impressed current at N.

Functional Description

Through division of the line frequency into the portions 1:50, 1:60, 1:10, and 1:3, the basis for 8 timing periods is created. The timing period is selected via inputs A, B, and C, according to the following truth table.

Timing range	A	B	C	Basic timing unit	Max. time at 50 Hz line	
1	L	L	L	1 s	63 s	(approx. 1 min)
2	L	L	H	3 s	189 s	(approx. 3 min)
3	L	H	L	10 s	630 s	(10.5 min)
4	L	H	H	30 s	1890 s	(31.5 min)
5	H	L	L	1 min	63 min	(approx. 1 hr)
6	H	L	H	3 min	189 min	(approx. 3 hrs)
7	H	H	L	10 min	630 min	(10.5 hrs)
8	H	H	H	30 min	1890 min	(31.5 hrs)

L and H potentials are referred to terminal 0, e.g. L = 0, H = V_s

The time basis of the set period is multiplied by the corresponding value in the flipflops 1, 2, 4, 8, 16, 32.

The delay time at output T results from connecting a terminal between D and I with terminal R. Should several of the pins D to I be connected to R, the corresponding delay times are added.

Reset during a timing period is accomplished by interrupting the connection to R, or by applying an H potential to R (in the latter case a protective resistor between R and D through I is necessary as those pins are not protected against short circuit to V_S), or by turning on and off V_S.

Application Hint

If R is connected to one of the pins D through I via a multiposition switch, and if during the changeover a reset of the timing period is to be avoided, a suitable capacitor is required between R and 0.

With the **connection of the supply voltage,** the circuit is automatically reset. A timing period does not commence if 0 potential is applied to S.

The SAB 0529 allows two operating modes to be set via pin FC (function changeover):

1. **"Momentary Switching Function"** in accordance with DIN 46120

The triac at pin T turns on with the rising edge at the start input S and turns off when the set time has passed, independent of the start pulse length.

Start Pulse at S | >40ms
Voltage at the Load | Set Time
Dead Time 20 to 40ms | max. 31.5 hrs | IET00453
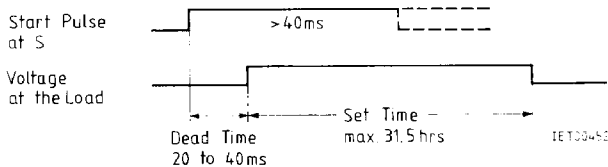
2. **"Switch-Off Delay"** in accordance with DIN 46120

The triac turns on with the rising edge at S. The falling edge at S starts the timing period. The triac remains in on-state until the set period has passed.

Start Pulse at S | >40ms
Voltage at the Load | Set Time
Dead Time 20 to 40ms | max. 31.5 hrs | IET00453
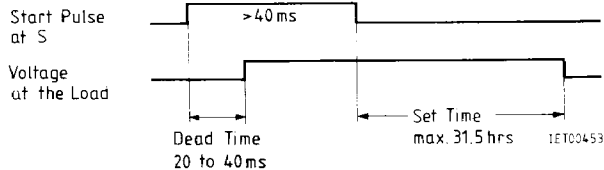
To protect the start input S against external interference and contact bounce, it has a **dead time** of between 20 and 40 ms for its positive switching edge, depending on the phase of the 50-Hz line.

Both operating modes are **retriggerable** during the timing period.

Function Changeover

FC	Function
L	momentary switching
H	switch-off delay

Triac Stage

Pin TS (triac synchronization) is the input of a zero voltage switch and serves to synchronize the output T (open collector) with the load voltage or the load current.

With $V_S < 3$ V, the output current is disconnected.

The input TC has a double function:

● to change TS over to voltage synchronization

● to adjust the triac trigger pulse width (by connecting a capacitor C_e to TC) in case of current synchronization.

Three operation modes are possible by varying the connection of the pins TC and/or TS:

Operating Mode 1

TC to V_S: Output T is connected to the zero voltage switch. T operates when $V_S - 1.3$ V $\leq V_{TS} \leq V_S + 1.3$ V.

Is utilized in case of voltage synchronization; **see application circuit 1** (operation with resistive load) and **pulse diagram.**

Operating Mode 2

TC via C_e to Q: Output T is connected to the zero voltage switch via a monoflop. If $V_S - 1.3$ V has fallen below or $V_S + 1.3$ V exceeded at TS, the output T releases a triac gate trigger pulse determined by C_e.

Is utilized in case of current synchronization; **see application circuit 2** and **pulse diagram.**

Operating Mode 3

TC and TS to V_S: Output T conducts after release of start pulse.

Is utilized for any load in case of continuous triac triggering (e.g. low performance), or if any other load is to be operated instead of the triac **(see application circuits 3, 4, 5).**

Operation with Line Voltage

A series resistor R_s and a charging capacitor C_{ch} serve for line voltage supply. If a diode is connected in series with R_s (anode to N), the rms current consumption is halved. The series resistor may also be an RC network **(see application circuit 6).**
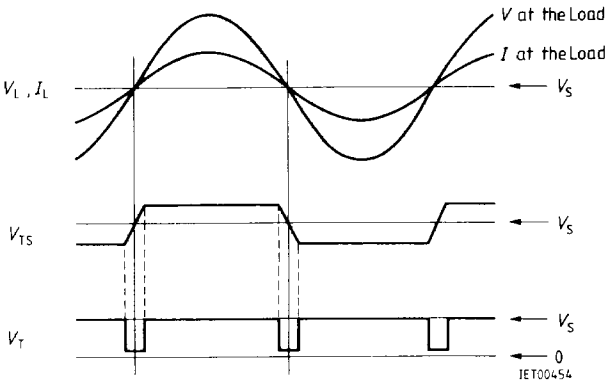
Operation with DC Voltage

This IC can also be operated with dc voltage or current **(see application circuits 4 and 5).**

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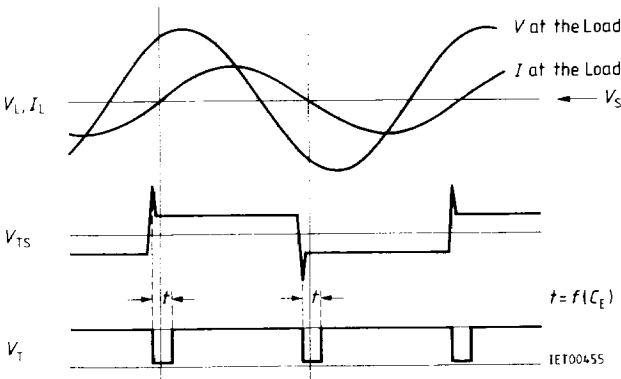## Pulse Diagrams for Triac Operation Modes 1 and 2

Operating Mode 1

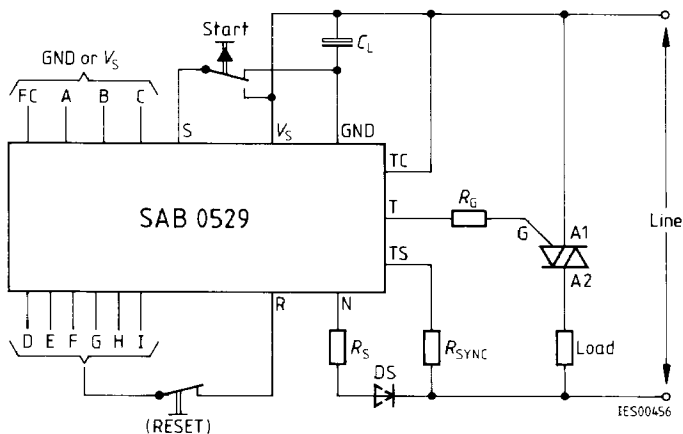Voltage synchronization with resistive loads (TC to V_S)

Operating Mode 2

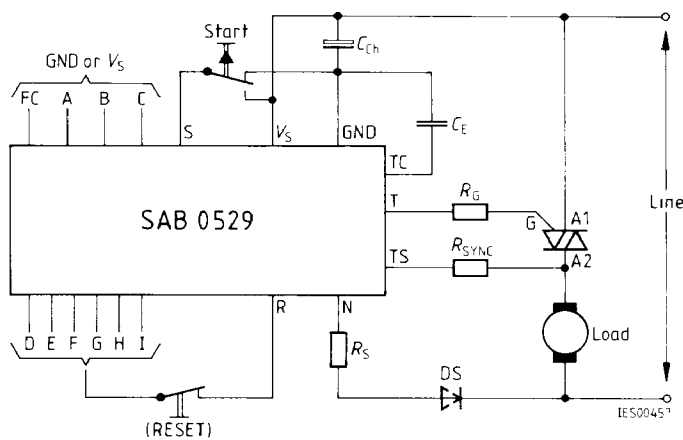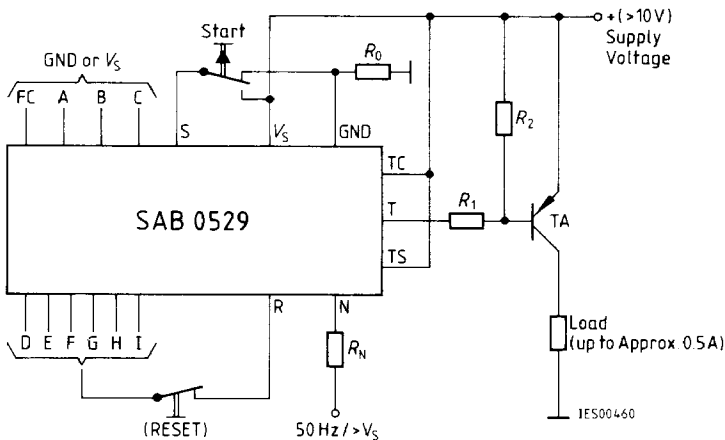Current synchronization with nonresistive loads (capacitance C_e to TC)

Application Circuits

1. Operation with Resistive Loads

2. Operation with Resistive, Capacitive, or Inductive Loads

3. Operation with any Load and Continuous Triac Triggering

Figure showing SAB 0529 circuit with Start, GND or V_S, FC A B C, S, V_S, GND, C_{Ch}, TC, T, R_G, TS, G, A1, A2, Line, R, N, D E F G H I, R_S, Load, D S, (RESET), IES00458

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4. Operation with 5 V DC Voltage

Figure showing SAB 0529 circuit with Start, GND or V_S, FC A B C, S, V_S, GND, +5V, Load (up to 100 mA), TC, T, TS, R, N, D E F G H I, R_N, (RESET), 50 Hz/>2V, IES00459

Note: The diode D in **application circuits 1 to 3** must not necessarily be used. This diode, however, may halve the power dissipation at R_S.

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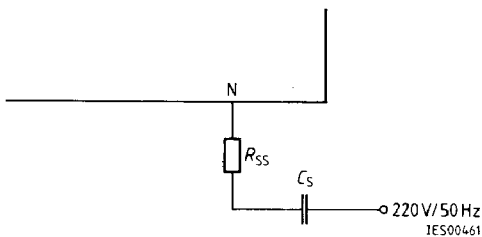
5. Operation with DC Voltage> 10 V (limited only by transistor TA)

6. Operation with Capacitive Series Resistor

In the **application circuits 1 to 3,** a series connection of R and C may be utilized instead of R_s or R_s and D.

Note: If not required, the reset key may be omitted in **application circuits 1 to 5.**

Dimensioning the Application Circuits

The following formulae give reference values for operation with sine-shaped ac voltages of 50 Hz. The triac is always triggered in the 2nd and 4th quadrant (negative gate trigger current).

Trigger pulse length Z: $Z = \dfrac{5 \text{ x holding current}}{\text{rms load current}}$ (ms); applies to $Z \leq 1$ ms

$R_G = \dfrac{V_S - V_{ATL} - \text{gate trigger voltage}}{\text{gate trigger current}}$

$R_s = \dfrac{0.5 \text{ x rms line voltage} - V_S}{I_S + \text{average gate trigger current}}$ (with or without diode D)

average gate trigger current = gate trigger current x $\dfrac{Z}{10}$ (Z in ms)

Power dissipation at R_s :

(without diode D) $= \dfrac{(\text{rms line voltage})^2}{R_s}$

(with diode D) $= 0.5 \times \dfrac{(\text{rms line voltage})^2}{R_s}$

$C_{ch} = 20 \times \dfrac{\text{rms line voltage}}{R_s}$ (μF, V, kΩ)

(residual ac voltage at $V_{Spp} \leq 0.5$ V)

Note for C_{ch}

If short-term line failures are to be compensated, C_{ch} has to be accordingly larger (approx. 1000 μF for ≤ 5 s line failure).

Application Circuit 1 (voltage synchronization for resistive load)

$R_{SYNC} = \dfrac{0.22 \ Z \text{ x rms line voltage} - 1.3}{0.04} \geq \dfrac{\text{peak line voltage}}{4}$ (kΩ, V, mA, ms)

Notes for Application Circuit 1

An average I_{TS} of 0.04 mA was inserted into the formula approximating R_{SYNC}.

As $I_{TS}+$ and $I_{TS}-$ contain production deviations, utilizing the determined R_{SYNC} requires certain tolerances to be taken into account for pulse length Z.

To minimize the effect of these tolerances, a resistor may be connected between V_S and TS, which generates a constant current of $\dfrac{V_{TS}}{R}$ to be added to I_{TS}.

However, a TC of -4 mV/K should be noted for v_{TS}.

Application Circuit 2 (current synchronization)

$C_e = 22 \times Z$ (nF, ms)

$R_{SYNC} \geq \dfrac{\text{max. on-state voltage} - 1.3}{I_{TSmin}}$

$R_{SYNC} \geq \dfrac{\text{peak line voltage}}{4}$ } The largest value applies (kΩ, V, mA)

$R_{SYNC} \leq \dfrac{\text{gate trigger voltage} - 1.3}{I_{TSmax}}$ (kΩ, V, mA)

Notes for Application Circuit 2

In this circuit, an even shorter pulse length than determined for Z is sufficient to trigger the triac. This is possible by the trigger pulse being automatically repeated until the holding current is reached. Overdimensioning of Z for safety reasons is, therefore, not necessary. The disadvantage of multiple trigger pulses, however, is a somewhat larger interference band during the triggering.

The interference band and/or the interference amplitude generated also depend on the amount of the gate trigger voltage necessary to trigger the triac after each current zero passage. That voltage is determined by the size of R_{SYNC} and should not exceed 20 V.

Application Circuit 3

Dimensioning of R_s, R_G, and C_{ch} as described at the beginning of this section.

Application Circuit 4

$R_N \approx 15 \times$ ac voltage (50 Hz) (kΩ,Vrms)

Application Circuit 5

R_N see above. The AC voltage for the timing base must be greater than (supply voltage -4.8 V).

$R_0 = \dfrac{\text{supply voltage} - 6.8 \text{ V}}{I_S + I_{R1}}$ $I_{R1} = I_{B(TA)} + I_{R2}$

$R_1 = \dfrac{6.8 \text{ V} - V_{QTL} - V_{B(TA)}}{I_{R1}}$ $I_{R2} \approx 0.05 \, I_{B(TA)}$

$R_2 = \dfrac{V_{B(TA)}}{I_{R2}}$

Application Circuit 6

$C_s = \dfrac{3.5}{R_s}$ (μF, kΩ)

$R_{ss} = 0.2 \, R_s$ } applies to 50 Hz

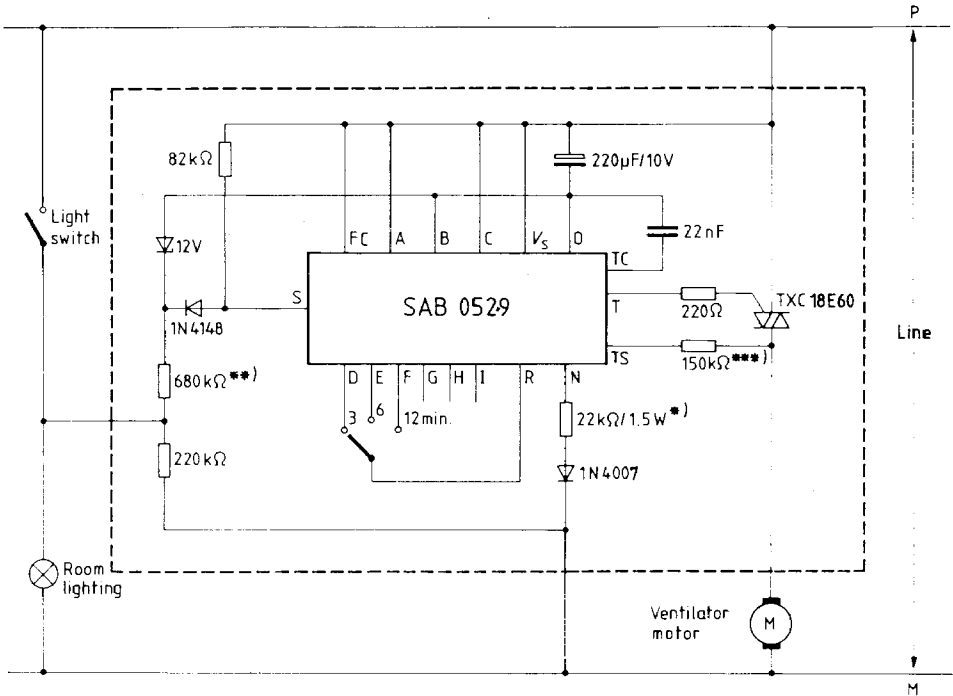To limit the inrush current, R_{ss} has to be $\geq 0.2 \, R_s$. Otherwise, the circuit may be damaged.

Internal Connection of Inputs, Outputs, and Supply Pins

S; FC; R; B, C; R   D; E; F; G; H; I   TC

V_{REF}

V_S

GND

N

TS

T

IES00462
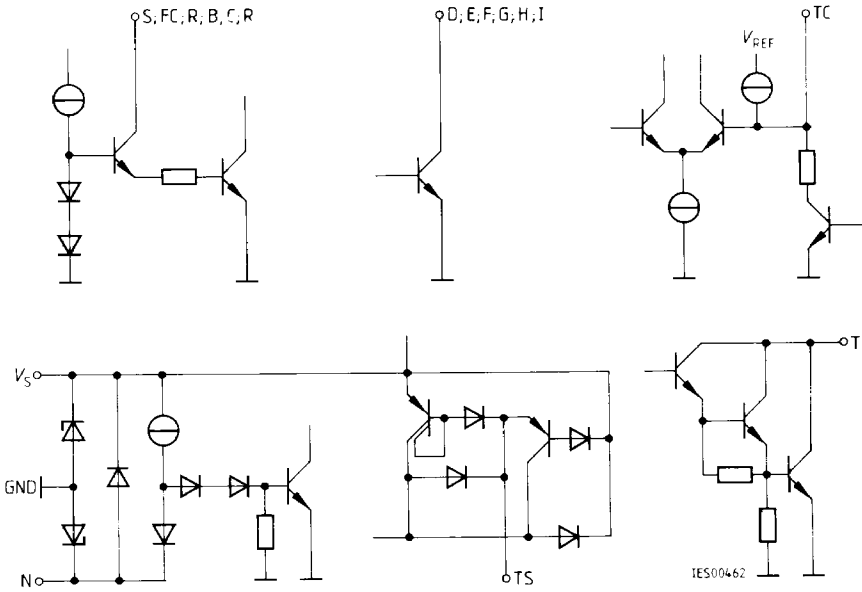
Typical Application

Time control for ventilator motor, adjustable to 3, 6, or 12 minutes' ventilation

*) for 220 Vac, 10 kΩ for 110 Vac; ⎫
**) for 220 Vac, 330 kΩ for 110 Vac; ⎬ (high-voltage proof)
***) for 220 Vac, 82 kΩ for 110 Vac; ⎭