Radiator fan controlled timer

Description

The bipolar integrated circuit, U 6049 B, is designed as a radiator fan controlled timer. After the ignition is switched off, the thermal switch of the engine can activate the radiator fan via relay for a preset period, to support the cool-off process.

Features

- Delay time range: 3.7 s to 20 h
- Cool-off time starts when thermal switch is closed
- RC oscillator determines switching characteristics
- Relay driver with Z-diode
- Debounced input for coolant temperature switch
- Not debounced input for ignition key (Terminal 15)
- Load dump protection
- RF interference protected
- Protection according to ISO/TR 7637-1 (VDE 0839)

Cases: DIP 8, SO 8

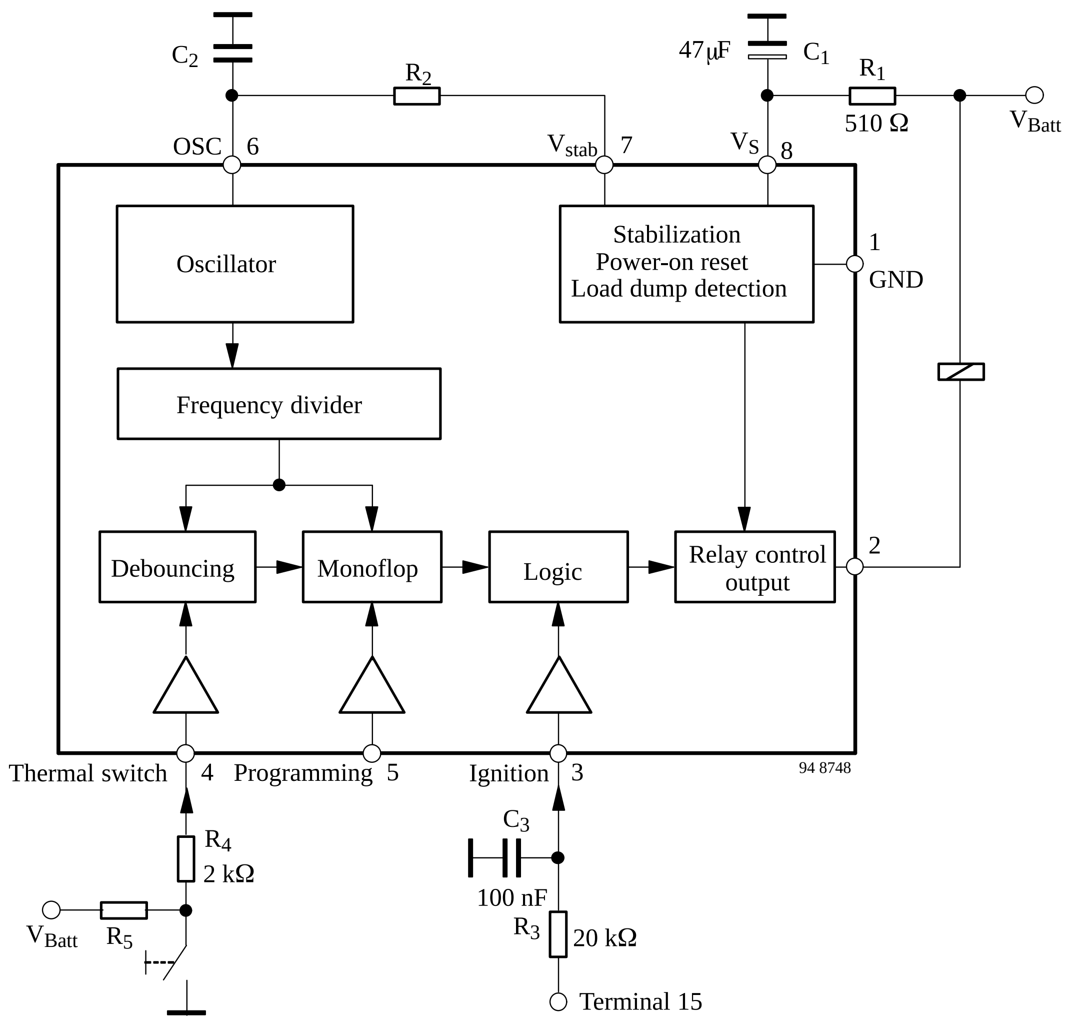
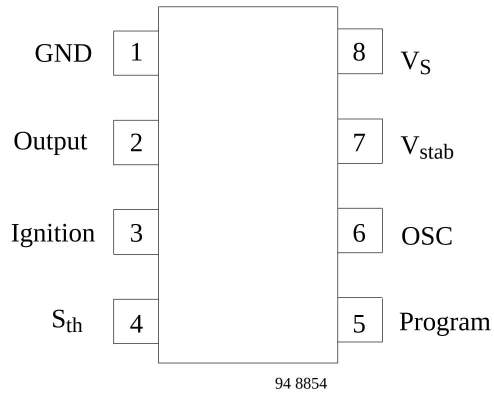


Figure 1 Block diagram with external circuit

Pin Configuration

Pin	Symbol	Function
1	GND	Reference point, ground
2	Output	Relay control output
3	Ignition	Signal input, ignition
4	S_{th}	Thermal switch, input
5	Program	Programming input
6	OSC	RC oscillator input
7	V_{stab}	Stabilized voltage
8	V_S	Supply voltage



Functional description

Power supply, Pin 8

For reasons of interference protection and surge immunity, the supply voltage (Pin 8) must be provided with an RC circuit as shown in figure 2a. Dropper resistor, R_1, limits the current in case of overvoltage, whereas C_1 smoothes the supply voltage at Pin 8.

Recommended values are: R_1 = 510 Ω, C_1 = 47 µF.

The integrated Z-diode (14 V) protects the supply voltage,V_S, therefore, the operation of the IC is possible between 6 V and 16 V, supplied by V_{Batt}.

However, it is possible to operate the integrated circuit with a 5 V supply, but it should be free of interference voltages. In this case, Pin 7 is connected to Pin 8 as shown in figure 2b, and the R_1C_1 circuit is omitted.

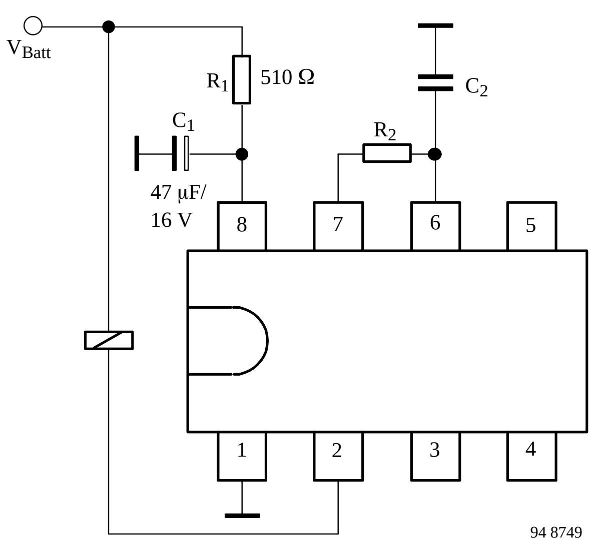


Figure 2a Basic circuit for 12 V voltage supply and oscillator

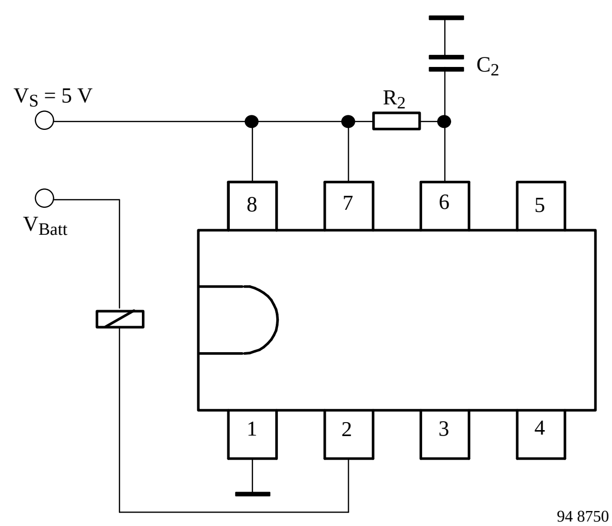


Figure 2b Basic circuit for V_S = 5 V

Oscillator, Pin 6

Oscillator frequency, f, is determined mainly by R_2C_2-circuit. Resistance, R_2, determines the charge time, whereas the integrated resistance (2 kΩ) is responsible for discharge time. For the stability of the oscillator frequency, it is recommended to select R_2 much greater than internal resistance (2 kΩ), because the temperature response and the tolerances of the integrated resistance are considerably greater than the external resistance value.

Oscillator frequency, f, is calculated as follows:

$$f = \frac{1}{t_1 + t_2}$$

where
t_1 = charge time = $\alpha_1 \cdot R_2 \cdot C_2$
t_2 = discharge time = $\alpha_2 \cdot 2\ k\Omega \cdot C_2$

α_1 and α_2 are constants and has
$\alpha_1 = 0.833$ and $\alpha_2 = 1.551$ when C_2 = 470 pF to 10 nF
$\alpha_1 = 0.746$ and $\alpha_2 = 1.284$ when C_2 = 10 nF to 4700 nF

Debounce time, t_3, and the delay time, t_d, depend on the oscillator frequency, f, as follows:

$$t_3 = 6 \cdot \frac{1}{f}$$

$$t_d = 73728 \cdot \frac{1}{f}$$

Table 1 shows relationships between t_3, t_d, C_2, R_2 and frequencies from 1 Hz to 20 kHz.

Output, Pin 2

Output Pin 2 is an open collector Darlington circuit with integrated 23-V Z-diode for limitation of the inductive cut–off pulse of the relay coil. The maximum static collector current must not exceed 300 mA and the saturation voltage is typically 1.1 V @ 200 mA.

Interference voltages and load dump

The lC supply is protected by R_1, C_1, and an integrated Z-diode, while the inputs are protected by a series resistor, integrated Z-diode and RF-capacitor (refer to Figure 3).

The relay control output is protected via the integrated 23-V Z-diode in the case of short interference peaks. It is switched to conductive condition for a battery voltage of greater than approx. 40 V in the case of load dump. The output transistor is dimensioned so that it can withstand the current produced.

Power-on reset

When the operating voltage is switched on, an internal power-on reset pulse (POR) is generated which sets the logic of the circuits to a defined initial condition. The relay control output is disabled.

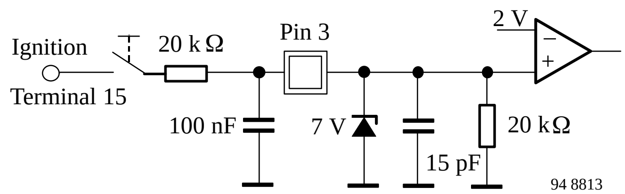


Figure 3a Input circuit for ignition (Pin 3)

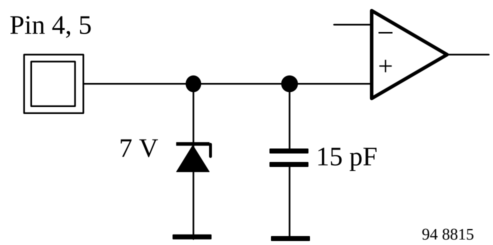


Figure 3b Input circuit Pin 4 and Pin 5

Relay control output behaviour, Pin 2

Integrated circuit control the cooling fan motor in automobile by means of a relay.

Figure 3a shows the internal input circuit of ignition (Pin 3). It has an integrated pull-down resistor (20 kΩ), RF-capacitor (15 pF) and 7-V Z-diode. It reacts to voltages greater than 2 V.

For the programming input, Pin 5, and thermal switch input, Pin 4, there is neither pull-up nor pull-down resistor integrated internally (figure 3b).

One can reduce the standby current through the internal Z-diode by selecting a higher value for resistance R_4 (see figure 5, R_4 up to 200 kΩ). Resistance R_5 determines the contact current through the thermal control switch, S_{th}.

Ignition input (terminal 15) is not debounced. Debouncing can be achieved by external circuit (R_3,C_3) connected to Pin 3 (see figures 1 and 5).

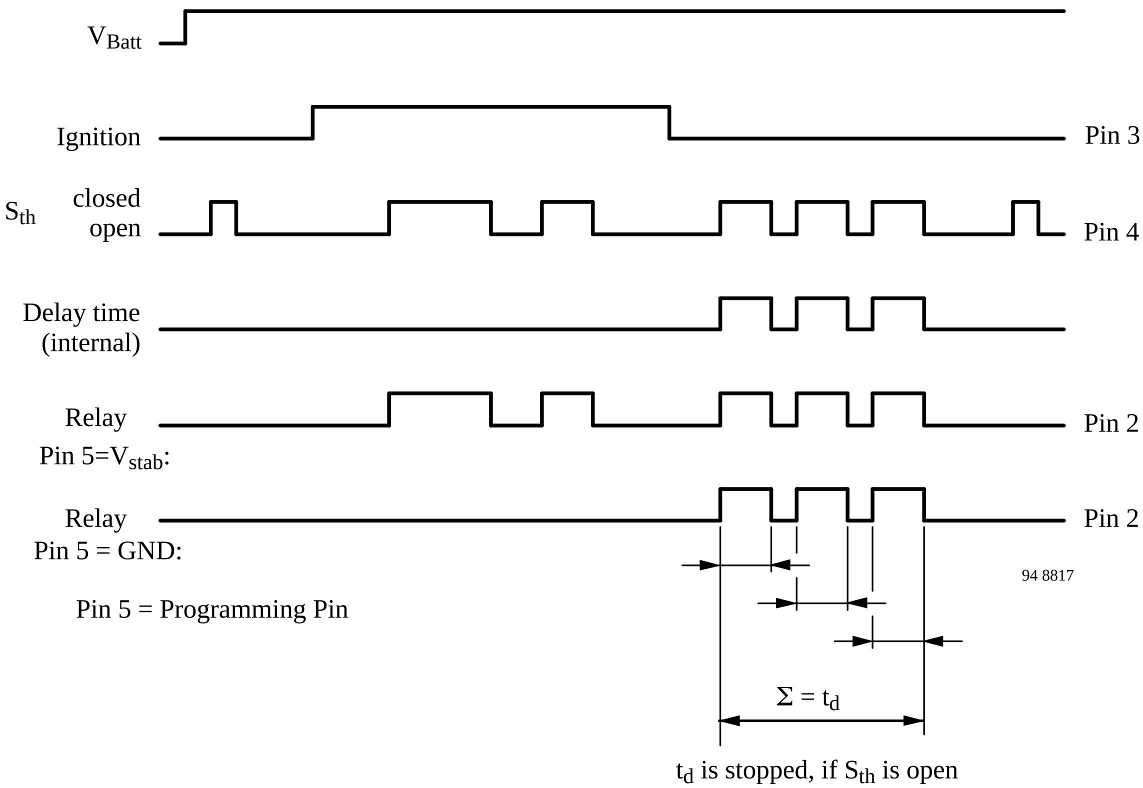
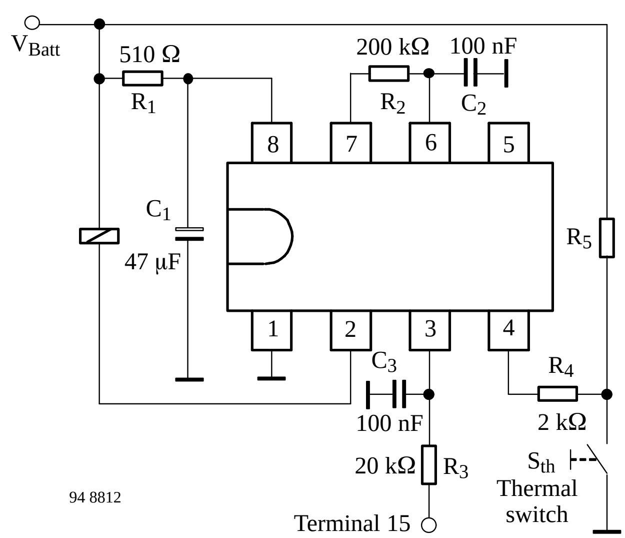


Figure 4 Timing waveform

Programming input (Pin 5) is high-ohmic, therefore it should be connected to Pin 7 (V_{stab}) or GND. Relay control output is shown according to Pin 5 connection.

Thermal switch input, Pin 4, is debounced (see figure 1). Relay control output, Pin 2, is disabled when the battery voltage, V_{Batt}, is applied. Relay control output follows the conditions of the switch, S_{th}, only when the ignition is switched-ON. This is possible only after the debounce time, t_3. In this case Pin 5 is connected to Pin 7.

Timing waveforms are shown in figure 4. Total delay time, t_d, is the sum of all ON-pulses caused by the thermostatic switching. This can run down at once or in parts. If S_{th} (Pin 4) is open, the oscillator is stopped (switched-off) internally but when it starts (S_{th} closed), the delay time, t_d, starts running again. In case of renewed switching of ignition, the counter of the delay time is reset.



R_4 = 2 kΩ to 200 kΩ

Figure 5 Basic circuit

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Operating voltage, static, 5 min	V_{Batt}	24	V
Ambient temperature range	T_{amb}	–40 to +125	°C
Storage temperature range	T_{stg}	–55 to +125	°C
Junction temperature	T_j	150	°C

Thermal Resistance

Parameters	Symbol	Maximum	Unit
Junction ambient DIP 8	R_{thJA}	110	K/W
Junction ambient SO 8	R_{thJA}	160	K/W

Electrical Characteristics

V_{Batt} =13.5 V, T_{amb} = 25°C, reference point ground, figure 2, unless otherwise specified

Parameters	Test Conditions / Pin	Symbol	Min	Typ	Max	Unit
Operating voltage	$R_1 \geq 510\ \Omega$ t < 5 min t < 60 min	V_{Batt}	6		16 24 18	V
5 V supply	Without R_1, C_1 figure 2b Pins 7 and 8	V_8, V_7	4.3		6.0	V
Stabilized voltage	Pin 7	V_7	5.0	5.2	5.4	V
Undervoltage threshold	Power on reset	V_S	3.0		4.2	V
Supply current	Pushbuttons open Pin 8	I_S		1.3	2.0	mA
Internal Z-diode	I_8 = 10 mA Pin 8	V_Z	13.5	14	16	V
Relay output Pin 2						
Saturation voltage	I_2 = 200 mA I_2 = 300 mA	V_2		1.2	 1.5	V
Leakage current	V_2 = 14 V	I_{lkg}		2	100	µA
Output current		I_2			300	mA
Output pulse current						
Load dump pulse		I_2			1.5	A
Internal Z-diode	I_2 = 10 mA	V_2	20	22	24	V
Oscillator input f = 0.001 to 40 kHz, see table 1 Pin 6						
Internal discharge resistance		R_6	1.6	2.0	2.4	kΩ
Switching voltage	Lower Upper	V_{6L} V_{6H}	0.9 2.8	1.1 3.1	1.4 3.5	V
Input current	V_6 = 0 V	$–I_6$			1	µA
Switching times						
Debounce time		t_3	5		7	cycles
Delay time		t_d	72704		74752	cycles
Inputs Pin 3, 4, 5						
Switching threshold		$V_{3,4,5}$	1.6	2.0	2.4	V
Internal Z-diode	$I_{3, 4, 5}$ = 10 mA	$V_{3,4,5}$	6.5	7.1	8.0	V
Ignition input **Pin 3**						
Pull-down resistance	Switched to V_{Batt} (15)	R_3	13	20	50	kΩ
Thermal switch Pin 4						
Input current	V_4 = 0 V	$– I_4$			2	µA
Programming input Pin 5						
Input current	V_5 = 0 V	$– I_5$			2	µA

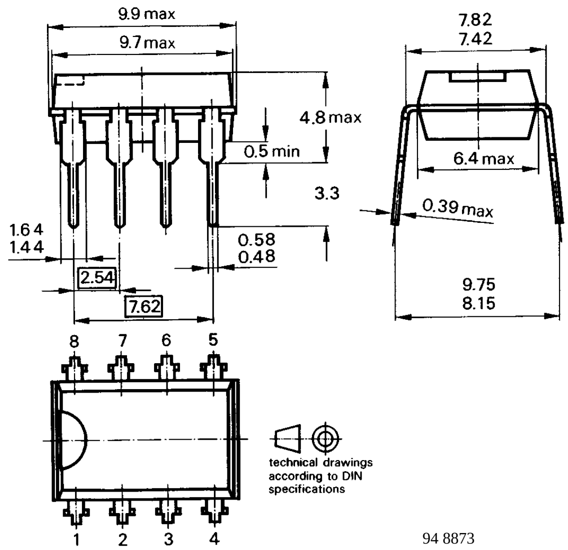
Table 1 Oscillator frequency, debounce time, delay time. dimensioning

Frequency f	Debounce time t_3	Delay time t_d		C_2	R_2
Hz	ms	min	s	nF	kΩ
1	6000	1229		4700	280
2	3000	614		1000	650
3	2000	410		1000	440
4	1500	307		1000	330
5	1200	246		1000	260
6	1000	205		1000	220
7	857	176		1000	190
8	750	154		1000	160
9	667	137		1000	140
10	600	123		1000	130
20	300	61		100	650
30	200	41		100	440
40	150	31		100	330
50	120	25		100	260
60	100	20		100	220
70	86	18		100	190
80	75	15		100	160
90	67	14		100	140
100	60	12		100	130
200	30		369	10	600
300	20		246	10	400
400	15		184	10	300
500	12		147	10	240

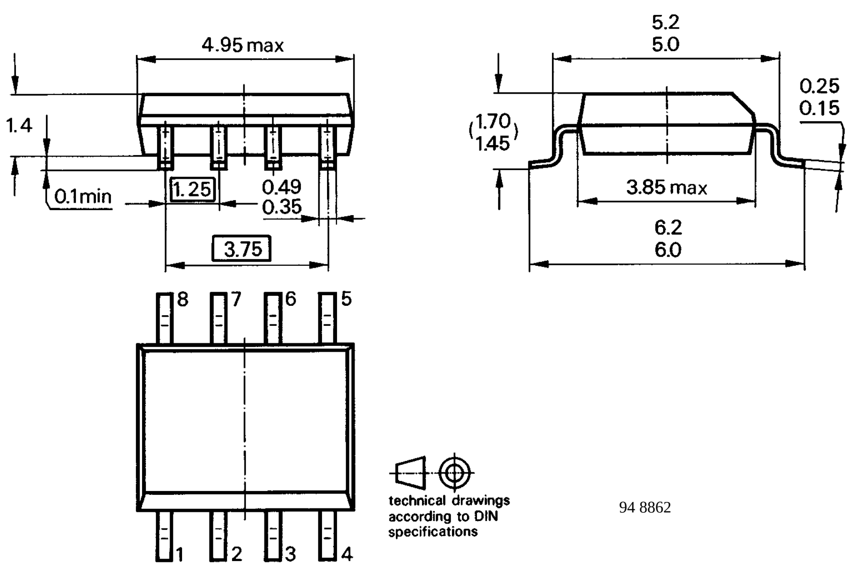
Frequency f	Debounce time t_3	Delay time t_d		C_2	R_2
Hz	ms	min	s	nF	kΩ
600	10		123	10	200
700	9		105	10	170
800	8		92	10	150
900	7		82	10	130
1000	6		74	10	120
2000	3.00		37	1	600
3000	2.00		25	1	400
4000	1.50		18	1	300
5000	1.20		15	1	240
6000	1.00		12	1	200
7000	.86		11	1	170
8000	.75		9	1	150
9000	.67		8	1	130
10000	.60		7	1	120
11000	.55		6.7	1	110
12000	.50		6.1	1	99
13000	.46		5.7	1	91
14000	.43		5.3	1	85
15000	.40		4.9	1	79
16000	.38		4.6	1	74
17000	.35		4.3	1	70
18000	.33		4.1	1	66
19000	.32		3.9	1	62
20000	.30		3.7	1	59

Dimensions in mm

Package: DIP 8



Package: SO 8



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TEMIC TELEFUNKEN microelectronic GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany
Telephone: 49 (0)7131 67 2831, Fax Number: 49 (0)7131 67 2423