Automotive TOGGLE switch

Description

The bipolar integrated circuit, U 6032 B, is designed as a TOGGLE switch. It controls an electrical load, for example, fog lamp, high/ low beam or heated windows for automotive applications. It has a defined power-on status.

Features

- Debounce time: 0.3 ms to 6 s
- RC oscillator determines switching characteristics
- Relay driver with Z-diode
- Debounced input for toggle switch
- Two debounced inputs: ON and OFF
- Load dump protection
- RF interference protected
- Protection according to ISO/TR7637-1 (VDE 0839)

Cases: DIP 8, SO 8

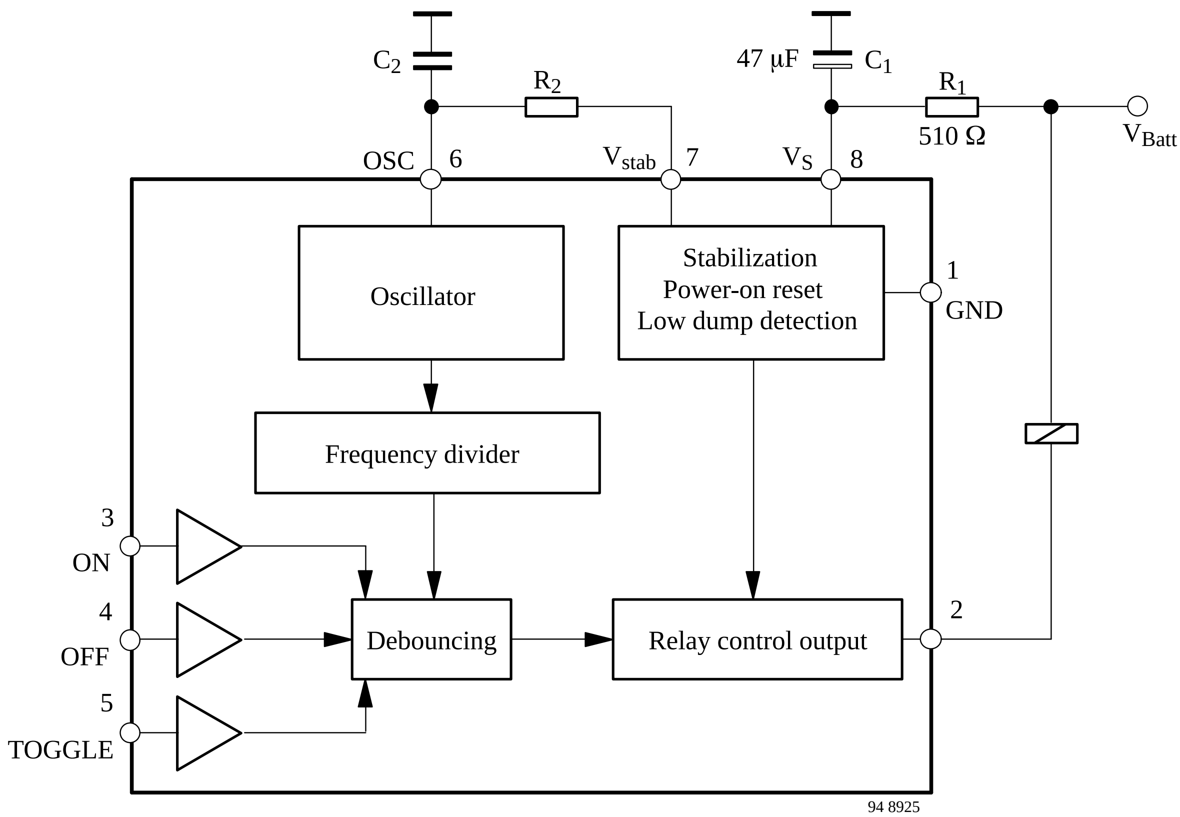
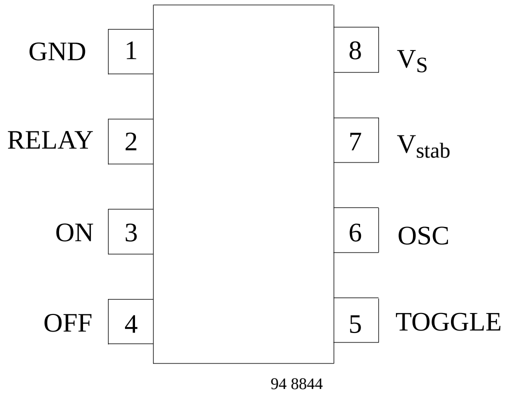


Figure 1 Block diagram with external circuit

Pin Configuration

Pin	Symbol	Function
1	GND	Reference point, ground
2	RELAY	Relay control output
3	ON	Switch-on input
4	OFF	Switch-off input
5	TOGGLE	Toggle 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.

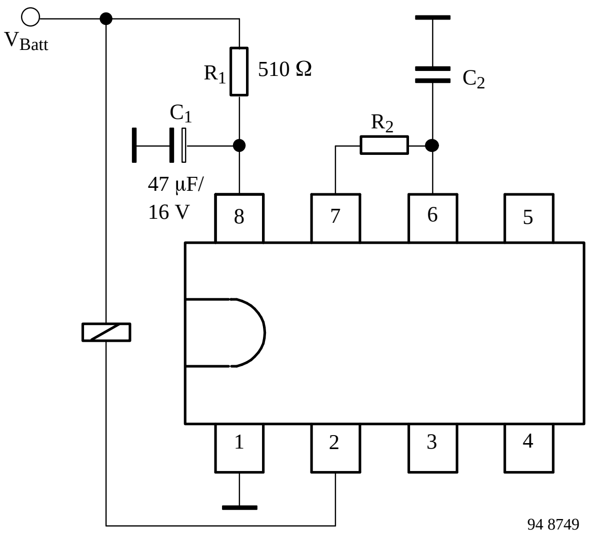


Figure 2a Basic circuit for 12 V supply and oscillator

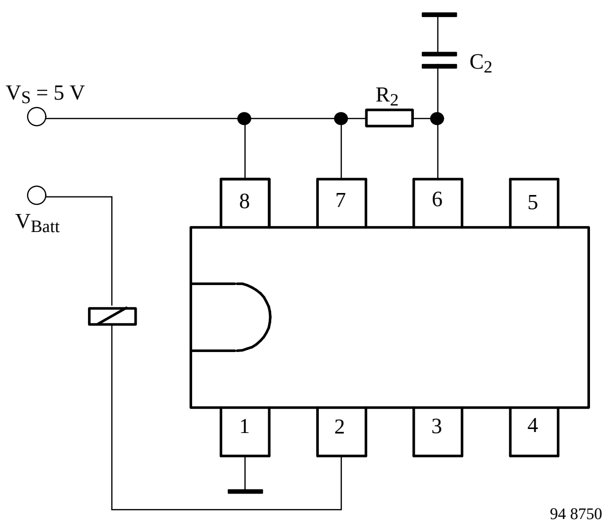


Figure 2b Basic circuit for V_S = 5 V

Oscillator, Pin 6

Oscillator frequency, f, is determined mainly by the R_2C_2 circuit. Resistance, R_2, determines the charge time, and the integrated resistance (2 kΩ) is responsible for discharge time. For the stability of the oscillator frequency, it is recommended that the selected R_2 value be much greater than the 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 = $\alpha_1 . R_2 . C_2$
t_2 = discharge time = $\alpha_2 \cdot 2\ k\Omega \cdot C_2$

α_1 and α_2 are constants as such
$\alpha_1 = 0.833$ 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.

Relay control output

The relay control output is an open collector Darlington circuit with an 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 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 6).

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 output is disabled.

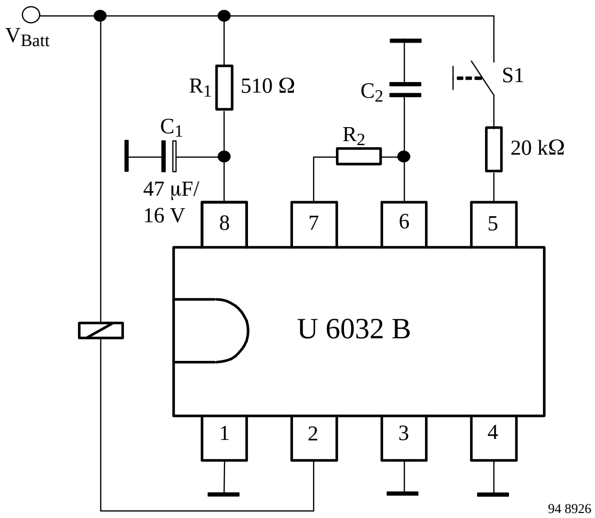


Figure 3 TOGGLE function

Relay control output behaviour, Pin 2

Time functions (relay output) can be started or interrupted by the three inputs i.e., ON, OFF or TOGGLE (Pins 3, 4 and 5).

The relay becomes active if the time function is triggered, and the relay contact is interrupted after the elapse of delay time, t_d. There are two input possibilities:

Toggle input, figure 3

When the push-button (TOGGLE) switch, S_1, is pressed for the first time, the relay becomes active after the debounce time, t_3, i.e., the relay output, Pin 2, is active.

Renewed operation of S_1 causes the interruption of the relay contact and the relay is disabled. Each operation of the toggle switch, S_1, changes (alters) the condition of the relay output when the debounce time, t_d, is exceeded i.e., the TOGGLE function.

If the relay output is not disabled by pressing the switch S_1, the output is active.

ON, OFF inputs, Pins 3 and 4, fig. 4

To avoid simultaneous operation of both inputs, Pin 3 (ON) and Pin 4 (OFF), use of two-way contact with centre-off position with spring returns (also known as rocker-actuated switch) is recommended.

Pressing the push-button switch (Pin 3-ON) leads to the activation of the relay after the debounce time, t_3, whereas the switching of the Pin 4 switch correspondingly leads to the relay being de-energized. If the relay is not de-energized by the push-button switch, the output remains active.

Combined operation, “TOGGLE and ON/OFF” is not possible due to the fact that there is only one debouncing circuit. Debouncing functions on both sides i.e., whenever S_1 is ON or OFF.

Figure 5 shows the input circuit of U 6032 B. It has an integrated pull-down resistance (20 kΩ), RF capacitor (15 pF) and Z-diode (7 V). It reacts to voltages greater than 2 V. The external protective resistor has a value of 20 kΩ and the push-button switch, S, is connected to the battery as shown in the diagram.

Contact current, I, is calculated as follows:

$$I = \frac{V_{Batt}-V_Z}{R(=\ 20\ k\Omega)} \quad \text{where } V_{Batt} = 12\ V,\ V_Z = 7\ V$$

$$I = \frac{(12-7)\ V}{20\ k\Omega} \approx 0.25\ mA$$

It can be increased by connecting a 5.6 kΩ resistor from the push-button switch to ground as shown in figure 6.

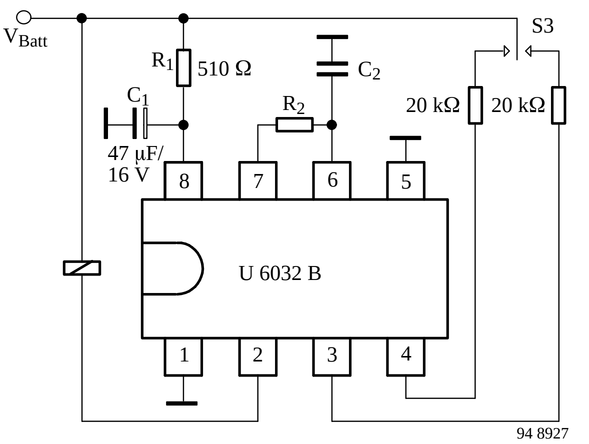


Figure 4 ON/OFF function

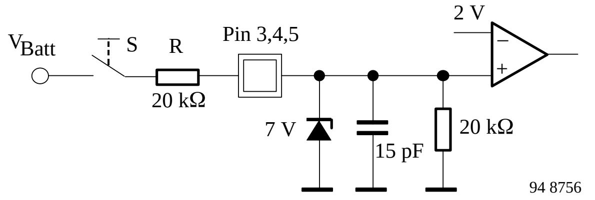


Figure 5 Input circuit

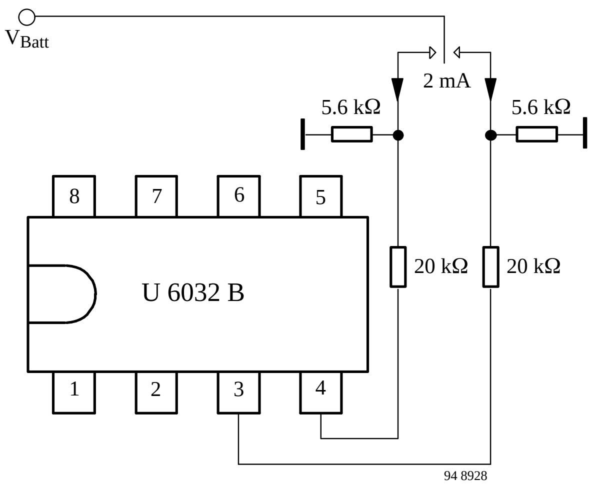


Figure 6 Increasing the contact current by parallel resistors

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	T_{thJA}	110	K/W
	SO 8	T_{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	V_{Batt} = 12 V 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	All 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 control 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	$t \leq 300$ ms	I_2			1.5	A
Internal Z-diode	I_2 = 10 mA	V_Z	20	22	24	V
Oscillator input	f = 0.001 to 40 kHz, see table 1	Pin 6				
Internal discharge resistance	V_6 = 5 V	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
Inputs ON, OFF, TOGGLE	Pins 3, 4 and 5					
Switching threshold voltage		$V_{3,4,5}$	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
Pull-down resistance	$V_{3,4,5}$ = 5 V	$R_{3,4,5}$	13	20	50	kΩ

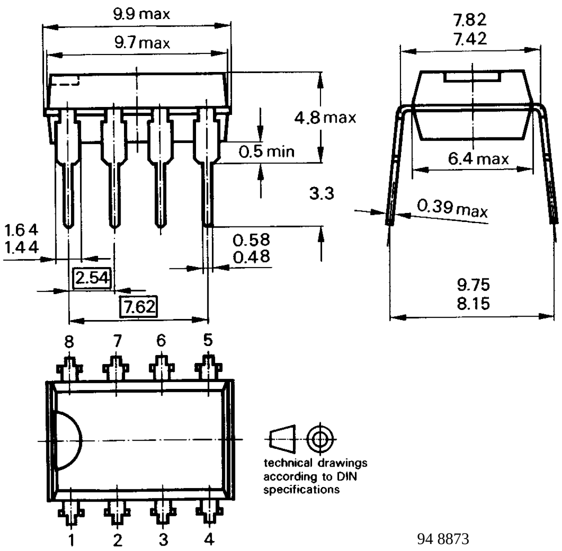
Table 1 Oscillator frequency, debounce time, dimensioning

Frequency f	Debounce time t_3	C_2	R_2
Hz	ms	nF	kΩ
1	6000	4700	280
2	3000	1000	650
3	2000	1000	440
4	1500	1000	330
5	1200	1000	260
6	1000	1000	220
7	857	1000	190
8	750	1000	160
9	667	1000	140
10	600	1000	130
20	300	100	650
30	200	100	440
40	150	100	330
50	120	100	260
60	100	100	220
70	86	100	190
80	75	100	160
90	67	100	140
100	60	100	130
200	30	10	600
300	20	10	400
400	15	10	300
500	12	10	240
600	10	10	200

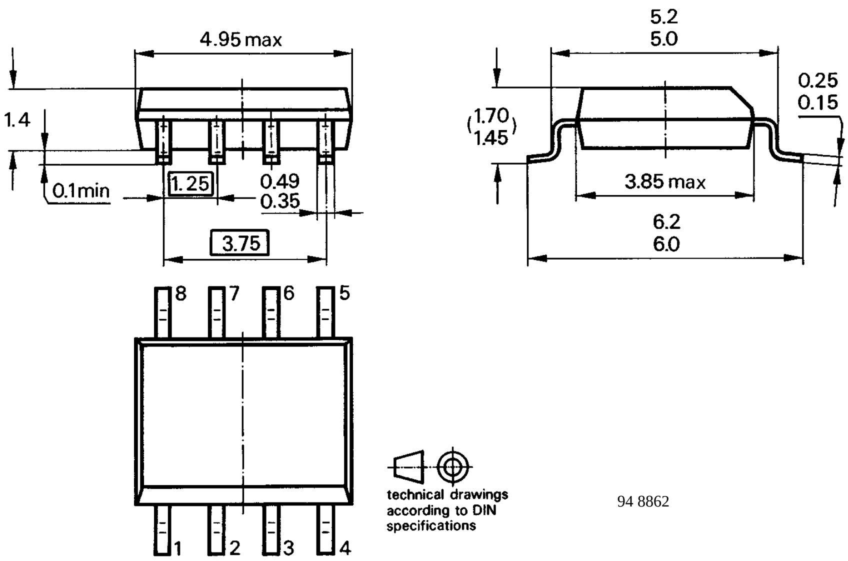
Frequency f	Debounce time t_3	C_2	R_2
Hz	ms	nF	kΩ
700	9	10	170
800	8	10	150
900	7	10	130
1000	6	10	120
2000	3.00	1	600
3000	2.00	1	400
4000	1.50	1	300
5000	1.20	1	240
6000	1.00	1	200
7000	.86	1	170
8000	.75	1	150
9000	.67	1	130
10000	.60	1	120
11000	.55	1	110
12000	.50	1	99
13000	.46	1	91
14000	.43	1	85
15000	.40	1	79
16000	.38	1	74
17000	.35	1	70
18000	.33	1	66
19000	.32	1	62
20000	.30	1	59

Dimensions in mm

Package: DIP 8



Package: SO 8



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

The Montreal Protocol (1987) and its London Amendments (1990) will soon 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.

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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 and

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

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