

## 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.

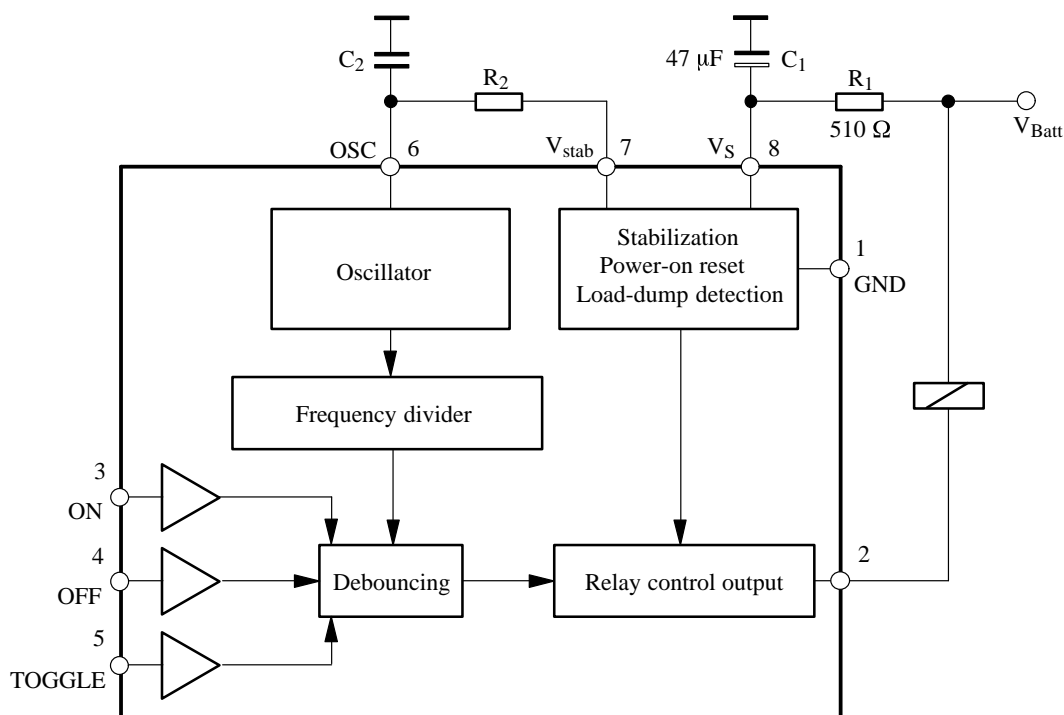
### Features

- 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)

### Ordering Information

Extended Type Number	Package	Remarks
U6032B	DIP8	
U6032B-FP	SO8	

### Block Diagram

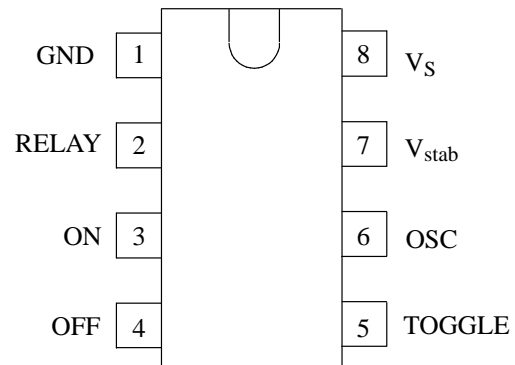


94 8925

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 <sub>stab</sub>	Stabilized voltage
8	V <sub>S</sub>	Supply voltage



94 8844

Figure 2. Pinning

## Functional Description

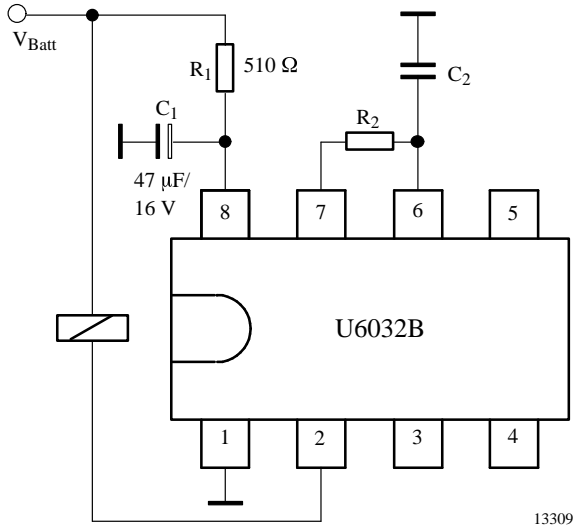
### Power Supply, Pin 8

For reasons of interference protection and surge immunity, the supply voltage (Pin 8) must be provided with an RC circuit as shown in figure 3. The dropping resistor,  $R_1$ , limits the current in case of overvoltage, whereas  $C_1$  smoothes the supply voltage at Pin 8.

Recommended values are:  $R_1 = 510 \Omega$ ,  $C_1 = 47 \mu\text{F}$ .

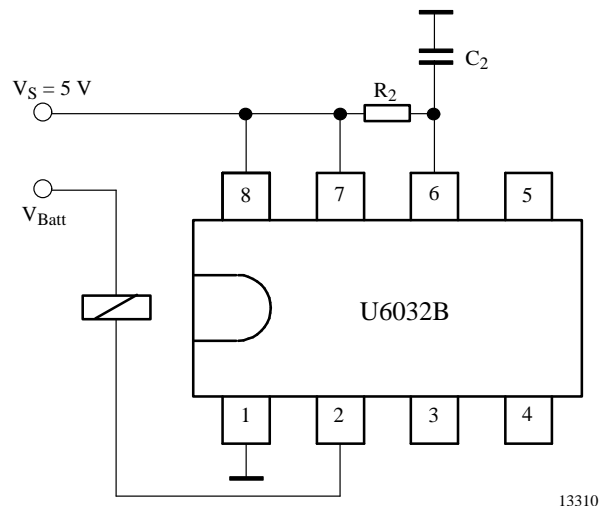
The integrated Z-diode (14 V) protects the supply voltage,  $V_S$ , therefore, the operation of the IC is possible between 6 V and 16 V, supplied by  $V_{\text{Batt}}$ .

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 4, and the  $R_1C_1$  circuit is omitted.



13309

Figure 3. Basic circuit for 12-V supply and oscillator



13310

Figure 4. Basic circuit for  $V_S = 5 \text{ V}$

## Oscillator, Pin 6

The oscillator frequency,  $f$ , is determined mainly by the  $R_2C_2$ -circuit. The resistance,  $R_2$ , determines the charge time, and the integrated resistance ( $2\text{ k}\Omega$ ) is responsible for discharge time. For the stability of the oscillator frequency, it is recommended that the selected  $R_2$  value has to be much greater than the internal resistance ( $2\text{ k}\Omega$ ), because the temperature response and the tolerances of the integrated resistance are considerably greater than the external resistance value.

The oscillator frequency,  $f$ , is calculated as follows:

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

where

$$t_1 = \text{charge time} = \alpha_1 \cdot R_2 \cdot C_2$$

$$t_2 = \text{discharge time} = \alpha_2 \times 2\text{ k}\Omega \times C_2$$

$\alpha_1$  and  $\alpha_2$  are constants as such

$$\alpha_1 = 0.833 \text{ and } \alpha_2 = 1.551 \text{ when } C_2 = 470\text{ pF to } 10\text{ nF}$$

$$\alpha_1 = 0.746 \text{ and } \alpha_2 = 1.284 \text{ when } C_2 = 10\text{ nF to } 4700\text{ nF}$$

The debounce time,  $t_3$ , and the delay time,  $t_d$ , depend on the oscillator frequency,  $f$ , as follows:

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

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

Table 1 shows the relationship 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 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 IC 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

greater than 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.

## Relay Control Output Behavior, Pin 2

Time functions (relay output) can be started or interrupted by the three inputs ON, OFF or TOGGLE (Pins 3, 4 and 5, input circuit of these pins see figure 6).

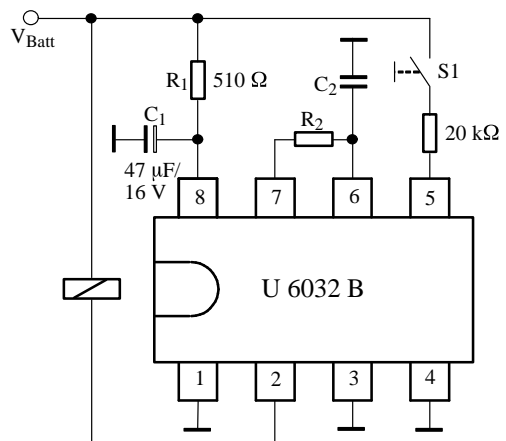
The relay becomes active if the time function is triggered, and the relay contact is interrupted after the elapse of delay time,  $t_d$ . There are two input possibilities.

## Toggle Input, Pin 5

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.



94 8926

Figure 5. TOGGLE function

## ON, OFF Inputs, Pins 3 and 4

To avoid simultaneous operation of both inputs, Pin 3 (ON) and Pin 4 (OFF), the 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 6 shows the input circuit of U 6032 B. It has an integrated pull-down resistor (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:

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

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

It can be increased by connecting a 5.6 kΩ resistor from the push-button switch to ground as shown in figure 8.

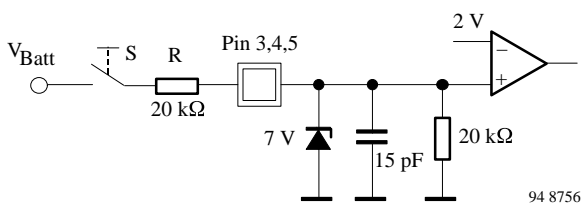


Figure 6. Input circuit

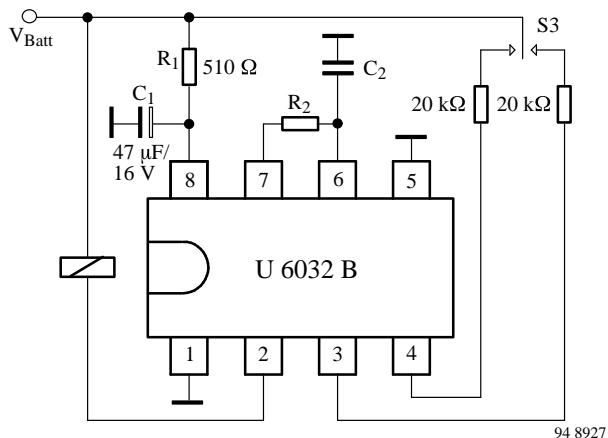


Figure 7. ON/OFF function

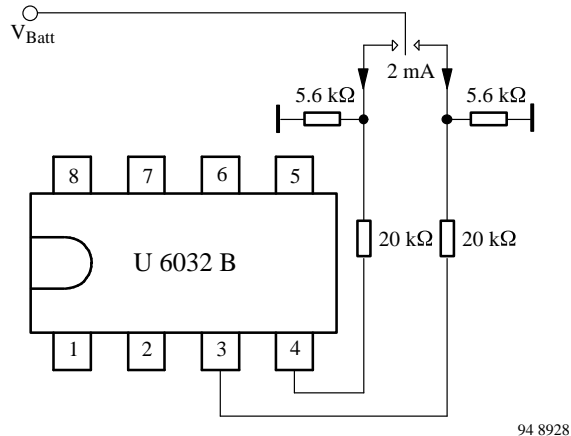


Figure 8. Increasing the contact current by parallel resistors

## 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 DIP8	$T_{thJA}$	110	K/W
SO8	$T_{thJA}$	160	K/W

## Electrical Characteristics

$V_{Batt} = 13.5$  V,  $T_{amb} = 25$ °C, reference point ground, figure 1, 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
<b>Relay control output</b> 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
<b>Output pulse current</b>						
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
<b>Oscillator input</b> $f = 0.001$ 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	$V_{6L}$	0.9	1.1	1.4	V
	Upper	$V_{6H}$	2.8	3.1	3.5	V
Input current	$V_6 = 0$ V	$-I_6$			1	μA
<b>Switching times</b>						
Debounce time		$t_3$	5		7	cycles
<b>Inputs ON, OFF, TOGGLE</b> 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. Values for  $C_2$  and  $R_2$  for a given oscillator frequency and debounce time

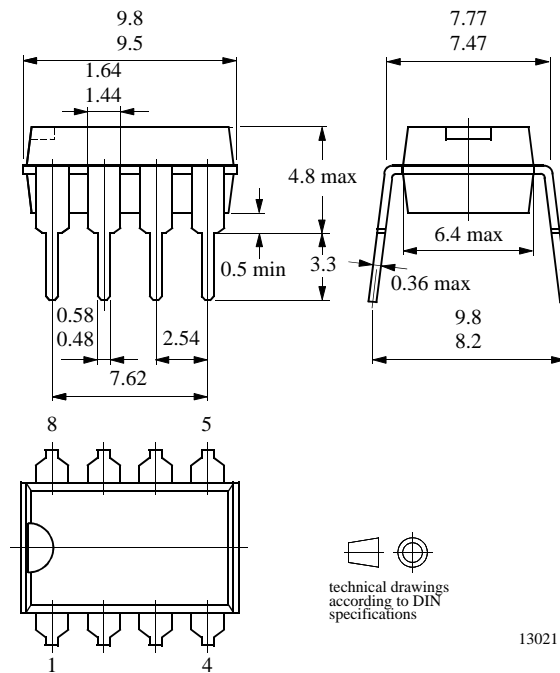
Frequency f	Debounce time $t_3$	$C_2$	$R_2$
Hz	ms	nF	k $\Omega$
1	6000	4700	280
2	3000	1000	650
3	2000	1000	440
4	1500	1000	330
5	1200	1000	260
6	1000	1000	220
7	857	1000	190
8	750	1000	160
9	667	1000	140
10	600	1000	130
20	300	100	650
30	200	100	440
40	150	100	330
50	120	100	260
60	100	100	220
70	86	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	k $\Omega$
700	9.00	10	170
800	8.00	10	150
900	7.00	10	130
1000	6.00	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	0.86	1	170
8000	0.75	1	150
9000	0.67	1	130
10000	0.60	1	120
11000	0.55	1	110
12000	0.50	1	99
13000	0.46	1	91
14000	0.43	1	85
15000	0.40	1	79
16000	0.38	1	74
17000	0.35	1	70
18000	0.33	1	66
19000	0.32	1	62
20000	0.30	1	59

**Package Information**

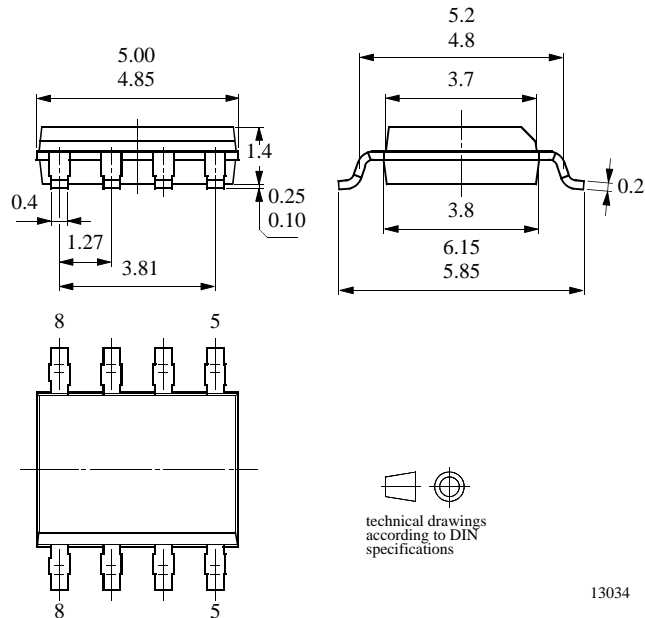
Package DIP8

Dimensions in mm



Package SO8

Dimensions in mm



## Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC TELEFUNKEN microelectronic 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.

**TEMIC TELEFUNKEN microelectronic GmbH** semiconductor division 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.

**TEMIC** can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

**We reserve the right to make changes to improve technical design and may do so without further notice.**

Parameters can vary in different applications. All operating parameters must be validated for each customer application by the customer. Should the buyer use TEMIC products for any unintended or unauthorized application, the buyer shall indemnify TEMIC against all claims, costs, damages, and expenses, arising out of, directly or indirectly, any claim of personal damage, injury or death associated with such unintended or unauthorized use.

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