# Automotive Toggle Switch

Description

The bipolar integrated circuit U6032B 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

- Three debounced inputs: ON, OFF and TOGGLE
- Load-dump protection
- RF interference protected
- Protection according to ISO/TR7637-1 (VDE 0839)

Block Diagram
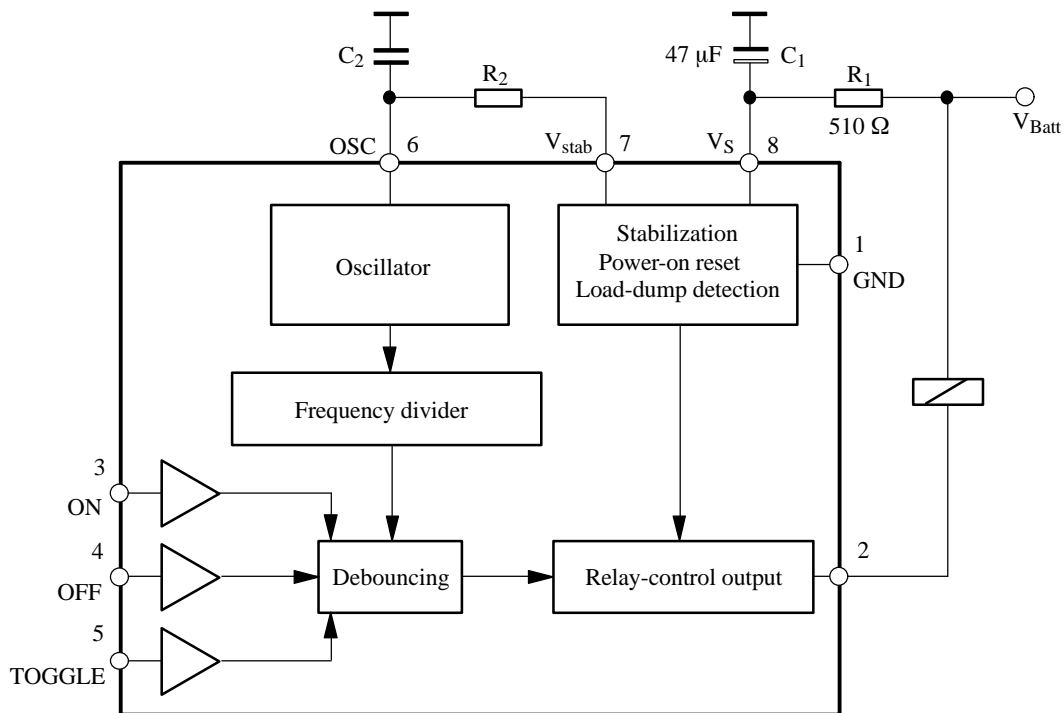
Figure 1. Block diagram with external circuit

Ordering Information

Extended Type Number	Package	Remarks
U6032B	DIP8	
U6032B–FP	SO8	

U6032B

Pin Description

| 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
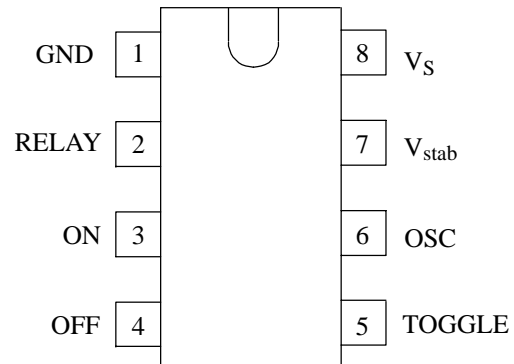
Figure 2. Pinning

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: $R_1 = 510\ \Omega$, $C_1 = 47\ \mu F$.

An integrated Z diode (14 V) protects the supply voltage, V_S, thus enabling stable operation in a supply-voltage range of 6 V to 16 V, supplied by V_{Batt}.

It is possible to operate the integrated circuit with a 5-V supply, but it should be assured that there are no interference voltages. In this case, Pin 7 is connected to Pin 8 as shown in figure 4, and the $R_1 C_1$ circuit is omitted.
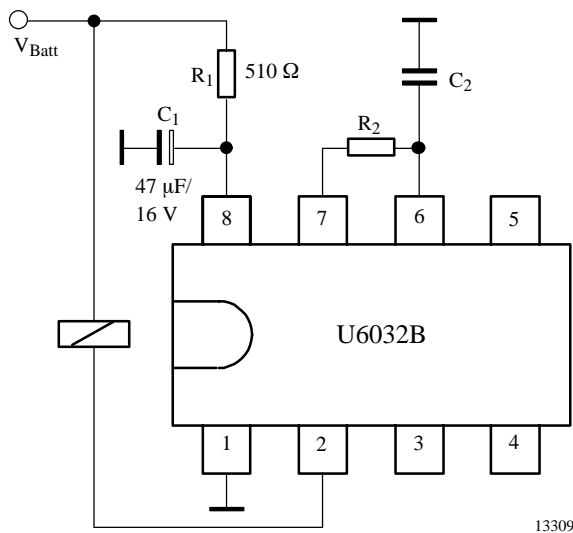
Figure 3. Basic circuit for 12-V supply and oscillator
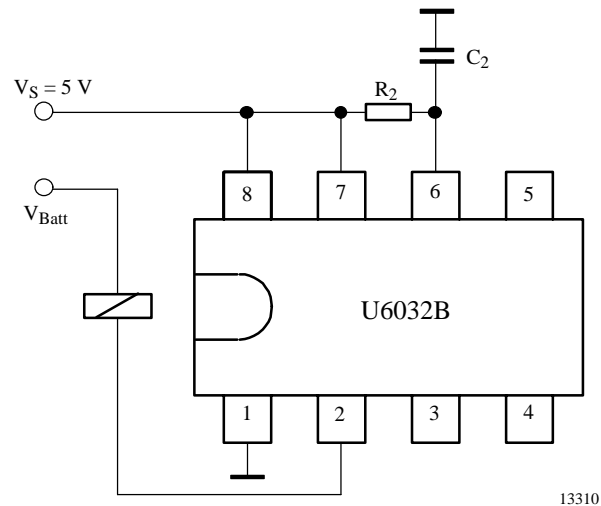
Figure 4. Basic circuit for $V_S = 5$ V

Oscillator, Pin 6

The oscillator frequency, f, is determined mainly by the $R_2 C_2$ circuit. The resistance, R_2, determines the charge time, and the integrated resistance (2 kΩ) is responsible for the discharge time. For the stability of the oscillator frequency, it is recommended that the selected R_2 value is remarkably greater than the internal resistance (2 kΩ), as 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 = charge time = $\alpha_1 \times R_2 \times C_2$
t_2 = discharge time = $\alpha_2 \times 2\text{ k}\Omega \times C_2$

α_1 and α_2 are constants, e.g.:
$\alpha_1 = 0.833$ 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

The debounce time, t_3, depends on the oscillator frequency, f, as follows:

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

Table 1 shows the relationship between t_3, 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 limiting 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 6).

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

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 the 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.

Repeated operation of S_1 causes the interruption of the relay contact, thus disabling the relay. 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 stays active.
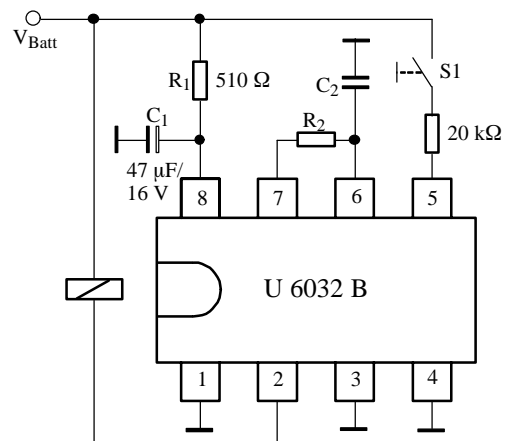
Figure 5. TOGGLE function

ON, OFF Inputs, Pins 3 and 4

To avoid simultaneous operation of both inputs, Pin 3 (ON) and Pin 4 (OFF), the use of a 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 an activation of the relay after the debounce time, t_3, has ellapsed whereas the switching of Pin 4 switch correspondingly leads to the de-energization of the relay. 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 is possible in both modes, i.e., whenever S_1 is ON or OFF.

Figure 6 shows the input circuit of U6032B. 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.

The contact current, I, is calculated as follows:

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

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

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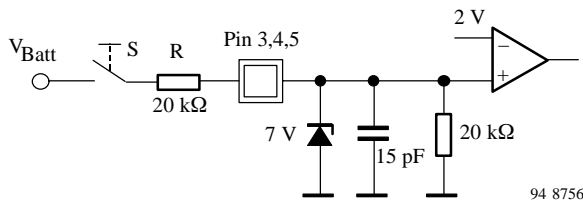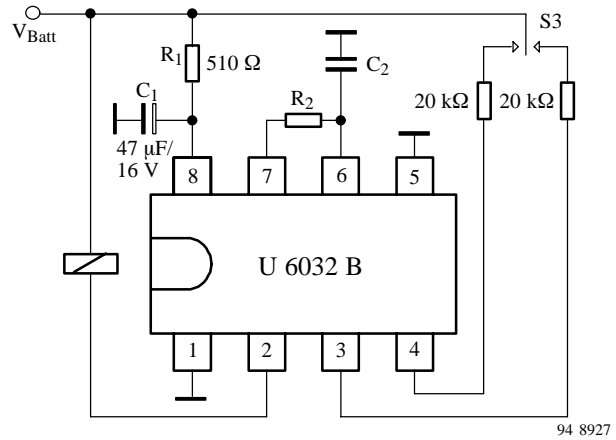

Figure 6. Input circuit
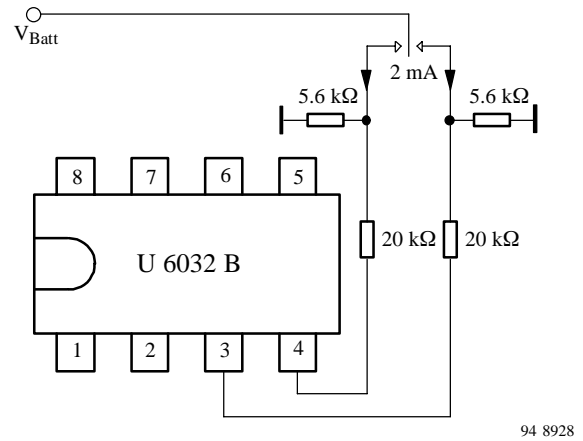

Figure 7. ON/OFF function

Figure 8. Increasing the contact current by parallel resistors

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Operating voltage, static, 5 minutes	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 push buttons 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 ≤ 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 thresholds	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

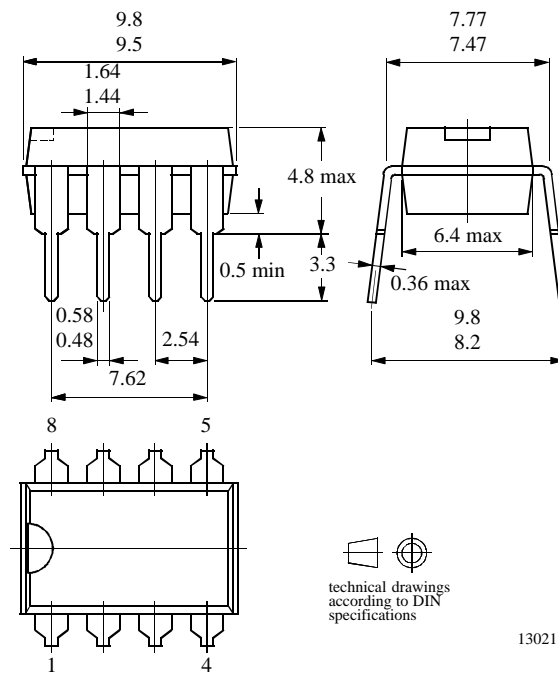Table 1 Values for C_2 and R_2 for a given oscillator frequency and debounce time

Frequency f	Debounce Time t_3	C_2	R_2	Frequency f	Debounce Time t_3	C_2	R_2
Hz	ms	nF	kΩ	Hz	ms	nF	kΩ
1	6000	4700	280	700	9.00	10	170
2	3000	1000	650	800	8.00	10	150
3	2000	1000	440	900	7.00	10	130
4	1500	1000	330	1000	6.00	10	120
5	1200	1000	260	2000	3.00	1	600
6	1000	1000	220	3000	2.00	1	400
7	857	1000	190	4000	1.50	1	300
8	750	1000	160	5000	1.20	1	240
9	667	1000	140	6000	1.00	1	200
10	600	1000	130	7000	0.86	1	170
20	300	100	650	8000	0.75	1	150
30	200	100	440	9000	0.67	1	130
40	150	100	330	10000	0.60	1	120
50	120	100	260	11000	0.55	1	110
60	100	100	220	12000	0.50	1	99
70	86	100	190	13000	0.46	1	91
80	75	100	160	14000	0.43	1	85
90	67	100	140	15000	0.40	1	79
100	60	100	130	16000	0.38	1	74
200	30	10	600	17000	0.35	1	70
300	20	10	400	18000	0.33	1	66
400	15	10	300	19000	0.32	1	62
500	12	10	240	20000	0.30	1	59
600	10	10	200				

Package Information

Package DIP8
Dimensions in mm

9.8
9.5
1.64
1.44
4.8 max
0.5 min
3.3
0.58
0.48
2.54
7.62

7.77
7.47
6.4 max
0.36 max
9.8
8.2

8   5

1   4

technical drawings
according to DIN
specifications

13021

Package SO8
Dimensions in mm

5.00
4.85
1.4
0.4
0.25
0.10
1.27
3.81

5.2
4.8
3.7
3.8
0.2
6.15
5.85

8   5

1   4

technical drawings
according to DIN
specifications

13034
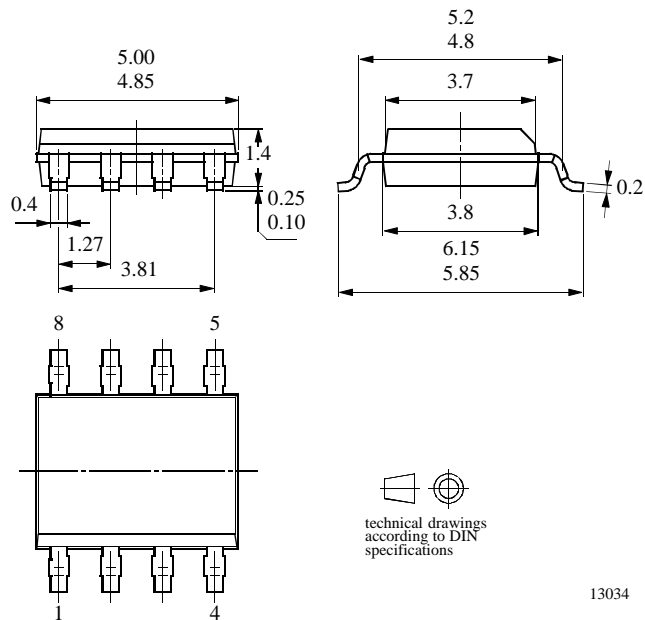
Ozone Depleting Substances Policy Statement

It is the policy of **Atmel Germany 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.

Atmel Germany GmbH 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.

Atmel Germany GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

Data sheets can also be retrieved from the Internet: http://www.atmel–wm.com