Features

- **Delay Time Range: 3.7s to 20h**
- **RC Oscillator Determines Timing 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)**
- **Inputs Switched to V_{Batt}**

Pb Lead Free

Rear Window Heating Timer/ Long-term Timer

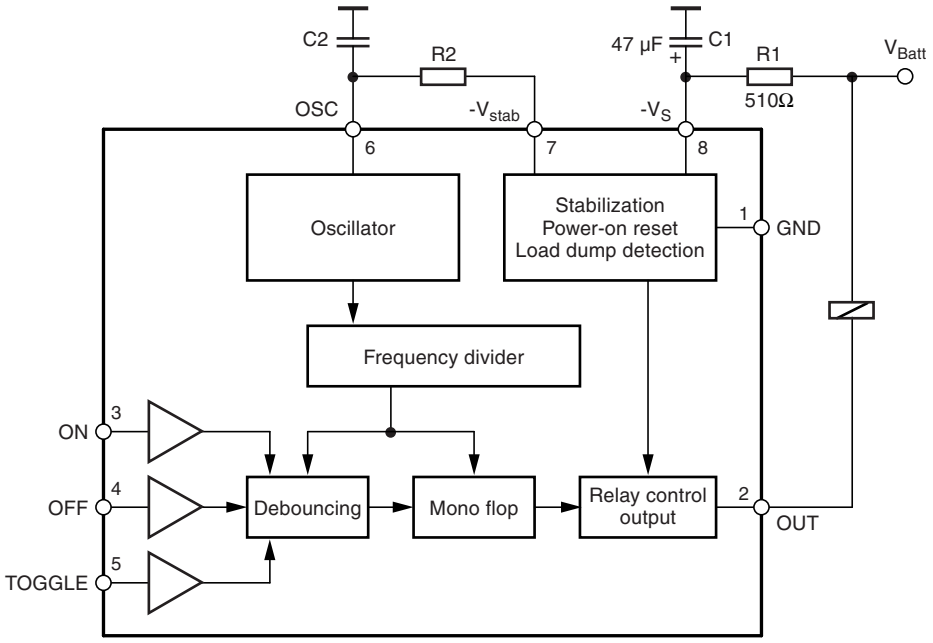
U6046B

1. Description

The bi-polar long-term timer U6046B is designed to automatically limit the operation time of high loads in the harsh automotive environment with a preset delay time. With the power-on-reset function the timers guarantee that current consuming devices are not operated unintentionally.

The delay time can be interrupted manually, but a retrigger function is not provided.

Figure 1-1. Block Diagram with External Circuit



Rev. 4674B–AUTO–09/05

2. Pin Configuration

Figure 2-1. Pinning

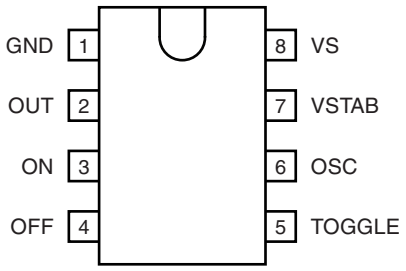


Table 2-1. Pin Description

Pin	Symbol	Function
1	GND	Reference point, ground
2	OUT	Relay control output
3	ON	Switch-on input
4	OFF	Switch-off input
5	TOGGLE	Toggle input
6	OSC	RC-oscillator input
7	VSTAB	Stabilized voltage
8	VS	Supply voltage

3. Functional Description

3.1 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 3-1. Dropper resistor, R_1, limits the current in case of overvoltage, whereas C_1 smooths the supply voltage at pin 8.

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

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

However, it is possible to operate the integrated circuit with a 5V supply, but it should be free of interference voltages. In this case, pin 7 is connected to pin 8 as shown in Figure 3-2 on page 3, and the R_1C_1 circuit is omitted.

Figure 3-1. Basic Circuit for 12V Supply and Oscillator

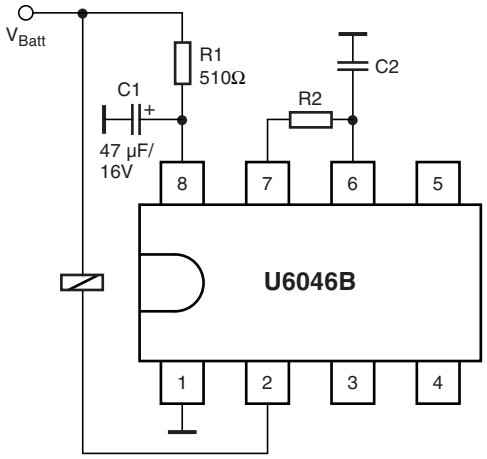
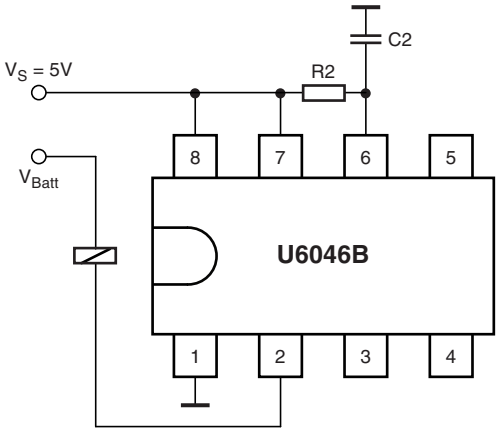


Figure 3-2. Basic Circuit for V_S = 5V



3.2 Oscillator (Pin 6)

The external components R_2 and C_2 determine the oscillator frequency. The capacitor C_2 is charged by R_2 and discharged by an integrated 2-kΩ resistor.

A stable oscillator frequency with minimal influence of the temperature coefficient of the integrated resistor is achieved with $R_2 >> 2\ k\Omega$

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 = $\alpha_2 \times 2\ k\Omega \times C_2$

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

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 6-1 on page 9 shows relationships between t_3, t_d, C_2, R_2 and frequencies from 1 Hz to 20 kHz.

3.3 Relay Control Output (OUT)

The relay control output is an open-collector Darlington circuit with an integrated 23-V Z-diode to limit the inductive cut-off pulse of the relay coil. The maximum static collector current must not exceed 300 mA and saturation voltage is typically 1.1V at 200 mA.

3.4 Interference Voltages and Load-dump

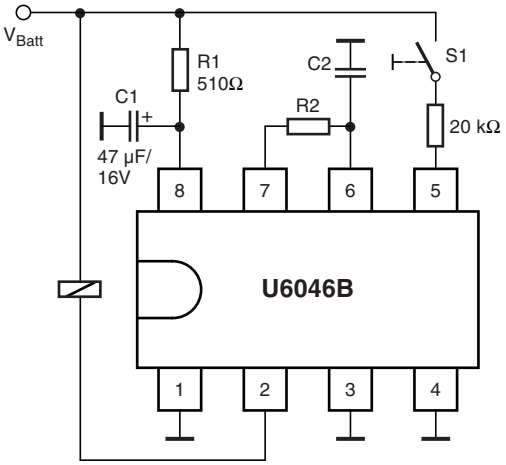
The IC supply is protected by R_1, C_1, and an integrated Z-diode, while the inputs are protected by a series resistor, integrated Z-diode and RF capacitor (see Figure 3-6 on page 7).

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

3.5 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 3-3. TOGGLE Function



3.6 Relay Control Output Behavior (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:

3.6.1 Toggle Input

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 (see Figure 3-3 on page 5).

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_3, is exceeded i.e., the TOGGLE function.

If the relay output is not disabled by pressing the switch S_1, the output is active until the delay time, t_d, is over.

3.6.2 ON, OFF Inputs (Pins 3 and 4)

To avoid simultaneous operation of both inputs, pin 3 (ON) and pin 4 (OFF), use of two-way contacts with a centre-off position with spring returns (also known as rocker-actuated switch) is recommended (see Figure 3-4 on page 6).

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, it becomes disabled after the delay time, t_d, is over.

Combined operation, TOGGLE and ON/OFF is not possible because both inputs are connected to the same debounce stage. Debouncing functions on both edges i.e., whenever S_1 is ON or OFF.

If pin 3 (input ON) is continuously closed, the delay time, t_d, still elapses and the relay is interrupted. This can be used to generate a defined power-on-reset pulse to trigger, for example, a delay time, t_d, when the battery voltage, V_{Batt}, is applied.

Figure 3-6 on page 7 shows the input circuit of U6046B. It has an integrated pull-down resistance (20 kΩ), RF capacitor (15 pF) and Z-diode (7V). It reacts to voltages greater than 2V. 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.

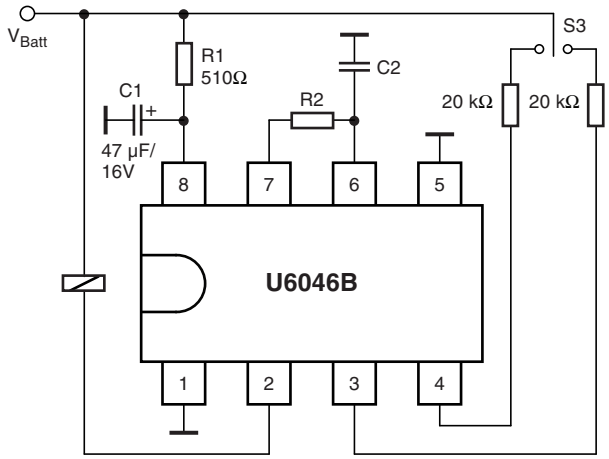
Contact current, I, is calculated as follows:

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

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

It can be increased by connecting a 5.6 kΩ resistor from the push-button switch to ground as shown in Figure 7-4 on page 12.

Figure 3-4. ON/OFF Function



3.7 Timing Waveform

Figure 3-5. Behavior of the Relay Control Output as a Function of Input Condition

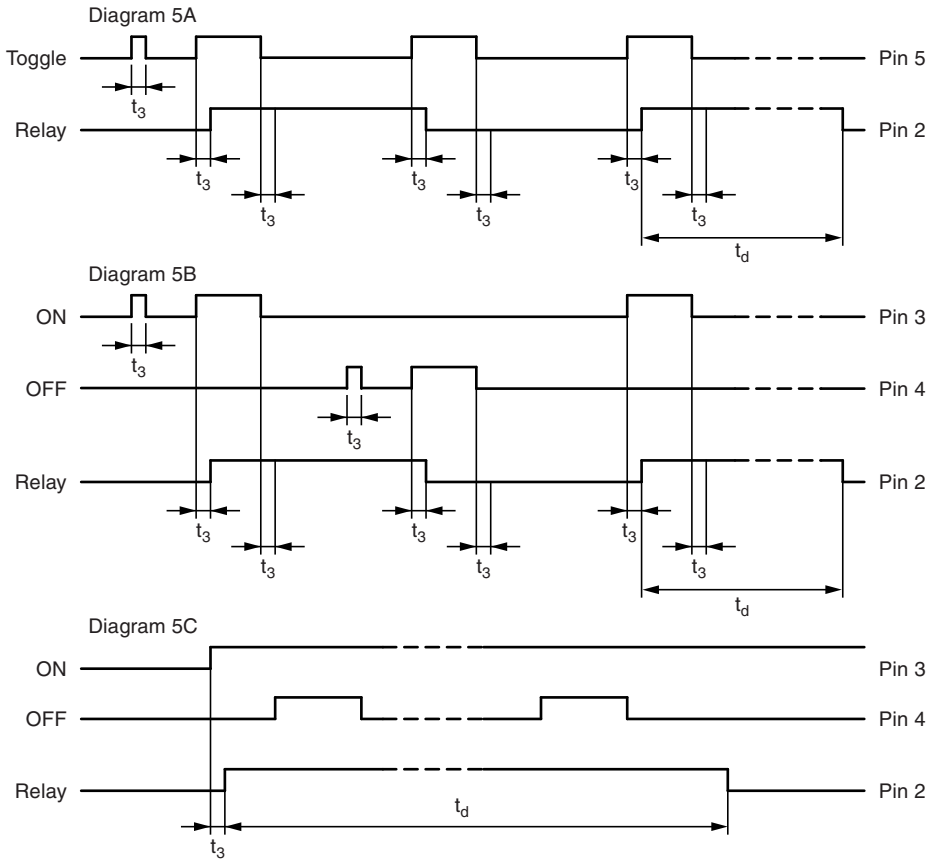
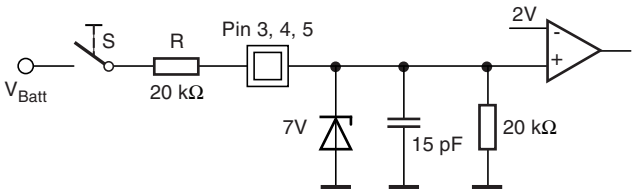


Figure 3-6. Input Circuit U6046B



4. Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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

5. Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient DIP8 SO8	R_{thJA} R_{thJA}	120 160	K/W K/W

6. Electrical Characteristics

V_{Batt} =13.5V, T_{amb} = 25°C, reference point ground, Figure 2-1 on page 2, unless otherwise specified

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
1.1	Operating voltage	$R_1 \geq 510\Omega$ t < 5 min t < 60 min		V_{Batt}	6		16 24 18	V
1.2	5V supply	Without R_1, C_1, Figure 3-2 on page 3	7, 8	V_8, V_7	4.3		6.0	V
1.3	Stabilized voltage	V_{Batt} = 12V	7	V_7	5.0	5.2	5.4	V
1.4	Undervoltage threshold	Power on reset		V_8	3.0		4.2	V
1.5	Supply current	All push buttons open	8	I_8		1.3	2.0	mA
1.6	Internal Z-diode	I_8 = 10 mA	8	V_8	13.5	14	16	V
2	**Relay Control Output, Pin 2**							
2.1	Saturation voltage	I_2 = 200 mA I_2 = 300 mA		V_2		1.2	 1.5	V
2.2	Leakage current	V_2 = 14V		I_2		2	100	µA
2.3	Output current			I_2			300	mA
3	**Output Pulse Current**							
3.1	Load dump pulse	t ≤ 300 ms		I_2			1.5	A
3.2	Internal Z-diode	I_2 = 10 mA		V_2	20	22	24	V
4	**Oscillator Input f = 0.001 to 40 kHz, See Table 6-1 on page 9, Pin 6**							
4.1	Internal discharge resistance	V_6 = 5V		R_6	1.6	2.0	2.4	kΩ
4.2	Switching voltage	Lower Upper		V_{6L} V_{6H}	0.9 2.8	1.1 3.1	1.4 3.5	V
4.3	Input current	V_6 = 0V		$-I_6$			1	µA

6. Electrical Characteristics (Continued)

V_{Batt} =13.5V, T_{amb} = 25°C, reference point ground, Figure 2-1 on page 2, unless otherwise specified

No.	Parameters	Test Conditions	Pin	Symbol	Min.	Typ.	Max.	Unit
5	**Switching Time**							
5.1	Debounce time			t_3	5		7	cycles
5.2	Delay time			t_d	72704		74752	cycles
6	**Inputs ON, OFF, TOGGLE; Pins 3, 4, 5**							
6.1	Switching threshold voltage			$V_{3,4,5}$	1.6	2.0	2.4	V
6.2	Internal Z-diode	$I_{3, 4, 5}$ = 10 mA		$V_{3,4,5}$	6.5	7.1	8.0	V
6.3	Pull-down resistance	$V_{3,4,5}$ = 5V		$R_{3,4,5}$	13	20	50	kΩ

Table 6-1. Dimensioning for Oscillator Frequency, Debounce Time and Delay Time

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
600	10		123	10	200
700	9.00		105	10	170
800	8.00		92	10	150
900	7.00		82	10	130
1000	6.00		74	10	120

Table 6-1. Dimensioning for Oscillator Frequency, Debounce Time and Delay Time (Continued)

Frequency f	Debounce Time t_3	Delay Time t_d		C_2	R_2
Hz	ms	min	s	nF	kΩ
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	0.86		11	1	170
8000	0.75		9	1	150
9000	0.67		8	1	130
10000	0.60		7	1	120
11000	0.55		6.7	1	110
12000	0.50		6.1	1	99
13000	0.46		5.7	1	91
14000	0.43		5.3	1	85
15000	0.40		4.9	1	79
16000	0.38		4.6	1	74
17000	0.35		4.3	1	70
18000	0.33		4.1	1	66
19000	0.32		3.9	1	62
20000	0.30		3.7	1	59

7. Applications

Figure 7-1. Generation of a Monostable Delay Time, t_d, Caused by Applying the Operating Voltage V_{Batt}, not Externally Deactivatable

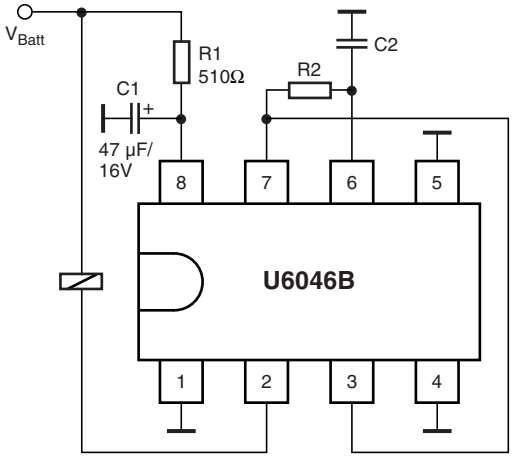


Figure 7-2. Generation of a Monostable Delay Time, t_d, by Applying the Operating Voltage V_{Batt}, Deactivatable by the OFF Push-button

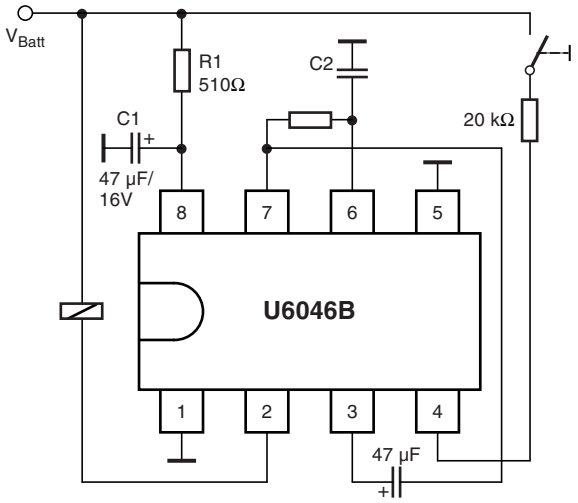


Figure 7-3. Monostable Delay Time, t_d, can be Activated by the ON Push-button, not Externally Deactivatable

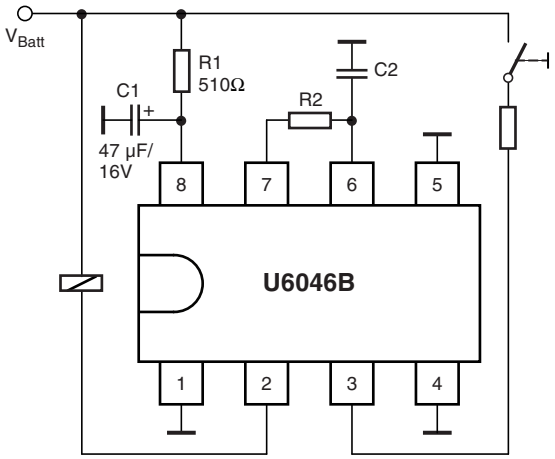
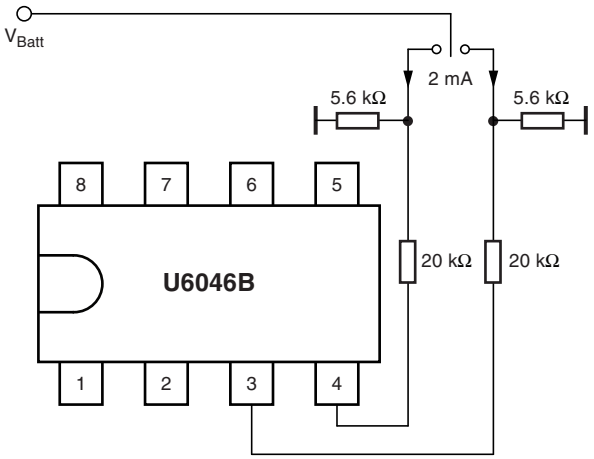


Figure 7-4. Increasing the Contact Current by Parallel Resistors

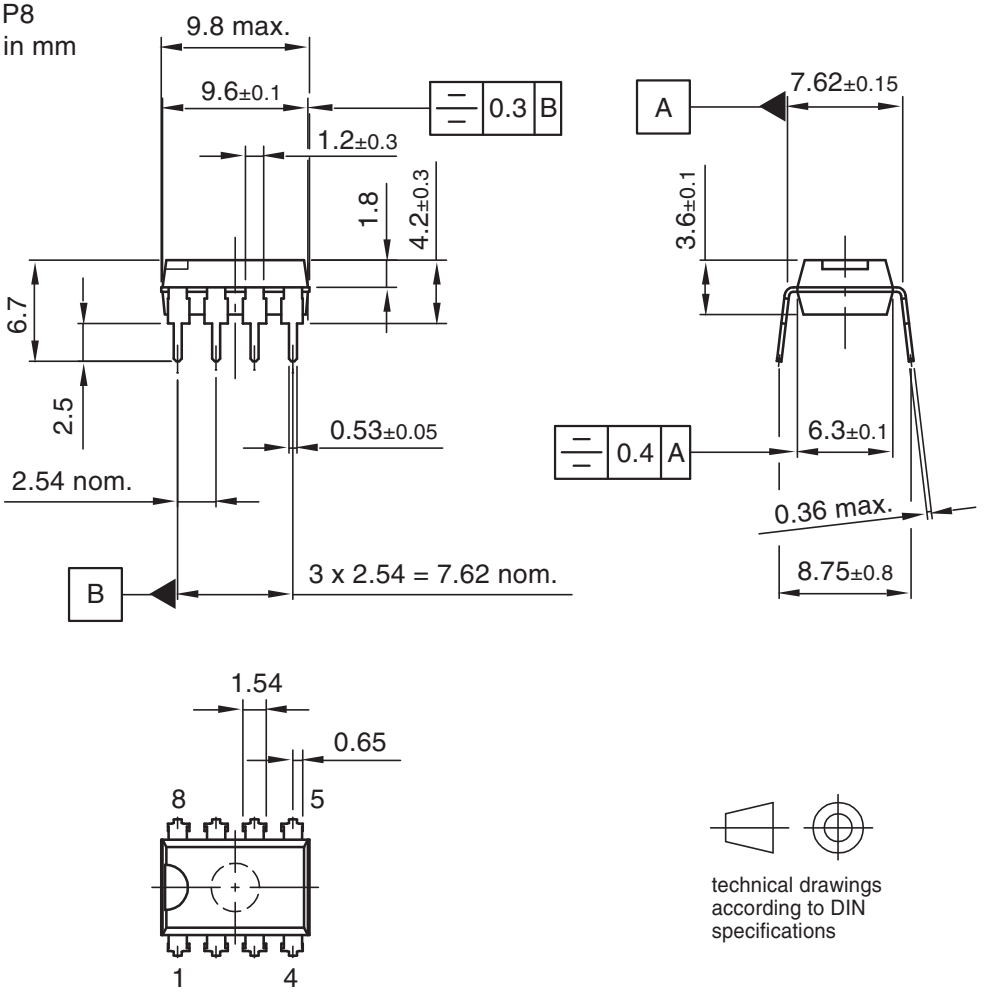


8. Ordering Information

Extended Type Number	Package	Remarks
U6046B-MY	DIP8	Pb-free
U6046B-MFPY	SO8	Tubed, Pb-free
U6046B-MFPG3Y	SO8	Taped and reeled, Pb-free

9. Package Information

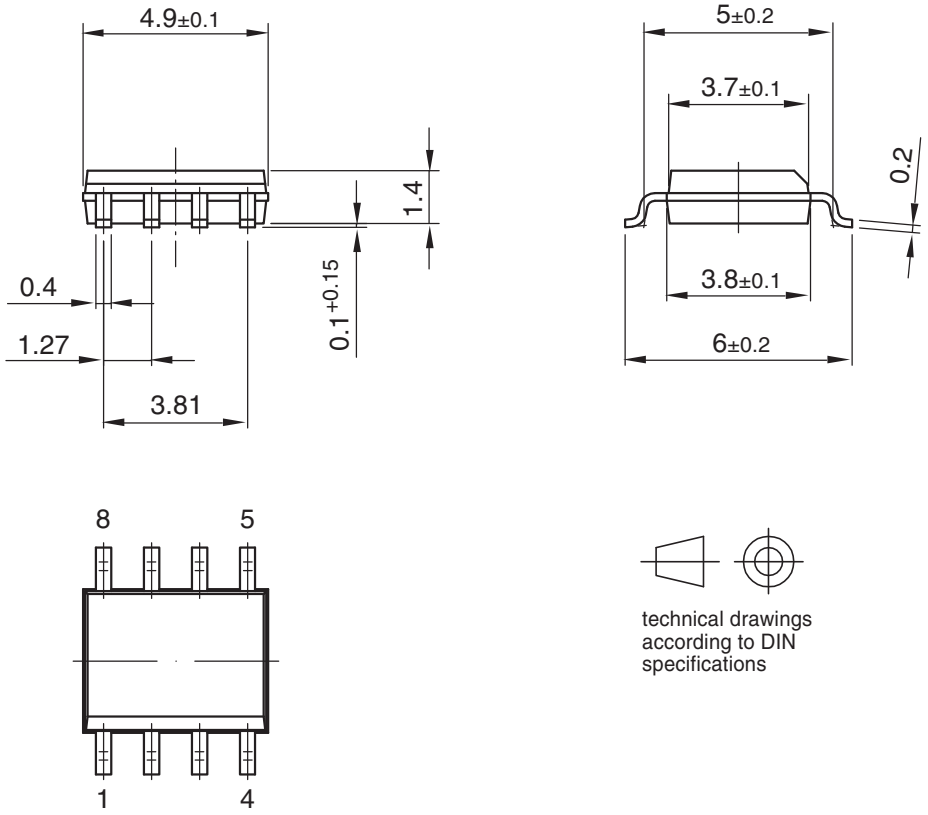
Package: DIP8
Dimensions in mm



Drawing-No.: 6.543-5040.01-4
Issue: 1; 16.01.02

Package: SO 8

Dimensions in mm



technical drawings
according to DIN
specifications

Drawing-No.: 6.541-5031.01-4

Issue: 1; 15.08.06

10. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
4674B-AUTO-09/05	• Put datasheet in a new template • Pb-free Logo on page 1 added • Heading Rows on Table “Absolute Maximum Ratings” on page 9 added • Table “Ordering Information” on page 14 changed

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