# U 6030 B / U 6031 B

## Switch ON/OFF delay circuit for timing relays

### Description

The bipolar integrated circuits, U 6030 B and U 6031 B, are designed as switch ON/ OFF delay circuits for timing relays. They have a defined switch ON/ OFF delay time.

### Features

- Delay time range: 3.7 s to 20 h
- RC oscillator determines switching characteristics
- Relay driver with Z-diode
- Low supply current
- Load dump protection
- RF interference protected
- Protection according to ISO/TR7637-1 (VDE 0839)
- U 6030 B: Switch ON delay
- U 6031 B: Switch OFF delay

### Cases:

| | |
|---|---|
| DIP 8 | U 6030 B, U 6031 B |
| SO 8 | U 6030 B-FP, U 6031 B-FP |

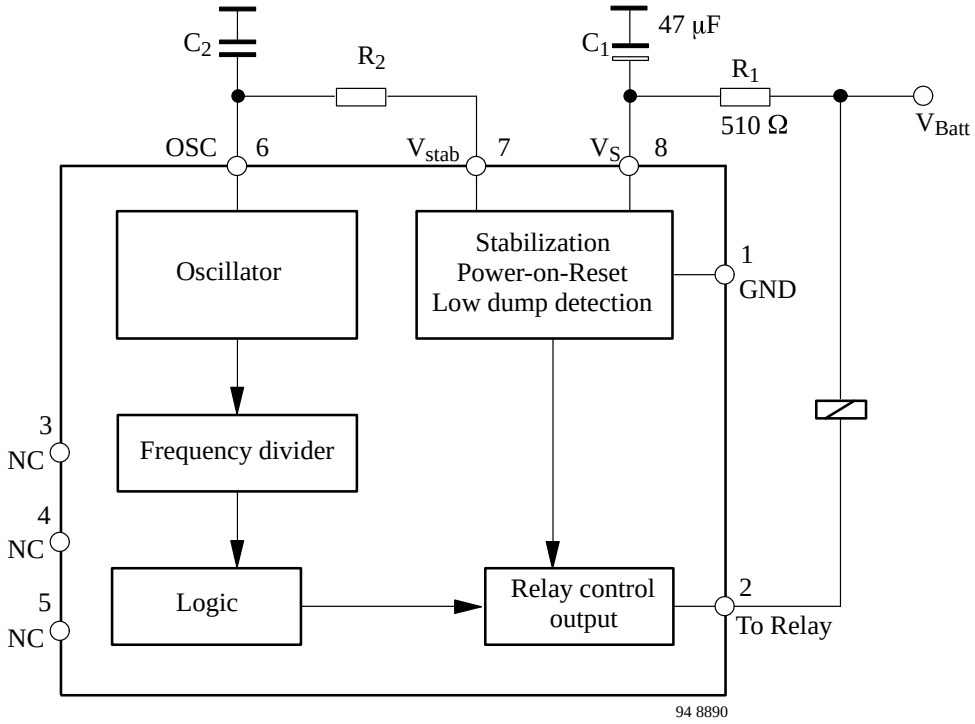
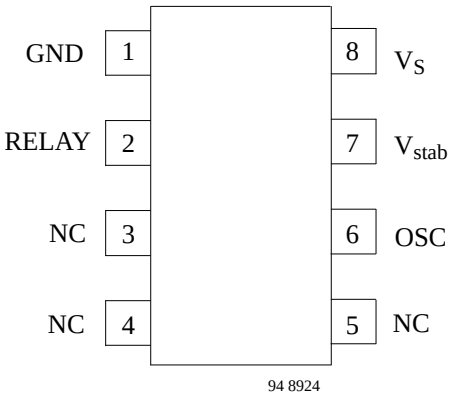



Figure 1 Block diagram with external circuit

## Pin Configuration

| Pin | Symbol | Function |
|---|---|---|
| 1 | GND | Reference point, ground |
| 2 | RELAY | Relay control output |
| 3 | NC | Not connected |
| 4 | NC | Not connected |
| 5 | NC | Not connected |
| 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.

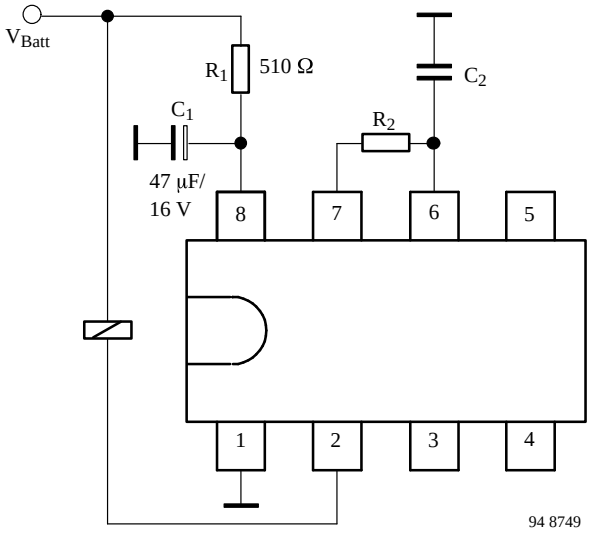



Figure 2a Basic circuit for 12 V supply and oscillator

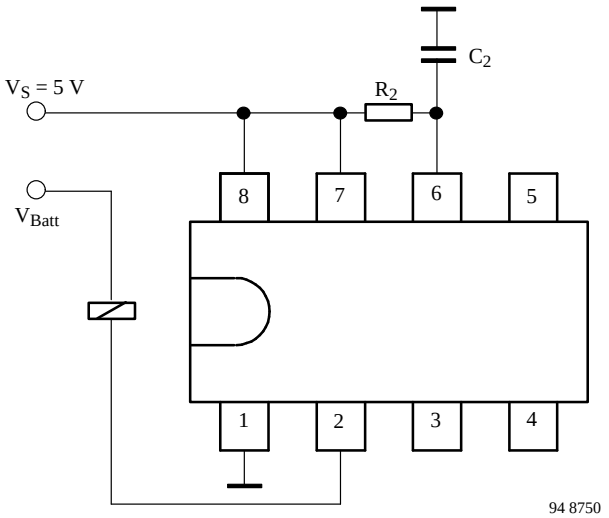



Figure 2b Basic circuit for $V_S$ = 5 V

### 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 = $\alpha_2 \cdot 2\ k\Omega \cdot C_2$

$\alpha_1$ and $\alpha_2$ 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.

## Timing waveform

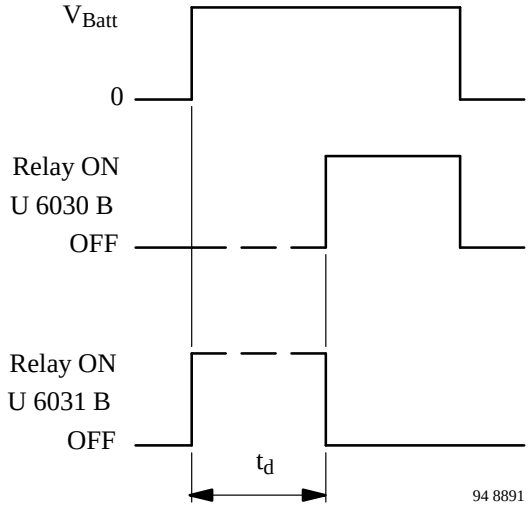



Figure 3 Behaviour of the control output as a function of supply voltage

## 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 | $R_1 \geq 510\ \Omega$<br>t < 5 min<br>t < 60 min | $V_{Batt}$ | 6 | | 16<br>24<br>18 | V |
| 5 V supply | Without $R_1$, $C_1$<br>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<br>$I_2$ = 300 mA | $V_2$ | | 1.2 | <br>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 voltage | Lower<br>Upper | $V_{6L}$<br>$V_{6H}$ | 0.9<br>2.8 | 1.1<br>3.1 | 1.4<br>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 |

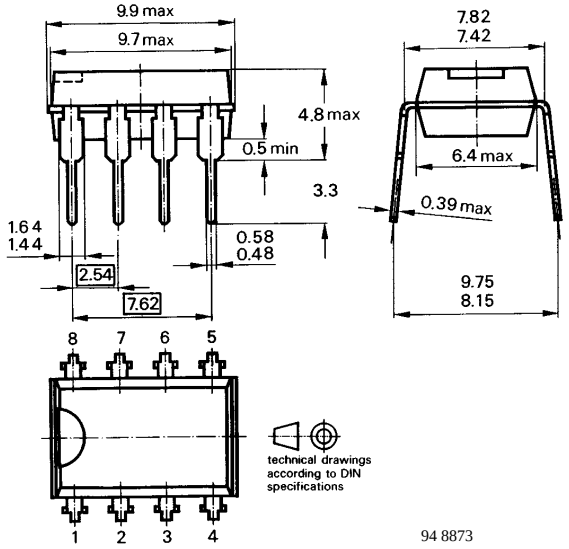
Table 1 Oscillator frequency, debounce time, delay time. dimensioning

| 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 |
| 600 | 10 | | 123 | 10 | 200 |

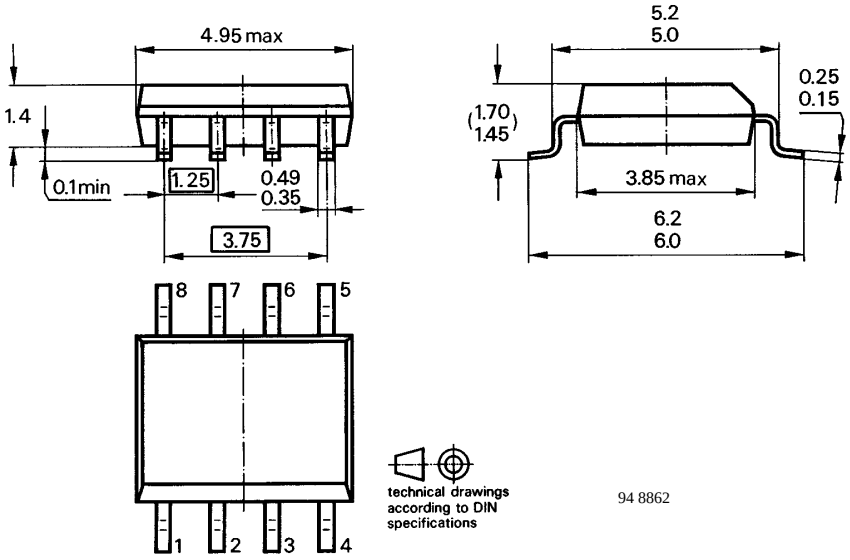
| Frequency $f_0$ | Debounce time $t_3$ | Delay time $t_d$ | | $C_2$ | $R_2$ |
|---|---|---|---|---|---|
| Hz | ms | min | s | nF | kΩ |
| 700 | 9 | | 105 | 10 | 170 |
| 800 | 8 | | 92 | 10 | 150 |
| 900 | 7 | | 82 | 10 | 130 |
| 1000 | 6 | | 74 | 10 | 120 |
| 2000 | 3.00 | | 37 | 1 | 600 |
| 3000 | 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