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## Features

- Digital Self-supervising Watchdog with Hysteresis
- Three 250-mA Output Drivers
- One Relay Driver, Two Lamp Drivers
- Lamp Drivers with Auxiliary Ground
- Lamp Drivers Short-circuit Protected
- Lamp Drivers with Status Feedback
- Enable Output
- Over-/Undervoltage Detection and Reset
- All Power Outputs Protected Against Standard Transients
- All Power Outputs Protected Against 40-V Load Dump
- Automatically Activated Lamp Drivers if  $V_S$  is Disconnected
- Automatically Activated Lamp Drivers Via AUX GND if Standard Ground is Disconnected

## Description

The U6809B is designed to support the fail-safe function of safety-critical systems such as ABS. It includes a relay driver, two independent short-circuit-protected lamp drivers which are supplied by redundant ground lines, two monitoring circuits for the lamp driver output voltage and output current, a watchdog controlled by an external RC network and a reset circuit initiated by an over- and undervoltage condition of the 5-V supply providing a positive and a negative reset signal.



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## Fail-safe IC with Relay Driver and Lamp Driver

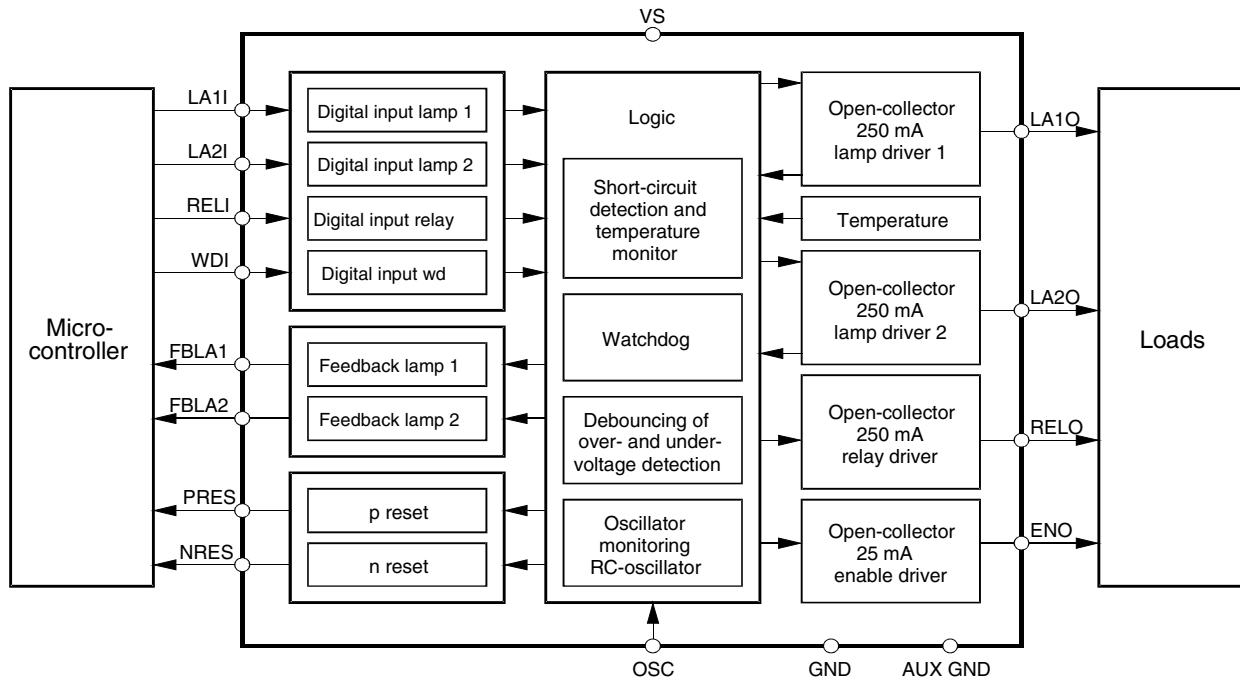
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**U6809B**

Rev. 4764A-AUTO-10/03

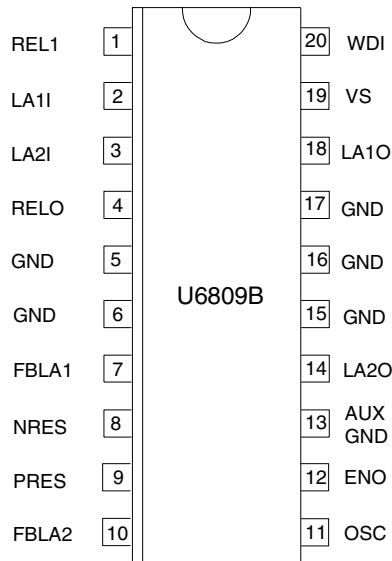


**Figure 1. Block Diagram**



## Pin Configuration

**Figure 2. Pinning SO20**

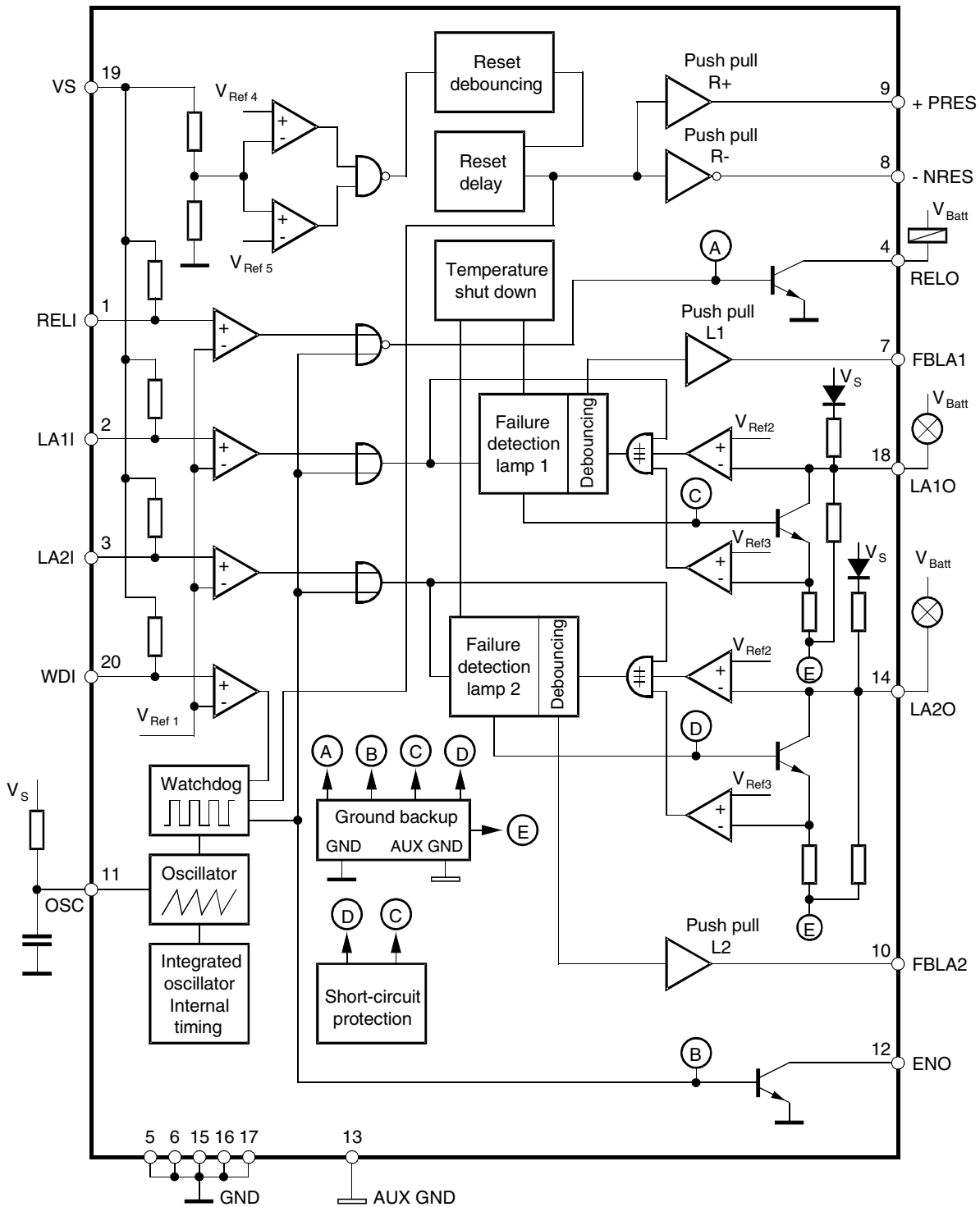


## Pin Description

| Pin        | Name     | Type                         | Function                         | Logic                                          |
|------------|----------|------------------------------|----------------------------------|------------------------------------------------|
| 1          | RELI     | Digital input                | Activation of relay driver       | Driver on: L<br>Driver off: H                  |
| 2          | LA1I     | Digital input                | Activation of lamp driver 1      | Driver off: L<br>Driver on: H                  |
| 3          | LA2I     | Digital input                | Activation of lamp driver 2      | Driver off: L<br>Driver on: H                  |
| 4          | RELO     | Open-collector driver output | Fail-safe relay driver           | Driver off: ---<br>Driver on: L                |
| 5, 6       | GND      | Supply                       | Standard ground                  |                                                |
| 7          | FBLA1    | Digital output               | Feedback lamp1                   | See Table 1 on page 5 and<br>Table 2 on page 5 |
| 8          | NRES     | Digital output               | Negative reset signal            | Reset: L<br>No reset: H                        |
| 9          | PRES     | Digital output               | Positive reset signal            | Reset: H<br>No reset: L                        |
| 10         | FBLA2    | Digital output               | Feedback lamp 2                  | See Table 1 on page 5 and<br>Table 2 on page 5 |
| 11         | OSC      | Analog input                 | External RC for watchdog timer   |                                                |
| 12         | ENO      | Open-collector output        | Watchdog disable output          | Watchdog ok: ---<br>Watchdog n ok: L           |
| 13         | AUX, GND | Supply                       | Auxiliary ground of lamp drivers |                                                |
| 14         | LA2O     | Open-collector driver output | Warning lamp driver              | Driver off: ---<br>Driver on: L                |
| 15, 16, 17 | GND      | Supply                       | Standard ground                  |                                                |
| 18         | LA1O     | Open-collector driver output | Warning lamp driver              | Driver off: ---<br>Driver on: L                |
| 19         | VS       | Supply                       | 5 V supply                       |                                                |
| 20         | WDI      | Digital input                | Watchdog trigger signal          | Pulse sequence                                 |

## Detailed Block Diagram with External Components

Figure 3. Detailed Block Diagram



**Table 1.** Truth Table for Lamp Drivers and Lamp Feedback

| Inputs   |              |              | Outputs             |              |               | Comment                                                                 |
|----------|--------------|--------------|---------------------|--------------|---------------|-------------------------------------------------------------------------|
| Lamp (I) | Lamp Voltage | Lamp Current | Lamp Driver Current | Lamp Current | Feedback Lamp |                                                                         |
| 0        | 1            | 0            | off                 | off          | 1             | Output ok or open (internal pull-up) or shorted to $V_{Batt}$           |
| 0        | 1            | 1            | on                  | off          | 1             | Output shorted to $V_{Batt}$ and faulty input level                     |
| 0        | 0            | 1            | on                  | on           | 0             | Internal driver activated due to internal failure                       |
| 0        | 0            | 0            | off                 | on           | 0             | Output shorted to GND                                                   |
| 1        | 0            | 1            | on                  | on           | 0             | Output ok                                                               |
| 1        | 1            | 1            | on                  | off          | 1             | Output shorted to $V_{Batt}$                                            |
| 1        | 1            | 0            | off                 | off          | 1             | Internal driver deactivated due to internal failure or thermal shutdown |
| 1        | 0            | 0            | off                 | on/off       | 1             | Output shorted to GND or open                                           |

**Explanation**

Lamp voltage is logic 1 if output voltage > threshold voltage detection

Lamp voltage is logic 0 if output voltage < threshold voltage detection

Lamp current is logic 1 if output current > threshold current detection

Lamp current is logic 0 if output current < threshold current detection

**Table 2.** Table of Fault Detection

| Condition                         | Feedback Lamp              |                           |
|-----------------------------------|----------------------------|---------------------------|
|                                   | Lamp Input is 0 (Lamp off) | Lamp Input is 1 (Lamp on) |
| Normal operation                  | 1                          | 0                         |
| Lamp output shorted to GND        | 0 (= detection)            | 1 (= detection)           |
| Lamp output shorted to $V_{Batt}$ | 1 (= no detection)         | 1 (= detection)           |
| Lamp output open                  | 1 (= no detection)         | 1 (= detection)           |
| Feedback shorted to GND           | 0 (= detection)            | 0 (= no detection)        |
| Feedback shorted to $V_S$         | 1 (= no detection)         | 1 (= detection)           |
| Lamp input shorted to GND         | 1 (= no detection)         | 1 (= detection)           |
| Lamp input shorted to $V_S$       | 0 (= detection)            | 0 (= no detection)        |

**Fail-safe Functions**

A fail-safe IC has to maintain its monitoring function even if there is a fault condition at one of the pins (e.g., short circuit). This ensures that a microcontroller system would not be brought into a critical status. A critical status is reached if the system is not able to actuate a warning lamp and switch off the relay. The following table shows fault conditions for different pins during which the IC still works as a fail-safe device.

**Table 3.** Table of Fault Condition

| Pin   | Function                                      | Short to $V_S$  | Short to $V_{Batt}$ | Short to GND    | Open Circuit    |
|-------|-----------------------------------------------|-----------------|---------------------|-----------------|-----------------|
| LA2O  | Short-circuit proof driver for warning lamp   | LA2O partly on  | LA2O off            | LA2O on         | LA2O off        |
| LA2I  | Digital input to activate warning lamp        | LA2O on         | LA2O on             | LA2O off        | LA2O on         |
| FBLA2 | Digital feedback of warning lamp              | Faulty feedback | Faulty feedback     | Faulty feedback | Faulty feedback |
| LA1O  | Short-circuit proof driver for warning lamp   | LA1O partly on  | LA1O off            | LA1O on         | LA1O off        |
| LA1I  | Digital input to activate warning lamp        | LA1O on         | LA1O on             | LA1O off        | LA1O on         |
| FBLA1 | Digital feedback of warning lamp              | Faulty feedback | Faulty feedback     | Faulty feedback | Faulty feedback |
| RELI  | Digital input to activate the fail safe relay | Relay off       | Relay off           | Relay on        | Relay off       |
| WDI   | Watchdog trigger input                        | Watchdog reset  | Watchdog reset      | Watchdog reset  | Watchdog reset  |
| OSC   | Capacitor and resistor of watchdog            | Watchdog reset  | Watchdog reset      | Watchdog reset  | Watchdog reset  |

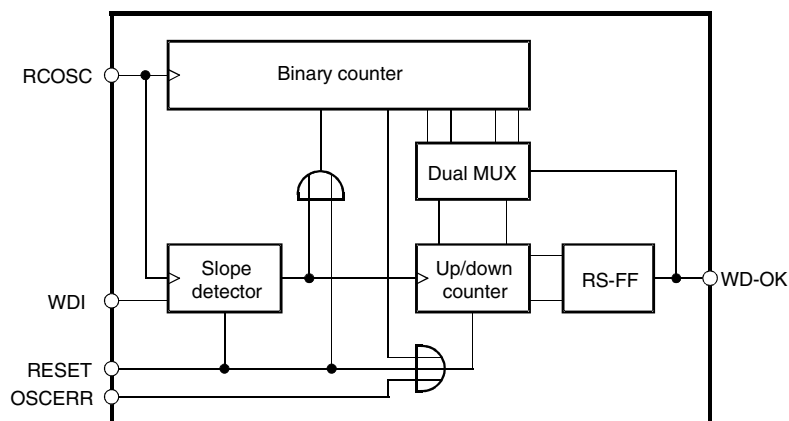
## Description of the Watchdog

### Abstract

The microcontroller is monitored by a digital window watchdog which accepts an incoming trigger signal of a constant frequency for correct operation. The frequency of the trigger signal can be varied in a broad range as the watchdog's time window is determined by external RC components.

The following description refers to Figure 1 on page 2.

**Figure 4.** Watchdog Block Diagram



## WDI Input (Pin 20)

The microcontroller has to provide a trigger signal with the frequency  $f_{WDI}$  which is fed to the WDI input. A positive edge of  $f_{WDI}$  detected by a slope detector resets the binary and clocks the up/down counter additionally. The up/down counter only counts from 0 to 3 or reverse. Each correct trigger increments the up/down counter by 1, each wrong trigger decrements it by 1. As soon as the counter reaches the count of 3 the RS flip-flop is set (see Figure 5). A missing incoming trigger signal is detected after 250 clocks of the internal watchdog frequency  $f_{RC}$  (see WD-OK output) and resets the up/down counter directly.

## RCOSC Input

With an external RC circuitry the IC generates a time base (frequency  $f_{RC}$ ) independent from the microcontroller. The watchdog's time window refers to a frequency of

$$RC = 100 \times f_{WDI}$$

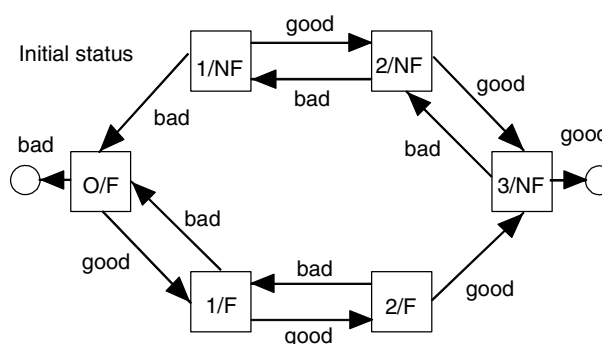
## Reset Input

During power-on and under-/overvoltage detection a reset signal is fed to this pin. It resets the watchdog timer and sets the initial state.

## WD - OK Output

After the up/down counter has been incremented to the count of 3 (see Figure 5, WD state diagram), the RS flip-flop is set and the WD-OK output becomes logic "1". This information is available for the microcontroller at the open-collector output ENO. If, on the other hand, the up/down counter is decremented to 0 the RS flip flop is reset, the WD OK output and the ENO output are disabled. The WD OK output also controls a dual MUX stage which shifts the time window by one clock after a successful trigger, thus forming a hysteresis to provide stable conditions for the evaluation of the trigger signal "good or false". The WD OK signal is also reset in case the watchdog counter is not reset after 250 clocks (missing trigger signal).

## Watchdog State Diagram **Figure 5. Watchdog State Diagram**



## Explanation

In each block, the first character represents the state of the counter. The second notation indicates the fault status of the counter. A fault status is indicated by an "F" and a no fault status is indicated by an "NF". When the watchdog is powered up initially, the counter starts at the O/F block (initial state). "Good" indicates that a pulse has been received whose width resides within the timing window. "Bad" indicates that a pulse has been received whose width is either too short or too long.

## Watchdog Window Calculation

Example with recommended values

$C_{osc} = 3.3 \text{ nF}$  (should be preferably 10%, NPO)

$R_{osc} = 39 \text{ k}\Omega$  (may be 5%,  $R_{osc} < 100 \text{ k}\Omega$  due to leakage current and humidity)

## RC Oscillator

$$t_{WDC} \text{ (s)} = 10^{-3} \times [C_{osc} \text{ (nF)} \times [(0.00078 \times R_{osc} \text{ (k}\Omega)) + 0.0005]]$$

$$f_{WDC} \text{ (Hz)} = 1/(t_{WDC})$$

## Watchdog WDI

$$f_{WDI} \text{ (Hz)} = 0.01 \times f_{WDC}$$

$$t_{WDC} = 100 \text{ }\mu\text{s} \rightarrow f_{WDC} = 10 \text{ kHz}$$

$$f_{WDI} = 100 \text{ Hz} \rightarrow t_{WDI} = 10 \text{ ms}$$

## WDI Pulse Width for Fault Detection After 3 Pulses

Upper watchdog window

$$\text{Minimum: } 169/f_{WDC} = 16.9 \text{ ms} \rightarrow f_{WDC}/169 = 59.1 \text{ Hz}$$

$$\text{Maximum: } 170/f_{WDC} = 17.0 \text{ ms} \rightarrow f_{WDC}/170 = 58.8 \text{ Hz}$$

Lower watchdog window

$$\text{Minimum: } 79/f_{WDC} = 7.9 \text{ ms} \rightarrow f_{WDC}/79 = 126.6 \text{ Hz}$$

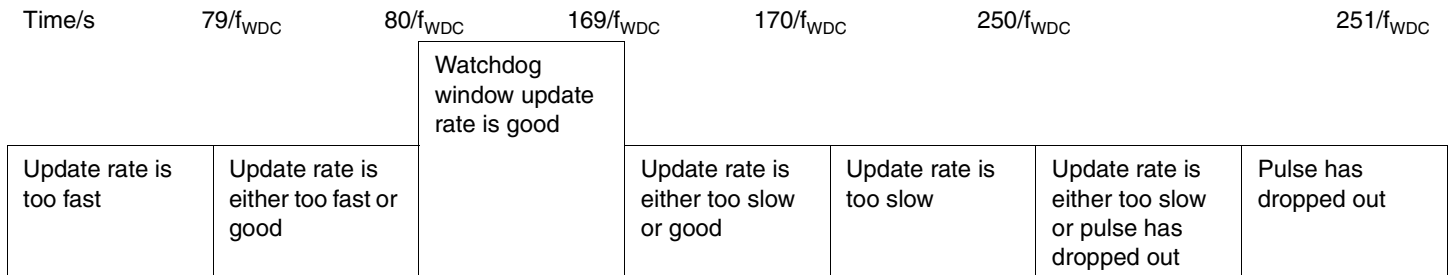
$$\text{Maximum: } 80/f_{WDC} = 8.0 \text{ ms} \rightarrow f_{WDC}/80 = 125.0 \text{ Hz}$$

## WDI Dropouts for Immediate Fault Detection

$$\text{Minimum: } 250/f_{WDC} = 25 \text{ ms}$$

$$\text{Maximum: } 251/f_{WDC} = 25.1 \text{ ms}$$

**Figure 6.** Watchdog Timing Diagram with Tolerances



## Remark to Reset Delay

The duration of the over- or undervoltage pulses determines the enable and reset output. A pulse duration shorter than the debounce time has no effect on the outputs. A pulse longer than the debounce time results in the first reset delay. If a pulse appears during this delay, a 2nd delay time is triggered. Therefore, the total reset delay time can be longer than specified in the datasheet.



## 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             |
|-------------------------------------------------------------------------|------------|-------------|------------------|
| Supply voltage range                                                    | $V_S$      | -0.2 to +16 | V                |
| AUX GND offset voltage to GND                                           | $V_{AUX}$  | $\pm 1.5$   | V                |
| AUX GND offset current to GND                                           | $I_{AUX}$  | -600        | mA               |
| Power dissipation $V_S = 5\text{ V}$ ;<br>$T_{amb} = 125^\circ\text{C}$ | $P_{tot}$  | 700         | mW               |
| Thermal resistance                                                      | $R_{thjc}$ | 25          | K/W              |
| Junction temperature                                                    | $T_j$      | 150         | $^\circ\text{C}$ |
| Ambient temperature range                                               | $T_{amb}$  | -40 to +125 | $^\circ\text{C}$ |
| Storage temperature range                                               | $T_{stg}$  | -55 to +155 | $^\circ\text{C}$ |

## Electrical Characteristics

$V_S = 5\text{ V}$ ,  $T_{amb} = -40\text{ to }+125^\circ\text{C}$ ; reference pin is GND;  $f_{intern} = 100\text{ kHz} + 50\% - 45\%$ ,  $f_{WDC} = 10\text{ kHz} \pm 10\%$ ;  $f_{WDI} = 100\text{ Hz}$

| Parameters                                       | Test Conditions               | Symbol | Min.             | Typ. | Max.                 | Unit          |
|--------------------------------------------------|-------------------------------|--------|------------------|------|----------------------|---------------|
| <b>Supply Voltage</b>                            |                               |        |                  |      |                      |               |
| Operation range general                          |                               | $V_S$  | 4.5              |      | 5.5                  | V             |
| Operation range reset                            |                               | $V_S$  | 1.5              |      | 16.0                 | V             |
| <b>Supply Current</b>                            |                               |        |                  |      |                      |               |
| Lamp driver on, relay off                        | $T_{amb} = -40^\circ\text{C}$ |        |                  |      | 40                   | mA            |
|                                                  | $T_{amb} = 125^\circ\text{C}$ |        |                  |      | 35                   | mA            |
| Lamp driver off, relay on                        | $T_{amb} = -40^\circ\text{C}$ |        |                  |      | 25                   | mA            |
|                                                  | $T_{amb} = 125^\circ\text{C}$ |        |                  |      | 20                   | mA            |
| Lamp driver off, relay off                       | $T_{amb} = -40^\circ\text{C}$ |        |                  |      | 15                   | mA            |
|                                                  | $T_{amb} = 125^\circ\text{C}$ |        |                  |      | 10                   | mA            |
| <b>Auxiliary Ground (AUX GND)</b>                |                               |        |                  |      |                      |               |
| AUX GND offset voltage operation range           | $T_{amb} = -40^\circ\text{C}$ |        | -1.2             |      | 1.2                  | V             |
|                                                  | $T_{amb} = 90^\circ\text{C}$  |        | -0.65            |      | 1.0                  | V             |
|                                                  | $T_{amb} = 125^\circ\text{C}$ |        | -0.5             |      | 0.8                  | V             |
| AUX GND offset voltage to GND                    | $I_{AUX} = -600\text{ mA}$    |        | -1.7             |      | 3.0                  | V             |
| <b>Digital Inputs (LA1I, LA2I, REL1 and WDI)</b> |                               |        |                  |      |                      |               |
| Detection low                                    |                               |        | -0.2             |      | $0.2 \times V_S$     | V             |
| Detection high                                   |                               |        | $0.7 \times V_S$ |      | $V_S + 0.5\text{ V}$ | V             |
| Resistance to $V_S$                              |                               |        | 10               |      | 40                   | k $\Omega$    |
| Input current low                                | Input voltage = 0 V           |        | 100              |      | 550                  | $\mu\text{A}$ |
| Input current high                               | Input voltage = $V_S$         |        | -5               |      | 5                    | $\mu\text{A}$ |

## Electrical Characteristics (Continued)

$V_S = 5\text{ V}$ ,  $T_{\text{amb}} = -40\text{ to }+125^\circ\text{C}$ ; reference pin is GND;  $f_{\text{intern}} = 100\text{ kHz} + 50\% - 45\%$ ,  $f_{\text{WDC}} = 10\text{ kHz} \pm 10\%$ ;  $f_{\text{WDI}} = 100\text{ Hz}$

| Parameters                                                           | Test Conditions                                                                                                               | Symbol | Min.                                       | Typ. | Max.              | Unit                                            |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------|--------------------------------------------|------|-------------------|-------------------------------------------------|
| <b>Digital Outputs; Lamp Driver Feedbacks (FBLA1, FBLA2)</b>         |                                                                                                                               |        |                                            |      |                   |                                                 |
| Voltage low                                                          | $I \leq 1.6\text{ mA}$                                                                                                        |        | 0                                          |      | 0.5               | V                                               |
| Voltage high                                                         | $I \leq 10\text{ A}$<br>$10\text{ A} \leq I \leq 1.6\text{ mA}$                                                               |        | $0.8 \times V_S$<br>$0.7 \times V_S + 0.1$ |      | $V_S$             | V                                               |
| Threshold voltage detection                                          |                                                                                                                               |        | $0.4 \times V_S$                           |      | $0.5 \times V_S$  | V                                               |
| Threshold current detection                                          |                                                                                                                               |        | 10                                         |      | 50                | mA                                              |
| <b>Digital Outputs (PRES and NRES)</b>                               |                                                                                                                               |        |                                            |      |                   |                                                 |
| Voltage high                                                         | $I \leq 100\text{ A}$                                                                                                         |        | $0.7 \times V_S + 0.1$                     |      | $V_S$             | V                                               |
| Voltage low                                                          | $I \leq 1\text{ mA}$                                                                                                          |        | 0                                          |      | 0.3               | V                                               |
| <b>Digital Output (ENO) with Open Collector</b>                      |                                                                                                                               |        |                                            |      |                   |                                                 |
| Saturation voltage low                                               | $I \leq 25\text{ mA}$                                                                                                         |        | 0                                          |      | 0.3               | V                                               |
| Clamping voltage                                                     |                                                                                                                               |        | 26                                         |      | 30                | V                                               |
| Current limit low                                                    |                                                                                                                               |        | 25                                         |      |                   | mA                                              |
| Leakage current                                                      | $V_{\text{ENO}} = 5\text{ V}$<br>$V_{\text{ENO}} = 16\text{ V}$<br>$V_{\text{ENO}} = 26\text{ V}$                             |        |                                            |      | 20<br>100<br>200  | $\mu\text{A}$<br>$\mu\text{A}$<br>$\mu\text{A}$ |
| <b>Lamp Drivers (LA10 and LA20) with Integrated Pull-up Resistor</b> |                                                                                                                               |        |                                            |      |                   |                                                 |
| Saturation voltage                                                   | $I \leq 125\text{ mA}$ ; $V_S = 5\text{ V}$<br>$I \leq 125\text{ mA}$ ; $V_S = 0\text{ V}$                                    |        |                                            |      | 0.5<br>1.5        | V<br>V                                          |
| Saturation voltage<br>250 mA requires enhanced heat sink             | $I \leq 250\text{ mA}$ ; $V_S = 5\text{ V}$<br>$I \leq 250\text{ mA}$ ; $V_S = 0\text{ V}$<br>$I \leq 250\text{ mA}$ ; no GND |        |                                            |      | 1.0<br>2.0<br>3.0 | V<br>V<br>V                                     |
| Maximum load current                                                 | $T_{\text{amb}} = 90^\circ\text{C}$<br>$T_{\text{amb}} = 125^\circ\text{C}$                                                   |        | 250<br>180                                 |      |                   | mA<br>mA                                        |
| Clamping voltage                                                     |                                                                                                                               |        | 26                                         |      | 30                | V                                               |
| Leakage current                                                      | $V_{\text{LA10, LA20}} = 16\text{ V}$<br>$V_{\text{LA10, LA20}} = 26\text{ V}$                                                |        |                                            |      | 1<br>3            | mA<br>mA                                        |
| Threshold current limitation                                         |                                                                                                                               |        | 0.5                                        |      | 1.0               | A                                               |
| Pull-up resistor                                                     |                                                                                                                               |        | 2                                          |      | 17                | k $\Omega$                                      |
| <b>Relay Driver (RELO)</b>                                           |                                                                                                                               |        |                                            |      |                   |                                                 |
| Saturation voltage                                                   | $I \leq 250\text{ mA}$                                                                                                        |        |                                            |      | 0.5               | V                                               |
| Maximum load current                                                 | $T_{\text{amb}} = 90^\circ\text{C}$<br>$T_{\text{amb}} = 125^\circ\text{C}$                                                   |        | 250<br>200                                 |      |                   | mA<br>mA                                        |
| Clamping voltage                                                     |                                                                                                                               |        | 26                                         |      | 30                | V                                               |
| Leakage current                                                      | $V_{\text{Batt}} = 16\text{ V}$<br>$V_{\text{Batt}} = 26\text{ V}$                                                            |        |                                            |      | 20<br>200         | $\mu\text{A}$<br>$\mu\text{A}$                  |
| <b>Reset and <math>V_S</math> Control</b>                            |                                                                                                                               |        |                                            |      |                   |                                                 |
| Lower reset level                                                    |                                                                                                                               | $V_S$  | 4.5                                        |      | 4.8               | V                                               |
| Upper reset level                                                    |                                                                                                                               | $V_S$  | 5.2                                        |      | 5.5               | V                                               |
| Hysteresis                                                           |                                                                                                                               |        | 25                                         |      |                   | mV                                              |
| Reset debounce time                                                  |                                                                                                                               |        | 120                                        |      | 500               | $\mu\text{s}$                                   |

## Electrical Characteristics (Continued)

$V_S = 5\text{ V}$ ,  $T_{amb} = -40\text{ to }+125^\circ\text{C}$ ; reference pin is GND;  $f_{intern} = 100\text{ kHz} + 50\% - 45\%$ ,  $f_{WDC} = 10\text{ kHz} \pm 10\%$ ;  $f_{WDI} = 100\text{ Hz}$

| Parameters                                                      | Test Conditions                 | Symbol         | Min.  | Typ. | Max.  | Unit          |
|-----------------------------------------------------------------|---------------------------------|----------------|-------|------|-------|---------------|
| Reset delay                                                     |                                 |                | 20    |      | 80    | ms            |
| <b>Watchdog Timing</b>                                          |                                 |                |       |      |       |               |
| Feedback reaction time (FBLA1, FBLA2)                           | No fault, edge at LA1I, LA2I    | $t_{FB}$       | 2.56  |      | 12.8  | ms            |
| Minimum lamp input toggle time for a secure feedback reaction   | No fault, pulse at LA1I, LA2I   | $t_{P,FB}$     | 10.24 |      |       | ms            |
| Power-on-reset prolongation time                                |                                 | $t_{POR}$      | 34.3  |      | 103.1 | ms            |
| Detection time for RC-oscillator fault                          | $V_{RC} = \text{constant}$      | $t_{RCerror}$  | 81.9  |      | 246   | ms            |
| Time interval for over-/undervoltage detection                  |                                 | $t_{D,OUV}$    | 0.16  |      | 0.64  | ms            |
| Reaction time of NRES output on over-/undervoltage              |                                 | $t_{R,OUV}$    | 0.187 |      | 0.72  | ms            |
| Minimum toggle time for a secure broken ground detection        |                                 | $t_{P,BGND}$   | 13.3  |      |       | $\mu\text{s}$ |
| Maximum reaction time for broken ground detection               |                                 | $t_{R,BGND}$   |       |      | 100   | $\mu\text{s}$ |
| Nominal frequency for WDI                                       | $f_{RC} = 100 \times f_{WDI}$   | $f_{WDI}$      | 10    |      | 130   | Hz            |
| Nominal frequency for RC                                        | $f_{WDI} = 1/100 \times f_{RC}$ | $f_{RC}$       | 1     |      | 13    | kHz           |
| Minimum pulse duration for a secure WDI input pulse detection   |                                 | $t_{P,WDI}$    | 182   |      |       | $\mu\text{s}$ |
| Frequency range for a correct WDI signal                        |                                 | $f_{WDI}$      | 64.7  |      | 112.5 | Hz            |
| Number of incorrect WDI trigger counts for locking the outputs  |                                 | $n_{lock}$     |       | 3    |       |               |
| Number of correct WDI trigger counts for releasing the outputs  |                                 | $n_{release}$  |       | 3    |       |               |
| Detection time for a stuck WDI signal                           | $V_{WDI} = \text{constant}$     | $t_{WDIerror}$ | 24.5  |      | 25.5  | ms            |
| <b>Watchdog Timing Relative to <math>f_{RC}</math></b>          |                                 |                |       |      |       |               |
| Minimum pulse duration for a securely WDI input pulse detection |                                 |                |       | 2    |       | cycles        |
| Frequency range for a correct WDI signal                        |                                 |                | 80    |      | 170   | cycles        |
| Hysteresis range at the WDI ok margins                          |                                 |                |       | 1    |       | cycle         |
| Detection time for a stuck WDI signal                           | $V_{WDI} = \text{constant}$     |                | 250   |      | 251   | cycles        |

## Protection Against Transient Voltages According to ISO TR 7637-3 Level 4 (Except Pulse 5)

| Pulse | Voltage | Source Resistance <sup>(1)</sup> | Rise Time | Duration | Amount |
|-------|---------|----------------------------------|-----------|----------|--------|
| 1     | -110 V  | 10 $\Omega$                      | 100 V/s   | 2 ms     | 15.000 |
| 2     | +110 V  | 10 $\Omega$                      | 100 V/s   | 0.05 ms  | 15.000 |
| 3a    | -160 V  | 50 $\Omega$                      | 30 V/ns   | 0.1 s    | 1 h    |
| 3b    | +150 V  | 50 $\Omega$                      | 20 V/ns   | 0.1 s    | 1 h    |
| 5     | 40 V    | 2 $\Omega$                       | 10 V/ms   | 250 ms   | 20     |

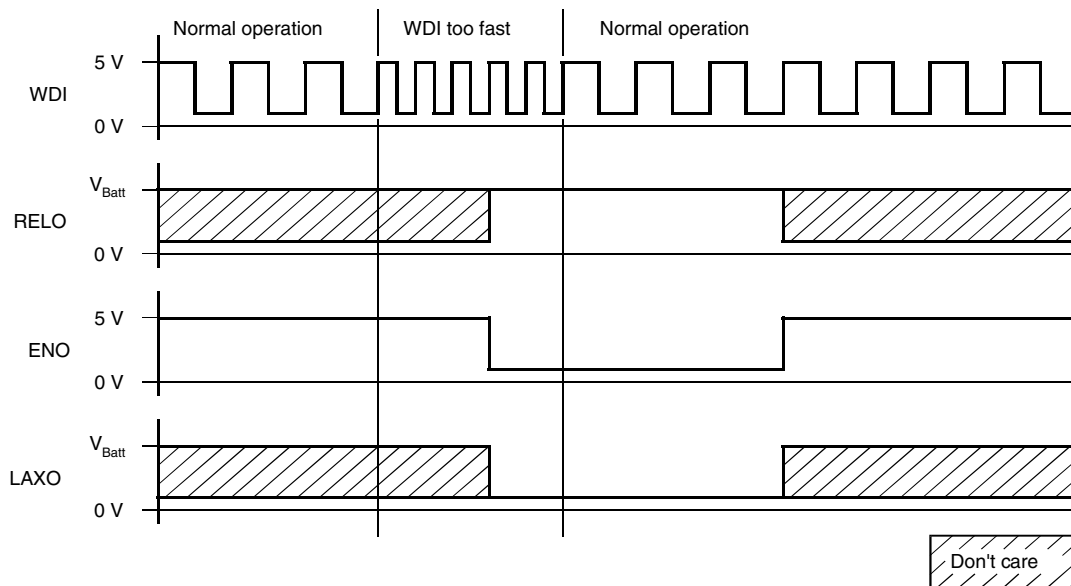
Notes: 1. Lamp drivers: 1.2  $\Omega$  lamps need to be added to the source resistance.  
 Relay driver: relay coil with  $R_{\min} = 70 \Omega$  need to be added to the source resistance.

### Application Hints

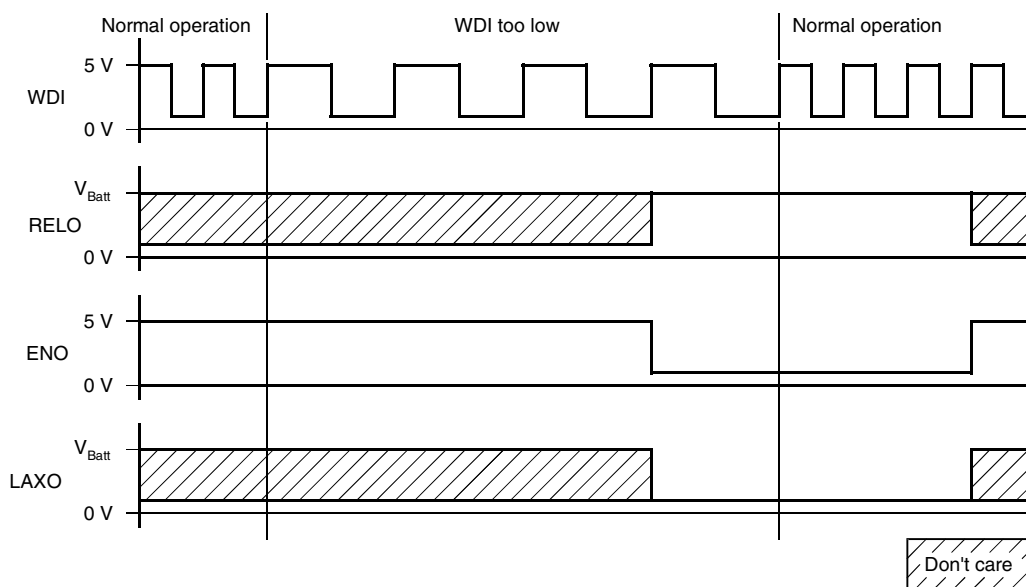
- The lamp output pins LA1O and LA2O may need to be protected by external protection diodes against reversed battery (e.g., BAV 202) in order to avoid a reset during negative pulses.
- If pilot lamps with a wattage of  $P > 1.2 \text{ W}$  are connected, external Zener diodes are mandatory.

## Timing Diagrams

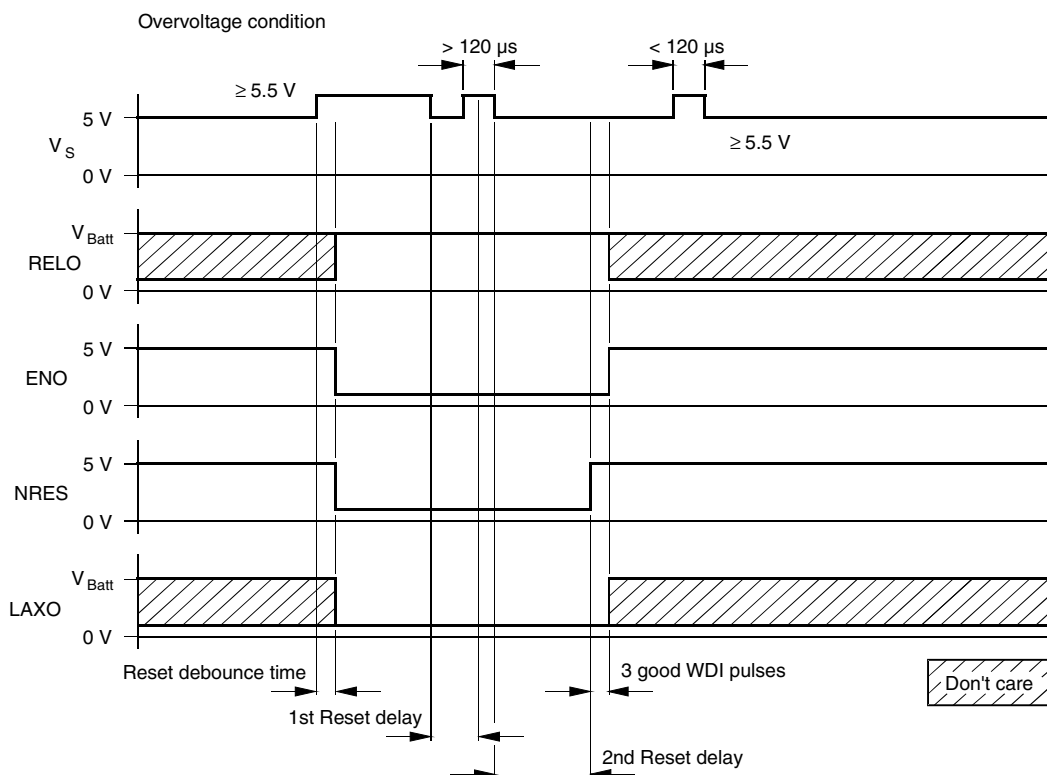
Figure 7. Watchdog in Too Fast Condition



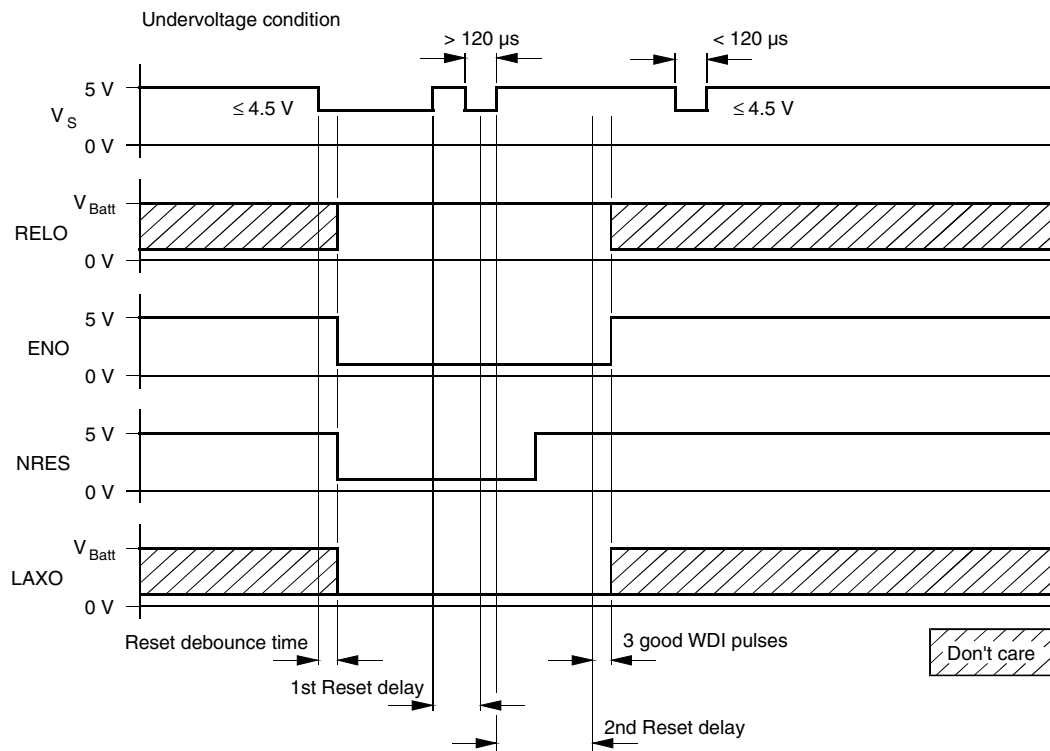
**Figure 8. Watchdog in Too Slow Condition**



**Figure 9. Overvoltage Condition**



**Figure 10. Undervoltage Condition**



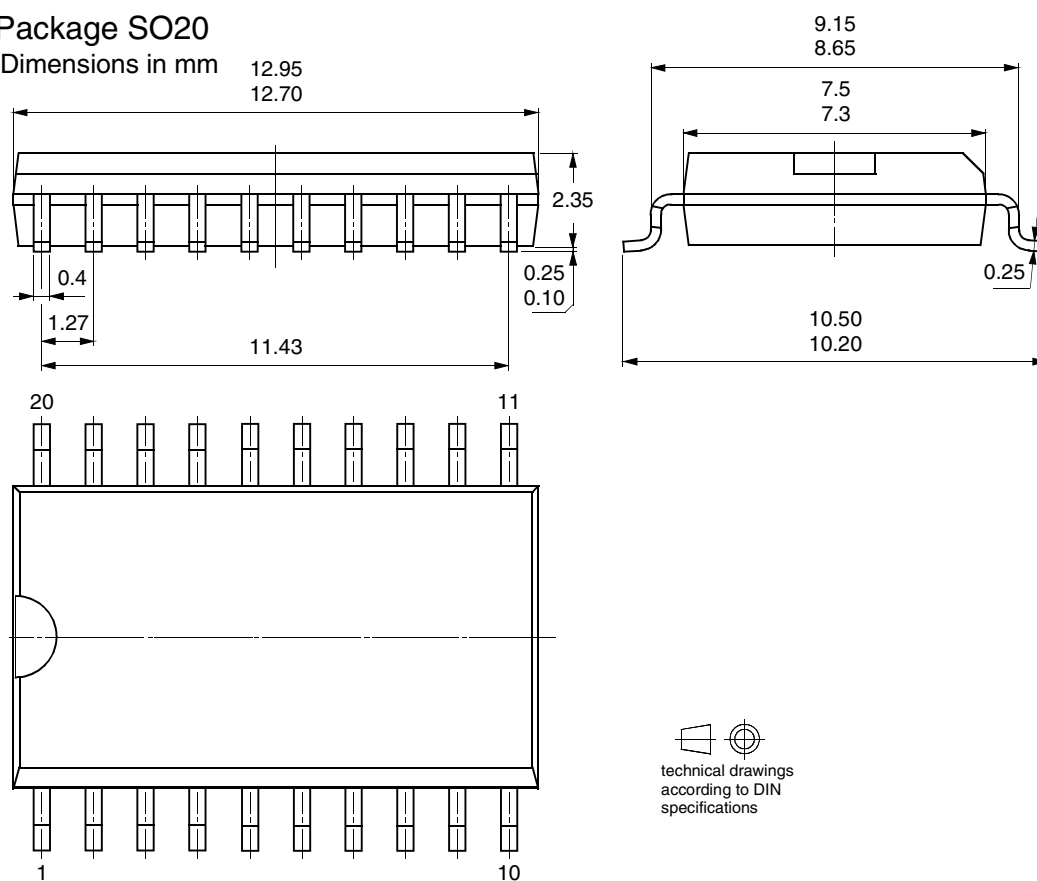
## Ordering Information

| Extended Type Number | Package                 | Remarks |
|----------------------|-------------------------|---------|
| U6809B               | SO20 special lead frame | —       |

## Package Information

### Package SO20

Dimensions in mm



technical drawings  
according to DIN  
specifications



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