

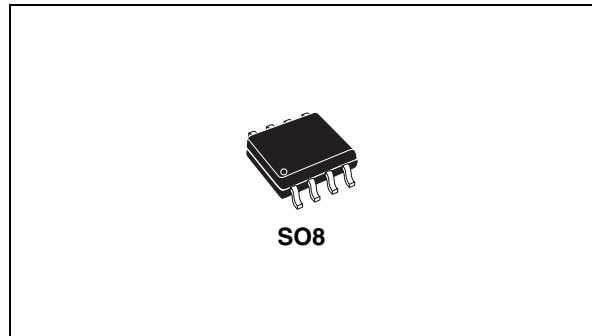
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## Monolithic bus driver with ISO 9141 interface

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### Features

- Operating power supply voltage range  
 $4.5\text{ V} \leq V_S \leq 36\text{ V}$  (40 V for transients)
- Reverse supply (battery) protected down to  
 $V_S \geq -24\text{ V}$
- Standby mode with very low current consumption  
 $I_{S_{SB}} \leq 1\text{ mA}$  @  $V_{CC} \leq 0.5\text{ V}$
- Low quiescent current in off condition  
 $I_{S_{OFF}} = 120\text{ }\mu\text{A}$
- TTL compatible TX input
- Bidirectional K-I/O pin with supply voltage dependent input threshold
- Overtemperature shut down function Selective to K-I/O pin
- Wide input and output voltage range  
 $-24\text{ V} \leq V_K \leq V_S$
- K output current limitation, typ.  $I_K = 60\text{ mA}$
- Defined OFF output status in undervoltage condition and  $V_S$  or GND interruption
- Controlled output slope for low EMI



- High input impedance for open  $V_S$  or GND connection
- Defined output ON status of LO or RX for open LI or K inputs
- Defined K output OFF for TX input open
- Integrated pull up resistors for TX, RX and LO
- EMI robustness optimized

### Description

The L9637 is a monolithic integrated circuit containing standard ISO 9141 compatible interface functions.

**Table 1. Device summary**

| Order code                   | Package | Packing       |
|------------------------------|---------|---------------|
| L9637D                       | SO8     | Tube          |
| L9637D013TR                  | SO8     | Tape and reel |
| E-L9637D <sup>(1)</sup>      | SO8     | Tube          |
| E-L9637D013TR <sup>(1)</sup> | SO8     | Tape and reel |

1. Device in ECOPACK® package (see [Section 4: Package information on page 13](#)).

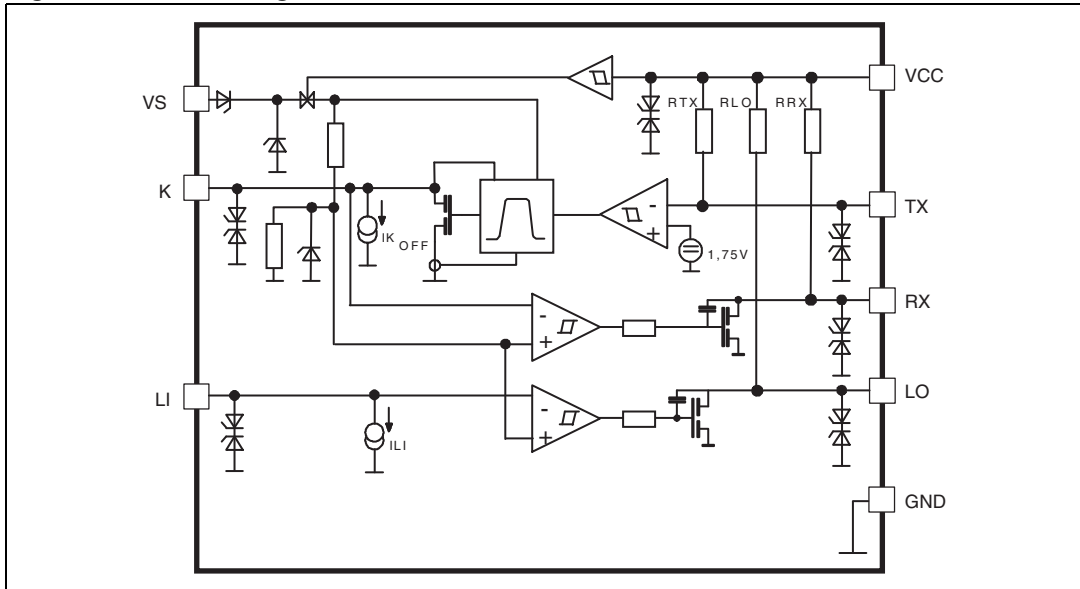
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# 1 Block diagram and pin description

## 1.1 Block diagram

Figure 1. Block diagram



## 1.2 Pin description

Figure 2. Pin connection (top view)

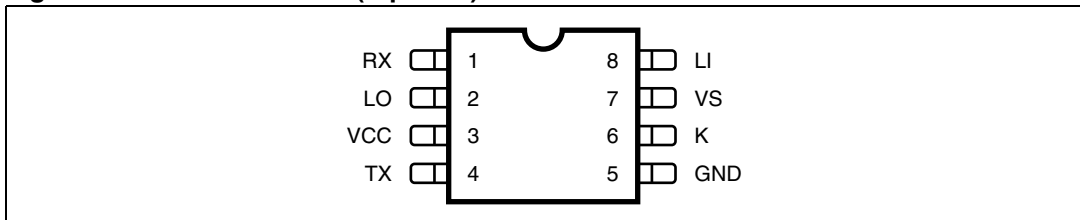


Table 2. Pin description

| N. | Name | Function                  |
|----|------|---------------------------|
| 1  | RX   | Output for K as input     |
| 2  | LO   | Output L comparator       |
| 3  | VCC  | Stabilized voltage supply |
| 4  | TX   | Input for K as output     |
| 5  | GND  | Common GND                |
| 6  | K    | Bidirectional I/O         |
| 7  | VS   | Supply voltage            |
| 8  | LI   | Input L comparator        |

## 2 Electrical specification

### 2.1 Absolute maximum ratings

**Table 3. Absolute maximum ratings (No damage or latch)**

| Symbol           | Parameter   | Value                    | Unit             |
|------------------|---|--------------------------|------------------|
| $V_S$            | Supply voltage ISO transients<br>$t = 400 \text{ ms}$ | -24 to +36<br>-24 to +40 | V                |
| $V_{CC}$         | Stabilized voltage                                    | -0.3 to +7               | V                |
| $\Delta V_S/d_t$ | Supply voltage transient                              | -10 to +10               | V/ $\mu\text{s}$ |
| $V_{LI, K}$      | Pin voltage   | -24 to $V_S$             | V                |
| $V_{LO, RX, TX}$ |   | -24 to $V_{CC}$          | V                |

*Note:* Max. ESD voltages are  $\pm 2\text{kV}$  with human body model  $C = 100\text{pF}$ ,  $R = 1.5\text{k}$  corresponds to maximum energy dissipation  $0.2\text{mJ}$  according to MIL883C.

### 2.2 Thermal data

**Table 4. Thermal data**

| Symbol         | Parameter   | Min. | Typ. | Max. | Unit                        |
|----------------|---|------|------|------|-----------------------------|
| $T_{JSDon}$    | Temperature K shutdown switch on threshold          | 160  | -    | 200  | $^{\circ}\text{C}$          |
| $T_{JSDoff}$   | Temperature K shutdown switch off threshold         | 150  | -    | 200  | $^{\circ}\text{C}$          |
| $R_{th j-amb}$ | Thermal steady state junction to ambient resistance | 130  | 155  | 180  | $^{\circ}\text{C}/\text{W}$ |

### 2.3 Electrical characteristics

The electrical characteristics are valid within the below defined operating conditions, unless otherwise specified. The function is guaranteed by design until  $T_{JSDon}$  temperature shutdown switch-on-threshold.

**Table 5. Electrical characteristics**

| Symbol   | Parameter               | Test condition  | Min. | Typ. | Max. | Unit               |
|----------|-------------------------|---|------|------|------|--------------------|
| $V_S$    | Supply voltage          | -   | 4.5  | -    | 36   | V                  |
| $V_{CC}$ | Stabilized voltage      | see note <sup>(1)</sup>   | 3    | 5    | 7    | V                  |
| $T_j$    | Junction temperature    | -   | -40  | -    | 150  | $^{\circ}\text{C}$ |
| $I_{CC}$ | Supply $V_{CC}$ current | $V_{CC} \leq 5.5 \text{ V}; V_{LI}, V_{TX} = 0 \text{ V}$   | -    | 1.4  | 2.3  | mA                 |
|          |                         | $V_K \geq V_{K_{high}}; V_{LI} \geq V_{LI_{high}}$<br>$V_{TX} = V_{CC} @ V_{CC} \leq 5.5 \text{ V}$ | -5   | <1   | 5    | $\mu\text{A}$      |

Table 5. Electrical characteristics (continued)

| Symbol                                 | Parameter                     | Test condition  | Min.                      | Typ.                     | Max.               | Unit |
|--|-------------------------------|---|---------------------------|--------------------------|--------------------|------|
| IS <sub>ON</sub>                       | Supply V <sub>S</sub> current | V <sub>S</sub> ≤ 16 V; VLI, VTX = 0 V   | -                         | 1.2                      | 3                  | mA   |
| IS <sub>OFF</sub>                      |                               | VK ≥ VK <sub>high</sub> ; VLI ≥ VLI <sub>high</sub><br>VTX ≥ VTX <sub>high</sub> @ V <sub>S</sub> ≤ 12 V                                | -                         | 120                      | 220                | μA   |
| IS <sub>SB</sub>                       |                               | V <sub>CC</sub> ≤ 0.5 V @ V <sub>S</sub> ≤ 12 V   | -                         | <1                       | -                  | μA   |
| VK <sub>low</sub>                      | Input voltage low state       | RX output status LOW<br>4.5 V ≤ V <sub>S</sub> ≤ 18 V   | -24                       | -                        | 0.45V <sub>S</sub> | V    |
|  |                               | RX output status LOW<br>18 V < V <sub>S</sub>   | -24                       | -                        | 8                  | V    |
| VK <sub>high</sub>                     | Input voltage high state      | RX output status HIGH<br>4.5 V ≤ V <sub>S</sub> ≤ 18 V  | 0.55V <sub>S</sub>        | -                        | V <sub>S</sub>     | V    |
|  |                               | RX output status HIGH<br>18 V < V <sub>S</sub>  | 12                        | -                        | V <sub>S</sub>     | V    |
| V <sub>Khys</sub>                      | Input threshold hysteresis    | VK <sub>high</sub> - VK <sub>low</sub>  | -                         | 0.025<br>V <sub>S</sub>  | 0.8                | V    |
| I <sub>Koff</sub>                      | Input current                 | @ VTX ≥ VTX <sub>high</sub><br>VK ≤ V <sub>S</sub> ; V <sub>S</sub> , V <sub>CC</sub> ≥ 0 or<br>V <sub>S</sub> , V <sub>CC</sub> = open | -5                        | 4                        | 25                 | μA   |
| RK <sub>ON</sub>                       | Output ON impedance           | @ V <sub>S</sub> ≥ 6.5 V<br>VTX ≤ VTX <sub>low</sub><br>I <sub>K</sub> ≥ 7 mA <sup>(2)</sup>  | -                         | 10                       | 30                 | Ω    |
| IK <sub>SC</sub>                       | Short circuit current         |   | 30                        | 60                       | 100                | mA   |
| VTX <sub>low</sub>                     | Input voltage LOW state       |   | -24                       | -                        | 1                  | V    |
| VTX <sub>high</sub>                    | Input voltage HIGH state      |   | 2.5                       | -                        | V <sub>CC</sub>    | V    |
| RRX <sub>ON</sub><br>RLO <sub>ON</sub> | Output ON impedance           | VK ≤ VK <sub>low</sub> ; VLI ≤ VLI <sub>low</sub><br>V <sub>S</sub> ≥ 6.5 V I <sub>RX, LO</sub> ≥ 1 mA                                  | -                         | 40                       | 90                 | Ω    |
| IRX <sub>SC</sub><br>ILO <sub>SC</sub> | Output short circuit current  |   | 9                         | 20                       | 35                 | mA   |
| VRX <sub>H</sub><br>VLO <sub>H</sub>   | Output voltage HIGH state     | 10MΩ ≤ R <sub>LRX</sub><br>10MΩ ≤ R <sub>LLO</sub>  | V <sub>CC</sub> -<br>0.25 | V <sub>CC</sub> -<br>0.1 | V <sub>CC</sub> -  | V    |
| RLO<br>RRX                             | Output pull-up resistance     | Output status = (HIGH)<br>-0.15 V ≤ VLO ≤ V <sub>CC</sub> + 0.15 V<br>-0.15 V ≤ VRX ≤ V <sub>CC</sub> + 0.15 V                          | 5                         | 10                       | 20                 | kΩ   |
| RTX                                    | Input pull up resistance      | -0.15 V ≤ VTX ≤ V <sub>CC</sub> + 0.15 V  | 10                        | 20                       | 40                 | kΩ   |
| VLI <sub>low</sub>                     | Input voltage LOW state       | LO output status LOW<br>4.5 V ≤ V <sub>S</sub> ≤ 18 V   | -24                       | -                        | 0.45V <sub>S</sub> | V    |
|  |                               | LO output status LOW 18 V < V <sub>S</sub>  | -24                       | -                        | 8                  | V    |

Table 5. Electrical characteristics (continued)

| Symbol  | Parameter                  | Test condition  | Min.            | Typ.       | Max.  | Unit    |
|---|----------------------------|---|-----------------|------------|-------|---------|
| $V_{L_{high}}$                                      | Input voltage HIGH state   | LO output status HIGH<br>$4.5 V \leq V_S \leq 18 V$<br>LO output status HIGH $18 V < V_S$   | $0.55V_S$<br>12 | -          | $V_S$ | V       |
| $V_{L_{hys}}$                                       | Input threshold hysteresis | $V_{L_{high}} - V_{L_{low}}$  | -               | $0.025V_S$ | 0.8   | V       |
| ILI   | Input current              | $V_{LI} \leq V_S$ , $V_S$ , $V_{CC} \geq 0$ or<br>$V_S$ , $V_{CC} = \text{open}$  | -5              | 4          | 25    | $\mu A$ |
| $C_{K_{i,LO,RX}}$                                   | Internal output capacities |   | -               | -          | 20    | pF      |
| $f_{LI-LO}$<br>$f_{K-RX}$<br>$f_{TX-K}$             | Transmission frequency     | $9 V < V_S < 16 V$ (external loads)<br>$R_{KO} = 510 \Omega$ , $C_K \leq 1.3 \text{ nF}$<br>in active mode see <a href="#">Figure 5</a>   | -               | -          | 50    | kHz     |
| $t_{rLI-LO}$<br>$t_{rK-RX}$<br>$t_{rTX-K}$          | Rise time                  | for the definition of $t_r$ , $t_f$ see<br><a href="#">Figure 3</a>   | -               | 2          | 6     | $\mu s$ |
| $t_{fLI-LO}$<br>$t_{fK-RX}$<br>$t_{fTX-K}$          | Fall time                  | $9 V < V_S < 16 V$ (external loads)<br>$R_{KO} = 510 \Omega$ , $C_K \leq 1.3 \text{ nF}$  | -               | 2          | 6     | $\mu s$ |
| $t_{OFF,LI-LO}$<br>$t_{OFF,K-RX}$<br>$t_{OFF,TX-K}$ | Switch OFF time            | for the definition of $t_{on}$ , $t_{OFF}$ see<br><a href="#">Figure 3</a> .  | -               | 4          | 17    | $\mu s$ |
| $t_{ON,LI-LO}$<br>$t_{ON,K-RX}$<br>$t_{ON,TX-K}$    | Switch ON time             | $9 V < V_S < 16 V$ (external loads)<br>$R_{KO} = 510 \Omega$ , $C_K \leq 1.3 \text{ nF}$<br>(inactive mode see <a href="#">Figure 5</a> ) | -               | 4          | 17    | $\mu s$ |

1. Specs are tested at 5V only. Compliance on Vcc full range is guaranteed by design.
2. For output currents lower than this value a series protection diode can become active. See also [Figure 8](#) and [9](#).

Figure 3. Input to output timings and output pulse shape

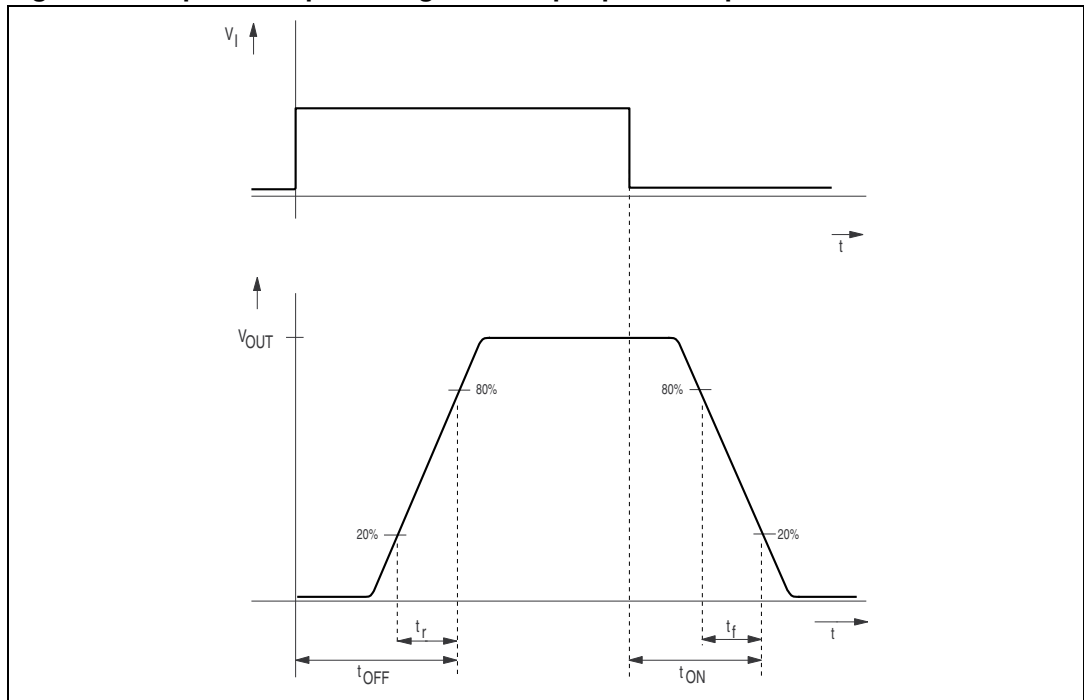
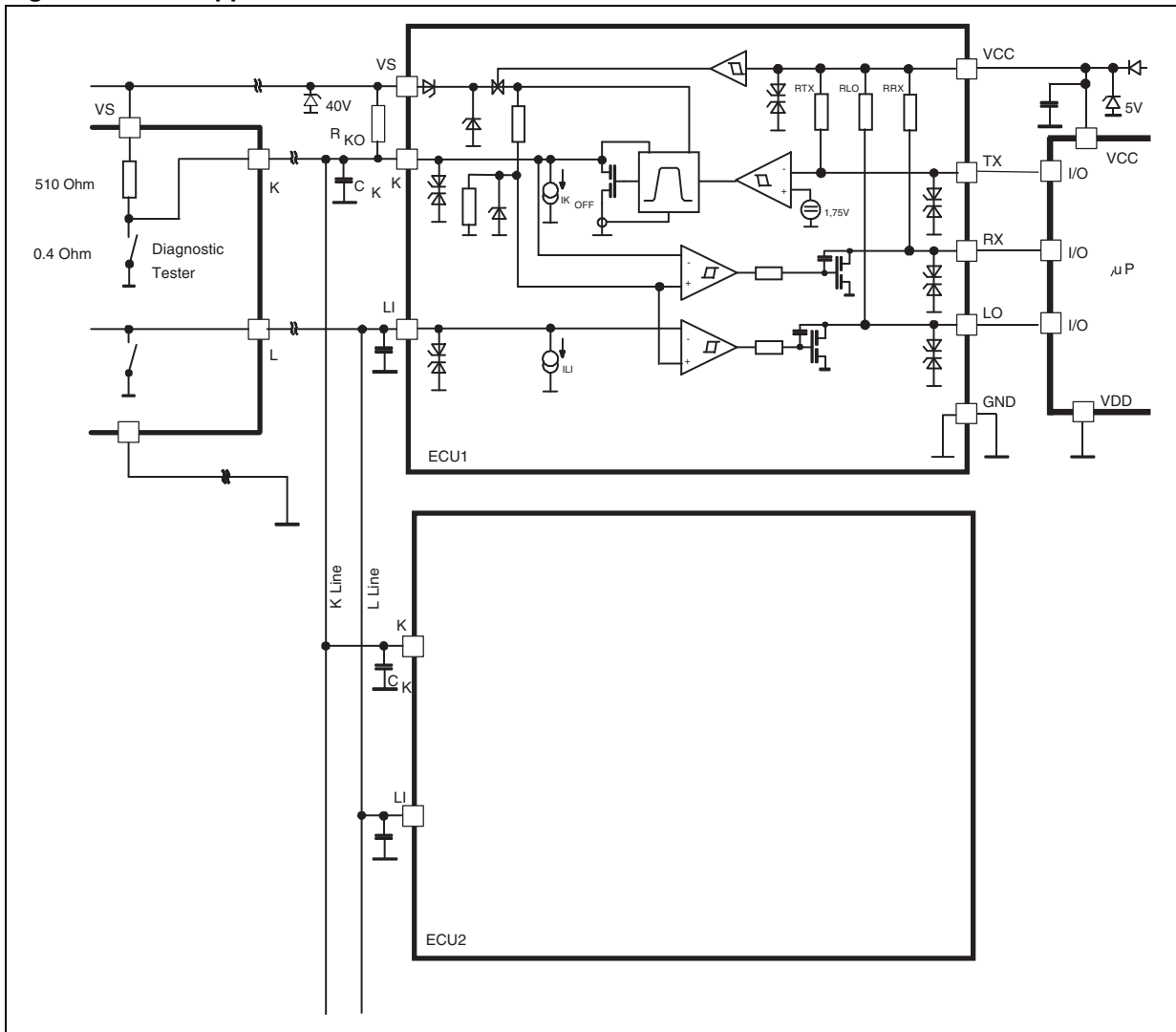


Figure 4. ISO application circuit



### 3 Functional description

The L9637 is a monolithic bus driver designed to provide bidirectional serial communication in automotive diagnostic applications according to the specification "Diagnostic Systems ISO9141".

The device provides a bidirectional link, called K, to the  $V_{Bat}$  related diagnosis bus. It also includes a separate comparator L which is also able to be linked to the  $V_{Bat}$  bus. The input TX and output RX of K are related to  $V_{CC}$  with her integrated pull up resistances. Also the L comparator output LO has a pull up resistance connected to  $V_{CC}$ .

The maximum external pull up resistance at K related to  $V_S$  should not be higher than  $R_{KO} \leq 5 \text{ k}\Omega$  to achieve clear output ON conditions.

All  $V_{Bat}$  bus defined inputs LI and K have supply voltage dependent thresholds together with sufficient hysteresis to suppress line spikes. These pins are protected against overvoltages, shorts to GND and  $V_S$  and can also be driven beyond  $V_S$  and GND.

These features are also given for TX, RX and LI only taking into account the behavior of the internal pull up resistances. The thermal shut down function switches OFF the K output if the chip temperature increases above the thermal shut down threshold. To reactivate K again the temperature must decrease below the K switch ON temp. To achieve no fault for  $V_S$  undervoltage conditions the outputs will be switched OFF and stay at high impedance.

The device is also protected against reverse battery condition. During lack of  $V_S$  or GND all pins shows high impedance characteristic. To realize a lack of the  $V_S$  related bus line LI and K the outputs LO and RX shows defined ON status.

Suppressing all 4 classes of "Schaffner" signals all pins can be load with short energy pulses of max.  $\pm 0.2 \text{ mJ}$ . All these features together with a high possible baud rate  $> 50 \text{ Kbaud}$ , controlled output slopes for low EMI, a wide power supply voltage range and a very small quiescent current during OFF (TX LI K=High) condition  $I_{S_{off}} \text{ typ} \leq 120 \mu\text{A}$ , and a real standby function with zero power consumption  $I_{S_{SB}} \text{ typ} \leq 1 \mu\text{A}$  during system de powering  $V_{CC} \leq 0.5 \text{ V}$  make this device high efficient for automotive bus system.

After wake up of the system from OFF or SB condition the first output signal will have an additional delay time  $t_{d_{typ}} \leq 5 \mu\text{s}$  see also [Figure 5](#).

The typical output voltage behavior for the K, LO, RX outputs as a function of the output current is shown in [Figure 6](#). [Figure 7](#) shows a waveform of the output signal when the low level changes from  $R_{ON} * I_{OUT}$  to  $I_{OUT} * 2 * R_{ON} + U_{BE}$  state. This variation occurs due to too low output current or after a negative transient forced to the output or to the supply voltage line.

Figure 5. Typical timing for mode transitions

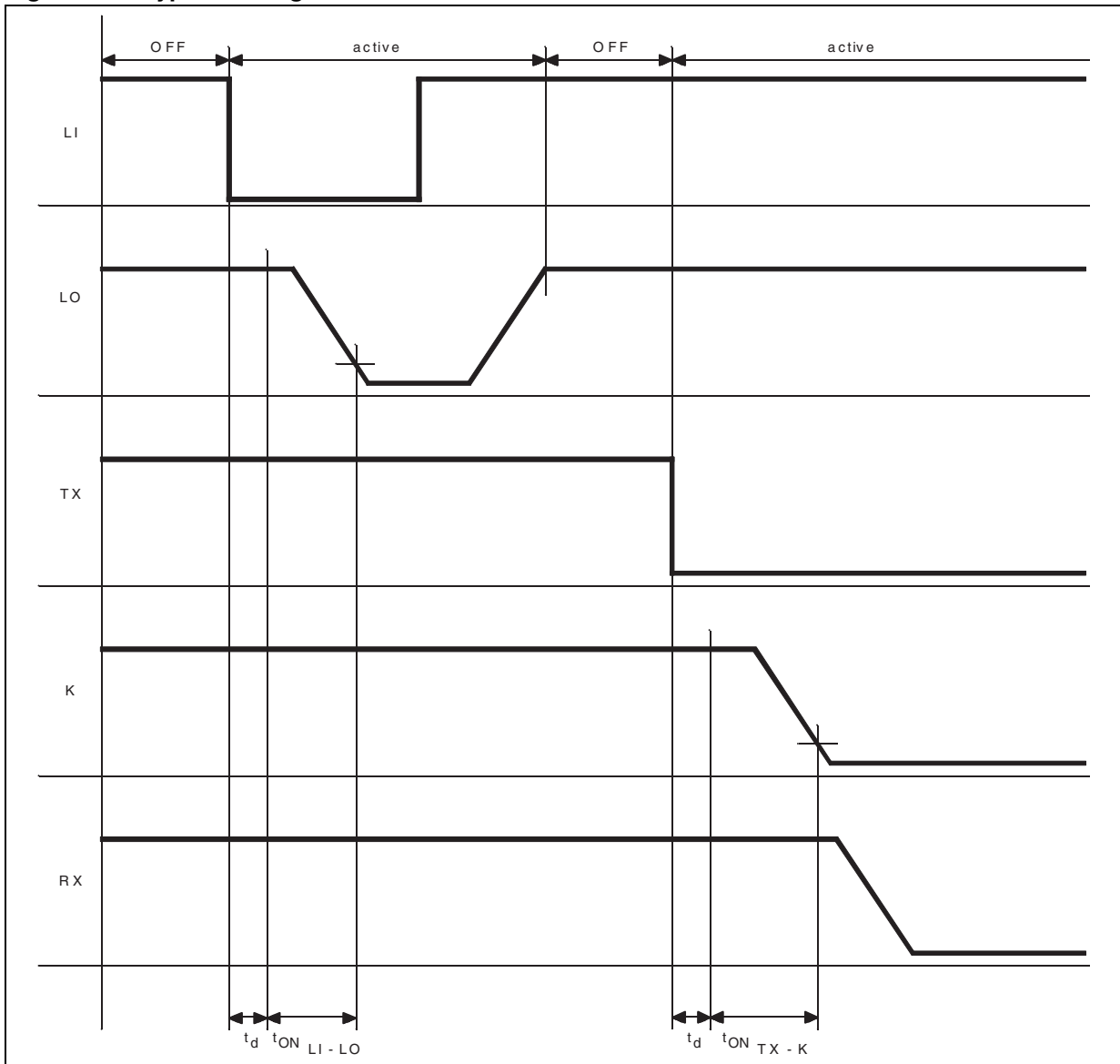


Figure 6. Output characteristics at K, LO, RX

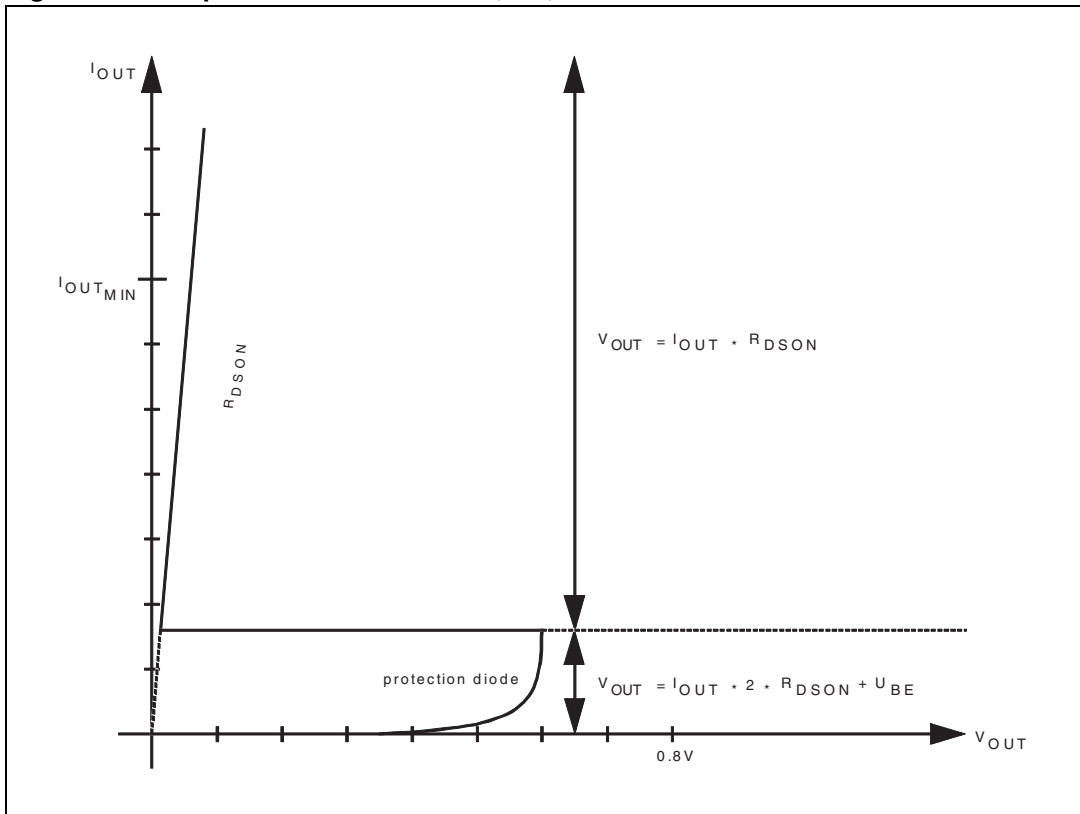


Figure 7. Output signal shape related to output current

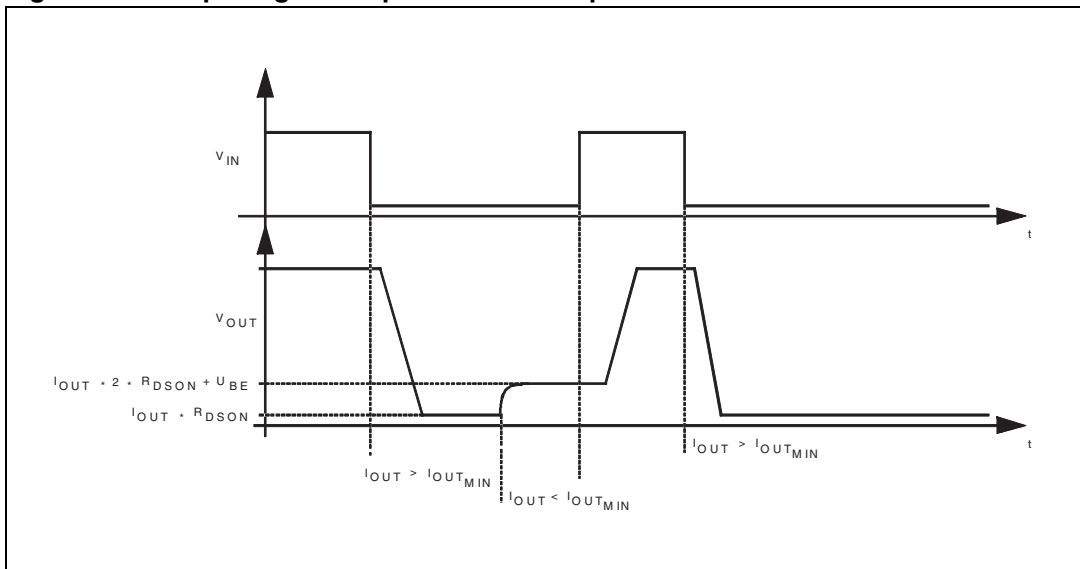


Figure 8. EMS performance (ISO 9141 bus system)

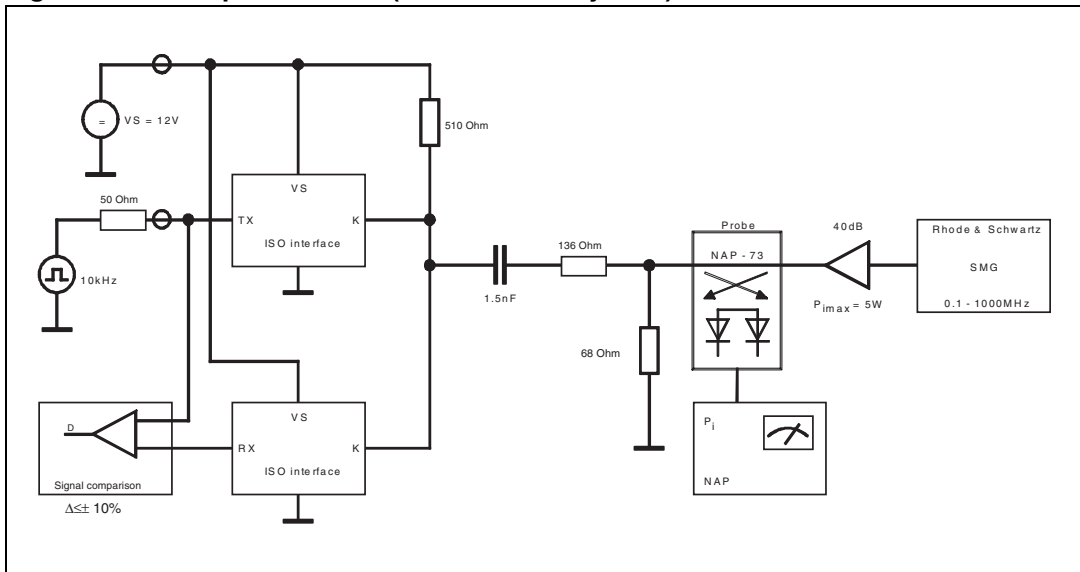
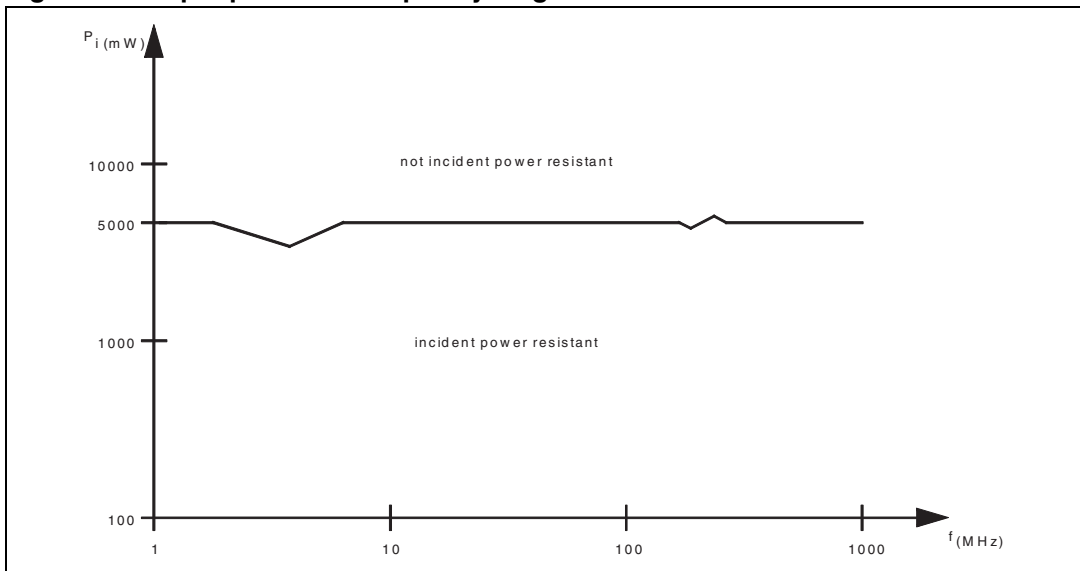


Figure 9. Input power vs. frequency diagram

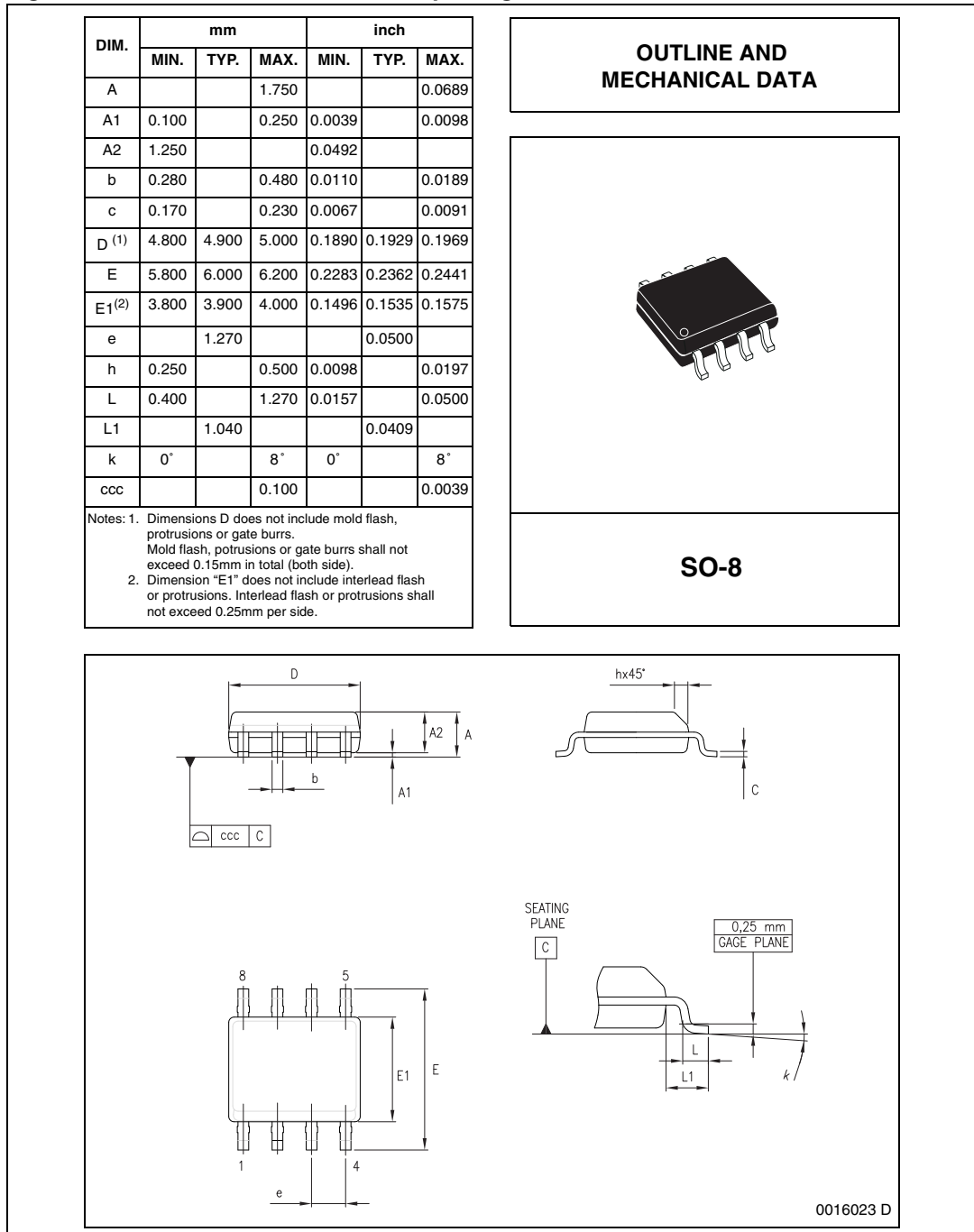


# 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

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**Figure 10. SO8 mechanical data and package dimensions**



## 5 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes   |
|-------------|----------|---|
| 24-Jan-2002 | 5        | Initial release.  |
| 07-Nov-2008 | 6        | Document reformatted.<br>Added <a href="#">Table 1: Device summary on page 1</a> .<br>Updated <a href="#">Section 4: Package information on page 13</a> . |
| 15-Jun-2009 | 7        | Updated the values of “stabilized voltage” and “transmission frequency” parameters on <a href="#">Table 5: Electrical characteristics</a> .               |
| 20-Sep-2013 | 8        | Updated disclaimer.   |

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