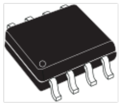
# L9613

## Data interface

## Features

- Operating power supply voltage range $4.8V \leq V_S \leq 36V$ (40V for transients)
- Reverse supply (battery) protected down to $V_S \geq -24V$
- Standby mode with very low current consumption $IS_{SB} \leq 1mA$ @ $V_{CC} \leq 0.5V$
- Min. possible Baud rate according to ISO9141 $\geq$ 130 kBaud
- Low quiescent current in off condition $IS_{OFF}$ = 120µA
- TTL compatible TX input
- Bidirectional K-I/O pin with supply voltage dependent input threshold
- Over temperature shut down function selective to K-I/O pin
- Wide input and output voltage range: $-24V \leq V_K \leq V_S$
- K output current limitation, typ. $I_K$ = 60mA
- Defined OFF output status in under voltage condition and $V_S$ or GND interruption
- Controlled output slope for low EMI



SO8

- 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 L9613 is a monolithic integrated circuit containing standard ISO 9141 compatible interface functions.

**Table 1. Device summary**

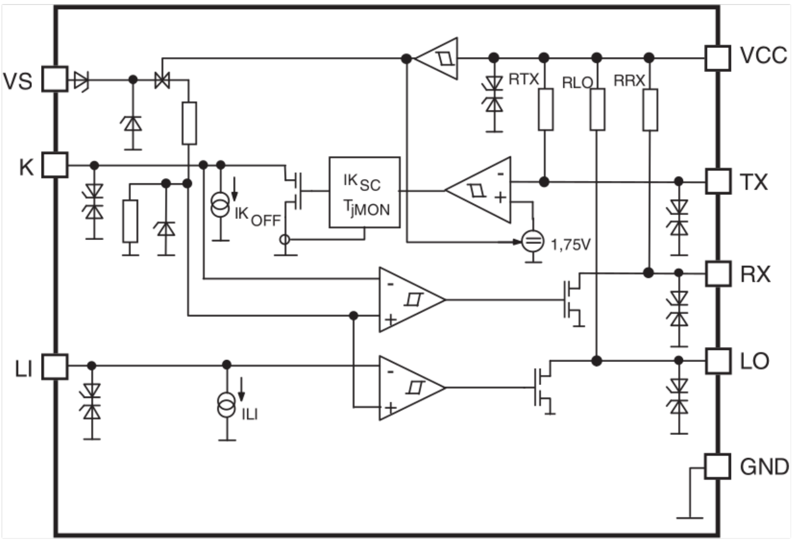
| Order code | Package | Packing |
|---|---|---|
| L9613B | SO8 | Tube |
| L9613B013TR | SO8 | Tape and reel |

# Contents

# 1 Block diagram and pin description

## 1.1 Block diagram

**Figure 1. Block diagram**




## 1.2 Pin description

**Figure 2. Pin connection (top view)**

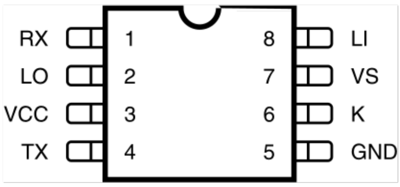



**Table 2. Pin description**

| 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<br>ISO transients t ≤ 400 ms | -24 to +36<br>-24 to +40 | V |
| $V_{CC}$ | Stabilized voltage | -24 to +7 | V |
| $\Delta V_S/d_t$ | Supply voltage transient | -10 to +10 | V/µs |
| $V_{LI,\ K}$ | Pin voltage | -24 to $V_S$ | V |
| $V_{LO,\ RX,\ TX}$ | | -24 to $V_{CC}$ | V |

*Note: Max. ESD voltages are ±2kV with human body model C = 100pF, R = 1.5k corresponds to maximum energy dissipation 0.2mJ 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 | °C |
| $T_{JSDoff}$ | Temperature K shutdown switch off threshold | 150 | | 200 | °C |
| $R_{th\ j\text{-}amb}$ | Thermal steady state junction to ambient resistance | 130 | 155 | 180 | °C/W |

## 2.3 Electrical characteristics

**Table 5. 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. $V_S$ = 4.8 to 18V; $V_{CC}$ = 3 to 7V; $T_j$ = -40 to +150°C).

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}$ | Supply $V_{CC}$ current | $V_{CC} \le 5.5V$; VLI,VTX = 0V | | 1.4 | 2.3 | mA |
| | | $VK \ge VK_{high}$; $VLI \ge VLI_{high}$<br>$VTX = V_{CC}$ @ $V_{CC} \le 5.5V$ | -5 | 40 | 150 | µA |
| $IS_{ON}$ | Supply $V_S$ Current | VLI, VTX = 0V<br>$V_{CC} \le 0.5V$ @ $V_S \le 12V$ (1) | | 3.5<br><1 | 10<br>50 | mA<br>µA |
| $IS_{SB}$ | | $V_{CC} \le 0.5V$ @ $V_S \le 16V$ | | | 100 | µA |
| $VK_{low}$ | Input voltage low state | RX output status LOW | -24 | | $0.40V_S$ | V |
| $VK_{high}$ | Input voltage high state | RX output status HIGH | $0.60V_S$ | | $V_S$ | V |

**Table 5. Electrical characteristics (continued)**
(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. $V_S$ = 4.8 to 18V; $V_{CC}$ = 3 to 7V; $T_j$ = -40 to +150°C).

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $VK_{hys}$ | Input threshold hysteresis | $VK_{high}$ - $VK_{low}$<br>$V_S \geq 8V$<br>$V_S \geq 6V$ | 0.2<br>0.08 | $0.05V_S$ | 1 | V |
| $IK_{off}$ | Input current | @ $VTX \geq VTX_{high}$<br>$V_S$, $V_{CC} \geq 0$ or $V_S$<br>$V_{CC}$ = open or<br>GND = open | -5 | 4 | 25 | µA |
| $RK_{ON}$ | Output ON impedance | @ $V_S \geq 6.5V$<br>$VTX \leq VTX_{low}$ $IK \geq 7mA$ (2) | | 10 | 30 | Ω |
| $IK_{SC}$ | Short circuit current | @ $V_S \geq 6.5V$ | 40 | 60 | 150 | mA |
| $VK_{sat}$ | Output saturation voltage | $R_{KO}$ = 1.5kΩ | | | 1 | V |
| $VTX_{low}$ | Input voltage LOW state | | -24 | | 1 | V |
| $VTX_{high}$ | Input voltage HIGH state | | 3.5 | | $V_{CC}$ | V |
| $RRX_{ON}$<br>$RLO_{ON}$ | Output ON impedance | $VK \leq VK_{low}$; $VLI \leq VLI_{low}$<br>$V_S \geq 6.5V$ $I_{RX, LO} \geq 1mA$ | | 40 | 90 | Ω |
| $VRX_{sat}$<br>$VLO_{sat}$ | Saturation output voltage | no external load | | | 1 | V |
| $IRX_{SC}$<br>$ILO_{SC}$ | Output short circuit current | @ $V_S \geq 6.5V$ | 9 | 20 | 50 | mA |
| RTX | Input pull-up resistance | Output status = (HIGH)<br>$T_{amb}$ = ≤ 85°C<br>$-0.15V \leq VLO \leq V_{CC} + 0.15V$<br>$-0.15V \leq VRX \leq V_{CC} + 0.15V$ | 5 | 10 | 18 | kΩ |
| RTX | Input pull up resistance | $-0.15V \leq VTX \leq V_{CC} + 0.15V$<br>$T_{amb}$ = ≤ 125°C | 10 | 20 | 40 | kΩ |
| $VLI_{low}$ | Input voltage LOW state | LO output status LOW | -24 | | $0.40V_S$ | V |
| $VL_{high}$ | Input voltage HIGH state | LO output status HIGH | $0.60V_S$ | | $V_S$ | V |
| $VLI_{hys}$ | Input threshold hysteresis | $VLI_{high}$ - $VLI_{low}$ | | $0.025V_S$ | 0.8 | V |
| ILI | Input current | $V_S$, $V_{CC} \geq 0$ or<br>$V_S$, $V_{CC}$ = open or<br>GND = open | -5 | 4 | 40 | µA |
| $C_{Ki,LO,RX}$ | Internal output capacities | | | | 20 | pF |
| $f_{LI\text{-}LO}$<br>$f_{K\text{-}RX}$<br>$f_{TX\text{-}k}$ | Transmission frequency | $9V < V_S < 16V$ (external loads)<br>$T_{min} \geq 20 \cdot R_{KO} \cdot C_K - K_{line}$ | 130 | | | kHz |

**Table 5. Electrical characteristics (continued)**
(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. $V_S$ = 4.8 to 18V; $V_{CC}$ = 3 to 7V; $T_j$ = -40 to +150°C).

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{rLI\text{-}LO}$<br>$t_{rK\text{-}RX}$<br>$t_{rTX\text{-}K}$ | Rise time | for the definition of $t_r$, $t_f$ see *Figure 6* (3)<br>9V < $V_S$ < 16V (external loads)<br>$T_{min} \geq 20 \cdot R_{KO} \cdot C_K - K_{line}$ | | 0.4 | 2 | µs |
| $t_{fLI\text{-}LO}$<br>$t_{fK\text{-}RX}$<br>$t_{fTX\text{-}K}$ | Fall time | | | 0.4 | 2 | µs |
| $t_{OFF,LI\text{-}LO}$<br>$t_{OFF,K\text{-}RX}$<br>$t_{OFF,TX\text{-}K}$ | Switch OFF time | for the definition of ton, $t_{OFF}$ see *Figure 6*.<br>9V < $V_S$ < 16V (external loads)<br>$T_{min} \geq 20 \cdot R_{KO} \cdot C_K - K_{line}$ | | 1 | 13 | µs |
| $t_{ON,LI\text{-}LO}$<br>$t_{ON,K\text{-}RX}$<br>$t_{ON,TX\text{-}K}$ | Switch ON time | | | 1 | 13 | µs |
| $td_{SB\ ON}$<br>$td_{SB\ OFF}$ | Standby reaction time | VTX = 0V, IK ≥ 7mA<br>VLI = 0V, 9V < VS < 16V<br>see | | 10<br>20 | 20<br>40 | µs |

1. In case of spikes on VCC ≥ 0.5V KOUT will be switched On for typical 10µs which represents the standby $td_{SB}$ reaction time.
2. For output currents lower than this value a series protection diode can become active. See also *Figure 5* and *7*.
3. Speed limitation related to external capacitance $C_{ext\ RX,\ LO}$ and internal impedance CLO, RX, RLO, RRX for rise time.

$$tr = R_{LO,\ RX} \cdot (C_{LO,RX} + C_{ext\ RX,\ LO}) \cdot 1.38.$$

# 3 Functional description

The L9613 is a monolithic bus driver designed to provide bidirectional serial communication in automotive applications.

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 VCC with her integrated pull up resistances. Also the L comparator output LO has a pull up resistance connected to VCC.

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 over voltages, shorts to GND and VS and can also be driven beyond VS 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 chip temperature must decrease below the K switch ON temp. To achieve no fault for VS intervillage conditions the outputs will be switched OFF and stay at high impedance. The device is also protected against reverse battery condition. During lack of VS or GND all pins shows high impedance characteristic. To realize a lack of the VS related bus line LI and K the outputs LO and RX shows defined ON status. Suppressing all 4 classes of "Schaffner" signals (Schaffner 1; 2; 3a,b; 4) all pins can be load with short energy pulses of max. $\pm$0.2mJ. All these features together with a high possible baud rate >130Kbaud, controlled output slopes for low EMI, a wide power supply voltage range and a real standby function with zero power consumption $IS_{SB\ typ} \leq 1\mu A$ during system de powering $VCC \leq 0.5V$ make this device high efficient for automotive bus system.

After wake up of the system from SB condition the first output signal will have an additional delay time $td_{typ} \leq 5\mu s$.

The typical output voltage behavior for the K, LO, RX outputs as a function of the output current is shown in *Figure 4*. *Figure 5* shows a waveform of the output signal when the low level changes from $R_{ON} \cdot I_{OUT}$ to $I_{OUT} \cdot 2 \cdot R_{ON} + U_{BE}$ 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 3. Application circuit

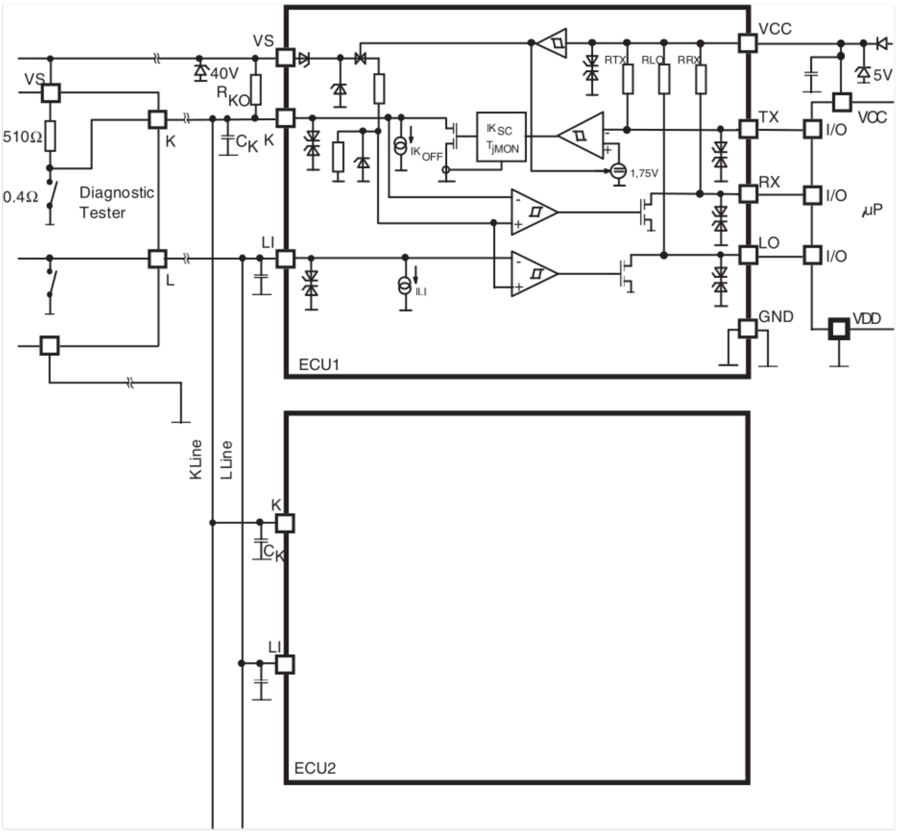



Figure 4. Output characteristics at K, LO, RX

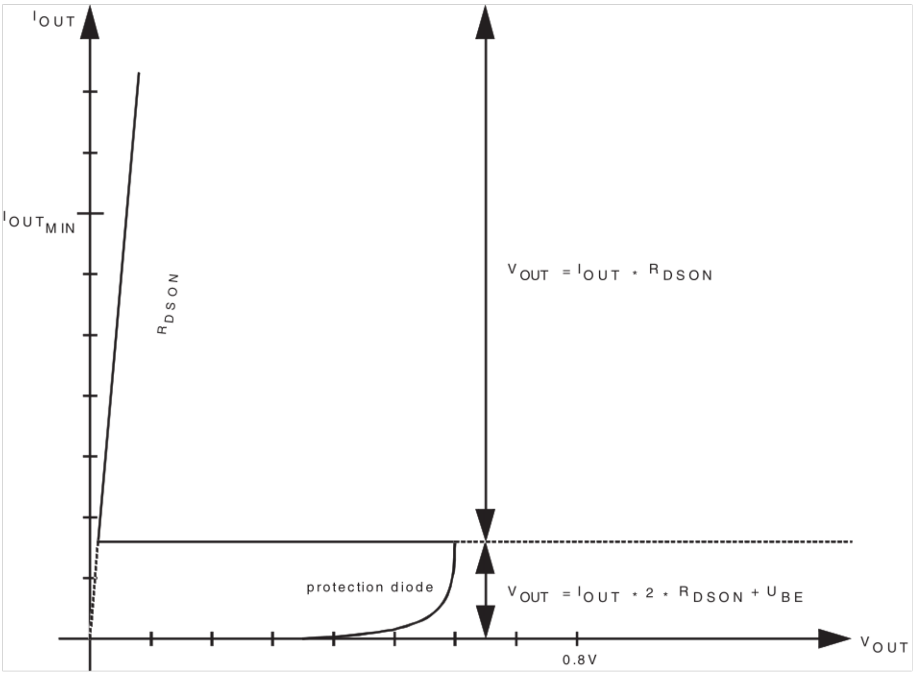


**Figure 5. Output signal shape related to output current**

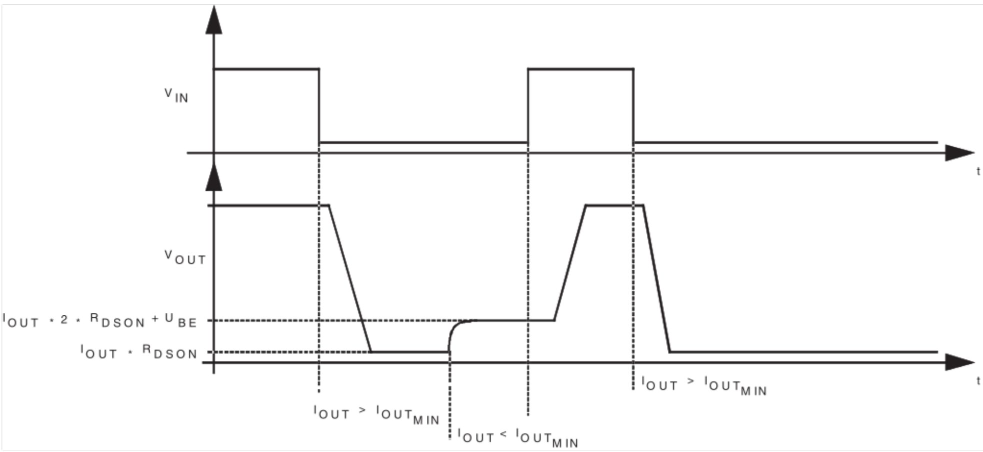



**Figure 6. Input to output timings and output pulse shape**

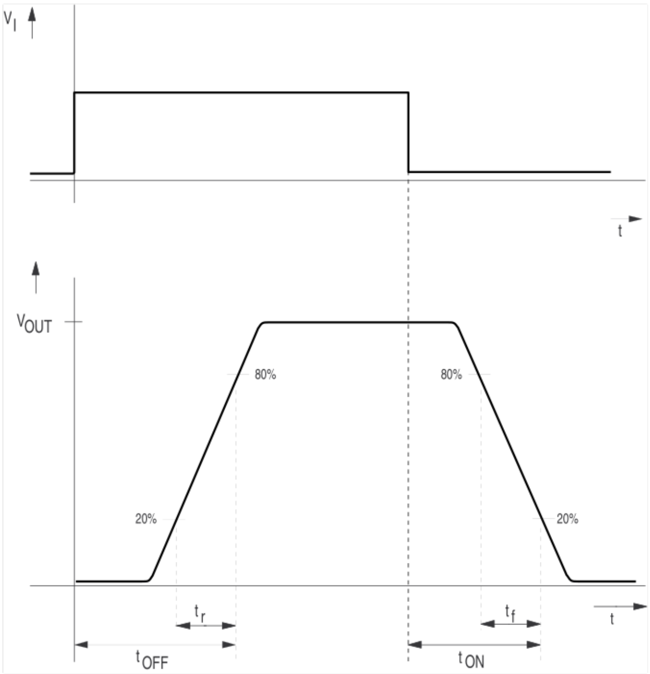


Figure 7. Standby reaction time

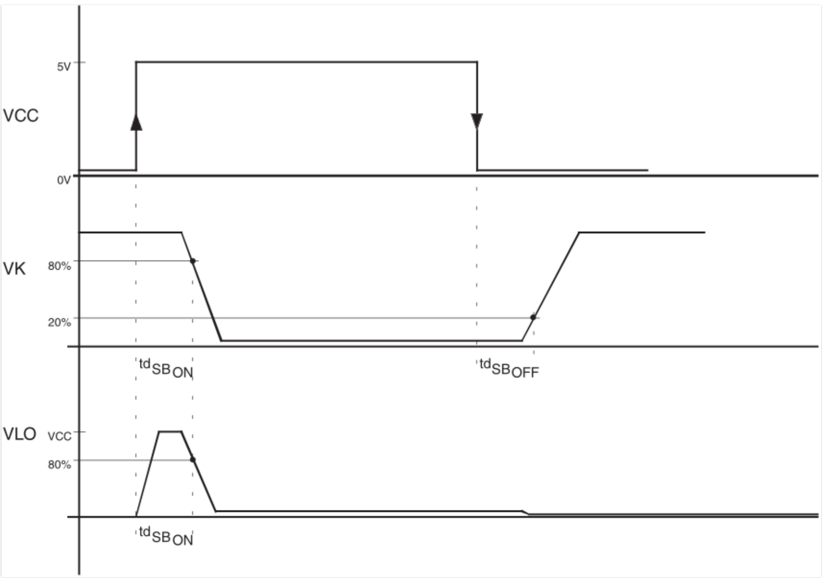



Figure 8. Standby current consumption

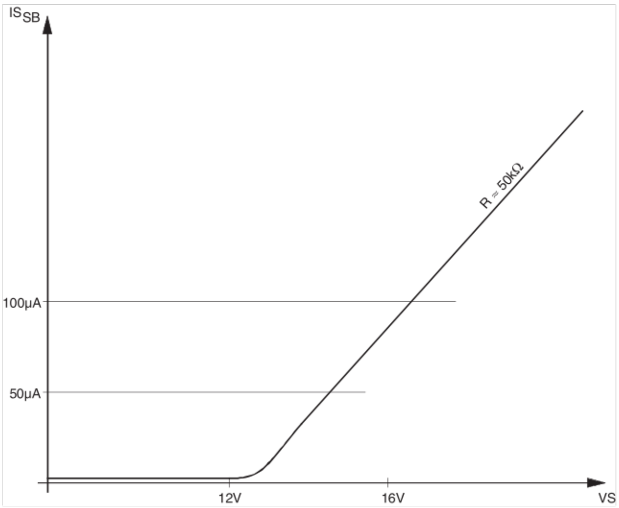


**Figure 9. EMS performance (ISO 9141 BUS system) diagram**

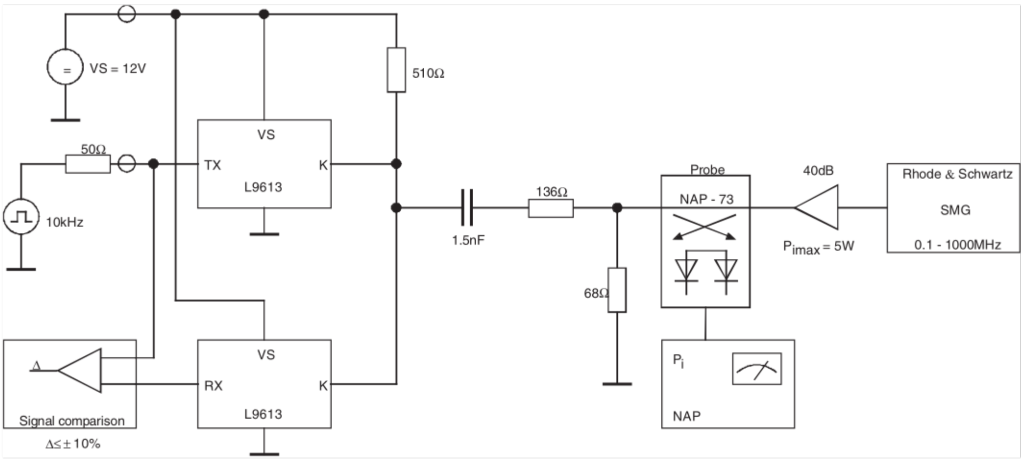
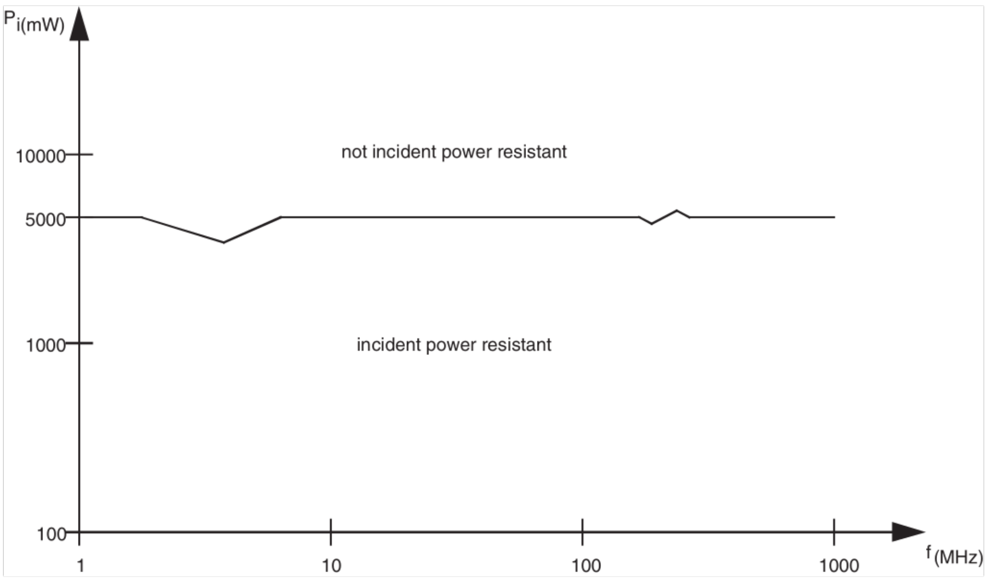



**Figure 10. EMS rejection frequency vs. power**



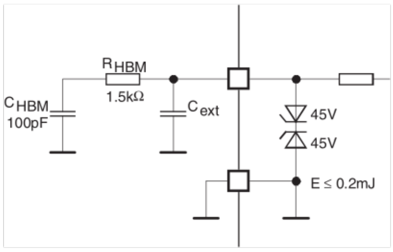
## 3.1 ESD application hints

To improve the ESD robustness of this device above specified ±2 kV/HBM external blocking capacitors must be used. Nevertheless the max. energy which can be clamped by this device should not exceeds 0.2mJ for each pin. An equivalent input diagram for calculation can be seen in *Figure 11*.

ESD discharge model:

$$E_{ESD} = \frac{1}{2}C_{HBM}U_{ESD}^2 = 0.2\text{mJ} + \frac{1}{2}C_{EXT} \cdot (45\text{V})^2$$

**Figure 11. Input diagram for calculation**



# 4 Package information

In order to meet environmental requirements, ST (also) offers these devices in ECOPACK® packages. ECOPACK® packages are lead-free. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

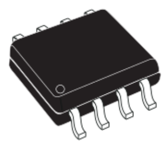
ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

**Figure 12. SO8 mechanical data and package dimensions**

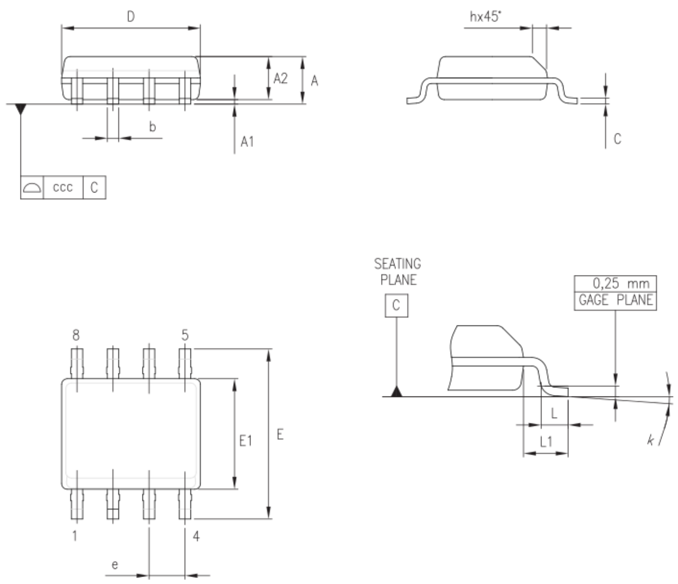
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.750 | | | 0.0689 |
| A1 | 0.100 | | 0.250 | 0.0039 | | 0.0098 |
| A2 | 1.250 | | | 0.0492 | | |
| b | 0.280 | | 0.480 | 0.0110 | | 0.0189 |
| c | 0.170 | | 0.230 | 0.0067 | | 0.0091 |
| D (1) | 4.800 | 4.900 | 5.000 | 0.1890 | 0.1929 | 0.1969 |
| E | 5.800 | 6.000 | 6.200 | 0.2283 | 0.2362 | 0.2441 |
| E1 (2) | 3.800 | 3.900 | 4.000 | 0.1496 | 0.1535 | 0.1575 |
| e | | 1.270 | | | 0.0500 | |
| h | 0.250 | | 0.500 | 0.0098 | | 0.0197 |
| L | 0.400 | | 1.270 | 0.0157 | | 0.0500 |
| L1 | | 1.040 | | | 0.0409 | |
| k | 0° | | 8° | 0° | | 8° |
| ccc | | | 0.100 | | | 0.0039 |

Notes: 1. Dimensions D does not include mold flash, protrusions or gate burrs. Mold flash, potrusions or gate burrs shall not exceed 0.15mm in total (both side).
2. Dimension "E1" does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25mm per side.

**OUTLINE AND MECHANICAL DATA**



**SO-8**




0016023 D

# 5 Revision history

**Table 6. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 24-Jan-2002 | 1 | Initial release. |
| 11-Nov-2008 | 2 | Document reformatted.<br>Added *Table 1: Device summary on page 1*.<br>Updated *Section 4: Package information on page 13*. |
| 19-Sep-2013 | 3 | Updated Disclaimer. |