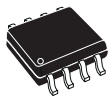
# L9637D

## ISO 9141 INTERFACE

- OPERATING POWER SUPPLY VOLTAGE RANGE 4.5V ≤ $V_S$ ≤ 36V (40V FOR TRANSIENTS)
- REVERSE SUPPLY (BATTERY) PROTECTED DOWN TO $V_S$ ≥ -24V
- STANDBY MODE WITH VERY LOW CURRENT CONSUMPTION $IS_{SB}$ 1µA @ $V_{CC}$ 0.5V
- LOW QUIESCENT CURRENT IN OFF CONDITION $IS_{OFF}$ = 120µA
- 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 -24V ≤ $V_K$ ≤ $V_S$
- K OUTPUT CURRENT LIMITATION, TYP $I_K$ = 60mA
- DEFINED OFF OUTPUT STATUS IN UNDERVOLTAGE CONDITION AND VS OR GND INTERRUPTION
- CONTROLLED OUTPUT SLOPE FOR LOW EMI
- HIGH INPUT IMPEDANCE FOR OPEN $V_S$ OR GND CONNECTION



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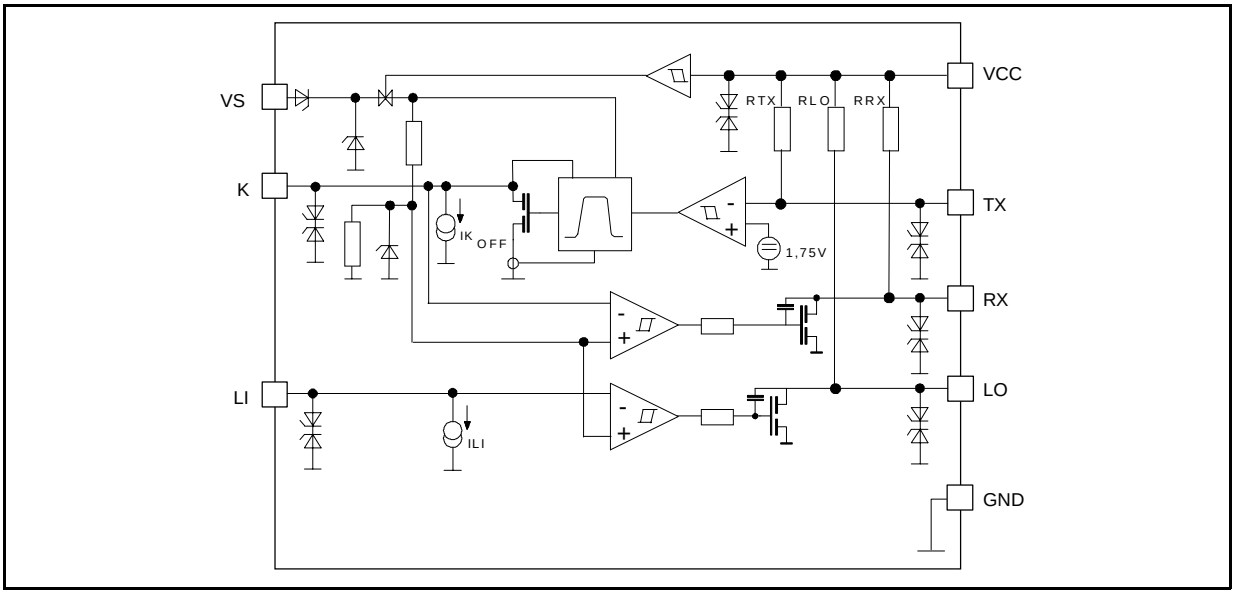
- DEFINED OUTPUT ON STATUS OF LO OR RX FOR OPEN LI OR K INPUTS
- DEFINED K OUTPUT OFF FOR TX INPUT OPEN
- INTEGRATED PULL UP RESISTORS FOR TX, RX AND LO
- EMI ROBUSTNESS OPTIMIZED

### DESCRIPTION

The L9637D is a monolithic integrated circuit containing standard ISO 9141 compatible interface functions.

### BLOCK DIAGRAM

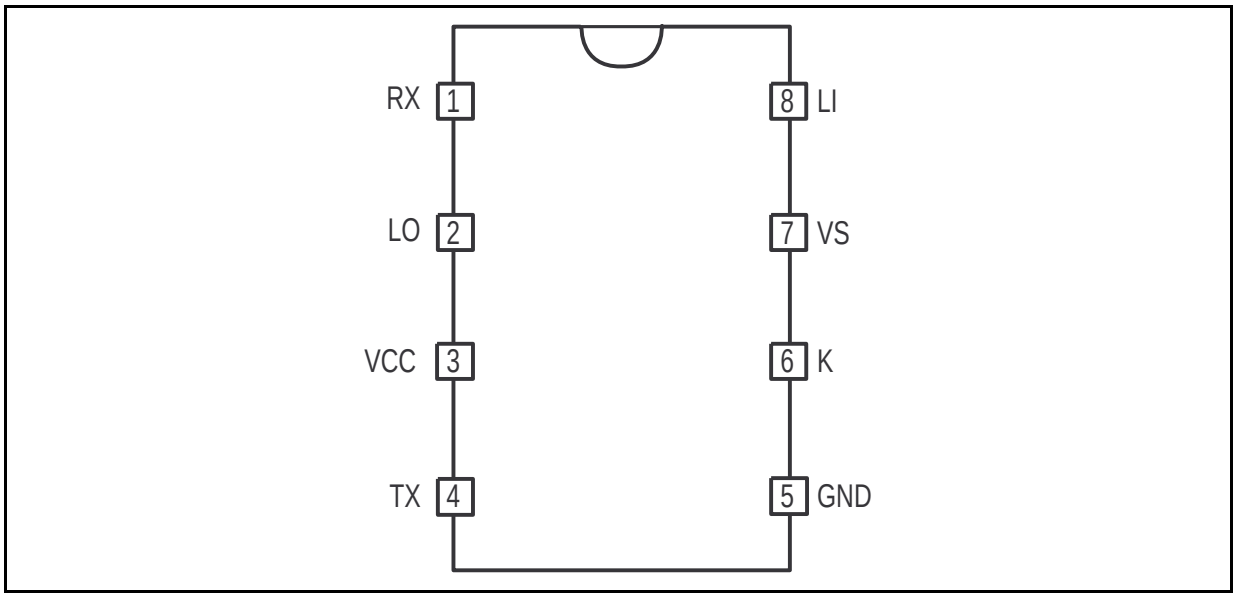


## ABSOLUTE MAXIMUM RATINGS (No damage or latch)

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

## PIN CONNECTION (Top view)




## THERMAL DATA

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

## 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 |

**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.)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_S$ | Supply Voltage | | 4.5 | | 36 | V |
| $V_{CC}$ | Stabilized Voltage | | 3 | | 7 | V |
| $T_j$ | Junction temperature | | -40 | | 150 | °C |
| $I_{CC}$ | Supply $V_{CC}$ Current | $V_{CC} \leq 5.5V$; VLI,VTX = 0V | | 1.4 | 2.3 | mA |
| | | $VK \geq VK_{high}$; $VLI \geq VLI_{high}$ $VTX = V_{CC}$ @ $V_{CC} \leq 5.5V$ | -5 | <1 | 5 | µA |
| $IS_{ON}$ | Supply VS Current | $V_S \leq 16V$; VLI, VTX = 0V | | 1.2 | 3 | mA |
| $IS_{OFF}$ | | $VK \geq VK_{high}$; $VLI \geq VLI_{high}$ $VTX \geq VTX_{high}$ @ $V_S \leq 12V$ | | 120 | 220 | µA |
| $IS_{SB}$ | | $V_{CC} \leq 0.5V$ @ $V_S \leq 12V$ | | <1 | | µA |
| $VK_{low}$ | Input Voltage Low state | RX output status LOW $4.5V \leq V_S \leq 18V$ | -24 | | $0.45V_S$ | V |
| | | RX output status LOW $18V < V_S$ | -24 | | 8 | V |
| $VK_{high}$ | Input Voltage High state | RX output status HIGH $4.5V \leq V_S \leq 18V$ | $0.55V_S$ | | $V_S$ | V |
| | | RX output status HIGH $18V < V_S$ | 12 | | $V_S$ | V |
| $VK_{hys}$ | Input Threshold Hysteresis | $VK_{high}$ - $VK_{low}$ | | 0.025 $V_S$ | 0.8 | V |
| $IK_{off}$ | Input Current | @ $VTX \geq VTX_{high}$ $VK \leq V_S$ $V_S$, $V_{CC} \geq 0$ or $V_S$, $V_{CC}$ = open | -5 | 4 | 25 | µA |
| $RK_{ON}$ | Output ON Impedance | @ $V_S \geq 6.5V$ $VTX \leq VTX_{low}$ $I_K \geq 7mA$ 1) | | 10 | 30 | Ω |
| $IK_{SC}$ | Short Circuit Current | | 30 | 60 | 100 | mA |
| $VTX_{low}$ | Input voltage LOW state | | -24 | | 1 | V |
| $VTX_{high}$ | Input voltage HIGH state | | 2.5 | | $V_{CC}$ | V |
| $RRX_{ON}$ $RLO_{ON}$ | Output ON Impedance | $VK \leq VK_{low}$; $VLI \leq VLI_{low}$ $V_S \geq 6.5V$ $I_{RX, LO} \geq 1mA$ 1) | | 40 | 90 | Ω |
| $IRX_{SC}$ $ILO_{SC}$ | Output Short Circuit Current | | 9 | 20 | 35 | mA |
| $VRX_H$ $VLO_H$ | Output Voltage HIGH state | $10M\Omega \leq R_{LRX}$ $10M\Omega \leq R_{LLO}$ | $V_{CC}$ - 0.25 | $V_{CC}$ - 0.1 | $V_{CC}$ | V |
| RLO RRX | Output pull-up resistance | Output status = (HIGH) $-0.15V \leq VLO \leq V_{CC} + 0.15V$ $-0.15V \leq VRX \leq V_{CC} + 0.15V$ | 5 | 10 | 20 | KΩ |
| RTX | Input pull up resistance | $-0.15V \leq VTX \leq V_{CC} + 0.15V$ | 10 | 20 | 40 | KΩ |
| $VLI_{low}$ | Input voltage LOW state | LO output status LOW $4.5V \leq V_S \leq 18V$ | -24 | | $0.45V_S$ | V |
| | | LO output status LOW $18V < V_S$ | -24 | | 8 | V |
| $VL_{high}$ | Input voltage HIGH state | LO output status HIGH $4.5V \leq V_S \leq 18V$ | $0.55V_S$ | | VS | V |
| | | LO output status HIGH $18V < V_S$ | 12 | | VS | V |
| $VLI_{hys}$ | Input threshold hysteresis | $VLI_{high}$ - $VLI_{low}$ | | $0.025V_S$ | 0.8 | V |
| ILI | Input current | $VLI \leq V_S$ $V_S$, $V_{CC} \geq 0$ or $V_S$, $V_{CC}$ = open | -5 | 4 | 25 | µA |

**ELECTRICAL CHARACTERISTIC** (continued)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{Ki, LO, RX}$ | Internal output capacities | | | | 20 | pF |
| $f_{LI-LO}$<br>$f_{K-RX}$<br>$f_{TX-k}$ | Transmission Frequency | 9V < $V_S$ < 16V<br>(external loads)<br>$R_{KO}$ = 510Ω, $C_K$ ≤ 1.3nF<br>in active mode see Fig. 3 | 50 | 100 | | kHz |
| $t_{rLI-LO}$<br>$t_{rK-RX}$<br>$t_{rTX-K}$ | Rise Time | for the definition of tr, $t_f$ see Fig.1.<br><br>9V < $V_S$ < 16V (external loads)<br>$R_{KO}$ = 510Ω, $C_K$ ≤ 1.3nF | | 2 | 6 | µs |
| $t_{fLI-LO}$<br>$t_{fK-RX}$<br>$t_{fTX-K}$ | Fall Time | | | 2 | 6 | µs |
| $t_{OFF,LI-LO}$<br>$t_{OFF,K-RX}$<br>$t_{OFF,TX-K}$ | Switch OFF time | for the definition of ton, $t_{OFF}$ see Fig.1.<br><br>9V < $V_S$ < 16V (external loads)<br>$R_{KO}$ = 510Ω, $C_K$ ≤ 1.3nF<br>(inactive mode see Fig. 3) | | 4 | 17 | µs |
| $t_{ON,LI-LO}$<br>$t_{ON,K-RX}$<br>$t_{ON,TX-K}$ | Switch ON time | | | 4 | 17 | µs |

**1)** For output currents lower than this value a series protection diode can become active. See also Fig. 4 and 5.

**Figure 1:** Input to Output Timings and Output Pulse Shape.

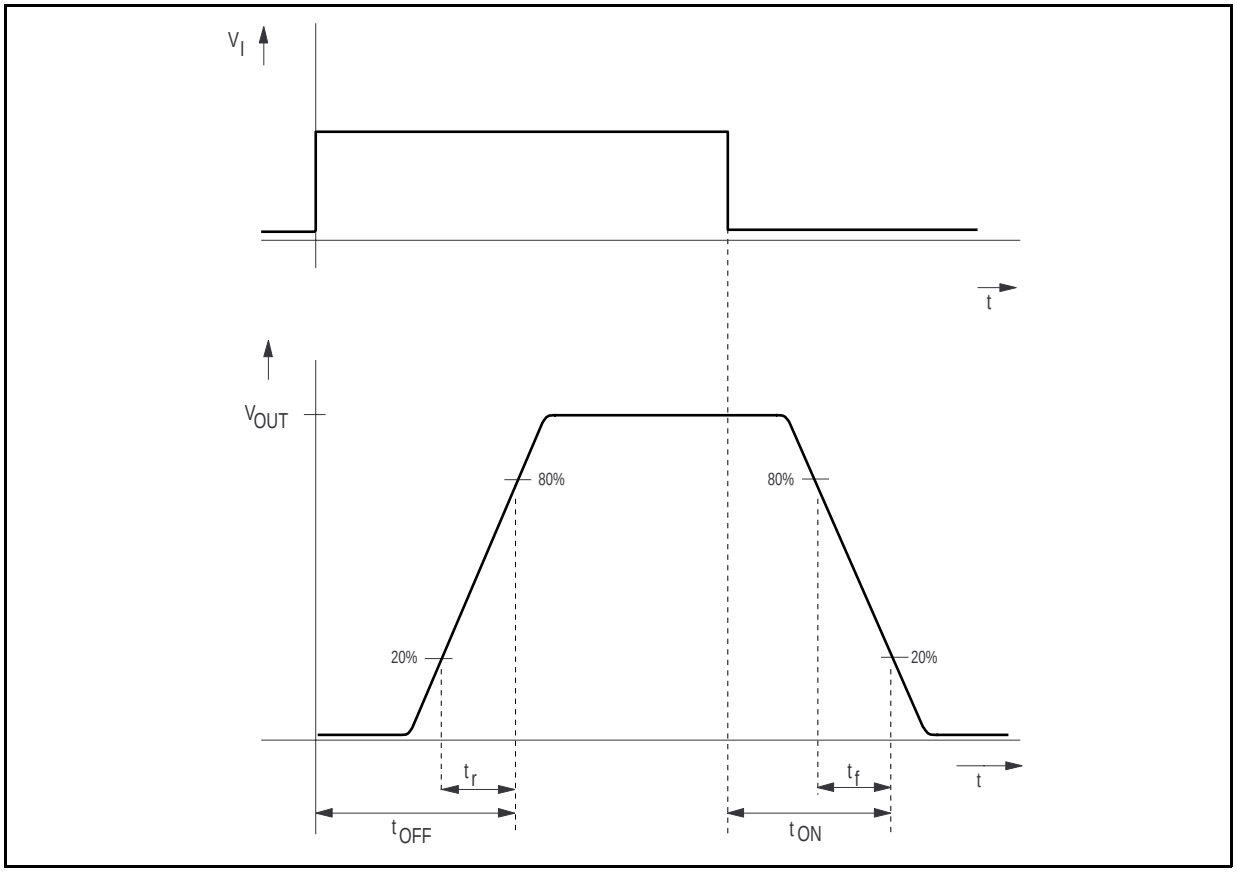
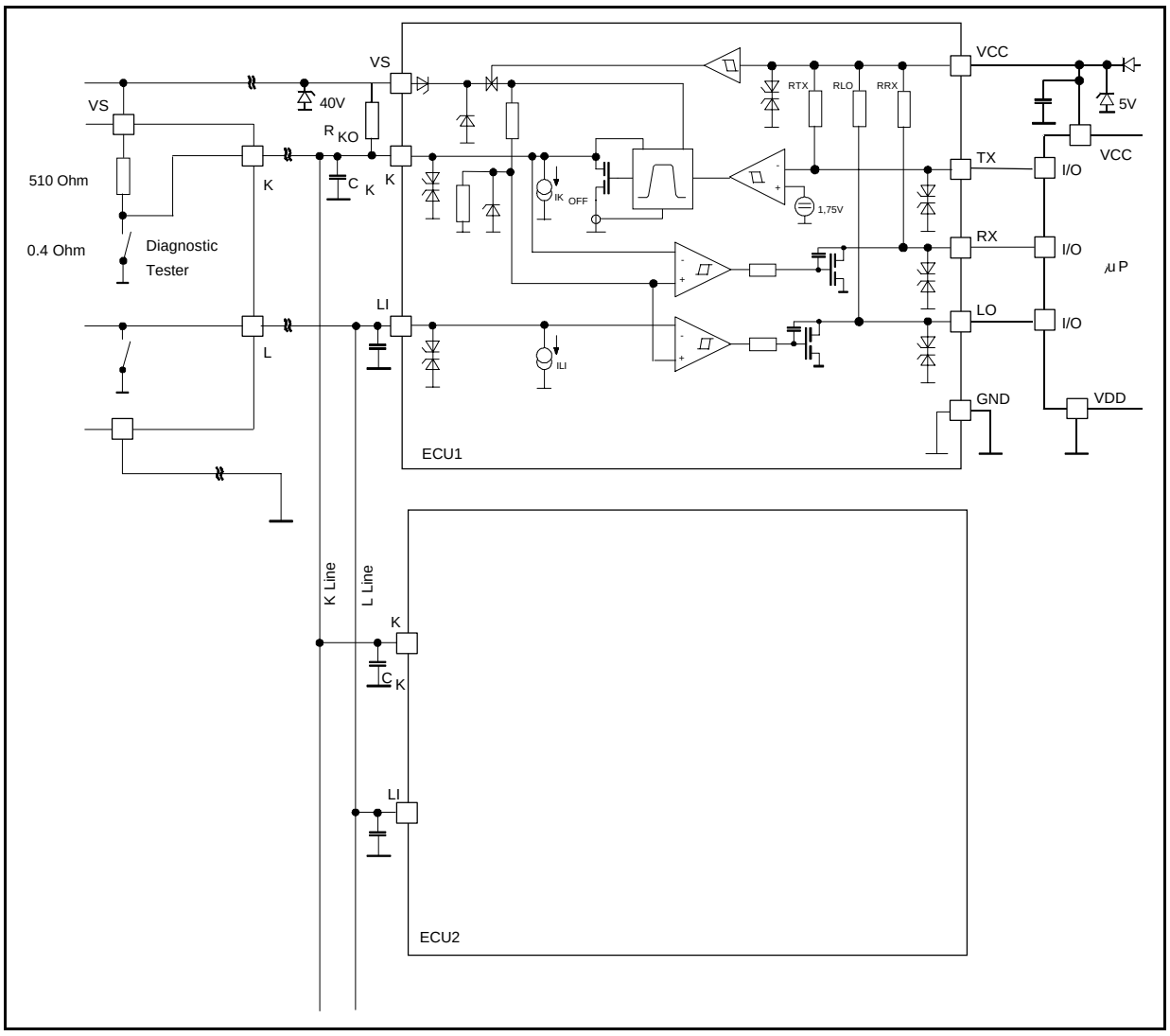


**Figure 2:** ISO Application Circuit




## FUNCTIONAL DESCRIPTION

The L9637D 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 $R_{KO} \leq 5K\Omega$ to achieve clear output ON conditions.

All $V_{Bat}$ bus defined inputs LI and K have supply voltage dependent thresholds together with sufficent 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 behaviour 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 $V_S$ 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.

Supressing all 4 classes of "Schaffner" signals all pins can be load with short energy pulses of max. ±0.2mJ. All these features together with a high possible baud rate >50Kbaud, 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 $IS_{off\ typ} \leq 120\mu A$, and a real standby function with zero power consumption $IS_{SB\ typ} \leq 1\mu A$ during system depowering $V_{CC} \leq 0.5V$ 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 $td_{typ} \leq 5\mu s$ see also Fig. 3.

The typical output voltage behaviour for the K, LO, RX outputs as a function of the output current is shown in Fig.4. Fig.5 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 3:** Typical timing for mode transitions.

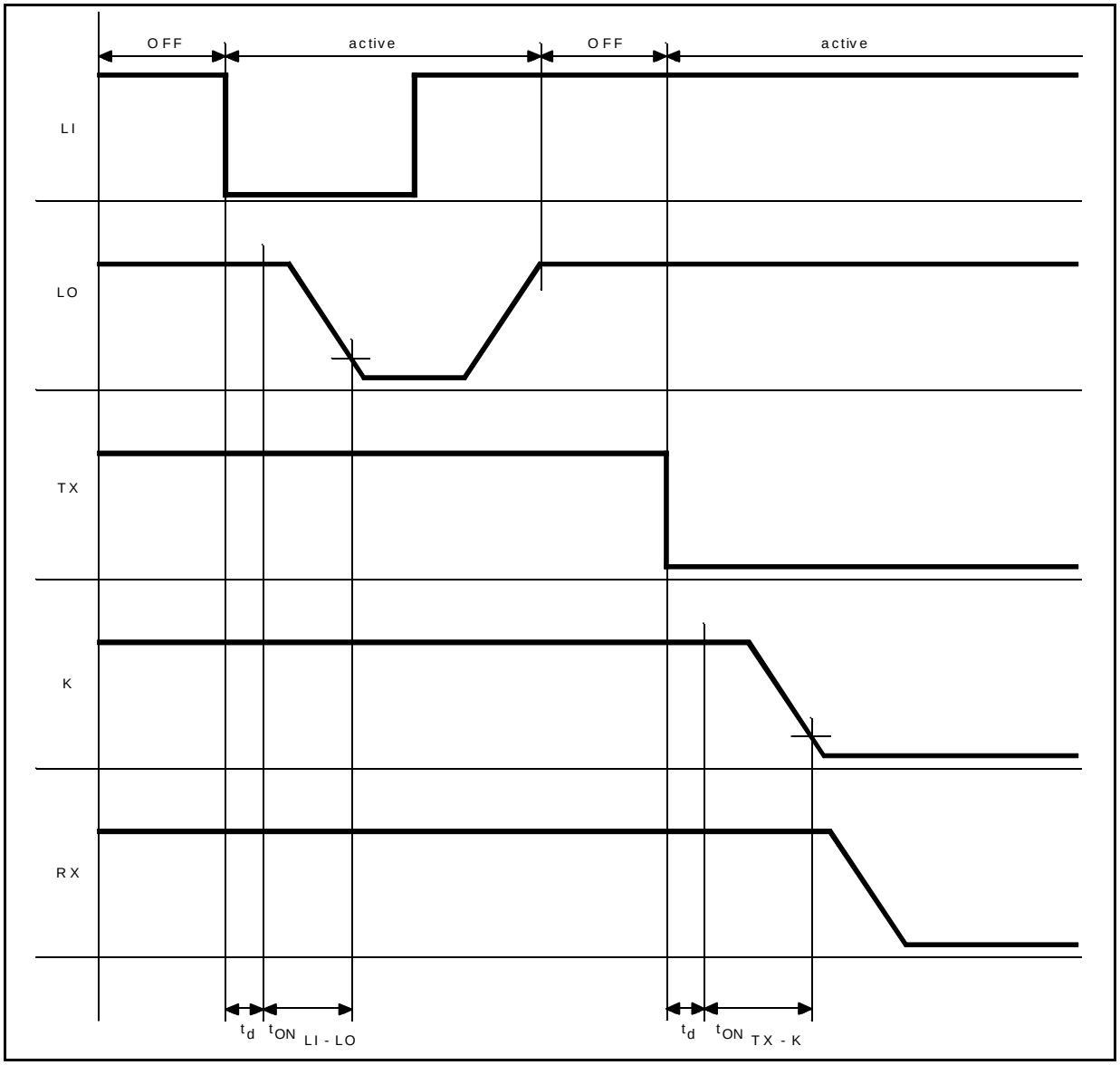


**Figure 4:** Output Characteristics at K, LO, RX.

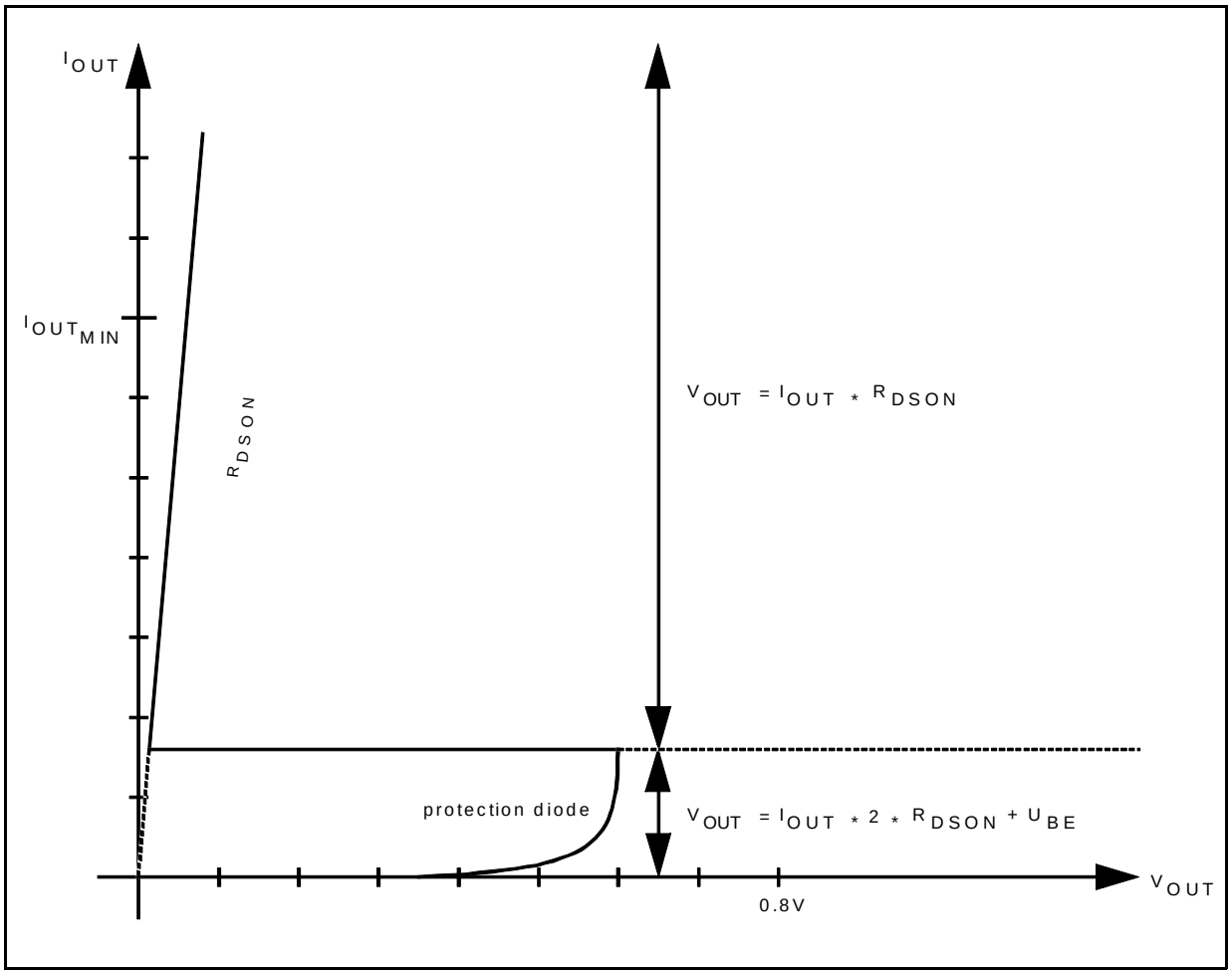



**Figure 5:** Output Signal Shape Related to Output Current.

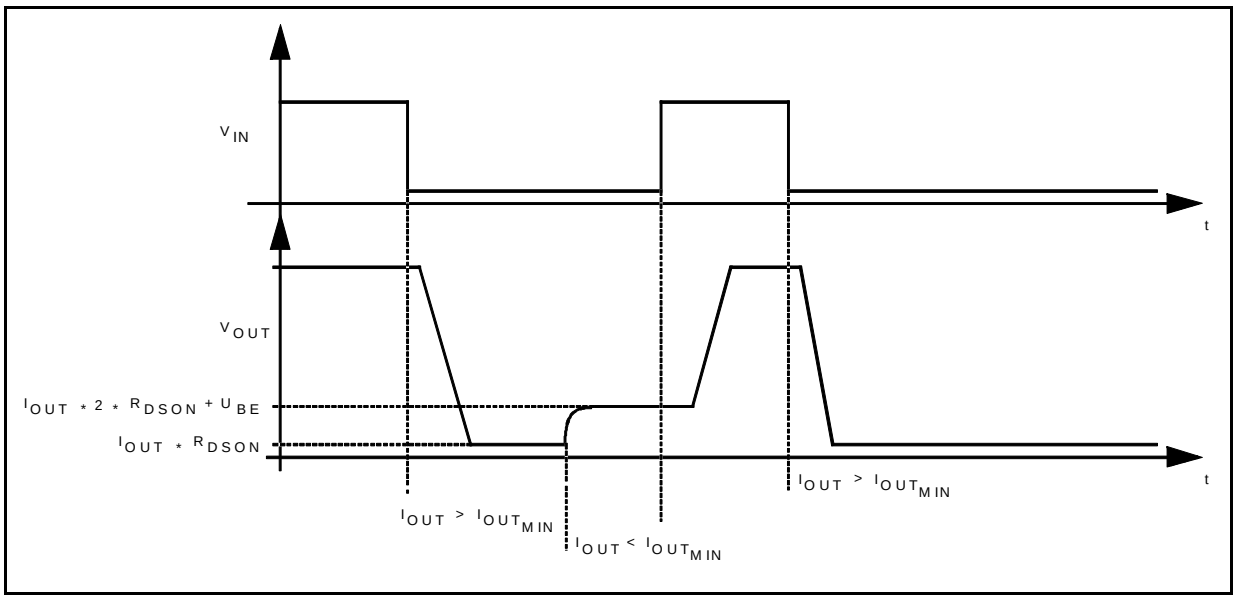


**Figure 6:** EMS Performance (ISO 9141 BUS system).

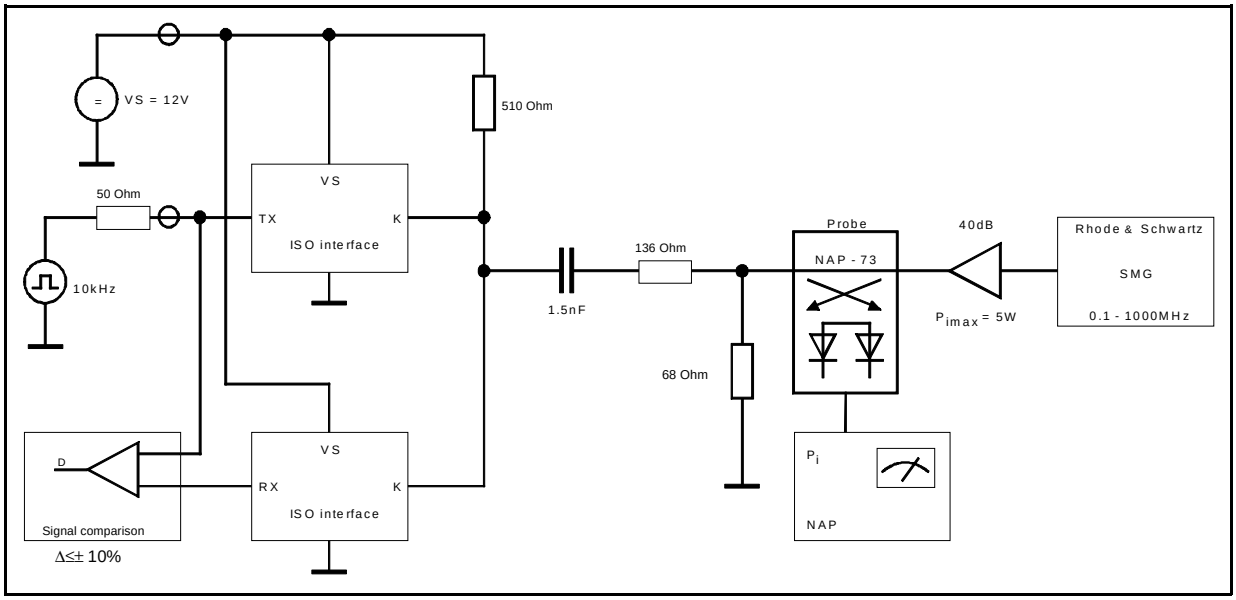
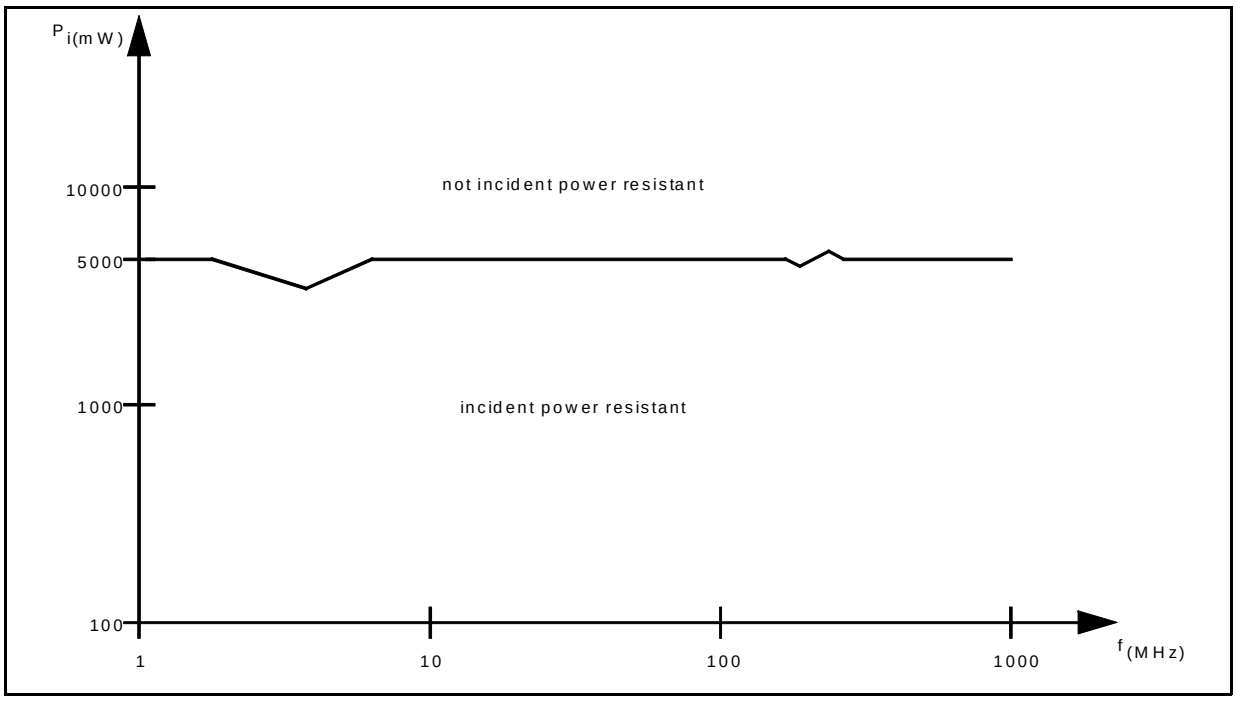


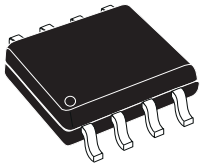

**Figure 7.**



| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.069 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.65 | | | 0.065 |
| a3 | 0.65 | | 0.85 | 0.026 | | 0.033 |
| b | 0.35 | | 0.48 | 0.014 | | 0.019 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | 0.25 | | 0.5 | 0.010 | | 0.020 |
| c1 | 45° (typ.) | | | | | |
| D (1) | 4.8 | | 5.0 | 0.189 | | 0.197 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 3.81 | | | 0.150 | |
| F (1) | 3.8 | | 4.0 | 0.15 | | 0.157 |
| L | 0.4 | | 1.27 | 0.016 | | 0.050 |
| M | | | 0.6 | | | 0.024 |
| S | 8° (max.) | | | | | |

(1) D and F do not include mold flash or protrusions. Mold flash or potrusions shall not exceed 0.15mm (.006inch).

## OUTLINE AND MECHANICAL DATA



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