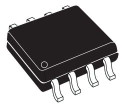
L9613

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 ≥ 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

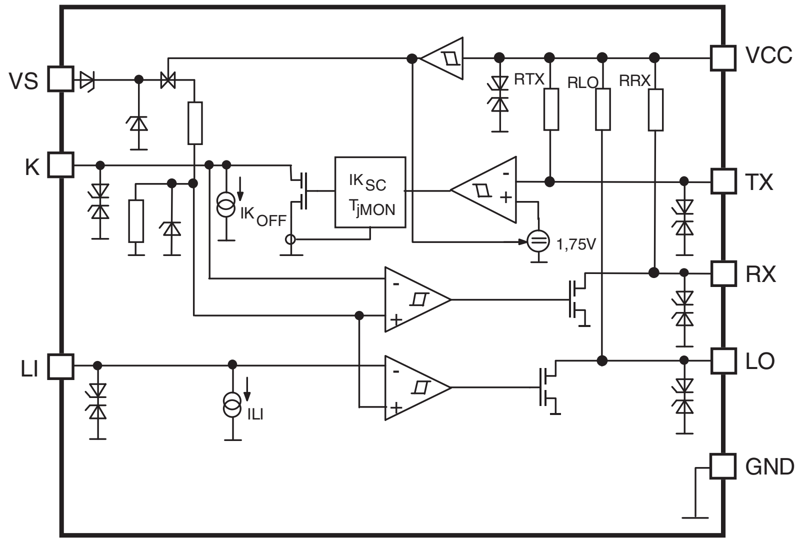
Order code	Package	Packing
L9613B	SO8	Tube
L9613B013TR	SO8	Tape and reel

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)

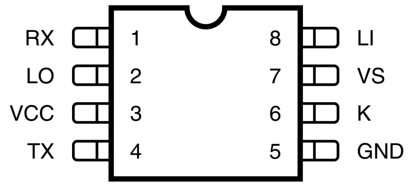


Table 2. Pin description

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 ISO transients t ≤ 400 ms	-24 to +36 -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
		$VK \ge VK_{high}$; $VLI \ge VLI_{high}$ VTX = V_{CC} @ $V_{CC} \le 5.5V$	-5	40	150	µA
IS_{ON}	Supply V_S Current	VLI, VTX = 0V $V_{CC} \le 0.5V$ @ $V_S \le 12V$ (1)		3.5 <1	10 50	mA 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} $V_S \geq 8V$ $V_S \geq 6V$	0.2 0.08	$0.05V_S$	1	V
IK_{off}	Input current	@ $VTX \geq VTX_{high}$ V_S, $V_{CC} \geq 0$ or V_S V_{CC} = open or GND = open	-5	4	25	µA
RK_{ON}	Output ON impedance	@ $V_S \geq 6.5V$ $VTX \leq VTX_{low}$ $IK \geq 7mA$ (2)		10	30	Ω
IK_{SC}	Short circuit current	@ $V_S \geq 6.5V$	40	60	150	mA
VK_{sat}	Output saturation voltage	$R_{KO} = 1.5k\Omega$			1	V
VTX_{low}	Input voltage LOW state		-24		1	V
VTX_{high}	Input voltage HIGH state		3.5		V_{CC}	V
RRX_{ON} RLO_{ON}	Output ON impedance	$VK \leq VK_{low}$; $VLI \leq VLI_{low}$ $V_S \geq 6.5V$ $I_{RX, LO} \geq 1mA$		40	90	Ω
VRX_{sat} VLO_{sat}	Saturation output voltage	no external load			1	V
IRX_{SC} ILO_{SC}	Output short circuit current	@ $V_S \geq 6.5V$	9	20	50	mA
RTX	Input pull-up resistance	Output status = (HIGH) $T_{amb} = \leq 85°C$ $-0.15V \leq VLO \leq V_{CC} + 0.15V$ $-0.15V \leq VRX \leq V_{CC} + 0.15V$	5	10	18	kΩ
RTX	Input pull up resistance	$-0.15V \leq VTX \leq V_{CC} + 0.15V$ $T_{amb} = \leq 125°C$	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 V_S, V_{CC} = open or GND = open	-5	4	40	µA
$C_{Ki,LO,RX}$	Internal output capacities				20	pF
f_{LI-LO} f_{K-RX} f_{TX-k}	Transmission frequency	$9V < V_S < 16V$ (external loads) $T_{min} \geq 20 \cdot R_{KO} \cdot C_K$ - 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
$t_{rLI\text{-}LO}$ $t_{rK\text{-}RX}$ $t_{rTX\text{-}K}$	Rise time	for the definition of t_r, t_f see *Figure 6* [3] 9V < V_S < 16V (external loads) $T_{min} \geq 20 \cdot R_{KO} \cdot C_K - K_{line}$		0.4	2	µs
$t_{fLI\text{-}LO}$ $t_{fK\text{-}RX}$ $t_{fTX\text{-}K}$	Fall time			0.4	2	µs
$t_{OFF,LI\text{-}LO}$ $t_{OFF,K\text{-}RX}$ $t_{OFF,TX\text{-}K}$	Switch OFF time	for the definition of ton, t_{OFF} see *Figure 6*. 9V < V_S < 16V (external loads) $T_{min} \geq 20 \cdot R_{KO} \cdot C_K - K_{line}$		1	13	µs
$t_{ON,LI\text{-}LO}$ $t_{ON,K\text{-}RX}$ $t_{ON,TX\text{-}K}$	Switch ON time			1	13	µs
$td_{SB\ ON}$ $td_{SB\ OFF}$	Standby reaction time	VTX = 0V, IK ≥ 7mA VLI = 0V, 9V < VS < 16V see		10 20	20 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. ±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

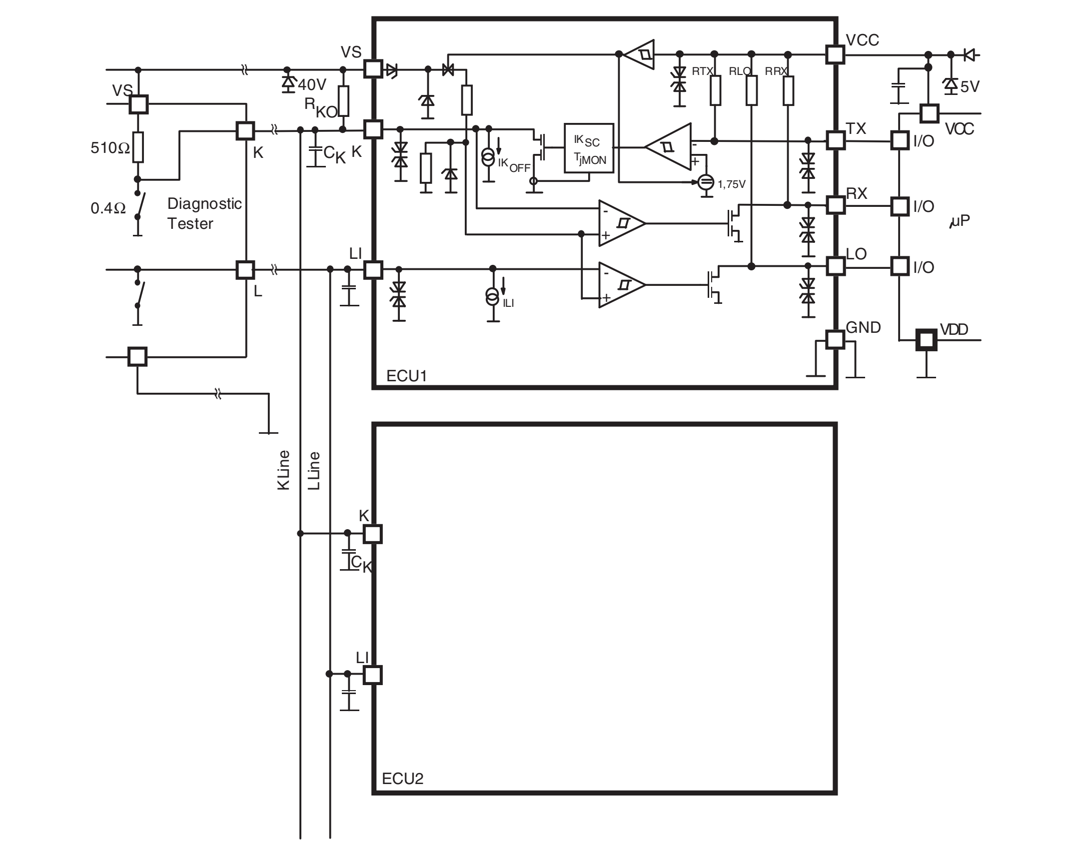


Figure 4. Output characteristics at K, LO, RX

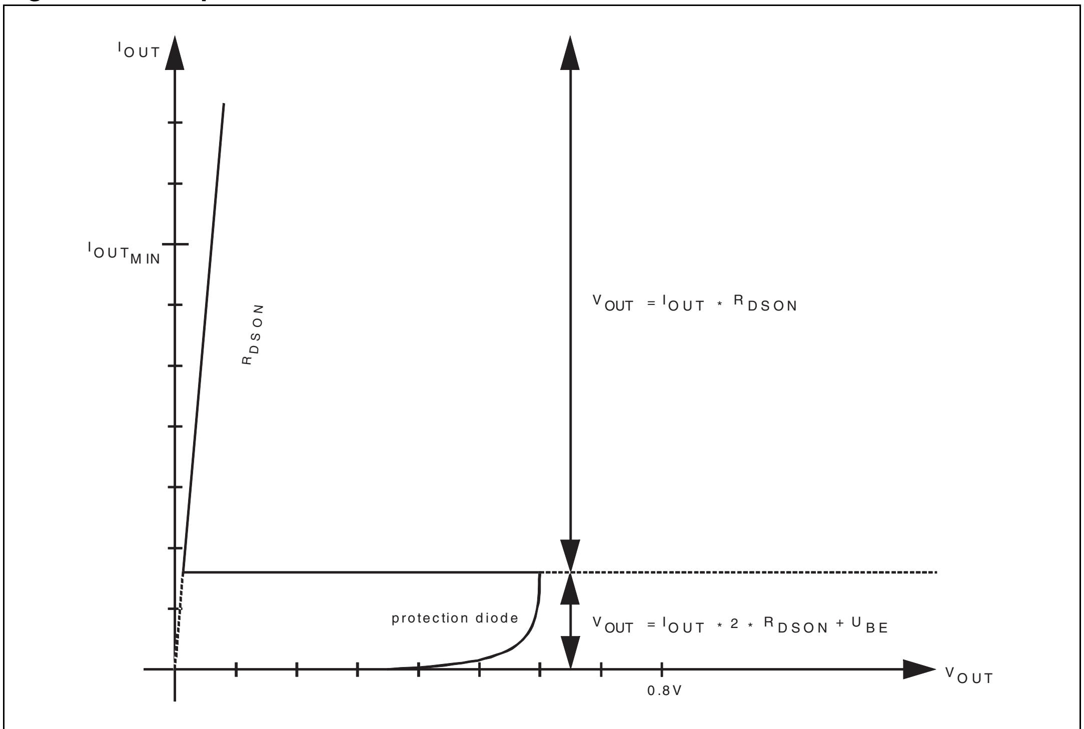


Figure 5. Output signal shape related to output current

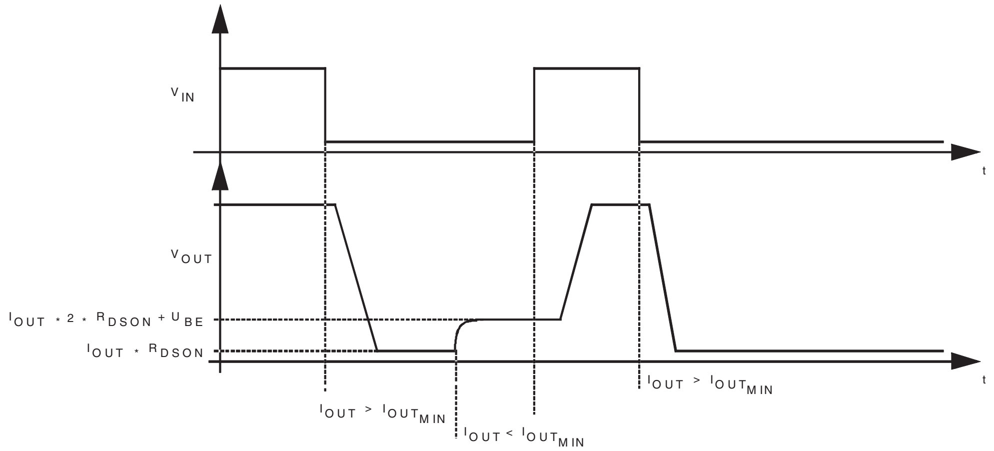


Figure 6. Input to output timings and output pulse shape

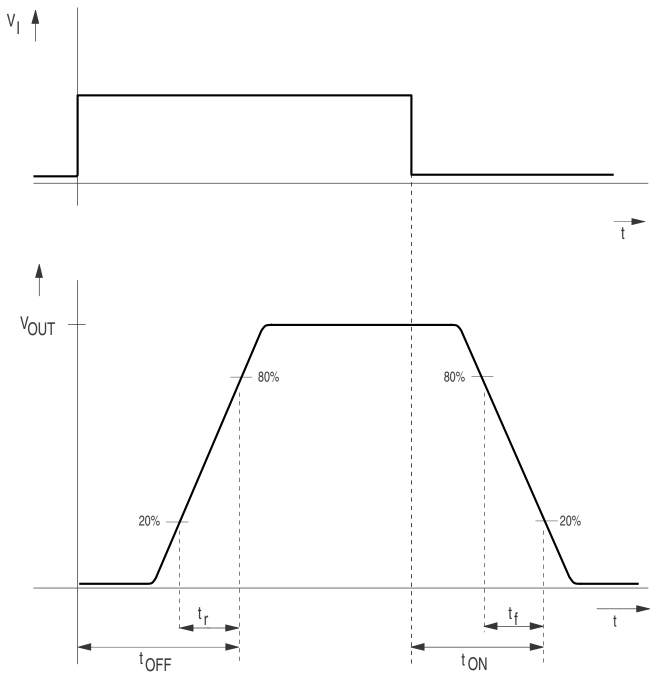


Figure 7. Standby reaction time

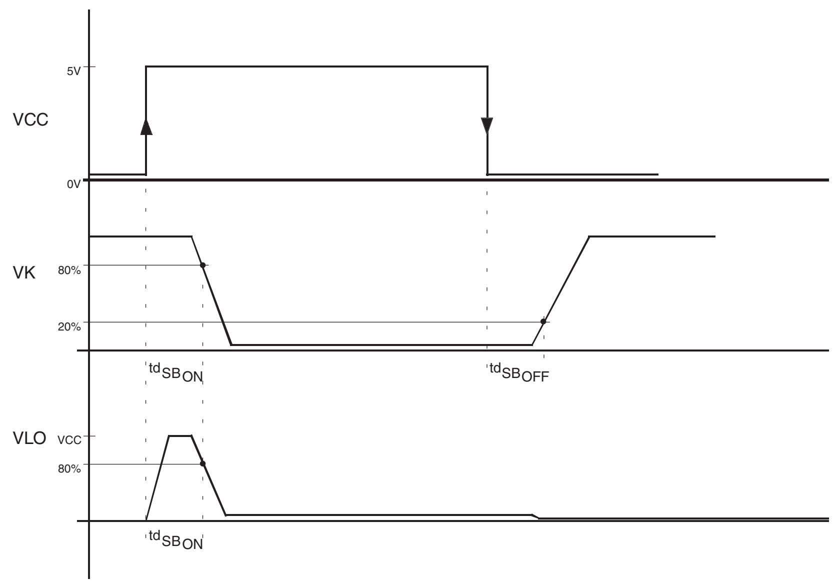


Figure 8. Standby current consumption

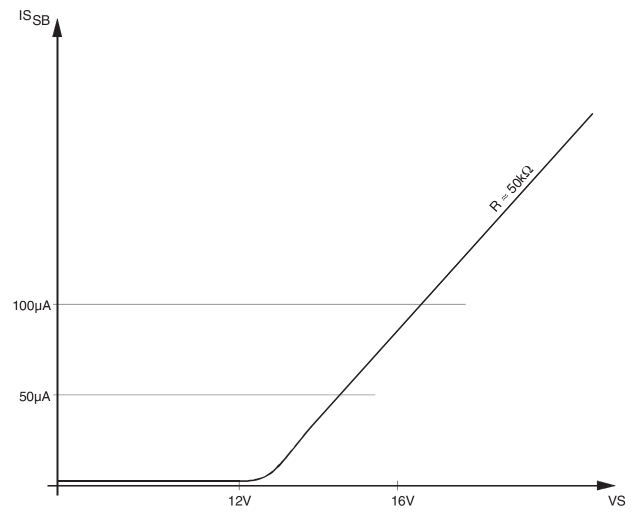


Figure 9. EMS performance (ISO 9141 BUS system) diagram

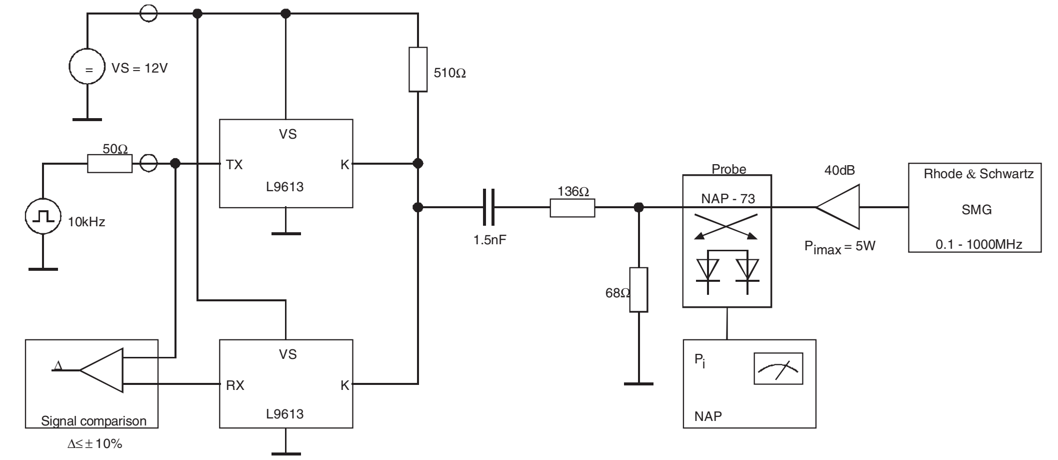
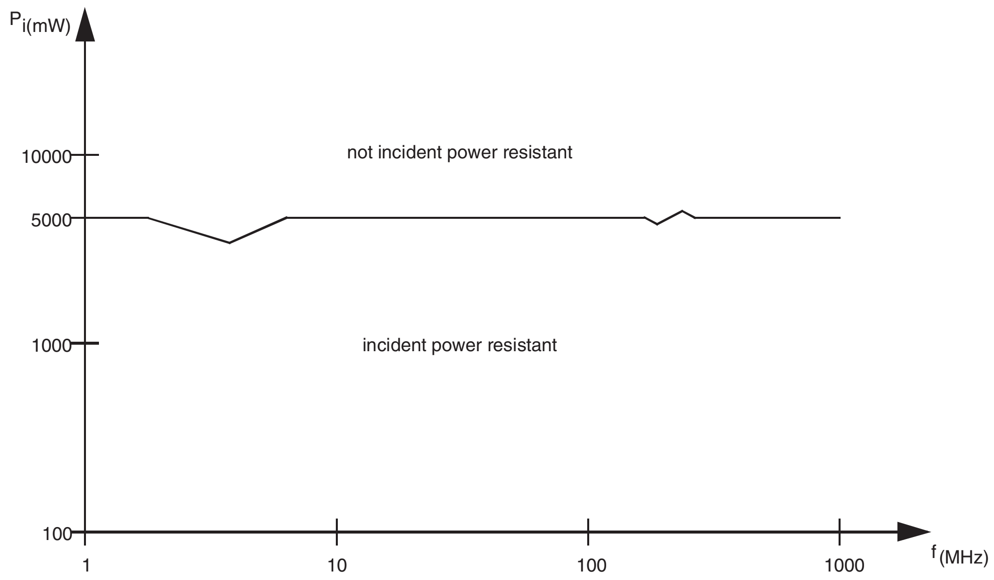


Figure 10. EMS rejection frequency vs. power



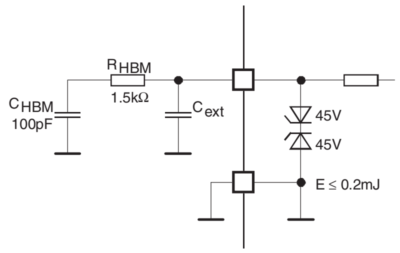
3.1 ESD application hints

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:

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

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.

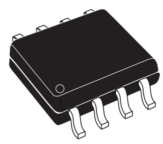
ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

Figure 12. SO8 mechanical data and package dimensions

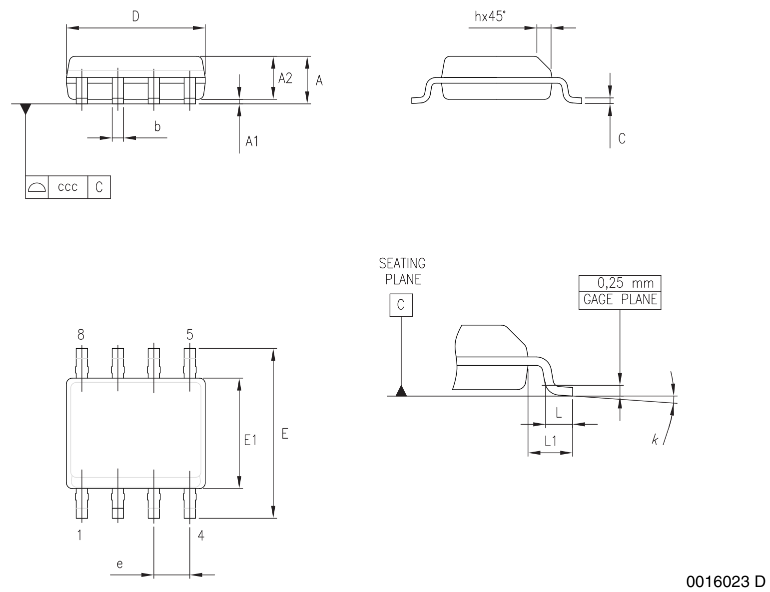
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.750			0.0689
A1	0.100		0.250	0.0039		0.0098
A2	1.250			0.0492		
b	0.280		0.480	0.0110		0.0189
c	0.170		0.230	0.0067		0.0091
D (1)	4.800	4.900	5.000	0.1890	0.1929	0.1969
E	5.800	6.000	6.200	0.2283	0.2362	0.2441
E1 (2)	3.800	3.900	4.000	0.1496	0.1535	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



5 Revision history

Table 6. Document revision history

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

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