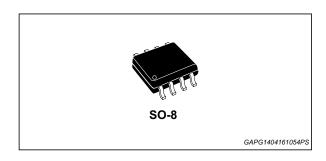


### Automotive high speed CAN bus transceiver

#### Datasheet - production data



#### **Features**



- AEC-Q100 qualified
- ISO/DIS 11898 up to 1 Mbaud

This is information on a product in full production.

- Transmitter:
  - Generation of differential output signals
  - Short circuit protected from -5 V to 36 V, detection and shutdown

- Slope control to reduce RFI and EMI
- Two states adjustable slope control (≤1 Mbaud / ≤250 Kbaud)
- Receiver:
  - Differential input with high interference suppression
  - Common mode input voltage range ( $V_{COM}$ ) from -2 V to  $V_S$ +3 V
- ESD protection level up to 4 kV
- Package: SO-8

#### **Description**

The L9616 is a bidirectional transceiver for signal conditioning and processing in connection with a CAN controller. Data rates of up to 1 Mbaud are supported using either shielded or non-shielded pair of lines.

**Table 1. Device summary** 

Order code	Package	Packing
L9616	SO-8	Tube
L9616-TR	SO-8	Tape & Reel

Contents L9616

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L9616 Block diagram

# 1 Block diagram

TXO

ASC

RXO

M

VREF

VCLmax

M

VREF

PROTECTION

TRANSMITTER

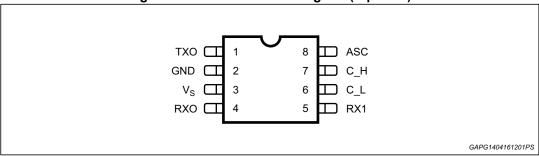
GAPS1404161149PS

Figure 1. Block diagram

Pins description L9616

# 2 Pins description

Figure 2. Pins connection diagram (top view)



**Table 2. Pins function** 

Pin#	Name	Function
1	TXO	Transmitter input
2	GND	Ground
3	Vs	Supply voltage
4	RXO	Receive output
5	RX1	Reference voltage
6	C_L	Low side bus output
7	C_H	High side bus output
8	ASC	Adjustable slope control

## 3 Electrical specifications

### 3.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V <sub>S</sub>	Supply voltage	-0.3 to 7	V
V <sub>C_H</sub> , V <sub>C_L</sub>	Bus voltage at C_H, C_L (V <sub>S</sub> = 0 to 5.5 V)	-5 to 36	V
I <sub>C_H</sub> , I <sub>C_L</sub>	Off state leakage current at C_H, C_L ( $V_S$ = 0 to 5.5 V, $V_{C_H}$ = -5 to 36 V, $V_{C_L}$ = -5 to 36 V)	-3 to 5	mA
V <sub>DC</sub>	DC voltage at TXO, ASC (V <sub>S</sub> = 0 to 5.5 V)	GND -0.3 to Vs +0.3	V
I <sub>RXO</sub>	Output current at RXO (V <sub>S</sub> = 0 to 5.5 V)	-0.3 to 1	mA
T <sub>stg</sub> , T <sub>J</sub>	Storage and junction temperature range	-40 to 150	°C
T <sub>op</sub>	Operating temperature range	-40 to 125	°C

Note: All voltages, except bus voltage, are defined with respect to pin 2.

Positive currents flow into the IC.

#### 3.2 Electrical characteristics

 $T_{OP}$  = -40 to 125 °C;  $V_S$  = 4.5 to 5.5 V; Dominant: VTXO = GND; Recessive: VTXO =  $V_S$ ; All voltages, except bus voltage, are defined with respect to pin 2. Positive currents flow into the IC unless otherwise specified.

**Table 4. Electrical characteristics** 

Symbol	Parameter	Test condition	Min.	Тур.	Max.	Unit
V <sub>S</sub>	Supply voltage	-	4.5	5	5.5	V
l <sub>a</sub>	Supply current	Dominant	-	-	80	mA
I <sub>S</sub>	Зарріу сапені	Recessive	-	-	20	mA
Transmitter Section ( $R_A = 60 \Omega$ between C_H and C_L)						
C <sub>TXO</sub>	TXO input capacitance	0 V < V <sub>TXO</sub> < V <sub>S</sub>	-	25	-	pF
V <sub>TXO</sub>	TXO high level input voltage	-	0.7 V <sub>S</sub>	-	V <sub>S</sub>	-
V TXO	TXO low level input voltage	-	0	-	0.3 V <sub>S</sub>	-
les ce	TXO high level input current	$V_{TXO} = V_{S}$	-2	0	2	μΑ
I <sub>TXO</sub>	TXO low level input current	V <sub>TXO</sub> = GND	-275	0	-25	μΑ
C <sub>ASC</sub>	ASC input capacitance	0 V < V <sub>ASC</sub> < V <sub>S</sub>	-	25	-	pF



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Table 4. Electrical characteristics (continued)

	Table 4. Electrical characteristics (continued)						
Symbol	Parameter	Test condition	Min.	Тур.	Max.	Unit	
V <sub>ASC</sub>	ASC input voltage for high speed	-	0	-	0.1 V <sub>S</sub>	-	
	ASC input voltage for low speed	-	0.9 V <sub>S</sub>	-	V <sub>S</sub>	-	
1	ASC input current	V <sub>ASC</sub> = V <sub>S</sub>	25	-	275	μA	
I <sub>ASC</sub>	AGC input current	V <sub>ASC</sub> = 0 V	-2	0	2	μΑ	
$V_{C\_H}, V_{C\_L}$	Bus voltage recessive	Recessive	0.4 V <sub>S</sub>	0.5 V <sub>S</sub>	0.6 V <sub>S</sub>	-	
la la .	Leakage current recessive	$V_{C_L} = V_{C_H} = -2 \text{ to } 7 \text{ V}$	-0.7	-	0.7	mA	
I <sub>С_Н</sub> , I <sub>С_L</sub>	Leakage current recessive	V <sub>C_L</sub> = V <sub>C_H</sub> = 1 to 4 V	-0.3	-	0.3	mA	
R <sub>IN(C_H, C_L)</sub>	Input resistance	Recessive	5	-	50	kΩ	
R <sub>Diff(C_H, C_L)</sub>	Differential input resistance	Recessive	10	-	100	kΩ	
V <sub>Diff</sub> = V <sub>C H</sub> -	Differential output voltage	Dominant, R <sub>A</sub>	1.5	-	3	V	
V <sub>C_L</sub>	Differential output voltage	Recessive	-500	0	50	mV	
t <sub>d</sub>	Short circuit detection time C_H to C_L; C_H to B	R <sub>CS</sub> < 1 Ω	1	5	10	μS	
I <sub>A</sub>	Supply current in case of short circuit, C_H to C_L, C_H to B (time = $t_d$ )	-	-	150	-	mA	
V <sub>C_Lmax</sub>	Overvoltage protection threshold on C_L	-	7	8	10	V	
Receive sectio	n						
V <sub>RXO</sub>	RXO high level output voltage	$V_{\rm Diff}$ < 0.5 V; $I_{\rm RXO}$ = 0.3 mA; $V_{\rm C\_H}$ = -2 to 7 V; $V_{\rm C\_L}$ = -2 to 7 V;	0.9 Vs	-	V <sub>s</sub>	V	
-	RXO low level output voltage	$V_{Diff} > 0.9 \text{ V; } I_{RXO} = 1 \text{ mA;}$ $V_{C\_H} = -2 \text{ to } 7 \text{ V; } V_{C\_L} = -2 \text{ to } 7 \text{ V;}$	-	-	0.5	V	
V <sub>S</sub> = V <sub>C_H</sub> - V <sub>C_L</sub>	Input signal threshold	$V_{C_H} = -2 \text{ to } 7 \text{ V}; V_{C_L} = -2 \text{ to } 7 \text{ V}$	500	700	900	mV	
$V_{COM} = (V_{C_H} + V_{C_L})/2$	Input common mode voltage range	-	-2	-	7	V	
V <sub>HYS</sub>	Differential input hysteresis	-	ı	150	-	mV	
REFERENCE C	REFERENCE OUTPUT						
V <sub>RX1</sub>	Reference voltage	I <sub>RX1</sub> = 0	0.45 V <sub>S</sub>	0.5 V <sub>S</sub>	0.55 V <sub>S</sub>	V	
R <sub>RX1</sub>	Output resistance	-	2	-	9	kΩ	
	1						

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## 3.3 Dynamic characteristics

 $C_A$  = 47 pF between C\_H and C\_L;  $V_S$  = 5 V;  $t_R$  < 5 ns;  $C_{RXO}$  = 20pF between RXO and B;  $R_A$  = 60  $\Omega$  between C\_H and C\_L.

**Table 5. Dynamic characteristics** 

Symbol	Parameter	Test Condition	Min.	Тур.	Max.	Unit
t <sub>OT</sub>	Signal Delay TXO to C_H, C_L	-	-	-	50	ns
S <sub>R</sub>	Differential Output Slew Rate	V <sub>ASC</sub> = 0 V	20	-	50	V/µs
	(Transmitter)	V <sub>ASC</sub> = V <sub>S</sub>	5	-	20	V/µs
t <sub>OR</sub>	Signal Delay C_H, C_L to Rxo	V <sub>ASC</sub> = 0 V	-	-	150	ns
t <sub>OTR</sub>	Signal Delay Txo to Rxo	V <sub>ASC</sub> = 0V	-	-	300	ns



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#### **Functional description** 4

The L9616 is used as an interface between a CAN controller and the physical bus. The device provides transmitting capability to the CAN controller.

The transmitter outputs C H and C L are protected against short circuits and electrical transients which may occur in an automotive environment.

In case of short circuit (C H to C L, C H to B) the protection circuit recognizes this fault condition and the transmitter output stages are disabled with a delay of max. 10 ms to prevent destruction of the IC and high consumption of supply current I<sub>S</sub>. If  $V_{C\ L} > V_{C\ L\ max}$ the transmitter output stages would be disabled immediately.

Pin ASC makes it possible to select two different modes of operation: high speed (≤ 1 Mbaud) and low speed (≤ 250 kbaud).

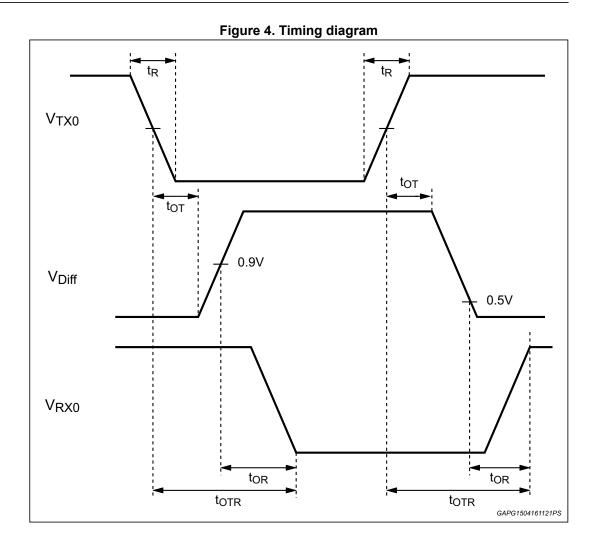
The ASC pin is tied to GND for normal operation at ≤ 1 Mbaud. For slower speed operation at ≤ 250 kbaud the rise and fall slope of the bus output can be decreased to reduce EMI by connecting the ASC pin to V<sub>S</sub>.

**Table 6. Functional table** 

**TXO** C\_H C\_L **Bus state RXO** L Η L L Dominant H or Floating Floating Vs/2 Floating Vs/2 Recessive

SYSTEM n SYSTEM m CAN BUS CONTROLLER CONTROLLER L9616 L9616  $V_{GNDn}$ V<sub>GNDm</sub> LV<sub>GNDm</sub> GAPG1504161116PS

Figure 3. Typical application

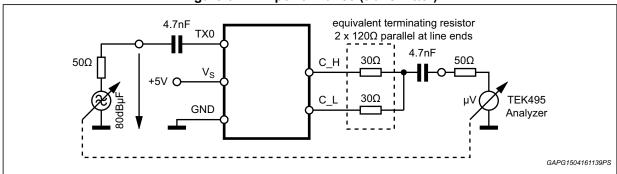




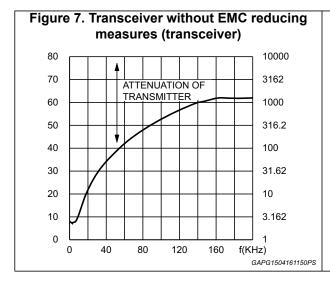
EQUIVALENT TERMINATING RESISTOR 2 x 120Ω PARALLEL AT LINE ENDS 6.8µF 30Ω CAN CAN 450Ω CONTROLLER TRANSCELVER \_\_\_\_250kbit/sec Ust (Noise signal) MONITORING 100Ω (BIT COMPARISON) 40dB HP8640 CAN 6.8µF CAN 90%AM, 1kHz CONTROLLER TRANSCELVER \_\_\_\_250kbit/sec NOT NOISE RESISTANT 30V<sub>SS</sub> NOISE RESISTANT  $20V_{SS}$ min. request boundary (automotive industry)  $10V_{\rm SS}$ 1MHz 500MHz 1GHz 10MHz 100MHz GAPG1504161127PS

Figure 5. EMC performance (receiver)





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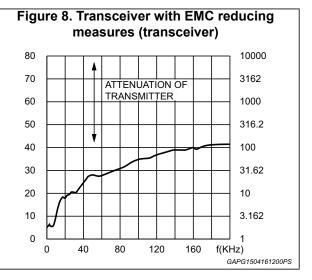
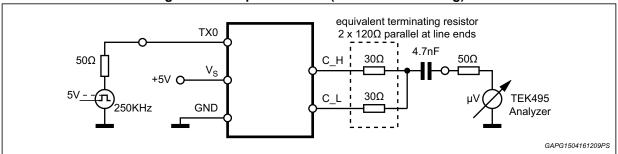
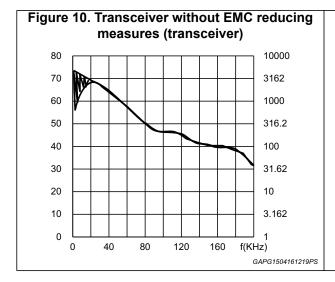
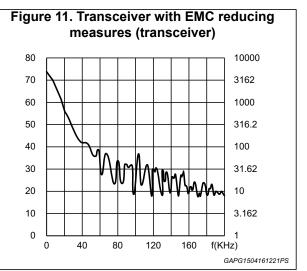


Figure 9. EMC performance (transceiver sending)







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Package information L9616

## 5 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: <a href="https://www.st.com">www.st.com</a>. ECOPACK® is an ST trademark.

### 5.1 SO-8 package information

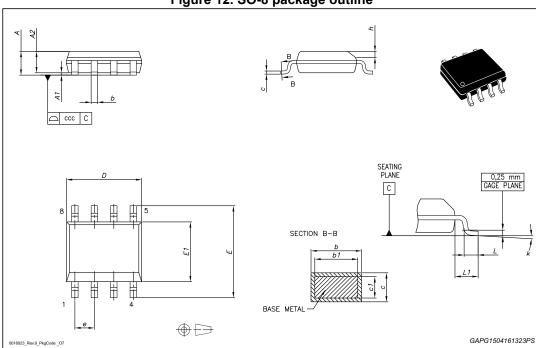


Figure 12. SO-8 package outline

L9616 Package information

Table 7. SO-8 package mechanical data

	Dimensions						
Ref	Millimeters			Inches <sup>(1)</sup>			
	Min.	Тур.	Max.	Min.	Тур.	Max.	
Α	-	-	1.75	-	-	0.0689	
A1	0.1	-	0.25	0.0039	-	0.0098	
A2	1.25	-	-	0.0492	-	-	
b	0.28	-	0.48	0.0110	-	0.0189	
С	0.17	-	0.23	0.0067	-	0.0091	
D <sup>(2)</sup>	4.8	4.9	5	0.1890	0.1929	0.1969	
Е	5.8	6	6.2	0.2283	0.2362	0.2441	
E1 <sup>(3)</sup>	3.8	3.9	4	0.1496	0.1535	0.1575	
е	-	1.27	-	-	0.0500	-	
h	0.25	-	0.5	0.0098	-	0.0197	
L	0.4	-	1.27	0.0157	-	0.0500	
L1	-	1.04	-	-	0.0409	-	
k	-	-	8	-	-	0.3150	
ccc	-	-	0.1	-	-	0.0039	

<sup>1.</sup> Values in inches are converted from mm and rounded to 4 decimal digits.

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Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15mm in total (both side).

<sup>3.</sup> Dimension "E1" does not include inter-lead flash or protrusions. Inter lead flash or protrusions shall not exceed 0.25mm per side.

Revision history L9616

# 6 Revision history

**Table 8. Document revision history** 

Date	Revision	Changes	
11-Jun-2008	1 Initial release.		
27-Sep-2013	2	Updated disclaimer.	
14-Jun-2016	3	Modified title in cover page.  Added bullet "AEC-Q100 qualified" in cover page.  Updated order codes in <i>Table 1: Device summary on page 1.</i> Updated <i>Section 5: Package information on page 14.</i>	



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