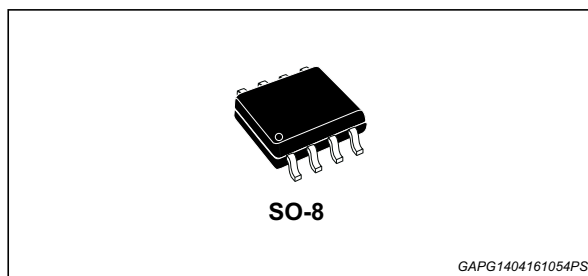


## Automotive high speed CAN bus transceiver

Datasheet - production data



### Features

- AEC-Q100 qualified
- ISO/DIS 11898 up to 1 Mbaud
- 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 ( $\leq 1$  Mbaud /  $\leq 250$  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 |

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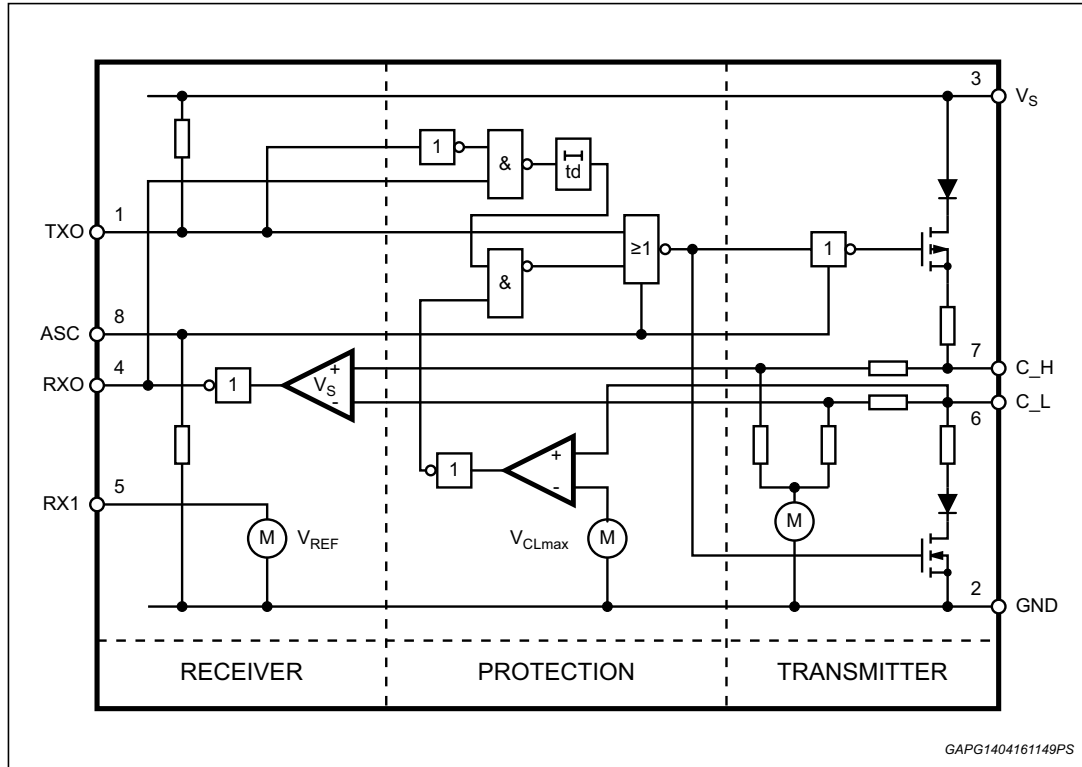
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# 1 Block diagram

Figure 1. Block diagram



## 2 Pins description

Figure 2. Pins connection diagram (top view)

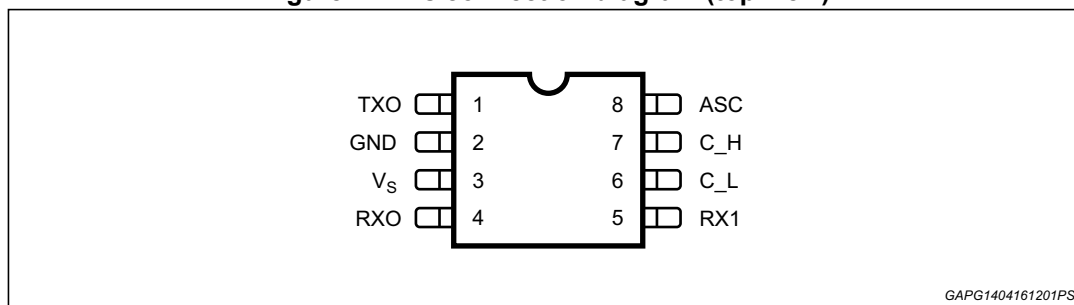


Table 2. Pins function

| Pin # | Name           | Function                 |
|-------|----------------|--------------------------|
| 1     | TXO            | Transmitter input        |
| 2     | GND            | Ground                   |
| 3     | V <sub>S</sub> | Supply voltage           |
| 4     | RXO            | Receive output           |
| 5     | RX1            | Reference voltage        |
| 6     | C <sub>L</sub> | Low side bus output      |
| 7     | C <sub>H</sub> | 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 |
|----------------------|---|-------------------------|------|
| $V_S$                | Supply voltage  | -0.3 to 7               | V    |
| $V_{C\_H}, V_{C\_L}$ | Bus voltage at C_H, C_L ( $V_S = 0$ to 5.5 V)   | -5 to 36                | V    |
| $I_{C\_H}, I_{C\_L}$ | 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   |
| $V_{DC}$             | DC voltage at TXO, ASC ( $V_S = 0$ to 5.5 V)  | GND -0.3 to $V_S + 0.3$ | V    |
| $I_{RXO}$            | Output current at RXO ( $V_S = 0$ to 5.5 V)   | -0.3 to 1               | mA   |
| $T_{stg}, T_J$       | Storage and junction temperature range  | -40 to 150              | °C   |
| $T_{op}$             | 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:  $V_{TXO} = GND$ ; Recessive:  $V_{TXO} = V_S$ ; 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.      | Typ. | Max.      | Unit    |
|---|------------------------------|-----------------------|-----------|------|-----------|---------|
| $V_S$   | Supply voltage               | -                     | 4.5       | 5    | 5.5       | V       |
| $I_S$   | Supply current               | Dominant              | -         | -    | 80        | mA      |
|   |                              | Recessive             | -         | -    | 20        | mA      |
| <b>Transmitter Section (<math>R_A = 60 \Omega</math> between C_H and C_L)</b> |                              |                       |           |      |           |         |
| $C_{TXO}$   | TXO input capacitance        | $0 V < V_{TXO} < V_S$ | -         | 25   | -         | pF      |
| $V_{TXO}$   | TXO high level input voltage | -                     | $0.7 V_S$ | -    | $V_S$     | -       |
|   | TXO low level input voltage  | -                     | 0         | -    | $0.3 V_S$ | -       |
| $I_{TXO}$   | TXO high level input current | $V_{TXO} = V_S$       | -2        | 0    | 2         | $\mu A$ |
|   | TXO low level input current  | $V_{TXO} = GND$       | -275      | 0    | -25       | $\mu A$ |
| $C_{ASC}$   | ASC input capacitance        | $0 V < V_{ASC} < V_S$ | -         | 25   | -         | pF      |

Table 4. Electrical characteristics (continued)

| Symbol  | Parameter  | Test condition  | Min.                | Typ.               | 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>      | -    |
| I <sub>ASC</sub>  | ASC input current  | V <sub>ASC</sub> = V <sub>S</sub>   | 25                  | -                  | 275                 | μA   |
|   |  | V <sub>ASC</sub> = 0 V  | -2                  | 0                  | 2                   | μA   |
| V <sub>C_H</sub> , V <sub>C_L</sub>                         | Bus voltage recessive  | Recessive   | 0.4 V <sub>S</sub>  | 0.5 V <sub>S</sub> | 0.6 V <sub>S</sub>  | -    |
| I <sub>C_H</sub> , I <sub>C_L</sub>                         | Leakage current recessive  | V <sub>C_L</sub> = V <sub>C_H</sub> = -2 to 7 V   | -0.7                | -                  | 0.7                 | mA   |
|   |  | 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> - V <sub>C_L</sub>     | Differential output voltage  | Dominant, R <sub>A</sub>  | 1.5                 | -                  | 3                   | V    |
|   |  | Recessive   | -500                | 0                  | 50                  | mV   |
| t <sub>d</sub>  | Short circuit detection time<br>C <sub>H</sub> to C <sub>L</sub> ; C <sub>H</sub> to B                                   | R <sub>CS</sub> < 1 Ω   | 1                   | 5                  | 10                  | μs   |
| I <sub>A</sub>  | Supply current in case of short circuit, C <sub>H</sub> to C <sub>L</sub> , C <sub>H</sub> to B (time = t <sub>d</sub> ) | -   | -                   | 150                | -                   | mA   |
| V <sub>C_Lmax</sub>   | Overvoltage protection threshold on C <sub>L</sub>   | -   | 7                   | 8                  | 10                  | V    |
| <b>Receive section</b>                                      |  |   |                     |                    |                     |      |
| V <sub>RXO</sub>  | RXO high level output voltage  | V <sub>Diff</sub> < 0.5 V; I <sub>RXO</sub> = 0.3 mA; V <sub>C_H</sub> = -2 to 7 V; V <sub>C_L</sub> = -2 to 7 V; | 0.9 V <sub>S</sub>  | -                  | V <sub>S</sub>      | V    |
| -   | RXO low level output voltage   | V <sub>Diff</sub> > 0.9 V; I <sub>RXO</sub> = 1 mA; V <sub>C_H</sub> = -2 to 7 V; V <sub>C_L</sub> = -2 to 7 V;   | -                   | -                  | 0.5                 | V    |
| V <sub>S</sub> = V <sub>C_H</sub> - V <sub>C_L</sub>        | Input signal threshold   | V <sub>C_H</sub> = -2 to 7 V; V <sub>C_L</sub> = -2 to 7 V  | 500                 | 700                | 900                 | mV   |
| V <sub>COM</sub> = (V <sub>C_H</sub> + V <sub>C_L</sub> )/2 | Input common mode voltage range  | -   | -2                  | -                  | 7                   | V    |
| V <sub>HYS</sub>  | Differential input hysteresis  | -   | -                   | 150                | -                   | mV   |
| <b>REFERENCE OUTPUT</b>                                     |  |   |                     |                    |                     |      |
| 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   |



### 3.3 Dynamic characteristics

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

**Table 5. Dynamic characteristics**

| Symbol    | Parameter                                   | Test Condition  | Min. | Typ. | Max. | Unit       |
|-----------|---|-----------------|------|------|------|------------|
| $t_{OT}$  | Signal Delay TXO to C_H, C_L                | -               | -    | -    | 50   | ns         |
| $S_R$     | Differential Output Slew Rate (Transmitter) | $V_{ASC} = 0$ V | 20   | -    | 50   | V/ $\mu$ s |
|           |   | $V_{ASC} = V_S$ | 5    | -    | 20   | V/ $\mu$ s |
| $t_{OR}$  | Signal Delay C_H, C_L to RXO                | $V_{ASC} = 0$ V | -    | -    | 150  | ns         |
| $t_{OTR}$ | Signal Delay TXO to RXO                     | $V_{ASC} = 0$ V | -    | -    | 300  | ns         |

## 4 Functional description

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  $I_S$ . 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 ( $\leq 1$  Mbaud) and low speed ( $\leq 250$  kbaud).

The ASC pin is tied to GND for normal operation at  $\leq 1$  Mbaud. For slower speed operation at  $\leq 250$  kbaud the rise and fall slope of the bus output can be decreased to reduce EMI by connecting the ASC pin to  $V_S$ .

Table 6. Functional table

| TXO           | C_H              | C_L              | Bus state | RXO |
|---------------|------------------|------------------|-----------|-----|
| L             | H                | L                | Dominant  | L   |
| H or Floating | Floating $V_S/2$ | Floating $V_S/2$ | Recessive | H   |

Figure 3. Typical application

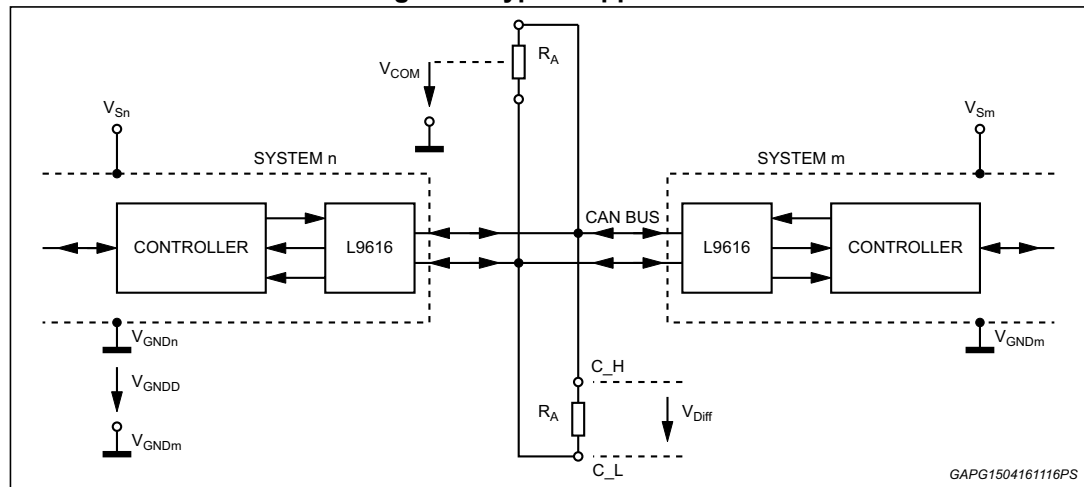


Figure 4. Timing diagram

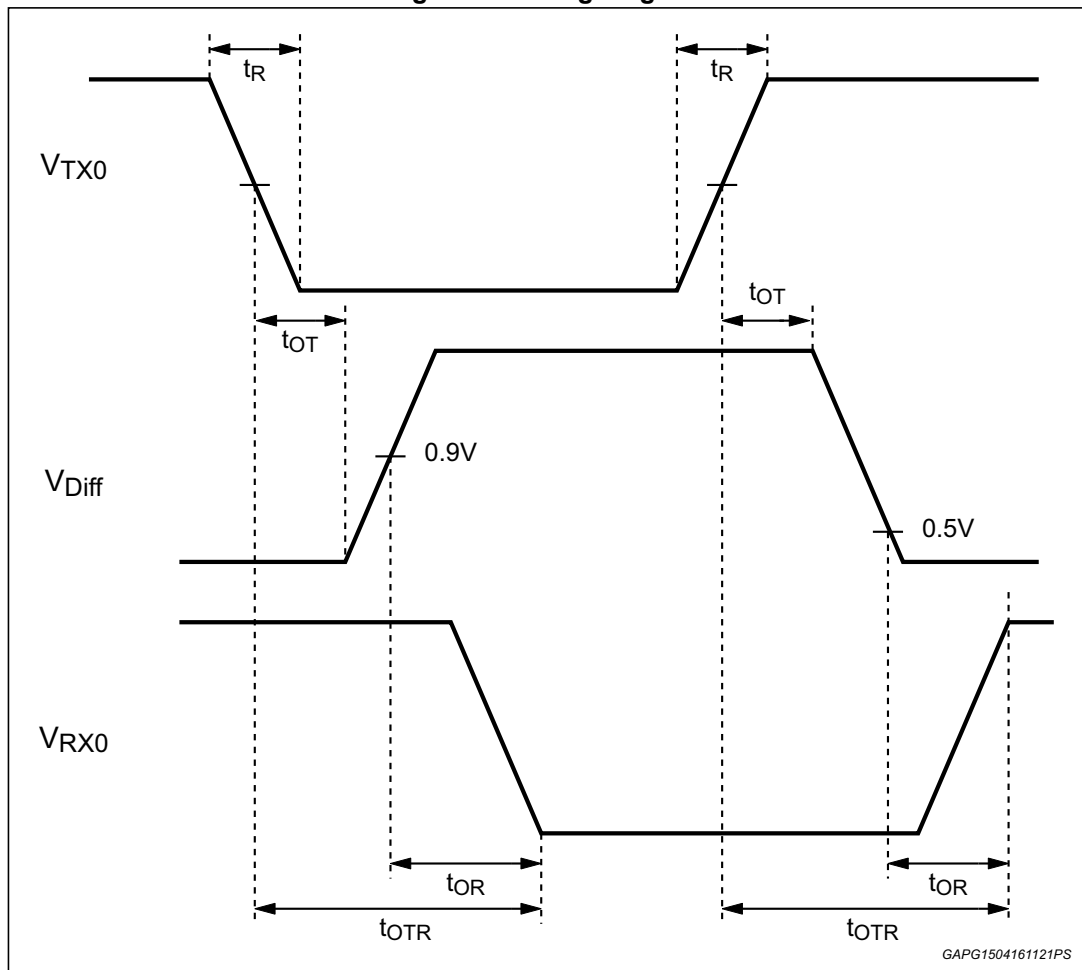


Figure 5. EMC performance (receiver)

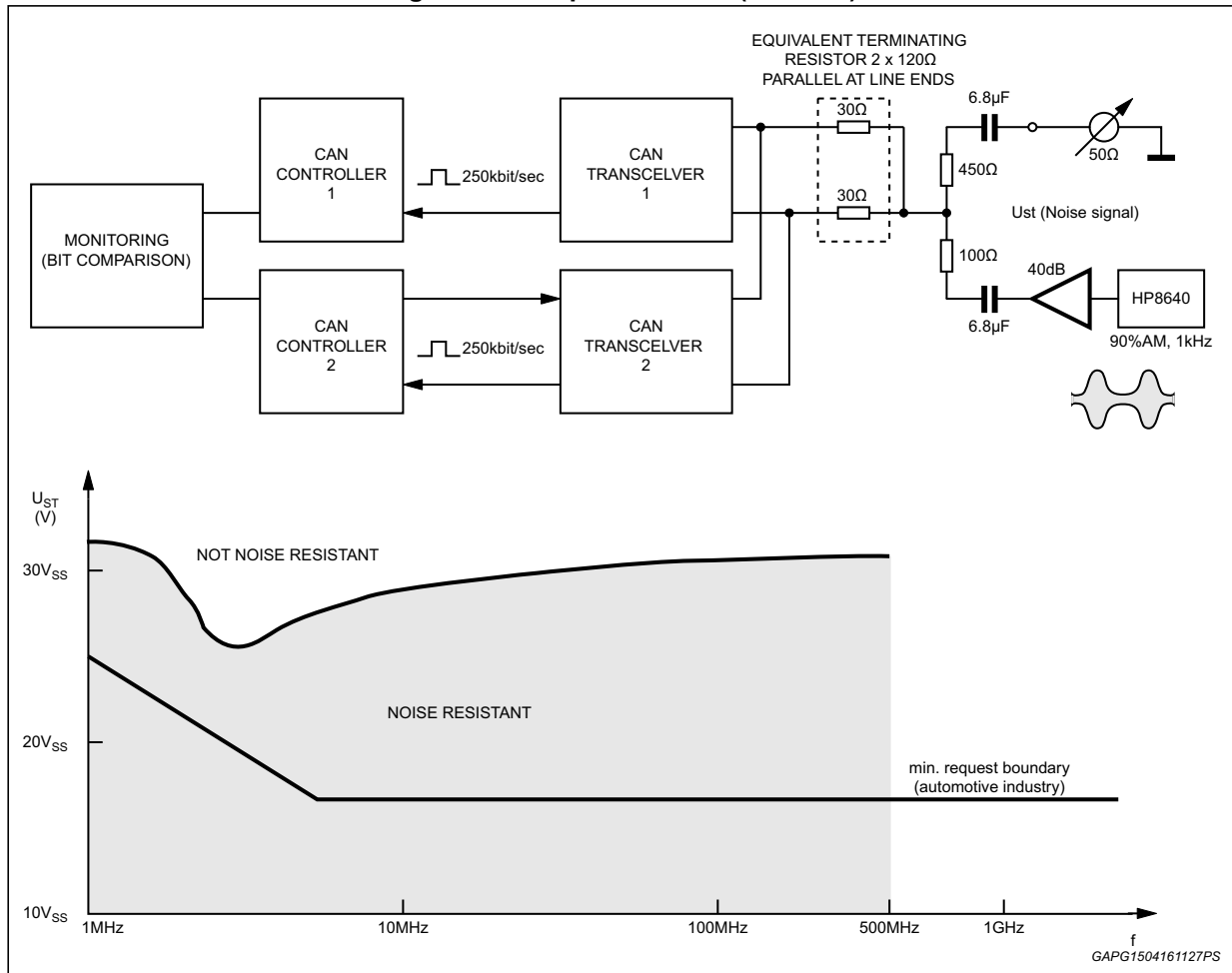
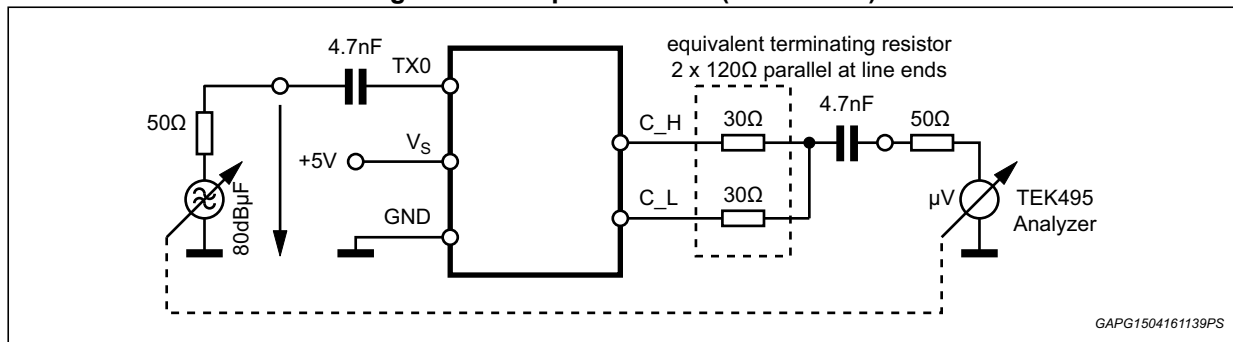
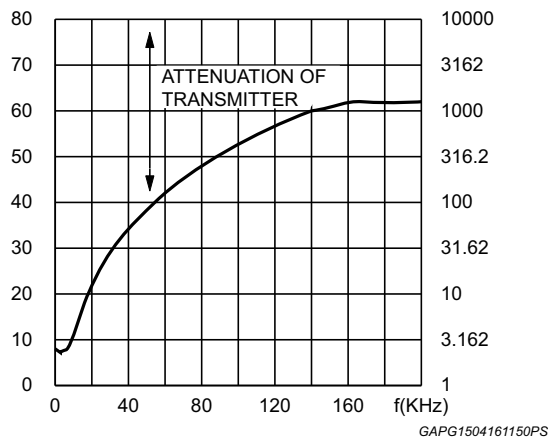


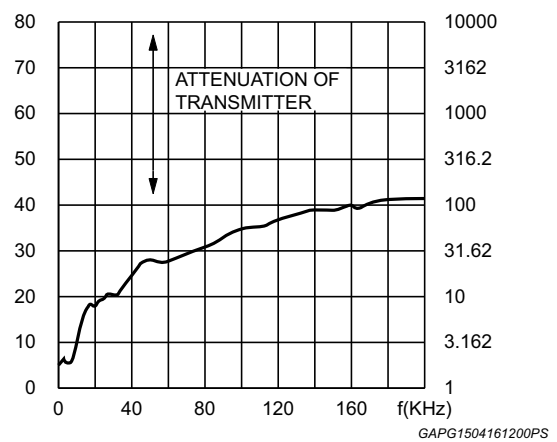
Figure 6. EMC performance (transmitter)



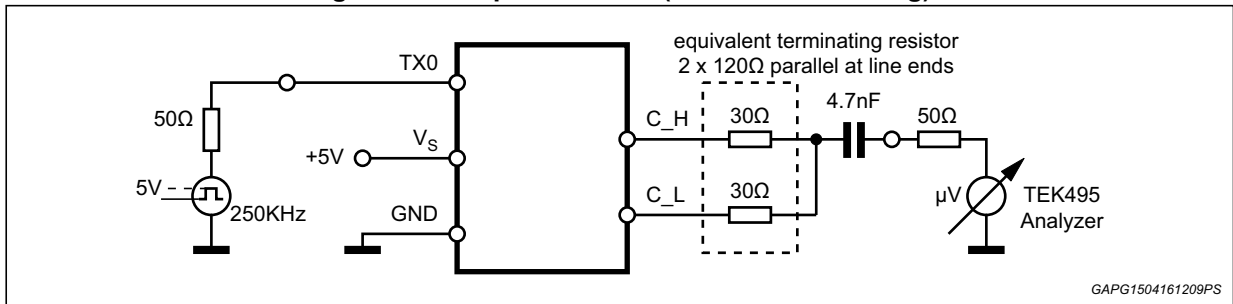
**Figure 7. Transceiver without EMC reducing measures (transceiver)**



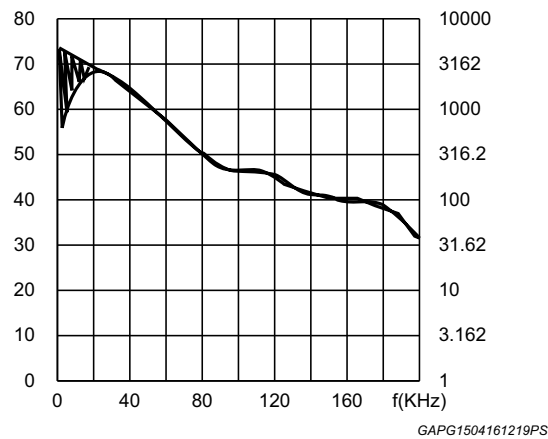
**Figure 8. Transceiver with EMC reducing measures (transceiver)**



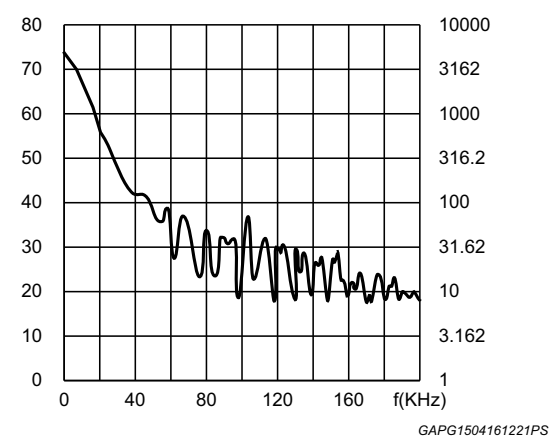
**Figure 9. EMC performance (transceiver sending)**



**Figure 10. Transceiver without EMC reducing measures (transceiver)**



**Figure 11. Transceiver with EMC reducing measures (transceiver)**



## 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: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

### 5.1 SO-8 package information

Figure 12. SO-8 package outline

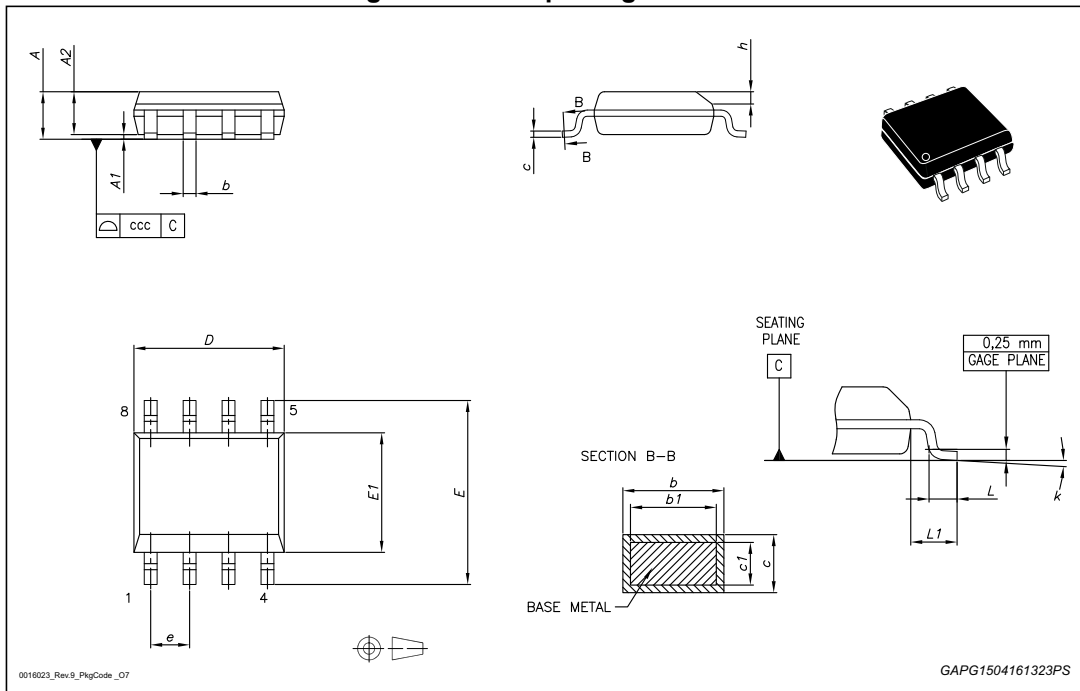


Table 7. SO-8 package mechanical data

| Ref               | Dimensions  |      |      |                       |        |        |
|-------------------|-------------|------|------|-----------------------|--------|--------|
|                   | Millimeters |      |      | Inches <sup>(1)</sup> |        |        |
|                   | Min.        | Typ. | Max. | Min.                  | Typ.   | Max.   |
| A                 | -           | -    | 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 |
| c                 | 0.17        | -    | 0.23 | 0.0067                | -      | 0.0091 |
| D <sup>(2)</sup>  | 4.8         | 4.9  | 5    | 0.1890                | 0.1929 | 0.1969 |
| E                 | 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 |
| e                 | -           | 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 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.
2. 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).
3. Dimension "E1" does not include inter-lead flash or protrusions.  
Inter lead flash or protrusions shall not exceed 0.25mm per side.

## 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.<br>Added bullet "AEC-Q100 qualified" in cover page.<br>Updated order codes in <a href="#">Table 1: Device summary on page 1</a> .<br>Updated <a href="#">Section 5: Package information on page 14</a> . |



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