

Single Wire CAN-Transceiver

Final Data Sheet

1 Features

- Single wire transceiver for up to 33 kBit/s bus speed
- Excellent EMC performance
- High speed mode for up to 100 kBit/s bus speed
- Ambient operation range 40 °C to 125 °C
- Supply voltage operation range 5.5 V to 28 V
- Typ. 30 μ A total current consumption in sleep mode
- 4 kV ESD protection
- Short circuit and overtemperature protected
- Input bilevel feature for wake-up detection
- Output bilevel feature for wake up call
- Loss of Ground protection
- Bus dominant timeout feature
- Programmable slewrate

THATTA
P-DSO-14-8; -9

Туре	Ordering Code	Package
TLE 6255 G	Q67006-A9352	P-DSO-14-9 (SMD)

2 Description

The TLE 6255 G is a special featured low speed transceiver for use in single wire applications.

The device is primarily designed for use in single wire CAN systems operating with various CSMA/CR (carrier sense multiple access/collision resolution) protocols such as the BOSCH Controller Area Network (CAN).

The normal communication bitrate in CAN-systems is up to 33 kBit/s. For software or diagnostic data download a high speed mode is offered that allows transmission rates up to 100 kBit/s.

With many integrated features such as slewrate controlled output, loss of ground circuit, bi-level wake-up and sleep mode for low power consumption the TLE 6255 G is optimized for use in automotive applications.

The device is based on Siemens power technology SPT[®] which allows bipolar and CMOS control circuitry to be integrated with DMOS power devices on the same monolithic circuitry.

Additional features like short circuit and overtemperature protection, over- and undervoltage lockout are integrated. To enhance the reliability and robustness of the TLE 6255 G the enhanced power SO-14 package is used in order to provide high thermal capacity and low thermal resistance.



3

Pin Configuration

(top view)



Figure 1 Pin Configuration

RxD = H indicates a bus recessive state, RxD = L a bus normal or high voltage dominant state.



4	Pin	Definitions	and	Functions
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Pin No.	Symbol	Function
1, 7, 8, 14	GND	Ground; internally connected to leadframe
2	TxD	Transceive-Input ; low active, logic command to transmit on the single wire CAN bus; inverting: $TxD = low$ causes CANH = dominant (high level); internal 10 k Ω pull up
3	MO	Mode-Input 0 ; to program the device operating mode; internal pull down
4	M1	Mode-Input 1 ; to program the device operating mode; internal pull down
5	RxD	Receive-Output ; open drain, logic data as sensed on the single wire CAN bus; inverting (RxD = L when CANH is dominant)
6	V _{CC}	Supply Voltage; input for 5 V logic supply voltage
9	RSL	Slewrate-Program-Input ; an external resistor to $V_{\rm CC}$ on this pin is required to program the bus output slewrate
10	V_{batt}	Battery Supply Voltage; external blocking capacitor necessary (see application circuit)
11	LOAD	Unit-Load Resistor Input; internal termination to GND
12	CANH	CAN Bus Input/Output ; single wire bus input and output; short circuit protected
13	N.C.	not connected



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Block Diagram



Figure 2 Block Diagram



6 Functional Description and Application Hints

6.1 Mode Control

By use of the two mode control pins M0 and M1 the transceiver can be set in the following modes.

Table 1Transceiver Modes

#	MO	M1	Mode
1	Low	Low	Sleep mode
2	High	Low	High speed mode
3	Low	High	Wake-up call
4	High	High	Normal mode

Sleep-Mode

In the sleep mode the total current consumption of the TLE 6255 G is reduced to typically 30 μ A. Nodes not set to sleep mode can communicate without disturbing ECUs that are already set to sleep mode. To achieve a wake-up via the CAN bus a high voltage level message (wake-up call) is necessary. Only high voltage level messages are reported to the RxD pin in sleep mode. A wake-up from sleep mode of the transceiver itself has to be done by setting the control inputs M0 and M1. If there is no modification on the mode inputs the device remains in sleep mode after the wake-up signal is removed from the bus.

The transceiver's loss of ground protection circuit connection to ground is not interrupted when in the sleep mode.

High-Speed-Mode

The high-speed mode can be used for software or diagnostic data download with bitrates up to 100 kBit/s. Therefore the slewrate control feature is deactivated to achieve the required timings. Further an additional external resistor of 100 Ω from CANH to GND is necessary in this mode.

Wakeup-Call Mode

In this mode the TLE 6255 G sends the message to be transmitted as a high voltage wake-up message.

The bus includes a special node wake up capability which allows normal communication to take place among some nodes while leaving the other nodes in an undisturbed sleep state. This is accomplished by controlling the level of the signal voltages such that all nodes must wake up when they receive a higher voltage message signal waveform.

Communication at the lower, normal voltage levels shall not disturb the sleeping nodes $(V_{\text{batt}} > 9 \text{ V})$.



Normal Mode

In the normal mode the TLE 6255 G sends a normal voltage message waveform on the bus. It is possible to run the transceiver up to transmission rates of 33 kBits/s in this mode.

The waveform as well as the slew rate of the rising edge (recessive to dominant transition) are controlled by the internal active wave shaping circuit to minimize EME (electromagnetic emission). For the same reason waveform trailing edge control is required to assure that high frequency content is minimized at the beginning of the downward voltage slope (dominant to recessive transition). The remaining fall time occurs after the bus is inactive with drivers off and is determined by the RC time constant of the total bus load.

6.2 Slew-Rate Control

The CANH output voltage and current is controlled by an internal waveshaping circuit. For optimized adjusting of the slew rate to the system timing, the slew rate is programmable by an external resistor connected from pin RSL to $V_{\rm CC}$. Figure 4 shows the correlation of the slew rate to the resistor $R_{\rm RSL}$.

6.3 Transmitter

The TLE 6255 G contains a high current fully short circuit and overtemperature protected highside-driver (pin CANH). To minimize spectral content the CANH-output waveform is controlled.

Logic low (TxD = L) on pin TxD will command the output stage to switch to dominant high potential; TxD = H to recessive low on the bus.

To avoid the bus to be blocked by a permanent dominant TxD input signal, the TLE 6255 G incorporates a timeout feature. In case of TxD = L for longer than the internal fixed timeout the CANH output is switched off automatically. The timeout is resetted by a H-signal at TxD without a delay.

The loss of an ECU ground may cause the ECU to source current through the various ECU circuits to the communications bus instead of to the vehicle system ground. Therefore the unit-load resistor of any ECU is connected to the LOAD-pin. The TLE 6255 G incorporates a reverse protected switch from LOAD to ground potential. This switch is automatically switched off in a loss of ground state.

6.4 Receiver

In normal, high speed and wakeup-mode all data on the bus is sensed by the receive comparator and transmitted to the RxD output. In sleep mode no normal level data is detected. The receiver threshold is set to the wake-up level. So a wake-up interrupt is sent only in case of a wake-up call on the bus. An internal fixed filter improves the EMC susceptibility.



7 Absolute Maximum Ratings

Parameter	Symbol	Limit V	alues	Unit	Remarks
		min.	max.		

Voltages

Supply voltage	V_{batt}	- 0.3	40	V	_
CAN bus input/output voltage	V _{CANH}	- 28	28	V	-
Load voltage	V_{LOAD}	- 28	28	V	-
Logic supply voltage	V _{CC}	- 0.3	7	V	-
Logic voltages	Vlogic	- 0.3	7	V	-
$(V_{RxD}; V_{TxD}; V_{M0}; V_{M1}; V_{RSL})$					

Currents

CAN Bus current	I _{CANH}	-	-	mA	internally limited
Load current	I_{LOAD}	_	_	mA	internally limited

ESD-Protection (Human Body Model; According to MIL STD 833 D)

Pin CANH, V _{batt}	$V_{\rm ESD}$	- 4000	4000	V	-
Other pins	$V_{\rm ESD}$	- 2000	2000	V	-

Temperatures

Junction temperature	T _j	- 40	150	°C	-
Junction temperature	Tj	-	175	°C	<i>t</i> < 1000 h
Junction temperature	Tj	-	200	°C	<i>t</i> < 10 h
Storage temperature	T _{stg}	- 50	150	°C	-

Thermal Resistances

Junction to pin	$R_{ m thj-pin}$	-	40	K/W	junction to pin 1
Junction ambient	R _{thj-a}	_	65	K/W	-

Note: Maximum ratings are absolute ratings; exceeding any one of these values may cause irreversible damage to the integrated circuit.



8 Operating Range

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	V_{batt}	V_{UVOFF}	28	V	After $V_{\rm batt}$ rising above $V_{\rm UV \ ON}$
Supply voltage increasing	V_{batt}	- 0.3	$V_{\rm UV ON}$	V	Outputs in tristate
Supply voltage decreasing	V_{batt}	- 0.3	$V_{\rm UVOFF}$	V	Outputs in tristate
Logic supply voltage	V _{CC}	V _{POROF}	5.5	V	After $V_{\rm CC}$ rising above $V_{\rm PORON}$
Logic supply voltage; increasing	V _{CC}	- 0.3	V_{PORON}	V	Outputs in tristate
Logic supply voltage; decreasing	V _{CC}	- 0.3	V_{POROF}	V	Outputs in tristate
Junction temperature	Tj	- 40	150	°C	-
RSL resistance	R _{RSL}	35	200	kΩ	-

Thermal Shutdown

Thermal shutdown junction temperature	$T_{\rm jSD}$	150	200	°C	-
Thermal switch-on junction temperature	$T_{\rm jSO}$	120	170	°C	temperature hysteresis ΔT = 30 K (typ.)





9 Electrical Characteristics

5.5 V < V_{batt} < 16 V; 4.75 V < V_{CC} < 5.25 V; - 40 °C < T_{j} < 150 °C; M0 = M1 = H; R_{UL} = 9.1 k Ω (connected between CANH and LOAD); R_{RSL} = 39 k Ω ; all voltages with respect to ground; positive current defined flowing into pin; unless otherwise specified

Parameter	Sym-	Lim	nit Val	ues	Unit	Test Condition
	bol	min.	typ.	max.		

Current Consumption

Supply current at V_{batt} ; sleep mode	I _{batt}	_	20	40	μA	M0 = M1 = L;
Supply current at V_{CC} ; sleep mode	I _{CC}	-	10	30	μA	M0 = M1 = L;
Supply current at V_{batt}	I _{batt}	-	3	6	mA	TxD = L
Supply current at V_{batt}	$I_{\rm batt}$	-	1.5	3	mA	TxD = H
Supply current at V_{batt}	I _{batt}	-	5	9	mA	TxD = L; M0 = L
Supply current at V_{batt}	I _{batt}	-	4	6	mA	TxD = H; MO = L
Supply current at V _{CC}	I _{CC}	_	3	5	mA	TxD = H or L; M0 = H or L

Over- and Under Voltage Lockout

UV Switch ON voltage	$V_{\rm UVON}$	-	5.2	5.6	V	V_{batt} increasing; $V_{\text{CC}} = 5 \text{ V}$
UV Switch OFF voltage	V_{UVOFF}	4.00	4.6	5.1	V	$V_{\rm batt}$ decreasing; $V_{\rm CC}$ = 5 V
UV ON/OFF Hysteresis	$V_{\rm UVHY}$	_	0.6	_	V	$V_{\rm UVON} - V_{\rm UVOFF}$
OV Switch OFF voltage	V_{OVOFF}	30	33	38	V	$V_{\rm batt}$ increasing
OV Switch ON voltage	$V_{\rm OVON}$	28	32	36	V	$V_{\rm batt}$ decreasing
OV ON/OFF Hysteresis	V _{OVHY}	0.2	2	-	V	$V_{\rm OVOFF} - V_{\rm OVON}$



Parameter S	Sym- Limit Values				Unit	Test Condition
	bol	min.	typ.	max.		

Power ON/OFF Reset at V_{cc}

Power ON Reset voltage	V_{PORON}	4.00	4.25	4.50	V	$V_{\rm CC}$ increasing
Power OFF Reset voltage	V_{POROF}	3.50	3.75	4.00	V	$V_{\rm CC}$ decreasing
POR ON/OFF Hysteresis	V _{PORHY}	0.1	0.5	-	V	$V_{\rm PORON} - V_{\rm POROF}$

Transceive Input TxD

H-input voltage threshold	V_{TxDH}	-	2.6	$0.7 imes V_{ m CC}$	V	-
L-input voltage threshold	V_{TxDL}	$0.3 imes V_{ m CC}$	2.4	_	V	-
Hysteresis of input voltage	V_{TxDHY}	50	200	500	mV	-
Pull up current	I _{TxD}	- 20	- 10	- 5	μΑ	$0 V < V_{TxD} < 4 V$
Timeout reaction time	t _{TOR}	5	10	30	ms	-

Receive Output RxD

Output leakage current	I _{RxDLK}	-2	0	10	μΑ	V_{RxD} = 5 V
Output low voltage level	V_{RxDL}	-	0.2	0.4	V	$I_{\text{RxDL}} = 2 \text{ mA}$
Falltime	t _{FRxD}	-	80	200	ns	C_{RxD} = 25 pF to GND



Parameter	Sym-	Lim	nit Val	ues	Unit	Test Condition
	bol	min.	typ.	max.		

Mode Input M0 and M1

H-input voltage threshold	$V_{\rm M0,1H}$	-	2.6	$0.7 imes V_{ m CC}$	V	-
L-input voltage threshold	$V_{\rm M0,1L}$	$0.3 imes V_{ m CC}$	2.4	-	V	-
Hysteresis of input voltage	$V_{\rm M0,1HY}$	50	200	500	mV	-
Pull down current	<i>I</i> _{M0,1}	5	20	50	μΑ	1 V < V _{M0,1} < 5 V

Mode Change Delaytimes

-					-	
Normal to high-speed	t _{DNH}	-	5	30	μs	M1 H to L; (guaranteed by design)
Normal to wakeup call	t _{DNW}	_	5	30	μs	M0 H to L (guaranteed by design)
Normal to sleep	t _{DNS}	-	5	500	μs	M0 and M1 H to L (guaranteed by design)
Sleep to normal	t _{DSN}	_	5	50	μs	M0 and M1 L to H (guaranteed by design)

Slewrate Input RSL

Output voltage	V_{RSL}	2.5	3	3.5	V	I_{RSL} = 100 μ A



Parameter	Sym- bol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

CANH as Bus Input / Receiver

Wake up offset threshold	$V_{\rm IHWUO}$	V _{batt} – 4.30	-	V _{batt} – 3.25	V	V _{batt} = 8 V see note; see Figure 8
Wake up fixed threshold	V_{IHWUF}	6.15	7.1	8.10	V	V _{batt} = 14 V see note; see Figure 8
Wakeup dead time	t _{DWU}	10	21	50	μs	-
Wakeup minimal pulse time	t _{WUMIN}	1	5	10	μs	-
Receive threshold; in normal, high-speed and wake-up mode	V _{IH}	1.8	2	2.2	V	6 V < V _{batt} < 16 V
Receive hysteresis	V_{RHY}	50	80	200	mV	-
Receive propagation time	t _{CRF}	0.05	0.3	1	μs	$V_{\text{CANH}} > (V_{\text{IH}} + 0.8 \text{ V}) \text{ to}$ RxD = L; 6 V < V_{batt} < 16 V
Receive propagation time; high speed	t _{CRF}	0.05	0.25	0.5	μs	$V_{\text{CANH}} > (V_{\text{IH}} + 0.8 \text{ V}) \text{ to}$ RxD = L; M1 = L; $6 \text{ V} < V_{\text{batt}} < 16 \text{ V};$ $T_{\text{j}} < 125 ^{\circ}\text{C}$
Receive propagation time	t _{CRR}	0.05	0.3	1	μs	$V_{\text{CANH}} < (V_{\text{IH}} - 0.8 \text{ V}) \text{ to}$ RxD = H; R_{RxD} = 2.4 k Ω 6 V < V_{batt} < 16 V
Receive propagation time; high speed	t _{CRR}	0.05	0.25	0.5	μs	$V_{\text{CANH}} < (V_{\text{IH}} - 0.8 \text{ V}) \text{ to}$ RxD = H; R_{RxD} = 2.4 k Ω M1 = L; 6 V < V_{batt} < 16 V; T_{j} < 125 °C
Receive blanking time after CANH H to L transition	t _{CRB}	1.5	3.0	5.0	μs	see Figure 7

Note: The device will send a wake up call to the microcontroller at the minimum of $V_{\rm IHWUO}$ or $V_{\rm IHWUF}$.



Parameter	Sym- bol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

CANH as Bus Output / Transmitter

Offset wakeup output high voltage	V _{OHWUO}	V _{batt} – 1.5	_	V_{batt}	V	$220 \ \Omega < R_{UL} < 9.1 \ k\Omega;$ TxD = L; M0 = L; 6 V < V _{batt} < V _{OHWUF}
Fixed wakeup output high voltage	V_{OHWUF}	9.7	_	12	V	$\begin{array}{l} 220 \; \Omega < R_{\rm UL} < 9.1 \; \mathrm{k}\Omega \\ \mathrm{TxD} = \mathrm{L}; \; \mathrm{M0} = \mathrm{L} \\ \mathrm{V}_{\rm OHWUF} < V_{\rm batt} < 16 \mathrm{V} \end{array}$
Bus output high voltage; normal and high speed	V _{OH}	3.60	4.0	4.55	V	100 Ω < $R_{\rm UL}$ < 9.1 kΩ TxD = L; 6 V < $V_{\rm batt}$ < 16 V
Bus output current limit	I _{OLI}	200	250	350	mA	$TxD = L; V_{CANH} = 0 V$
Bus output leakage current	I _{OLK}	- 10	_	200	μΑ	$\label{eq:transform} \begin{array}{l} {\rm TxD} = {\rm H}; \ T_{\rm j} < 125 \ ^{\circ}{\rm C}; \\ V_{\rm batt} - 28 \ {\rm V} < V_{\rm CANH} < \\ V_{\rm batt} - 1 \ {\rm V} \end{array}$
Bus output leakage current (loss of ground)	I _{OLK}	- 50	-	200	μΑ	$\begin{array}{l} 0 \; V < V_{\mathrm{batt}} < V_{\mathrm{UVOFF}}; \\ V_{\mathrm{batt}} - 28 \; V < V_{\mathrm{CANH}} < \\ V_{\mathrm{batt}} - 1 \; V \end{array}$
Slew rate rising edge, normal mode	S _{CANH}	_	2.0	_	V/µs	20% < V _{CANH} < 80%
Slew rate rising edge, wake-up mode	S_{CANH}	-	4.0	-	V/µs	$20\% < V_{CANH} < 80\%$ M0 = L; V_{batt} = 12 V
Slew rate rising edge; high speed;	S _{CANH}	5	16	25	V/µs	$20\% < V_{CANH} < 80\%$ M1 = L; $T_{\rm j} < 125~^{\circ}{\rm C}$
Transmit propagation time; normal mode	t _{TCF}	2	5	6	μs	$\begin{aligned} \text{TxD} &= (\text{H to L}) \text{ to} \\ V_{\text{CANH}} &= (V_{\text{IH}} + 0.8 \text{ V}) \\ 1.0 \ \mu\text{s} < \tau < 3.6 \ \mu\text{s}; \end{aligned}$
Transmit propagation time; wake-up mode	t _{TCF}	1	5	4	μs	TxD = (H to L) to $V_{CANH} = (V_{1H} + 0.8 \text{ V});$ $M0 = L; V_{batt} = 12 \text{ V};$ $1.0 \mu\text{s} < \tau < 3.6 \mu\text{s}$



Parameter	Sym- bol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Transmit propagation time; high speed mode	t _{TCF}	_	0.5	1.5	μs	TxD = (H to L) to $V_{CANH} = (V_{IH} + 0.8 V);$ M1 = L; $\tau < 1 \mu s;$ $T_j < 125 °C$
Transmit propagation time; normal mode	t _{TCR}	3	5	8	μs	TxD = (L to H) to $V_{CANH} = (V_{IH} - 0.8 V)$ 1.0 µs < τ < 3.6 µs;
Transmit propagation time; wake-up mode	t _{TCR}	3	-	12.7	μs	TxD = (L to H) to $V_{CANH} = (V_{IH} - 0.8 V);$ M0 = L; 1.0 µs < τ < 3.6 µs;
Transmit propagation time; high speed	t _{TCRH}	-	_	3.0	μs	TxD = (L to H) to $V_{CANH} = (V_{IH} - 0.8 V);$ M1 = L; $\tau < 1.6 \ \mu s; T_j < 125 \ ^{\circ}C$

Unit-Load Resistor Ground Input LOAD

Output low voltage level	V_{LOAD}	-	20	100	mV	$I_{\text{LOAD}} = 2 \text{ mA};$ 8 V < $V_{\text{batt}} < 16 \text{ V}$
Output leakage current (loss of ground)	I _{loadlk}	- 50	-	50	μA	$\begin{array}{l} 0 \; V < V_{\mathrm{bat}} < V_{\mathrm{UVOFF}} \\ T_{\mathrm{j}} < 125 \;^{\circ}\mathrm{C}; \; V_{\mathrm{batt}} - 28 \; V \\ < V_{\mathrm{CANH}} < V_{\mathrm{batt}} - 1 \; V \end{array}$



10 Diagrams



Figure 3 Input/Output-Timing (Pin CANH, TxD and RxD)





Figure 4 Slewrate S_{CANH} vs. Programming Resistor R_{RSL} (Pin RSL)



Figure 5 Wakeup Deadtime t_{DWU}





Figure 6 Bus Dominant Blanking Time *t*_{TOR}





Figure 7 RxD Blanking Time t_{CRB}





Figure 8 Wake-up Threshold V_{IHWU} vs. Supply Voltage V_{S}



11 Application Circuit



Figure 9 Application Circuit



12 Package Outlines





Sorts of Packing Package outlines for tubes, trays etc. are contained in our Data Book "Package Information". SMD = Surface Mounted Device

Dimensions in mm

GPS09222





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