1. DESCRIPTION

The XL1051T/3 is a high-speed CAN transceiver that provides an interface between a Controller Area Network (CAN) protocol controller and the physical two-wire CAN bus. The transceiver is designed for high-speed CAN applications in the automotive industry, providing differential transmit and receive capability to (a microcontroller with) a CAN protocol controller.

Compared to XL1050. It offers improved ElectroMagnetic Compatibility (EMC) and ElectroStatic Discharge (ESD) performance, and also features:

--Ideal passive behavior to the CAN bus when the supply voltage is off .

--XL1051T/3 can be interfaced directly to microcontrollers with supply voltages from 3 V to 5 V

The XL1051T/3 implements the CAN physical layer as defined in ISO 11898-2:2016 and SAE J2284-1 to SAE J2284-5. This implementation enables reliable communication in the CAN FD fast phase at data rates up to 5 Mbit/s. These features make the XL1051T/3 an excellent choice for all types of HS-CAN networks, in nodes that do not require a standby mode with wake-up capability via the bus.

2. FEATURES

- SO 11898-2:2016 and SAE J2284-1 to SAE J2284-5 compliant
- Timing guaranteed for data rates up to 5 Mbit/s in the CAN FD fast phase
- Suitable for 12 V and 24 V systems
- Low ElectroMagnetic Emission (EME) and high ElectroMagnetic Immunity (EMI)
- V_{IO} function allows for direct interfacing with 3 V to 5 V system
- Dark green product (halogen free and Restriction of Hazardous Substances (RoHS) compliant)
- Functional behavior predictable under all supply conditions
- Transceiver disengages from the bus when not powered up (zero load)
- High ElectroStatic Discharge (ESD) handling capability on the bus pins
- Bus pins protected against transients in a variety of variety complex environments environments
- Transmit Data (TXD) dominant time-out function
- Undervoltage detection on pins VCC and VIO
- Thermally protected

3. QUICK REFERENCE DATA

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CC}	supply voltage		4.5		5.5	V
V_{IO}	supply voltage on pin V_{IO}		2.8		5.5	V
$V_{UVd(VCC)}$	undervoltage detection voltage on pin V_{CC}		3.5		4.5	V
$V_{UVd(VIO)}$	undervoltage detection voltage on pin V_{IO}		1.3	2.0	2.7	V
I_{CC}	supply current	Silent mode	0.1	1	2.5	mA
		Normal mode; bus recessive	2.5	5	10	mA
		Normal mode; bus dominant	20	50	70	mA
I_{IO}	supply current on pin V_{IO}	Normal/Silent mode				μA
		recessive;V_{TXD} =V_{IO}	-	80	250	μA
		dominant;V_{TXD}=0V	-	350	500	μA
V_{ESD}	electrostatic discharge voltage	IEC 61000-4-2 at pins CANH and CANL	-8	-		kV
V_{CANH}	voltage on pin CANH		-58	-	+58	V
V_{CANL}	voltage on pin CANL		-58	-	+58	V
T_{Vj}	virtual junction temperature		-40	-	+125	°C

4. BLOCK DIAGRAM

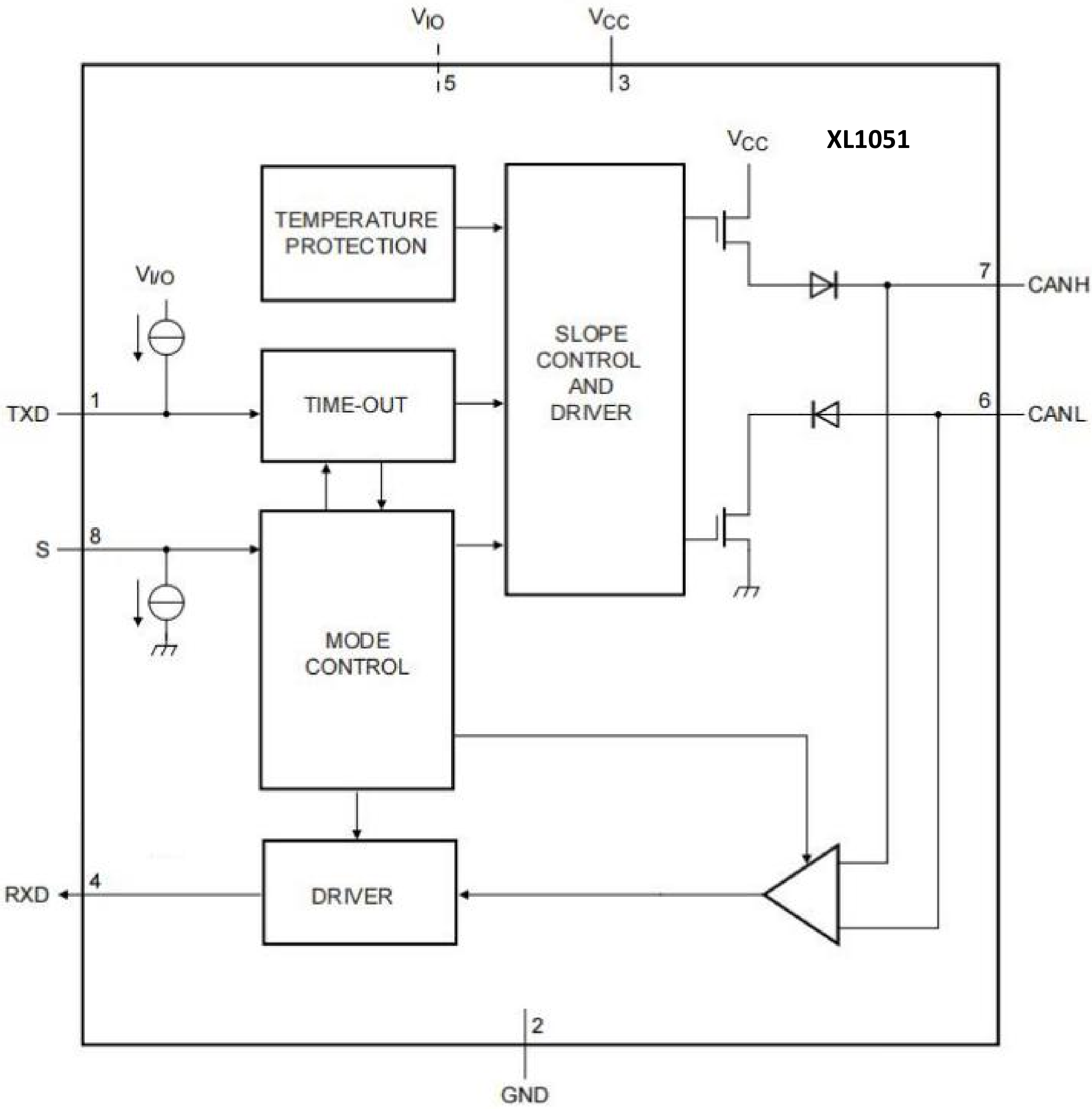
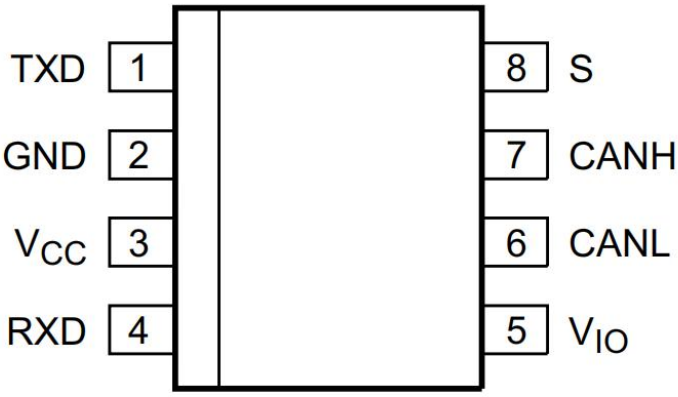


Figure 1. Block diagram

5. PINNING INFORMATION

5.1. Pinning



(Top View)
Figure 2. Pin configuration diagrams

5.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
TXD	1	transmit data input
GND	2	ground
V_{CC}	3	supply voltage
RXD	4	receive data output; reads out data from the bus lines
V_{IO}	5	supply voltage for I/O level adapter
CANL	6	LOW-level CAN bus line
CANH	7	HIGH-level CAN bus line
S	8	Silent mode control input

6. FUNCTIONAL DESCRIPTION

The XL1051 is a high-speed CAN stand-alone transceiver with Silent mode. It combines the functionality of the XL1050 transceiver with improved EMC and ESD handling capability. Improved slope control and high DC handling capability on the bus pins provides additional application flexibility.

6.1. Operating modes

The XL1051 supports two operating modes, Normal and Silent, which are selected via pin S. See Table 3 for a description of the operating modes under normal supply conditions.

Table 4. Operating modes

The XL1051T/3 supports two operating modes, Normal and Silent. The operating mode is selected via pin S. See Table 4 for a description of the operating modes under normal supply conditions.

Mode	Inputs		Outputs	
	Pin S	Pin TXD	CAN driver	Pin RXD
Normal	LOW	LOW	dominant	active
	LOW	HIGH	recessive	active
Silent	HIGH	X	recessive	active
Off	X	X	floating	floating

6.1.1. Normal mode

A LOW level on pin S selects Normal mode. In this mode, the transceiver is able to transmit and receive data via the bus lines CANH and CANL (see Figure 1 for the block diagram). The differential receiver converts the analog data on the bus lines into digital data which is output to pin RXD. The slopes of the output signals on the bus lines are controlled internally and are optimized in a way that guarantees the lowest possible ElectroMagnetic Emission (EME).

6.1.2. Silent mode

A HIGH level on pin S selects Silent mode. In Silent mode the transmitter is disabled, releasing the bus pins to recessive state. All other IC functions, including the receiver, continue to operate as in Normal mode. Silent mode can be used to prevent a faulty CAN controller from disrupting all network communications.

6.2. Fail-safe features

6.2.1. TXD dominant time-out functior

A 'TXD dominant time-out' timer is started when pin TXD is set LOW. If the LOW state on pin TXD persists for longer than tto(dom)TXD, the transmitter is disabled, releasing the bus lines to recessive state. This function prevents a hardware and/or software application failure from driving the bus lines to a permanent dominant state (blocking all network communications). The TXD dominant time-out timer is reset when pin TXD is set HIGH. The TXD dominant time-out time also defines the minimum possible bit rate of 20 kbit/s

6.2.2. Undervoltage detection on pins Vcc and Vio

Should VCC or VIO drop below their respective undervoltage detection levels (Vuvd(VCC) and Vuvd (VIO); see Table 7), the transceiver will switch off and disengage from the bus (zero load) until VCC and VIO have recovered.

6.2.3. Overtemperature protection

The output drivers are protected against overtemperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature, Tj(sd), the output drivers will be disabled until the virtual junction temperature falls below Tj(sd) and TXD becomes recessive again. Including the TXD condition ensures that output driver oscillations due to temperature drift are avoided.

6.3. Vio supply pin

Pin VIO on the XL1051T/3 should be connected to the microcontroller supply voltage (see Figure 6). This will adjust the signal levels of pins TXD, RXD and S to the I/O levels of the microcontroller. This sets the signal levels of pins TXD, RXD and S to levels compatible with 3V or 5 V microcontrollers.

7. LIMITING VALUES

Table 4. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are referenced to GND

Symbol	Parameter	Conditions	Min	Typ	Max
VX	voltage on pin x[1]	on pins CANH, CANL	-58	+58	V
		on any other pin	-0.3	+6.5	V
$V_{(CANH-CANL)}$	voltage between pin CANH and pin CANL		-27	+27	V
Vtrt	transient voltage	on pins CANH, CANL[2]			
		pulse 1	-100	-	V
		pulse 2a	-	75	V
		pulse 3a	-120	-	V
		pulse 3b	-	100	V
VESD	electrostatic discharge voltage	IEC 61000-4-2(150 pF, 330Ω)[3]			
		at pins CANH and CANL	-8	+8	kV
		Human Body Model (HBM); 100 pF, 1.5 kΩ[4]			
		at pins CANH and CANL	-8	+8	kV
		at any other pin	-4	+4	KV
		Machine Model (MM); 200 pF, 0.75 μH, 10 Ω[5]			
		at any pin	-200	+200	V
		Charged Device Model (CDM); field Induced charge;4 pF[6]			
		at corner pins	-500	+500	V
		at any pin	-300	+300	V
Tvj	virtual junction temperature	[7]	-40	+125	°C
Tstg	storage temperature		-55	+150	°C

[1] The device can sustain voltages up to the specified values over the product lifetime, provided applied voltages (including transients) never exceed these values.

[2] According to IEC TS 62228 (2007), Section 4.2.4; parameters for standard pulses defined in ISO7637 part 2: 2004-06.

[3] According to IEC TS 62228 (2007), Section 4.3; DIN EN 61000-4-2.

[4] In accordance with IEC 60747-1. An alternative definition of virtual junction temperature is: Tvj = Tamb + P Rth(vj-a), where Rth(vj-a) is a fixed value to be used for the calculation of Tvj. The rating for Tvj limits the allowable combinations of power dissipation (P) and ambient temperature (Tamb)

8. THERMAL CHARACTERISTICS

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Value	Unit
Rth(vj-a)	thermal resistance from virtual junction to ambient	SO8 package; in free air	160	K/W

9. STATIC CHARACTERISTICS

Table 6. Static characteristics

T_{vj} = -40 °C to +125°C; V_{CC}= 4.5 V to 5.5 V; V_{IO}= 2.8 V to 5.5 V[1]; R_L = 60Ω unless specified otherwise; All voltages are defined with respect to ground; Positive currents flow into the IC[2].

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply; pin V_{CC}						
V_{CC}	supply voltage		4.5	-	5.5	V
		Silent mode	0.1	1	2.5	mA
		Normal mode				
		recessive; V_{TXD} =V_{IO}	-	5	10	mA
		dominant; V_{TXD} = 0 V		50	70	mA
		dominant; V_{TXD} = 0 V; short circuit on bus lines; -3 V<V_{CANH} = V_{CANL}) <+18 V	2.5	80	110	mA
$V_{uvd(VCC)}$	undervoltage detection voltage on pin V_{CC}		3.5	-	4.5	V
I/O level adapter supply; pin VIO[1]						
V_{IO}	supply voltage on pin V_{IO}		2.8	-	5.5	V
I_{IO}	supply current on pin V_{IO}	Normal/Silent mode				
		recessive; V_{TXD} = V_{OI}	-	-	200	μA
		dominant; V_{TXD} =0V	-	-	500	μA
$V_{uvd(VIO)}$	undervoltage detection voltage on pin V_{IO}		1.3	2.0	2.7	V
Mode control inputs; pins S						
V_{IH}	HIGH-level input voltage	[3]	0.7V_{IO}	-	V_{IO}+0.3	V
V_{IL}	LOW-level input voltage		-0.3	-	0.3V_{IO}	V
I_{IH}	HIGH-level input current	V_S = V_{IO}; V_{EN} = V_{IO}	1	4	10	μA
I_{IL}	LOW-level input current	V_S = 0 V; V_{EN} = 0 V	-1	0	+1	μA
CAN transmit data input; pin TXD						
V_{IH}	HIGH-level input voltage		0.7V_{IO}	-	V_{IO} +0.3	V
V_{IL}	LOW-level input voltage		-0.3	-	+0.3VIO	V
I_{IH}	HIGH-level input current	V_{TXD} = V_{IO}	-5	0	+5	μA
I_{IL}	LOW-level input current	Normal mode; V_{TXD} =0V	-260	-150	-30	μA
C_i	input capacitance	[3]	-	5	10	pF
CAN receive data output; pin RXD						
I_{OH}	HIGH-level output current	V_{RXD} = V_{IO} -0.4 V	-8	-3	-1	mA
I_{OL}	LOW-level output current	V_{RXD} = 0.4 V; bus dominant	2	5	10	mA
Bus lines; pins CANH and CANL						
$V_{O(dom)}$	dominant output voltage	V_{TXD} = 0 V; t < $t_{to(dom)TXD}$				
		pin CANH; R_L = 50Ω to 65Ω	2.75	3.5	4.5	V
		pin CANL; R_L = 50Ω to 65Ω	0.5	1.5	2.25	V
$V_{dom(TX)sym}$	transmitter dominant voltage symmetry	$V_{dom(TX)sym}$ = V_{CC}-V_{CANH}-V_{CANL}	-500	-	+500	mV
V_{TXsym}	transmitter voltage symmetry	V_{TXsym} = V_{CANH} + V_{CANL}; f_{TXD} = 250 kHz, 1 MHz and 2.5 MHz; V_{CC} = 4.75 V to 5.25 V; C_{SPLIT} = 4.7 nF	0.9V_{CC}	-	1.1V_{CC}	V
$V_{O(dif)}$	differential output voltage	dominant: Normal mode; V_{TXD} = 0 V; t<$t_{to(dom)TXD}$; V_{CC} = 4.75 V to 5.25 V				
		R_L = 45Ω to 65 Ω	1.5	-	3	V
		R_L = 45Ω to 70 Ω	1.5	-	3.3	V
		R_L = 2240 Ω	1.5	-	5	V
		recessive; no load				
		Normal mode: V_{TXD} = V_{IO}	-100	-	+100	mV
$V_{O(rec)}$	recessive output voltage	Normal/Silent mode; V_{TXD} = V_{IO}; no load	2	0.5V_{CC}	3	V

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{th(RX)dif}$	differential receiver thresholdvoltage	Normal/Silent mode; -30 V ≤ V_{CANL} ≤ +30 V; -30 V ≤ V_{CANH} ≤ +30 V	0.5	.7	0.9	V
$V_{rec(RX)}$	receiver recessive voltage	Normal/Silent mode; -30 V ≤ V_{CANL}≤ +30 V; -30 V ≤ V_{CANH}≤ +30 V	-4	-	0.5	V
$V_{dom(RX)}$	receiver dominant voltage	Normal/Silent mode; -30 V ≤ V_{CANL}≤ +30 V; -30 V ≤ V_{CANH} ≤ +30 V	0.9	-	9.0	V
$V_{hys(RX)dif}$	differential receiver hysteresis voltage	Normal/Silent mode; -30 V ≤ V_{CANL} ≤ +30 V; -30 V ≤ V_{CANH} ≤ +30 V	50	150	300	mV
$I_{O(sc)dom}$	dominant short-circuit output current	V_{TXD} = 0 V; t < $t_{to(dom)TXD}$; V_{CC} = 5 V				
		pin CANH; V_{CANH} = -15V to+ 40 V	-100	-70	-40	mA
		pin CANL; V_{CANL} = -15 V to + 40 V	40	70	100	mA
$I_{O(sc)rec}$	recessive short-circuit output current	Normal/Silent mode; V_{TXD} = V_{IO}; V_{CANH} = V_{CANL} = -27 V to +32 V	-5	-	+5	mA
I_L	leakage current	V_{CC} = V_{IO} = 0 V or V_{CC} = V_{IO} = shorted to ground via 47 kΩ; V_{CANH} = V_{CANL} =5V	-5	0	+5	µA
R_i	input resistance	-2 V ≤ V_{CANL} ≤ +7 V; -2 V ≤ V_{CANH} ≤ +7 V [5]	9	-	52	kΩ
R_i	nput resistance deviation	0 V ≤ V_{CANL} ≤ +5 V; 0 V ≤ V_{CANH} ≤ +5 V [5]	-6	-	+6	%
$R_{i(dif)}$	differential input resistance	-2 V ≤ V_{CANL} ≤ +7 V; -2 V ≤ V_{CANH} ≤ +7 V [5]	19	48.5	55	kΩ
$C_{i(cm)}$	common-mode input capacitance	[5]	-	-	20	pF
$C_{i(dif)}$	differential input capacitance	[5]	-	-	10	pF
Temperature protection						
$T_{j(sd)}$	shutdown junction temperature	[5]	-	180	-	°C

[1] Only XL051T/3 have a V_{IO} pin.

[2] All parameters are guaranteed over the virtual junction temperature range by design. Factory testing uses correlated test conditions to cover the specified temperature and power supply voltage range.

[3] Maximum value assumes V_{CC} < V_{IO}; if V_{CC} > V_{IO}, the maximum value will be V_{CC} + 0.3 V.

[4] Not tested in production; guaranteed by design.

[5] The test circuit used to measure the bus output voltage symmetry (which includes C_{SPLIT}) is shown in Figure 7

10. DYNAMIC CHARACTERISTICS

Table 8. Dynamic characteristics

Tvj = -40 °C to +125°C; V_{CC} = 4.5 V to 5.5 V; V_{IO} = 2.8 V to 5.5 V[1]; R_L = 60 Ω unless specified otherwise. All voltages are defined with respect to ground. Positive currents flow into the IC.[2]

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Transceiver timing; pins CANH, CANL, TXD and RXD; see Figure 6 and Figure 2						
$td_{(TXD-busdom)}$	delay time from TXD to bus dominant	Normal mode	-	65	-	ns
$td_{(TXD-busrec)}$	delay time from TXD to bus recessive	Normal mode	-	90	-	ns
$td_{(busdom-RXD)}$	delay time from bus dominant to RXD	Normal/Silent mode	-	60	-	ns
$td_{(busrec-RXD)}$	delay time from bus recessive to RXD	Normal/Silent mode	-	65	-	ns
$td_{(TXDL-RXDL)}$	delay time from TXD LOW to RXD LOW	Normal mode: versions with V_{IO} pin	40	-	300	ns
		Normal mode: other versions	40	-	250	ns
$td_{(TXDH-RXDH)}$	delay time from TXD HIGH to RXD HIGH	Normal mode: versions with V_{IO} pin	40	-	280	ns
		Normal mode: other versions	40	-	250	ns
$t_{bit(bus)}$	transmitted recessive bit width	$t_{bit(TXD)}$ = 500 ns [3]	435	-	550	ns
		$t_{bit(TXD)}$ = 200 ns [3]	155	-	230	ns
$t_{bit(RXD)}$	bit time on pin RXD	$t_{bit(TXD)}$ = 500 ns [3]	400	-	550	ns
		$t_{bit(TXD)}$= 200 ns [3]	120	-	220	ns
Δt_{rec}	receiver timing symmetry	$t_{bit(TXD)}$ = 500 ns [3]	-65	-	+40	ns
		$t_{bit(TXD)}$ = 200 ns [3]	-45	-	+15	ns
$t_{to(dom)TXD}$	TXD dominant time-out time	V_{TXD} = 0 V; Normal mode [4]	0.3	2	5	ms

[1] XL1051T/3 have a VIO pin.

[2] All parameters are guaranteed over the virtual junction temperature range by design. Factory testing uses correlated test conditions to cover the specified temperature and power supply voltage range.

[3] See Figure 3.

[4] Minimum value of 0.8ms required according to SAE J2284; 0.3ms is allowed according to ISO11898-2:2016 for legacy devices.

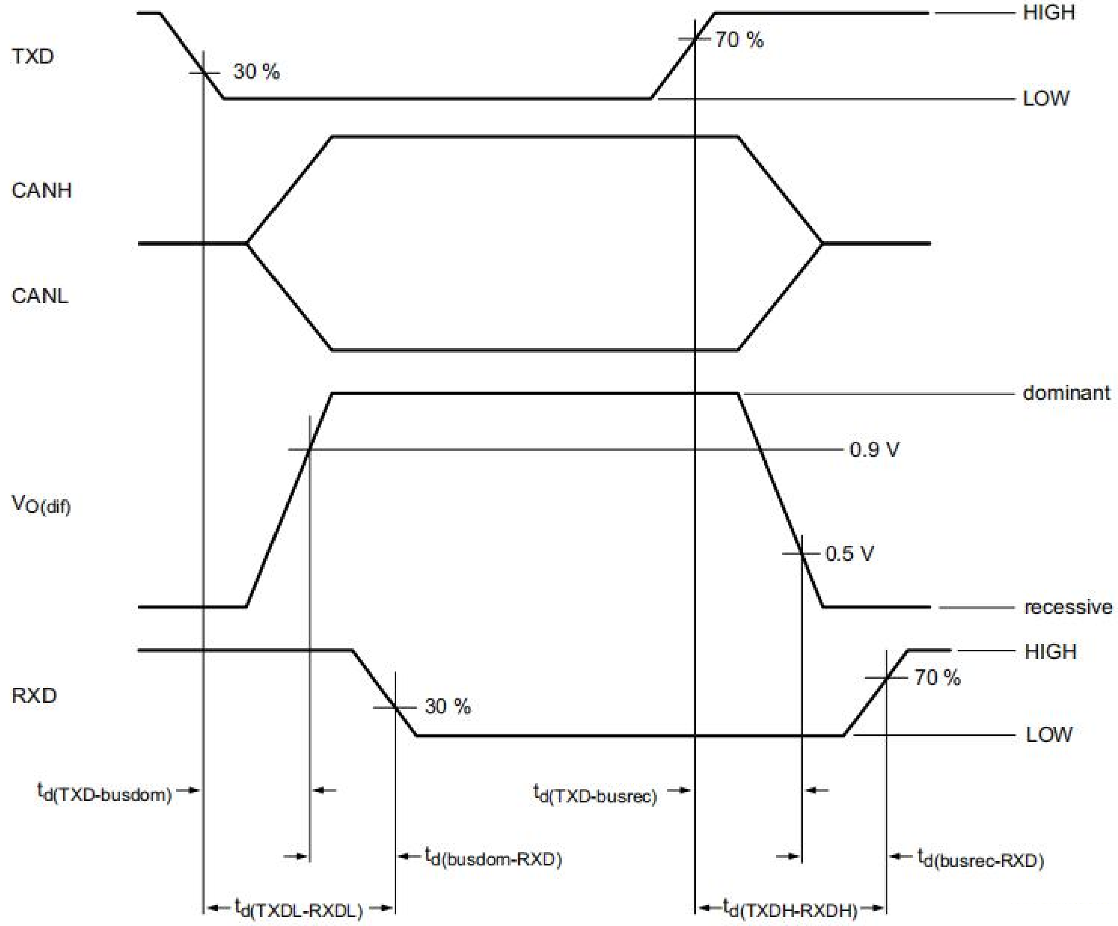


Figure 3. CAN transceiver timing diagram

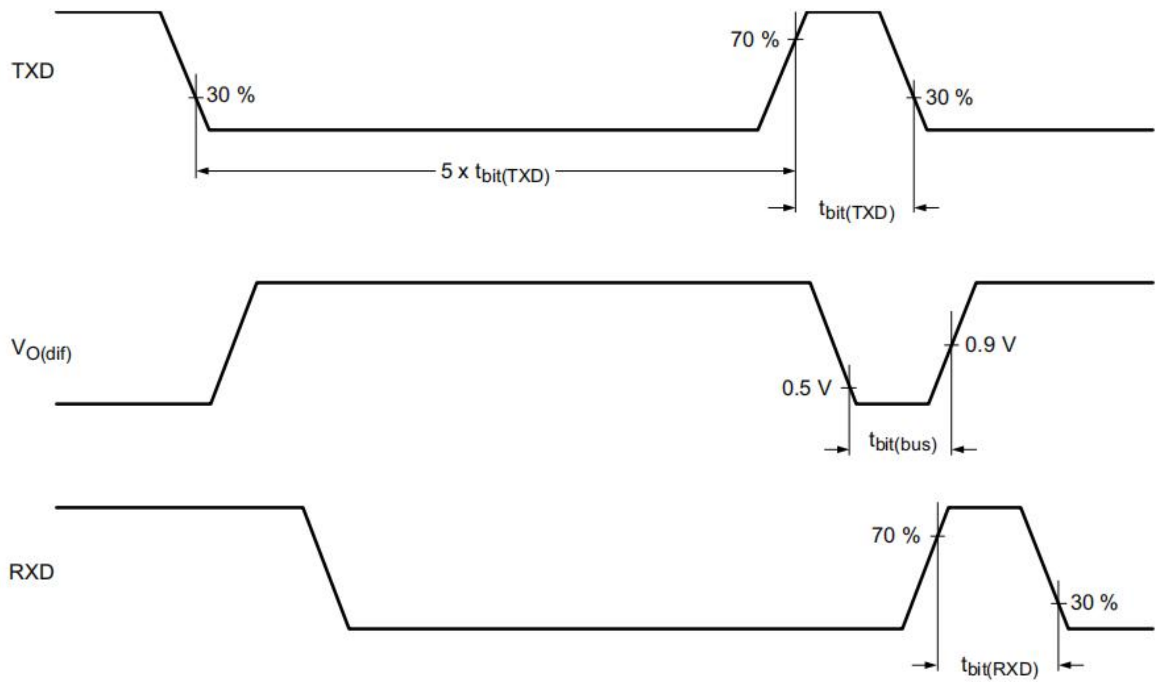
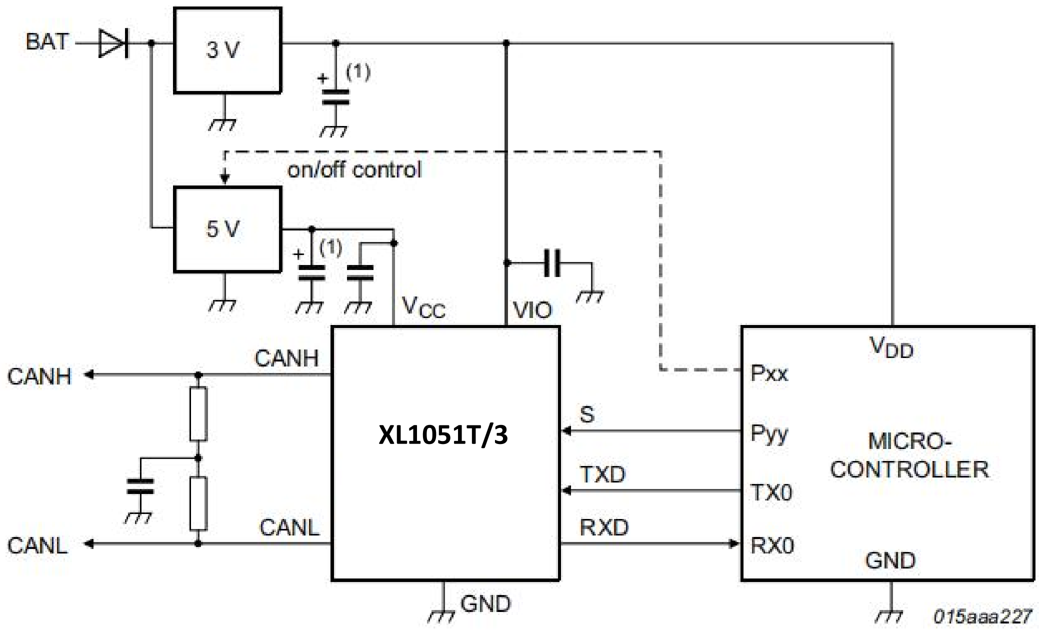


Figure 4. CAN FD timing definitions according to ISO 11898-2:2016

11. APPLICATION INFORMATION

11.1. Application diagrams



(1) Optional, depends on regulator.

Figure 5. Typical application of the XL1051T/3 with 3V system

12. TEST INFORMATION

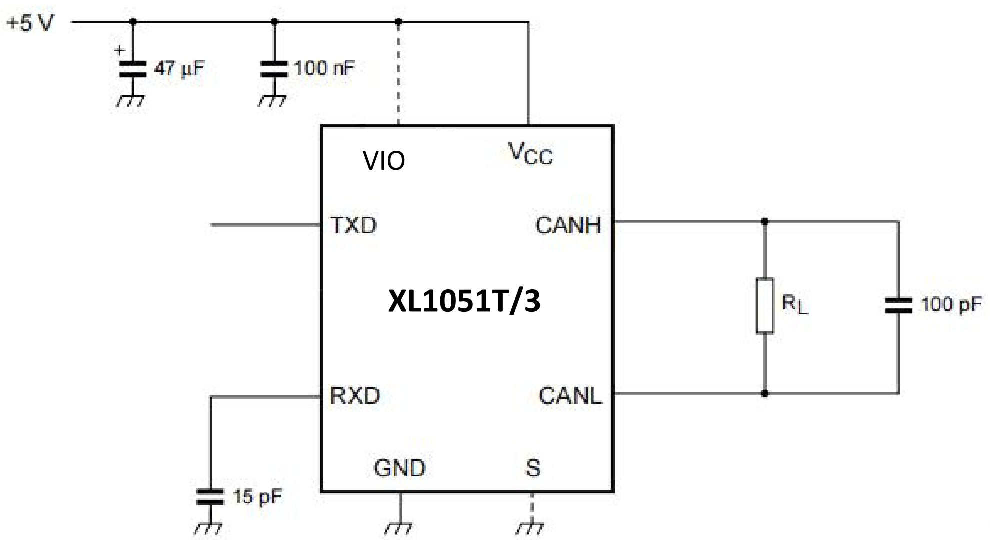


Figure 6. Timing test circuit for CAN transceiver

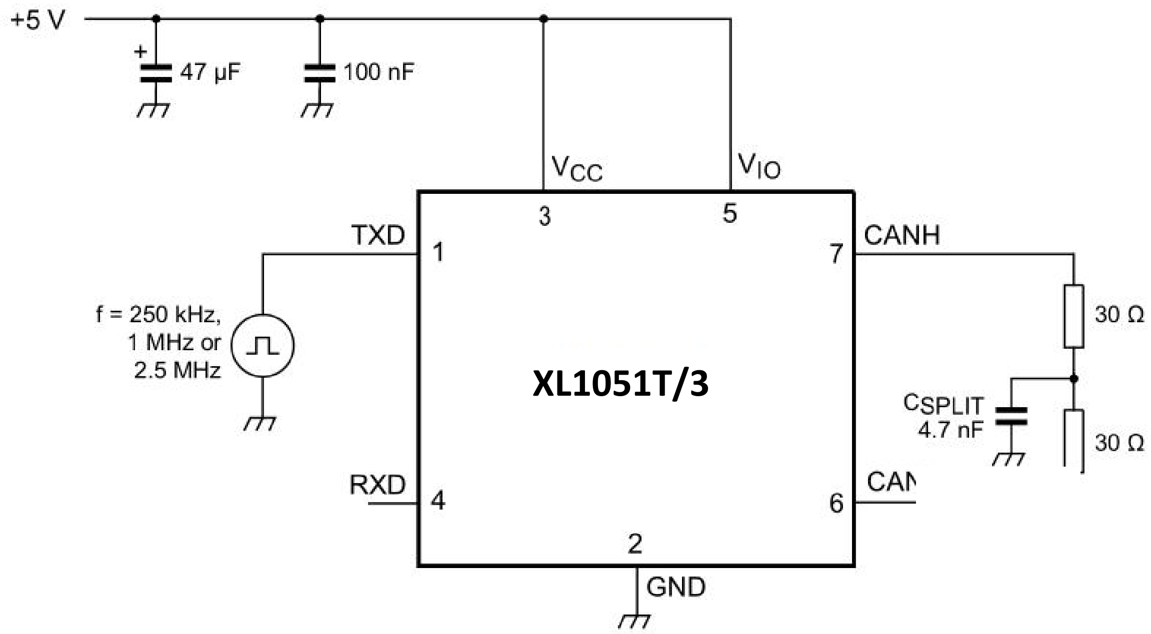


Figure 7. Test circuit for measuring transceiver driver symmetry

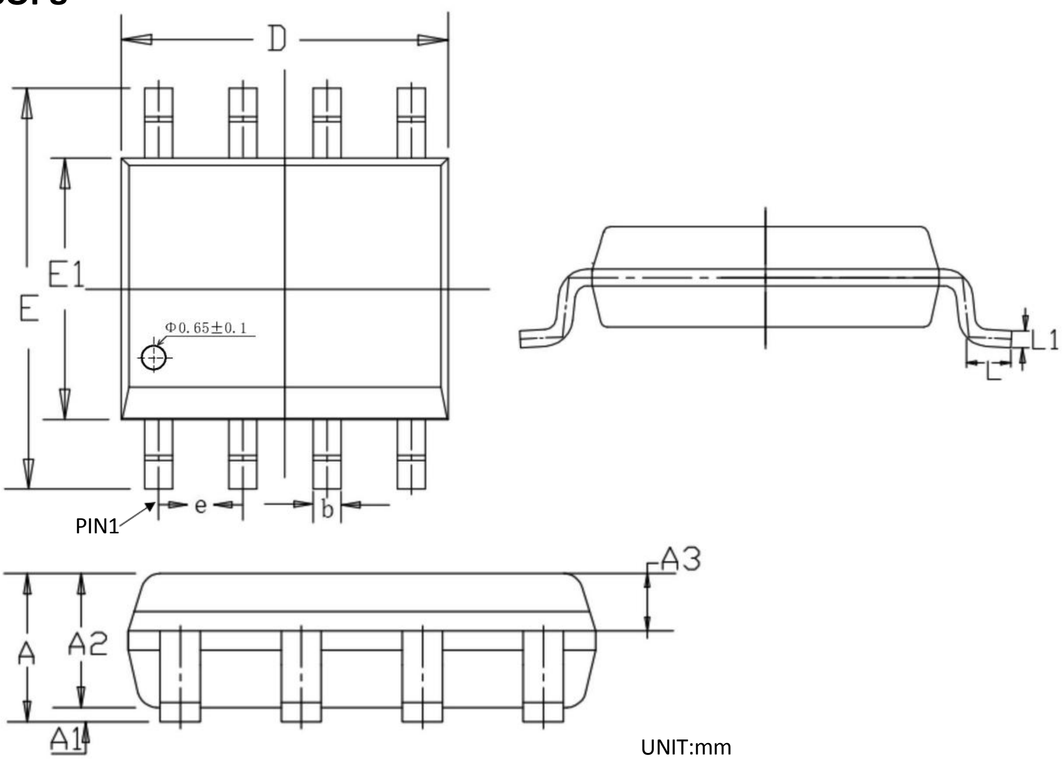
13. ORDERING INFORMATION

Ordering Information

Part Number	Device Marking	Package Type	Body size (mm)	Temperature (°C)	MSL	Transport Media	Package Quantity
XL1051T/3	XL1051T3	SOP8	4.90 * 3.90	- 40 to 125	MSL3	T&R	2500

14. DIMENSIONAL DRAWING

SOP8



UNIT:mm

	MIN	NOM	MAX
A	1.450	1.550	1.650
A1	0.100	0.150	0.200
A2	1.300	1.400	1.500
A3	0.600	0.650	0.700
b	0.380	–	0.510
e	1.240	1.270	1.300
D	4.800	4.900	5.000
E	5.800	6.000	6.200
E1	3.800	3.900	4.000
L	0.450	0.600	0.750
L1	–	0.25BSC	–