

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Features

- Meets the ISO 11898-2:2024 and CiA601-4 for Signal Improvement Capability (SIC) and SAE J2284-1 to SAE J2284-5 Physical Layer Standards
- Supports Classical CAN and Optimized CAN FD SIC up to 8 Mbps Data Rates
- Short and Symmetrical Propagation Delay and Fast Loop Delay for Enhanced Timing Margin
- 5-V Power Supply, I/O Voltage Range Supports 1.7-V to 5.5-V MCU Interface
- Standby Mode and Extra Low Current Sleep Mode with Local and Remote Bus Wake-Up Capability and INH Output
- Ideal Passive Behavior to CAN Bus when Unpowered
- Glitch-free on CAN Bus and RXD when Power on/off
- Protection Feature:
 - Bus HBM ESD protection up to 15 kV and IEC 61000-4-2 ESD Protection
 - Bus Fault Protection: ± 45 V
 - Undervoltage Protection
 - TXD Dominant Time-Out Function and Bus-Dominant Time-Out Function
 - Thermal Shutdown Protection
- Available in SOP14 Package and DFN4.5X3-14 Package with Improved Automated Optical Inspection (AOI) Capability
- AEC-Q100 Qualified for Automotive Application, Grade 1

Applications

- All Devices Supporting Highly Loaded CAN Networks
- Automotive and Transportation
 - Body Electronics / Lighting
 - Power Train / Chassis
 - Infotainment / Cluster
 - ADAS / Safety

Description

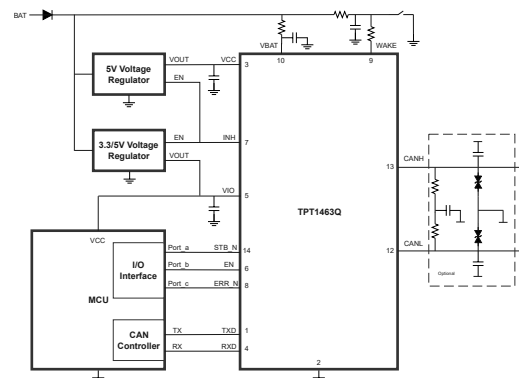
The TPT1463Q is a CAN transceiver that meets the ISO11898-2:2024, CiA601-4 signal improvement capability (SIC) and SAEJ2284-1 to SAE J2284-5 high-speed CAN (Controller Area Network) physical layer standard.

The devices are designed to be used in CAN FD networks up to 8 Mbps with enhanced timing margin. The system design could be optimized with excellent electromagnetic compatibility (EMC) and electrostatic discharge (ESD) performance. The TPT1463Q has a secondary power supply input VIO pin for I/O level shifting to support 1.8-V, 2.5-V, 3.3-V and 5-V MCU logic levels directly. The device has low-current standby and sleep mode with CAN bus waked-up capability via wake-up pattern (WUP) which is defined in ISO11898-2:2024. The device supports ultra-low power management to power down the entire node and enables the power supply by the INH pin through the local or remote wake-up with wake-up source recognition capability.

As designed, the devices feature bus fault protection from -45 V to $+45$ V, TXD dominant time-out (DTO), and over-temperature shutdown (TSD). Additionally, all devices include power-off ideal passive behavior fail-safe features to enhance the network robustness.

The TPT1463Q is available in SOP14 and DFN4.5X3.0-14 packages and is AEC-Q100 qualified for automotive applications.

Typical Application Circuit



**Automotive Low-Power Fault Protected High-Speed CAN FD SIC
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**Automotive Low-Power Fault Protected High-Speed CAN FD SIC
Transceiver with Sleep Mode****Product Family Table**

Order Number	VCC (V)	VIO (V)	BUS Protection (V)	Package
TPT1463Q-SO2R-S	4.5 to 5.5	1.7 to 5.5	±45	SOP14
TPT1463Q-DFKR-S	4.5 to 5.5	1.7 to 5.5	±45	DFN4.5X3-14

Revision History

Date	Revision	Notes
2023-09-10	Rev.Pre.0	Initial version
2025-06-09	Rev.A.0	Released version
2025-11-04	Rev.A.1	Updated the values for I _{BAT} and the test conditions for some parameters Updated application information Updated thermal information

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Pin Configuration and Functions

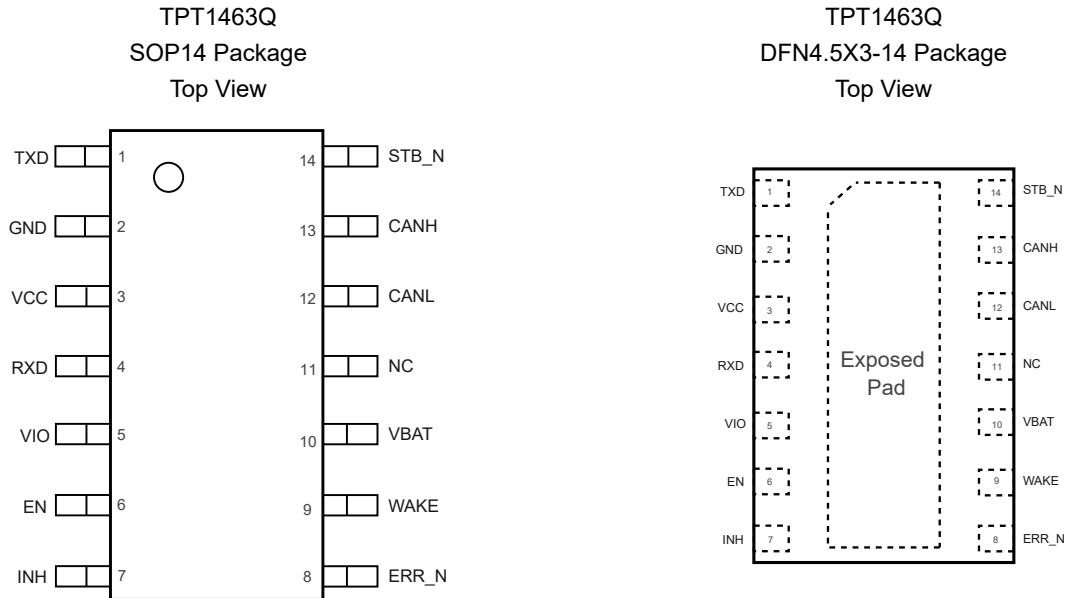


Table 1. Pin Functions: TPT1463Q

Pin		I/O	Description
No.	Name		
1	TXD	Input	CAN transmit data input (low for dominant and high for recessive bus states)
2	GND	GND	Ground connection
3	VCC	Power	5-V CAN bus supply voltage
4	RXD	Output	CAN receive data output (low for dominant and high for recessive bus states), tri-state
5	VIO	Power	I/O supply voltage
6	EN	Input	Enable input for mode control, integrated pull down
7	INH	Output	Can be used to control system voltage regulators
8	ERR_N	Output	Fault output, inverted logic
9	WAKE	Input	Wake input terminal, high voltage input
10	VBAT	Power	Reverse-blocked battery supply input
11	NC	-	No connect (not internally connected)
12	CANL	Bus I/O	Low-level CAN bus input/output line
13	CANH	Bus I/O	High-level CAN bus input/output line
14	STB_N	Input	Standby input for mode control, integrated pull down
	Exposed pad	GND	Thermal pad of DFN package, required to connect the exposed pad to Ground

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Specifications

Absolute Maximum Ratings ⁽¹⁾

Parameter		Min	Max	Unit
V _{BAT}	Battery Supply Voltage Range	-0.3	45	V
V _{CC}	5-V Bus Supply Voltage Range	-0.3	7	V
V _{IO}	I/O Level-Shifting Voltage Range	-0.3	7	V
V _{BUS}	CAN Bus I/O Voltage Range (CANH, CANL)	-45	45	V
V _{BUS_DIFF}	Differential Voltage of CAN Bus, CANH - CANL	-45	45	V
V _{LOGIC_IN}	Logic Input Voltage Range (TXD, STB_N, EN)	-0.3	7	V
V _{LOGIC_OUT}	Logic Input Voltage Range (RXD, ERR_N)	-0.3	V _{IO} + 0.3	V
V _{WAKE}	WAKE Input Pin Voltage Range	-45	45	V
V _{INH}	INH Output Pin Voltage Range	-0.3	V _{BAT} + 0.3	V
T _J	Junction Temperature	-55	150	°C
T _{STG}	Storage Temperature Range	-55	150	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

ESD and Transient Ratings

Parameter	Condition	Min	Max	Unit
V _{ESD}	Electrostatics Discharge			
	Contact discharge on bus pins (CANH, CANL); VBAT pin with 100nF capacitor; WAKE pin with 33 kΩ resistor, per IEC61000-4-2 (150pF,330Ω discharge circuit),	-8	8	kV
	Human Body Model (HBM) on bus pins (CANH, CANL), per AEC Q100-002	-15	15	kV
	Human Body Model (HBM) on all pins, per AEC Q100-002	-8	8	kV
	Charged Device Model (CDM) on all pins, per AEC Q100-011	-1.5	1.5	kV
V _{TRAN}	Transient Immunity ISO 7637-2 on CANH, CANL, VBAT, WAKE Pins			
	Pulse1	-100		V
	Pulse2a		75	V
	Pulse3a	-150		V
	Pulse3b		100	V

**Automotive Low-Power Fault Protected High-Speed CAN FD SIC
Transceiver with Sleep Mode****Recommended Operating Conditions**

Description		Min	Max	Unit
V _{BAT}	Battery Supply Voltage Range	4.5	40	V
V _{IO}	Input/output Voltage TXD, RXD, STB_N, ERR_N, EN	1.7	5.5	V
V _{CC}	Power Supply	4.5	5.5	V
I _{OH_RXD}	RXD Terminal High-Level Output Current	-4	-	mA
I _{OL_RXD}	RXD Terminal Low-Level Output Current	-	4	mA
I _{O_INH}	INH Output Current	-	1	mA
T _A	Operating Ambient Temperature	-40	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JB}	θ_{JC}	Unit
SOP14	79.65	38.22	41.5	°C/W
DFN4.5x3-14	35.26	14.98	36.56	°C/W

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Electrical Characteristics

All test conditions: $V_{CC} = 4.5\text{ V to }5.5\text{ V}$, $V_{IO} = 1.7\text{ V to }5.5\text{ V}$, $V_{BAT} = 4.5\text{ V to }40\text{ V}$, $R_L = 60\ \Omega$, $T_A = -40^\circ\text{C to }125^\circ\text{C}$, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Pin VCC; Power Supply						
V_{CC}	Supply Voltage		4.5	-	5.5	V
UV_{VCC_R}	Undervoltage Recovery on V_{CC}	V_{CC} Rising	-	3.6	4.3	V
UV_{VCC_F}	Undervoltage Detection on V_{CC}	V_{CC} Falling	3	3.4	-	V
V_{HYS_UVVCC}	Hysteresis Voltage on UV_{VCC}		50	100	-	mV
I_{CC}	Supply Current	Normal mode (dominant), $V_{TXD} = 0\text{ V}$; $t < t_{TXD_DTO}$	-	42	65	mA
		Normal mode (recessive), $V_{TXD} = V_{IO}$	-	7	9	mA
		Silent mode	-	5	8	mA
		Standby/Sleep mode	-	-	2	μA
		Dominant with bus fault, short circuit on bus line, $V_{TXD} = 0\text{ V}$, $-40\text{ V} < (V_{CANH} = V_{CANL}) < +40\text{ V}$	-	-	115	mA
Pin VIO; I/O Supply						
V_{IO}	Supply Voltage on V_{IO} Pin		1.7	-	5.5	V
UV_{VIO_R}	Undervoltage Recovery on V_{IO}	V_{IO} Rising	-	-	1.65	V
UV_{VIO_F}	Undervoltage Detection on V_{IO}	V_{IO} Falling	1.35	-	-	V
V_{HYS_UVVIO}	Hysteresis Voltage on UV_{VIO}		-	50	-	mV
I_{IO}	Supply Current from VIO	Normal mode, $V_{TXD} = 0\text{ V}$, Dominant	-	90	250	μA
		Normal/Silent mode, $V_{TXD} = V_{IO}$, Recessive	-	-	3	μA
		Standby/Sleep mode	-	-	2	μA
Pin VBAT; Supply from Battery						
V_{BAT}	Battery Supply Voltage		4.5	-	40	V
UV_{BAT_R}	Undervoltage Recovery on V_{BAT}	V_{BAT} rising	-	3.65	4.3	V
UV_{BAT_F}	Undervoltage Detection on V_{BAT}	V_{BAT} falling	3	3.45	-	V
V_{HYS_UVBAT}	Hysteresis Voltage on UV_{BAT}		-	100	-	mV
I_{BAT}	Battery Supply Current	Normal or Silent mode; pin INH left open	-	80	300	μA
		Normal or Silent mode; pin INH left open, $T_A \leq 25^\circ\text{C}$; $V_{BAT} = 14.5\text{ V}$	-	80	100	μA

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Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
		Standby mode, pin INH left open, $V_{WAKE} = V_{BAT}$	-	13	30	μA
		Sleep mode, $V_{WAKE} = V_{BAT}$	-	13	30	μA
Pin TXD; CAN Transmit Data Input						
V_{IH_TXD}	High-level Input Voltage		$0.7 \times V_{IO}$	-	-	V
V_{IL_TXD}	Low-level Input Voltage		-	-	$0.3 \times V_{IO}$	V
V_{HYS_TXD}	Hysteresis Voltage on TXD Inputs		50	500	-	mV
R_{PU_TXD}	TXD Pin Pull-Up Resistance		20	-	80	k Ω
C_i	Input Capacitance ⁽¹⁾		-	-	10	pF
Pin RXD; CAN Receive Data Output						
I_{OH_RXD}	High-level Output Current	$V_{RXD} = V_{IO} - 0.4 V$	-10	-	-1	mA
I_{OL_RXD}	Low-level Output Current	$V_{RXD} = 0.4 V$; Bus dominant	1	-	35	mA
Pin STB_N, EN; Standby and Enable Control Input						
V_{IH}	High-level Input Voltage		$0.7 \times V_{IO}$	-	-	V
V_{IL}	Low-level Input Voltage		-	-	$0.3 \times V_{IO}$	V
V_{HYS}	Hysteresis Voltage on STB_N, EN Inputs		50	500	-	mV
R_{PD}	STB_N, EN Pin Pull-down Resistance		20	-	80	k Ω
C_i	Input Capacitance ⁽¹⁾		-	-	10	pF
Pin ERR_N; Error and Power-on Indication Output						
$I_{OH_ERR_N}$	High-level Output Current	$V_{ERR_N} = V_{IO} - 0.4 V$	-50	-	-4	μA
$I_{OL_ERR_N}$	Low-level Output Current	$V_{ERR_N} = 0.4 V$	0.1	-	2	mA
Pin WAKE; Local Wake-up Pin						
R_{PU_WAKE}	WAKE Pin Pull-up Resistance		100	-	400	k Ω
R_{PD_WAKE}	WAKE Pin Pull-down Resistance		100	-	400	k Ω
V_{IH_WAKE}	Wake-up High-level Input Voltage	Sleep or Standby mode	2.6	-	-	V
V_{IL_WAKE}	Wake-up Low-level Input Voltage	Sleep or Standby mode	-	-	1.8	V
V_{HYS_WAKE}	Hysteresis Voltage on WAKE		90	200	-	mV
Pin INH; Inhibit High Voltage Output						
ΔV_H	High-level Voltage Drop	$\Delta V_H = V_{BAT} - V_{INH}$; $I_{INH} = -1$ mA	0	-	1	V
		$\Delta V_H = V_{BAT} - V_{INH}$; $I_{INH} = -2$ mA	0	-	2	V
I_{L_INH}	Leakage Current	Sleep mode; Off mode	-2	-	2	μA
I_{OS_INH}	Short-circuit Output Current	$V_{INH} = 0 V$	-30	-	-	mA

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit	
Pin CANH, CANL; CAN Bus Lines							
V _{O_DOM}	Dominant Bus Output Voltage	CANH	4.75 V ≤ V _{CC} ≤ 5.25 V, V _{TXD} = 0 V, 50 Ω ≤ R _L ≤ 65 Ω, C _L = open, t < t _{TXD_DTO}	2.89	3.5	4.26	V
		CANL		0.77	1.5	2.13	V
V _{SYM}	Transient Symmetry (dominant or recessive) (V _{O(CANH)} + V _{O(CANL)}) / V _{CC} ⁽¹⁾	R _L = 60 Ω, C _L = open, C _{SPLIT} = 4.7 nF, T _{XD} = 250 kHz, 1 MHz, 2.5 MHz	0.9	-	1.1	V/V	
V _{CM_STEP}	Common Mode Voltage Step ⁽¹⁾		-150	-	150	mV	
V _{CM_PP}	Peak to Peak Common Mode Voltage ⁽¹⁾		-300	-	300	mV	
V _{OD_DOM}	Differential Output Voltage (dominant)	Normal mode, t < t _{TXD_DTO} , 4.75 V ≤ V _{CC} ≤ 5.25 V, V _{TXD} = 0 V, 50 Ω ≤ R _L ≤ 65 Ω, C _L = open	1.5	-	2.75	V	
		Normal mode, t < t _{TXD_DTO} , 4.75 V ≤ V _{CC} ≤ 5.25 V, V _{TXD} = 0 V, 45 Ω ≤ R _L ≤ 70 Ω, C _L = open	1.4	-	3.3	V	
		Normal mode, t < t _{TXD_DTO} , 4.75 V ≤ V _{CC} ≤ 5.25 V, V _{TXD} = 0 V, R _L = 2240 Ω, C _L = open	1.5	-	5.0	V	
V _{OD_REC}	Differential Output Voltage (recessive)	Normal/Silent mode, V _{TXD} = V _{IO} , no load	-50	-	50	mV	
		Standby/sleep mode	-0.2	-	0.2	V	
V _{O_REC}	Recessive Output Voltage	Normal/Silent mode, V _{TXD} = V _{IO} , no load	2	2.5	3	V	
		Standby/sleep mode	-0.1	-	0.1	V	
V _{TH_RX_DIF}	Differential Receiver Threshold Voltage	Normal mode; t < t _{TXD_DTO} ; -12V ≤ V _{CANH} / V _{CANL} ≤ 12 V	0.5	-	0.9	V	
		Standby mode; t < t _{TXD_DTO} ; -12 V ≤ V _{CANH} / V _{CANL} ≤ 12 V	0.4	-	1.1	V	
V _{REC_RX}	Receiver Recessive Voltage	Normal mode; t < t _{TXD_DTO} ; -12 V ≤ V _{CANH} / V _{CANL} ≤ 12 V	-4	-	0.5	V	
		Standby mode; t < t _{TXD_DTO} ; -12 V ≤ V _{CANH} / V _{CANL} ≤ 12 V	-4	-	0.4	V	
V _{DOM_RX}	Receiver Dominant Voltage	Normal mode; t < t _{TXD_DTO} ; -12 V ≤ V _{CANH} / V _{CANL} ≤ 12 V	0.9	-	9	V	
		Standby mode; t < t _{TXD_DTO} ; -12 V ≤ V _{CANH} / V _{CANL} ≤ 12 V	1.1	-	9	V	
V _{HYS_RX_DIF_NO} M	Differential Receiver Hysteresis Voltage	Normal mode; t < t _{TXD_DTO} ; -12 V ≤ V _{CANH} / V _{CANL} ≤ 12 V	100	150	-	mV	

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Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{HYS_RX_DIF_STB} ⁽¹⁾	Differential Receiver Hysteresis Voltage	Standby mode; $t < t_{TXD_DTO}$; $-12\text{ V} \leq V_{CANH}/V_{CANL} \leq 12\text{ V}$	100	150	-	mV
I _{O_SC_DOM}	Dominant Short-circuit Output Current	$-40\text{ V} \leq V_{CANH}/V_{CANL} \leq 40\text{ V}$	-	-	100	mA
I _{O_SC_REC}	Recessive Short-circuit Output Current	$-40\text{ V} \leq V_{CANH}/V_{CANL} \leq 40\text{ V}$	-3	-	3	mA
I _L	Leakage Current	V _{CC} = V _{IO} = 0 V or pins shorted to GND via 47kΩ; V _{CANH} = V _{CANL} = 5 V	-10	-	10	μA
R _{IN}	Input Resistance (CANH or CANL)	$-2\text{ V} \leq V_{CANH}/V_{CANL} \leq +7\text{ V}$	25	40	50	kΩ
ΔR _{IN}	Input Resistance Deviation: $[1 - R_{IN(CANH)}/R_{IN(CANL)}] \times 100\%$	$0\text{ V} \leq V_{CANH}/V_{CANL} \leq 5\text{ V}$	-3	-	3	%
R _{ID}	Differential Input Resistance	$-2\text{ V} \leq V_{CANH}/V_{CANL} \leq +7\text{ V}$	50	80	100	kΩ
C _{IN}	Input Capacitance to Ground (CANH or CANL) ⁽¹⁾		-	-	30	pF
C _{IN_DIF}	Differential Input Capacitance ⁽¹⁾		-	-	15	pF
Pin CANH, CANL; Bus Lines Signal Improvement Capability (SIC)						
R _{IN_DIF_ACT_REC}	Active Recessive Phase Differential Internal Resistance ⁽¹⁾	Bus dominant-to-recessive transition; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$; $+2\text{ V} \leq V_{CANH} \leq V_{CC} - 2\text{ V}$; $+2\text{ V} \leq V_{CANL} \leq V_{CC} - 2\text{ V}$	75	-	133	Ω
Temperature Detection						
T _{J_SD}	Shutdown Junction Temperature ⁽¹⁾		160	180	200	°C
T _{J_SD_R}	Recover Shutdown Junction Temperature ⁽¹⁾		130		150	°C

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

AC Timing Requirements

All test conditions: $V_{CC} = 4.5\text{ V to }5.5\text{ V}$, $V_{IO} = 1.7\text{ V to }5.5\text{ V}$, $R_L = 60\ \Omega$, $T_A = -40^\circ\text{C to }125^\circ\text{C}$, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
CAN Timing Characteristics						
$t_{D_TXD_BUSDOM}$	Delay Time from TXD to Bus Dominant	Normal mode; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	-	-	80	ns
$t_{D_TXD_BUSREC}$	Delay Time from TXD to Bus Recessive	Normal mode; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	-	-	80	ns
$t_{D_BUSDOM_RXD}$	Delay Time from Bus Dominant to RXD	Normal mode; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	-	-	110	ns
$t_{D_BUSREC_RXD}$	Delay Time from Bus Recessive to RXD	Normal mode; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	-	-	110	ns
$t_{D_TXDL_RXDL}$	Loop Delay Time from TXD Low to RXD Low	Normal mode; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	-	-	190	ns
		Normal mode; $4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	-	-	255	ns
$t_{D_TXDH_RXDH}$	Loop Delay Time from TXD High to RXD High	Normal mode; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	-	-	190	ns
		Normal mode; $4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	-	-	255	ns
CAN FD Timing Characteristics						
t_{BIT_BUS}	Transmitted Recessive Bit Width	2 Mbps, $t_{BIT_TXD} = 500\text{ ns}$; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	490	-	510	ns
		2 Mbps, $t_{BIT_TXD} = 500\text{ ns}$; $4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	470	-	530	ns
		5 Mbps, $t_{BIT_TXD} = 200\text{ ns}$; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	190	-	210	ns
		5 Mbps, $t_{BIT_TXD} = 200\text{ ns}$; $4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	170	-	230	ns
		8 Mbps, $t_{BIT_TXD} = 125\text{ ns}$; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	115	-	135	ns
		8 Mbps, $t_{BIT_TXD} = 125\text{ ns}$; $4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	105	-	145	ns
t_{BIT_RXD}	RXD Bit Width	2 Mbps, $t_{BIT_TXD} = 500\text{ ns}$; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	470	-	530	ns
		2 Mbps, $t_{BIT_TXD} = 500\text{ ns}$; $4.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	450	-	540	ns
		5 Mbps, $t_{BIT_TXD} = 200\text{ ns}$; $4.75\text{ V} \leq V_{CC} \leq 5.25\text{ V}$	170	-	220	ns

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
		5 Mbps, $t_{\text{BIT_TXD}} = 200 \text{ ns}$; $4.5 \text{ V} \leq V_{\text{CC}} \leq 5.5 \text{ V}$	150	-	240	ns
		8 Mbps, $t_{\text{BIT_TXD}} = 125 \text{ ns}$; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	95	-	145	ns
		8 Mbps, $t_{\text{BIT_TXD}} = 125 \text{ ns}$; $4.5 \text{ V} \leq V_{\text{CC}} \leq 5.5 \text{ V}$	85	-	155	ns
$\Delta t_{\text{BIT_BUS}}$	Transmitted Recessive Bit Width Variation	2 Mbps, 5 Mbps, 8 Mbps; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	-10	-	10	ns
	$\Delta t_{\text{BIT_BUS}} = t_{\text{BIT_BUS}} - t_{\text{BIT_TXD}}$	2 Mbps, 5 Mbps, 8 Mbps; $4.5 \text{ V} \leq V_{\text{CC}} \leq 5.5 \text{ V}$	-30	-	30	ns
$\Delta t_{\text{BIT_RXD}}$	Received Recessive Bit Width Variation	2 Mbps, 5 Mbps, 8 Mbps; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	-30	-	20	ns
	$\Delta t_{\text{BIT_RXD}} = t_{\text{BIT_RXD}} - t_{\text{BIT_TXD}}$	2 Mbps, 5 Mbps, 8 Mbps; $4.5 \text{ V} \leq V_{\text{CC}} \leq 5.5 \text{ V}$	-50	-	40	ns
Δt_{REC}	Receiver Timing Symmetry Variation	2 Mbps, 5 Mbps, 8 Mbps; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	-20	-	15	ns
	$\Delta t_{\text{REC}} = t_{\text{BIT_RXD}} - t_{\text{BIT_BUS}}$	2 Mbps, 5 Mbps, 8 Mbps; $4.5 \text{ V} \leq V_{\text{CC}} \leq 5.5 \text{ V}$	-45	-	15	ns
CAN FD Signal Improvement Capability (SIC) Timing Characteristics						
$t_{\text{D_TXD_BUSREC_END}}$	Delay Time from TXD to Bus Recessive End ⁽¹⁾	Normal mode; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	-	-	530	ns
$t_{\text{D_TXD_BUSACTREC_START}}$	Delay Time from TXD to Bus Active Recessive Start ⁽¹⁾	Normal mode; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	-	-	120	ns
$t_{\text{D_TXD_BUSACTREC_END}}$	Delay Time from TXD to Bus Active Recessive End ⁽¹⁾	Normal mode; $4.75 \text{ V} \leq V_{\text{CC}} \leq 5.25 \text{ V}$	335	-	-	ns
Device Timing Characteristics						
$t_{\text{TXD_DTO}}$	TXD Dominant Time-out Time ⁽¹⁾	Normal mode; $V_{\text{TXD}} = 0 \text{ V}$	0.8	-	9.0	ms
$t_{\text{BUS_DTO}}$	BUS Dominant Time-out Time ⁽¹⁾	Normal or Silent mode; $V_{\text{O_DIF}} > 0.9 \text{ V}$	0.8	-	9.0	ms
$t_{\text{WAKE_BUSDOM}}$	Bus Dominant Wake-up Time	Standby/Sleep mode	0.5	-	1.8	μs
$t_{\text{WAKE_BUSREC}}$	Bus Recessive Wake-up Time	Standby/Sleep mode	0.5	-	1.8	μs
$t_{\text{WAKE_BUS_TO}}$	Bus Wake-up Time-out Time ⁽¹⁾	Standby/Sleep mode	0.8	-	9.0	ms
t_{MODE}	Mode Transition Time ⁽¹⁾		-	-	50	μs
$t_{\text{START_UP}}$	Start-up Time ⁽¹⁾		-	-	1.5	ms
$t_{\text{START_UP_RXD}}$	RXD Start-up Time ⁽¹⁾	After wake-up detected	4	-	20	μs
$t_{\text{START_UP_INH}}$	INH Start-up Time ⁽¹⁾	After wake-up detected	4	-	50	μs
$t_{\text{H_GO_TO_SLEEP}}$	Go-to-sleep Hold Time ⁽¹⁾	STB_N = LOW and EN = HIGH hold time for entering Sleep mode	24	-	50	μs

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t _{MC_ERR_N}	Delay Time from Mode Change to ERR_N ⁽¹⁾	ERR_N stable in response to a mode transition	-	-	20	μs
t _{WAKE}	Wake-up Time ⁽¹⁾	In response to a falling or rising edge on pin WAKE; Standby/ Sleep mode	20	-	50	μs
t _{IO_FILTER}	I/O Filter Time ⁽¹⁾		1	-	5	μs
t _{UVD}	Undervoltage Detection Time ⁽¹⁾	Pin VBAT	-	-	30	μs
		Pin VCC	-	-	30	μs
		Pin VIO	-	-	30	μs
t _{UVD_LONG}	Long Undervoltage Detection Time ⁽¹⁾	Pin VCC or VIO	100	-	150	ms
t _{UVR}	Undervoltage Recovery Time ⁽¹⁾	Pin VCC	-	-	50	μs
		Pin VIO	-	-	50	μs

(1) The test data is based on bench test and design simulation.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC
Transceiver with Sleep Mode

Parameter Measurement Information

Test Circuit

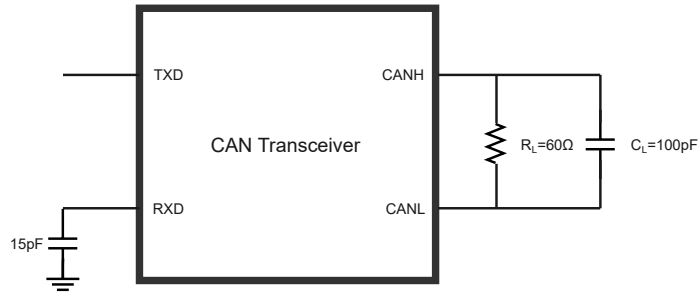


Figure 1. CAN Transceiver Timing Parameter Test Circuit

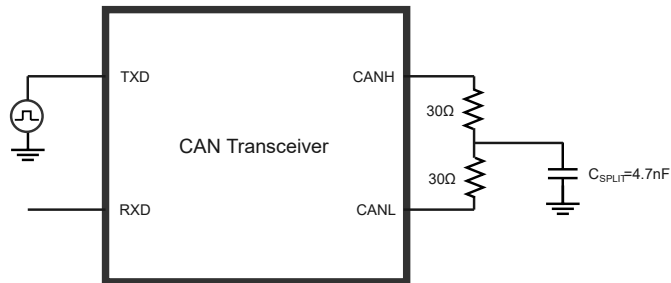


Figure 2. CAN Transceiver Driver Symmetry Test Circuit

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Parameter Diagram

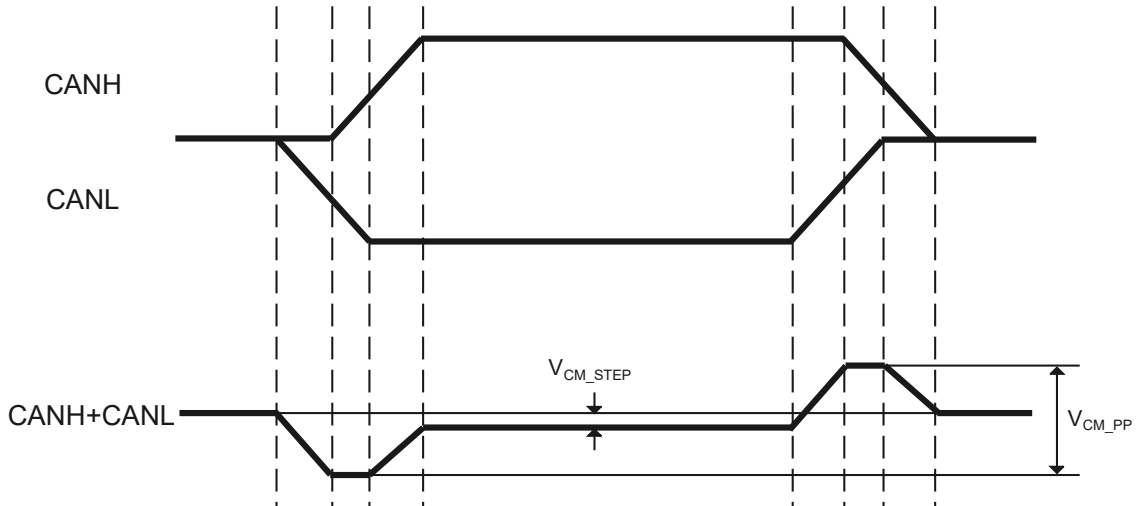


Figure 3. CAN Bus Common Mode Voltage

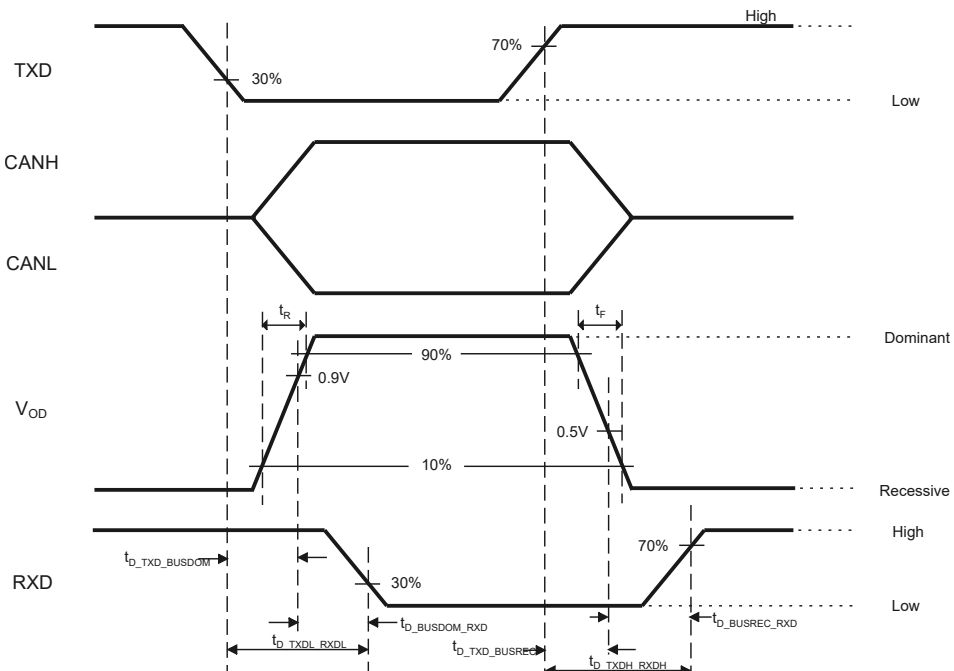


Figure 4. CAN Transceiver Timing Diagram

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

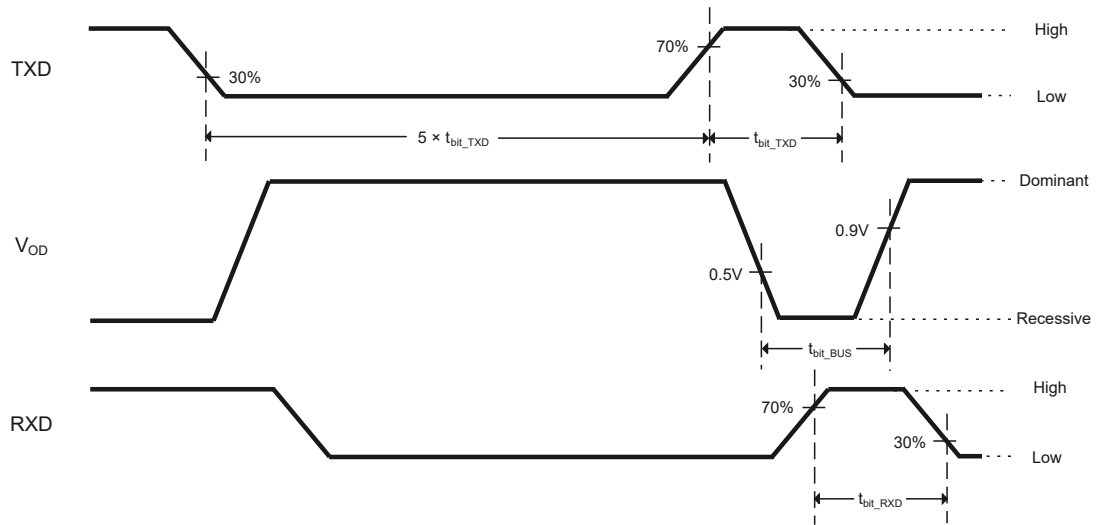


Figure 5. CAN FD Timing Parameter Diagram

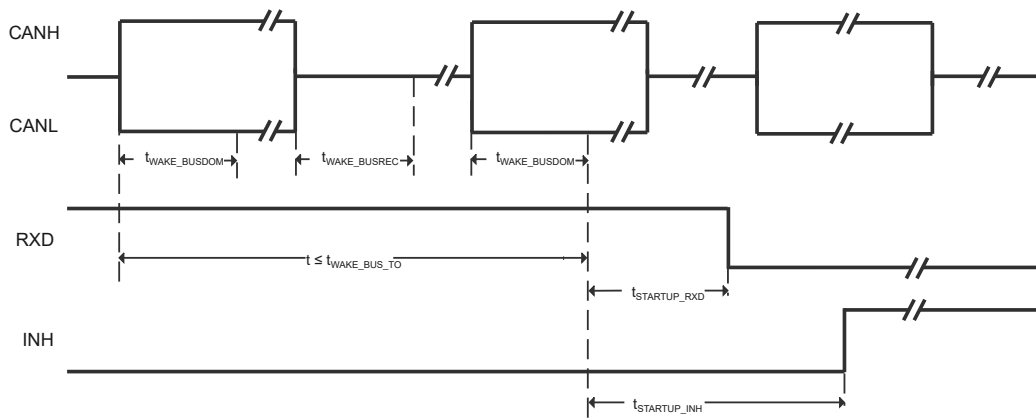


Figure 6. Wake-up Timing Diagram

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Detailed Description

Overview

The TPT1463Q is a CAN transceiver that meets the ISO11898-2:2024, CiA601-4 signal improvement capability (SIC) and SAEJ2284-1 to SAE J2284-5 high-speed CAN (Controller Area Network) physical layer standard. The devices are designed to be used in CAN FD networks up to 8 Mbps with enhanced timing margin. The system design could be optimized with excellent electromagnetic compatibility (EMC) and electrostatic discharge (ESD) performance. The TPT1463Q has a secondary power supply input VIO pin for I/O level shifting to support 1.8-V, 2.5-V, 3.3-V, and 5-V MCU logic levels directly. The device has low-current standby and sleep mode with CAN bus wake-up capability via wake-up pattern (WUP) which is defined in ISO11898-2:2024. The device supports ultra-low power management to power down the entire node and enables the power supply by the INH pin through the local or remote wake-up with wake-up source recognition capability. As designed, the devices feature bus fault protection from -45 V to $+45\text{ V}$, TXD dominant time-out (DTO), and over-temperature shutdown (TSD). Additionally, all devices include power-off ideal passive behavior fail-safe features to enhance the network robustness. The TPT1463Q is available in SOP14 and DFN4.5X3.0-14 packages and is AEC-Q100 qualified for automotive applications.

Functional Block Diagram

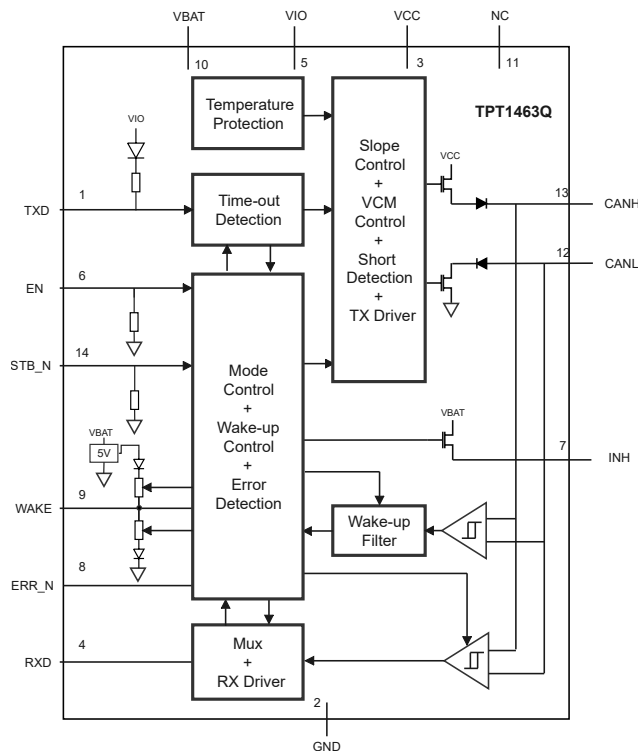


Figure 7. Functional Block Diagram

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Feature Description

Table 2. Driver Function Table

Device Mode	Inputs	Outputs		Driven BUS State
	TXD	CANH	CANL	
Normal	L	H	L	Dominant
	H or Open	Z	Z	Bus biased to VCC/2
Silent	X	Z	Z	Bus biased to VCC/2
Standby	X	Z	Z	Bus biased to GND
Sleep	X	Z	Z	Bus biased to GND
Off	X	Z	Z	Bus biased to high-ohmic

Table 3. Receiver Function Table

Device Mode	CAN Differential Inputs $V_{ID} = V_{CANH} - V_{CANL}$	BUS State	RXD Terminal
Normal/ Silent	$V_{ID} \geq V_{TH_RX_DIF+(MAX)}$	Dominant	L
	$V_{TH_RX_DIF-(MIN)} < V_{ID} < V_{TH_RX_DIF+(MAX)}$	Indeterminate	Indeterminate
	$V_{ID} \leq V_{TH_RX_DIF-(MIN)}$	Recessive	H
	Open ($V_{ID} \approx 0$ V)	Open	H
Standby/ Sleep	$V_{ID} \geq V_{TH_RX_DIF+(MAX)}$	Dominant	H, transition to L if the wake flag has been set
	$V_{TH_RX_DIF-(MIN)} < V_{ID} < V_{TH_RX_DIF+(MAX)}$	Indeterminate	
	$V_{ID} \leq V_{TH_RX_DIF-(MIN)}$	Recessive	
	Open ($V_{ID} \approx 0$ V)	Open	

System Operating Modes

The device has 5 operating modes: normal mode, standby mode, silent mode, sleep mode, and off mode. Operating mode selection is made via the EN pin and the STB_N pin and wake-up events when the power supply is valid.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

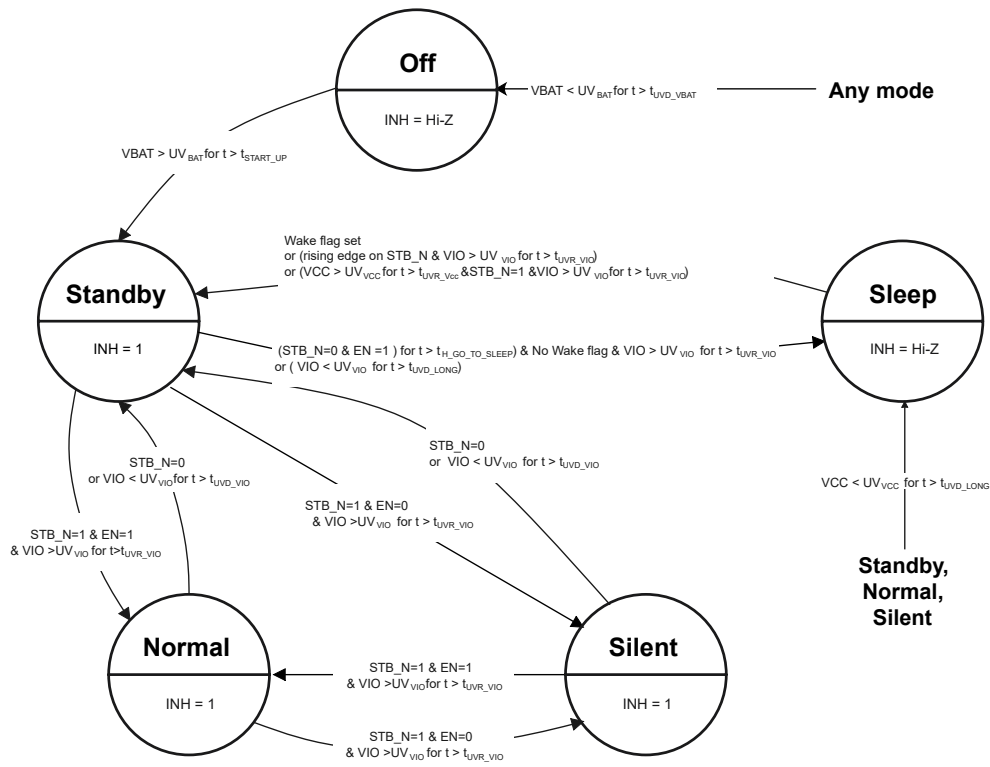


Figure 8. Mode Transition State Diagram

Normal Mode

This is the normal operating mode of the device. In the normal mode, the CAN driver and receiver block are fully operational. The transceiver transmits and receives data via the bus lines CANH and CANL. The driver translates the digital input data on the TXD pin to differential analog output on the CAN bus. The receiver translates the differential analog data on the CAN bus to digital data output to the RXD pin.

A HIGH level on pin STB_N and pin EN selects Normal mode, provided the battery supply voltage, VBAT, VCC, and VIO are present. The INH pin is active to enable the voltage regulated controlled by the INH pin.

Silent Mode

This is the listen-only mode of the device. In the silent mode, the driver is disabled, releasing the bus pins to a recessive state. All other blocks, including the receiver, continue to operate in the normal mode. The silent mode can be used to prevent a faulty CAN controller from disrupting CAN bus network communications.

A high level on pin STB_N and a low level on pin EN select Silent mode, provided VBAT, VCC, and VIO are present. The INH pin is active to enable the voltage regulated controlled by the INH pin.

Standby Mode

This is the first level of the low-power mode. In the standby mode, the driver and receiver of the CAN transceiver are disabled, and the device is unable to transmit or receive data. The low-power receiver is monitoring bus activity for valid wake-up requirements. The CAN bus pin is biased to the ground. The INH pin is active to enable the voltage regulator controlled by the INH pin. The pins RXD reflect active wake-up requests as VIO, VCC and VBAT are powered.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

When VBAT rises above the undervoltage detection threshold, UV_{BAT} , the device starts to boot up, triggering an initialization procedure. It switches to Standby mode after startup, resulting in a HIGH level on pin INH.

When VIO rises above the undervoltage detection threshold, UV_{VIO} , the device switches to Normal mode if pins STB_N and EN are high, and to silent mode if STB_N is high and EN is low. It remains in Standby mode if STB_N is low.

The device switches to Sleep mode if VIO remains below UV_{VIO} for t_{UVD_LONG} and/or VCC remains below UV_{VCC} for t_{UVD_LONG} . A transition from Standby mode to Sleep mode can also be triggered by holding STB_N low and EN high for $t_{H_GO_TO_SLEEP}$ (also known as a 'go-to-sleep' command). This 'go-to-sleep' command is overruled if the Wake flag is set, in which case the device remains in Standby mode.

Sleep Mode

This is the second level of low-power mode. In the sleep mode, the driver and receiver of the CAN transceiver are disabled, and the device is unable to transmit or receive data. The low-power receiver is monitoring bus activity for valid wake-up requirements. The CAN bus pin is biased to the ground. The INH pin is floating to disable the voltage regulator controlled by the INH pin for additional system-level power saving. The EN and STB_N pins can be used to change modes.

Sleep mode is entered in a number of ways:

- via Standby mode, in response to a 'go-to-sleep' command
- via Standby mode as a result of a VIO undervoltage longer than t_{UVD_LONG}
- via all other modes, except Off mode, as a result of a VCC undervoltage longer than t_{UVD_LONG}

A number of events cause the device to exit Sleep mode, switching to Standby mode:

- setting the Wake flag
- a rising edge on pin STB_N (if $VIO > UV_{VIO}$)
- $VCC > UV_{VCC}$, $VIO > UV_{VIO}$ and the 'go-to-sleep' command has not been activated.

After entering Standby mode, the device enters Normal or Silent if STB_N is high.

Off Mode

The device switches to Off mode from any mode when VBAT falls below UV_{BAT} .

In the off mode, the driver and receiver of the CAN transceiver are disabled, and the device is unable to transmit or receive data, pins INH, ERR_N, RXD, and CAN bus are in a high-ohmic state.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

CAN Operating Modes

The CAN state machine supports six operating modes.

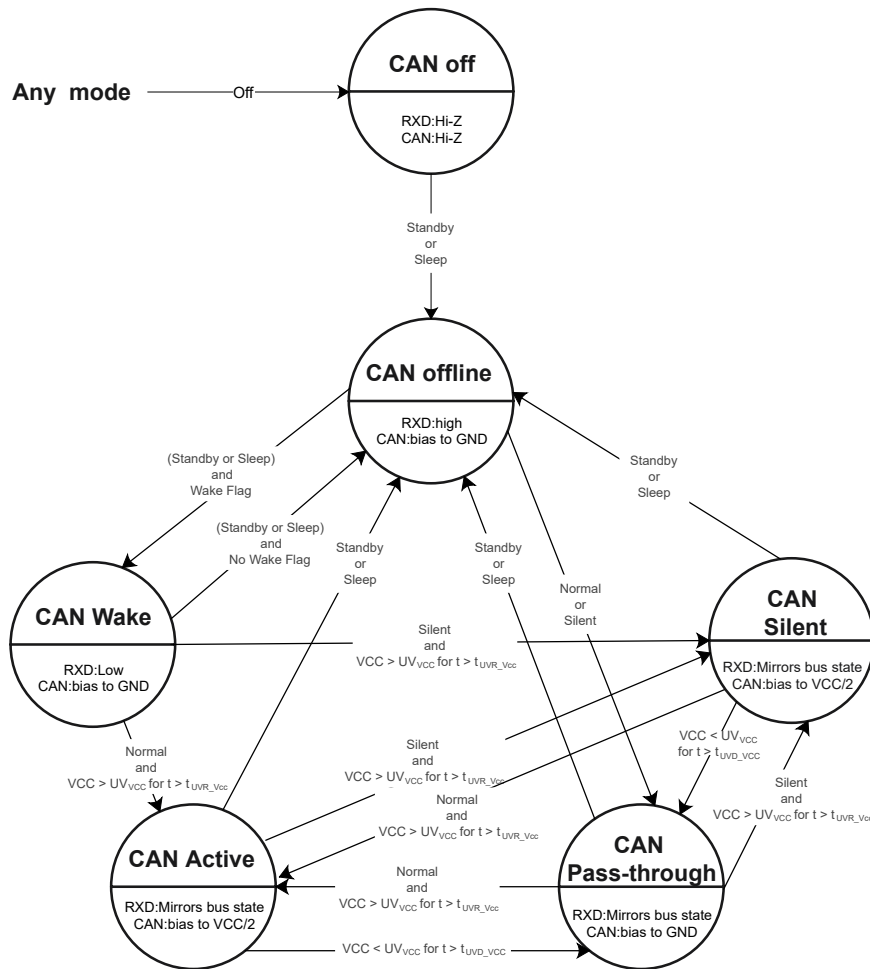


Figure 9. CAN State Diagram

CAN Off Mode

When the device is in Off mode, the CAN state machine is in CAN Off mode, with the bus pins and pin RXD in a high-ohmic state.

CAN Offline Mode

When the device is in Sleep or Standby mode and the Wake flag has not been set, the CAN state machine enters CAN Offline mode. The bus pins are biased to the ground. Pin RXD is high.

CAN Wake Mode

When the device is in Standby or Sleep mode and the wake flag has been set, the CAN state machine enters CAN Wake mode. Pin RXD turns low. The bus pins are biased to the ground.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

CAN Pass-through Mode

When the device is in Silent or Normal mode and V_{CC} is below UV_{VCC} , the CAN state machine turns into CAN Pass-through mode.

The bus pins are biased to the ground. The transceiver cannot transmit data via the bus lines in this mode. The low-power receiver monitors the dominant and recessive signals of CANH and CANL and reflects them to RXD.

CAN Active Mode

When the device is in Normal mode and V_{CC} is above the UV_{VCC} , the CAN state machine turns into CAN Active mode.

The transceiver can transmit and receive data via bus lines CANH and CANL. In this mode, pin TXD must be HIGH at least once before the first transmission can begin. The differential receiver monitors the dominant and recessive signals of CANH and CANL and reflects them to RXD. In the recessive state, the bus pins are biased to $V_{CC}/2$.

CAN Silent Mode

When the device is in Silent mode and V_{CC} is above UV_{VCC} , the CAN state machine turns into CAN Silent mode.

The transmitter is disabled. The differential receiver monitors the dominant and recessive signals of CANH and CANL and reflects them to RXD. The bus pins are biased to $V_{CC}/2$.

Internal Flags

The device has 4 Internal flags to support system diagnosis, these flags can output via ERR_N to allow the MCU to determine the status of the device and the system.

Table 4. Internal Flags via ERR_N

Internal Flag	Description	Available on ERR_N	Flag is Cleared
P _{WON}	P _{WON} is the V _{BAT} power-on flag	In Silent mode (coming from Standby or Sleep mode)	Entering Normal mode
Wake	The Wake flag is set when the transceiver detects a local or remote wake-up request.	In Standby mode and Sleep mode	Entering Normal mode or long VCC/VIO undervoltage
Wake-up source	Wake-up source recognition is provided via the wake-up source flag, which is set when the wake flag is set by a local wake-up request via the wake pin.	In Normal mode	Leaving Normal mode
Local failure	The four local failure events cause the local failure flag to be set: TXD dominant clamping, TXD-to-RXD short circuit, bus dominant clamping, and an overtemperature event.	In Silent mode (coming from Normal mode)	Entering the Normal mode or when RXD is dominant while TXD is recessive or by setting the P _{WON} flag

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Remote Wake-up

A dedicated wake-up pattern (ISO11898-2:2024) wakes up the device from standby mode or sleep mode. This filtering prevents the device from being woken up by noise or spikes on the bus. The wake-up pattern consists of the following:

- a dominant phase of at least t_{WAKE_BUSDOM} followed by
- a recessive phase of at least t_{WAKE_BUSREC} followed by
- a dominant phase of at least t_{WAKE_BUSDOM}

The complete wake-up pattern must be received within $t_{WAKE_BUS_TO}$, otherwise, the wake-up logic resets to wait for the next valid wake-up pattern.

Device Local Faults

TXD Dominant Time-out

The device is featured with the TXD dominant time-out detection function. This function prevents a permanent low on the TXD pin, resulting in the CAN bus being driven into permanent dominance, which causes the CAN bus network communication blocked. If the TXD remains low for longer than t_{TXD_DTO} , the transmitter is disabled until the fault flag has been cleared.

TXD Shorted to RXD Detection

The device is featured with the function of a short circuit between TXD and RXD detection. This function prevents the CAN bus from being locked in permanent dominance, which results in the CAN bus network communication being blocked. The transmitter is disabled until the fault flag has been cleared.

Bus Dominant Time-out

The device features the bus-dominant time-out detection function. This function prevents the CAN bus from being locked in permanent dominance, which results in the CAN bus network communication being blocked. The fault flag is set if the CAN bus remains dominant for longer than t_{BUS_DTO} and is released as soon as the bus returns to recessive.

Over-Temperature Protection (OTP)

The device integrates over-temperature protection circuit to prevent the device from over-heated induced damage. When the junction temperature is higher than the over-temperature protection threshold T_{OTP} , the device shuts down until the junction temperature T_J drops below the recovery threshold.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Application and Implementation

Note

Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

The TPT1463Q device is a CAN transceiver to support CAN FD function up to 8 Mbps, with BUS protection voltage from -45 V to +45 V, and over-temperature shutdown. The VIO of the TPT1463Q can support the voltage level of TXD and RXD from 1.7 V to 5.5 V, and V_{BAT} is from the battery power supply. The following sections show a typical application of the TPT1463Q.

Typical Application

Figure 10 shows the typical application schematic of the TPT1463Q.

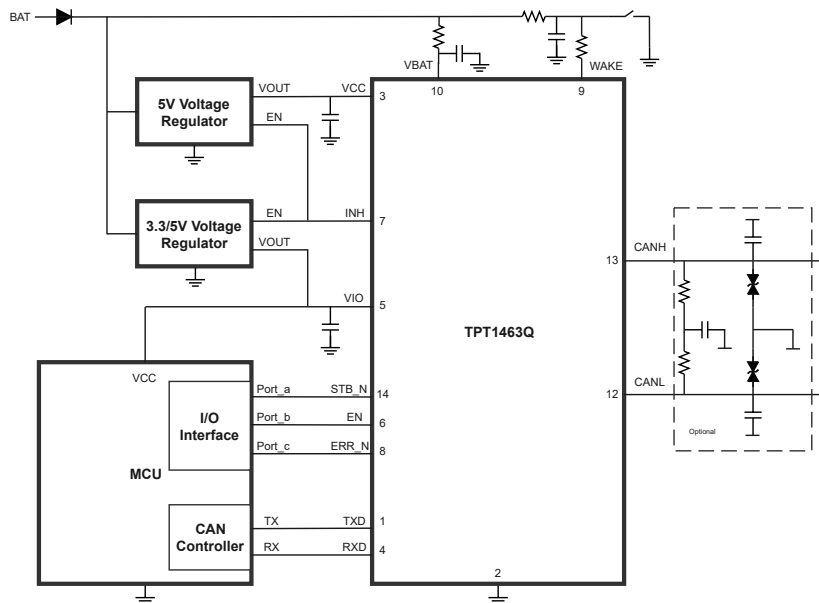
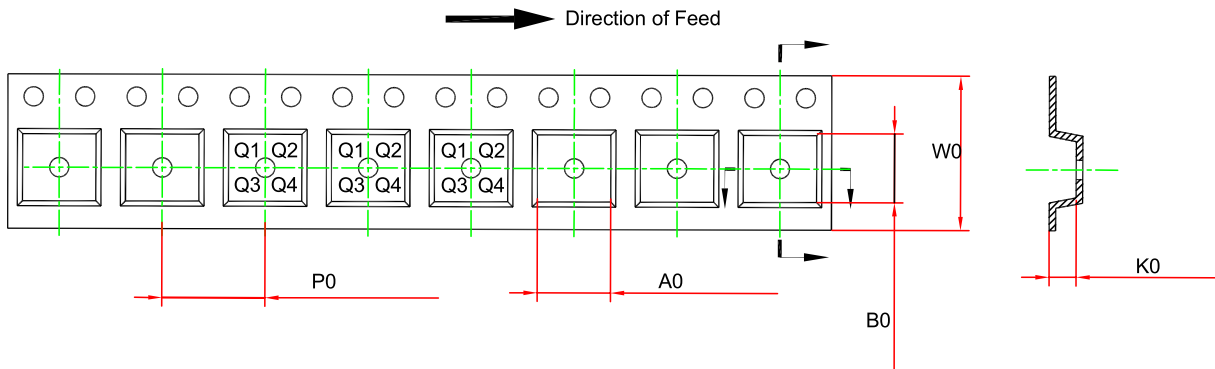
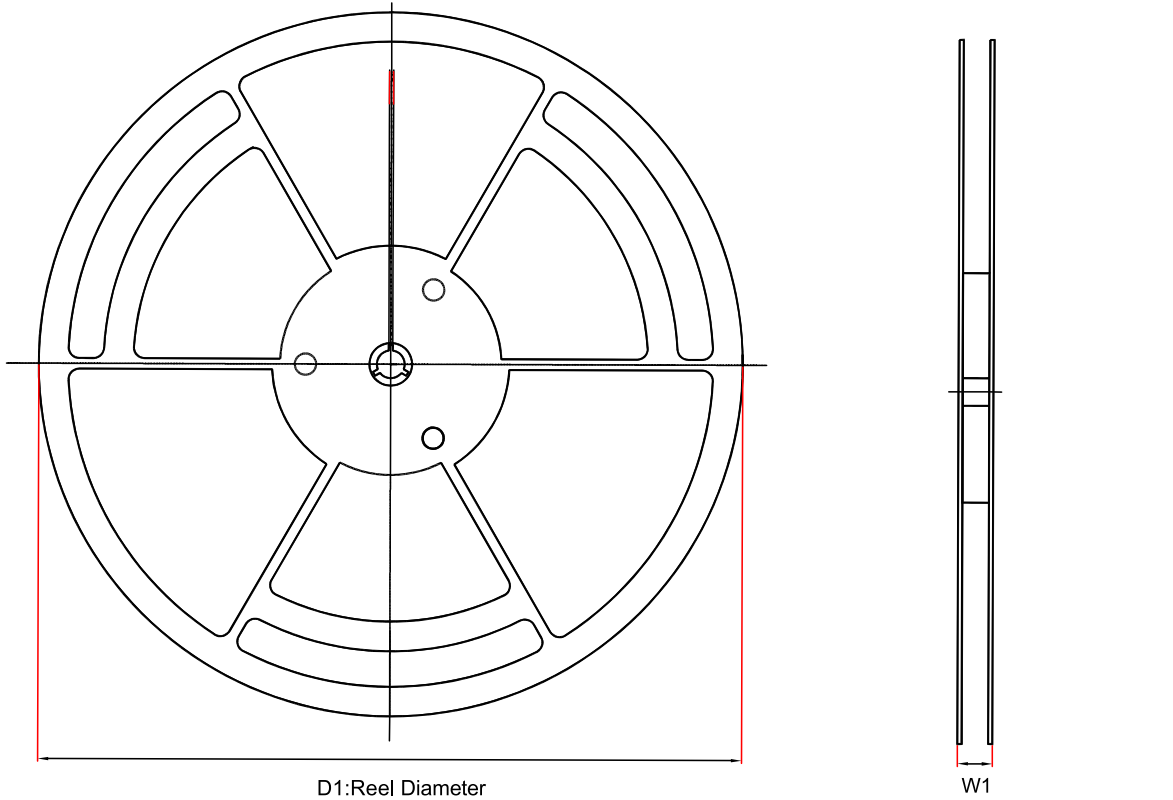


Figure 10. Typical Application Circuit

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Tape and Reel Information

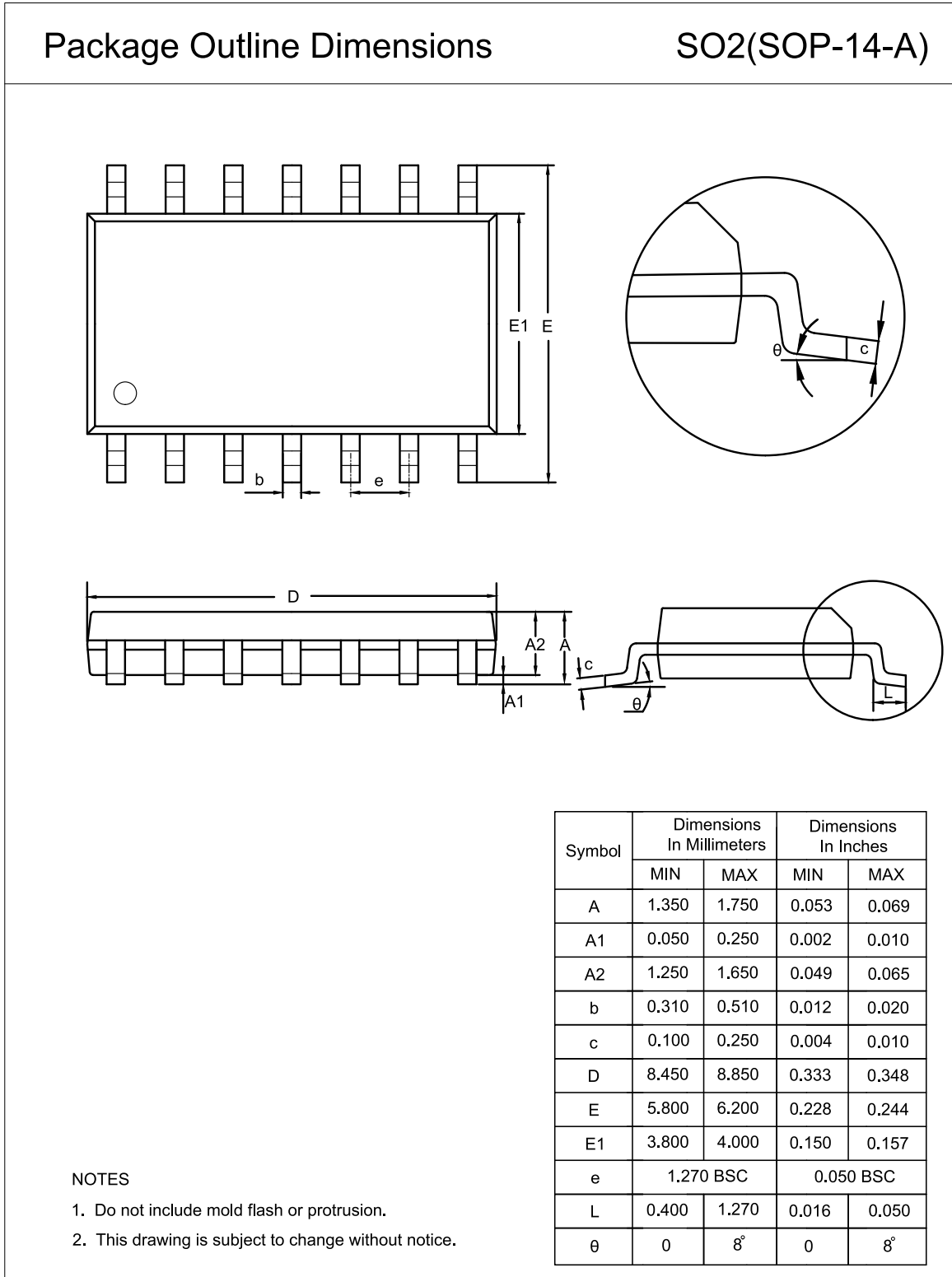


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPT1463Q-SO2R-S	SOP14	330	21.6	6.5	9.0	2.1	8.0	16	Q1
TPT1463Q-DFKR-S	DFN4.5X3-14	330	17.6	3.3	4.8	1.1	8.0	12	Q1

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Package Outline Dimensions

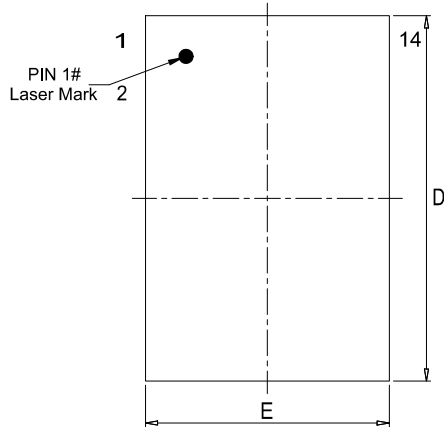
SOP14



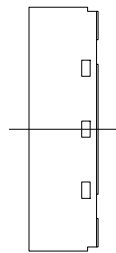
Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

DFN4.5X3-14

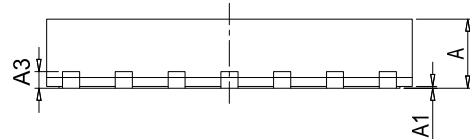
Package Outline Dimensions DFK(DFN4.5X3-14-WET-B)



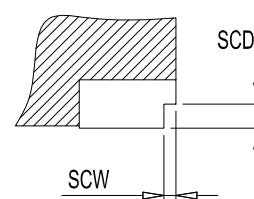
TOP VIEW



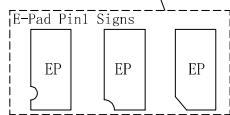
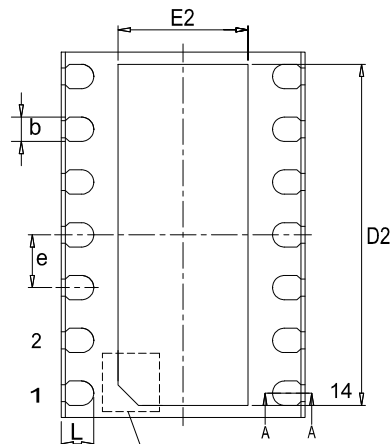
SIDE VIEW



SIDE VIEW



DETAIL A



BOTTOM VIEW

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. The many types of E-pad Pin1 signs may appear in the product.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	0.900	0.031	0.035
A1	0.000	0.050	0.000	0.002
b	0.250	0.350	0.010	0.014
A3	0.203 REF		0.008 REF	
D	4.400	4.600	0.173	0.181
E	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.300	0.500	0.012	0.020
D2	4.100	4.300	0.161	0.169
E2	1.500	1.700	0.059	0.067
SCW	0.010	0.090	0.0004	0.004
SCD	0.080	0.180	0.003	0.007

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT1463Q-SO2R-S	-40 to 125°C	SOP14	T163Q	MSL1	Tape and Reel, 2500	Green
TPT1463Q-DFKR-S	-40 to 125°C	DFN4.5X3-14	T163Q	MSL1	Tape and Reel, 4000	Green

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

Automotive Low-Power Fault Protected High-Speed CAN FD SIC Transceiver with Sleep Mode

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