Features

- Meet the ISO 11898 Standard
- Support CAN FD and Data Rates up to 5 Mbps
- Typical Loop Delay: 110 ns
- 5-V Power Supply, 3.0-V~5.5-V IO Interface
- Receiver Common-Mode Input Voltage: ±30 V
- Bus Fault Protection: ±42 V
- Up to 110 Nodes in CAN Network
- Junction Temperatures from −40°C to 150°C
- Latch-up Performance Exceeds 500 mA
- BUS Pin ESD Protection :
  - ±8-kV Human-Body Model
  - ±1.5-kV Charged-Device Model

Applications

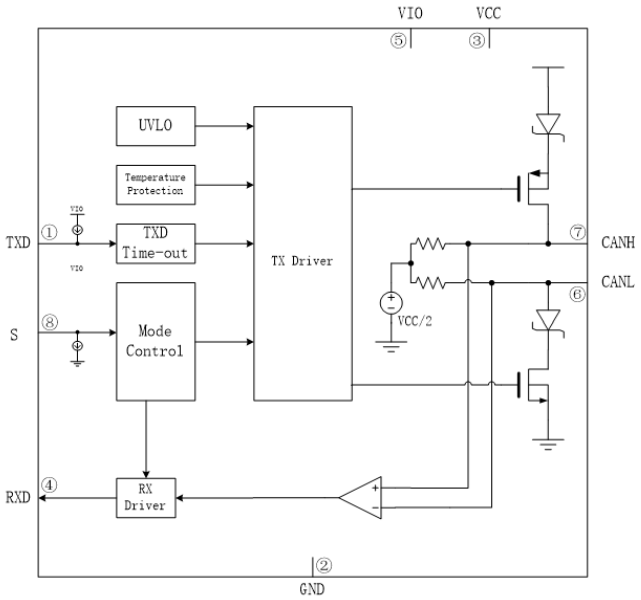
- All Devices Support Highly Loaded CAN Networks
- Field Industrial Automation, Sensors, and Drive Systems
- Building, Security Control Systems
- Energy Storage Systems
- Telecom Base Station Status and Control

Description

The TPT1051V is a CAN transceiver that meets the ISO11898 high-speed CAN (Controller Area Network) physical layer standard. The device is designed to be used in CAN FD networks up to 5 Mbps with enhanced timing margin higher data rates in long and highly loaded networks. As designed, the device features cross-wire, overvoltage, loss of ground protection from −42 V to +42 V, overtemperature shutdown, and a −30-V to +30-V common-mode range. The TPT1051V has a secondary power supply input for the I/O level, shifting the input pin thresholds and RXD output level, and the device comes with silent mode which is also commonly referred to as listen-only mode. It includes many protection features to enhance the device and network robustness.

The TPT1051V is available in SOP8 and DFN3x3-8 packages and is characterized from −40°C to +125°C.

Typical Application Circuit



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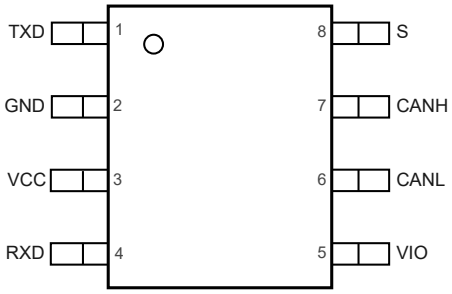
Revision History

Date	Revision	Notes
2020-02-18	Rev. Pre.0	Initial version.
2020-04-24	Rev. Pre.1	Updated the ESD level.
2020-05-18	Rev. Pre.2	Updated the electrical parameters.
2020-06-17	Rev. Pre.3	Added the DFN3×3-8L package.
2020-06-30	Rev.0	Released version.
2020-12-25	Rev.A.0	Updated the notes for Absolute Maximum Ratings.
2022-07-25	Rev.A.1	Updated the POD of SOP8 and DFN3×3-8.
2022-09-28	Rev.A.2	Updated the package drawing of DFN3×3-8.
2024-12-24	Rev.A.3	Updated to a new datasheet format. Updated the POD.

Pin Configuration and Functions

TPT1051V-SO1R
SOP8
Top View



TPT1051VL1-DF6R
DFN3×3-8L
Top View

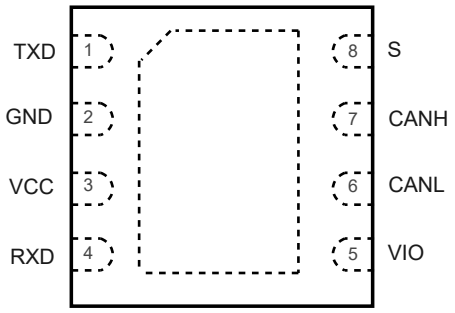


Table 1. Pin Functions: TPT1051V

Pin No.	Name	I/O	Description
1	TXD	I	CAN transmit data input (low for dominant and high for recessive bus states).
2	GND	GND	Ground.
3	VCC	POWER	Transceiver 5-V supply voltage.
4	RXD	O	CAN receive data output (low for dominant and high for recessive bus states).
5	VIO	POWER	Transceiver I/O level shifting supply voltage (devices with "V" suffix only).
6	CANL	BUS I/O	Low-level CAN bus input/output line.
7	CANH	BUS I/O	High-level CAN bus input/output line.
8	S	I	Silent mode control input (active high).

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
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)	−42	42	V
$V_{(Logic\_Input)}$	Logic Input Terminal Voltage Range (TXD, S)	−0.3	7	V
$V_{(Logic\_Output)}$	Logic Output Terminal Voltage Range (RXD)	−0.3	7	V
IO (RXD)	RXD (Receiver) Output Current	−8	8	mA
T_J	Maximum Operating Junction Temperature	−40	150	°C
T_{STG}	Storage Temperature Range	−65	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.
(2) This data was taken with the JEDEC low effective thermal conductivity test board.
(3) This data was taken with the JEDEC standard multilayer test boards.

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
$V_{I/O}$	Input/Output Voltage SCL1, SDA1, SCL2, SDA2	3.0		5.5	V
VCC	Power Supply	4.5		5.5	V
$I_{OH\ (RXD)}$	RXD Terminal High-Level Output Current	−2			mA
$I_{OL\ (RXD)}$	RXD Terminal Low-Level Output Current			2	mA
T_A	Operating Ambient Temperature	−40		125	°C

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1), bus pin	±8	kV
		ANSI/ESDA/JEDEC JS-001 (1), all other pins except for bus pin	±8	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	±1.5	kV
LU	Latch-Up	JESD78	±500	mA

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOP8	148	48	°C/W
DFN3×3-8	52	23	°C/W

Power Consumption

Symbol	Parameter	Test Condition	Value	Unit
P_D	Average Power Dissipation	V_{CC} = 5 V, V_{IO} = 3.3 V (if applicable), T_A = 25°C, R_L = 60 Ω, S at 0 V, Input to TXD at 250 kHz, C_{L_RXD} = 15 pF. Typical CAN operating conditions at 500 kbps with 25% transmission (dominant) rate.	65	mW
		V_{CC} = 5.5 V, V_{IO} = 3.6 V (if applicable), T_A = 125°C, R_L = 50 Ω, S at 0 V, Input to TXD at 0.5 MHz, C_{L_RXD} = 15 pF. Typical high load CAN operating conditions at 1 Mbps with 50% transmission (dominant) rate and loaded network.	135	mW

Electrical Characteristics

All test conditions: V_{CC} = 4.5 V to 5.5 V, V_{IO} = 3.0 V to 5.5 V, T_A = −40°C to 125°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
I_{CC}	Normal Mode (Dominant)	TXD = 0 V, R_L= 60 Ω, C_L = open, R_{CM} = open, S = 0 V		50	70	mA
		TXD = 0 V, R_L= 50 Ω, C_L = open, R_{CM} = open, S = 0 V		52	80	mA
	Normal Mode (Dominant-Bus Fault)	TXD = 0 V, S = 0 V, CANH = −12 V, R_L = open, C_L = open, R_{CM} = open		74	150	mA
	Normal Mode (Recessive)	TXD = V_{CC}, R_L = 50 Ω, C_L = open, R_{CM} = open, S = 0 V		1.3	2.5	mA
	Silent Mode	TXD = V_{CC}, R_L = 50 Ω, C_L = open, R_{CM} = open, S = V_{CC}		1.3	2.5	mA
I_{IO}	Normal and Silent Modes	RXD Floating, TXD = S = 0 or V_{IO}		73	300	μA
UV_{VCC}	Rising Undervoltage Detection on V_{CC} for Protected Mode			4.0	4.4	V
	Falling Undervoltage Detection on V_{CC} for Protected Mode		3.6	3.9	4.15	V
V_{HYS} (UVVCC)	Hysteresis Voltage on UV_{VCC}			200		mV
UV_{VIO}	Undervoltage Detection on V_{IO} for Protected Mode		1.3		2.75	V
V_{HYS} (UVVIO)	Hysteresis Voltage on UV_{VIO} for Protected Mode			150		mV
Pin-S (Mode Select Input)						
V_{IH}	High-Level Input Voltage		0.7 × V_{IO}			V
V_{IL}	Low-Level Input Voltage				0.3 × V_{IO}	V
I_{IH}	High-Level Input Leakage Current	S = V_{CC} or V_{IO} = 5.5 V			30	V
I_{IL}	Low-Level Input Leakage Current	S = 0 V, V_{CC} = V_{IO} = 5.5 V	−2	0	2	μA
$I_{lkg\ (OFF)}$	Unpowered Leakage Current	S = 5.5 V, V_{CC} = V_{IO} = 0 V	−1	0	1	μA
Pin- TXD (CAN Transmit Data Input)						
V_{IH}	High-Level Input Voltage		0.7 × V_{IO}			V
V_{IL}	Low-Level Input Voltage				0.3 × V_{IO}	V
I_{IH}	High-Level Input Leakage Current	S = V_{CC} or V_{IO} = 5.5 V	−2.5	0	1	μA

Symbol	Parameter		Conditions	Min	Typ	Max	Unit
I_{IL}	Low-Level Input Leakage Current		S = 0 V, V_{CC} = V_{IO} = 5.5 V	−100	−63	−7	μA
$I_{lkg\ (OFF)}$	Unpowered Leakage Current		TXD = 5.5 V, V_{CC} = V_{IO} = 0 V	−1	0	1	μA
C_I	Input Capacitance (1)				4.5		pF
Pin- RXD (CAN Receive Data Output)							
V_{OH}	High-Level Output Voltage		Devices with the "V" suffix (I/O level shifting), I_O = −2 mA	0.8 × V_{IO}			V
V_{OL}	Low-Level Output Voltage		Devices with the "V" suffix (I/O level shifting), I_O = +2 mA			0.2 × V_{IO}	V
$I_{lkg\ (OFF)}$	Unpowered Leakage Current		RXD = 5.5 V, V_{CC} = 0 V, V_{IO} = 0 V	−1	0	1	μA
Driver Electrical Characteristics							
$V_{O\ (DOM)}$	Bus Output Voltage (Dominant)	CANH	TXD = 0 V, S = 0 V, 50 Ω ≤ R_L≤ 65 Ω, C_L= open, R_{CM} = open	2.75		4.5	V
		CANL		0.5		2.25	V
$V_{O\ (REC)}$	Bus Output Voltage (Recessive)	CANH CANL	TXD = V_{CC}, V_{IO} = V_{CC}, S = V_{CC} or 0 V (2), R_L = open (no load), R_{CM} = open	2	0.5 × V_{CC}	3	V
$V_{OD\ (DOM)}$	Differential Output Voltage (Dominant)	CANH CANL	TXD = 0 V, S = 0 V, 45 Ω ≤ R_L < 50 Ω, C_L = open, R_{CM} = open	1.4		3	V
			TXD = 0 V, S = 0 V, 50 Ω ≤ R_L≤ 65 Ω, C_L = open, R_{CM} = open	1.5		3	V
			TXD = 0 V, S = 0 V, R_L = 2240 Ω, C_L = open, R_{CM} = open	1.5		5	V
$V_{OD\ (REC)}$	$V_{OD\ (REC)}$	$V_{OD\ (REC)}$	TXD = V_{CC}, S = 0 V, R_L = 60 Ω, C_L = open, R_{CM} = open	−120		12	mV
			TXD = V_{CC}, S = 0 V, R_L = open (no load), C_L = open, R_{CM} = open	−50		50	mV
V_{SYM}	Transient Symmetry (Dominant or Recessive) ($V_{O\ (CANH)}$ + $V_{O\ (CANL)}$) / V_{CC} (2)		S at 0 V, R_{term} = 60 Ω, C_{split} = 4.7 nF, C_L = open, R_{CM} = open, T_{XD} = 250 kHz, 1 MHz		1.0		V/V
V_{SYM_DC}	DC Output Symmetry (Dominant or Recessive) (V_{CC} − $V_{O\ (CANH)}$ − $V_{O\ (CANL)}$) (2)		S = 0 V, R_L = 60 Ω, C_L = open, R_{CM} = open	−1	0.2	1	V
$I_{OS\ (SS\_DOM)}$	Short-Circuit Steady-State Output Current, Dominant		S at 0 V, V_{CANH} = −5 V to 40 V, CANH = open, TXD = 0 V	−100			mA
			S at 0 V, V_{CANL} = −5 V to 40 V, CANH = open, TXD = 0 V			100	mA

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{OS\ (SS\_REC)}$	Short-Circuit Steady-State Output Current, Recessive	−27 V ≤ V_{BUS} ≤ 32 V, Where V_{BUS} = CANH = CANL, TXD = V_{CC}, all modes	−5		5	mA
Receiver Electrical Characteristics						
V_{CM}	Common Mode Range, Normal Mode	S = 0 or V_{CC} or V_{IO}	−30		+30	V
V_{IT+}	Positive-Going Input Threshold Voltage, All Modes	S = 0 or V_{CC} or V_{IO}, −20 V ≤ V_{CM} ≤ +20 V			900	mV
V_{IT-}	Negative-Going Input Threshold Voltage, All Modes		400			mV
V_{IT+}	Positive-Going Input Threshold Voltage, All Modes	S = 0 or V_{CC} or V_{IO}, −30 V ≤ V_{CM} ≤ +30 V			1000	mV
V_{IT-}	Negative-Going Input Threshold Voltage, All Modes		400			mV
V_{HYS}	Hysteresis Voltage (V_{IT+} − V_{IT-}) (2)	S = 0 or V_{CC} or V_{IO}		115		mV
$I_{lkg(IOFF)}$	Power-off (Unpowered) Bus Input Leakage Current	CANH = CANL = 5 V, V_{CC} = V_{IO} = 0 V			4.8	μA
C_I	Input Capacitance to Ground (CANH or CANL) (1)			35		pF
C_{ID}	Differential Input Capacitance (1)			20		pF
R_{ID}	Differential Input Resistance	TXD = V_{CC} = V_{IO} = 5 V, S = 0 V, −30 V ≤ V_{CM} ≤ +30 V	30		80	kΩ
R_{IN}	Input Resistance (CANH or CANL)		15		40	kΩ
$R_{IN\ (M)}$	Input Resistance Matching: [1 – $R_{IN(CANH)}$ / $R_{IN(CANL)}$] × 100%	V_{CANH} = V_{CANL} = 5 V	−2%		+2%	

(1) The typ data is based on the bench test by LRC meter E4980AL.
(2) The test data is based on the bench test and design simulation.

AC Timing Requirements

All test conditions: V_{CC} = 4.5 V to 5.5 V, V_{IO} = 3.0 V to 5.5 V, T_A = −40°C to 125°C, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Device Switching Characteristics						
t_{PROP} (LOOP1)	Total Loop Delay, Driver Input (TXD) to Receiver Output (RXD), Recessive to Dominant	S = 0 V, R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF		100	160	ns
t_{PROP} (LOOP2)	Total Loop Delay, Driver Input (TXD) to Receiver Output (RXD), Dominant to Recessive			110	175	ns
t_{MODE}	Mode Change Time, from Normal to Silent or from Silent to Normal			0.15	10	µs
Driver Switching Characteristics						
t_{pHR}	Propagation Delay Time, High TXD to Driver Recessive (Dominant to Recessive) (1)	S = 0 V, R_L = 60 Ω, C_L = 100 pF, R_{CM} = open		70		ns
t_{pLD}	Propagation Delay Time, Low TXD to Driver Dominant (Recessive to Dominant) (1)			42		ns
$t_{sk(p)}$	Pulse Skew ($\lvert t_{pHR} - t_{pLD} \rvert$) (1)			20		ns
t_R	Differential Output Signal Rise Time (1)			45		ns
t_F	Differential Output Signal Fall Time (1)			45		ns
t_{TXD_DTO}	Dominant Timeout	S = 0 V, R_L = 60 Ω, C_L = open	1.2		3.8	ms
Receiver Switching Characteristics						
t_{pRH}	Propagation Delay Time, Bus Recessive Input to High Output (Dominant to Recessive) (1)	S = 0 V, $C_{L(RXD)}$ = 15 pF		76		ns
t_{pDL}	Propagation Delay Time, Bus Dominant Input to Low Output (Recessive to Dominant) (1)			59		ns
t_R	RXD Output Signal Rise Time (1)			10		ns
t_F	RXD Output Signal Fall Time (1)			10		ns
FD Timing Parameters						
$t_{BIT(BUS)}$	Bit Time on CAN Bus Output Pins with $t_{BIT(TXD)}$ = 500 ns, All Devices	S = 0 V, R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF,	435		530	ns

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
	Bit Time on CAN Bus Output Pins with $t_{BIT(TXD)}$ = 200 ns, G Device Variants only	$\Delta t_{REC} = t_{BIT(RXD)} - t_{BIT(BUS)}$	155		210	ns
$t_{BIT\ (RXD)}$	Bit Time on RXD Output Pins with $t_{BIT(TXD)}$ = 500 ns, All Devices		400		550	ns
	Bit Time on RXD Output Pins with $t_{BIT(TXD)}$ = 200 ns, G Device Variants only		120		220	ns
Δt_{REC}	Receiver Timing Symmetry with $t_{BIT(TXD)}$ = 500 ns, All Devices		−65		40	ns
	Receiver Timing Symmetry with $t_{BIT(TXD)}$ = 200 ns, G Device Variants only		−45		15	ns

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

Detailed Description

Overview

The TPT1051V is a CAN transceiver that meets the ISO11898 high-speed CAN (controller area network) physical layer standard. The device is designed to be used in CAN FD networks up to 5 Mbps with enhanced timing margin and higher data rates in long and highly loaded networks. As designed, the device features cross-wire, overvoltage, loss of ground protection from −42 V to +42 V, overtemperature shutdown, and a −30-V to +30-V common-mode range. The TPT1051V has a secondary power supply input for the I/O level shifting the input pin thresholds and the RXD output level, and the device comes with silent mode which is also commonly referred to as listen-only mode, and it includes many protection features to enhance the device and network robustness.

Functional Block Diagram

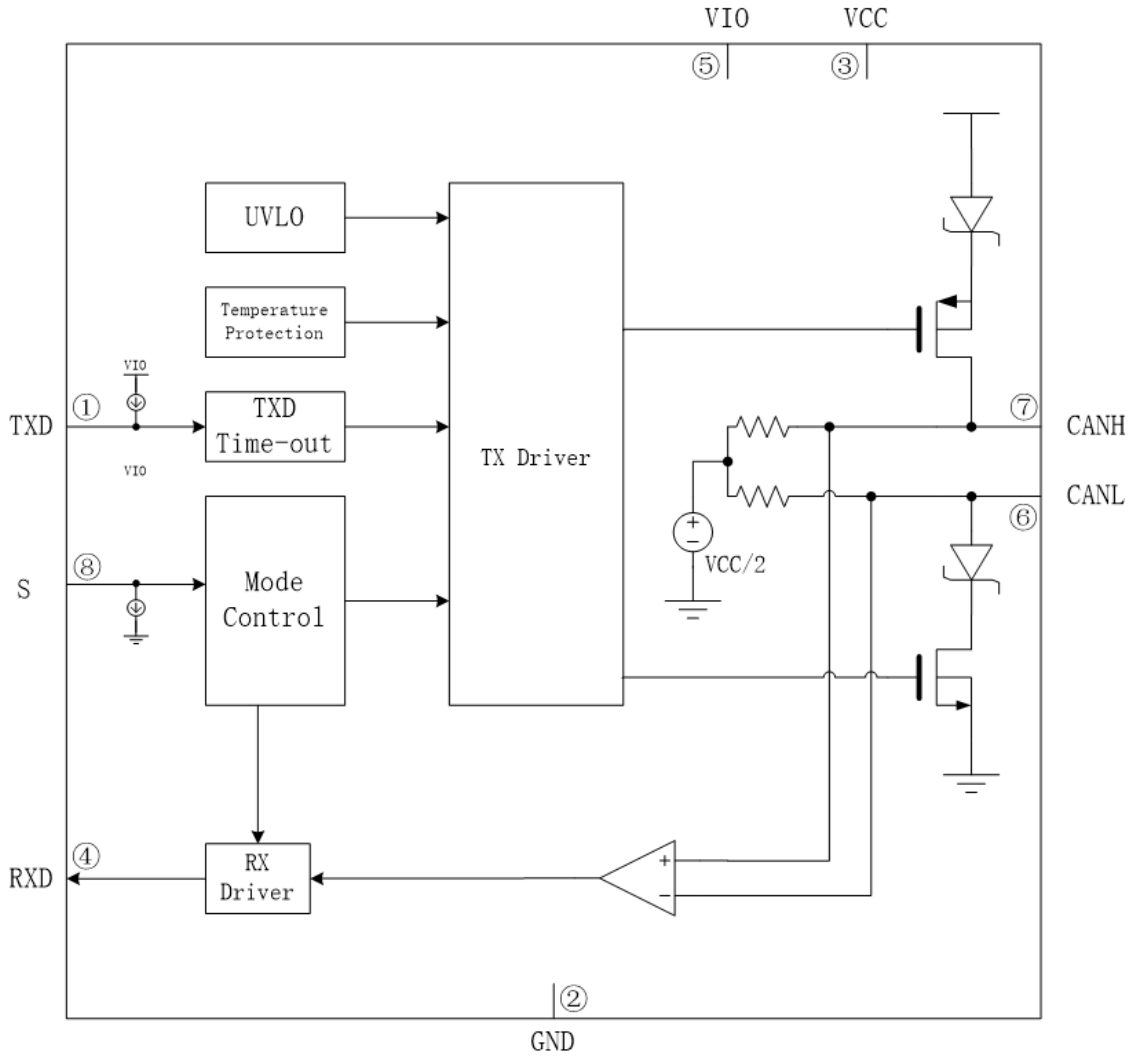


Figure 1. Functional Block Diagram

Feature Description

Driver Function Mode

Device	Inputs		Outputs		Driven BUS State
	S	TXD	CANH	CANL	
All Devices	L or open	L	H	L	Dominant
		H or Open	Z	Z	Recessive
	H	X	Z	Z	Recessive

Receiver Function Table

Device Mode	CAN Differential Inputs $V_{ID} = V_{CANH} – V_{CANL}$	BUS State	RXD Terminal
Normal or Silent	$V_{ID} \geq V_{IT+(MAX)}$	Dominant	L
	$V_{IT-(MIN)} < V_{ID} < V_{IT+(MAX)}$	Indeterminate	Indeterminate
	$V_{ID} \leq V_{IT-(MIN)}$	Recessive	H
	Open ($V_{ID} \approx 0$ V)	Open	H

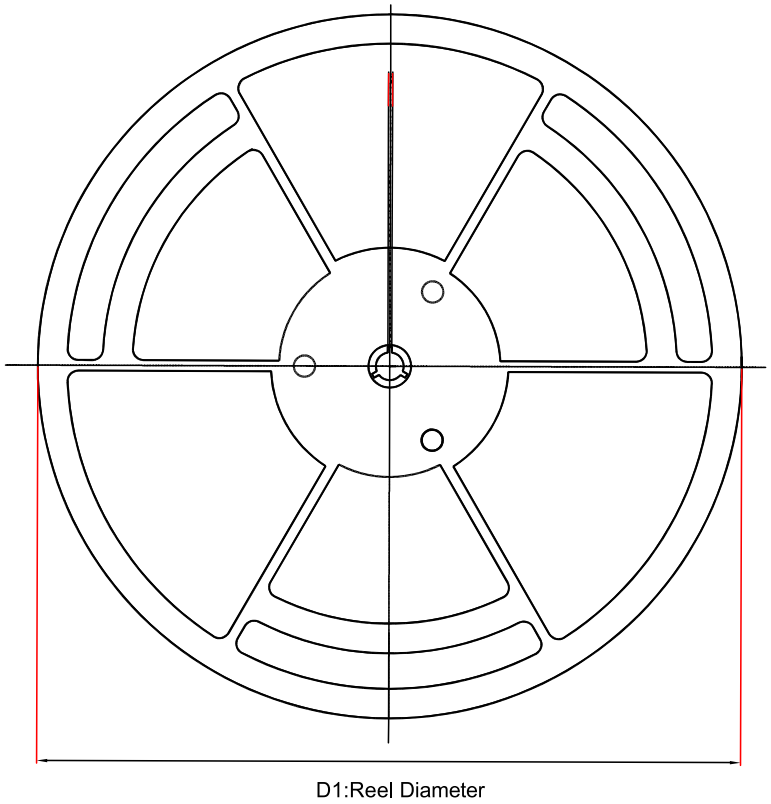
Normal Mode

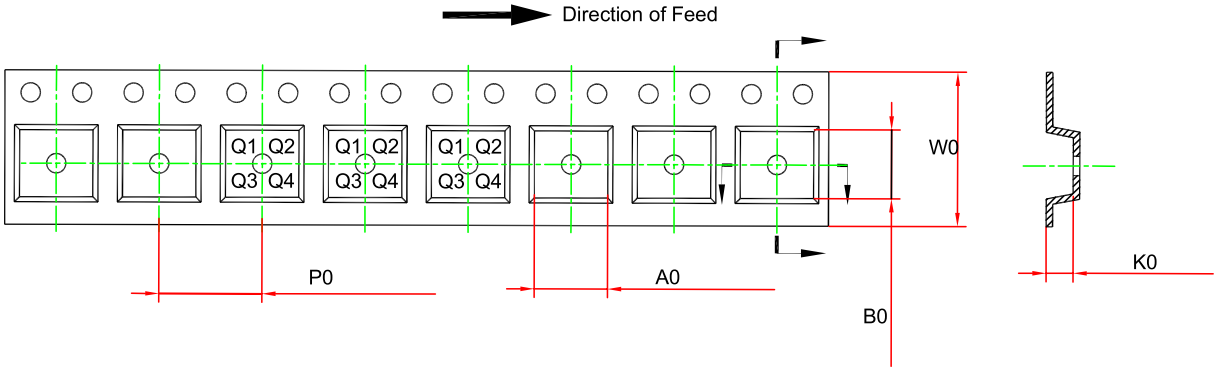
A Low level on the pin S selects the normal mode. In normal mode, the transceiver transmits and receives data via the bus lines CANH and CANL. The differential receiver converts the analog data on the bus lines into digital data which is output to the pin RXD. The slopes of the output signals on the bus lines are controlled internally and optimized to guarantee the lowest possible Electro Magnetic Emission (EME).

Silent Mode

A High level on the pin S selects the silent mode. In silent mode, the transmitter is disabled, releasing the bus pins to a recessive state. All other IC functions, including the receiver, continue to operate as in the normal mode, just like the listen-only mode. The silent mode can be used to prevent a faulty CAN controller from disrupting all network communications.

Tape and Reel Information





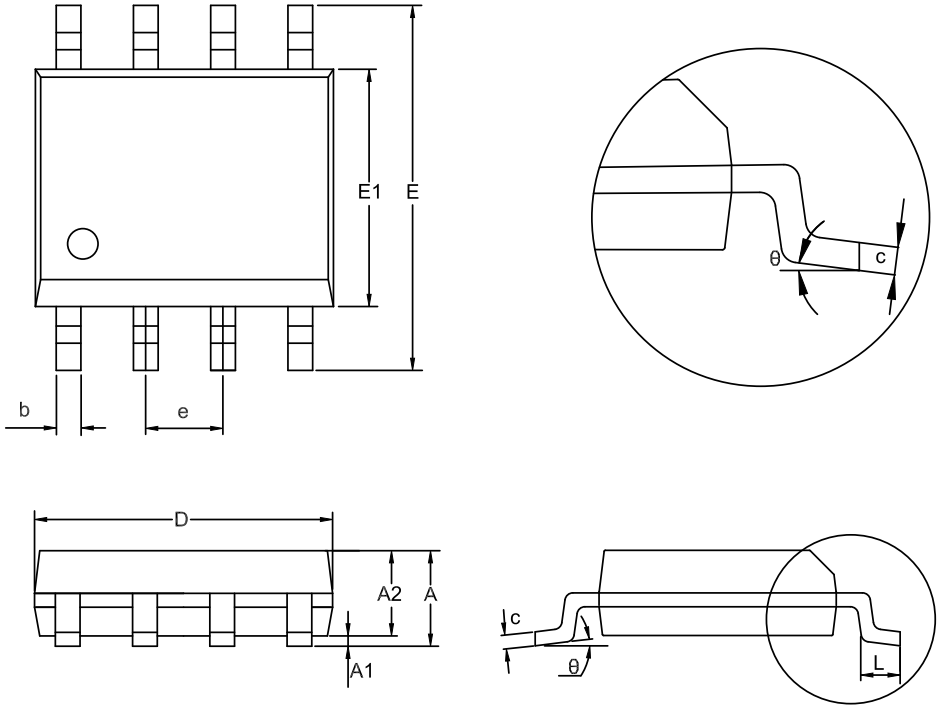
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPT1051V-SO1R	SOP8	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TPT1051V-DF6R	DFN3×3-8	330.0	17.6	3.3	3.3	1.1	8.0	12.0	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOP8

Package Outline Dimensions SO1(SOP-8-A)



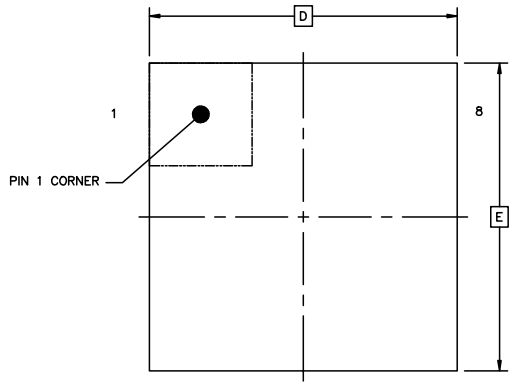
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8°	0	8°

NOTES

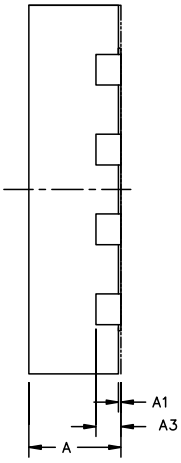
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

DFN3×3-8

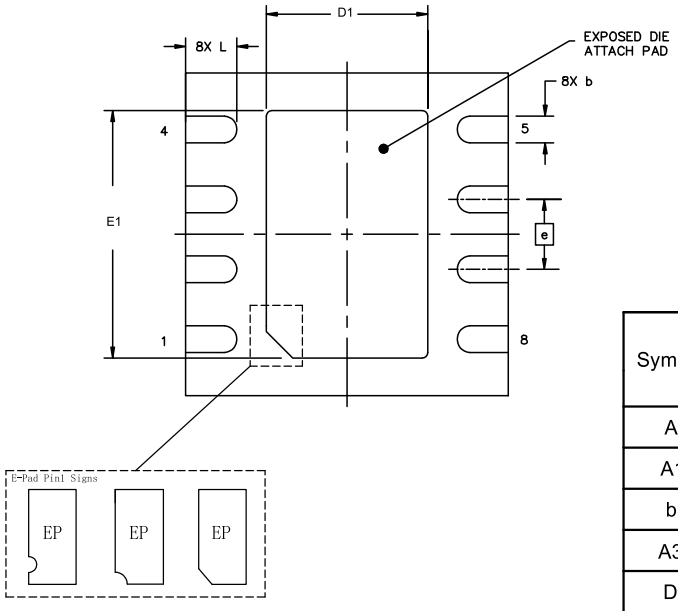
Package Outline Dimensions DF6(DFN3X3-8-A)



TOP VIEW



SIDE VIEW



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	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
b	0.200	0.350	0.008	0.014
A3	0.150	0.250	0.006	0.010
D	2.900	3.100	0.114	0.122
D1	1.400	1.600	0.055	0.063
E	2.900	3.100	0.114	0.122
E1	2.200	2.400	0.087	0.094
e	0.650 BSC		0.026 BSC	
L	0.224	0.575	0.009	0.023

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT1051V-SO1R	−40 to 125°C	SOP8	T1051V	3	Tape and Reel, 4000	Green
TPT1051V-DF6R	−40 to 125°C	DFN3x3-8	1051V	3	Tape and Reel, 4000	Green

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

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