Features

- Meet the ISO 11898-2:2016 and ISO 11898-5:2007 Physical Layer Standards
- 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
- Low power current in standby mode: 15 μA
- Receiver Common Mode Input Voltage: ±30 V
- Bus Fault Protection: ±70 V
- Up to 110 Nodes in CAN network
- Junction Temperature Range from −40°C to 150°C
- Latch-Up performance exceeds 500 mA
- BUS pin ESD Protection:
  - ±2.5 kV Human-Body Model
  - ±1.5 kV Charged-Device Model

Applications

- All devices supporting highly loaded CAN networks
- Automotive and Transportation
- Field Industrial Automation, Sensors and Drive Systems
- Building, Security Control Systems

Description

The TPT1042 is a CAN transceiver that meets the ISO11898 High-speed CAN (Controller Area Network) physical layer standard. The device is designed in CAN FD networks up to 5 Mbps, and enhances timing margin and higher data rates in long and highly-loaded networks. As the design, the device features cross-wire, overvoltage and loss of ground protection from −70 V to +70 V, overtemperature shutdown, a −30 V to +30 V common-mode range. The TPT1042 has a secondary power supply input for I/O level shifting the input pin thresholds and RXD output level, and the device comes with standby mode which is also waked up from CAN BUS, and it includes many protection features to enhance device and network robustness.

The TPT1042 is available in SOP-8 and DFN3X3-8L packages and is characterized from −40°C to +125°C.

Functional Block Diagram

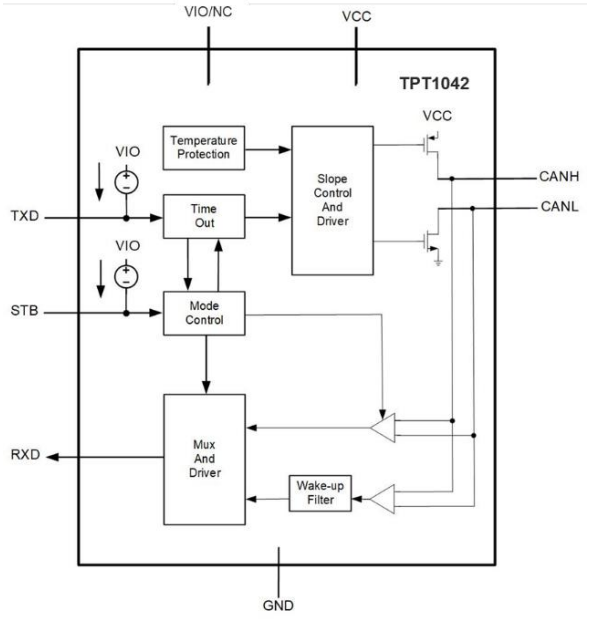


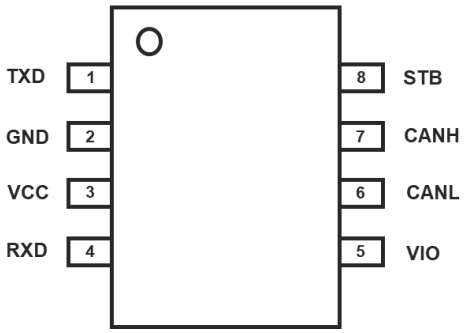
Table of Contents

Revision History

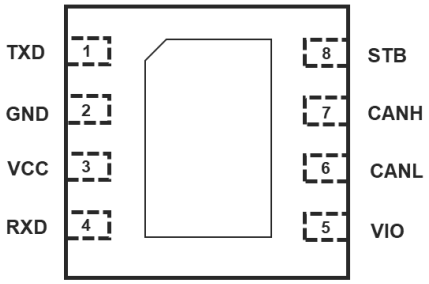
Date	Revision	Notes
2020-12-05	Rev.Pre.0	Initial Version
2021-10-21	Rev.Pre.1	Added electrical parameter
2022-01-12	Rev.Pre.2	Updated ESD data

Pin Configuration and Functions-TPT1042V

TPT1042V-SO1R
SOP8



TPT1042V-DF6R
DFN3X3-8L

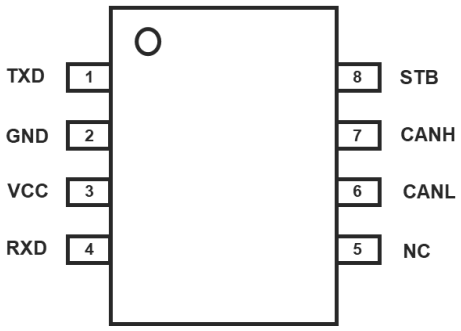


Pin Functions

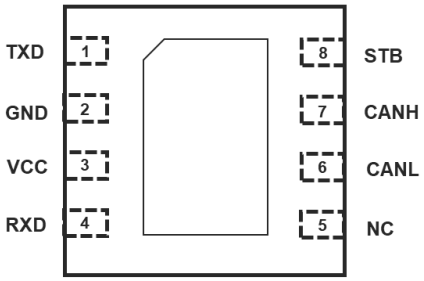
Pin		I/O	Description
No.	Name		
1	TXD	I	CAN transmit data input (LOW for dominant and HIGH for recessive bus states)
2	GND	GND	Ground
3	VCC	POWER	Transceiver 5 V supply voltage
4	RXD	O	CAN receive data output (LOW for dominant and HIGH for recessive bus states)
5	VIO	POWER	Transceiver I/O level shifting 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	STB	I	Standby Mode control input (active high)

Pin Configuration and Functions-TPT1042

TPT1042-SO1R
SOP8



TPT1042-DF6R
DFN3X3-8L



Pin Functions

Pin		I/O	Description
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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	NC	–	Not Connected
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	STB	I	Standby Mode control input (active high)

Specifications

Absolute Maximum Ratings

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)	−70	70	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 Junction Temperature	−40	150	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_{OTP}	Shutdown Junction Temperature		170	°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.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	HBM, per ANSI/ESDA/JEDEC JS-001 (1)	Bus Pin: CAN_H, CAN_L	±2.5	kV
		All Pin Except Bus Pin	±8	kV
CDM	CDM, per ANSI/ESDA/JEDEC JS-002 (2)	All Pin	±1.5	kV
LU	LU, per JESD78	All Pin	±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.

Recommended Operating Conditions

Parameter		Min	Max	Unit
$V_{I/O}$	Input/output voltage	3.0	5.5	V
V_{CC}	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

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
8-Pin SOIC	118	48	°C/W
8-Pin QFN	51	23	°C/W

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
I_{CC}	Normal mode (dominant)	TXD = 0 V, R_L = 60 Ω, C_L = open, R_{CM} = open, S = 0 V		50		mA
		TXD = 0 V, R_L = 50 Ω, C_L = open, R_{CM} = open, S = 0 V		52		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		mA
	Normal mode (recessive)	TXD = V_{CC}, R_L = 50 Ω, C_L = open, R_{CM} = open, S = 0 V		1.3		mA
	Standby mode	TXD = V_{CC}, RL = 50 Ω, C_L = open, R_{CM} = open, STB = V_{CC}		3.5		µA
I_{IO}	Normal and Standby modes	RXD Floating, TXD = S = 0 or V_{IO}		73		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 UVVCC			200		mV
UV_{VIO}	Undervoltage detection on VIO for protected mode		1.3		2.75	V
$V_{HYS(UVVIO)}$	Hysteresis voltage on UV_{VIO} for protected mode			150		mV
Pin-STB (mode select input)						
V_{IH}	High-level input voltage		0.7 x V_{IO}			V
V_{IL}	Low-level input voltage				0.3 x V_{IO}	V
I_{IH}	High-level input leakage current	STB = V_{CC} or V_{IO} = 5.5 V			30	µA
I_{IL}	Low-level input leakage current	STB = 0 V, V_{CC} = V_{IO} = 5.5 V	−2	0	2	µA
$I_{lkg(OFF)}$	Unpowered leakage current	STB = 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 x V_{IO}			V
V_{IL}	Low-level input voltage				0.3 x V_{IO}	V
I_{IH}	High-level input leakage current	S = V_{CC} or V_{IO} = 5.5 V	−2.5	0	1	µA
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

(1) Typ data is based on bench test by LRC meter E4980AL.

Electrical Characteristics (Continued)

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
Pin- RXD (CAN receive data output)							
V_{OH}	High-level output voltage		Devices with the "V" suffix (I/O levelshifting), I_O = −2 mA	0.8 × V_{IO}			V
V_{OL}	Low-level output voltage		Devices with the "V" suffix (I/O levelshifting), I_O = +2 mA			0.2 x 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 x 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} (1)		S at 0 V, Rterm = 60 Ω, Csplit = 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} – $V_{O(CANH)}$ – $V_{O(CANL)}$) (1)		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	
$I_{OS(SS\_REC)}$	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

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

Electrical Characteristics (Continued)

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
Receiver electrical characteristics						
V_{CM}	Common mode range, normal mode	STB = 0 or V_{CC} or V_{IO}	−30		+30	V
V_{IT+}	Positive-going input threshold voltage, all modes	STB = 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			
V_{IT+}	Positive-going input threshold voltage, all modes	STB = 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			
V_{HYS}	Hysteresis voltage (V_{IT+} − V_{IT-}) (1)	STB = 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) (2)			35		pF
C_{ID}	Differential input capacitance (3)			20		pF
R_{ID}	Differential input resistance	TXD = V_{CC} = V_{IO} = 5 V, STB = 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%	
Power Consumption						
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				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.				mW

(1) Test data based on bench test and design simulation.
(2) Typ data is based on bench test by LRC meter E4980AL.
(3) Typ data is based on bench test by LRC meter E4980AL.

Electrical Characteristics-AC Timing Requirements (Continued)

All test conditions: V_{DD} = 5 V, T_A = +25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Device Switching Characteristics						
$t_{PROP(LOOP1)}$	Total loop delay, driver input (TXD) to receiver output (RXD), recessive to dominant	STB = 0 V, R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF		100		ns
$t_{PROP(LOOP2)}$	Total loop delay, driver input (TXD) to receiver output (RXD), dominant to recessive			110		
t_{MODE}	Mode change time, from Normal to Silent or from Silent to Normal			0.15		µs
t_{pHR}	Propagation delay time, high TXD to driver recessive (dominant to recessive) (1)	STB = 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		
$t_{sk(p)}$	Pulse skew ($\|t_{pHR} - t_{pLD}\|$) (1)			20		
t_R	Differential output signal rise time (1)			45		
t_F	Differential output signal fall time (1)			45		
t_{TXD_DTO}	TXD 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)	STB = 0 V, $C_{L(RXD)}$ = 15 pF		75		ns
t_{pDL}	Propagation delay time, bus dominant input to low output (Recessive to Dominant) (1)			59		
t_R	RXD Output signal rise time (1)			10		
t_F	RXD Output signal fall time (1)			10		

(1) Test data based on bench test and design simulation

Electrical Characteristics-AC Timing Requirements (Continued)

All test conditions: V_{DD} = 5 V, T_A = +25°C, unless otherwise noted.

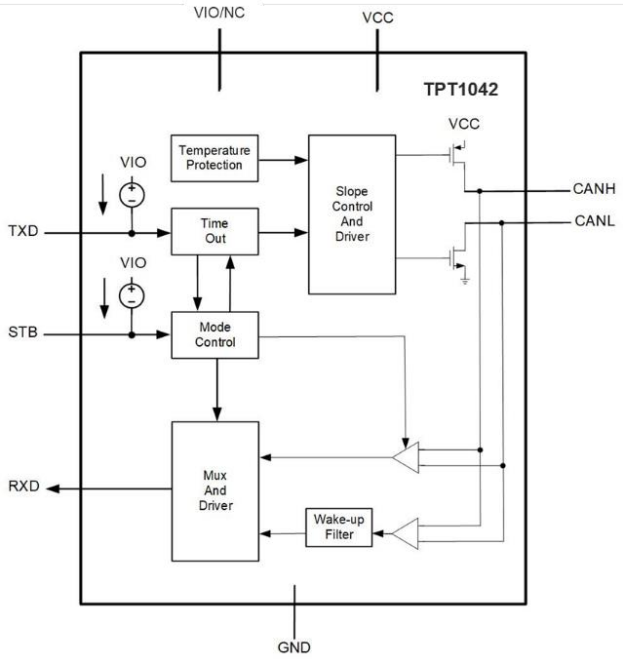
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
FD Timing Parameters						
$t_{BIT(BUS)}$	Bit time on CAN bus output pins with $t_{BIT(TXD)}$ = 500 ns, all devices	STB = 0 V, R_L = 60 Ω, C_L = 100 pF, $C_{L(RXD)}$ = 15 pF, $\Delta t_{REC} = t_{BIT(RXD)} - t_{BIT(BUS)}$	435		530	ns
	Bit time on CAN bus output pins with $t_{BIT(TXD)}$ = 200 ns, G device variants only		155		210	
$t_{BIT(RXD)}$	Bit time on RXD output pins with $t_{BIT(TXD)}$ = 500 ns, all devices		400		550	
	Bit time on RXD output pins with $t_{BIT(TXD)}$ = 200 ns, G device variants only		120		220	
Δt_{REC}	Receiver timing symmetry with $t_{BIT(TXD)}$ = 500 ns, all devices		−65		40	
	Receiver timing symmetry with $t_{BIT(TXD)}$ = 200 ns, G device variants only		−45		15	
t_{BUS_DTO}	bus dominant time-out time	Standby mode		2		ms
$t_{filtr(wake)bus}$	bus wake-up filter time	pin 5 = VIO, in standby mode		1.5		µs
$t_{d(stb-norm)}$	standby to normal mode delay time			25		µs

Detailed Description

Overview

The TPT1042 is a CAN transceiver that meets the ISO11898 High-speed CAN (Controller Area Network) physical layer standard. The device is designed in CAN FD networks up to 5 Mbps, and enhances timing margin and higher data rates in long and highly-loaded networks. As the design, the device features cross-wire, overvoltage and loss of ground protection from −70 V to +70 V, overtemperature shutdown, a −30 V to +30 V common-mode range. The TPT1042 has a secondary power supply input for I/O level shifting the input pin thresholds and RXD output level, and the device comes with standby mode which is also waked up from CAN BUS, and it includes many protection features to enhance device and network robustness.

Functional Block Diagram



Feature Description

Table 1 Driver Function Table

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

Table 2 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 pin STB selects Normal mode. In this mode, the transceiver will transmit and receive 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 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 Electro Magnetic Emission (EME).

Standby mode

Activate low power Standby mode by setting STB terminal high. In this mode the bus transmitter will not send data nor will the normal mode receiver accept data as the bus lines are biased to ground minimizing the system supply current. Only the low power receiver will be actively monitoring the bus for activity. RXD indicates a valid wake up event after a wake-up pattern (WUP) has been detected on the Bus. The low power receiver is powered using only the VIO pin. This allows V_{CC} to be removed reducing power consumption further.

The bus lines are biased to ground in Standby mode to minimize the required system supply current. The low power receiver is supplied by V_{IO} and is capable of detecting CAN bus activity even if V_{IO} is the only supply voltage available to the transceiver.

Time-out function in TXD dominant mode

When the TXD pin is set LOW, the timer of ‘TXD dominant time-out’ is started. If the LOW state on TXD persists for longer than t_{TXD_DTO}, the transmitter is disabled and the bus lines is in recessive state. This function prevents a hardware and/or software application failure from driving the bus lines to a permanent dominant state which will block all network communications. The TXD dominant time-out timer is reset as TXD is pulled to HIGH. The TXD dominant time-out time also defines the data rate should be faster than 40 kbit/s.

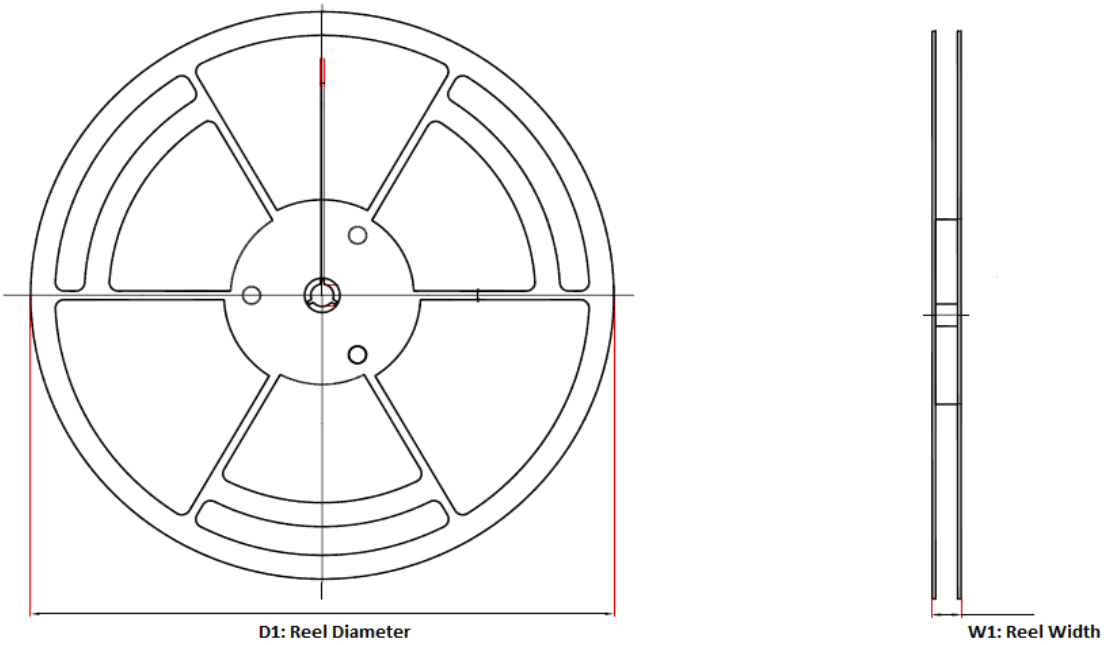
Time-out function in Bus dominant mode

In Standby mode, the timer of 'bus dominant time-out' is started when the CAN bus changes from recessive to dominant state. If the dominant state on the bus persists for longer than t_{BUS_DTO} bus, the RXD pin is reset to HIGH. If a bus short-circuit or a failure in one of the other nodes on the network, this function prevents a clamped dominant bus from generating a permanent wake-up request. The bus dominant time-out timer is reset when the CAN bus changes from dominant to recessive state.

Overtemperature protection

The output drivers are protected against overtemperature conditions. If the virtual junction temperature exceeds the shutdown junction temperature, T_{OTP}, the output drivers will be disabled until the virtual junction temperature falls below T_{OTP} and TXD becomes recessive again. Including the TXD condition ensures that output driver oscillation due to temperature drift is avoided.

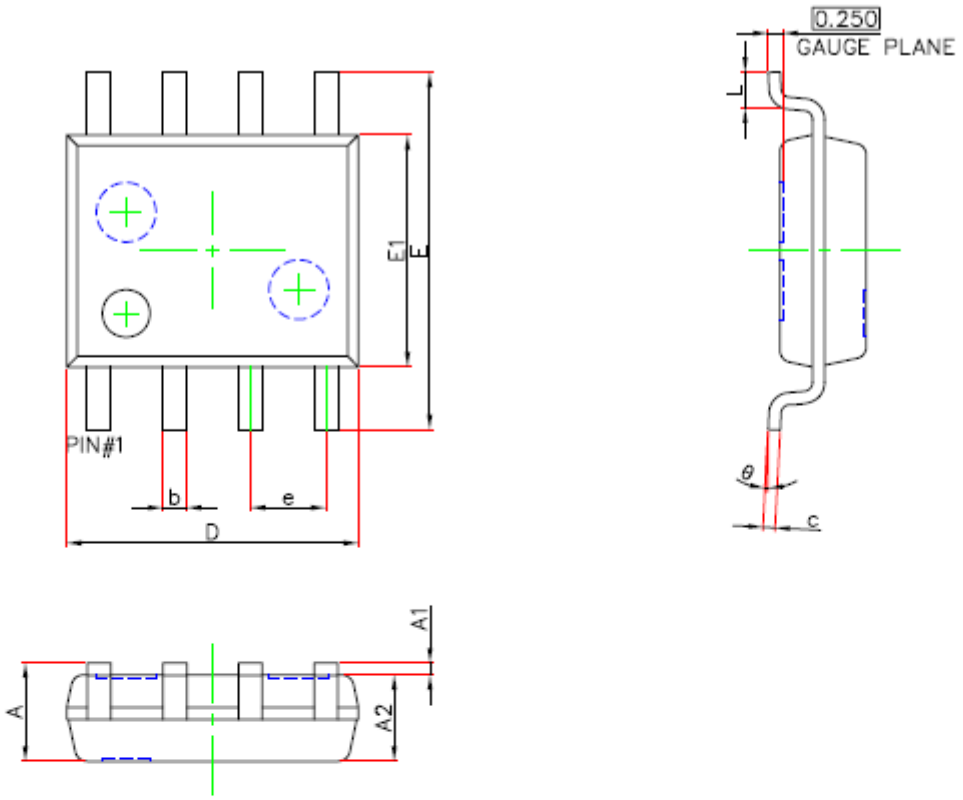
Tape and Reel Information



Order Number	Package	D1 (mm)	A0 (mm)	K0 (mm)	W0 (mm)	W1 (mm)	B0 (mm)	P0 (mm)	Pin1 Quadrant
TPT1042V-SO1R	8-Pin SOP	330.0	6.4	2.1	12.0	17.6	5.4	8.0	Q1
TPT1042V-DF6R	8-Pin DFN	330.0	3.3	1.1	12.0	17.6	3.3	8.0	Q1

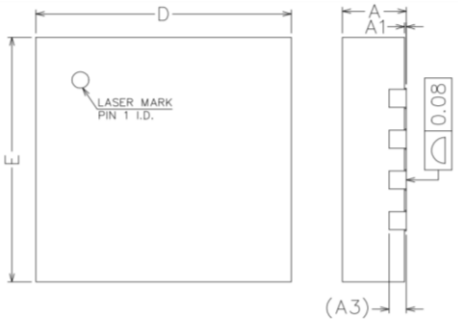
Package Outline Dimensions

SO1R(SOP-8)



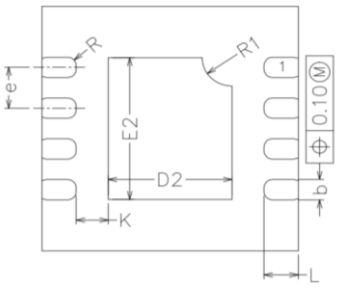
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.450	1.750	0.057	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270(BSC)		0.050(BSC)	
L	0.400	0.800	0.016	0.031
θ	0°	8°	0°	8°

DF6R (DFN3X3-8L)



TOP VIEW SIDE VIEW

SIDE VIEW



BOTTOM VIEW

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.203REF	
b	0.20	0.25	0.30
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.35	1.45	1.55
E2	1.64	1.74	1.84
e	0.40	0.50	0.60
K	0.275	0.375	0.475
L	0.30	0.40	0.50
R		0.10REF	
R1		0.35REF	

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT1042V-SO1R	−40 to 125°C	8-Pin SOP	1042V	MSL3	Tape and Reel, 4000	Green
TPT1042V-DF6R	−40 to 125°C	8-Pin DFN	1042V	MSL3	Tape and Reel, 4000	Green

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