3-V to 5.5-V, 1-Mbps Multi-Channel RS-232 Transceiver

Features

- Meets the Requirements of TIA/EIA- 232-F and ITU V.28 Standards
- Wide Power Supply Range: Single +3 V to +5.5 V
- Three Drivers and Five Receivers
- Operates up to 1 Mbps
- Low Standby Current: 1uA typical
- Requires Only Four External 0.1-μF Capacitors
- Auto-Power down Feature to Disable Driver Outputs When No Valid RS-232 Signal is Detected
- ESD Protection for RS-232 Bus Pins
  - ±15 kV (HBM)
  - ±12 kV (IEC61000-4-2, Contact Discharge)
  - ±15 kV (IEC61000-4-2, Air-Gap Discharge)

Applications

- Battery-Powered Equipment
- Industry Human Machine Interface
- Notebook, Computers
- Servers
- Printers

Description

The TPT3335 is ±12-kV IEC61000-4-2 contact ESD protected, 3.0-V to 5.5-V powered transceivers that meet the RS-232 standards for balanced communication. Each receiver converts TIA/RS-232 inputs to TTL/CMOS levels.

The charge pump and external capacitors support the device operating from a single 3.0-V to 5.5-V power supply. The device has an always-active output ROUT2B, which allows applications using the ring indicator to transmit data as the device is powered down.

The auto power-down function supports the ultra-low power mode. As the $\overline{\text{ONLINE}}$ is low and $\overline{\text{OFF}}$ is high, the driver outputs are disabled while the device does not sense a valid RS-232 signal. If $\overline{\text{OFF}}$ is set low, both drivers and receivers (except ROUT2B) are disabled, and the supply current is down to 1 μA.

The devices have a typical threshold of 1.25 V, a typical hysteresis of 0.3 V, and can accept ±25-V inputs. The device operates at data signaling rates up to 1 Mbps. The TPT3335 is available in TSSOP28, SSOP28, SOP28, and QFN32 packages, and is characterized from −40°C to 125°C.

Device Table

Device	Package	Body size
TPT3335-SS6R	SSOP28	10.2 mm x 5.3 mm
TPT3335-SO5R	SOP28	18.0 mm x 7.5 mm
TPT3335-TS6R	TSSOP28	9.8 mm x 4.4 mm
TPT3335-QFZR	QFN5X5-32	5.0 mm x 5.0 mm

Typical Application Circuit

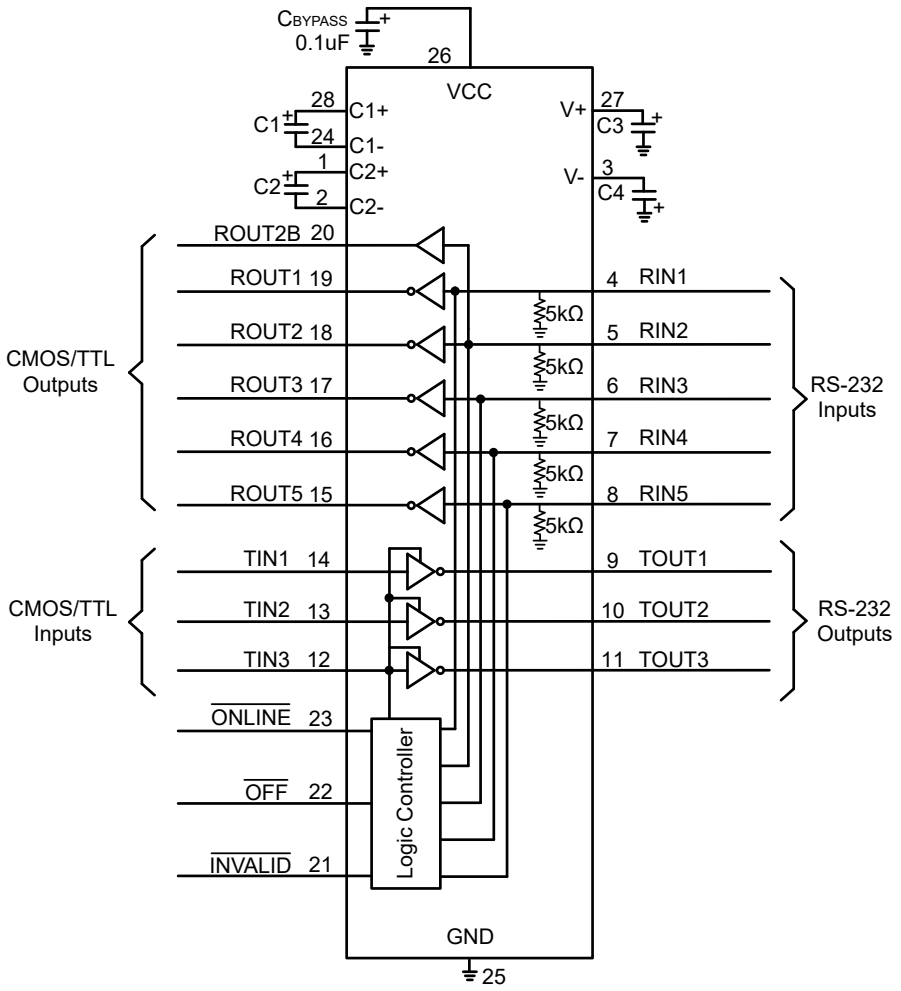


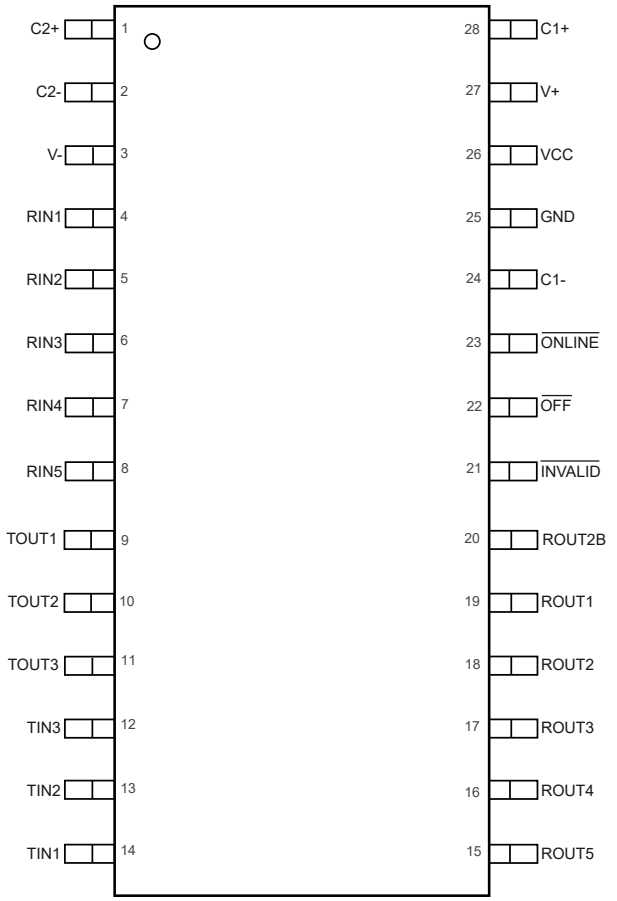
Table of Contents

Revision History

Date	Revision	Notes
2024-04-03	Rev. A.0	Released version

Pin Configuration and Functions

TPT3335
SOP28/TSSOP28/SSOP28 Package
Top View



TPT3335
QFN5X5-32
Top View

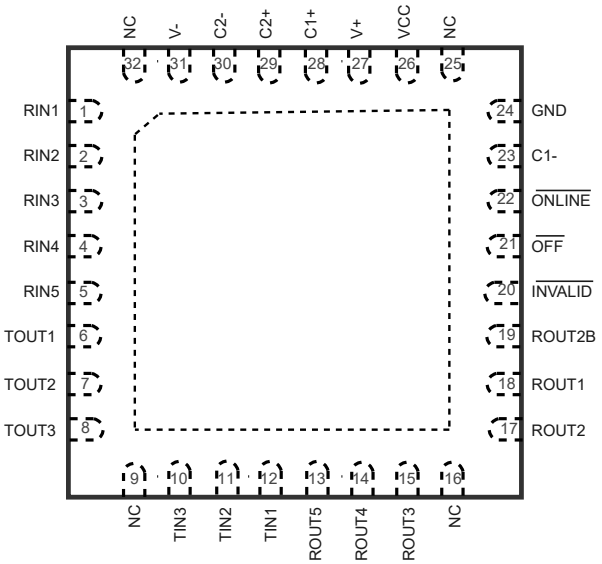


Table 1. Pin Functions: TPT3335

Pin		Name	I/O	Description
SOP/ SSOP /TSSOP	QFN			
1	29	C2+		Positive lead of C2 capacitor
2	30	C2-		Negative lead of C2 capacitor
3	31	V-	Output	Negative charge pump output for storage capacitor only
4-8	1-5	RINx	Input	Input of RS232 receiver, RS232 level
9-11	6-8	TOUTx	Output	Output of RS232 driver, RS232 level
12-14	10-12	TINx	Input	The input of the RS232 driver, TTL/CMOS level
15-19	13-15, 17,18	ROUTx	Output	Output of RS232 receiver, TTL/CMOS level
20	19	ROUT2B	Output	TTL/CMOS Noninverting Complementary Receiver Output. Always active.
21	20	$\overline{\text{INVALID}}$	Output	Output of the Valid Signal Detector. /INVALID is enabled high if a valid RS-232 level is present on any receiver input.
22	21	$\overline{\text{OFF}}$	Input	$\overline{\text{OFF}}$ Input, active low. Drive low to shut down transmitters, receivers (except ROUT2B), and on-board charge pump
23	22	$\overline{\text{ONLINE}}$	Input	Active low. High level to drive normal working, low level to enable aut opower down function ($\overline{\text{OFF}}$ must be high)
24	23	C1-		Negative lead of C1 capacitor
25	24	GND		Ground
26	26	VCC		Supply voltage
27	27	V+	Output	Positive charge pump output for storage capacitor only
28	28	C1+		Positive lead of C1 capacitor
	9,16,25,32	NC		Not connected internally
-		Thermal pad		Connect to GND internally

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
V_{CC}	Supply Voltage	−0.3	6	V
V+	Positive Output Supply Voltage	−0.3	7	V
V–	Negative Output Supply Voltage	−7	0.3	V
V+ – V–	Supply Voltage Difference		13	V
T_{INx}	Input Voltage of Driver, TTL/CMOS Level	−0.3	6	V
T_{OUTx}	Output Voltage of Driver, RS232 Level	−13.2	+13.2	V
R_{INx}	Input Voltage of Receiver, RS232 Level	−28	+28	V
R_{OUTx}	Output Voltage of Receiver, TTL/CMOS Level	−0.3	VCC +0.3	V
T_J	Operating Virtual Junction Temperature		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.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Value	Unit
IEC	IEC Contact Discharge	IEC-61000-4-2, Bus Pin: TOUTx, RINx	±12	kV
	IEC Air-Gap Discharge	IEC-61000-4-2, Bus Pin: TOUTx, RINx	±15	kV
HBM	Human Body Model ESD (1)	ANSI/ESDA/JEDEC JS-001, Bus Pin: TOUTx, RINx	±15	kV
		ANSI/ESDA/JEDEC JS-001, All Pin	±4	kV
CDM	Charged Device Model ESD (2)	ANSI/ESDA/JEDEC JS-002, All Pin	±1.5	kV
LU	Latch-up	LU, per JESD78, All Pin (3)	±400	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.
(3) Test at the temperature of 25℃.

Recommended Operating Conditions

Parameter		Min	Max	Unit
V_{CC}	Power Supply	3.0	5.5	V
$V_{IH(TXD)}$	Driver High-Level Input Voltage, V_{CC} = 5 V	2.4	5.5	V
	Driver High-Level Input Voltage, V_{CC} = 3.3 V	2	5.5	V
$V_{IL(TXD)}$	Driver Low-Level Input Voltage		0.8	V
VI	Receiver Input Voltage	−25	25	V
T_A	Operating Ambient Temperature	−40	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SSOP28	82	41	°C/W
TSSOP28	75	26	°C/W
SOP28	63	32	°C/W
QFN32	40	31	°C/W

Electrical Characteristics

All test conditions: V_{CC} = 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_I	Input Leakage Current	$\overline{OFF}$,$\overline{ONLINE}$	−1		1	μA
I_{CC}	Icc = Supply Current, Auto-Power Down Disabled	no load, $\overline{ONLINE}$ = $\overline{OFF}$ = VCC, TINx = GND or VCC		0.38	1	mA
	Auto-Power Down Enabled	no load, $\overline{OFF}$ = VCC, $\overline{ONLINE}$ =GND, all RINx are open, all TINx are grounded		1.7	10	μA
	Powered off	No load, $\overline{OFF}$ =GND		1.8	10	μA
Driver (TX)						
V_{IH}	Input Voltage of Logic High	TINx, VCC = 3.3 V	2			V
		TINx, VCC = 5.0 V	2.4			V
V_{IL}	Input Voltage of Logic Low	TINx, VCC = 3.3 V			0.8	V
		TINx, VCC = 5.0 V			0.8	V
I_{IH}	High-Level Input Current	TINx, VIN = VCC	−1		1	μA
I_{IL}	Low-Level Input Current	TINx, VIN = 0 V	−1		1	μA
V_{OH}	Output High Voltage	TOUT at RL=3kΩ to GND	5.0	5.4		V
V_{OL}	Output Low Voltage	TOUT at RL=3 kΩ to GND		-5.4	-5.0	V
I_{OS}	Output Short-Circuit Current (1)	VOUT = 0V	−60		60	mA
I_{OFF}	Output Leakage Current	$\overline{OFF}$ = GND, Vo = 12 V, VCC = 5.5 V	−25		25	μA
R_O	Output Resistance (1) (2)	VCC = V+ = V- = 0V, TOUTx = ±2 V	0.3	1500		kΩ
Receiver (RX)						
V_I	Receiver Input Voltage (1)		−25		25	V
V_{OL}	Output Voltage Low	IOUT = 1.5 mA			0.3	V
V_{OH}	Output Voltage High (3)	IOUT = −1.5 mA	VCC-0.5			V
V_{TH-}	Input Threshold Low	VCC = 3.3 V	0.6	1.2		V
		VCC = 5.0 V	0.8	1.5		V
V_{TH+}	Input Threshold High	VCC = 3.3 V		1.5	2.4	V
		VCC = 5.0 V		1.8	2.4	V
V_{hys}	Input Hysteresis (1)			0.3		V
I_{OFF}	Output Leakage Current (except ROUT2B)	$\overline{OFF}$ = GND, Vo = 12 V, VCC = 5.5 V	−10		10	μA
R_I	Input Resistance (1) (2)	VI = ±3 V or ±25 V	3	5	7	kΩ

(1) Test data based on bench test and design simulation ； NOT test in production.
(2) Typ data is based on bench test by LRC meter E4980AL.
(3) VCC = 5 V, RX VOH ≥ VCC-0.3 V; VCC = 3.3 V, RX VOH ≥ VCC-0.5 V

Electrical Characteristics - Timing Parameters

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{max}	Maximum Data Rate (1)	RL = 3 kΩ, CL = 1000 pF, one driver switching (1)		1		Mbps
t_{DPHL}	Driver Propagation Delay, high to low output, tDPHL	Driver input to Driver output, CL = 150 pF		100	300 (1)	ns
t_{DPLH}	Driver Propagation Delay, low to high output, tDPLH	Driver input to Driver output, CL = 150 pF		100	300 (1)	ns
t_{Dsk}	Driver Skew (1)	| tDPHL – tDPLH |		20		ns
SR_{tr}	Transition-Region Slew Rate	Vcc = 3.3 V, RL = 3 kΩ, CL = 1000 pF, TA = 25°C (1)	15	75	150	V/μs
t_{RPHL}	Receiver Propagation Delay, high to low output, tRPHL	Receiver input to receiver output, CL = 150 pF		190	300 (1)	ns
t_{RPLH}	Receiver Propagation Delay, low to high output, tRPLH	Receiver input to receiver output, CL = 150 pF		130	300 (1)	ns
t_{Rsk}	Receiver Skew (1)	| tDPHL – tDPLH |		60	100 (1)	ns
t_{en}	Output Enable Time			100	200 (1)	ns
t_{dis}	Output Disable Time			200	400 (1)	ns

(1) Test data is based on bench test and design simulation; NOT test in production.

Electrical Characteristics - Auto Power Down

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{valid}	Receiver Input Voltage for Valid RS232 Level		-2.7		2.7	V
$V_{invalid}$	Receiver Input Voltage for Invalid RS232 Level		-0.3		0.3	V
V_{OH}	$\overline{\text{INVALID}}$ Output High Voltage	IOH = −1.5 mA	VCC-0.3			V
V_{OL}	$\overline{\text{INVALID}}$ Output LOW Voltage	IOL = 1.5 mA			0.3	V
T_{valid}	Propagation Delay, Receiver Threshold to $\overline{\text{INVALID}}$ High (1)			1		µs
$T_{invalid}$	Propagation Delay, Receiver Threshold to $\overline{\text{INVALID}}$ Low (1)			30		µs
T_{online}	Propagation Delay, Receiver Threshold to Driver Enabled (1)			100		µs

(1) Test data is based on bench test and design simulation, NOT test in production.

Typical Performance Characteristics

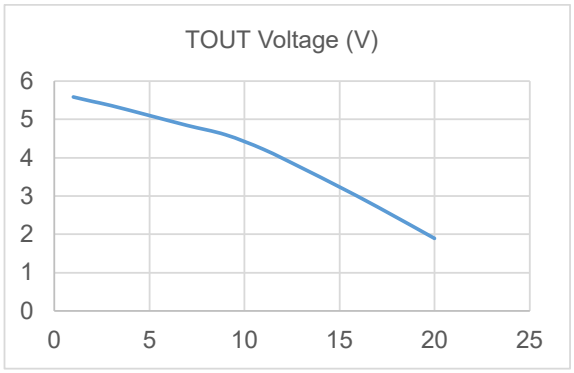


Figure 1. TOUT_VOH(V) vs TOUT Current (mA)

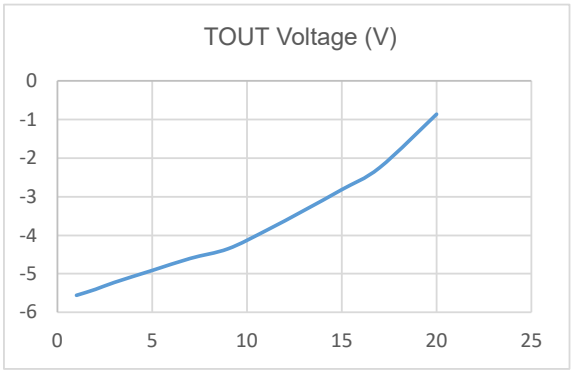


Figure 2. TOUT_VOL(V) vs TOUT Current (mA)

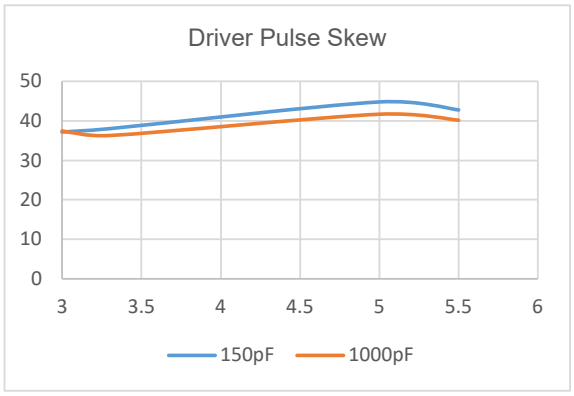


Figure 3. Driver Skew (ns) per VCC(V) with C_{Load}

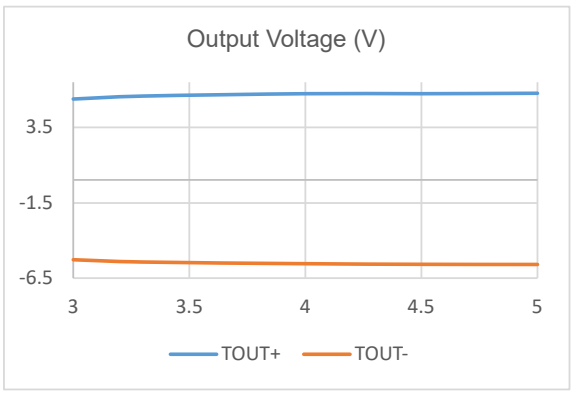


Figure 4. Output Voltage(V) per VCC(V)

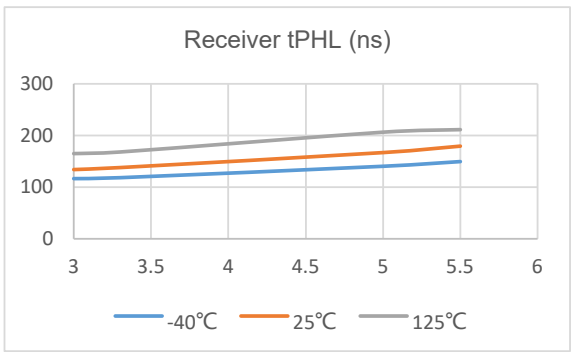


Figure 5. Receiver TPHL(ns) per Temperature(℃)

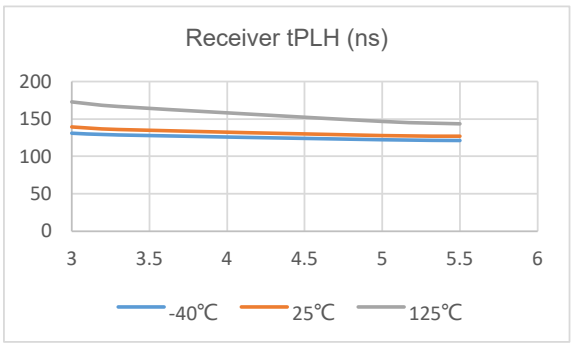


Figure 6. Receiver TPLH(ns) per Temperature(℃)

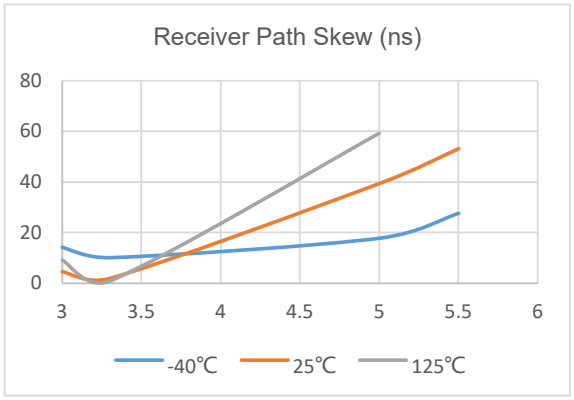


Figure 7. Receiver Skew(ns) per Temperature(℃)

Detailed Description

Overview

The TPT3335 is ±12kV IEC61000-4-2 contact ESD protected, 3.0-V to 5.5-V powered transceivers that meet the RS-232 standards for balanced communication. Each receiver converts TIA/RS-232 inputs to TTL/CMOS levels.

The charge pump and external capacitors support the device operating from a single 3.0-V to 5.5-V power supply. The device has an always-active output ROUT2B, which allows applications using the ring indicator to transmit data as the device is powered down.

The auto power-down function supports the ultra-low power mode. As the $\overline{\text{ONLINE}}$ is low and $\overline{\text{OFF}}$ is high, the driver outputs are disabled while the device does not sense a valid RS-232 signal. If $\overline{\text{OFF}}$ is set low, both drivers and receivers (except ROUT2B) are disabled, and the supply current is down to 1 μA.

The devices have a typical threshold of 1.25 V, a typical hysteresis of 0.3 V, and can accept ±25-V inputs. The device operates at data signaling rates up to 1 Mbps. The TPT3335 is available in TSSOP28, SSOP28, SOP28, and QFN32 packages, and is characterized from –40°C to 125°C.

Functional Block Diagram

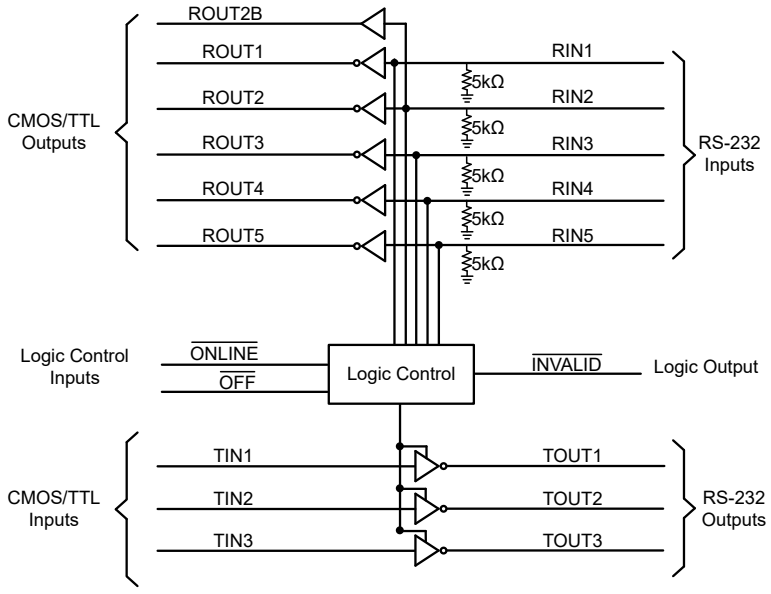


Figure 8. Functional Block Diagram

Parameter Measurement Information

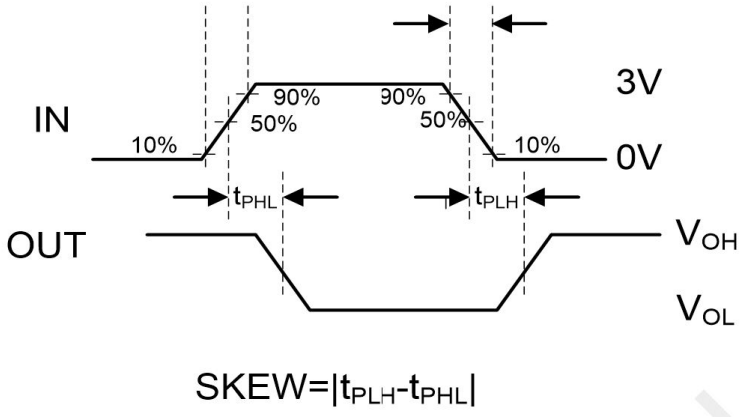


Figure 9. Receiver Propagation Delay and Receiver Skew

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.

Typical Application

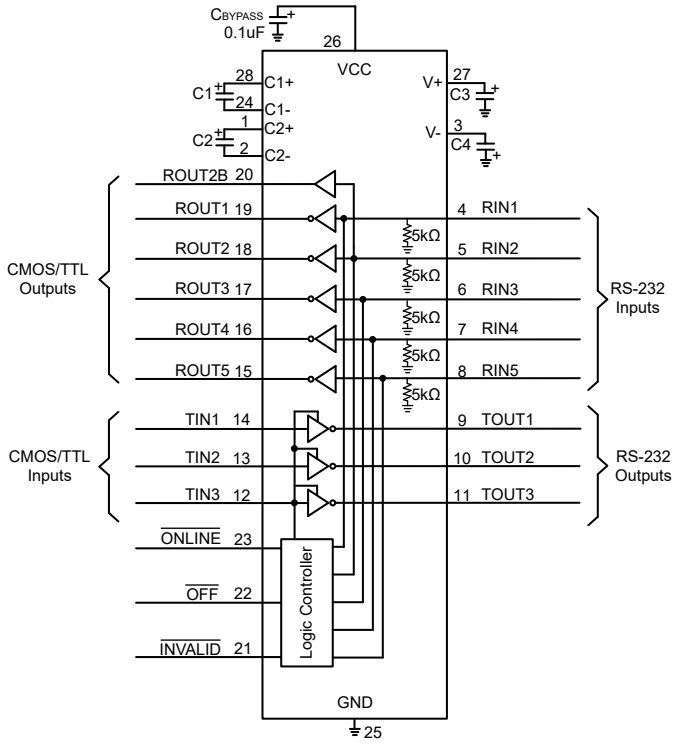


Figure 10. Typical Application Circuit

Non-polarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown in Figure 10. The recommended capacitor value of C1 to C4 is in Table 2. All cap is 0.1 uF for TPT3335.

Table 2. Required Minimum Capacitor Values

V_{CC}(V)	C1(μF)	C2, C3, C4(μF)
3.0 to 3.6	0.1	0.1
4.5 to 5.5	0.047	0.33
3.0 to 5.5	0.1	0.47

Layout

Layout Guideline

Reflections and matching are closely related to loop antenna theory, but different enough to warrant their discussion. When a PCB trace turns a corner at a 90° angle, a reflection can occur. This is primarily due to the change in the width of the trace. At the apex of the turn, the trace width is increased to 1.414 times its width. This change in width upsets the transmission line characteristics, especially the distributed capacitance and self-inductance of the trace, thus resulting in the reflection. Not all PCB traces can be straight, so they will have to turn corners. Figure 11 shows progressively better techniques of rounding corners. Only the last example (BEST) maintains constant trace width and minimizes reflections.

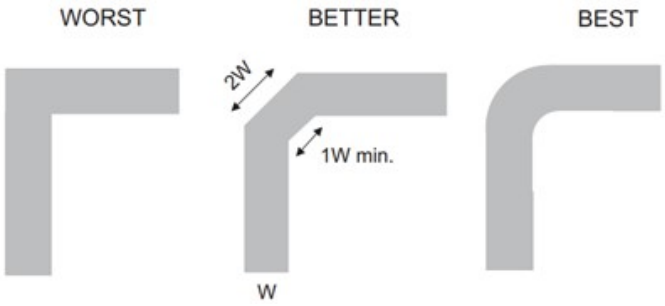


Figure 11. Trace Example

Route high-speed signals using a minimum of vias and corners which reduces signal reflections and impedance changes. When a via must be used, increase the clearance size around it to minimize its capacitance. Each via introduces discontinuities in the transmission line of the signal and increases the chance of picking up interference from the other layers of the board. Be careful when designing test points, through-hole pins are not recommended at high frequencies.

Layout Example

Figure 12 shows the location of external components as they appear on the PCB diagram.

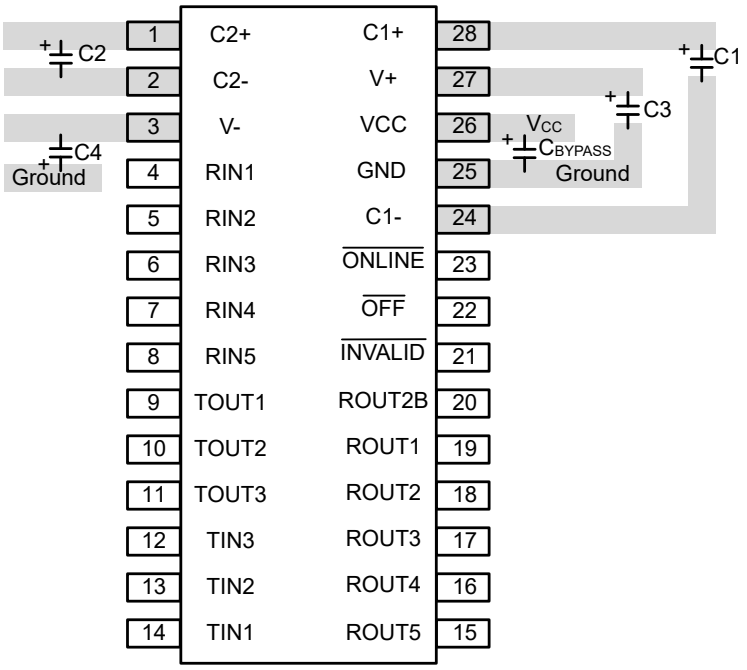
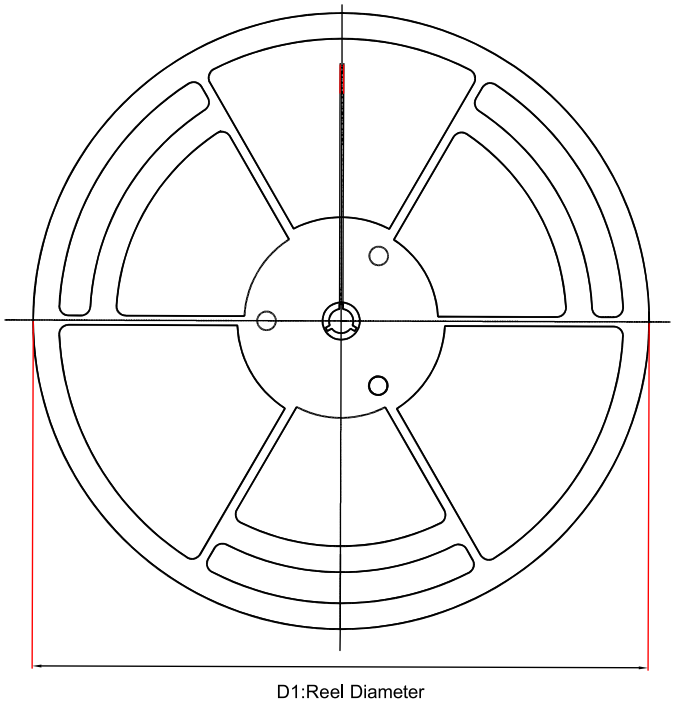
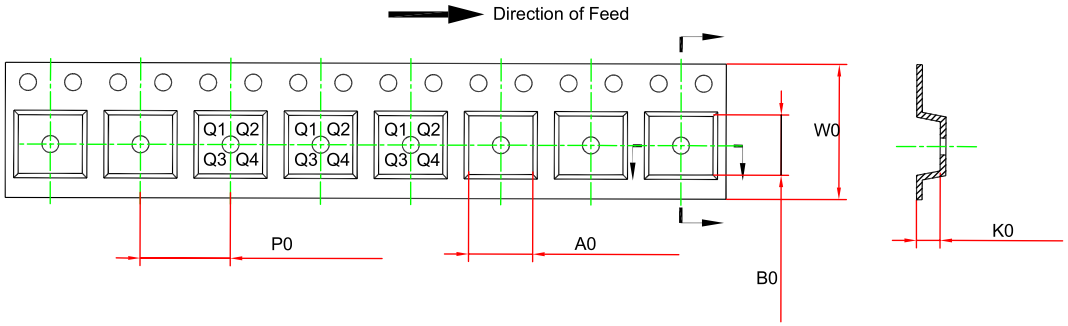


Figure 12. Layout Example Diagram

Tape and Reel Information



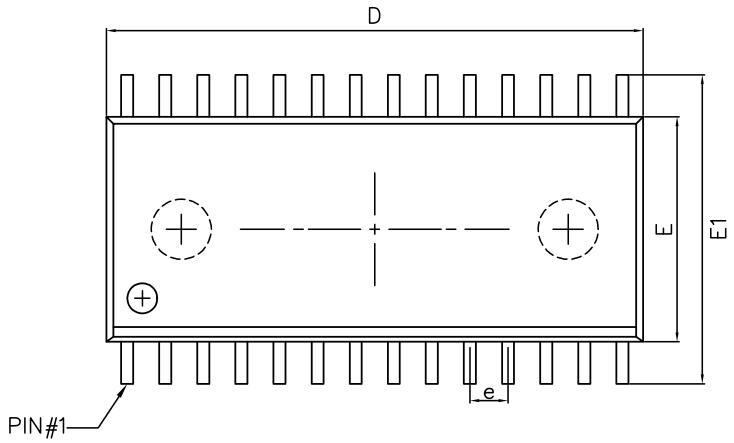


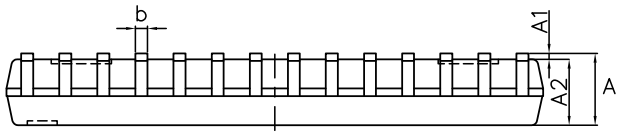
Order Number	Package	D1 (mm)	A0 (mm)	K0 (mm)	W0 (mm)	W1 (mm)	B0 (mm)	P0 (mm)	Pin1 Quadrant
TPT3335-SO5R	SOP28	330	10.8	3.05	24.0	30.4	18.6	12.0	Q1
TPT3335-TS6R	TSSOP28	330	6.8	1.6	16.0	21.6	10.15	8.0	Q1
TPT3335-SS6R	SSOP28	330	8.2	2.34	16.0	21.6	10.5	12.0	Q1
TPT3335-QFZR	QFN32L	330	5.3	1.1	12.0	17.6	5.3	8.0	Q2

Package Outline Dimensions

SOP28

Package Outline Dimensions SO5(SOP-28-A)





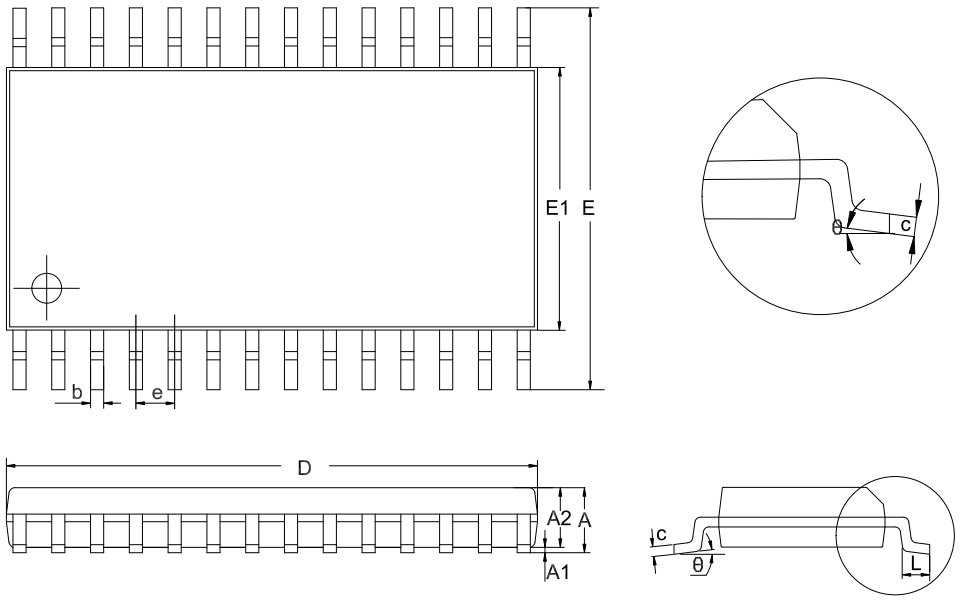
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	2.200	2.600	0.087	0.102
A1	0.100	0.300	0.004	0.012
A2	2.100	2.300	0.083	0.091
b	0.330	0.510	0.013	0.020
c	0.200	0.330	0.008	0.013
D	17.700	18.100	0.697	0.713
E	7.350	7.650	0.289	0.301
E1	10.100	10.500	0.398	0.413
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0	8°	0	8°

NOTES

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

TSSOP28

Package Outline Dimensions TS6(TSSOP-28-A)



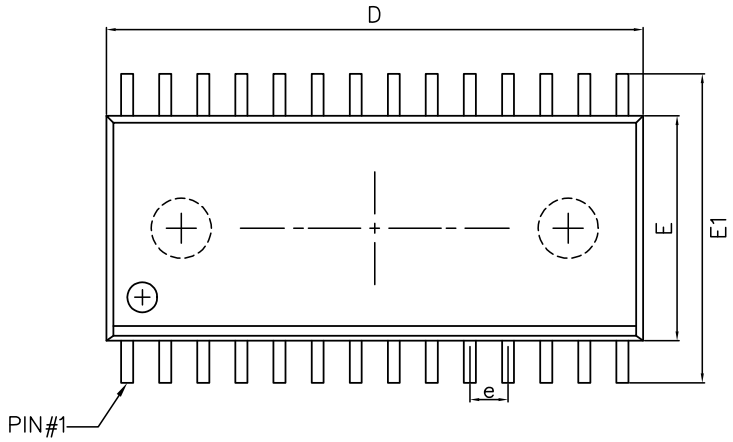
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	9.600	9.800	0.378	0.386
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

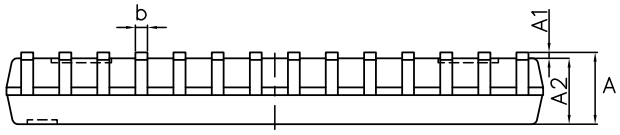
NOTES

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

SSOP28

Package Outline Dimensions SO5(SOP-28-A)





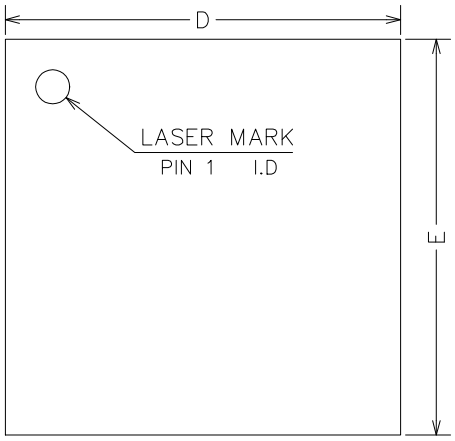
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	2.200	2.600	0.087	0.102
A1	0.100	0.300	0.004	0.012
A2	2.100	2.300	0.083	0.091
b	0.330	0.510	0.013	0.020
c	0.200	0.330	0.008	0.013
D	17.700	18.100	0.697	0.713
E	7.350	7.650	0.289	0.301
E1	10.100	10.500	0.398	0.413
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0	8°	0	8°

NOTES

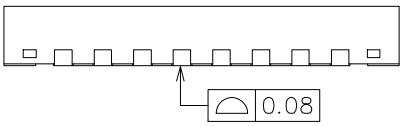
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

QFN5X5-32

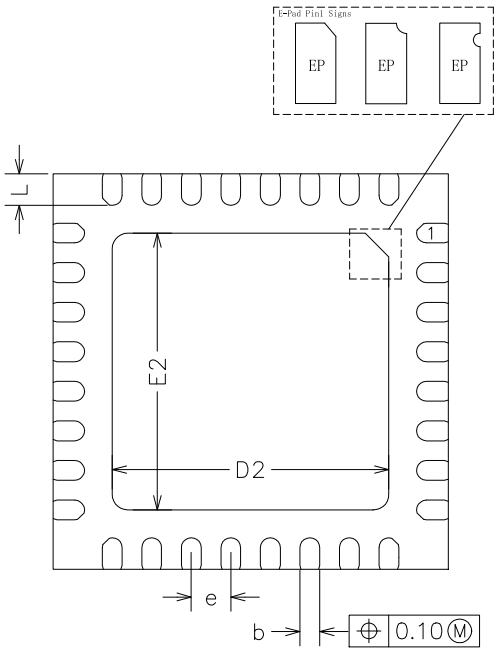
Package Outline Dimensions QFZ(QFN5X5-32-I)



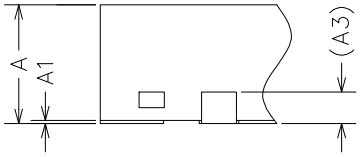
TOP VIEW



SIDE VIEW



BOTTOM VIEW



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
A3	0.180	0.250	0.007	0.010
b	0.180	0.300	0.007	0.012
D	4.900	5.100	0.193	0.201
E	4.900	5.100	0.193	0.201
e	0.400	0.600	0.157	0.236
D2	3.400	3.600	0.134	0.142
E2	3.400	3.600	0.134	0.142
L	0.300	0.450	0.012	0.018

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.

Order Information

Order Number	Junction Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT3335-SO5R	−40 to 125°C	SSOP28	T3335	MSL3	Tape and Reel, 1500	Green
TPT3335-TS6R	−40 to 125°C	TSSOP28	T3335	MSL3	Tape and Reel, 4000	Green
TPT3335-SS6R	−40 to 125°C	SOP28	T3335	MSL3	Tape and Reel, 2000	Green
TPT3335-QFZR	−40 to 125°C	QFN5x5-32	T3335	MSL3	Tape and Reel, 3000	Green

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

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