2-channel Single-ended or 1-channel Differential 2:1 Multiplexer or Demultiplexer Switch

Features

- Support 2:1 Multiplexer or Demultiplexer in both Options below:
  - One Bidirectional Differential Channel
  - Two Bidirectional Single-ended Channels
- High-speed Signal Switching up to 16 Gbps
- High Bandwidth: 12 GHz @ −3 dB
- Low Insertion Loss: −2.1 dB @ 8 GHz
- Low Return Loss: −12 dB @ 8 GHz
- Low Off-isolation: −10 dB @ 8 GHz
- Low Intra Channel Skew: 10 ps Max
- Support Anti-backflow to Power on Control Signals ($\overline{EN}$, SEL) and High Speed Data Channels
- Single Supply Voltage: 3.0 V to 3.6 V
- Control Signals (SEL, $\overline{EN}$) can Work at 1.8 V Logic
- Operating Temperature Range: −40°C to +125°C
- Package (Pb-Free & Green): QFN1.5×2.0-10

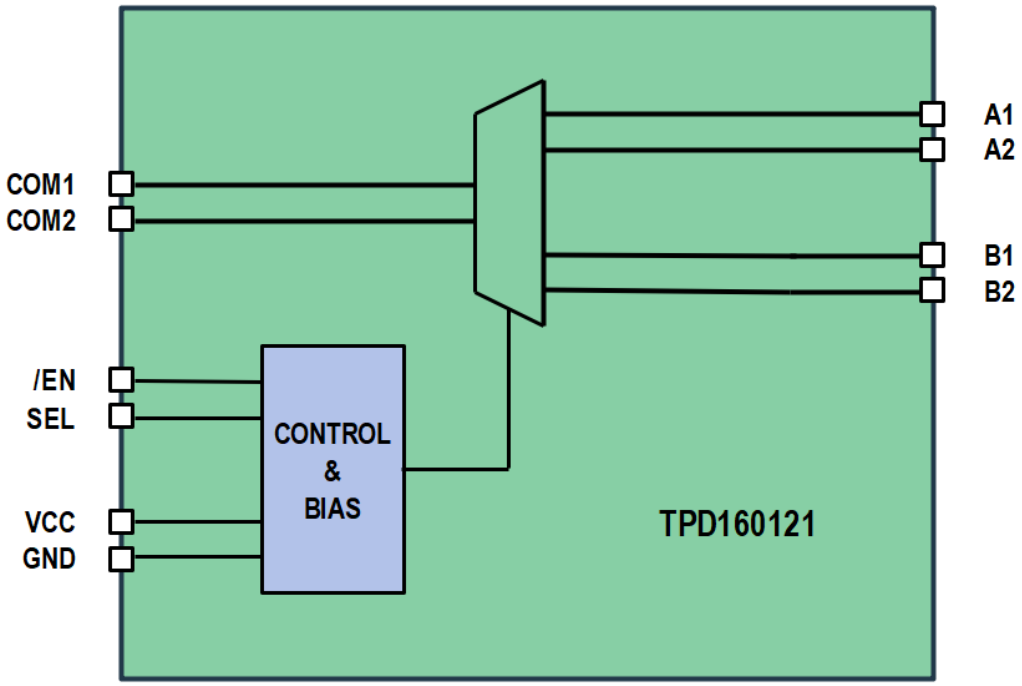
Applications

- Notebook, Tablets, PC, Server
- Switch, Router
- OTN Transport
- Medical Equipment
- Wireless Infrastructure
- Test and Measurements

Description

The TPD160121 is a one-channel differential 2:1 multiplexer or demultiplexer switch for PCIe Gen3.0, Gen4.0, DP1.3, DP1.4, USB3.1, USB3.2, or other high-speed serial interface signals. It can also mux/demux two-channel single-ended signals, such as SDA and SCL in I^2C or I^3C applications.

Typical Application Circuit



2-channel Single-ended or 1-channel Differential 2:1 Multiplexer or Demultiplexer Switch

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Product Family Table

Order Number	Maximum Data Rate	Package
TPD160121-QF4R-S	16 Gbps	QFN1.5X2.0-10

Revision History

Date	Revision	Notes
2025-07-07	Rev.A.0	Initial version.
2026-06-29	Rev.A.1	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. Updated POD and Feature Description.

Pin Configuration and Functions

TPD160121
QFN1.5X2.0-10 Package
Top View

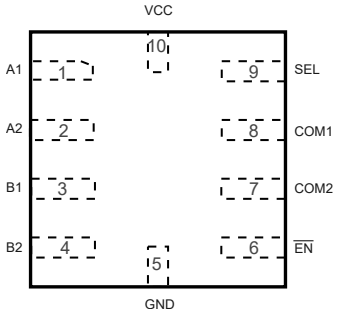


Table 1. Pin Functions: TPD160121

Pin		Type	Description
No.	Name		
1	A1	Input/Output	Signal Path A1
2	A2	Input/Output	Signal Path A2
3	B1	Input/Output	Signal Path B1
4	B2	Input/Output	Signal Path B2
5	GND	GND	Ground
6	$\overline{EN}$	Input	Enable (Active Low)
7	COM2	Input/Output	Common Signal Path 2
8	COM1	Input/Output	Common Signal Path 1
9	SEL	Input	Switch Select: Logic Low = COM to A Port, Logic High = COM to B Port
10	VCC	Power	3.3-V power supply

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
$V_{CC-ABSMAX}$	Power Supply Voltage	−0.5	4.6	V
$V_{CTL-ABSMAX}$	Control Voltage (OEB, SEL)	−0.5	4.6	V
$V_{HS-ABSMAX}$	High-speed Switch I/O Voltage	−0.5	min (4.6, V_{CC} + 0.5)	V
T_{STG}	Storage Temperature Range	−55	125	°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.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Minimum Value	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	±2000	V
CDM	Charged Device Model ESD	JEDEC specification JESD22-C101 (2)	±1500	V

(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	Nom	Max	Unit
V_{CC}	Supply Voltage	Normal	3.0	3.3	3.6	V
V_{IH}	Input Logic High Voltage	SEL/OEB pin	1.3			V
V_{IL}	Input Logic Low Voltage	SEL/OEB pin			0.6	V
V_{DIFF}	Differential-mode Input Voltage	Recommended op. condition	0	0.8	1.8	V
V_{CM}	Common-mode Input Voltage	Recommended op. condition	0	1.6	2.0	V
T_{AMB}	Operating Ambient Temperature	None	−40	27	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JB}	θ_{JC}	Unit
QFN1.5X2.0-10	190	117	94	°C/W

Electrical Characteristics

Parameter		Conditions	Min	Typ	Max	Units
Electrical Characteristics						
I_{CC_OP}	Supply Active Current	Operating mode, OEB = GND		200	300	μA
I_{CC_DOWN}	Supply Shutdown Current	Shutdown mode, OEB = V_{CC}		0.6	1	μA
V_{HS}	High-Speed Switch I/O Voltage	Input/output voltage range of the switch (AN, BN, CN)	0		V_{CC} (2)	V
$I_{HIZ,HS}$	Switch OFF-state Leakage Current	V_{HS} = 0 to V_{CC}, OEB = V_{CC}			1	μA
C_{HSOFF_A}	High-Speed Switch Terminal OFF-Capacitance	OEB = V_{CC} , V_{HS} = 0 V		0.8		pF
C_{HSOFF_BC}	High-Speed Switch Terminal OFF-Capacitance	OEB = V_{CC} , V_{HS} = 0 V		0.5		pF
C_{HSON}	High-Speed Switch Terminal ON-Capacitance	OEB = GND, V_{HS} = 0V		1.5		pF
R_{ON}	ON Resistance	V_{HS} = 0 V, I_{HS} = 30 mA (1)		5.4	11.5	Ω
R_{ON}	ON Resistance	V_{HS} = 1.2 V, I_{HS} = 30 mA (1)		6.5	13.5	Ω
R_{ON_FLAT}	ON Resistance Flatness	V_{HS} = 0 V, 1.2 V, I_{HS} = 15 mA (1)		0.8	3	Ω
ΔR_{ON}	Difference of ON-resistance between Switches	V_{HS} = 0 V, 1.2 V, I_{HS} = 15 mA (1)		0.1	0.5	Ω
V_{CTRL}	Control Input Voltage (SEL/OEB)		0		V_{CC}	V
$I_{IH,CTRL}$	Control Input High Current (SEL/OEB)	V_{CTRL} = 3.6 V			1	uA
$I_{IL,CTRL}$	Control Input Low Current (SEL/OEB)	V_{CTRL} = 0 V			1	uA
C_{CTRL}	Control Input Capacitance (SEL/OEB)	V_{HS} = 0 V		3		pF
Switching Characteristics						
t_{PLH}/t_{PHL}	Propagation Delay Time	C_L = 5 pF		80	-	ps
t_{ON}	Turn-ON Time (SEL to Output)	R_L = 50 Ω, C_L = 5 pF		26	35	ns
t_{ON}	Turn-ON Time (OEB to Output)	R_L = 50 Ω, C_L = 5 pF		22	50	us
t_{OFF}	Turn-OFF Time (SEL to Output)	R_L = 50 Ω, C_L = 5 pF		1	25	ns
t_{OFF}	Turn-OFF Time (OEB to Output)	R_L = 50 Ω, C_L = 5 pF		6.7	8.0	ns
t_{BBM}	Break before Make	R_L = 50 Ω, C_L = 5 pF		10.3		ns
t_{SKEW_INTRA}	Intra Pair Output Skew between P and N for the same channel	C_L = 5 pF		6.2		ps
High Speed Performance Parameters						
DOFFISO	Differential OFF Isolation	R_L = 50 Ω, f = 2.7 GHz		−17		dB
		R_L = 50 Ω, f = 4 GHz		−15		dB

Parameter		Conditions	Min	Typ	Max	Units
		R_L = 50 Ω, f = 8 GHz		−11		dB
DXT	Differential Crosstalk	R_L = 50 Ω, f = 2.7 GHz		−48		dB
		R_L = 50 Ω, f = 4 GHz		−46		dB
		R_L = 50 Ω, f = 8 GHz		−38		dB
DRL	Differential Return Loss	R_L = 50 Ω, f = 2.7 GHz		−19		dB
		R_L = 50 Ω, f = 4 GHz		−16		dB
		R_L = 50 Ω, f = 8 GHz		−12		dB
DIL	Differential Insertion Loss	R_L = 50 Ω, f = 2.7 GHz		−0.8		dB
		R_L = 50 Ω, f = 4 GHz		−1.0		dB
		R_L = 50 Ω, f = 8 GHz		−2.1		dB
BW	−3 dB Bandwidth	R_L = 50 Ω, C_L = 0 pF		12.0		GHz
BR	Signal Bit Rate	AN − BN / CN			16 (2)	Gbps

(1) ON-resistance is measured by measuring the voltage drop across the switch at the indicated current
(2) Design Guarantee Spec

Typical Performance Characteristics

All test conditions: V_{CC} = 3.3 V, T_A = +27°C, unless otherwise noted.

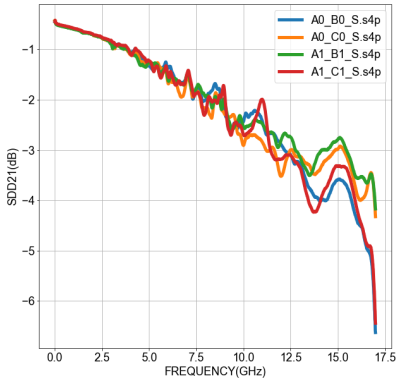


Figure 1. Differential Insertion Loss

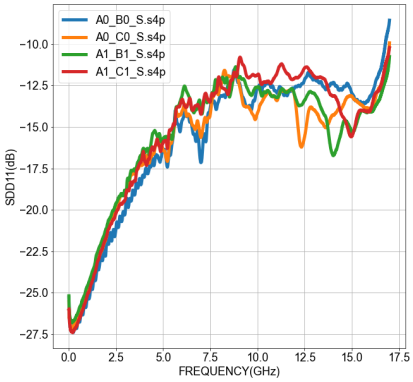


Figure 2. Differential Return Loss

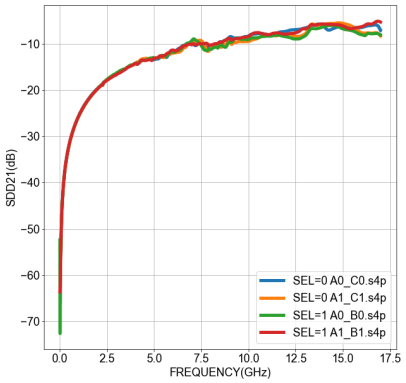


Figure 3. Differential Off Isolation

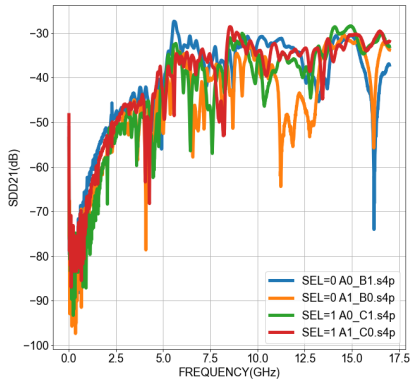


Figure 4. Differential Near End Crosstalk



Figure 5. 5.4GBPS Eye Diagram



Figure 6. 5.4 GBPS Jitter



Figure 7. 8.1 GBPS Eye Diagram



Figure 8. 8.1 GBPS Jitter



Figure 9. 10.0 GBPS Eye Diagram

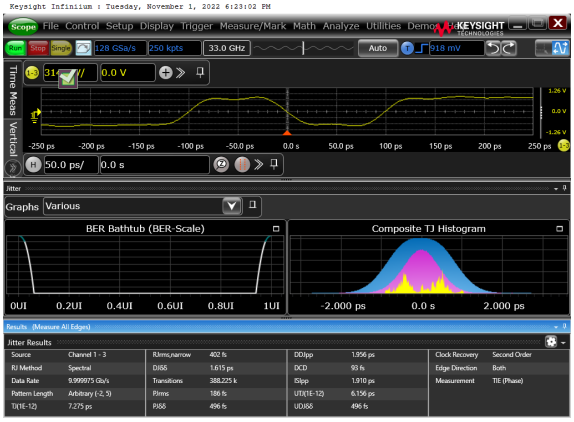


Figure 10. 10.0 GBPS Jitter



Figure 11. 16.0 GBPS Eye Diagram



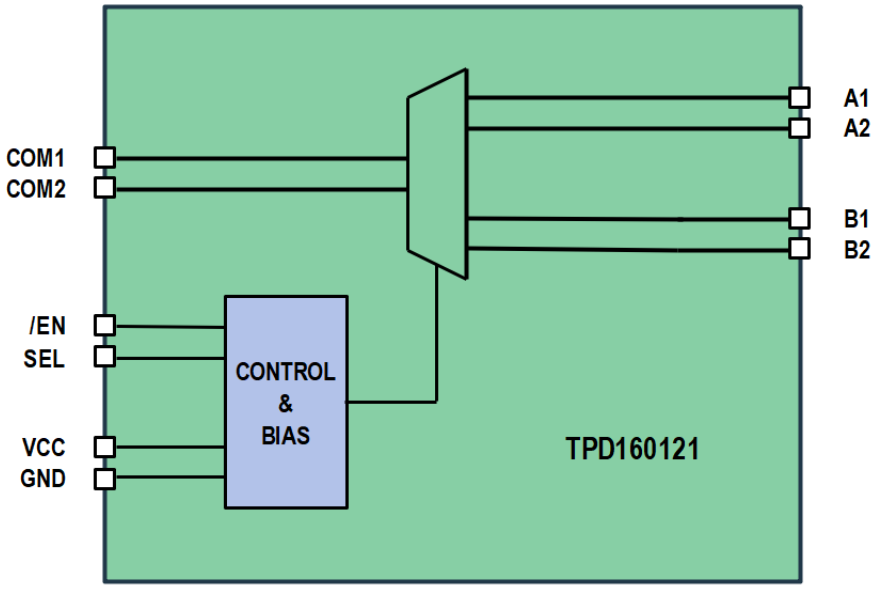
Figure 12. 16.0 GBPS Jitter

Detailed Description

Overview

The TPD160121 is a one differential or two single-ended 2:1 multiplexer or demultiplexer switch for PCIe Gen3, Gen4, and other high-speed serial link applications, the maximum data rate can be up to 16 Gbps.

Functional Block Diagram



Feature Description

PORT COM	PORT A / B CONNECTED TO PORT COM LOGIC	
	SEL = L	SEL = H
COM1	A1	B1
COM2	A2	B2

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 TPD160121 is a pure passive 2:1 multiplexer without any signal conditioning circuits, such as an equalizer or pre-emphasis. It can support various high-speed data signals provided that the differential amplitude is within 1.8 Vpp. In order to keep RON within a relatively small value (for example < 10 ohms), the common mode voltage should be less than 2.5 V. The TPD160121 is suitable for the following applications: USB 3.2 Gen1.0/2.0, 2.0, USB Type-C, PCIe Gen 1.0/2.0/3.0/4.0, SATA, SAS, DP 1.4, TBT 3.0, MIPI DSI, MIPI CSI-2, LVDS, GE/10GE, etc.

The TPD160121 can also work in single-ended signal mux/demux mode. A typical application is I^3C mux/demux beween the MCU and I^3C devices, such as DDR.

Typical Application

Figure 13 shows the typical I^3C application circuit.

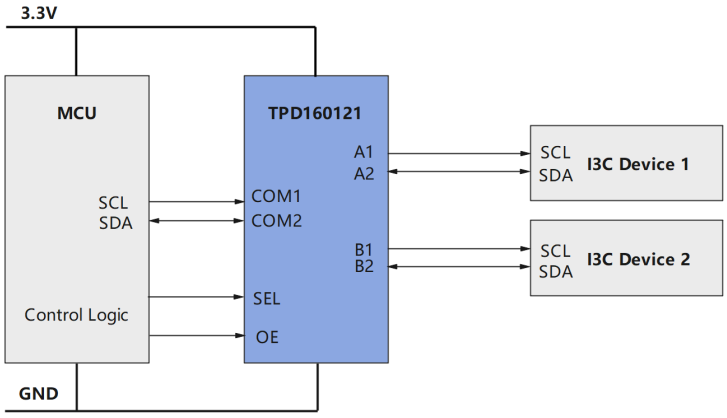


Figure 13. Typical I^3C Application Circuit

Layout

Layout Guideline

- Impedance matching (for example 50 Ω ± 10%) is recommended for high-speed signals to reduce the reflection of the trace.
- Try to control the length of high-speed traces to be the same.
- Exposed pads are recommended to be directly connected to the PCB grounding plane, and the copper area to be as large as possible.

Layout Example

Figure 14 shows the location of external components as they appear on the PCB.

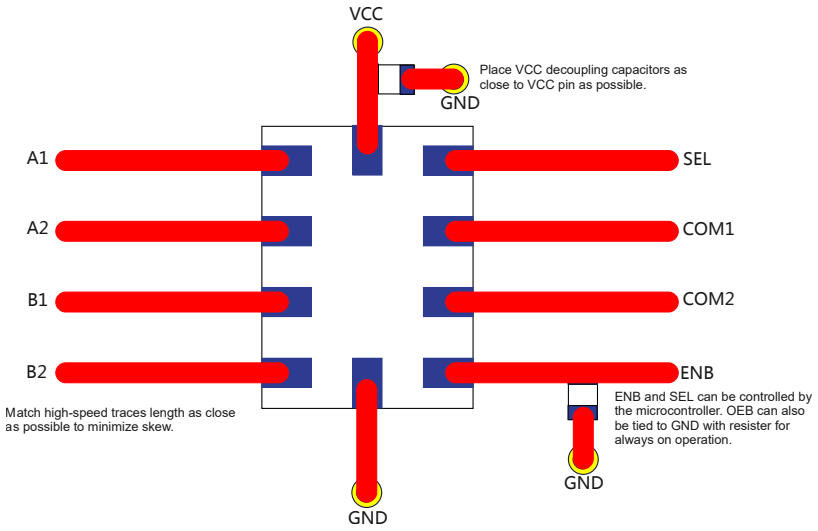
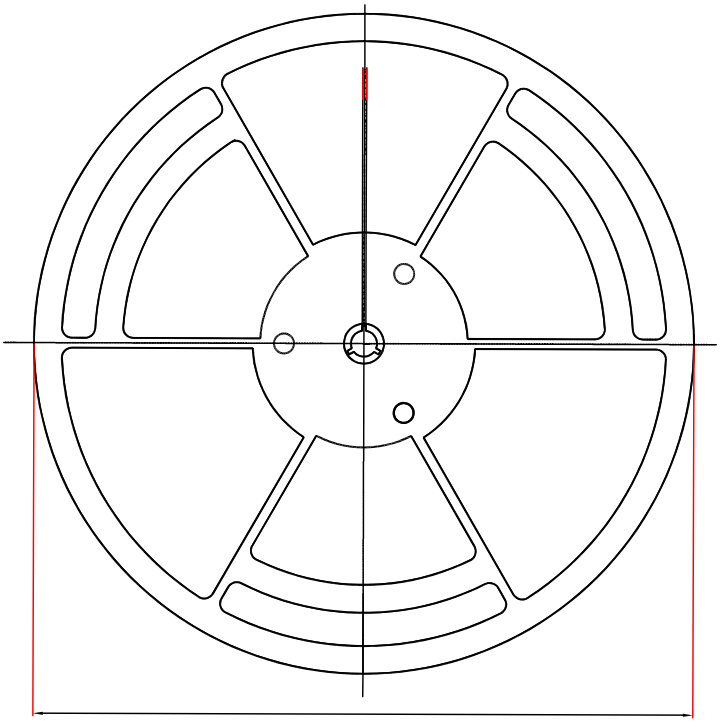
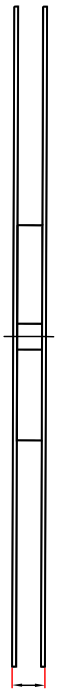
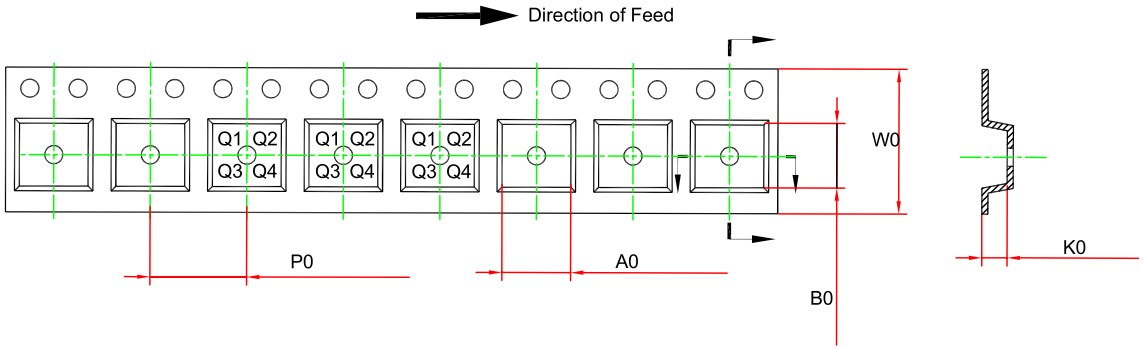


Figure 14. TPD160121 Layout Example

Tape and Reel Information





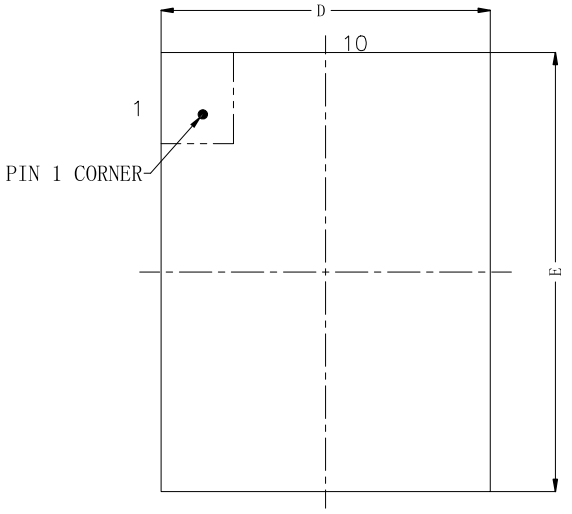


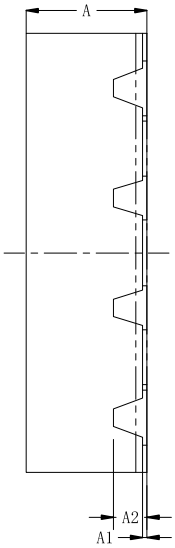
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPD160121-QF4R-S	QFN1.5X2.0-10	180.0	13.1	2.3	1.7	0.75	4.0	8.0	Q3

Package Outline Dimensions

QFN1.5X2-10

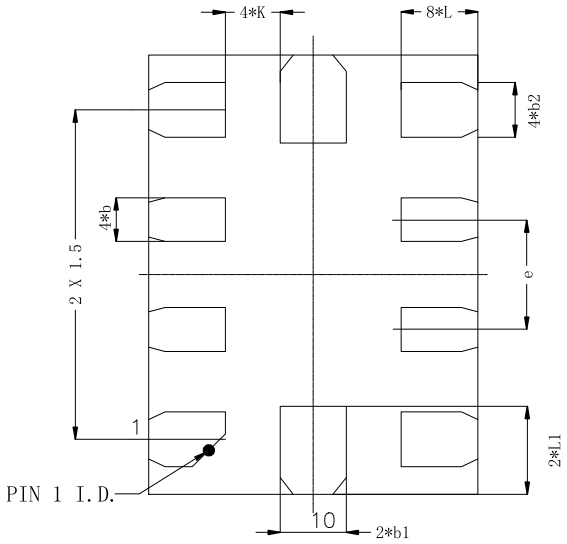
Package Outline Dimensions QF4(QFN1.5X2-10-A)





TOP VIEW

SIDE VIEW



BOTTOM VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.500	0.600	0.020	0.024
A1	0.000	0.050	0.000	0.002
A2	0.152 REF		0.006 REF	
b	0.150	0.250	0.006	0.010
b1	0.250	0.350	0.006	0.014
b2	0.200	0.300	0.008	0.012
D	1.500 BSC		0.059 BSC	
E	2.000 BSC		0.079 BSC	
e	0.500 BSC		0.020 BSC	
L	0.300	0.400	0.012	0.016
L1	0.350	0.450	0.014	0.018
K	0.250 BSC		0.010 BSC	

NOTES

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

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Package Quantity	Eco Plan
TPD160121-QF4R-S	−40 to 125°C	QFN1.5X2.0-10	MX1	3	Tape and Reel, 3000	Green

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

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