

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

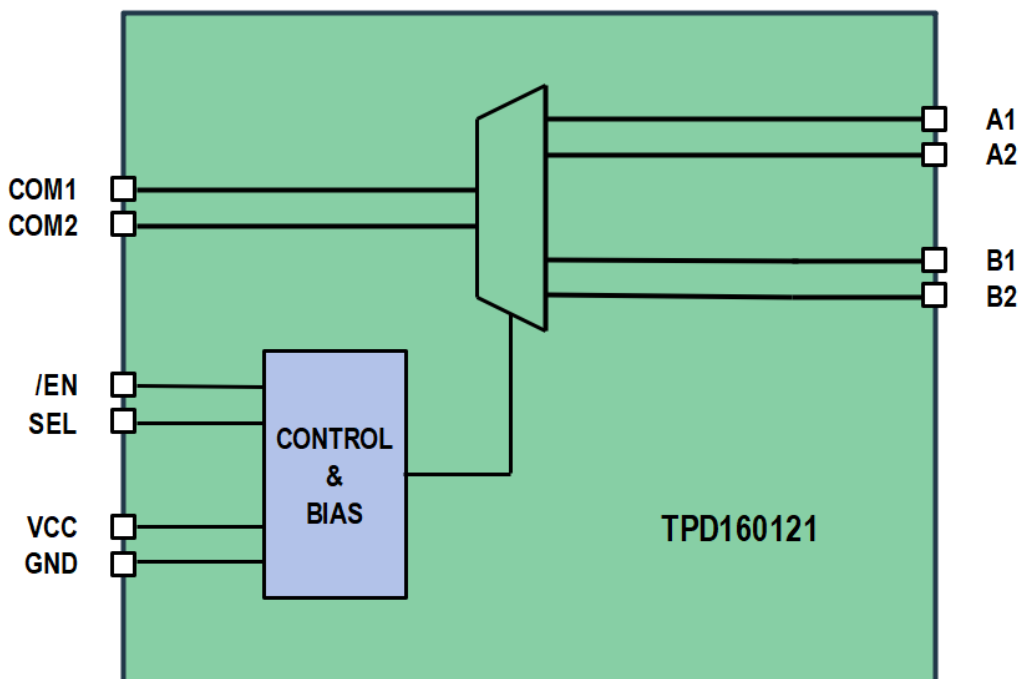
Applications

- 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 I²C or I³C applications.

Typical Application Circuit



2-channel Single-ended or 1-channel Differential 2:1 Multiplexer or Demultiplexer Switch**Table of Contents**

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

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Pin Configuration and Functions

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

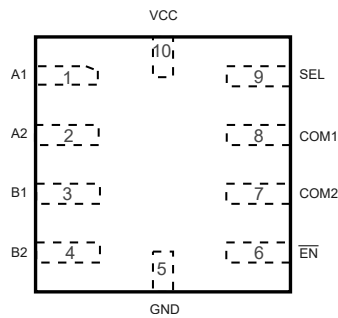


Table 1. Pin Functions: TPD160121

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	$\overline{\text{EN}}$	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

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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

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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

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

Parameter		Conditions	Min	Typ	Max	Units
		$R_L = 50 \Omega, f = 8 \text{ GHz}$		-11		dB
DXT	Differential Crosstalk	$R_L = 50 \Omega, f = 2.7 \text{ GHz}$		-48		dB
		$R_L = 50 \Omega, f = 4 \text{ GHz}$		-46		dB
		$R_L = 50 \Omega, f = 8 \text{ GHz}$		-38		dB
DRL	Differential Return Loss	$R_L = 50 \Omega, f = 2.7 \text{ GHz}$		-19		dB
		$R_L = 50 \Omega, f = 4 \text{ GHz}$		-16		dB
		$R_L = 50 \Omega, f = 8 \text{ GHz}$		-12		dB
DIL	Differential Insertion Loss	$R_L = 50 \Omega, f = 2.7 \text{ GHz}$		-0.8		dB
		$R_L = 50 \Omega, f = 4 \text{ GHz}$		-1.0		dB
		$R_L = 50 \Omega, f = 8 \text{ GHz}$		-2.1		dB
BW	-3 dB Bandwidth	$R_L = 50 \Omega, C_L = 0 \text{ pF}$		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

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

Typical Performance Characteristics

All test conditions: $V_{CC} = 3.3\text{ V}$, $T_A = +27^\circ\text{C}$, unless otherwise noted.

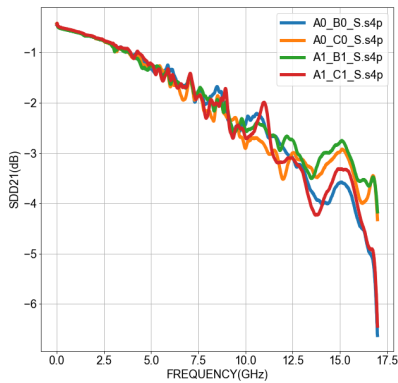


Figure 1. Differential Insertion Loss

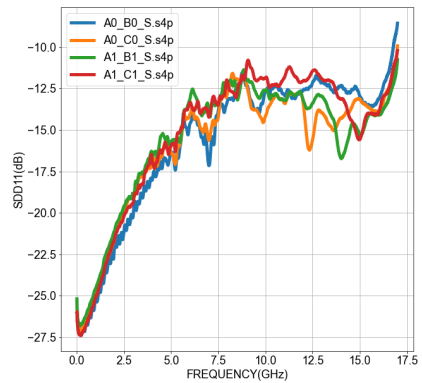


Figure 2. Differential Return Loss

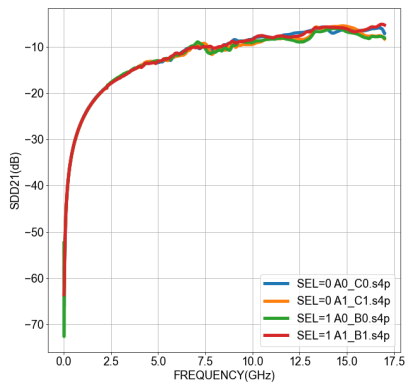


Figure 3. Differential Off Isolation

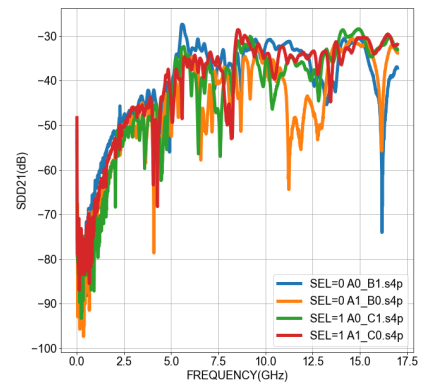


Figure 4. Differential Near End Crosstalk

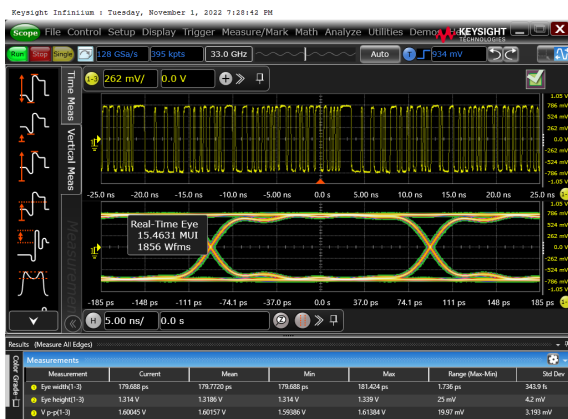


Figure 5. 5.4GBPS Eye Diagram



Figure 6. 5.4 GBPS Jitter

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



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

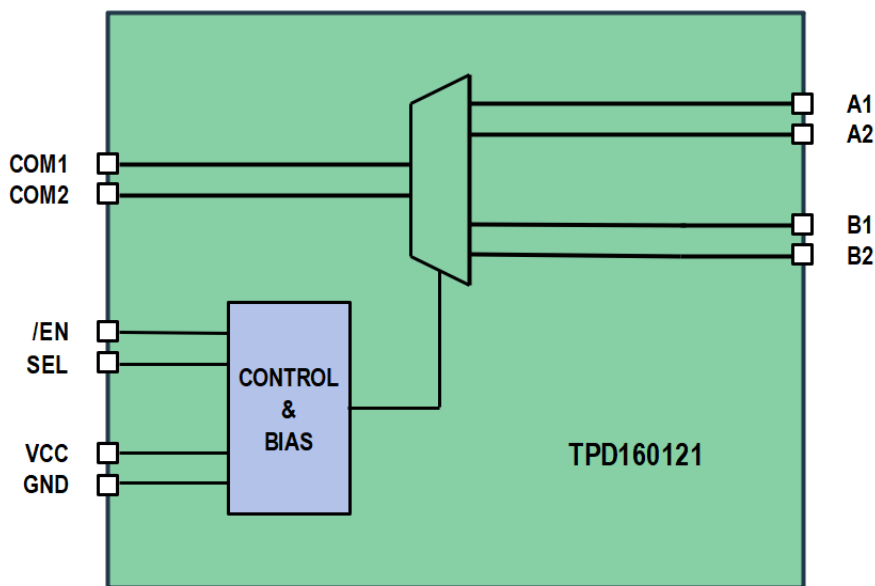
2-channel Single-ended or 1-channel Differential 2:1 Multiplexer or Demultiplexer Switch

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	A0	B0
COM2	A1	B1

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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 I³C mux/demux between the MCU and I³C devices, such as DDR.

Typical Application

Figure 13 shows the typical I³C application circuit.

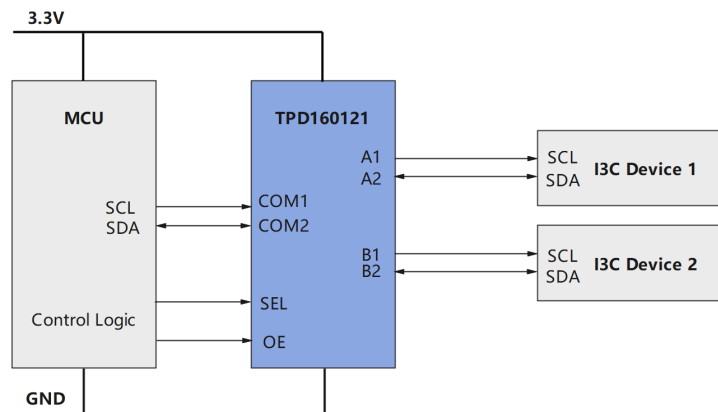


Figure 13. Typical I³C Application Circuit

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

Layout

Layout Guideline

- Impedance matching (for example $50 \Omega \pm 10\%$) 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.

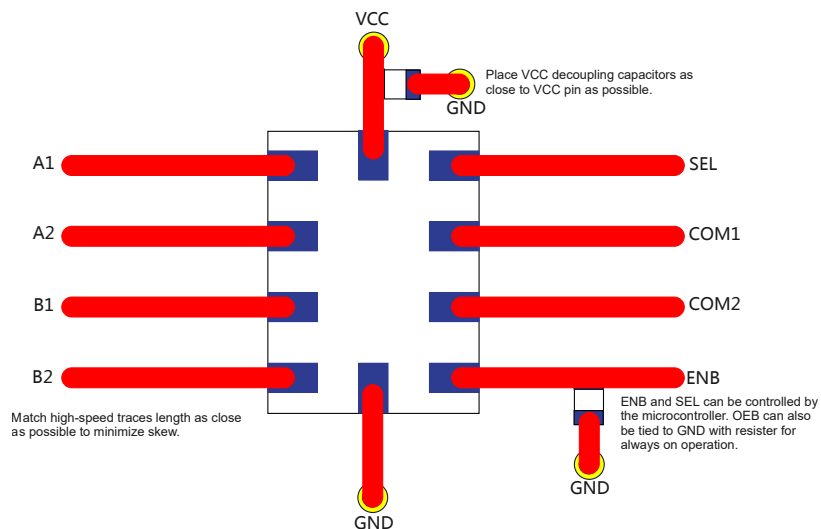
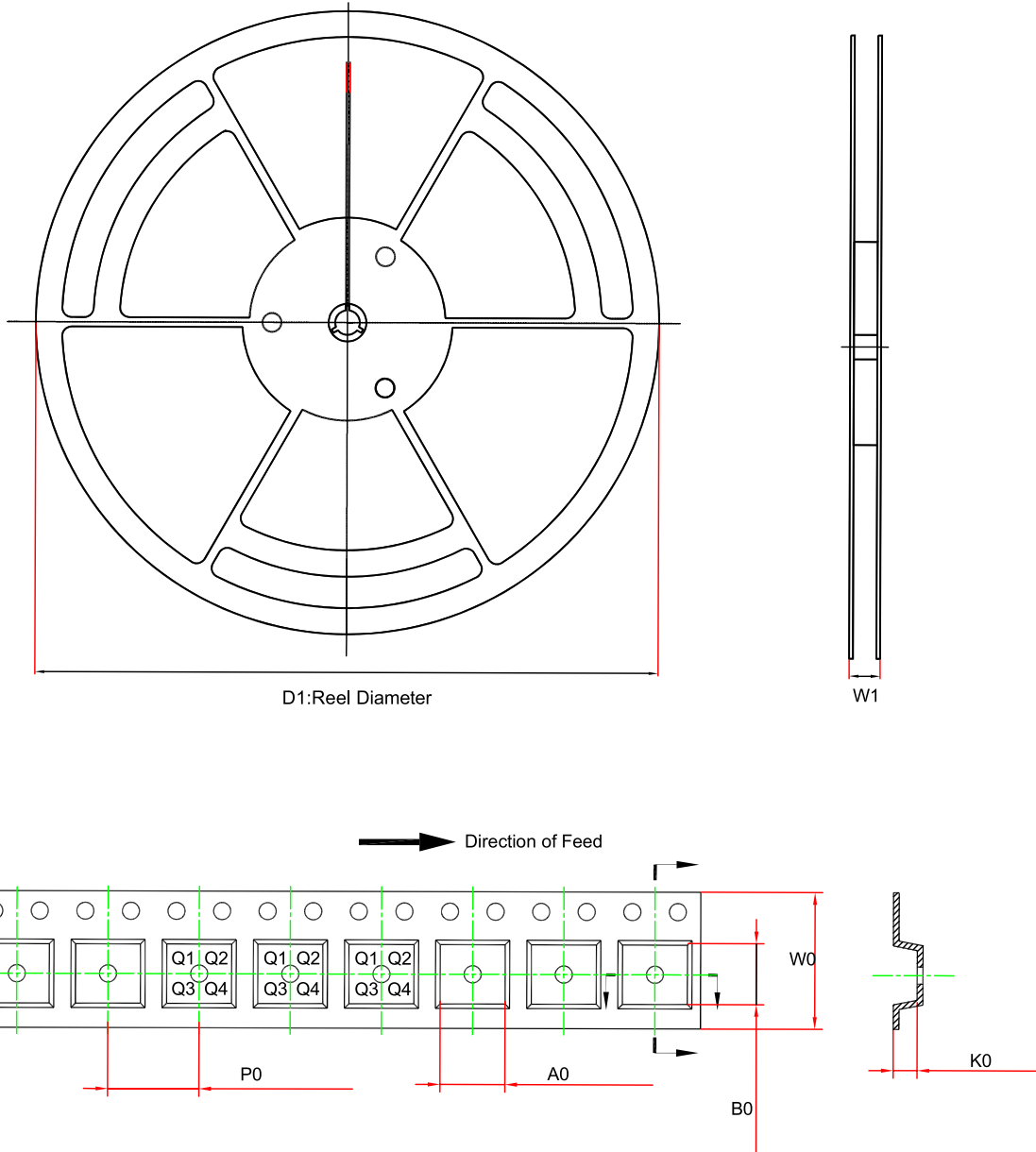


Figure 14. TPD160121 Layout Example

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

Tape and Reel Information

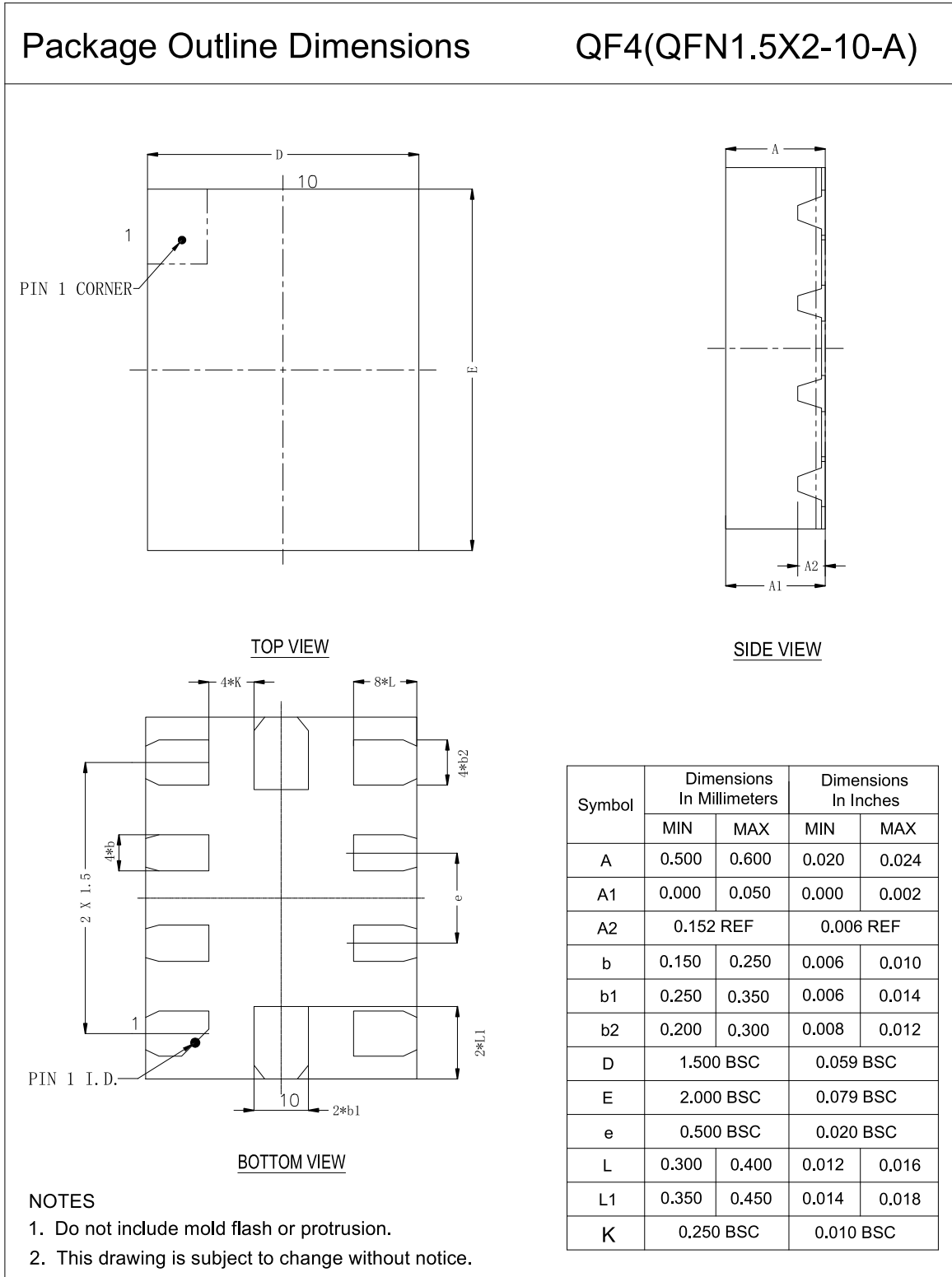


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPD160121-QF4R-S	QFN1.5X2.0-10	180.0	13.1	2.3	1.7	0.75	4.0	8.0	Q3

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Package Outline Dimensions

QFN1.5X2-10



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

2-channel Single-ended or 1-channel Differential 2:1 Multiplexer or Demultiplexer Switch**IMPORTANT NOTICE AND DISCLAIMER**

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