Dual Single-Pole, Double-Throw

USB 2.0 High-Speed Switch

Features

- AEC-Q100 qualified:
  - Device ambient temperature: -40°C ≤ T_A ≤ 125°C
  - Device junction temperature: -40°C ≤ T_J ≤ 150°C
- V_{CC} input voltage range: 2.3 V to 5.5 V
- High speed signal channels support up to 5.5 V
- Bandwidth (-3 dB) : 5.8 GHz
- R_{ON} (typ.): 4.6 Ω
- C_{ON} (typ.): 0.6 pF
- 1.8 V compatible control-pin inputs for /EN and SEL
- Low-power mode when /EN is disabled (1 μA)
- Ultra-low power consumption: 25 μA (typ.)
- Overvoltage tolerance on all I/O pins: 5.5 V

Applications

- Routing high-speed USB signals
- Automotive USB hubs
- Phone-controlled automotive infotainment

Package Information

Part Number	Package	Body Size
DIA3000	QFN-10	2.0 mm × 1.5 mm

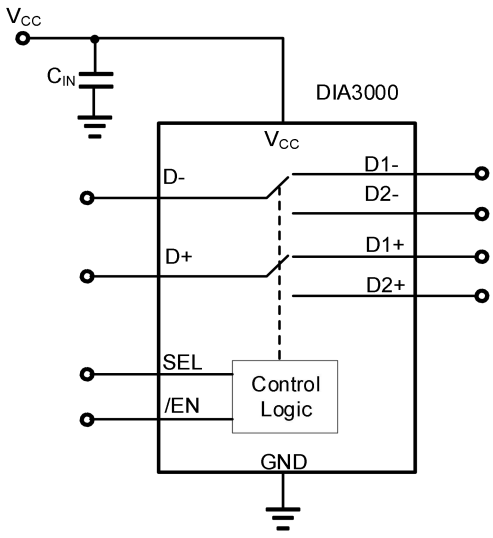
Description

The DIA3000 is a dual single-pole, double-throw (SPDT) switch with 5.8 GHz wide bandwidth. The device is designed to switch USB 2.0 signals in automotive hubs or controllers.

The DIA3000 supports a wide input voltage range of 2.3 V to 5.5 V and features an overvoltage tolerance function on all I/O pins, which allows the I/O pins to withstand an overvoltage of up to 5.5 V. The power-off protection feature forces all I/O pins in high-impedance mode when power supply is not present, in this case without excessive leakage current. 1.8 V compatible control logic of the DIA3000 allows the direct interface with the general-purpose I/O (GPIO) of the baseband processor.

The DIA3000 is housed in a small QFN2*1.5-10 package and is characterized by ambient temperature range from -40°C to 125°C, which makes it a perfect solution for automotive applications.

Simplified Schematic



Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIA3000QN10	YW 3D XX	1	Green	-40 to 125°C	QFN2*1.5-10	Tape & Reel, 3000

If you encounter any issue in the process of using the device, please contact our customer service at marketing@dioo.com or phone us at (+86)-21-62116882. If you have any improvement suggestions regarding the datasheet, we encourage you to contact our technical writing team at docs@dioo.com. Your feedback is invaluable for us to provide a better user experience.

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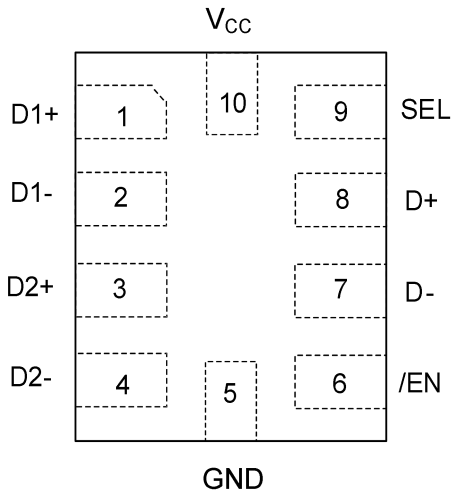
1. Pin Assignment and Functions



QFN2*1.5-10 (Top view)

Pin No.	Name	I/O	Description
1	D1+	I/O	Data link (Differential+)
2	D1-	I/O	Data link (Differential-)
3	D2+	I/O	Data link (Differential+)
4	D2-	I/O	Data link (Differential-)
5	GND	-	Ground
6	/EN	I	Output enable (Active low)
7	D-	I/O	Switch input/output (Differential-)
8	D+	I/O	Switch input/output (Differential+)
9	SEL	I	Switch select (LOW = D+ / D- to D1+ / D1-, HIGH = D+ / D- to D2+ / D2-)
10	V_{CC}	-	Power supply pin

2. Absolute Maximum Ratings

Exceeding the maximum ratings listed under Absolute Maximum Ratings when designing is likely to damage the device permanently. Do not design to the maximum limits because long-time exposure to them might impact the device's reliability. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter	Rating	Unit
V_{CC}	Supply voltage	-0.3 ~ 6	V
$V_{I/O}$	Input/output DC voltage	-0.3 ~ 6	V
V_{D-}	D- DC voltage(1)	-0.3 ~ 9	V
V_I	Digital input voltage (SEL, /EN)	-0.3 ~ 6	V
I_K	Input/output port diode current ($V_{I/O}$ < 0)	-50	mA
I_{IK}	Digital logic input clamp current (V_I < 0)	-50	mA
I_{CC}	Continuous current through V_{CC}	100	mA
I_{GND}	Continuous current through GND	-100	mA
T_{STG}	Storage temperature	-65 ~ 150	ºC

Note:

(1) This rating only applies to the D- pin with respect to GND. V_{CC} must be powered within the recommended operating conditions of 2.3 V to 5.5 V and the EN pin must be logic high for this rating to be applicable. Any condition where V_{CC} is unpowered or the EN pin is not high must refer to the rest of the Absolute Maximum Ratings Table.

3. Recommended Operating Conditions

Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter	Rating	Unit
V_{CC}	Supply voltage	2.3 to 5.5	V
$V_{I/O}$	Analog voltage	0 to V_{CC}	V
V_I	Digital input voltage (SEL, /EN)	0 to V_{CC}	V
t_{RAMP} (V_{CC})	Power supply ramp time requirement (V_{CC})	100 to 1000	μs/V
T_A	Operating free-air temperature	-40 to 125	ºC

4. ESD Ratings

When a statically-charged person or object touches an electrostatic discharge sensitive device, the electrostatic charge might be drained through sensitive circuitry in the device. If the electrostatic discharge possesses sufficient energy, damage might occur to the device due to localized overheating.

Model	Condition	Value	Unit
HBM	AEC-Q100-002	±6000	V
CDM	AEC-Q100-011	±2000	V

5. Thermal Considerations

The thermal resistance determines the heat insulation property of a material. The higher the thermal resistance is, the lower the heat loss. Accumulation of heat energy degrades the performance of semiconductor components.

Symbol	Metric	Value	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance	165	°C/W
$R_{\theta JC}$	Junction-to-case thermal resistance	64	°C/W

6. Electrical Characteristics

6.1. General characteristics

The values are obtained under these conditions unless otherwise specified: T_A = 25°C, typical values at V_{CC} = 3.3 V.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
R_{ON}	ON-state resistance	V_{CC} = 2.3 V; $V_{I/O}$ = 0.4 V, I_{ON} = -8 mA, T_A = -40°C to 125°C		4.6	7.5	Ω
ΔR_{ON}	ON-state resistance match between + and - paths	V_{CC} = 2.3 V, $V_{I/O}$ = 0.4 V, I_{ON} = -8 mA		0.1		Ω
I_{OZ}	OFF leakage current	V_{CC} = 5 V, switch off, $V_{D1/2±}$ = 0 V to 3.6 V, $V_{D±}$ = 0 V, T_A = -40°C to 125°C	-2		2	μA
I_{ON}	ON leakage current	V_{CC} = 5 V, switch on, $V_{D±}$ = NC; $V_{1/2±}$ = 0 V to 3.6 V, T_A = -40°C to 125°C	-2		2	μA
Digital control inputs (SEL, /EN)						
V_{IH}	Input logic high	V_{CC} = 2.3 V, T_A = -40°C to 125°C	1			V
		V_{CC} = 3.6 V	1.2			
		V_{CC} = 5 V	1.3			
		V_{CC} = 5.5 V, T_A = -40°C to 125°C	1.35			
V_{IL}	Input logic low	V_{CC} = 2.3 V, T_A = -40°C to 125°C			0.4	V
		V_{CC} = 3.6 V			0.6	
		V_{CC} = 5 V			0.7	
		V_{CC} = 5.5 V, T_A = -40°C to 125°C			0.75	
R_{PULL_DOWN}(1)	Pull-down resistor	/EN, SEL		6.5		MΩ
Dynamic characteristic						
C_{ON}	ON capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz, switch on		0.6		pF
O_{ISO}	OFF isolation	V_{CC} = 2.3 V to 5 V, R_L = 50 Ω, f = 240 MHz, switch off		-36		dB
X_{TALK}	Crosstalk	V_{CC} = 2.3 V to 5 V, R_L = 50 Ω, f = 240 MHz, switch on		-40		dB
BW	Path -3 dB bandwidth	V_{CC} = 2.3 V to 5 V, R_L = 50 Ω, switch on		5.8		GHz
Supply						
V_{CC}	Power supply voltage		2.3		5.5	V
I_{CC}	Positive supply current	V_{CC} = 5 V, V_{IN} = V_{CC} or GND, $V_{I/O}$ = 0 V, switch on or off, T_A = -40°C to 125°C		25	40	μA
$I_{CC, HZ}$	Power supply current in high-Z mode	V_{CC} = 5 V, V_{IN} = V_{CC} or GND, T_A = -40°C to 125°C $V_{I/O}$ = 0 V, switch on or off, /EN = High		1	5	μA

Note:

(1) Guaranteed by design.

(2) Specifications subject to change without notice.

6.2. Timing requirements

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
t_{switch_on}	Switching ON time (SEL to output)	See Figure 1	R_L = 50 Ω, C_L = 5 pF, V_{CC} = 2.3 V to 5 V		100		ns
t_{switch_off}	Switching OFF time (SEL to output)	See Figure 1			40		ns
t_{BBM}	Break-before-make time	See Figure 2			60		ns
$t_{ZH, ZL}$	Enable time (/EN to output)	$V_{I/O}$ = 0.8 V or 0 V			7		µs
$t_{HZ, LZ}$	Disable time (/EN to output)				30		ns

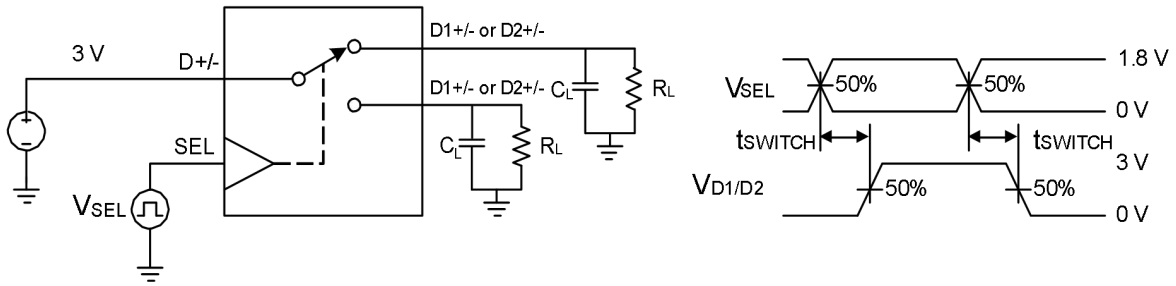


Figure 1. Timing diagram

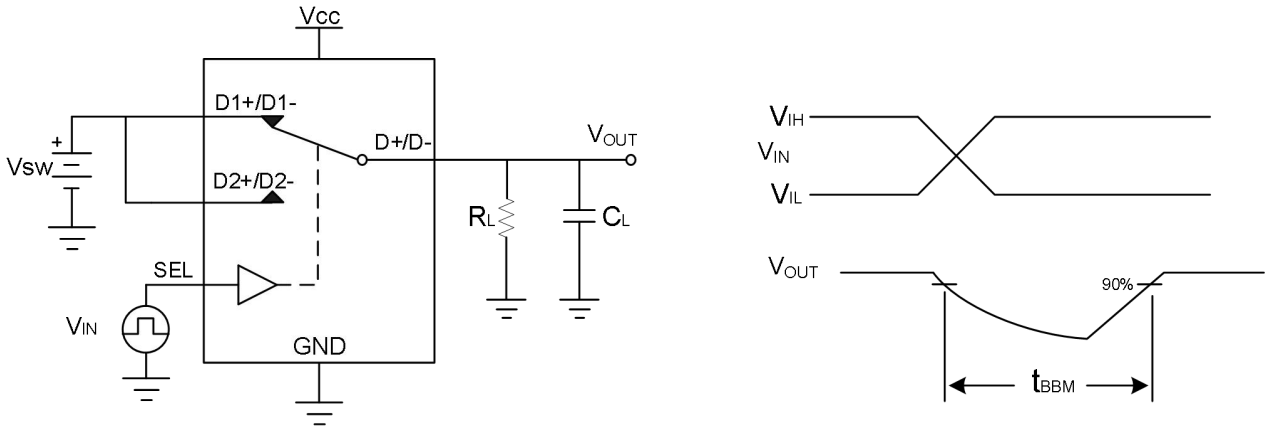
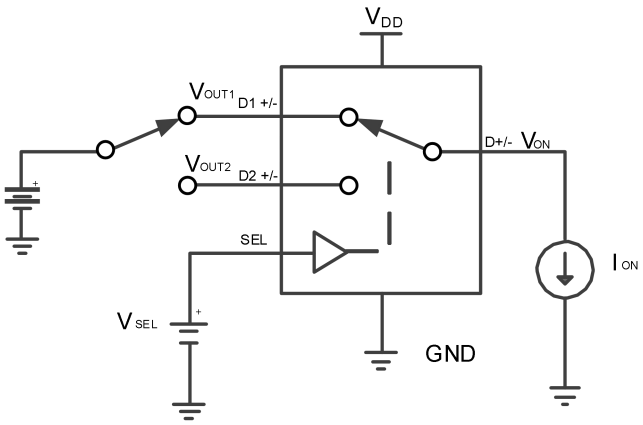


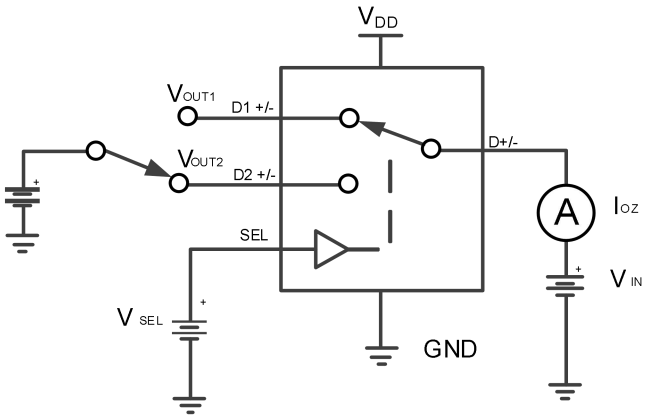
Figure 2. Break-before-make

7. Test Diagrams



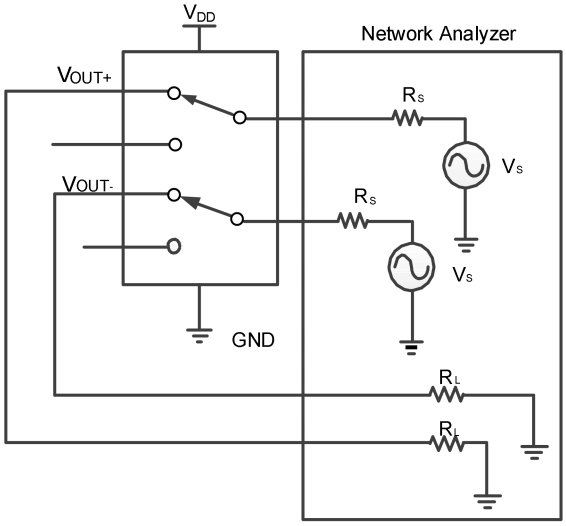
Channel on, R_{ON} = (V_{ON} - $V_{I/O1}$) /I_{ON} or (V_{ON} - $V_{I/O2}$) /I_{ON}, V_{SEL} = H or L

Figure 3. On-state resistance



Channel off, V_{SEL} = H or L

Figure 4. Off leakage current



Channel on, V_{SEL} = H or L, R_S = R_L= 50 Ω

Figure 5. Bandwidth (BW)

8. Typical Performance Characteristic

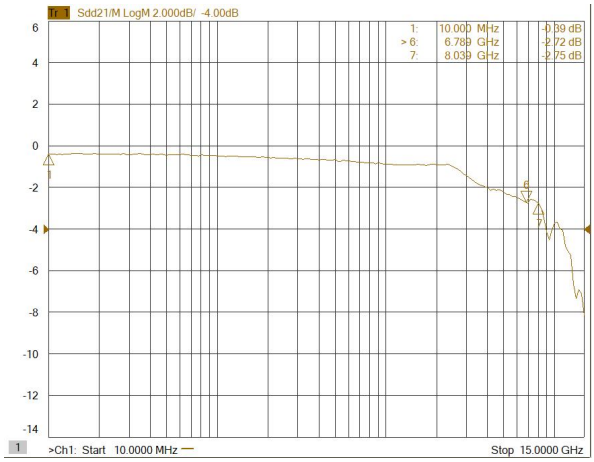


Figure 6. Differential Sdd21 vs. Frequency

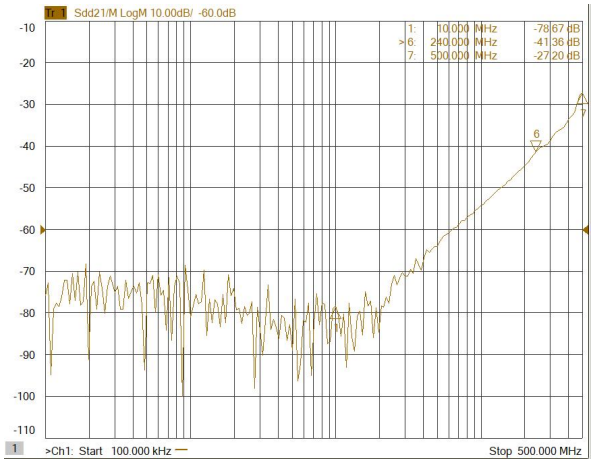


Figure 7. Differential crosstalk vs. Frequency

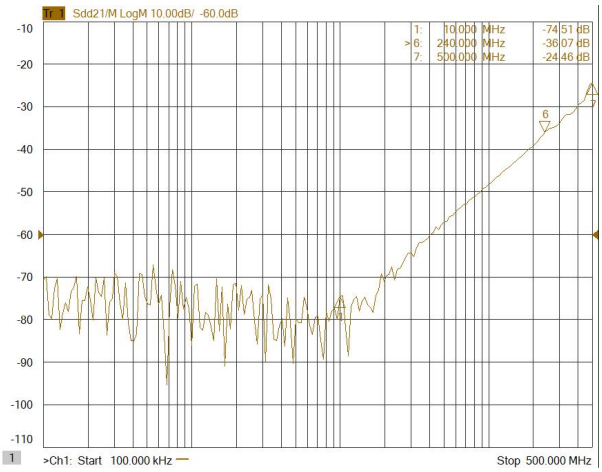


Figure 8. Differential off isolation vs. Frequency

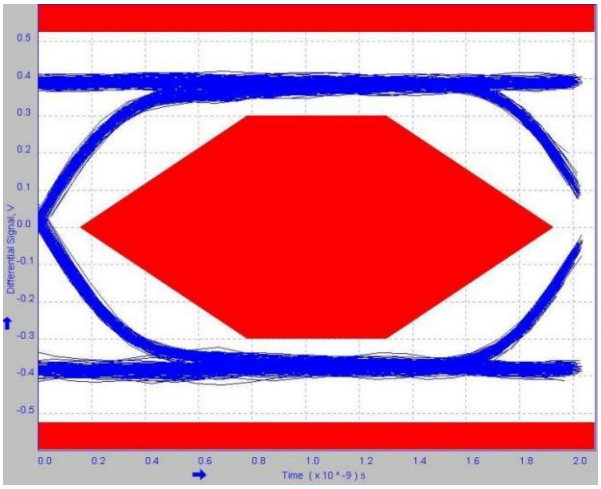
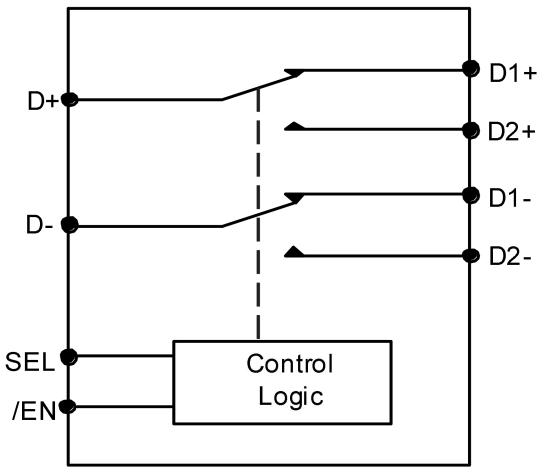


Figure 9. 480 Mbps USB 2.0 eye pattern

9. Block Diagram



10. Function Description

10.1. Low power mode

The DIA3000 has a low power mode that reduces the power consumption to 1 μA when the device is not in use. Setting the enable pin /EN with a logic high signal will put IC in low power mode.

10.2. High impedance mode

When the device is not in use, the DIA3000 switches to a high impedance mode. As shown in Table 1, high impedance mode is achieved by providing logic high to the bus-switch enable pin /EN.

Table 1. Function for high impedance mode

SEL	/EN	Switch Status
X	High	Both D1 and D2 switches in high-Z
Low	Low	D+/D- to D1+/D1-
High	Low	D+/D- to D2+/D2-

11. Application Information

Important notice: Validation and testing are the most reliable ways to confirm system functionality. The application information is not part of the specification and is for reference purposes only.

Figure 10 is a typical application of the DIA3000 USB switch. The DIA3000 has internal 6.5 MΩ pull-down resistors on /EN and SEL. The pull-down resistor on /EN pin enables the switch when power is applied. The pull-down resistor on SEL pin ensure the USB channel is selected by default.

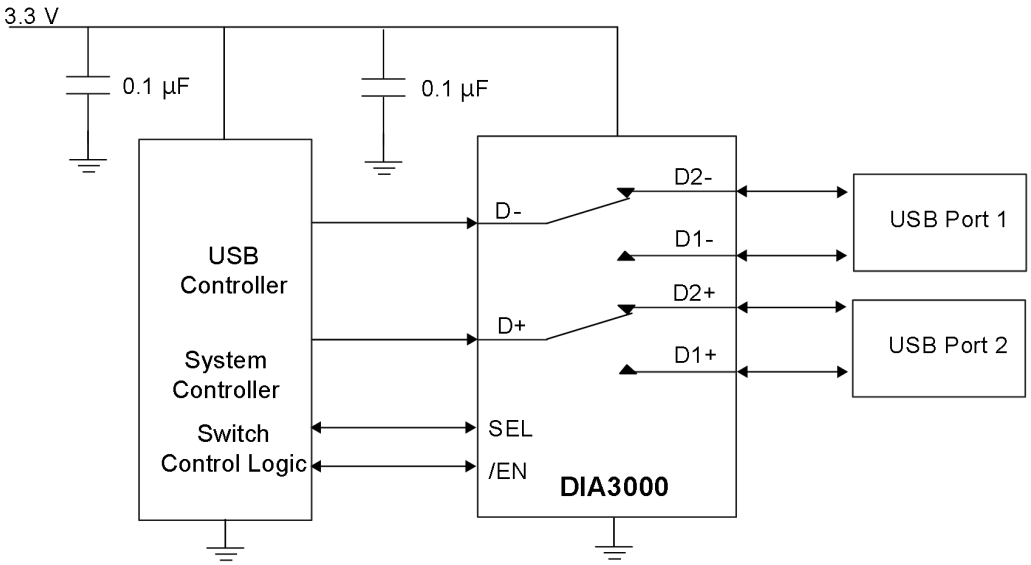
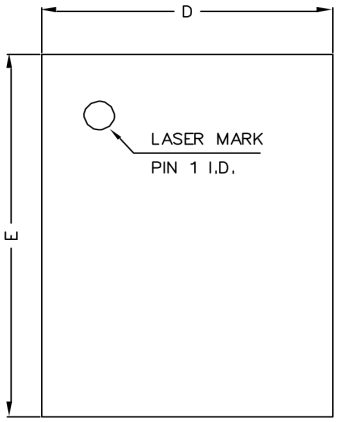
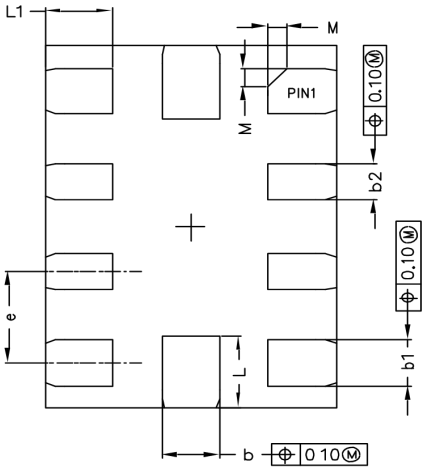


Figure 10. Application example

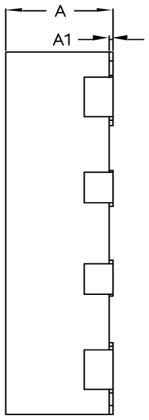
12. Physical Dimensions: QFN2*1.5-10



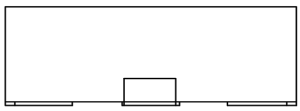
TOP VIEW



BOTTOM VIEW



SIDE VIEW



SIDE VIEW

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	0.50	0.55	0.60
A1	0	0.02	0.05
b	0.25	0.30	0.35
b1	0.20	0.25	0.30
b2	0.15	0.20	0.25
D	1.45	1.50	1.55
E	1.95	2.00	2.05
e	0.40	0.50	0.60
L	0.35	0.40	0.45
L1	0.30	0.35	0.40
M	0.10 REF		

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