DPDT USB 2.0 High-Speed and Mobile High-Definition Link Switch

Features

- V_{CC} input voltage range: 2.3 V to 5.5 V
- USB channel:
  - Bandwidth (-3 dB): 5.8 GHz
  - R_{ON} (typ.): 4.6 Ω
  - C_{ON} (typ.): 1.2 pF
- Mobile High-Definition Link (MHL) channel:
  - Bandwidth (-3 dB): 5.5 GHz
  - R_{ON} (typ.): 5.3 Ω
  - C_{ON} (typ.): 0.6 pF
- 1.8 V compatible control-pin inputs for EN and SEL
- Ultra low power consumption:
  - High-Z mode (/OE is disabled): 1 μA (typ.)
  - Low-low power consumption: 25 μA (typ.)
- Overvoltage tolerance on all I/O pins: 5.5 V
- Operating temperature range: -40°C to 105°C

Applications

- Portable instrumentation
- Digital still cameras
- Tablets
- Mobile phone

Package Information

Part Number	Package	Body Size
DIO3000	QFN-10	2 mm × 1.5 mm

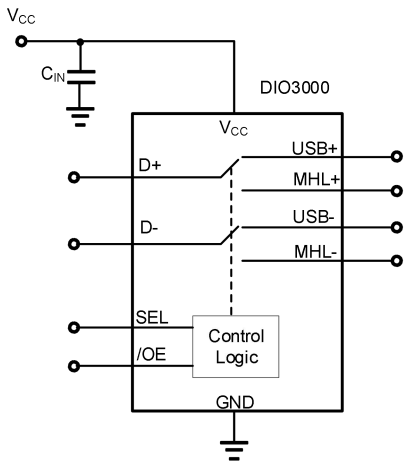
Description

The DIO3000 is a double-pole, double-throw (DPDT) multiplexer that includes a Mobile High-Definition Link (MHL) switch and a USB 2.0 High-speed (480 Mbps) switch housed in the same package. The wide bandwidth of this product allows the sharing of the USB connector for both MHL video signals and USB data transmission.

The DIO3000 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 DIO3000 allows the direct interface with the general-purpose I/O (GPIO) of the baseband processor.

The DIO3000 is housed in a small QFN2*1.5-10 package and is characterized by ambient temperature range from -40°C to 105°C, which makes it a perfect candidate to be used in handheld applications.

Simplified Schematic



Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIO3000QN10	YW3C	1	Green	-40 to 105°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

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1. Pin Assignment and Functions

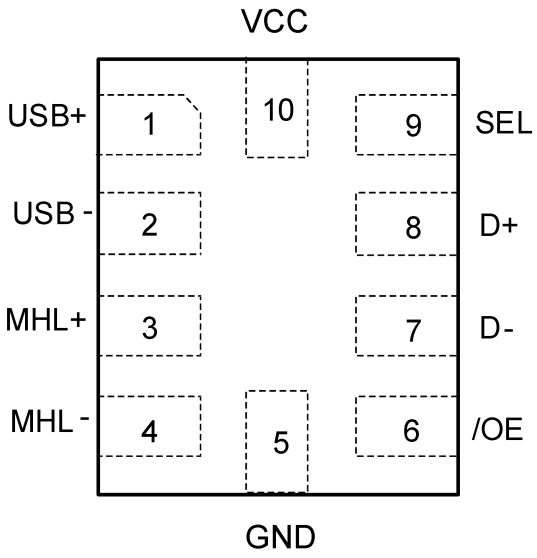


*Figure 1. QFN2*1.5-10 (Top view)*

Pin Name	Direction	Description
USB+	I/O	USB data link (Differential+)
USB-	I/O	USB data link (Differential-)
MHL+	I/O	MHL data link (Differential+)
MHL-	I/O	MHL data link (Differential-)
GND	-	Ground
/OE	I	Output enable (active low)
D-	I/O	Switch input/output (Differential-)
D+	I/O	Switch input/output (Differential+)
SEL	I	Switch select (Low = D+ / D- to USB+ / USB; High = D+ / D- to MHL+ / MHL-)
VCC	-	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	Min	Max	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, /OE)	-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	°C

Note:

(1) This rating only applies to the D-pin with respect to GND. VCC must be powered within the recommended operating conditions of 2.3 V to 5.5 V and the /OE pin must be logic high for this rating to be applicable. Any condition where VCC is unpowered or the /OE pin is not high must reference 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
$V_{I/O\ (USB)}$	Analog voltage	0 to V_{CC}	V
$V_{I/O\ (MHL)}$			
V_I	Digital input voltage (SEL, /OE)	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 105	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	ANSI/ESDA/JEDEC JS-001	±5500	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	Thermal Metric	QFN-10	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance	193	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	96	°C/W

6. Electrical Characteristics

T_A = 25°C, typical values are at V_{CC} = 3.3 V (unless otherwise noted).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
MHL switch						
R_{ON}	On-state resistance	V_{CC} = 2.7 V, $V_{I/O}$ = 1.65 V, I_{ON} = -8 mA, T_A = -40°C to 105°C		5.3	7.5	Ω
ΔR_{ON}	On-state resistance match between + and - paths	V_{CC} = 2.7 V, $V_{I/O}$ = 1.65 V, I_{ON} = -8 mA		0.1		Ω
I_{OZ}	Off leakage current	V_{CC} = 5 V, switch off, $V_{MHL\pm}$ = 1.65 V to 3.45 V, $V_{D\pm}$ = 0 V	-2		2	μA
I_{ON}	On leakage current	V_{CC} = 5 V, switch on, $V_{MHL\pm}$ = 1.65 V to 3.45 V, $V_{D\pm}$ = NC	-2		2	μA
USB switch						
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 105°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, $V_{USB\pm}$ = 0 V to 3.6 V, $V_{D\pm}$ = 0 V	-2		2	μA
I_{ON}	On leakage current	V_{CC} = 5 V, switch on, $V_{USB\pm}$ = 0 V to 3.6 V, $V_{D\pm}$ = NC	-2		2	μA
Digital control inputs (SEL, /OE)						
V_{IH}	Input logic high	V_{CC} = 2.3 V, T_A = -40°C to 105°C	1			V
		V_{CC} = 5.5 V, T_A = -40°C to 105°C	1.35			
V_{IL}	Input logic low	V_{CC} = 2.3 V, T_A = -40°C to 105°C			0.4	V
		V_{CC} = 5.5 V, T_A = -40°C to 105°C			0.75	
I_{IN}	Input leakage current	V_{CC} = 5 V, $V_{I/O}$ = 0 V to 3.6 V, V_{IN} = 0 to 5 V	-10		10	μA

Note:

(1) Specifications subject to change without notice.

7. Dynamic Characteristics

Over operating free-air temperature range (unless otherwise noted).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_{ON(MHL)}$	MHL path on capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz, switch on		0.6	1.8	pF
$C_{ON(USB)}$	USB path on capacitance	V_{CC} = 3.3 V, $V_{I/O}$ = 0 or 3.3 V, f = 240 MHz, switch on		1.2	1.6	pF
C_I	Digital input capacitance	V_{CC} = 3.3 V, V_I = 0 or 2 V		2.2		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
$B_{W(MHL)}$	MHL path -3 db bandwidth	V_{CC} = 2.3 V to 5 V, R_L = 50 Ω, switch on		5.5		GHz
$B_{W(USB)}$	USB 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 105°C		25	40	μA
$I_{CC, HZ}$	Power supply current in high-Z mode	V_{CC} = 5 V, V_{IN} = V_{CC} or GND, $V_{I/O}$ = 0 V, switch on or off, /OE = H		1	5	μA

8. Timing Requirements

Symbol	Conditions			Min	Nom	Max	Unit
t_{switch}	Switching time (SEL to output)	See Figure 2	R_L = 50 Ω, C_L = 5 pF, V_{CC} = 2.3 V to 5 V		60		ns
$t_{ZH, ZL(MHL)}$	MHL enable time (/OE to output)	$V_{I/O}$ = 3.3 V or 0 V			7		μs
$t_{HZ, LZ(MHL)}$	MHL disable time (/OE to output)				22		ns
$t_{ZH, ZL(USB)}$	USB enable time (/OE to output)	$V_{I/O}$ = 0.8 V or 0 V			7		μs
$t_{HZ, LZ(USB)}$	USB disable time (/OE to output)				17		ns

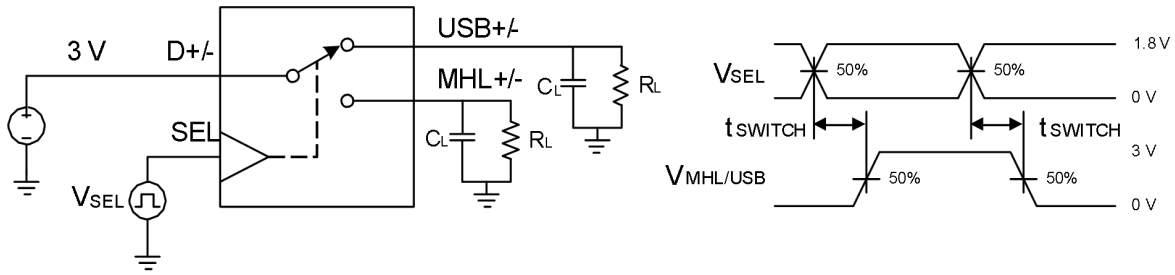


Figure 2. Timing diagram

Note:

(1) All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r < 5 ns, t_f < 5 ns.

(2) C_L includes probe and jig capacitance.

9. Typical Performance Characteristic

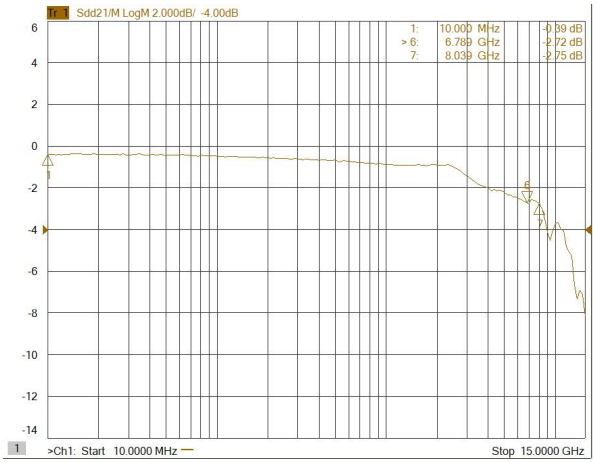


Figure 3. Differential Sdd21 vs. Frequency USB switch

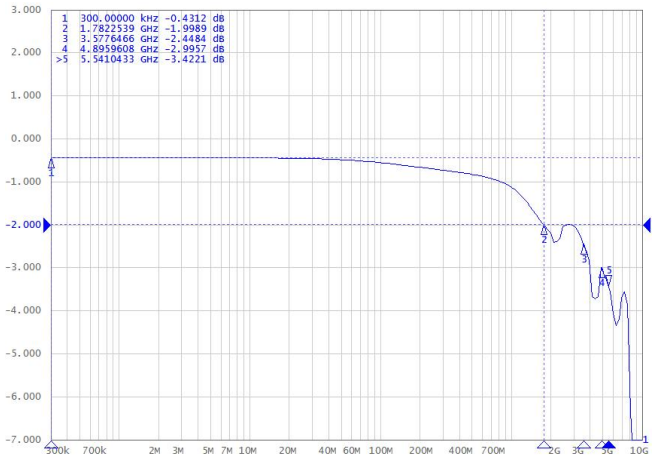


Figure 4. Differential Sdd21 vs. Frequency MHL switch

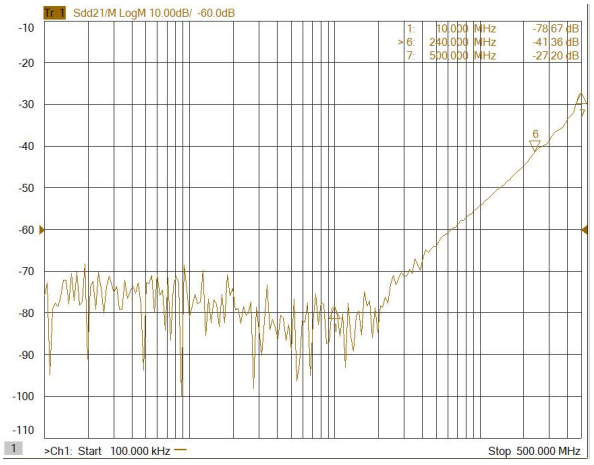


Figure 5. Differential crosstalk vs. Frequency for USB path

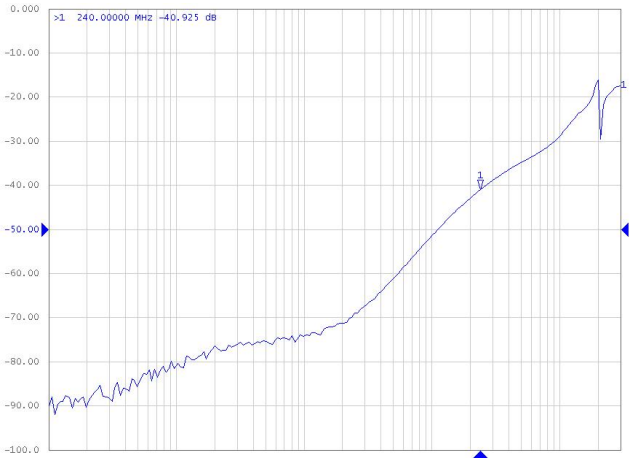


Figure 6. Crosstalk vs. Frequency for MHL path

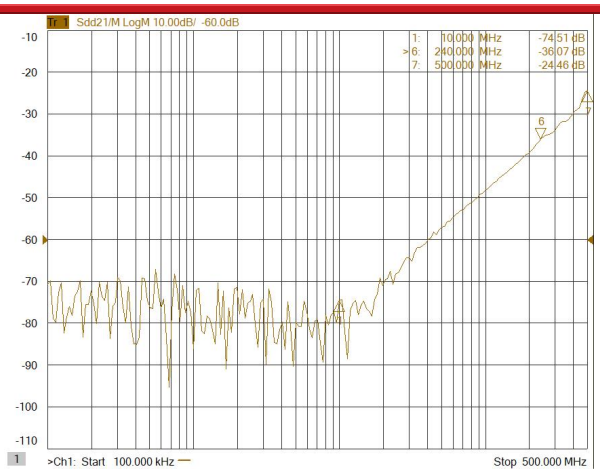


Figure 7. Differential off isolation vs. Frequency for USB path

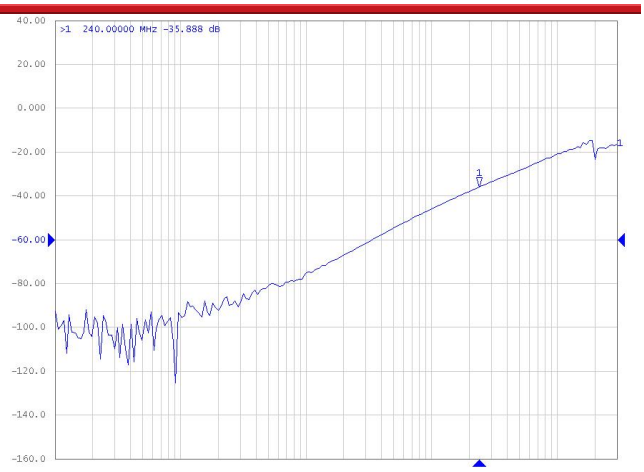


Figure 8. Off isolation vs. Frequency for MHL path

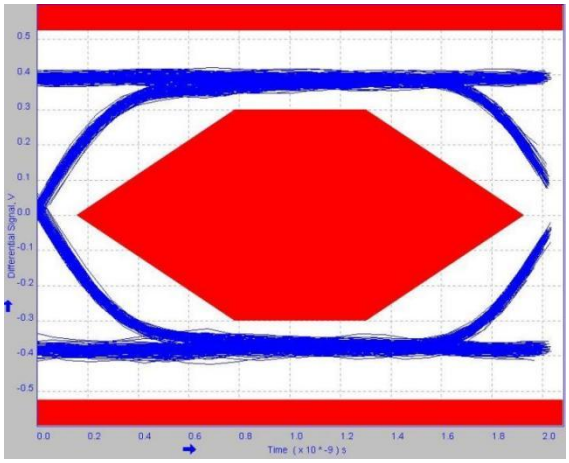
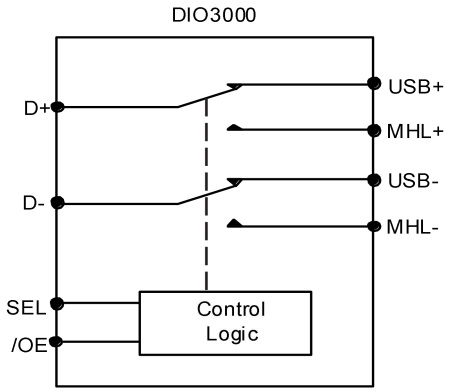


Figure 9. 480 Mbps USB 2.0 Eye pattern for USB switch

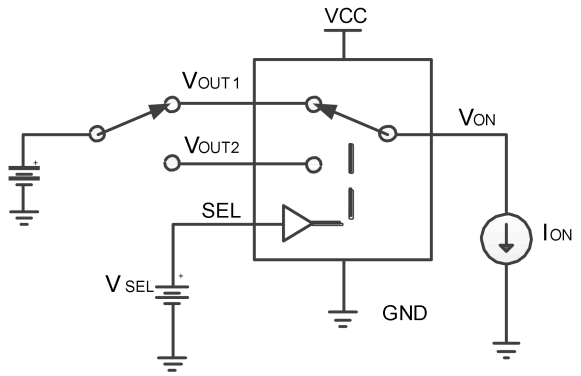
10. Block Diagram



SEL	/OE	Switch Status
X	High	Both USB and MHL switches in High-Z
Low	Low	D+/D- to USB+/USB-
High	Low	D+/D- to MHL+/MHL-

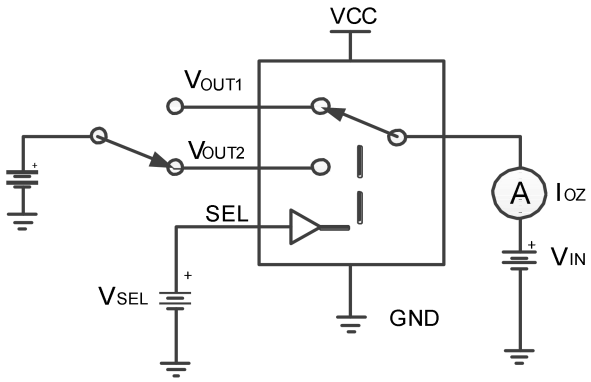
11. Application Information

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.



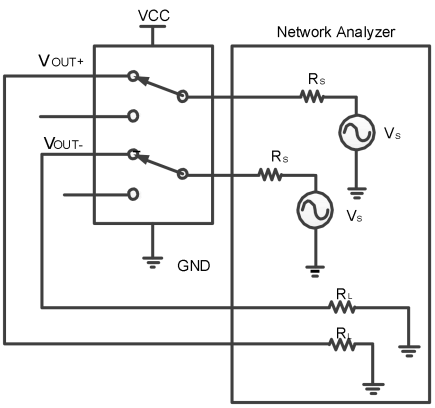
Channel ON, R_{ON} = (V_{ON} - $V_{I/O1}$) / I_{ON} or (V_{ON} - $V_{I/O2}$) / I_{ON}, V_{SEL} = H or L

Figure 10. ON-state resistance (R_{ON})



Channel OFF, V_{SEL} = H or L

Figure 11. OFF leakage current (I_{OZ})



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

Figure 12. Bandwidth (BW)

12. Function Description

12.1. Low power mode

The DIO3000 has a low power mode that reduces the power consumption to 1 μA while the device is not in use. Set enable pin /OE with a logic high signal to put IC in low power mode.

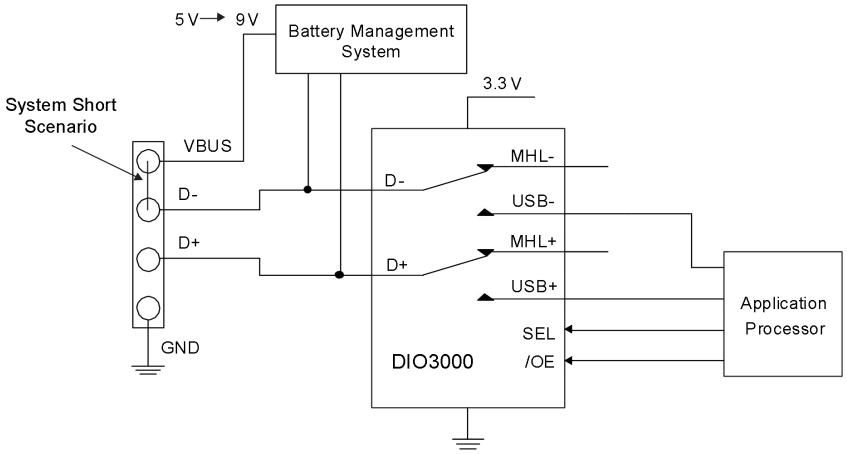


Figure 13. Potential VBUS to D-short example

12.2. Typical application

Figure 14 is a typical application of the DIO3000 USB/MHL switch. The DIO3000 has internal 6 MΩ pull-down resistors on /OE and SEL. The pulldown on the /OE pin enables the switch when power is applied. The pulldown on the SEL pin ensures that the USB channel is selected by default. The DIO3157E is a separate SPDT switch that is used to switch between MHL's CBUS and the USB ID line that is needed for the USB OTG (USB On-The-Go) application.

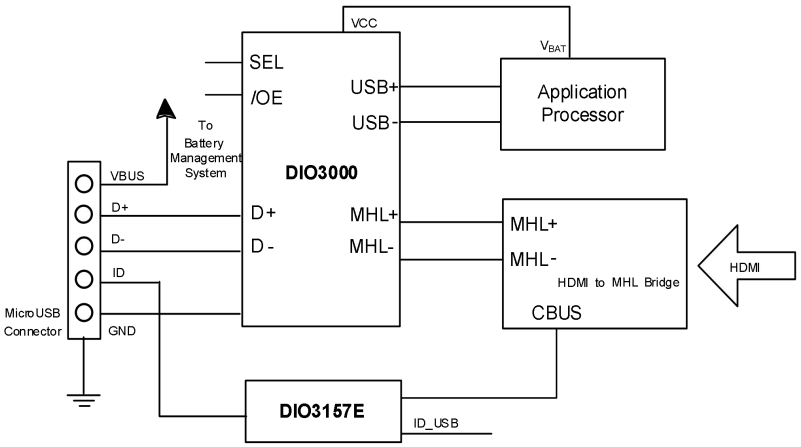
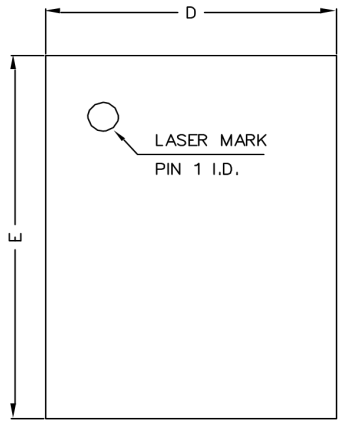
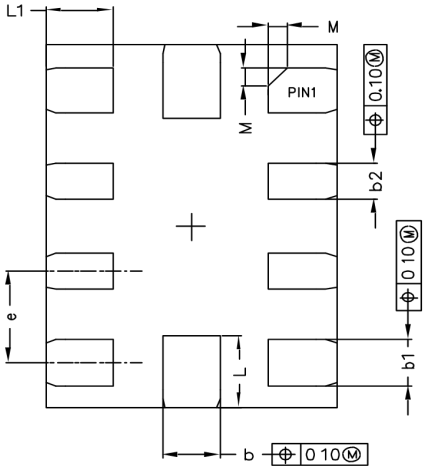


Figure 14. Typical DIO3000 application

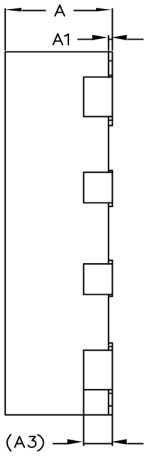
13. Physical Dimensions: QFN2*1.5-10



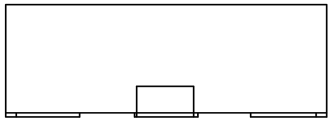
TOP VIEW



BOTTOM VIEW



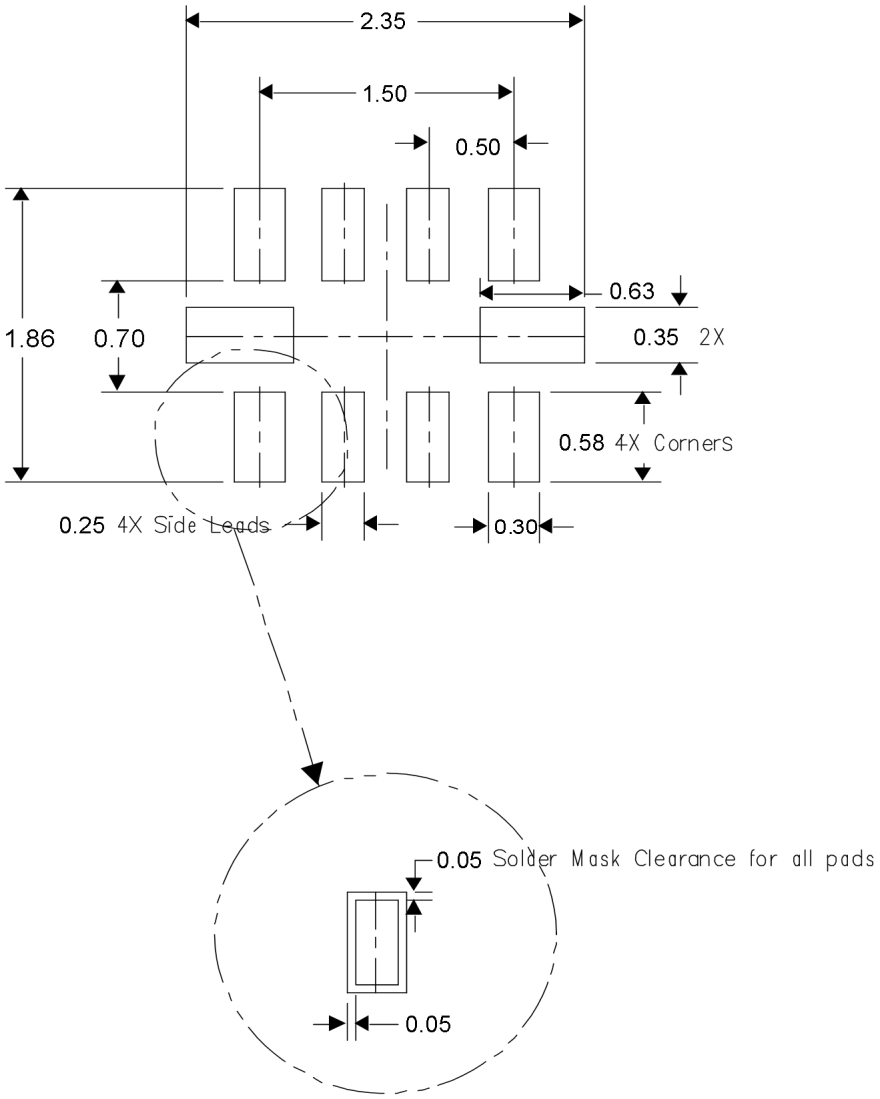
SIDE VIEW



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
A3		0.152 REF	
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	

Example Board Layout



Disclaimer

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