DIO57180

High Efficiency, 28 V, 1.5 A Synchronous Step-Down Regulator for Dimmable LED Driver

Features

- Wide input range: 4.75 V ~ 28 V
- Up to 1.5 A output current capability
- Low $R_{DS(ON)}$ for internal switches
  High side/low side: 125 mΩ / 75 mΩ
- Fixed 1 MHz switching frequency
- Cycle-by-cycle 4.1 A peak current limit for high side
- High accuracy for low dimming scale
- Analog dimming with PWM input
- Over-temperature protection
- Compact package: TSOT23-6, DFN2*1.5-6

Descriptions

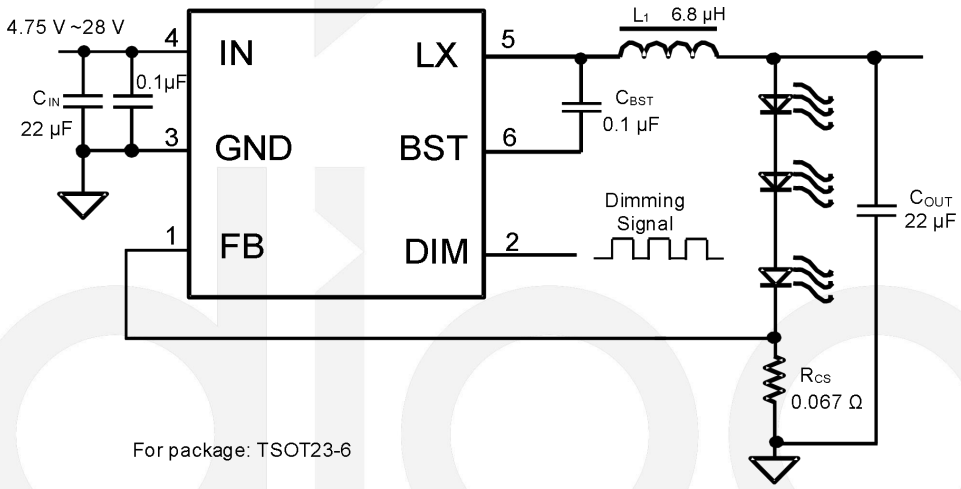
The DIO57180 is a high efficiency synchronous step-down LED regulator that achieves up to 1.5 A output current. It operates at 1 MHz and integrates two very low $R_{DS(ON)}$ power switches to minimize and reduce the external components.

It supports PWM dimming duty 0.5% ~ 100% to achieve dimmable LED lighting application.

Applications

- DVR or NVR (IP camera) system application
- 24 V DC lighting

Typical Applications

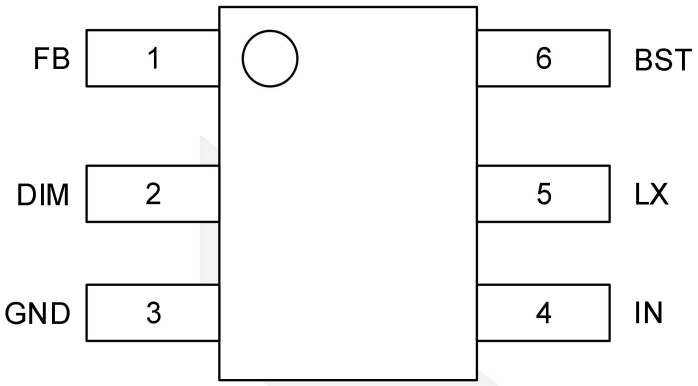


Ordering Information

Ordering Part No.	Top Marking	RoHS	T_A	Package	
DIO57180TST6	D8VW	Green	-40 to 85°C	TSOT23-6	Tape & Reel, 3000
DIO57180LT6	8VYW	Green	-40 to 85°C	DFN2*1.5-6	Tape & Reel, 3000

Pin Assignment

TSOT23-6



DFN2*1.5-6

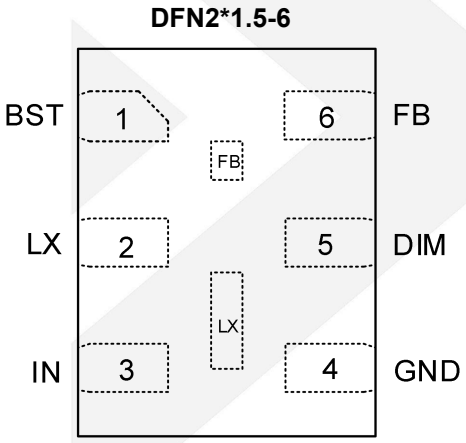


Figure 1. Pin assignment (Top view)

Pin Descriptions

Name	Description
FB	Output current feedback pin. The output current: I_{OUT} = 0.1 V/ R_{CS}.
DIM	Dimming signal input. The PWM dimming duty range: 0.5% ~ 100%. Support the dimming frequency from 10 kHz to 100 kHz.
GND	Ground pin.
IN	Input supply pin.
LX	Switching node pin. Connect this pin to the inductor.
BST	Boot-strap pin. Supply for top side gate driver. Decouple this pin to LX with a 0.1 μF ceramic cap.

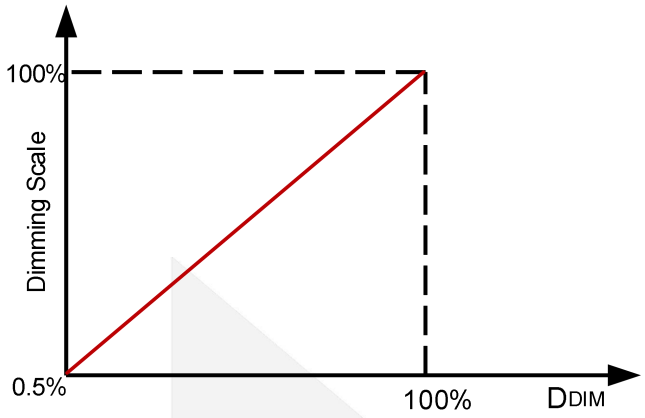


Figure 2. Ideal dimming curve of DIO57180 (dimming frequency 20 kHz)

Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Rating may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. DIOO does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter		Rating	Unit
$V_{IN, DIM, FB}$	Voltage of IN, DIM, FB pins		-0.3 to 38	V
V_{LX}	Voltage of LX pin		-0.3 to 38	V
BST-LX	Voltage differential between BST and LX pins		-0.3 to 5.5	V
P_D	Power dissipation, T_A = 25°C	TSOT23-6	1.5	W
		DFN2*1.5-6	1.39	
θ_{JA}	Package thermal resistance	Junction-to-ambient	66	°C /W
θ_{JC}		Junction-to-case	15	°C /W
T_J	Junction temperature range		-40 to 150	°C
T_L	Lead temperature		260	°C
T_{STG}	Storage temperature range		-65 to 150	°C

Recommend Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended Operating conditions are specified to ensure optimal performance to the datasheet specifications.

Symbol	Parameter	Rating	Unit
V_{IN}	Supply voltage IN	4.75 to 28	V
T_J	Junction temperature range	-40 to 125	°C

Electrical Characteristics

Typical value: V_{IN} = 12 V, V_{OUT} = 3.6 V, I_{OUT} = 1.5 A, T_A = 25°C, unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
IN pin						
V_{IN}	Input voltage range		4.75		28	V
V_{UVLO}	IN UVLO rising threshold			4.0	4.2	V
V_{UVLO_HYS}	UVLO hysteresis			0.17		V
FB pin						
V_{FB}	Feedback reference voltage	D_{DIM} = 100%	97	100	103	mV
Integrated power switches						
$R_{DS(ON)1}$ (1)	High side FET $R_{DS(ON)}$			125		mΩ
$R_{DS(ON)2}$ (1)	Low side FET $R_{DS(ON)}$			75		mΩ
I_{LIM_HIGH}	High side FET peak current limit			4.1		A
DIM pin						
D_{DIM}	PWM dimming duty range		0.5		100	%
V_{DIM_ON}	Dimming ON threshold		1.5			V
V_{DIM_OFF}	Dimming OFF threshold				0.4	V
BST pin						
V_{BST_LX}	Bias voltage for high FET driver	4.75 V ≤ V_{IN} ≤ 28 V		5		V
f_S	Operating frequency			1		MHz
t_{ON_MIN}	Min ON time			100		ns
D_{MAX}	Max duty cycle			95		%
Thermal shutdown						
T_{SD}	Thermal shutdown temperature			165		°C
T_{HYS}	Thermal shutdown hysteresis			20		°C

Note:

(1) Guaranteed by design.

(2) Specifications subject to change without notice.

Typical Performance Characteristics

Typical value: V_{IN} = 12 V, I_{OUT} = 1.5 A, 3 piece I_R LED, T_A = 25°C, unless otherwise specified.

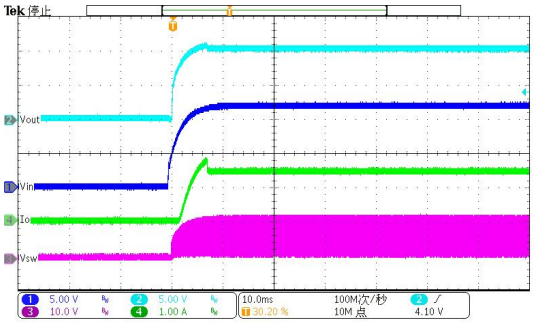


Figure 3. Start up

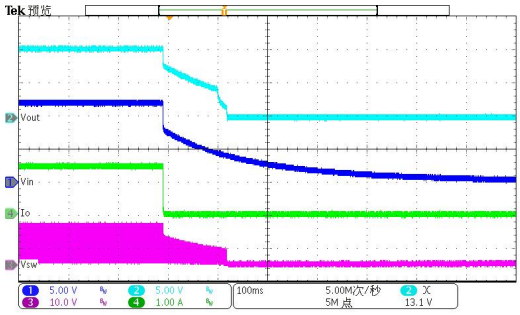


Figure 4. Shut down

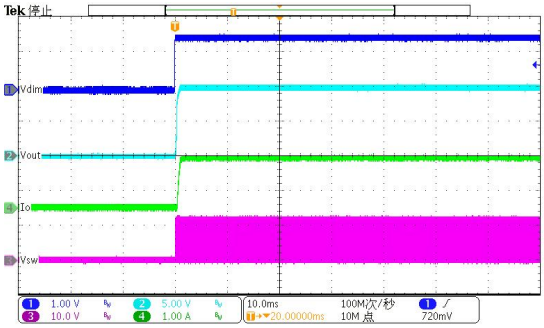


Figure 5. Dim on

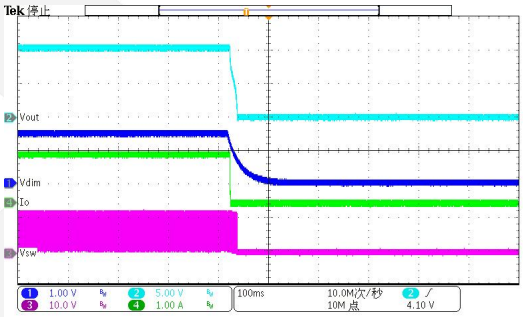
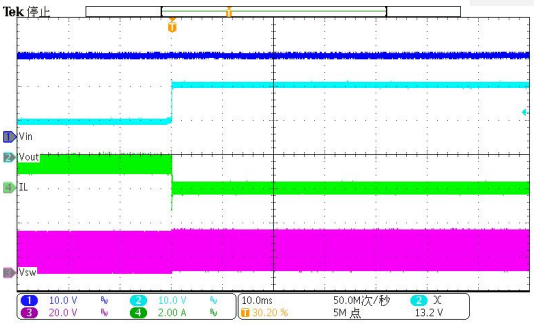
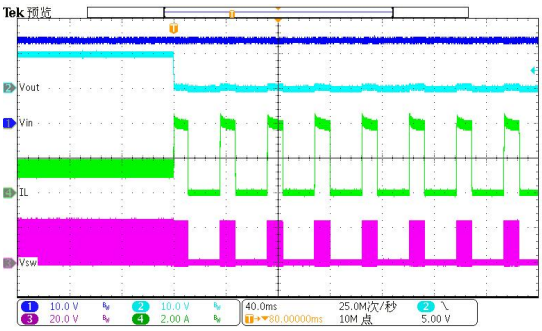


Figure 6. Dim off



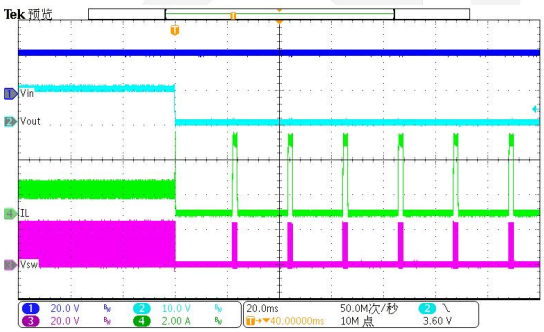
V_{IN} = 24 V, V_{DIM} = 1.5 V, R_{CS} = 0.068 Ω

Figure 7. Open LED test



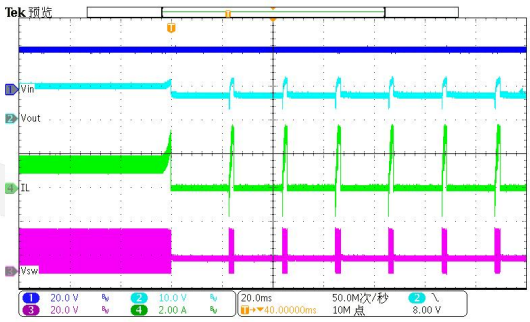
V_{IN} = 24 V, V_{DIM} = 1.5 V, R_{CS} = 0.068 Ω

Figure 8. Short LED test



V_{IN} = 24 V, V_{DIM} = 1.5 V, R_{CS} = 0.068 Ω

Figure 9. LED+ short to GND



V_{IN} = 24 V, V_{DIM} = 1.5 V, R_{CS} = 0.068 Ω

Figure 10. R_{CS} short

Functional Block Diagram

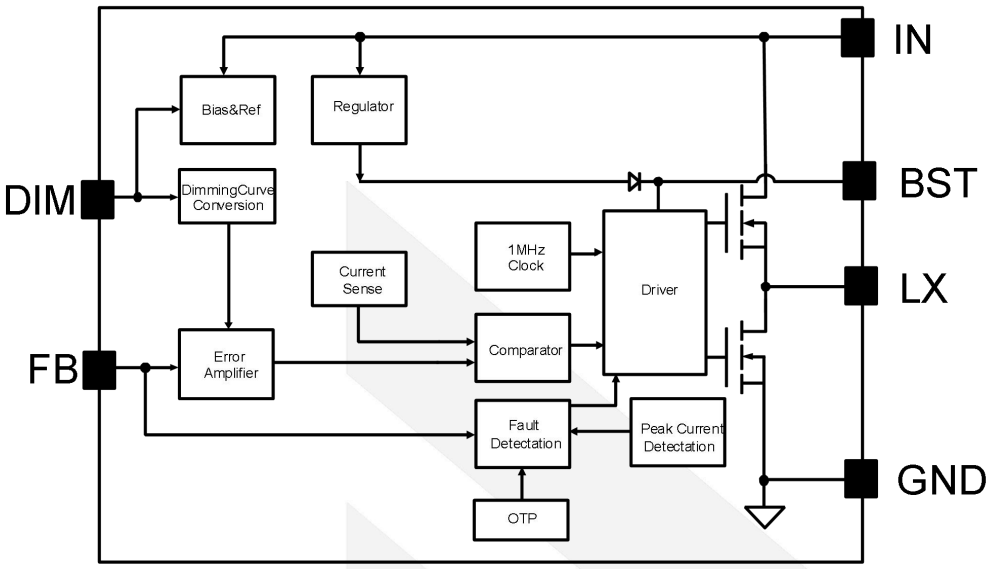


Figure 12. Functional block diagram

Operation

The DIO57180 is a synchronous buck regulator IC with a 28 V and up to 1.5 A constant output current capability. The device has two very low $R_{DS(ON)}$ power switches to minimize the switching transition loss and conduction loss. The high switching frequency minimizes the external inductor and capacitor size to reduce the cost and simplify the design. It supports the PWM dimming duty from 0.5% ~ 100% for DIM pin to achieve dimmable LED lighting application.

Application Information

Current sensing resistor R_{CS}

Choose the proper R_{CS} to program the output current I_{OUT}.

$$R_{CS} = \frac{0.1V}{I_{OUT}} \quad (1)$$

Input capacitor C_{IN}

The ripple current through input capacitor is calculated as the following equation.

$$I_{CIN\_RMS} = I_{OUT} \times \sqrt{D \times (1-D)} \quad (2)$$

A typical X7R or better grade ceramic capacitor with suitable capacitance should be chosen to handle this ripple current well. To minimize the potential noise problem, place this ceramic capacitor close to the IN and GND pins. Caution should be taken to minimize the loop area formed by C_{IN} and IN/GND pin.

Output capacitor C_{OUT}

The output capacitor is selected to improve the loop stability and handle the output current ripple noise requirements. For the best performance, use a X7R or better grade ceramic capacitor greater than 10 μF capacitance.

Main inductor L_1

There are several considerations in choosing this inductor.

1) Select the proper inductance to ensure the loop stability.

2) Choose the ripple current to be about 40% of the maximum output current as long as the loop stability allows. The inductance is calculated as the following equation.

$$L_1 = \frac{V_{OUT} \times (1 - \frac{V_{OUT}}{V_{IN,MAX}})}{f_S \times I_{OUT,MAX} \times 40\%} \quad (3)$$

Where f_S is the switching frequency and $I_{OUT,MAX}$ is the full scale LED current.

3) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT} \times (1 - \frac{V_{OUT}}{V_{IN,MAX}})}{2 \times f_S \times L_1} \quad (4)$$

Boost-strap capacitor C_{BST}

This capacitor provides the gate driver voltage for internal high side MOSFET. A low ESR more than 100 nF ceramic capacitor connected between BST pin and LX pin is recommended.

Dimming performance

The DIM pin is used to regulate output current by the PWM signal, which supports the frequency from 10 kHz to 100 kHz. The logic high voltage is 1.5 V and the logic low voltage is 0.4 V. The DIM duty from 0.5% to 100%, the output current will be 0.5% ~ 100%, the ideal dimming curve as shown in figure 2.

Layout

For the best efficiency and minimum noise problems,

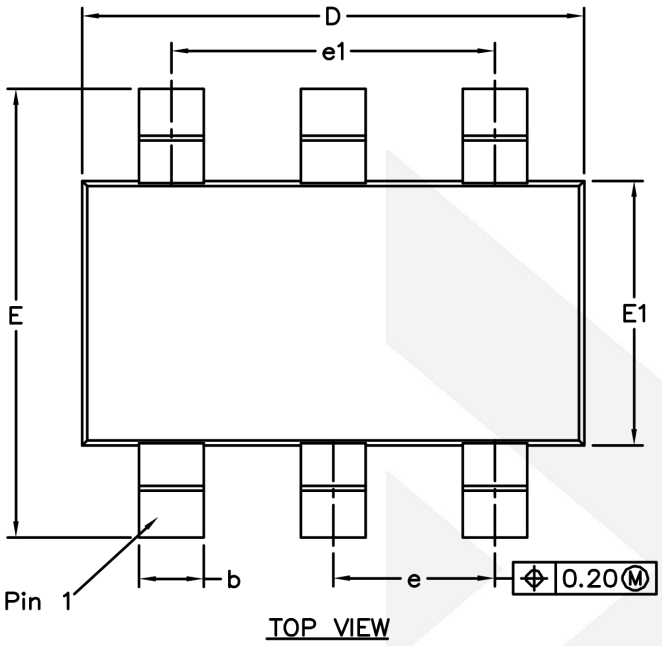
1) Maximize the PCB copper area connecting to GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable.

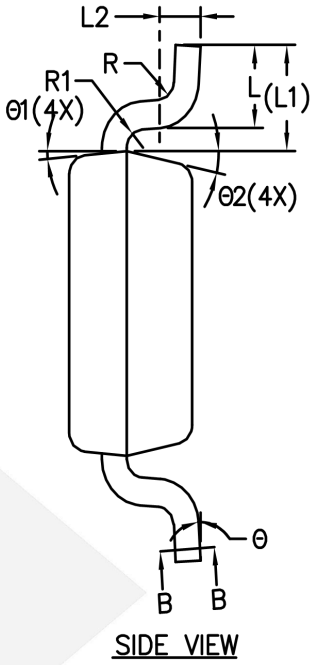
2) C_{IN} must be close to the pins IN and GND. The loop area formed by C_{IN} and GND must be minimized.

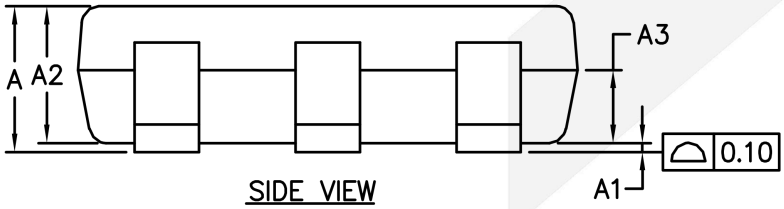
3) The PCB copper area associated with LX pin must be minimized to avoid the potential noise problem.

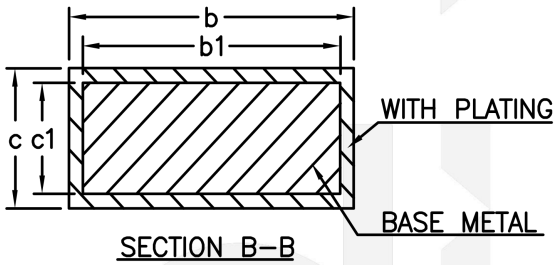
4) The FB pin must not be adjacent to the LX line on the PCB layout to avoid the noised problem.

Physical Dimensions: TSOT23-6



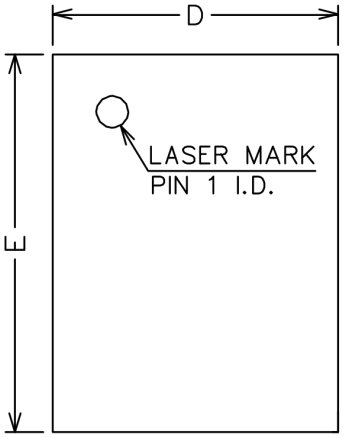




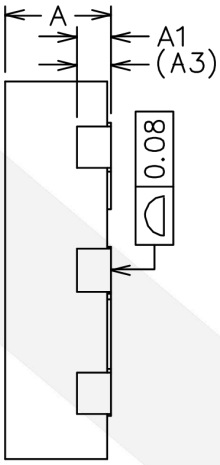


Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	0.90
A1	0	-	0.15
A2	0.65	0.75	0.85
A3	0.35	0.40	0.45
b	0.36	-	0.50
b1	0.36	0.38	0.45
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.85	2.95	3.05
E	2.60	2.80	3.00
E1	1.60	1.65	1.70
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.30	0.45	0.60
L1	0.575 REF		
L2	0.25 BSC		
R	-	-	0.25
R1	-	-	0.25
θ	0°	-	8°
θ1	3°	5°	7°
θ2	10°	12°	14°

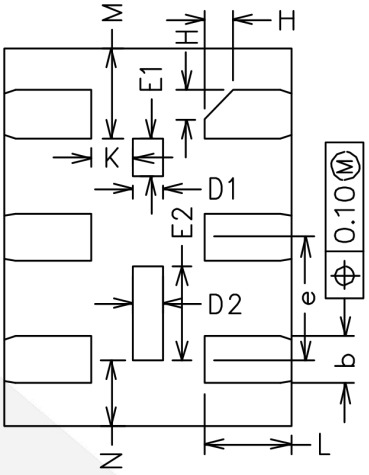
Physical Dimensions: DFN2*1.5-6



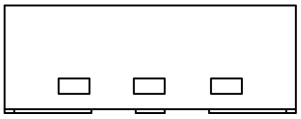
TOP VIEW



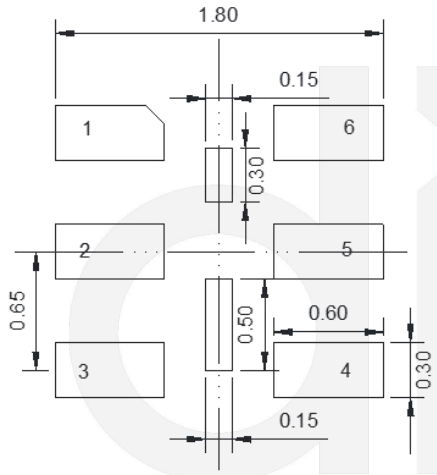
SIDE VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	0.50	0.55	0.60
A1	0.00	0.02	0.05
A3		0.152 REF	
b	0.20	0.25	0.30
D	1.40	1.50	1.60
E	1.90	2.00	2.10
D1	0.05	0.15	0.25
E1	0.10	0.20	0.30
D2	0.05	0.15	0.25
E2	0.40	0.50	0.60
e	0.55	0.65	0.75
H		0.15 REF	
K	0.10	-	-
L	0.35	0.45	0.55
M	0.33	0.48	0.63
N	0.20	0.35	0.50

CONTACT US

Dioo is a professional design and sales corporation for high-quality and performance analog semiconductors. The company focuses on industry markets, such as, cell phone, handheld products, laptop, and medical equipment and so on. Dioo's product families include analog signal processing and amplifying, LED drivers and charger IC. Go to http://www.dioo.com for a complete list of Dioo product families.

For additional product information, or full datasheet, please contact with our Sales Department or Representatives.