DIO6071

3-Channel PMU with 36 V Buck, 18 V Boost, and Super Capacitor Charger

Description

The DIO6071 is a three-channel PMU, including a 36 V input, high-efficiency synchronous buck converter, a low startup, high-efficiency 18 V boost converter, and a super capacitor charger. The buck converter withstands input voltage up to 42 V and provides a 3.1 V output with up to 500 mA current. The boost converter can provide output of up to 500 mA to 12 V from a single cell super capacitor or a battery at 2.5 V. A linear super capacitor charger also integrates a very high accuracy CV voltage. The output voltage of boost converter can be adjusted by an external resistor divider.

All three power modules are packaged in EP-SOIC8 and QFN3*4-24 packages.

Features

- Three-in-one: buck converter, boost, and super capacitor charger
- Buck wide working range:
  8.2 V ~ 36 V, 42 V input standoff
- Output power for buck converter: 3.1 V/500 mA
- Output power for boost converter at 2.5 V input: 12 V/500 mA
- Accuracy for charger CV voltage: 1%
- Constant charge current: 70 mA
- High efficiency PFM mode at light load
- Enable pin to auto-switch boost and charger
- Package: EP-SOIC8 and QFN3*4-24
- ±2 kV HBM ESD on all pins.

Applications

- Power meters
- PLC modules
- Any system that needs super capacitor as a backup power

Ordering Information

Part Number	Top Marking	RoHS	T_A	Package	
DIO6071XS8	DIOFVG1	Green	-40 to 85°C	EP-SOIC8	Tape & Reel, 2500
DIO6071QN24	DFVG1	Green	-40 to 85°C	QFN3*4-24	Tape & Reel, 5000

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.

Table of Contents

1. Pin Assignment and Functions 1
2. Absolute Maximum Ratings 2
3. Recommended Operating Condition 2
4. ESD Ratings 2
5. Thermal consideration 3
6. Electrical Characteristics 3
7. Typical Performance Characteristics 4
8. Block Diagram 6
9. Functional Description 6
9.1. Buck converter 6
9.2. Boost converter 7
9.3. Charger 7
9.4. Enable 7
9.5. Over-temperature protection 7
10. Application Information 7
10.1. Application examples 7
10.2. Boost output voltage setting 8
10.3. Boost and super-capacitor charger auto-switching threshold voltage setting 8
11. Physical Dimensions 9
11.1. EP-SOIC8 9
11.2. QFN3*4-24 10

List of Figures

Figure 1 . EP-SOIC8 1
Figure 2 . QFN3*4-24 1
Figure 3 . Boost V_{OUT} vs. I_{OUT} 4
Figure 4 . Boost efficiency vs. I_{OUT} 4
Figure 5 . Buck V_{OUT} vs. I_{OUT} 4
Figure 6 . Buck efficiency vs. I_{OUT} 4
Figure 7 . Buck UVLO 5
Figure 8 . Charger I_{chrg} & V_{chrg} 5
Figure 9 . Buck V_{OUT} vs. Temp 5
Figure 10 . Charger V_{CV} vs. Temp 5
Figure 11 . Boost V_{OUT} vs. Temp 5
Figure 12 . EN threshold vs. Temp 5

1. Pin Assignment and Functions

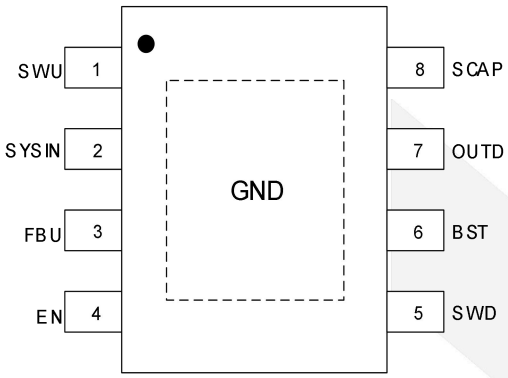


Figure 1. EP-SOIC8

Top view

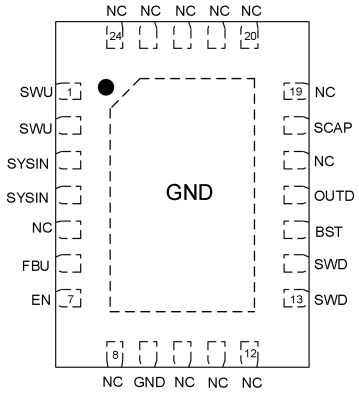


*Figure 2. QFN3*4-24*

Top view

Pin Name	Description
SWU	Switch pin for boost.
SYSIN	System power input pin.
FBU	External feedback pin for boost.
EN	Enable pin for auto-switching boost and charger. EN = 0, boost is ON and charger is OFF; EN = 1, charger is ON and boost is OFF.
SWD	Switch pin for buck.
BST	Bootstrap pin for buck. Connect a 10 nF or bigger cap from BST to SWD.
OUTD	Output voltage pin for buck. It is internally set to 3.1 V. It is also the input of charge.
SCAP	Super capacitor output. It is internally programmed to CV at 2.55 V.
GND	Ground.
NC	Do not connect.

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
	SYSIN voltage	−0.3 to 42	V
	SWD, EN voltage	−0.3 to SYSIN + 0.3	V
	SWU voltage	−0.3 to 18	V
	BST to SWD voltage	−0.3 to 6	V
	All other pin voltage	−0.3 to 6	V
T_A	Operating temperature range	−40 to 85	°C
T_{STG}	Storage temperature range	−65 to 150	°C
T_L	Lead temperature (soldering, 10 s)	260	°C

3. Recommended Operating Condition

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_{IN}	Operating input voltage range	8.2 to 36	V
T_A	Operating Temperature Range	-40 to 85	°C

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	Rating	Unit
ESD	HBM, JEDEC: JESD22-A114	± 2000	V

5. Thermal consideration

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	Parameter		Rating	Unit
$R_{\theta JC}$	EP-SOIC8	Junction-to-case thermal resistance	15	°C/W
$R_{\theta JA}$		Junction-to-ambient thermal resistance	50	°C/W
$R_{\theta JC}$	QFN3*4-24	Junction-to-case thermal resistance	12	°C/W
$R_{\theta JA}$		Junction-to-ambient thermal resistance	52	°C/W

6. Electrical Characteristics

V_{IN} = 12 V, unless otherwise noted. Typical values are at T_A = 25°C.

Parameter	Conditions	Min	Typ	Max	Unit
Buck					
Buck input standoff voltage		42			V
Buck input voltage range		8.2		36	V
Buck input UVLO rising			7.8	8.2	V
Buck input UVLO falling			4.1		V
Buck input OVP	Rising, hysteresis = 1 V		37		V
V_{OUTD} voltage	Internally set	3.033	3.100	3.170	V
Buck switching frequency			630		kHz
High-side switch on resistance	I_{SWD} = 100 mA		600		mΩ
Low-side switch on resistance	I_{SWD} = 100 mA		330		mΩ
High-side switch current limit			1		A
Low-side zero crossing limit			30		mA
Boost					
Boost input range		0.75		6	V
FBU feedback voltage		784	800	816	mV
FBU input current	V_{FBU} = 0 or 2 V			100	nA
Boost output voltage range		3		24	V
Boost switching frequency			1		MHz
Maximum duty cycle		92			%
NMOS switch on resistance	I_{SWU} = 100 mA		80		mΩ
NMOS switch current limit			4		A

SWU leakage current	V_{SWU} = 0 or 12 V, V_{EN} = GND			10	μA
Charger					
CV voltage		2.52	2.55	2.58	V
Charge current			70		mA
Dropout voltage	I_{OUT} = 30 mA		50		mV
System					
Quiescent current of SYSIN at EN = 0	V_{FBU} = 0.9 V, V_{OUTD} = 3.6 V		750		μA
Quiescent current of SYSIN at EN = 1	V_{FBU} = 0.9 V, V_{OUTD} = 3.6 V,V_{SCAP} = 3 V		500		μA
EN input current	V_{EN} = 12 V		5		μA
EN threshold	Rising, hysteresis = 0.2 V		1.5		V
Thermal shutdown	Rising, hysteresis = 20°C		150		°C

7. Typical Performance Characteristics

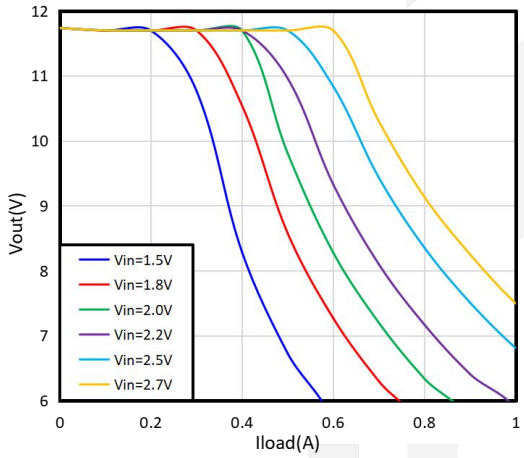


Figure 3. Boost V_{OUT} vs. I_{OUT}

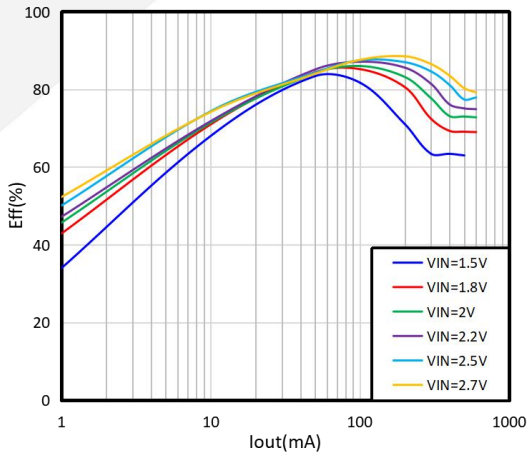


Figure 4. Boost efficiency vs. I_{OUT}

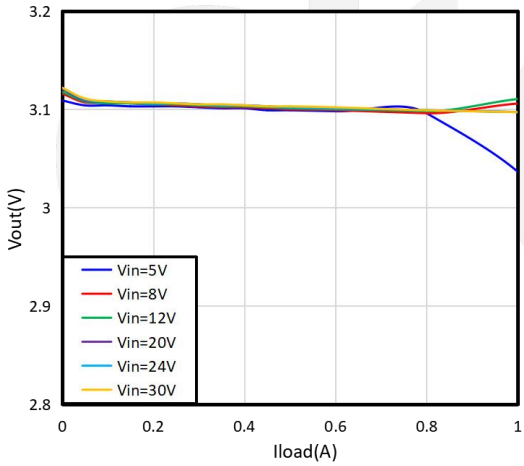


Figure 5. Buck V_{OUT} vs. I_{OUT}

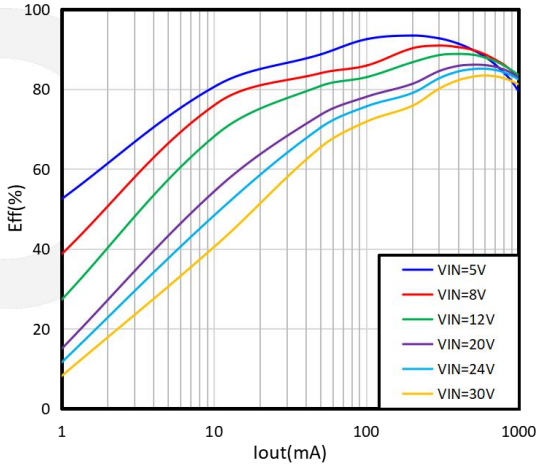


Figure 6. Buck efficiency vs. I_{OUT}

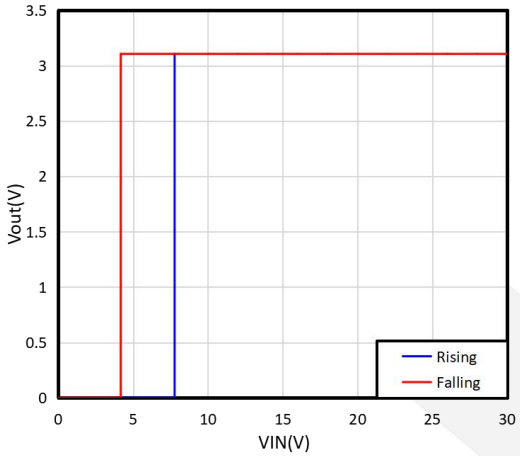


Figure 7. Buck UVLO

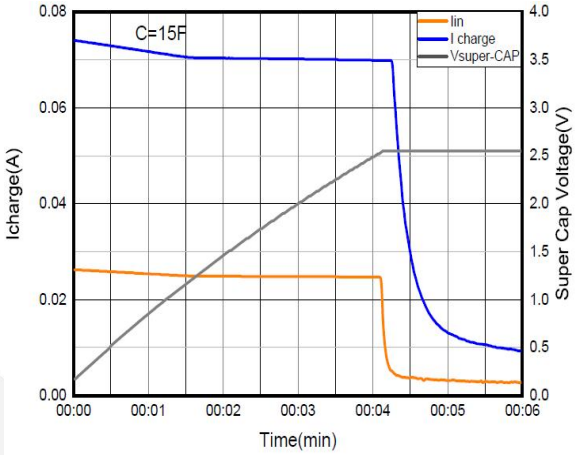


Figure 8. Charger I_{chrg} & V_{chrg}

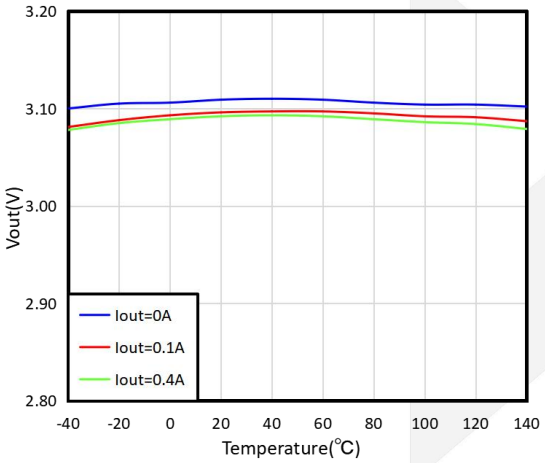


Figure 9. Buck V_{OUT} vs. Temp

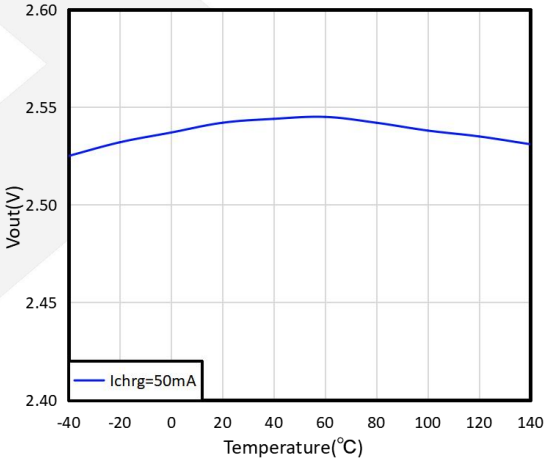


Figure 10. Charger V_{CV} vs. Temp

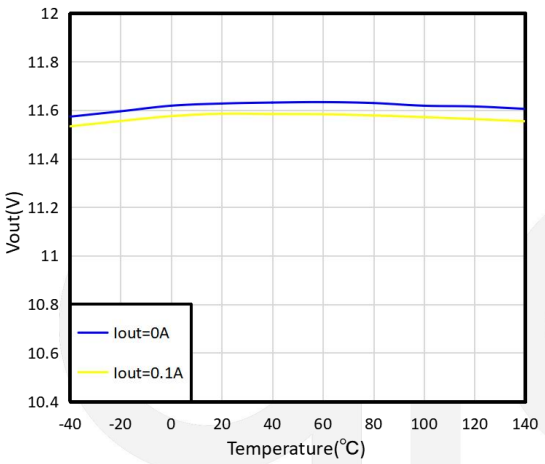


Figure 11. Boost V_{OUT} vs. Temp

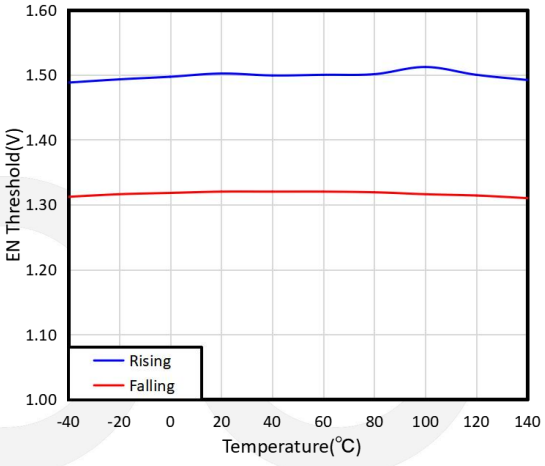
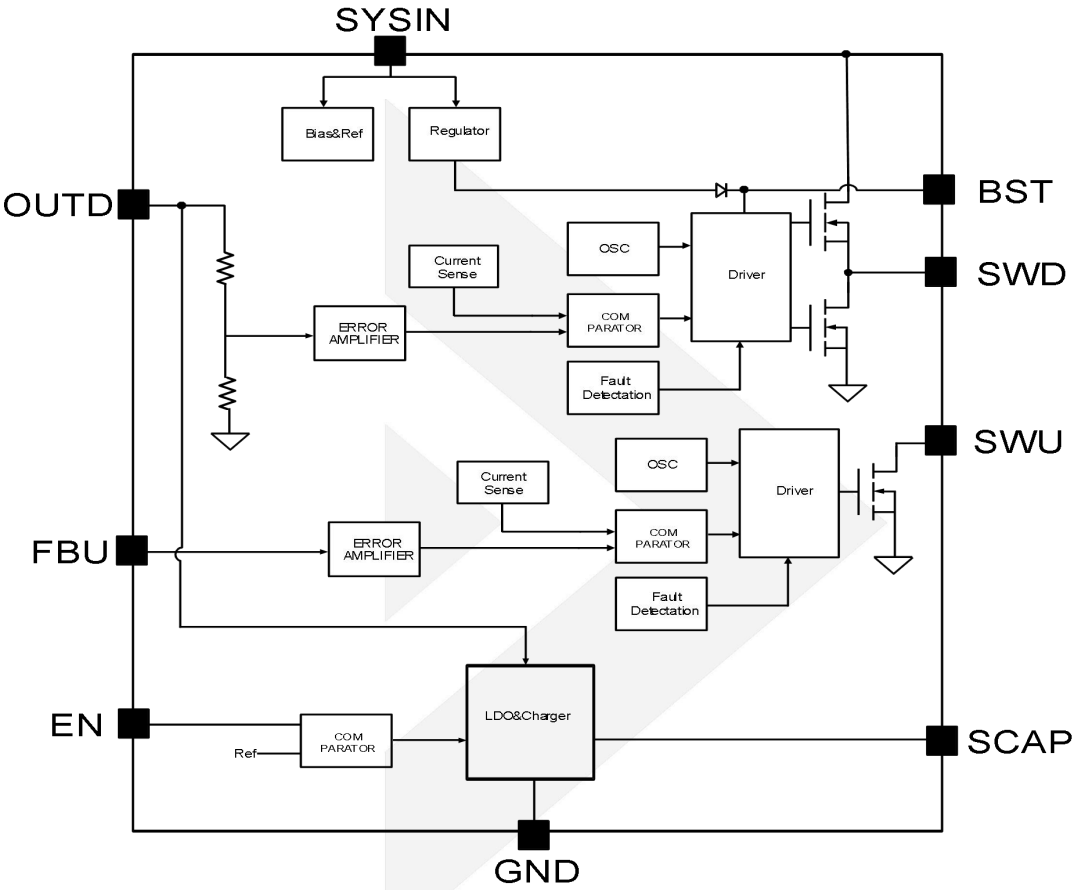


Figure 12. EN threshold vs. Temp

8. Block Diagram



9. Functional Description

The DIO6071 is a three-channel PMU that includes a wide input, high-efficiency, synchronous buck converter, a low startup, high-efficiency boost converter, and a super capacitor charger. The buck converter withstands input voltage up to 42 V and delivers a 3.1 V output with up to 500 mA current. The boost converter is capable of providing up to 500 mA to 12 V output from a single-cell super capacitor or a battery at 2.5 V. A linear super capacitor charger is also integrated with a very high accuracy CV voltage. The output voltage of boost converter can be adjusted by an external resistor divider.

9.1. Buck converter

The buck converter is a wide input range, high-efficiency, synchronous step-down switching regulator which output is fixed at 3.1 V, capable of delivering up to 0.5 A of output current. With a fixed switching frequency of 630 kHz, this current mode PWM controlled converter allows the use of small external components, such as ceramic input and output capacitors, as well as small inductors. An OVP function protects the IC itself and its downstream system against input voltage surges. With this OVP function, the IC can stand off input voltage as high as 42 V.

9.2. Boost converter

The boost converter is a high-efficiency, no-synchronous step-up converter. It is capable of delivering at least 6 W of power from 2.5 V, for example, 0.5 A at 12 V output. A switching frequency of 1 MHz minimizes solution footprint by allowing the use of tiny and low-profile inductors and ceramic capacitors. The output of boost can be set by an external resistor divider at FBU pin.

9.3. Charger

The charge is fully integrated with constant current (CC) / constant voltage (CV) function. It can deliver 70 mA of charge current with a final float voltage of 1%.

9.4. Enable

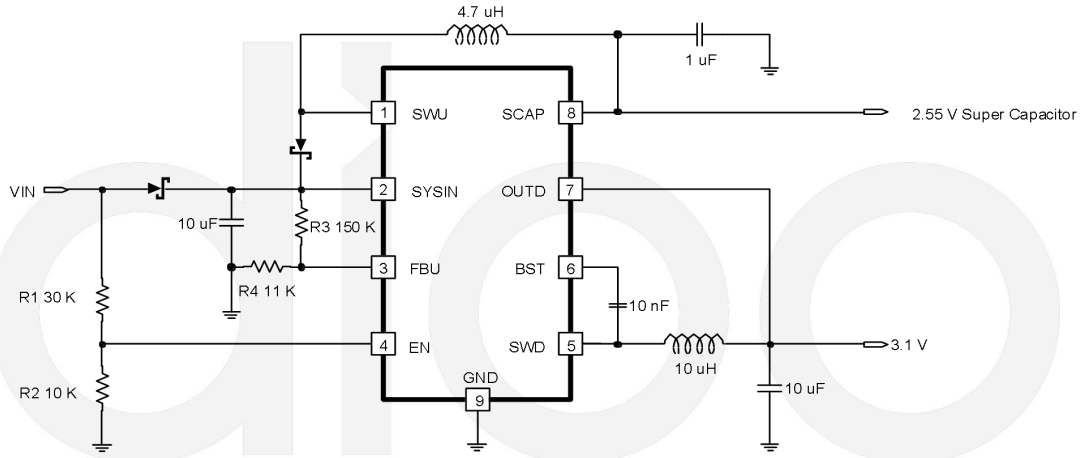
EN is a digital control pin that turns the boost converter and charger on and off. Drive EN high to turn on the charger and turn off the boost converter. Drive it low to turn off the charger and turn on the boost converter.

9.5. Over-temperature protection

Thermal protection disables buck converter, boost converter, and charger when the junction temperature rises to approximately 150°C, allowing the device to cool down. When the junction temperature cools to approximately 130°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits regulator dissipation, protecting the device from damage as a result of overheating.

10. Application Information

10.1. Application examples



10.2. Boost output voltage setting

The DIO6071 boost output is programmed by using an external resistor divider. The output voltage is calculated by using Equation 1.

$$V_{OUT} = V_{REF} \times (1 + \frac{R3}{R4}) \quad (1)$$

Where: V_{REF} = 0.8 V typically, R4 is the resistor between FBU and GND and R3 is the one between output and FBU pin. R4 has to be between 1 kΩ to 20 kΩ and thus R3 is calculated by the following equation.

$$R3 = (\frac{V_{OUT}}{V_{REF}} - 1) \times R4 \quad (2)$$

10.3. Boost and super-capacitor charger auto-switching threshold voltage setting

The EN pin also serves as a threshold voltage for auto-switching super capacitor charger and the boost converter. When the V_{IN} drops, and voltage of the EN pin is below the falling threshold voltage (1.3 V), the super-capacitor charger is disabled and the boost converter is then enabled at the same time. With a resistor ladder, R1 from V_{IN} to EN and R2 from EN to GND, the V_{IN} dropping threshold thus is programmed with the following equation.

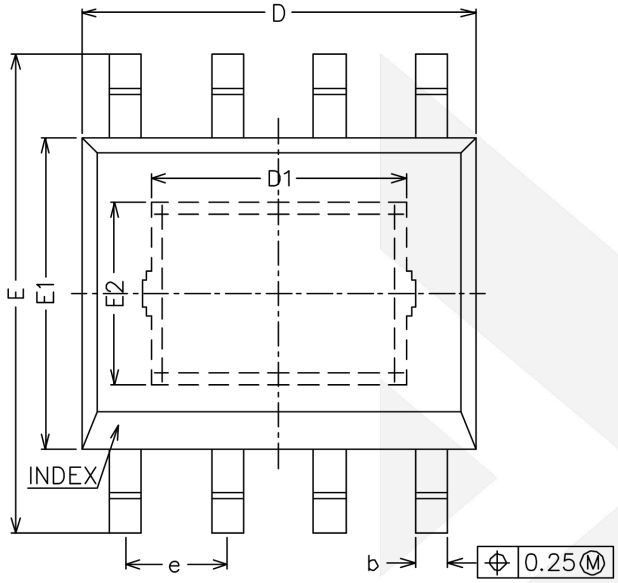
$$V_{INThreshold} = 1.3 \times (1 + \frac{R1}{R2}) \quad (3)$$

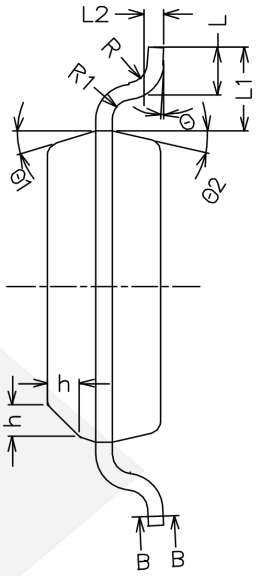
R2 has to be between 1 kΩ to 20 kΩ and thus R1 is calculated by the following equation.

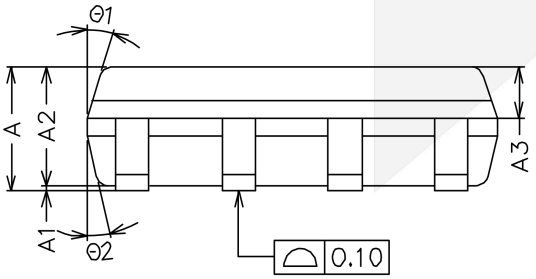
$$R1 = (\frac{V_{INThreshold}}{1.3} - 1) \times R2 \quad (4)$$

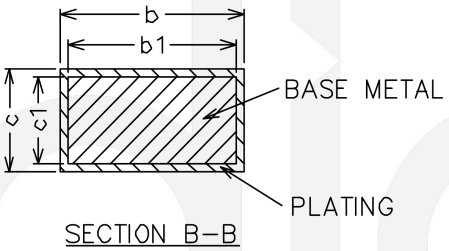
11. Physical Dimensions

11.1. EP-SOIC8



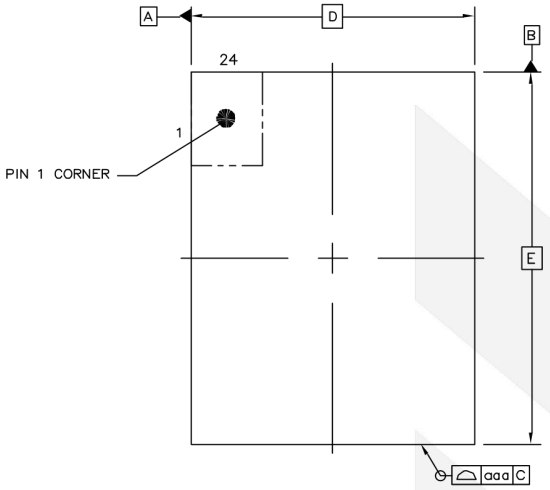




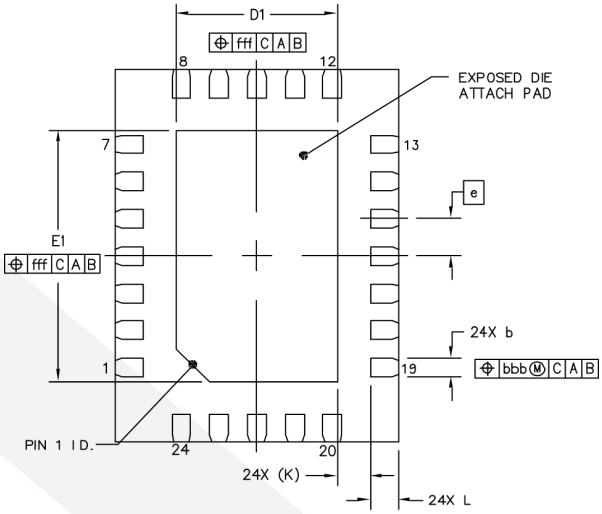


Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	1.35	1.45	1.65
A1	0	-	0.15
A2	1.35	1.40	1.55
A3	0.50	0.60	0.70
b	0.38	-	0.47
b1	0.37	0.40	0.43
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	4.80	4.90	5.00
D1	3.02	3.17	3.32
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
E2	2.13	2.28	2.43
e	1.17	1.27	1.37
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07	-	-
R1	0.07	-	-
h	0.30	0.40	0.50
θ	0°	-	8°
θ1	15°	17°	19°
θ2	11°	13°	15°

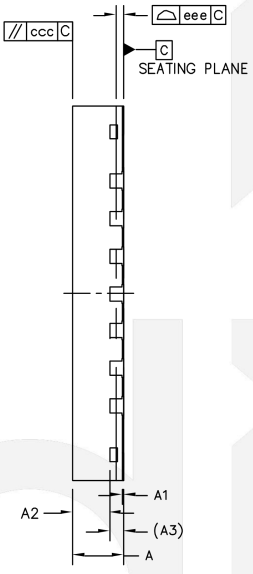
11.2. QFN3*4-24



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	0.5	0.55	0.6
A1	0	0.02	0.05
A2	-	0.4	-
A3		0.152 REF	
b	0.15	0.2	0.25
D		3 BSC	
E		4 BSC	
e		0.4 BSC	
D1	1.6	1.7	1.8
E1	2.6	2.7	2.8
L	0.25	0.3	0.35
K		0.35 REF	
aaa		0.1	
ccc		0.1	
eee		0.08	
bbb		0.1	
fff		0.1	

Disclaimer

This specification and information contained herein are provided on an “AS IS” basis and WITH ALL FAULTS. All product specifications, statements, information, and data (collectively, the “Information”) in this datasheet or made available on the website of www.dioo.com are subject to change without notice. The customer is responsible for checking and verifying the extent to which the Information contained in this publication is applicable to his/her application. All Information given herein is believed to be accurate and reliable, but it is presented without guarantee, warranty, or responsibility of any kind, express or implied.

