300 mA, High-Voltage, Ultra-Low Quiescent Current, Low-Dropout Regulator

Features

- Operating output voltage range:
  - Fixed 1.2 V to 5 V output voltage
  - Adjustable 1.2 V to 16 V output voltage
- Low quiescent current: 4 μA (typ.)
- Shutdown current: 300 nA
- 3 V to 40 V wide input voltage range with up to 45 V transient
- Maximum output current: 300 mA
- ±2% output voltage accuracy
- Typical dropout voltage: 500 mV at 300 mA load current for fixed 5 V output version
- Stable with low equivalent series resistance (0.001 Ω to 5 Ω) ceramic output-stability capacitor (1 μF to 200 μF)
- -40°C ≤ T_A ≤ 125°C
- HBM ESD at ±2000 V

Applications

- Smoke and heat detectors
- Thermostat
- Wireless electronic tools
- Battery pack
- Sport monitors (PIR, uWave, etc.)
- Motor drivers

Package Information

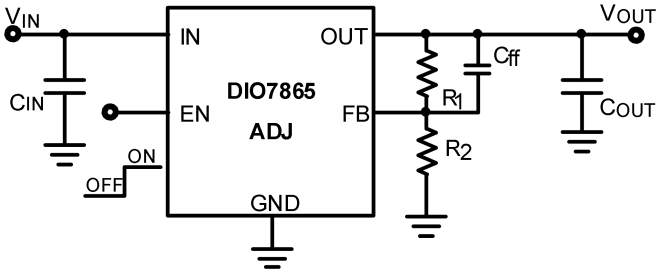
Part Number	Package	Body Size
DIO7865	DFN-6	2 mm × 2 mm
	EP-MSOP8	3 mm × 3 mm
	EP-SOIC8	4.9 mm × 3.9 mm
	SOT23-5	2.9 mm × 1.6 mm

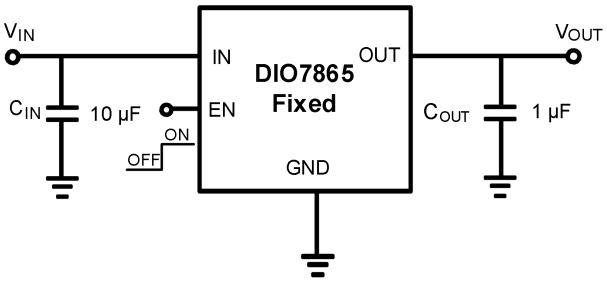
Description

The DIO7865 is a low-dropout linear regulator designed to function with an input voltage range from 3 V to 40 V. Its typical quiescent current at light load is only 4 μA. In always-on systems, low quiescent current (I_Q) is important for power saving and prolonging battery lifetime. This feature makes the device ideal for applications requiring low standby power consumption or multiple batteries.

A short-circuit and overcurrent protection is included in the device. The DIO7865 can operate in ambient temperatures from -40°C to 125°C. In addition, to dissipate the heat, a thermally conductive package is placed to ensure the device can function sustainably.

Simplified Schematic





Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIO7865BaaCD6	6EBX	3	Green	-40 to 125°C	DFN2*2-6	Tape & Reel, 3000
DIO7865BaaXM8	D6EBX	3	Green	-40 to 125°C	EP-MSOP8	Tape & Reel, 3000
DIO7865BADJCD6	6EBQ	3	Green	-40 to 125°C	DFN2*2-6	Tape & Reel, 3000
DIO7865BADJXM8	D6EBQ	3	Green	-40 to 125°C	EP-MSOP8	Tape & Reel, 3000
DIO7865BaaXS8	D6EBX	3	Green	-40 to 125°C	EP-SOIC8	Tape & Reel, 2500
DIO7865BADJXS8	D6EBQ	3	Green	-40 to 125°C	EP-SOIC8	Tape & Reel, 2500
DIO7865BaaST5	EBXYW	3	Green	-40 to 125°C	SOT23-5	Tape & Reel, 3000
DIO7865BADJST5	EBQYW	3	Green	-40 to 125°C	SOT23-5	Tape & Reel, 3000
DIO7865BaaST5-AE1	EBXYW	3	Green	-40 to 125°C	SOT23-5	Tape & Reel, 3000
DIO7865BADJST5-AE1	EBQYW	3	Green	-40 to 125°C	SOT23-5	Tape & Reel, 3000

Output Voltage Options								
Option Code "**aa**"	**12**	**15**	**18**	**20**	**25**	**30**	**33**	**50**
Voltage	1.2 V	1.5 V	1.8 V	2.0 V	2.5 V	3.0 V	3.3 V	5.0 V

Marking Definition	
6EBX	6EB: Product code; X: Voltage code
D6EBX	D6EB: Product code; X: Voltage code
6EBQ	6EBQ: Product code
D6EBQ	D6EBQ: Product code
EBXYW	EB：Product code; X: Voltage code; Y: Year code; W: Week code
EBQYW	EBQ：Product code; Y: Year code; W: Week code

Voltage Code								
Option Code "X"	F	G	H	Y	J	L	M	P
Voltage	1.2 V	1.5 V	1.8 V	2.0 V	2.5 V	3.0 V	3.3 V	5.0 V

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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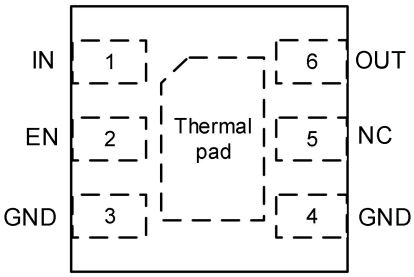
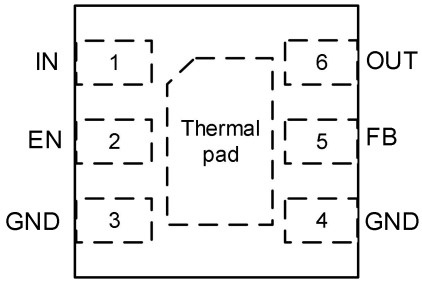
1. Pin Assignment and Functions

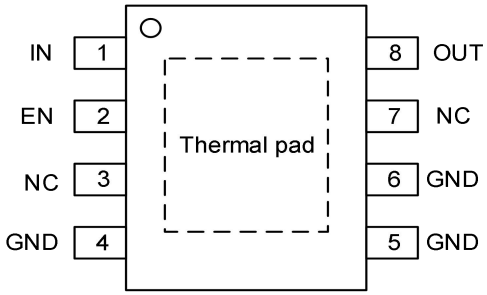


Fixed



Adjustable

DFN2*2-6 (Top view)



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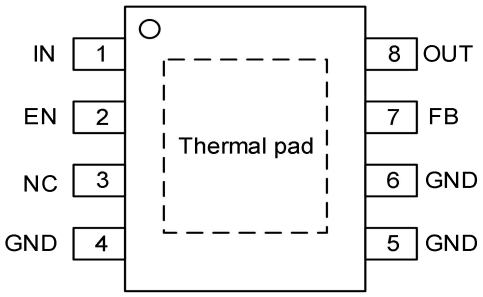
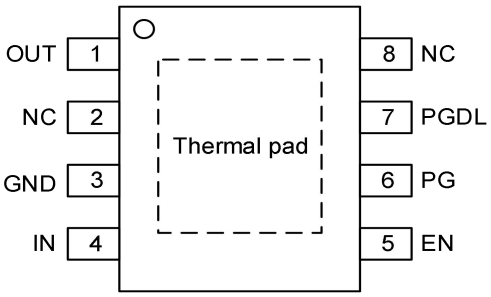
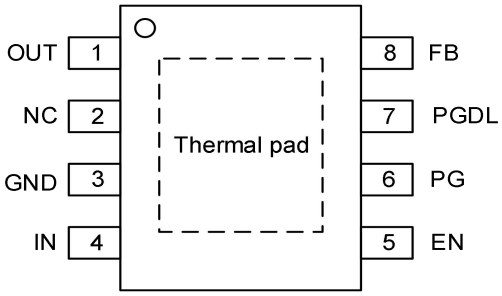


Adjustable

EP-MSOP8 (Top view)

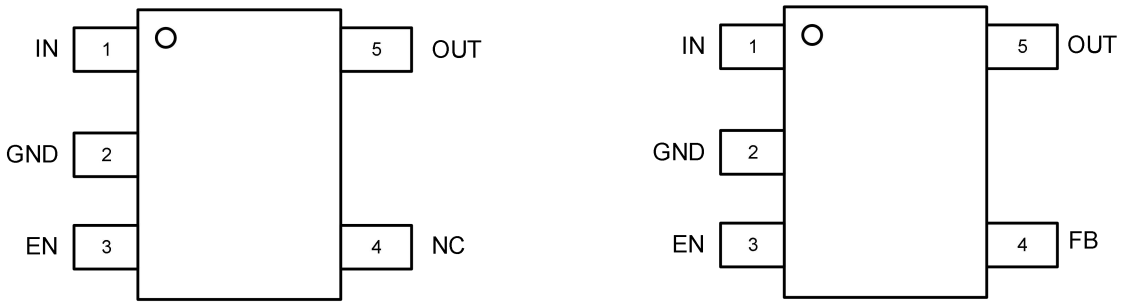


Fixed



Adjustable

EP-SOIC8 (Top view)



Fixed **Adjustable**

SOT23-5 (Top view)

Pin Name	Description
OUT	Regulated output voltage. The output should be bypassed with a small 1 μF ceramic capacitor.
FB	This pin is used as an input to the control loop error amplifier and is used to set the output voltage of the LDO.
PG	Power good. This pin can be left floating when not used.
PGDL	Programmable power-good delay. This pin can be left floating when not used.
EN	Enable pin. A logic low reduces the supply current to less than 1 μA. Connect to logic “High” for normal operation.
GND	Power supply ground.
IN	Input voltage supply pin.
Thermal pad	Connect the thermal pad to a large-area GND plane to improve the thermal performance.
NC	Not internally connected.

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_{IN}	Unregulated input(1)	-0.3 to 45	V
V_{EN}	Enable input(1)	-0.3 to V_{IN}	V
V_{OUT}	Regulated output voltage for fixed version	-0.3 to 6	V
	Output voltage for adjustable version	-0.3 to 20	V
T_J	Junction temperature	-40 to 150	°C
T_{STG}	Storage temperature	150	°C

Note:

(1) Absolute maximum voltage, withstand 45 V for 200 ms.

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_{IN}	Unregulated input voltage	3 to 40	V
V_{EN}	Enable input voltage	0 to V_{IN}	V
C_{OUT}	Output capacitor requirements(1)	1 to 200	μF
ESR	Output capacitor equivalent series resistance requirements(2)	0.001 to 5	Ω
T_A	Ambient temperature	-40 to 125	°C

Note:

(1) All voltage values are with respect to GND.

(2) Absolute maximum voltage, withstand 45 V for 200 ms.

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	ESDA/JEDEC JS-001	±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	EP-SOIC8	59	°C/W
$R_{\theta JC}$	Junction-to-case thermal resistance	EP-SOIC8	15	°C/W

6. Electrical Characteristics

V_{IN} = 14 V, 10 µF ceramic output capacitor, T_A = -40°C to 125°C, over operating ambient temperature range, unless otherwise noted.

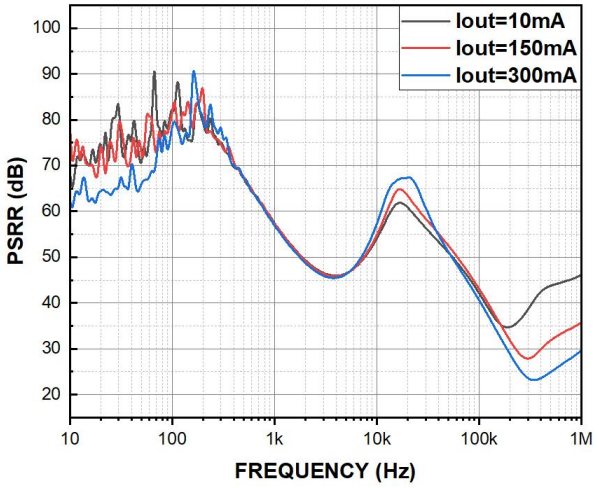
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input voltage		3		40	V
I_{SD}	Shutdown current	EN = 0 V, T_A = 25°C		0.3	1	µA
I_Q	Quiescent current	V_{IN} = (V_{OUT} +1) or 3 V, whichever is greater, to 40 V, EN ≥ 2 V, I_{OUT} = 0 mA, T_A = 25°C		4	6	µA
$V_{IN, UVLO}$(1)	V_{IN} undervoltage detection	Ramp V_{IN} down until the output turns ON			2.9	V
		Hysteresis		200		mV
V_{IL}(1)	Logic-input low level				0.6	V
V_{IH}(1)	Logic-input high level		1.2			V
V_{OUT}	Regulated output	V_{IN} = (V_{OUT} +1) or 3 V, whichever is greater, to 40 V, I_{OUT} = 10 mA, T_A = 25°C	-2		2	%
V_{FB}	Reference voltage (adjustable version)	T_A = 25°C	0.64	0.65	0.66	V
$V_{Line-Reg}$	Line regulation	V_{IN} = (V_{OUT} +1) or 3 V, whichever is greater, to 40 V, I_{OUT} = 10 mA, T_A = 25°C			10	mV
$V_{Load-Reg}$	Load regulation	V_{IN} = 14 V, I_{OUT} = 1 mA to 300 mA, T_A = 25°C			10	mV
$V_{Dropout}$	Dropout voltage	I_{OUT} = 300 mA, V_{OUT} = 5 V, T_A = 25°C	280	500	950	mV
		I_{OUT} = 300 mA, V_{OUT} = 3.3 V, T_A = 25°C	300	525	1030	
I_{OUT}(1)	Output current	V_{OUT} in regulation	0		300	mA
$I_{(CL)}$	Output current limit	V_{OUT} short to 90% × V_{OUT}, T_A = 25°C	310		800	mA
PSRR	Power-supply ripple rejection	$V_{(Ripple)}$ = 0.2 V_{PP}, I_{OUT} = 10 mA, frequency = 100 Hz, C_{OUT} = 2.2 µF		60		dB
T_{SD}	Junction shutdown temperature			160		°C
T_{HYST}	Hysteresis of thermal shutdown			40		°C

Note:

(1) Guaranteed by design.

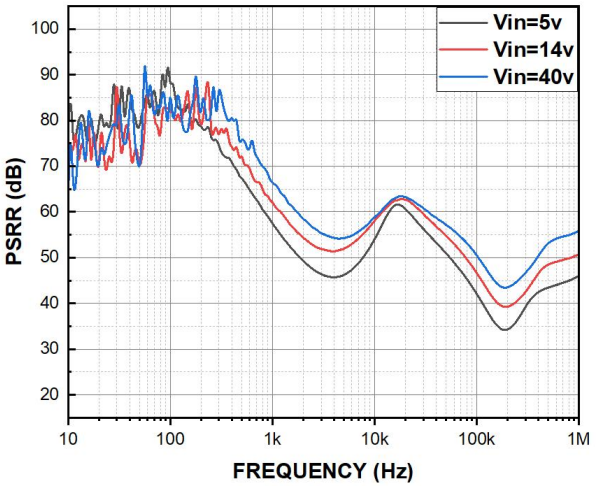
(2) Specifications subject to change without notice.

7. Typical Characteristics



V_{IN} = 5 V, V_{OUT} = 3.3 V, C_{OUT} = 1 µF

Figure 1. PSRR vs. Output and I_L



V_{OUT} = 3.3 V, I_L = 10 mA, C_{OUT} = 1 µF

Figure 2. PSRR vs. Frequency

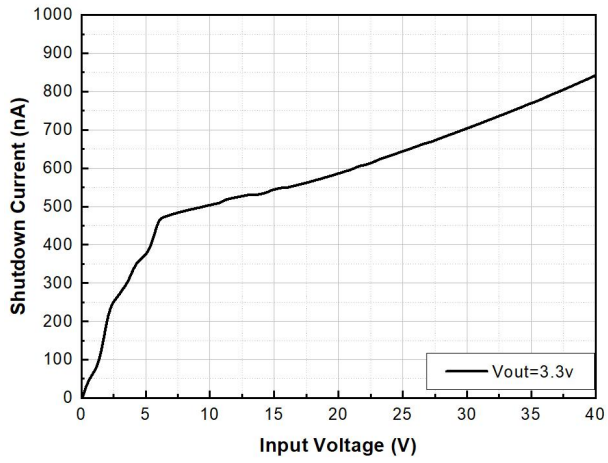


Figure 3. Shutdown current vs. Input voltage

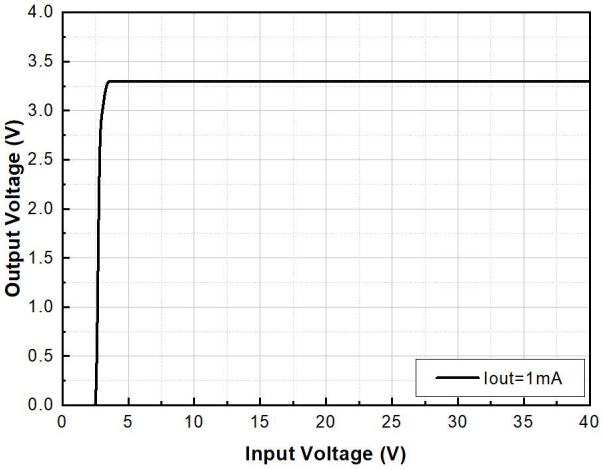


Figure 4. Output voltage vs. Input voltage at V_{OUT} = 3.3 V

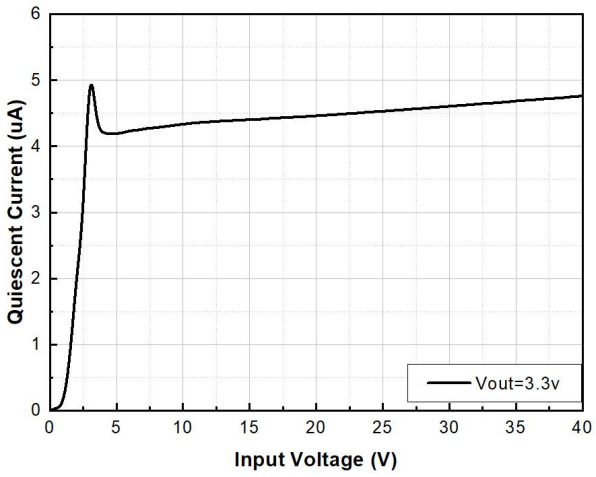


Figure 5. Quiescent current vs. Input voltage

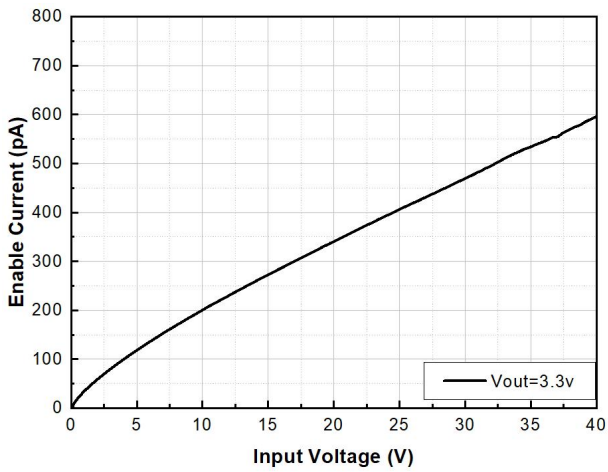
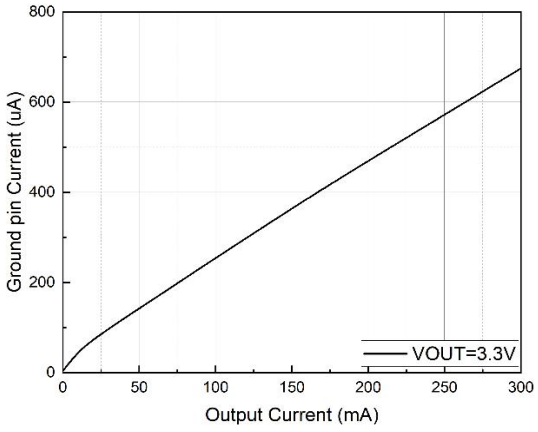


Figure 6. Enable current vs. Input voltage



V_{IN} = 5 V

Figure 7. Ground pin current vs. Output current

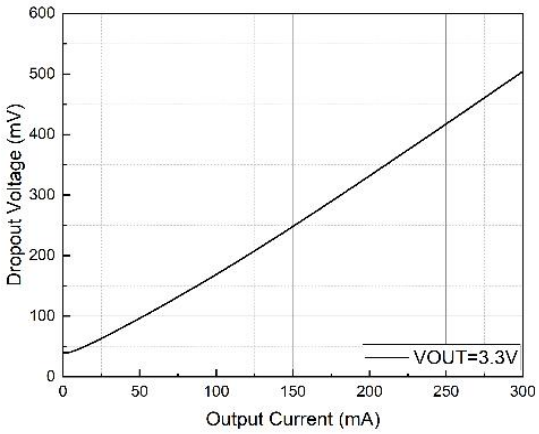
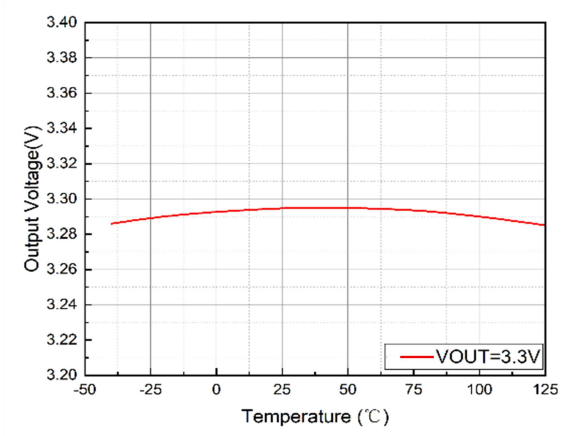
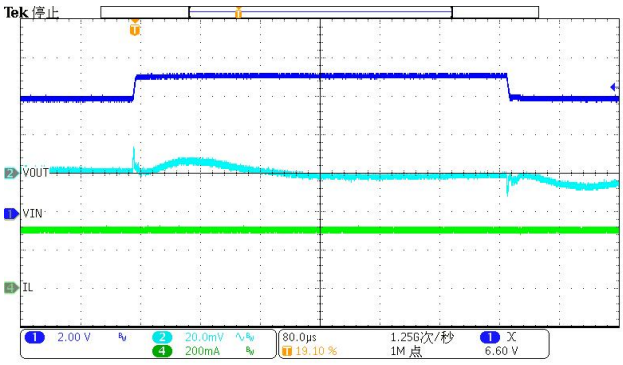


Figure 8. Dropout voltage vs. Output current



V_{IN} = 4.3 V, I_{OUT} = 1 mA

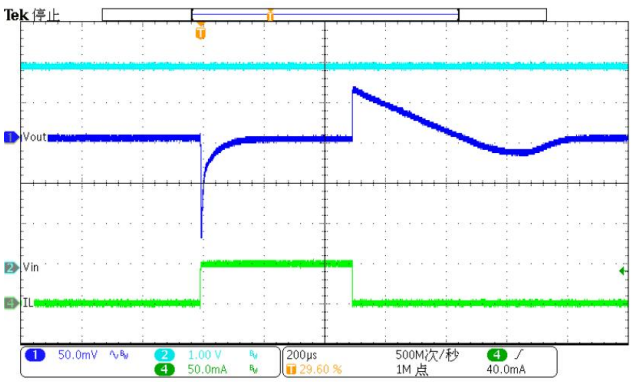
Figure 9. Output voltage vs. Temperature



V_{IN} = 6 V to 7 V, V_{OUT} = 3.3 V, C_{IN} = C_{OUT} = 1 μF,

I_L = 150 mA, edge speed at 5 μs

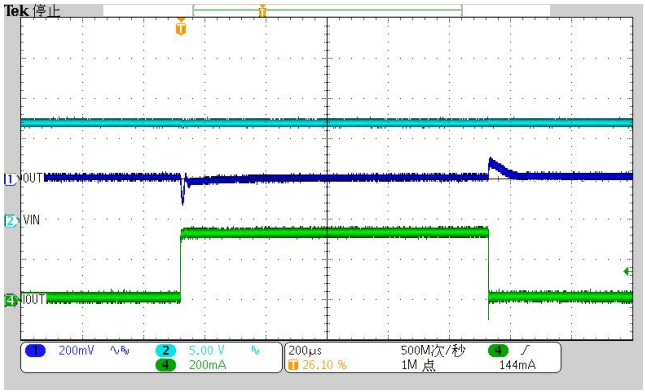
Figure 10. Line transient



V_{IN} = V_{EN} = 5 V, V_{OUT} = 3.3 V, C_{OUT} = 1 μF,

0.1 mA to 50 mA, edge speed at 1 μs

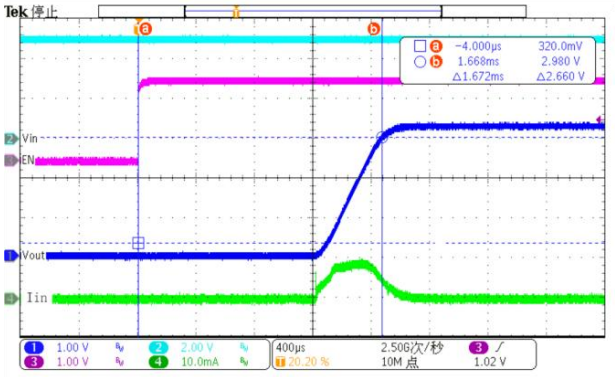
Figure 11. Load transient



V_{IN} = V_{EN} = 12 V, V_{OUT} = 3.3 V, C_{OUT} = 22 μF,

10 mA to 300 mA, edge speed at 1 μs

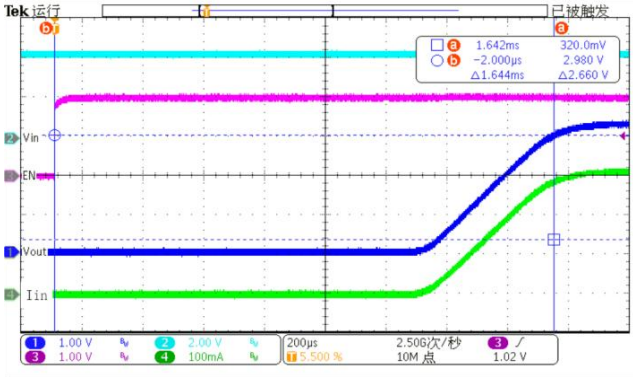
Figure 12. Load transient



V_{IN} = 4.3 V, V_{EN} = 2 V, V_{OUT} = 3.3 V,

C_{IN} = C_{OUT} = 1 μF, I_L = 0 mA

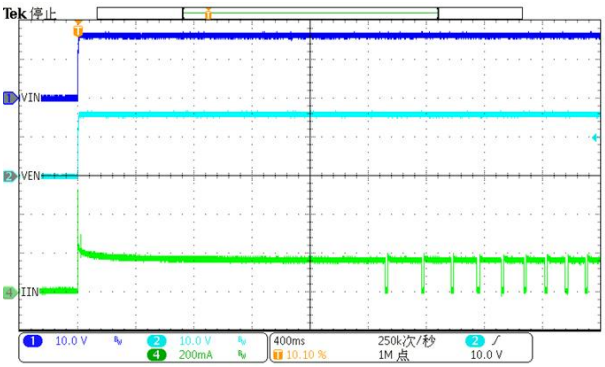
Figure 13. Turn-on time



V_{IN} = 4.3 V, V_{EN} = 2 V, V_{OUT} = 3.3 V,

C_{IN} = C_{OUT} = 1 μF, I_L = 300 mA

Figure 14. Turn-on time



V_{IN} = V_{EN} = 16 V

Figure 15. Short circuit start

8. Block Diagram

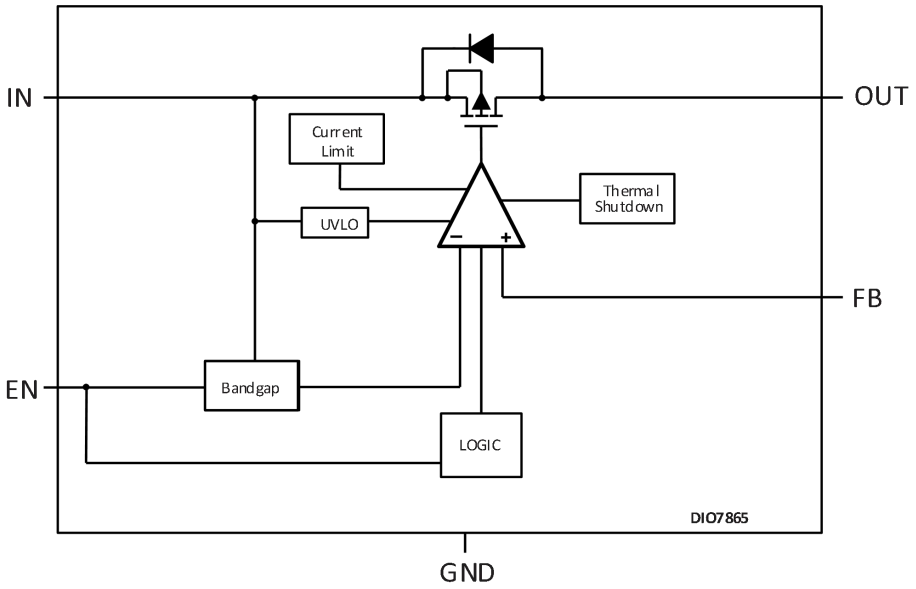


Figure 16. Block diagram - adjustable version

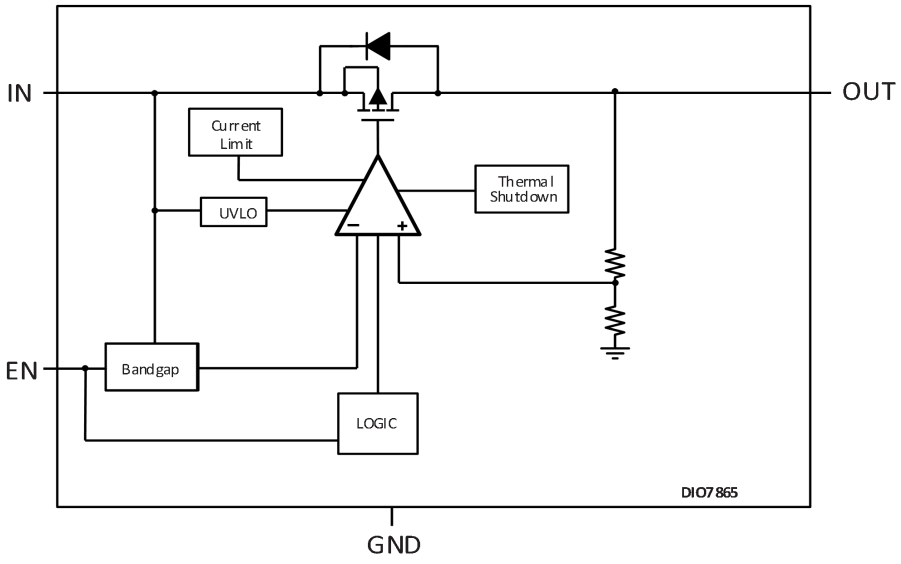


Figure 17. Block diagram - fixed version

Note: The block diagrams are for DFN2*2-6, EP-MSOP8, and SOT23-5 packages.

9. Function Description

The DIO7865 is a low-dropout linear regulator designed to function with an input voltage ranging from 3 V to 40 V and provides 45 V load dump protection. The typical quiescent current of the standby system at light load is only 4 μA.

9.1. Device enable (EN)

The device can be enabled and disabled by the EN pin. The EN pin is a high-voltage tolerant pin. A high input turns the regulation on and activates the device. To enable and disable the device, connect this pin to an external microcontroller or a digital circuit, or connect to the IN pin for self-bias applications.

9.2. Undervoltage shutdown

The DIO7865 will be shut down if the input voltage (V_{IN}) falls below an internal UVLO threshold (V_{UVLO}). In the event that the input voltage drops below UVLO threshold and recovers, as soon as the voltage returns to the proper range, the regulator shuts down and powers up with a normal power-up sequence. Ensure that the regulator does not latch into an unknown state during low-input-voltage conditions. The regulator shuts down and powers up with a normal power-up sequence when the input voltage is above the required level.

9.3. Thermal shutdown

The DIO7865 is protected by a thermal shutdown (T_{SD}) circuit from overheating. The junction temperature exceeding the T_{SD} trip point causes the output to turn off, and the output will turn on again when the junction temperature falls below the T_{SD} trip point.

9.4. Operation with V_{IN} lower than 3 V

The DIO7865 can operate with input voltages above 3 V and at lower input voltages, the maximum UVLO voltage is 2.9 V, and the device does not operate at input voltages below the actual UVLO voltage.

9.5. Operation with V_{IN} higher than 3 V

When V_{IN} is higher than the output set value plus the device dropout voltage and higher than 3 V, V_{OUT} is equal to the set value. Otherwise, V_{OUT} is equal to V_{IN} minus the dropout voltage.

10. 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.

10.1. Application examples

The DIO7865 is a low-dropout linear regulator designed to function with an input-voltage ranging from 3 V to 40 V with a 45 V load dump protection.

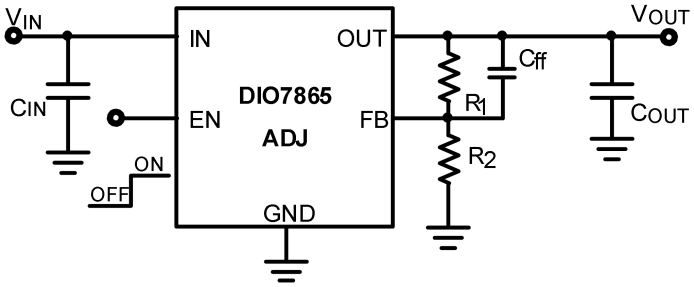


Figure 18. Typical application - adjustable version

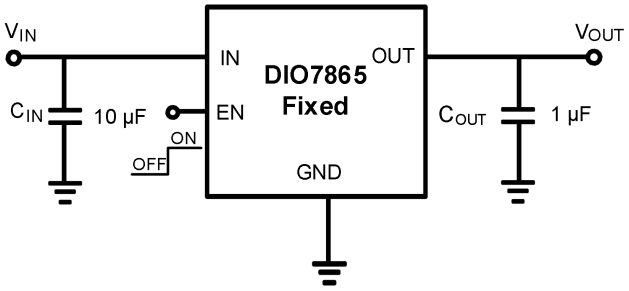


Figure 19. Typical application - fixed version

10.2. Detailed design procedure

To begin the design process, determine the input and output voltage range and output current.

For adjustable output voltage, it can be adjusted from 1.2 V to 16 V using two external resistors. The typical application schematics are shown in Figure 18.

$$V_{OUT} = V_{FB} \times (1 + R1/R2) \quad (1)$$

It is recommended to add Cff and keep the total serial resistance of resistors (R1 + R2) no greater than 100 kΩ.

Table 1. Recommended resistor for DIO7865 (Adjustable version)

V_{OUT} (V)	R_1 (kΩ)	R_2 (kΩ)
1.2	1.1	1.3
1.8	3.9	2.2
2.5	4.7	1.65
3	4.7	1.3

4.2	8.2	1.5
5	26.1	3.9
5.5	30	4.02
14	26.7	1.3

10.3. Input capacitor

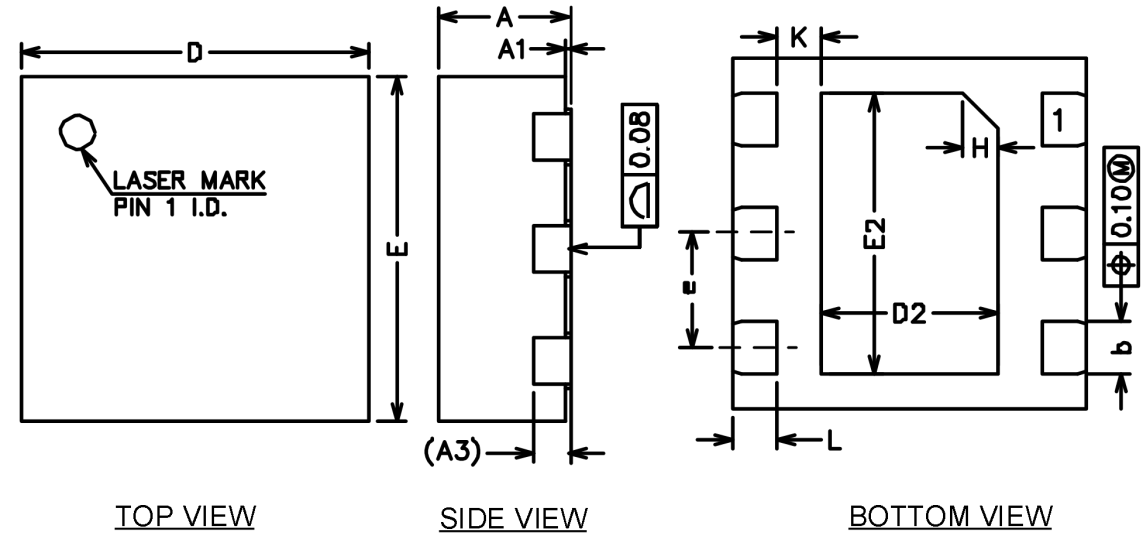
The voltage rating of the input capacitor must be greater than the maximum input voltage. An input capacitor is not required for stability. A good analog design practice is to connect a 10 μF to 22 μF capacitor from IN to GND.

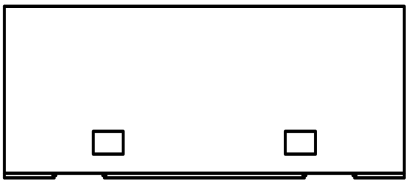
10.4. Output capacitor

The voltage rating of the output capacitor must be greater than the maximum output voltage. To better endure the stability of the DIO7865, an output capacitor with a value ranging from 1 μF to 200 μF and with an equivalent series resistance ranging between 0.001 Ω and 5 Ω is required. To improve the load transient response, select a ceramic capacitor with low equivalent series resistance.

11. Physical Dimensions

11.1. DFN2*2-6

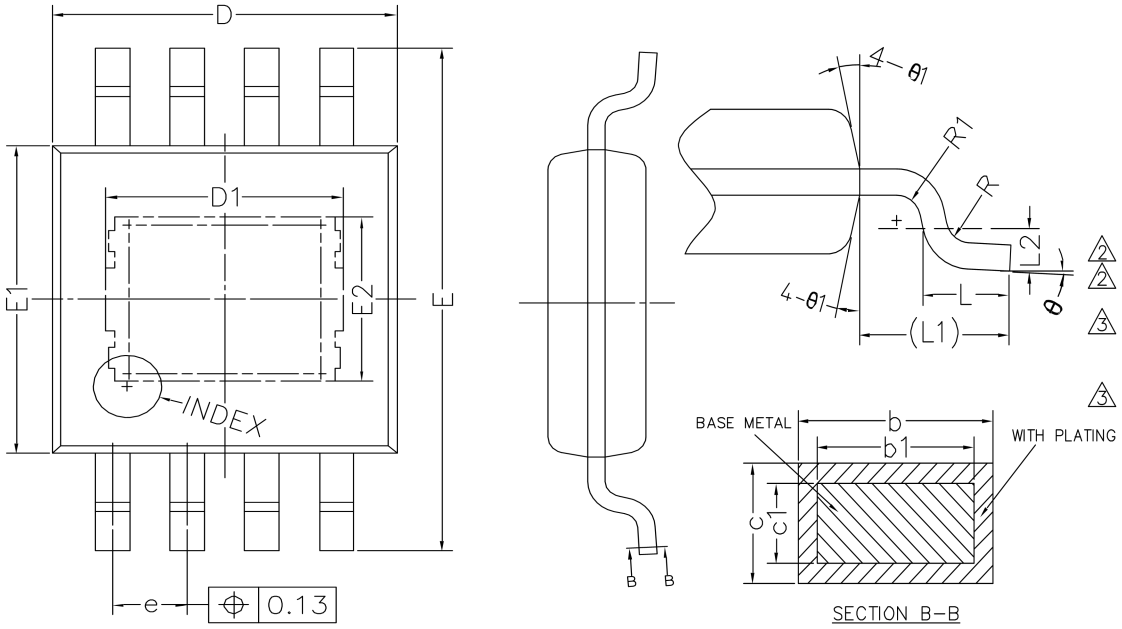


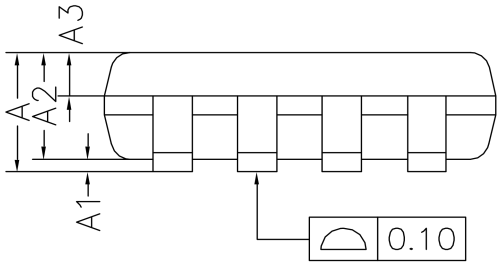


SIDE VIEW

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.20 REF	
b	0.25	0.30	0.35
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D2	0.90	1.00	1.10
E2	1.50	1.60	1.70
e	0.55	0.65	0.75
K	0.15	0.25	0.35
L	0.20	0.25	0.30
H		0.20 REF	

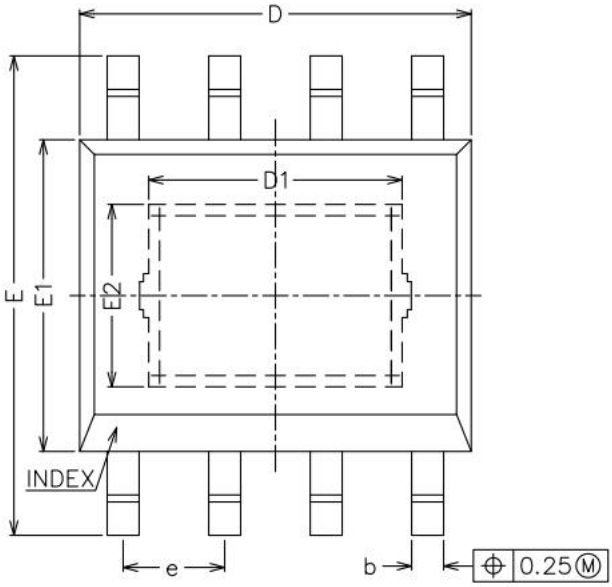
11.2. EP-MSOP8

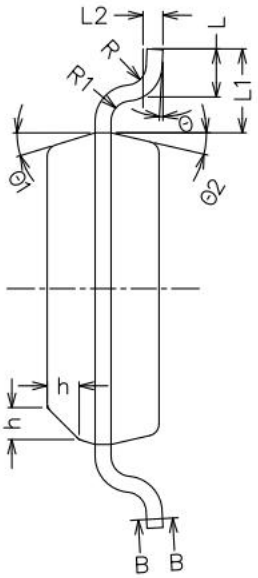


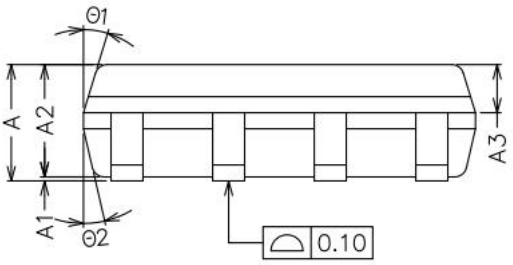


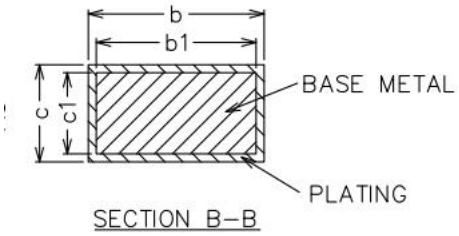
Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.10
A1	0.05	0.10	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.25	-	0.38
b1	0.24	0.30	0.33
c	0.13	-	0.20
c1	0.13	0.15	0.16
D	2.90	3.00	3.10
D1	1.92	2.07	2.22
E	4.75	4.90	5.05
E1	2.90	3.00	3.10
E2	1.45	1.60	1.75
e	0.55	0.65	0.75
L	0.40	0.55	0.70
L1	0.95 REF		
L2	0.25 BSC		
R	0.07	-	-
R1	0.07	-	-
θ	0°	-	8°
θ1	9°	12°	15°

11.3. EP-SOIC8



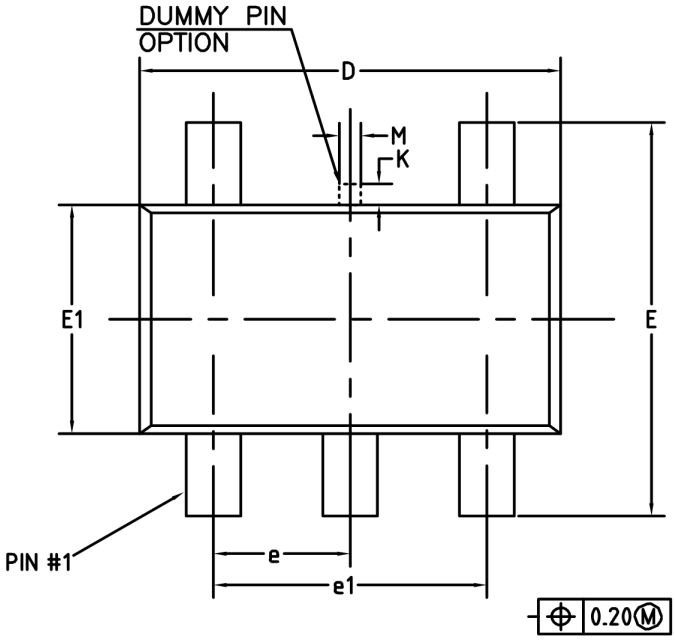


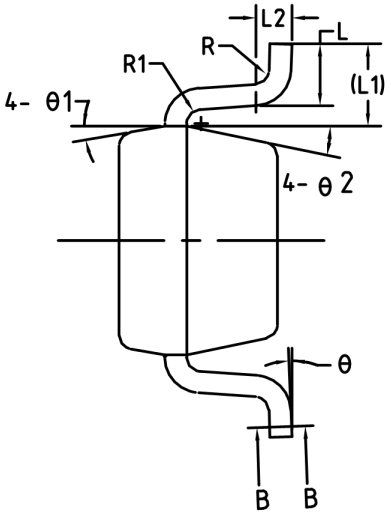


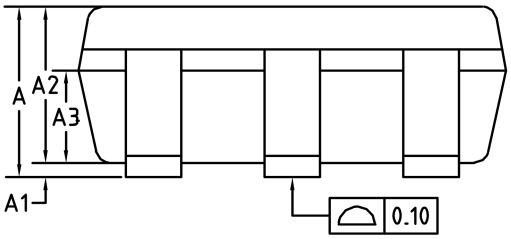


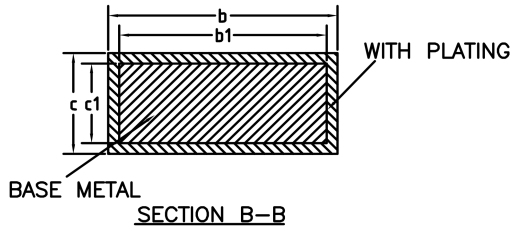
Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	1.35	1.45	1.65
A1	0	-	0.15
A2	1.35	1.40	1.50
A3	0.50	0.60	0.70
b	0.38	-	0.47
b1	0.37	0.40	0.43
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	4.80	4.90	5.00
D1	3.02	3.17	3.32
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
E2	2.13	2.28	2.43
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	
θ	0°	-	8°
θ1	15°	17°	19°
θ2	11°	13°	15°

11.4. SOT23-5









Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.25
A1	0	-	0.15
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.36	-	0.45
b1	0.35	0.38	0.41
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.826	2.926	3.026
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
K	0	-	0.25
L	0.30	0.40	0.60
L1	0.59 REF		
L2	0.25 BSC		
M	0.10	0.15	0.25
R	0.05	-	0.20
R1	0.05	-	0.20
Θ	0°	-	8°
Θ1	8°	10°	12°
Θ2	10°	12°	14°

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