1.5A, Wide V_{IN}, Low Noise, Fast Transient Response LDO Regulators

AWL5963

FEATURES

- Wide Input Voltage Range: **2.3V to 20V**
- Maximum Output Current: **1.5A**
- Low Dropout Voltage: **320mV** at 1.5A Load
- Low Noise: **15μV_{RMS}** (10Hz to 100kHz)
- Fixed Output Voltages: 1.8V, 2.5V, 3.3V
- Adjustable Output from 1.21V to 20V
- Operating Quiescent Current: **1mA** (Typ.)
- Low Shutdown Current: **<1μA**
- Excellent Load/Line Transient Response
- Stable with 10uF Output Capacitor
- Reverse Battery Protection
- Reverse Current Protection
- Current-Limit and Thermal Overload Protection
- SOP8L, TO263-5 and SOT223-3 Packages

APPLICATION

- Industrial and Instrumentation
- Medical and Healthcare
- Post Regulator for Switching Power Supplies

DESCRIPTION

The AWL5963 is a low-dropout (LDO) regulator optimized for fast transient response. The AWL5963 can regulates the input voltage from 2.3V to 20V to an adjustable output voltage from 1.21V to 20V.

The device can supply 1.5A of output current with only a very low dropout voltage of 320mV. Operating quiescent current is about 1mA and less than 1uA in shutdown mode. In addition to fast transient response, the AWL5963 also has very low output noise which makes them ideal for sensitive RF supply applications.

The AWL5963 regulator are stable with output capacitors as low as 10uF. The protection includes reverse battery, reverse current, current limit, thermal overload etc. The available fixed output voltages are 1.8V, 2.5V and 3.3V, and as an adjustable device with a 1.21V reference voltage. The AWL5963 are available in SOP8L, TO263-5 and SOT223-3 packages.

Typical Application

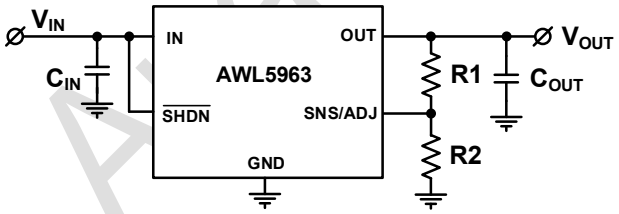

Fig.1 Schematic Diagram

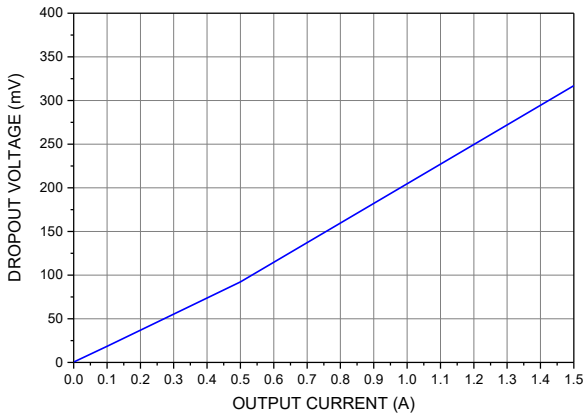

Fig.2 Dropout Voltage vs. Output Current

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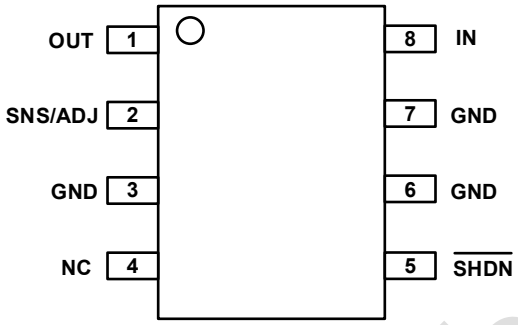
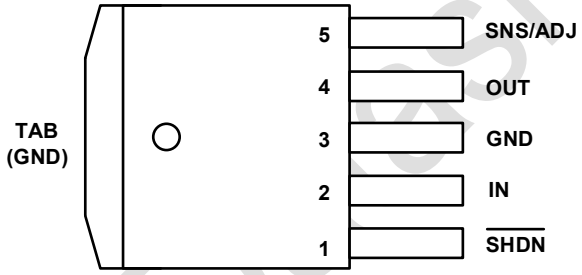
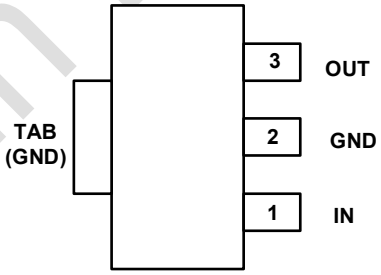
PIN CONFIGURATION

Package	Pin Configuration (Top View)
SOP8L (AA)	
TO263-5 (KA)	
SOT223-3 (SD)	

PIN DESCRIPTION

No.	Pin	Description
1	OUT	Output Voltage
2	SNS/ADJ	SNS: Sense Pin for Fixed Output Voltage Version; ADJ: Adjust Pin for Adjustable Output Voltage Version
3	GND	Ground
4	NC	No Connect
5	$\overline{SHDN}$	Shutdown
6	GND	Ground
7	GND	Ground
8	IN	Input Voltage

Table 1. AWL5963 SOP8L Pin Description

No.	Pin	Description
1	$\overline{SHDN}$	Shutdown
2	IN	Input Voltage
3	GND	Ground
4	OUT	Output Voltage
5	SNS/ADJ	SNS: Sense Pin for Fixed Output Voltage Version; ADJ: Adjust Pin for Adjustable Output Voltage Version
6	TAB	Ground

Table 2. AWL5963 TO263-5 Pin Description

No.	Pin	Description
1	IN	Input Voltage
2	GND	Ground
3	OUT	Output Voltage
4	TAB	Ground

Table 3. AWL5963 SOT223-3 Pin Description

ABSOLUTE MAXIMUM RATINGS

		Min	Max	Units
Input	VIN to GND	-20	20	V
	$\overline{SHDN}$ to GND	-20	20	
Output	OUT to GND	-20	20	V
	SNS to GND	-20	20	
	ADJ to GND	-5.5	5.5	
T_J	Junction temperature	-40	150	°C
T_S	Storage temperature	-55	150	

RECOMMENDED OPERATIONG CONDITIONS

		Min	Max	Units
Input	VIN	$V_{OUT}+V_{DO}$	20	V
	$\overline{SHDN}$	0	20	
Output	OUT	0	20	
	SNS	0	20	
	ADJ	0	5.5	
T_J	Junction temperature	-40	125	°C

ESD RATINGS

Symbol	Definition	Value	Units
V_{ESD}	HBM	±4000	V
	CDM	±2000	

THERMAL INFORMATION

Symbol	Definition	Value				Units
		AA	KA	SD	DF	
θ_{JA}	Junction to ambient thermal resistance	70	30	50	65	°C/W
θ_{JC}	Junction to case thermal resistance	16	1.2	3	3	

ELECTRICAL CHARACTERISTICS

Limits apply over the recommended operating junction temperature range of –40°C to +125°C, unless otherwise stated. Minimum and Maximum limits are specified through test, design or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated the following conditions apply: V_{IN} = 2.3 V to 20V, C_{OUT}=10µF. V_{OUT} is converter output voltage.

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{IN}	Minimum Input Voltage	I_{OUT}=0.5A		1.7		V
		I_{OUT}=1.5A		2.0	2.3	
V_{ADJ}	ADJ Pin Voltage	V_{IN}=2.3V, I_{OUT}=1mA, SOP8L	1.18	1.21	1.246	V
		V_{IN}=2.3V, I_{OUT}=1mA, TO263-5	1.17	1.21	1.246	
V_O	Fixed Output Voltage	V_{IN}=2.8V, I_{OUT}=1mA, AWL5963-18	1.74	1.8	1.86	V
		V_{IN}=3.5V, I_{OUT}=1mA, AWL5963-25	2.42	2.5	2.58	
		V_{IN}=4.3V, I_{OUT}=1mA, AWL5963-33	3.20	3.30	3.40	
ΔV_{OUT_LOAD}	Load Regulation	V_{IN}=2.3V, ΔI_{OUT}=1mA to 1.5A, AWL5963-ADJ		3	15	mV
		V_{IN}=2.8V, ΔI_{OUT}=1mA to 1.5A, AWL5963-18		4	18	
		V_{IN}=3.5V, ΔI_{OUT}=1mA to 1.5A, AWL5963-25		5	21	
		V_{IN}=4.3V, ΔI_{OUT}=1mA to 1.5A, AWL5963-33		7	25	
ΔV_{OUT_LINE}	Line Regulation	ΔV_{IN}=2.3V to 20V, I_{OUT}=1mA, AWL5963-ADJ		3		mV
		ΔV_{IN}=2.8V to 20V, I_{OUT}=1mA, AWL5963-18		4		
		ΔV_{IN}=3.5V to 20V, I_{OUT}=1mA, AWL5963-25		5		

		ΔV_{IN}=4.3V to 20V, I_{OUT}=1mA, AWL5963-33		7		
I_{SHDN}	Shutdown Supply Current	V_{SHDN}=0V V_{IN}=6V, T_J=25°C		0.05	1	μA
I_{GND}	Ground Current (V_{IN}=V_{OUT}+1V)	I_{OUT}=1mA		1.5	3.5	mA
		I_{OUT}=100mA		4	6	
		I_{OUT}=500mA		13	17	
		I_{OUT}=1.5A		30	35	
V_{DO}	Dropout Voltage (V_{IN} =V_{OUT})	I_{OUT}=1mA		5	20	mV
		I_{OUT}=100mA		20	100	
		I_{OUT}=500mA		100	200	
		I_{OUT}=1.5A		320	540	
V_{SHDN_ON}	V_{OUT} =OFF to ON	I_{OUT} =1mA		0.88	1.8	V
V_{SHDN_OFF}	V_{OUT} =ON to OFF	I_{OUT} =1mA	0.2	0.74		V
I_{SHDN_PIN}	Shutdown Pin Current	V_{SHDN} =0V, T_J=25°C		0.02	1	μA
		V_{SHDN} =20V, T_J=25°C		1.3	10	
I_{LIMIT}	Current Limit	V_{IN}=7V, V_{OUT}=0V	1.6	1.8		A
I_{ADJ}	ADJ Pin Bias Current	V_{IN}=2.3V, I_{OUT}=1mA		0.5	5	μA
I_{IL}	Input Reverse Leakage Current	V_{IN}=-20V, V_{OUT}=0V		70	800	μA
I_{RO}	Reverse Output Current	V_{IN}=0V, V_{OUT}=1.21V, T_J=25°C, AWL5963-ADJ		50	700	μA
		V_{IN}=0V, V_{OUT}=1.8V, T_J=25°C, AWL5963-18		200	900	
		V_{IN}=0V, V_{OUT}=2.5V, T_J=25°C, AWL5963-25		500	1200	
		V_{IN}=0V, V_{OUT}=3.3V, T_J=25°C, AWL5963-33		1300	1500	
PSRR	Power Supply Ripple Rejection	V_{IN}-V_{OUT}=1.5V I_{OUT}=0.75A @1kHz		60		dB
e_N	Output Voltage Noise (10Hz to 100kHz)	V_{OUT}=1.21V, I_{OUT} = 1.5A		15		μV_{RMS}
		V_{OUT}=3.3V, I_{OUT} = 1.5A		40		
Thermal						
T_{SD}	Thermal Shutdown			155		°C
T_{SD_HYS}	Thermal Shutdown Hysteresis			15		°C

TYPICAL CHARACTERISTICS

V_{IN}=2.3V to 20V, C_{OUT}=10μF, T_J =25°C unless otherwise specified. All min and max specifications are at T_J = -40°C to 125°C

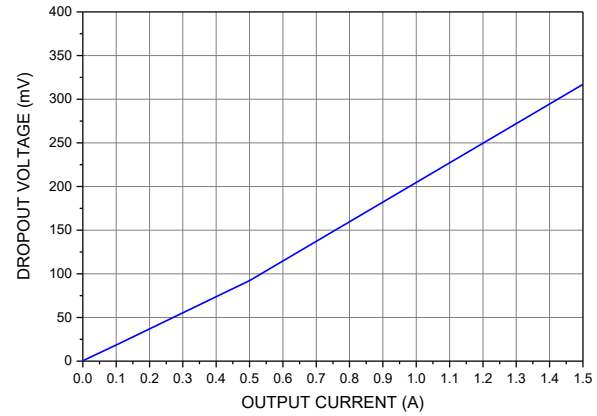


Fig.3 Dropout Voltage VS. Output Current

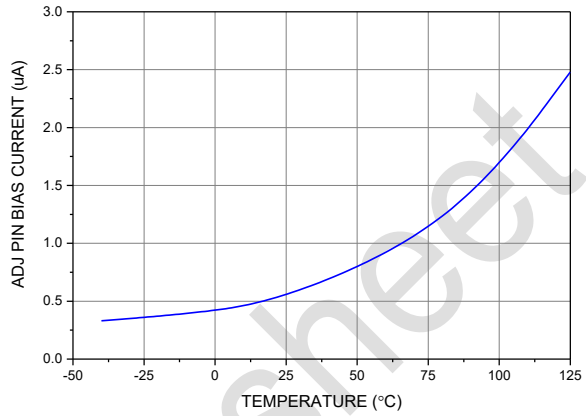


Fig.4 ADJ Pin Bias Current VS. Temperature

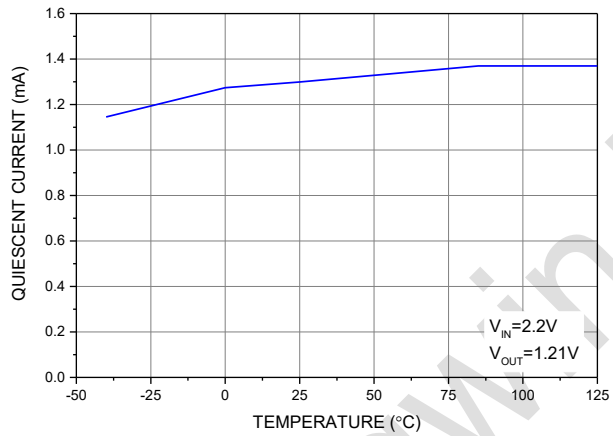


Fig.5 Quiescent Current VS. Temperature

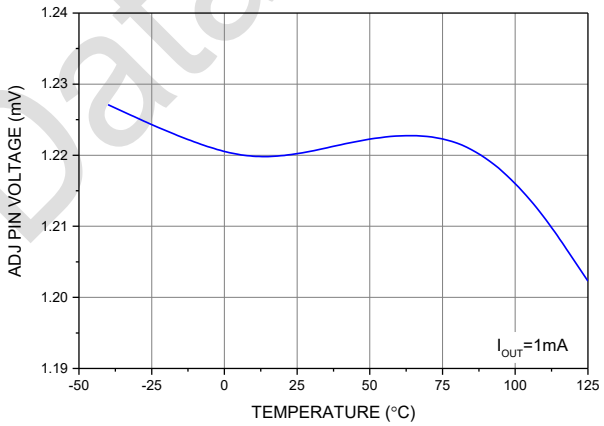


Fig.6 ADJ PIN Voltage VS. Temperature

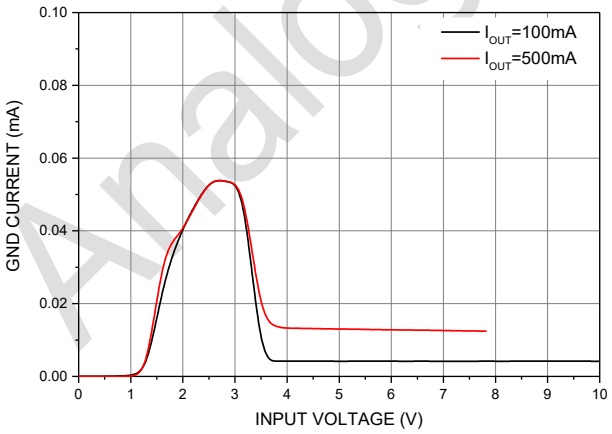


Fig.7 Ground Current VS. Input Voltage

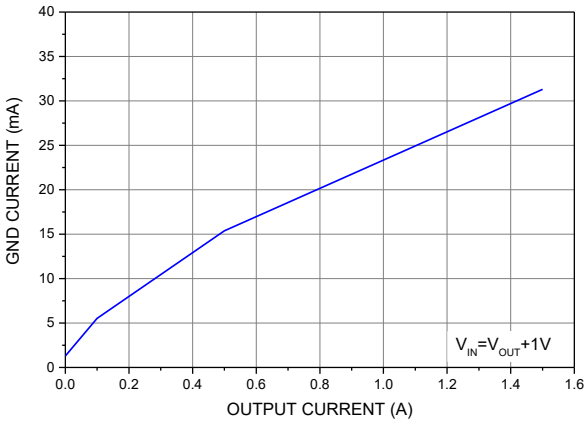


Fig.8 Ground Current VS. Output Current

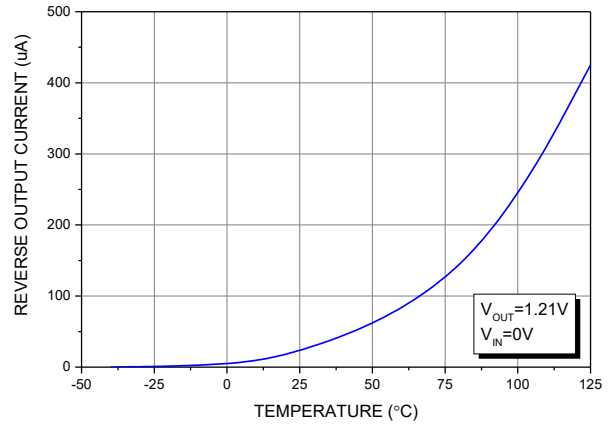


Fig.9 Reverse Output Current VS. Temperature

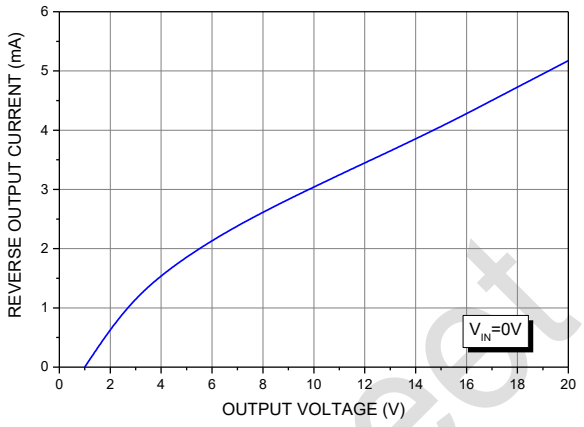


Fig.10 Reverse Output Current VS. Output Voltage

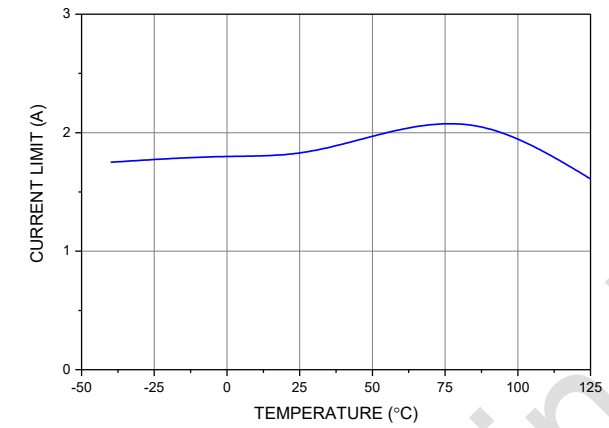


Fig.11 Current Limit VS. Temperature

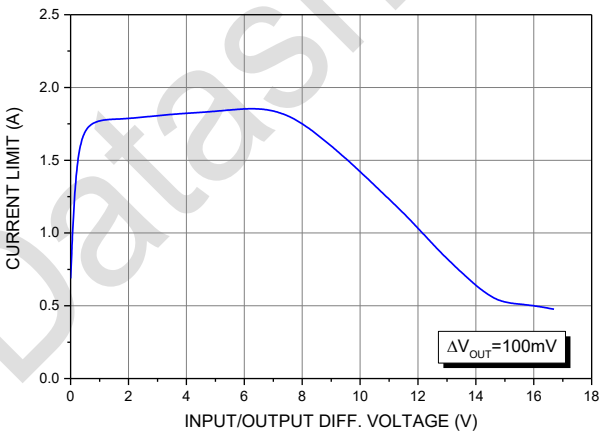


Fig.12 Current Limit VS. Input/Output Differential Voltage

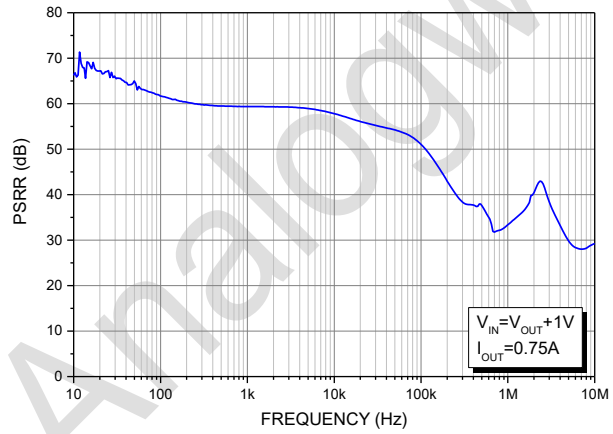


Fig.13 PSRR VS. Frequency

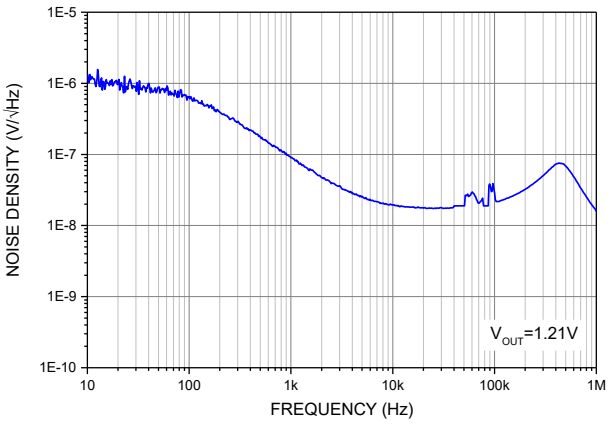


Fig.14 Output Noise VS. Frequency

BLOCK DIAGRAM

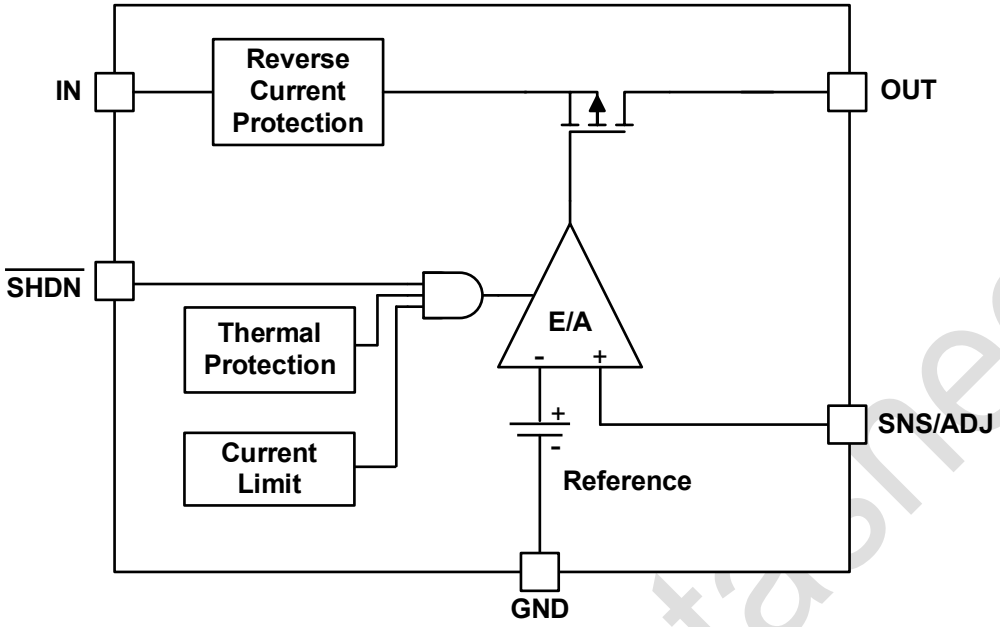


Fig.15 AWL5963 Block Diagram

PRODUCT OVERVIEW

The AWL5963 is an adjustable or fixed, low noise, low dropout linear regulator optimized for fast transient response. The input voltage range is 2.3V to 20V and it can deliver up to 1.5A of output current with a dropout voltage of 320 mV. Typical shutdown current consumption is less than 1μA. In addition to the low quiescent current, the AWL5963 incorporates several protection features that make them ideal for use in battery-powered systems. It can be protected against both reverse input and reverse output voltages. In battery-backup applications where the output can be held up by a backup battery when the input is pulled to ground, the AWL5963 can act as if it has a diode in series with its output and prevents reverse-current flow.

APPLICATION

Fig.16 shows an adjustable output voltage AWL5963 application circuit.

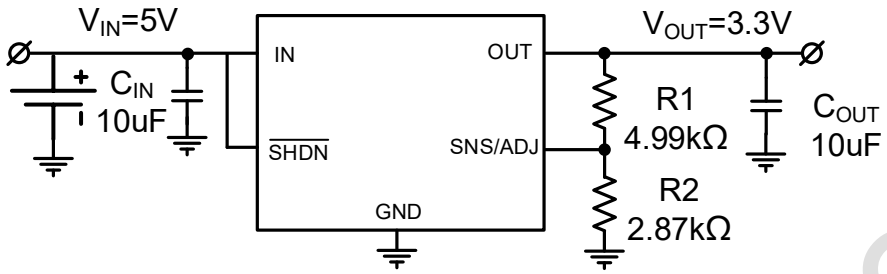


Fig.16 Adjustable Output Voltage Application Circuit

Fig.17 shows a fixed output voltage AWL5963 application circuit.

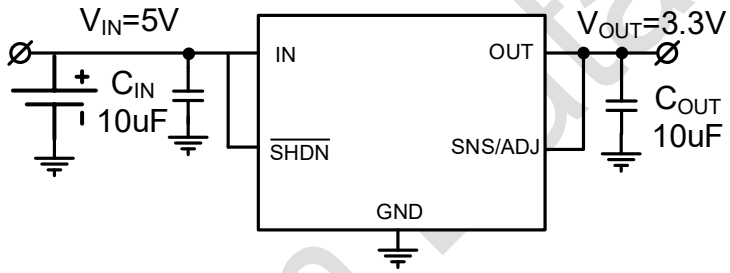


Fig.17 Fixed Output Voltage Application Circuit

Setting Output Voltage

The external feedback resistors connect to ADJ pin to set the output voltage. The feedback resistors value can be calculated with the below equation.

$$\boldsymbol{R2 = \frac{V_{REF} R1}{V_{OUT} - V_{REF}}}$$

While R1=4.99kΩ, V_{REF}=1.21V, V_{OUT}=3.3V

Calculate R2=2.87kΩ

Output Capacitor Selection

The AWL5963 can operate with most types capacitors as long as care as taken with regard to the effective series resistance (ESR) value. The ESR of the output capacitor affects the stability of the LDO control loop. A minimum of 10μF capacitance with an ESR of 0.2Ω or less is recommended to ensure the stability of the AWL5963.

Current Limit and Thermal Overload Protection

The AWL5963 is protected against damage due to excessive power dissipation by current and thermal overload protection circuits. When the output load exceeds 1.8 A (typical), the output voltage is reduced to maintain a constant current limit.

When the junction temperature starts to rise above 152°C (typical), the output is turned off, reducing the output current to zero. When the junction temperature drops below 137°C, the output is turned on again, and output current is restored to its operating value.

Application Waveforms

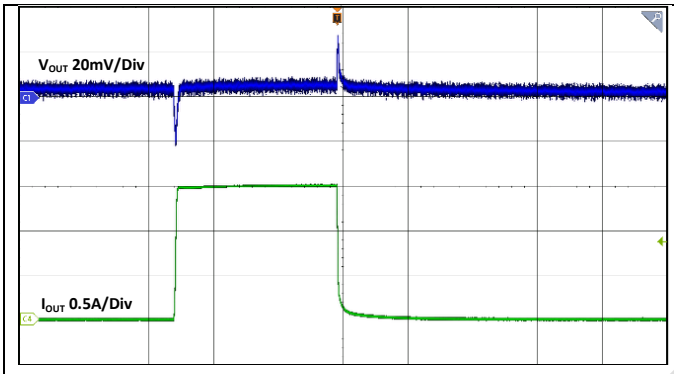


Fig.18 Load Transient @ I_{OUT}=10mA<->1.5A (1A/us)

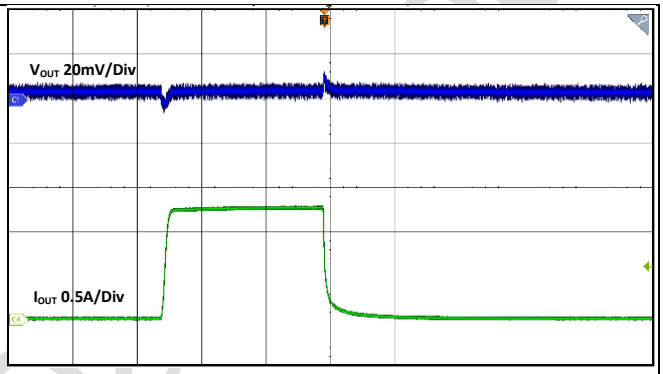


Fig.19 Load Transient @ I_{OUT}=10mA<->0.5A (1A/us)

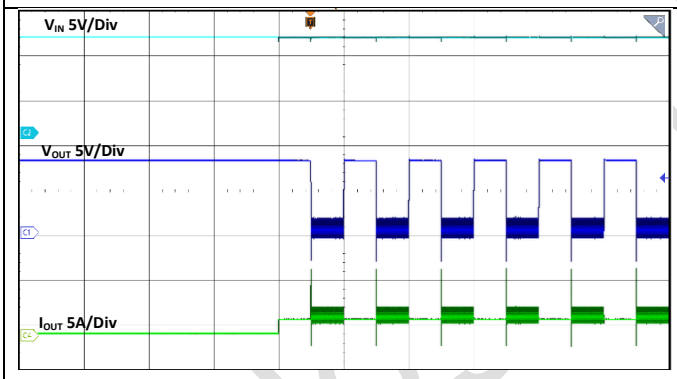


Fig.20 Turn On Then Short Circuit

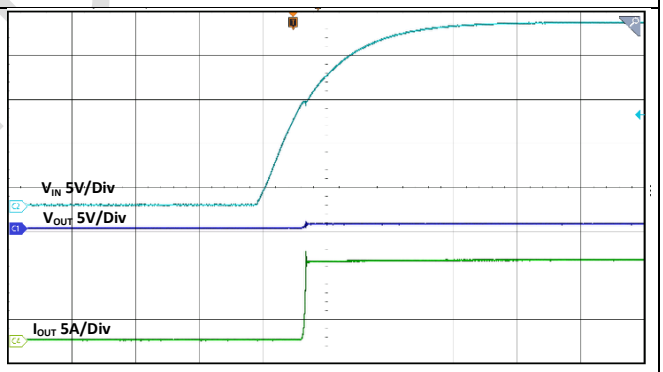


Fig.21 Short Circuit Then Turn On

PCB LAYOUT GUIDELINES

For best results, please follow the guidelines below.

1. Use wide traces for IN, OUT and GND.
2. Place a minimum 10μF low ESR ceramic capacitor as close to OUT and GND as possible.
3. The tab of KA and SD package should be connected to ground.

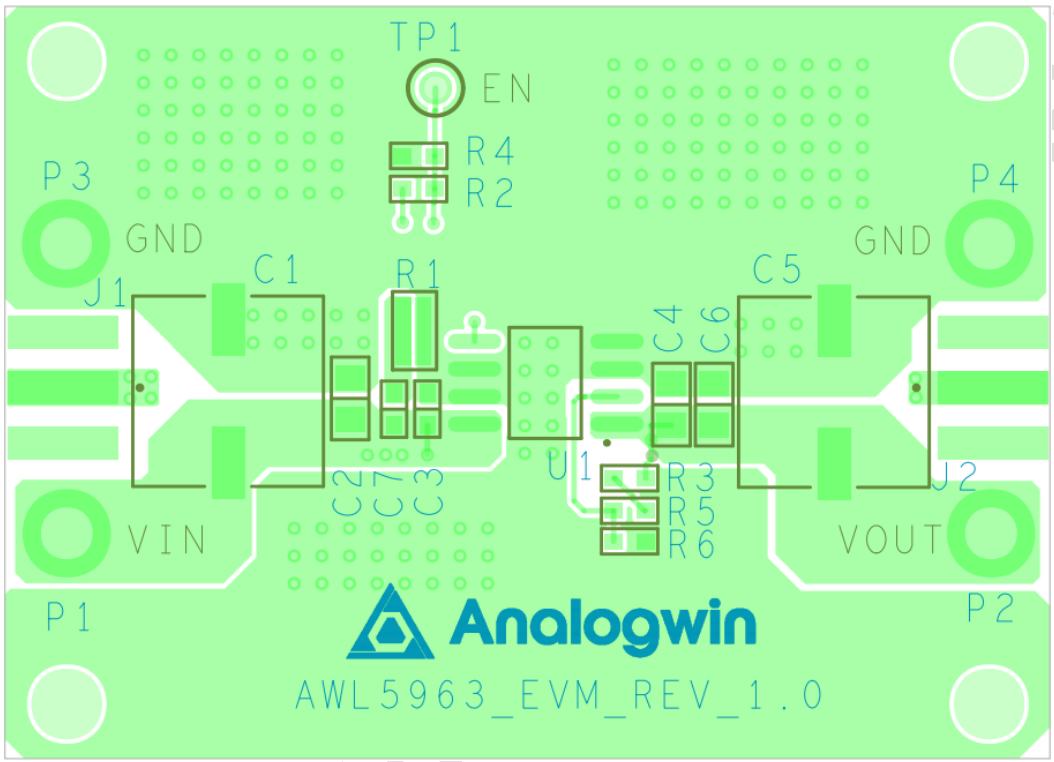


Fig.22 SOP8L Package Layout Example

PACKAGE INFORMAGION

Package Top marking

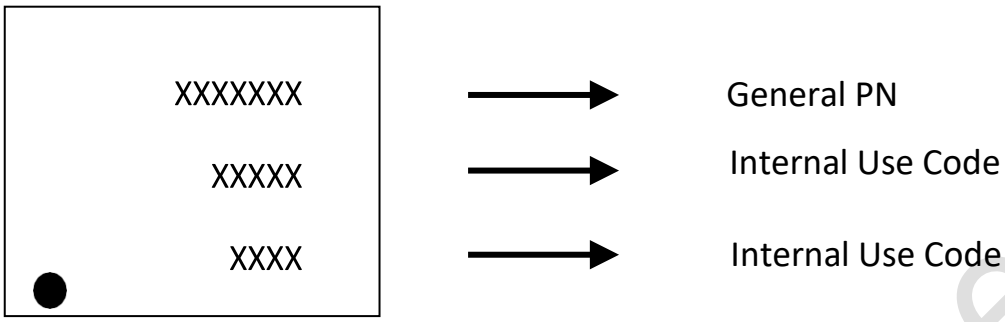


Fig.23 Package Top Marking

Tape and Reel Box Information

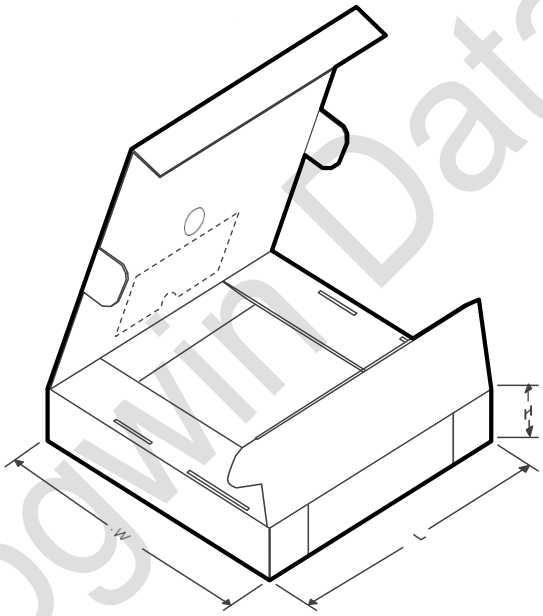


Fig.24 Tape and Reel Box Information

Device （mm）	PACKAGE TYPE	PACKAGE DRAWING	PINS	SPQ	LENG (mm)	WIDTH (mm)	HEIGHT (mm)
AWL5963AAR	SOP8L	AA	8	4000	336.0	336.0	48.0
AWL5963KAR	TO263-5	KA	5	800	370.0	340.0	65.0
AWL5963SDR	SOT223-3	SD	4	4000	336.0	336.0	48.0

Tape and Reel Information

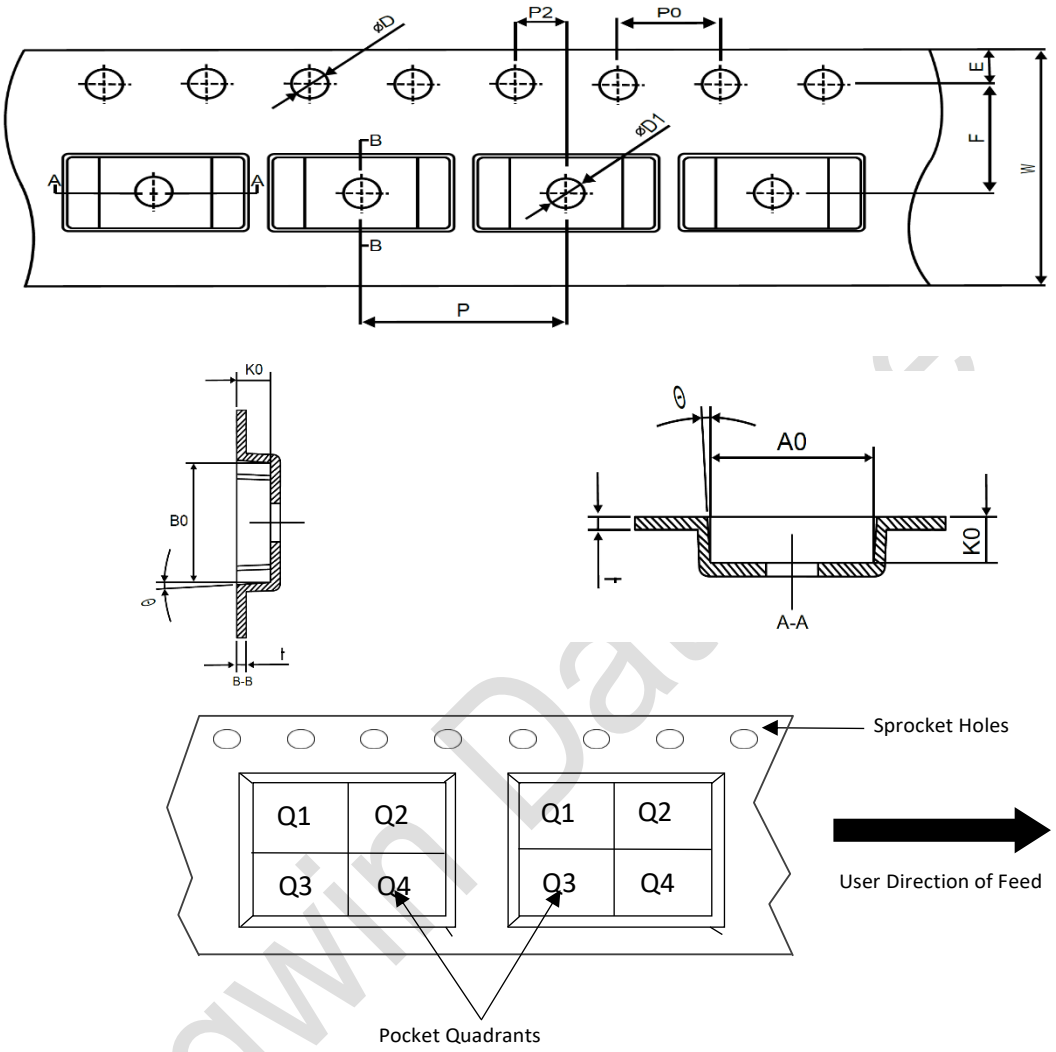


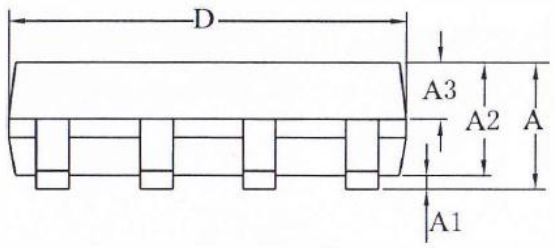
Fig.25 Tape and Reel Information

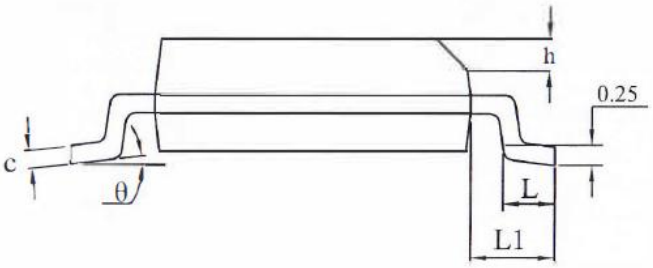
DIMENSIONS AND PIN1 ORIENTATION

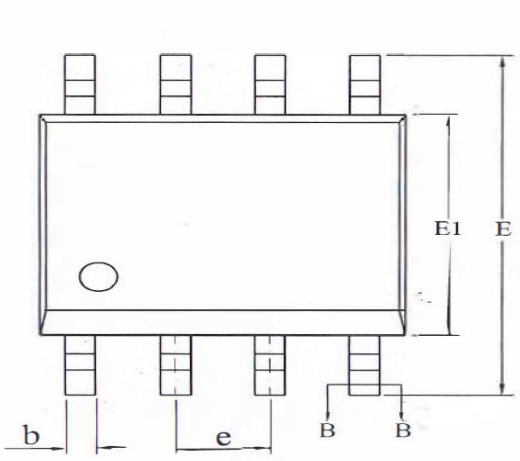
Device	Package Type	W (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P (mm)	P0 (mm)	Pin1 Quadrant	Quantity
AWL5963AAR	SOP8L	12.00	6.55	5.30	2.00	8.00	4.00	Q1	4000
AWL5963KAR	TO263-5L	24.00	10.80	16.30	4.85	16.0	4.00	Q1	800
AWL5963SDR	SOT223-3L	12.20	6.80	7.30	1.90	8.00	4.00	Q3	4000

All dimensions are nominal

Package Outlines

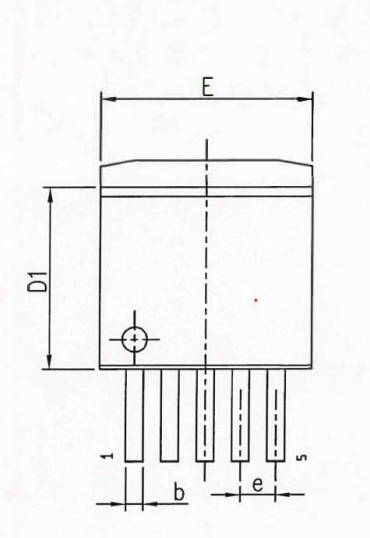


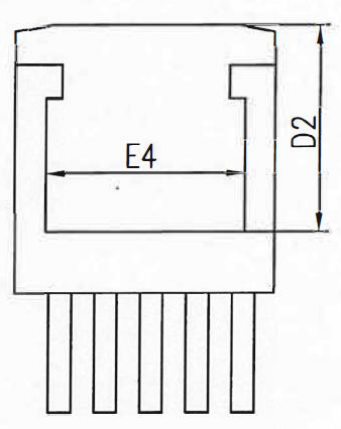


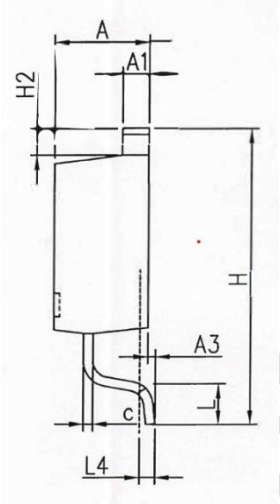


SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
L	0.50	—	0.80
h	0.25	—	0.50
L1	1.05REF		
θ	0	—	8°

Fig.26 SOP8L Package

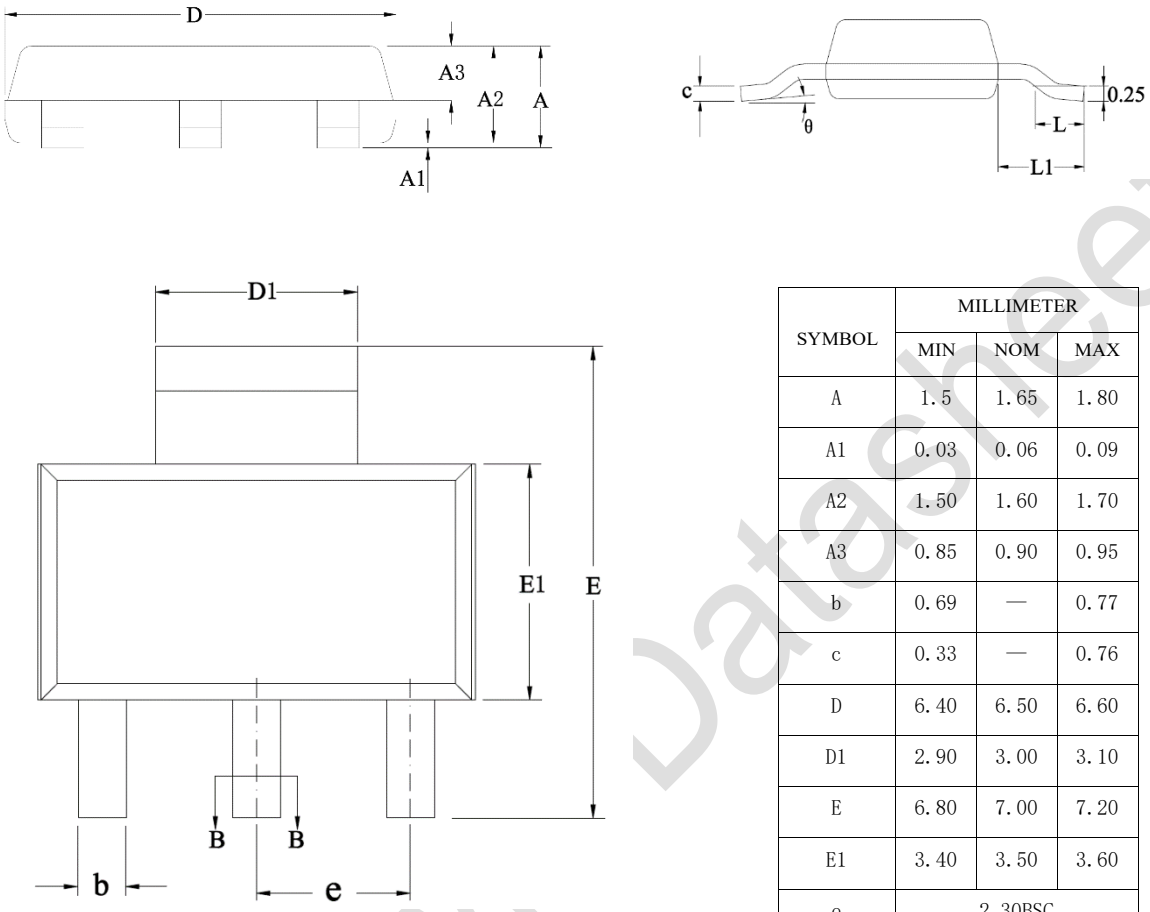






SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	4.37	4.57	4.77
A1	1.17	1.27	1.42
A3	0	—	0.25
b	0.71	—	0.97
c	0.33	—	0.76
D1	8.38	8.70	9.00
D2	6.00	—	—
E	9.90	10.16	10.39
E4	7.30	—	—
e	1.70BSC		
H	—	—	14.35
H2	—	—	1.27
L	—	1.98	—
L4	—	0.76	—

Fig.27 TO263-5 Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.5	1.65	1.80
A1	0.03	0.06	0.09
A2	1.50	1.60	1.70
A3	0.85	0.90	0.95
b	0.69	—	0.77
c	0.33	—	0.76
D	6.40	6.50	6.60
D1	2.90	3.00	3.10
E	6.80	7.00	7.20
E1	3.40	3.50	3.60
e	2.30BSC		
L	0.90	—	1.15
L1	1.75REF		
θ	0	—	7°

Fig.28 SOT223-3L Package

ORDERING INFORMATION

Order Part No.	ADJ/FIXED	Package	QTY
AWL5963AAR-ADJ	ADJ	SOP8L，Pb-Free	4000
AWL5963AAR-18	1.8V		
AWL5963AAR-25	2.5V		
AWL5963AAR-33	3.3V		
AWL5963KAR-ADJ	ADJ	TO263-5L，Pb-Free	800
AWL5963KAR-18	1.8V		
AWL5963KAR-25	2.5V		
AWL5963KAR-33	3.3V		
AWL5963SDR-18	1.8V	SOT223-3L，Pb-Free	4000
AWL5963SDR-25	2.5V		
AWL5963SDR-33	3.3V		

REVISION HISTORY

DATE	REVISION	NOTES
Nov., 2023	1.0	Initial release
Dec., 2023	1.1	1. In Page 6, add -1.8V,-2.5V line regulation values in Typ. and Max. 2. In Page 6, change ADJ and -3.3V line regulation from “15” to “35” and from “65” to “85”, respectively.
Jan., 2024	1.2	1. In Page 7, change Input Reverse Leakage Current from “500” to “800”.
March., 2024	1.3	1. In Page 14 & 15&19, Change the Quantity of SOP8L package from “3000” to “4000”. 2. Translate Fig.22 into a clearer source.
June., 2024	1.4	1. Delate the package about DFN. 2. In Page 14 &15 &19, Change the Quantity of SDR package from “2500” to “4000”.
July, 2024	1.5	1. In Page 6, Add 1.8V and 2.5V load regulation values in Typ. and Max. 2. In Page6, Delate ADJ,1.8V,2.5V and 3.3V line regulation Max. values. 3. In Page 6, Add 1.8V and 2.5V fixed output voltage values in Min., Typ. and Max. 4. In Page 7, Add 1.8V and 2.5V reverse output current values in Typ. And Max.
June, 2025	1.6	1. In Page 18, Change the ‘D’ value of SOT223-3L from ”0.6” to “6.6”.
June, 2025	1.7	1. In Page 6, Add TO263-5 ADJ pin voltage values in Min., Typ. and Max.