3A, Wide V_{IN}, Low Noise, Fast Transient Response LDO Regulators

AWL5764

FEATURES

- Wide Input Voltage Range: **2.7V to 20V**
- Maximum Output Current: **3A**
- Low Dropout Voltage: **300mV** at 3A Load
- Low Noise: **15μV_{RMS}** (10Hz to 100kHz)
- Fixed Output Voltages:
  1.8V, 2.5V, 3.3V, 5V
- Adjustable Output from 1.21V to 20V
- Operating Quiescent Current: **2.7mA** (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
- TO263-5 Package

APPLICATIONS

- Industrial and Instrumentation
- Medical and Healthcare
- Post Regulator for Switching Power Supplies
- 3.3V to 2.5V Logic Power Supply
- Post Regulator for Switching Supplies

DESCRIPTION

The AWL5764 is a low-dropout (LDO) regulator optimized for fast transient response. The AWL5764 can regulate the input voltage from 2.7V to 20V to an adjustable output voltage from 1.21V to 20V.

The device can supply 3A of output current with only a very low dropout voltage of 300mV. Operating quiescent current is about 2.7mA and less than 1uA in shutdown mode. In addition to fast transient response, the AWL5764 also has very low output noise which makes them ideal for sensitive RF supply applications.

The AWL5764 regulator is 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 ,3.3V and 5V and as an adjustable device with a 1.21V reference voltage.

The AWL5764 is available in TO263-5 package.

Typical Application

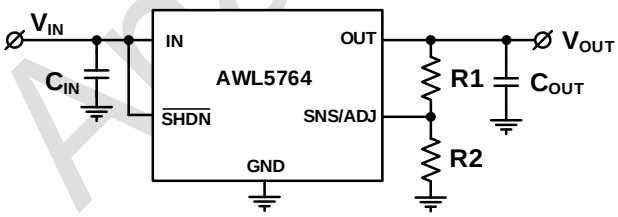


Fig.1 Schematic Diagram

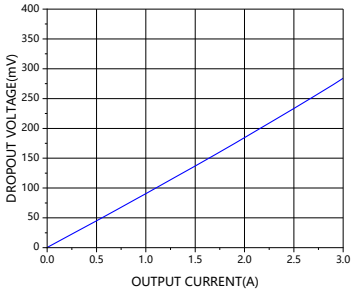
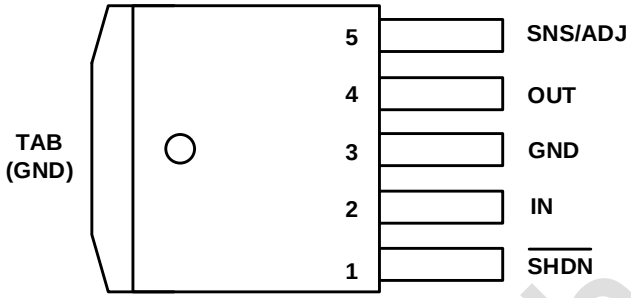


Fig.2 Dropout Voltage vs Output Current

Table of Contents

PIN CONFIGURATION

Package	Pin Configuration (Top View)
TO263-5 (KA)	

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

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	-55	150	°C
T_S	Storage temperature	-55	150	

RECOMMENDED OPERATIONG CONDITIONS

		Min	Max	Units
Input	VIN	$V_{OUT}+V_{DO}$ (1)	20	V
	$\overline{SHDN}$	0	20	
Output	OUT	0	20	
	SNS	0	20	
	ADJ	0	5.5	
T_J	Junction temperature	-40	125	°C

(1) To satisfy requirements for minimum input voltage, the AWL5764-ADJ and AWL5764-18 recommend minimum voltage is 2.7V

ESD RATINGS

Symbol	Definition	Value	Units
V_{ESD}	HBM	±2500	V
	CDM	±2000	

THERMAL INFORMATION

Symbol	Definition	Units	
		KA	
θ_{JA}	Junction to ambient thermal resistance	30	°C/W
θ_{JC}	Junction to case thermal resistance	1.2	

ELECTRICAL CHARACTERISTICS

Limits apply over the recommended operating junction temperature range of –40℃ to +125℃, 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℃, and are provided for reference purposes only. Unless otherwise stated the following conditions apply: V_{IN} = 2.7 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}=1.5A		1.7	2.5	V
		I_{OUT}=3A		1.9	2.6	
V_{ADJ}	ADJ Pin Voltage	2.7V < V_{IN} < 20V, 1mA < I_{OUT} < 3A, AWL5764-ADJ	1.168	1.21	1.246	V
V_O	Fixed Output Voltage	2.8V < V_{IN} < 20V, 1mA < I_{OUT} < 3A, AWL5764-18	1.737	1.8	1.854	V
		3.5V < V_{IN} < 20V, 1mA < I_{OUT} < 3A, AWL5764-25	2.412	2.5	2.575	
		4.3V < V_{IN} < 20V, 1mA < I_{OUT} < 3A, AWL5764-33	3.14	3.3	3.445	
		6V < VIN < 20V, 1mA < I_{OUT} < 3A, AWL5764-50	4.65	5	5.245	
ΔV_{OUT_LOAD}	Load Regulation	V_{IN}=2.7V, ΔI_{OUT}=1mA to 3A, AWL5764-ADJ		2	15	mV
		V_{IN}=2.8V, ΔI_{OUT}=1mA to 3A, AWL5764-18		2	15	
		V_{IN}=3.5V, ΔI_{OUT}=1mA to 3A, AWL5764-25		4	15	
		V_{IN}=4.3V, ΔI_{OUT}=1mA to 3A, AWL5764-33		4	15	
		V_{IN}=6V, ΔI_{OUT}=1mA to 3A, AWL5764-50		4	15	
ΔV_{OUT_LINE}	Line Regulation	ΔV_{IN}=2.21V to 20V, I_{OUT}=1mA, AWL5764-ADJ		6	22	mV
		ΔV_{IN}=2.3V to 20V, I_{OUT}=1mA, AWL5764-18		8	25	

		ΔV_{IN}=3V to 20V, I_{OUT}=1mA, AWL5764-25		8	30	
		ΔV_{IN}=3.8V to 20V, I_{OUT}=1mA, AWL5764-33		10	35	
		ΔV_{IN}=5.5V to 20V, I_{OUT}=1mA, AWL5764-50		15	60	
I_{SHDN}	Shutdown Supply Current	V_{SHDN}=0V V_{IN}=6V, T_J=25°C		0.2	1	μA
I_{GND}	Ground Current (V_{IN} = V_{OUT}+1V)	I_{OUT}=0mA		2.7	5	mA
		I_{OUT}=1mA		2.7	5	
		I_{OUT}=100mA		2.9	5	
		I_{OUT}=500mA		3.5	6	
		I_{OUT}=1500mA		4.3	7	
		I_{OUT}=3000mA		6.1	10	
V_{DO}	Dropout Voltage[2][3] (V_{IN} = V_{OUT})	I_{OUT}=1mA, AWL5764-ADJ, AWL5764-25, AWL5764-33, AWL5764-50		0.5 75 80 85	8 110 120 125	mV
		I_{OUT}=100mA, AWL5764-ADJ AWL5764-25, AWL5764-33, AWL5764-50		10 75 80 85	40 110 125 130	
		I_{OUT}=500mA, AWL5764-ADJ AWL5764-25, AWL5764-33, AWL5764-50		50 80 85 90	120 125 135 135	
		I_{OUT}=1500mA, AWL5764-ADJ AWL5764-25, AWL5764-33, AWL5764-50		150 140 125 110	300 300 250 200	
		I_{OUT}=3000mA, AWL5764-ADJ AWL5764-25, AWL5764-33, AWL5764-50		300 300 250 220	600 600 500 450	

V_{SHDN_ON}	V_{OUT} = OFF to ON	I_{OUT} =1mA		0.9	1.6	V
V_{SHDN_OFF}	V_{OUT} = ON to OFF	I_{OUT} =1mA	0.35	0.75		V
I_{SHDN_PIN}	Shutdown Pin Current	V_{SHDN} =0V, T_J=25°C		0.001	0.5	µA
		V_{SHDN} =20V, T_J=25°C		1.1	6	
I_{LIMIT}	Current Limit	V_{IN}=7V, V_{OUT}=0V	3.3	4		A
I_{ADJ}	ADJ Pin Bias Current	V_{IN}=2.21V, I_{OUT}=1mA, T_J=25°C		0.001	0.5	uA
I_{IL}	Input Reverse Leakage Current	V_{IN}=-20V, V_{OUT}=0V		100	700	µA
I_{RO}	Reverse Output Current	V_{IN}=0V, V_{OUT}=1.21V, T_J=25°C, AWL5764-ADJ		32	100	µA
		V_{IN}=0V, V_{OUT}=1.8V, T_J=25°C, AWL5764-18		150	250	
		V_{IN}=0V, V_{OUT}=2.5V, T_J=25°C, AWL5764-25		250	400	
		V_{IN}=0V, V_{OUT}=3.3V, T_J=25°C, AWL5764-33		360	500	
		V_{IN}=0V, V_{OUT}=5V, T_J=25°C, AWL5764-50		500	700	
PSRR	Power Supply Ripple Rejection	V_{IN}-V_{OUT}=1.5V I_{OUT}=1.5A @120Hz, T_J=25℃	53	63		dB
e_N	Output Voltage Noise (10Hz to 100kHz)	V_{OUT}=1.21V, I_{OUT} = 3A, T_J=25℃		7.5		μV_{RMS}
		V_{OUT}=3.3V, I_{OUT} = 3A, T_J=25℃		7.83		
Thermal						
T_{SD}	Thermal Shutdown			150		°C
T_{SD_HYS}	Thermal Shutdown Hysteresis			5		°C

(2) For AWL5764-18 dropout voltage will be limited by the minimum input voltage specification under some output voltage/load conditions.

(3) To satisfy requirements for minimum input voltage, the AWL5764 (adjustable version) is tested and specified for these conditions with an external resistor divider (two 4.12k resistors) for an output voltage of 2.42V.

TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN}=2.7V to 20V, C_{OUT}=10μF, T_J =25℃ unless otherwise specified. All min and max specifications are at T_J = -40℃ to 125℃

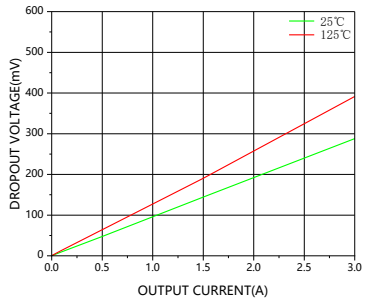


Fig.3 Typical Dropout Voltage

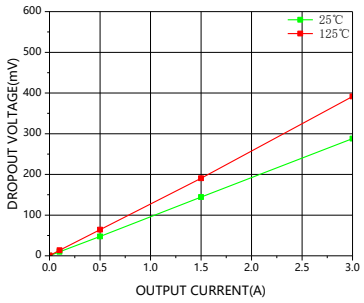


Fig.4 Guaranteed Dropout Voltage

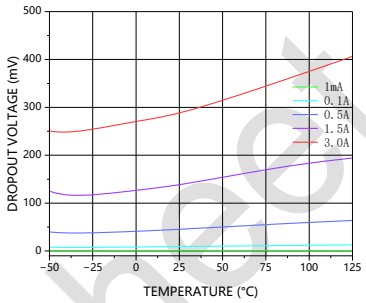


Fig.5 Dropout Voltage

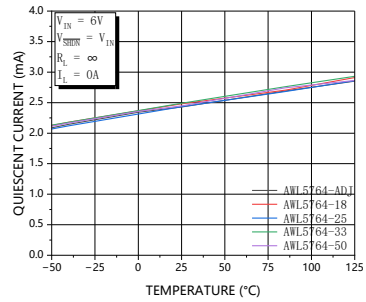


Fig.6 Quiescent Current

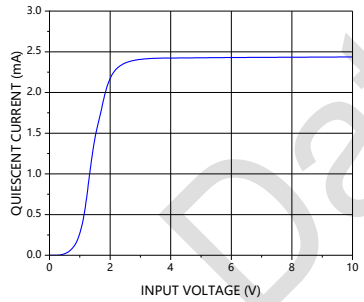


Fig.7 AWL5764-ADJ Quiescent Current

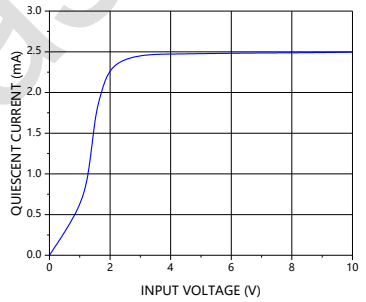


Fig.8 AWL5764-18 Quiescent Current

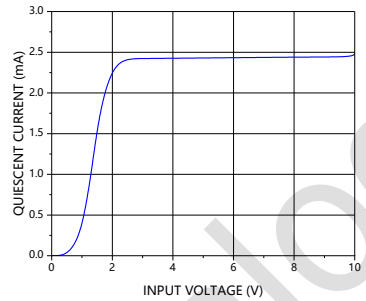


Fig.9 AWL5764-25 Quiescent Current

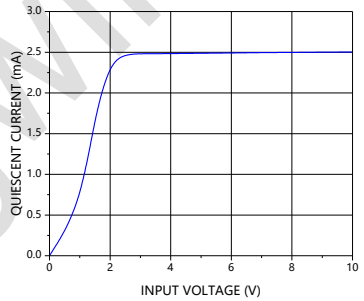


Fig.10 AWL5764-33 Quiescent Current

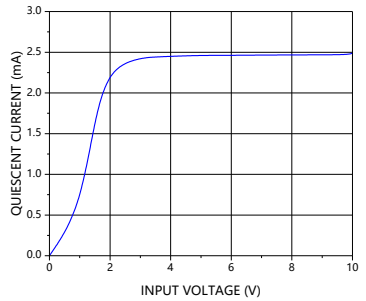


Fig.11 AWL5764-50 Quiescent Current

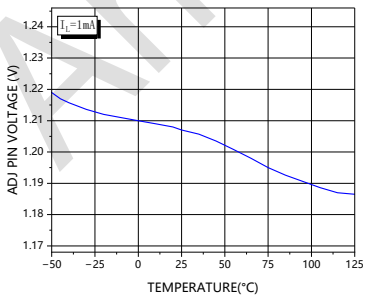


Fig.12 AWL5764-ADJ Output Voltage

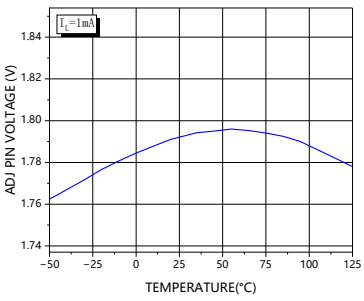


Fig.13 AWL5764-18 Output Voltage

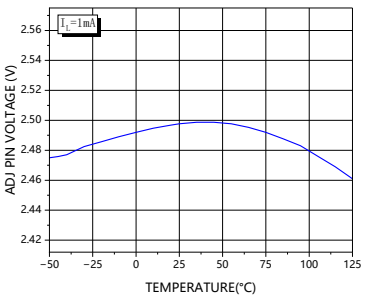


Fig.14 AWL5764-25 Output Voltage

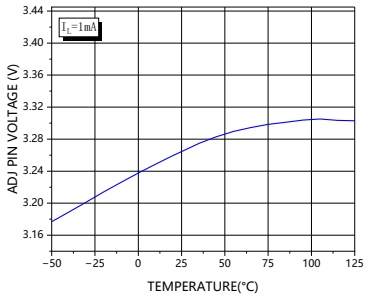


Fig.15 AWL5764-33 Output Voltage

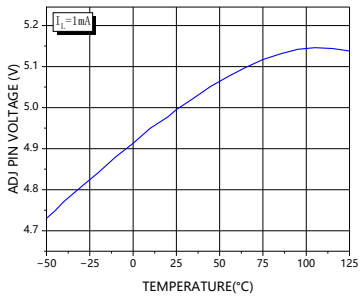


Fig.16 AWL5764-50 Output Voltage

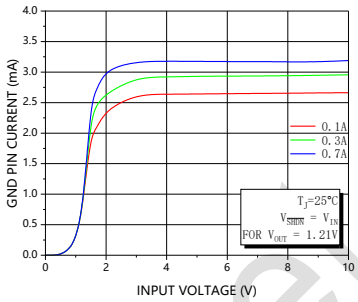


Fig.17 AWL5764-ADJ GND Pin Current

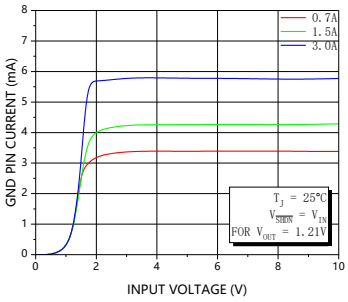


Fig.18 AWL5764-ADJ GND Pin Current

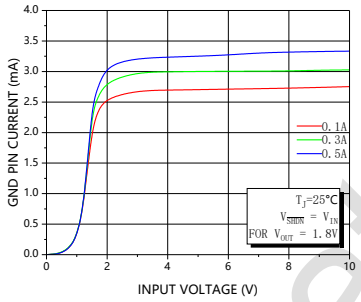


Fig.19 AWL5764-18 GND Pin Current

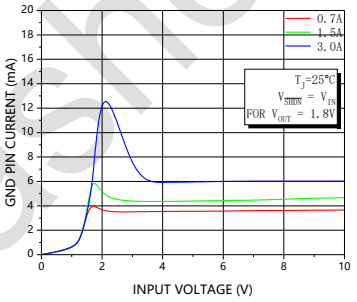


Fig.20 AWL5764-18 GND Pin Current

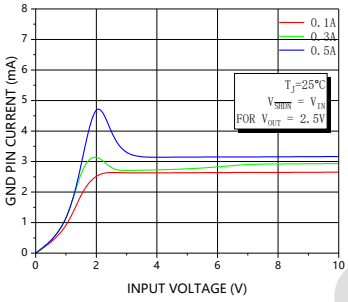


Fig.21 AWL5764-25 GND Pin Current

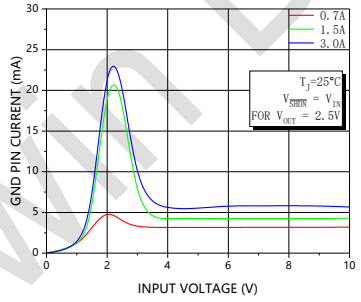


Fig.22 AWL5764-25 GND Pin Current

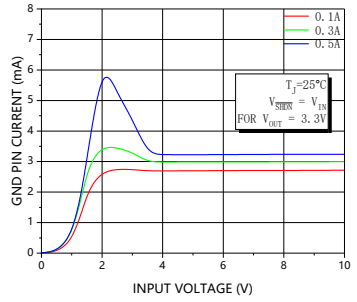


Fig.23 AWL5764-33 GND Pin Current

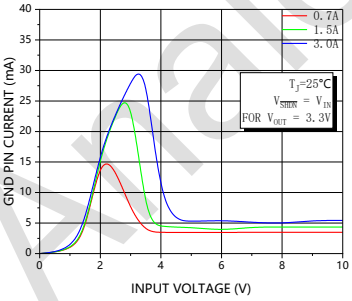


Fig.24 AWL5764-33 GND Pin Current

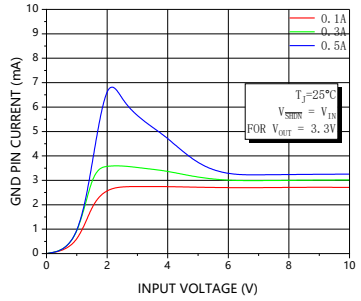


Fig.25 AWL5764-50 GND Pin Current

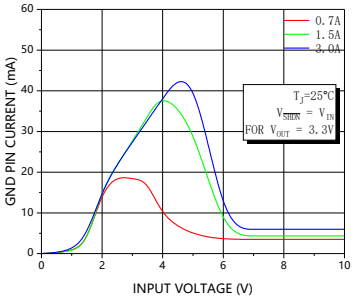


Fig.26 AWL5764-50 GND Pin Current

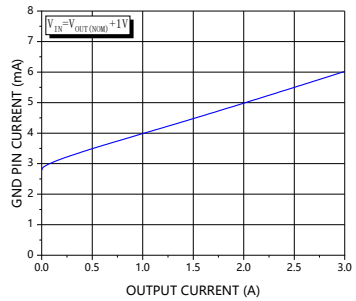


Fig.27 GND Pin Current vs I_{LOAD}

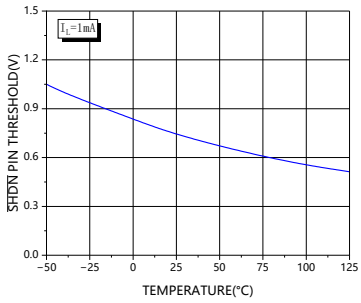


Fig.28 $\overline{SHDN}$ Pin Threshold (On-to-Off)

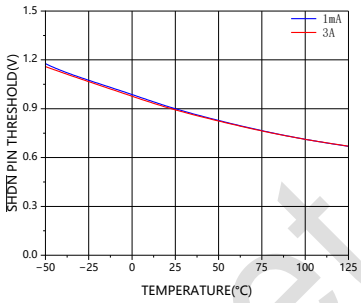


Fig.29 $\overline{SHDN}$ Pin Threshold (Off-to-On)

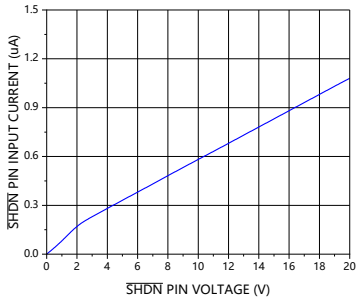


Fig.30 $\overline{SHDN}$ Pin Input Current

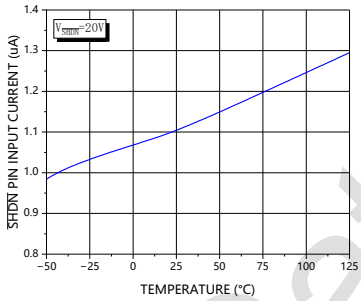


Fig.31 $\overline{SHDN}$ Pin Input Current

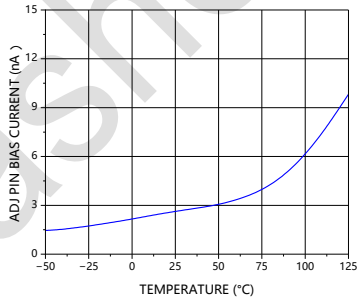


Fig.32 ADJ Pin Bias Current

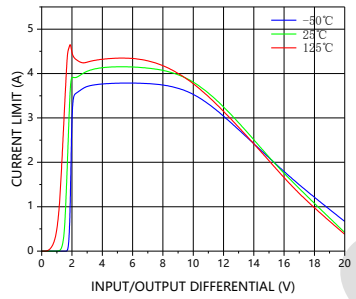


Fig.33 Current Limit

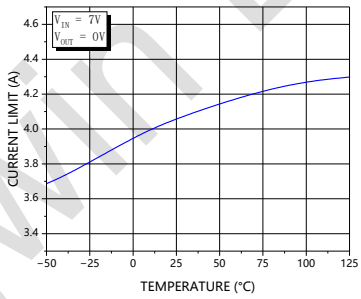


Fig.34 Current Limit

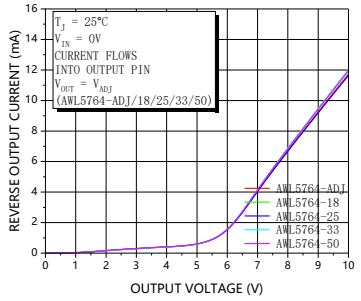


Fig.35 Reverse Output Current

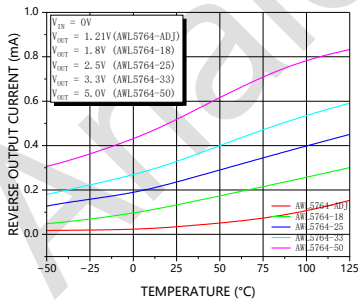


Fig.36 Reverse Output Current

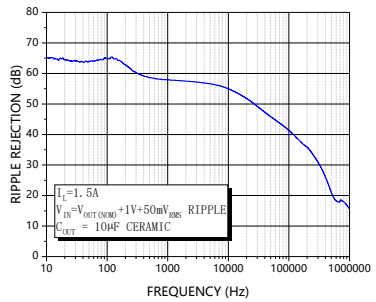


Fig.37 Ripple Rejection

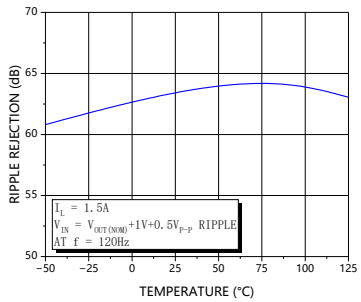


Fig.38 Ripple Rejection

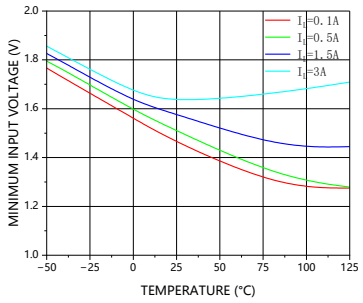


Fig.39 AWL5764-ADJ Minimum Input Voltage

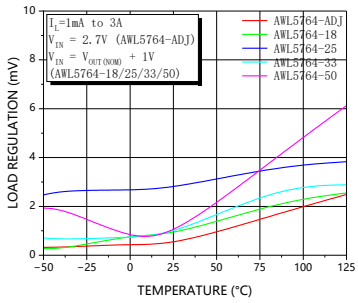


Fig.40 Load Regulation

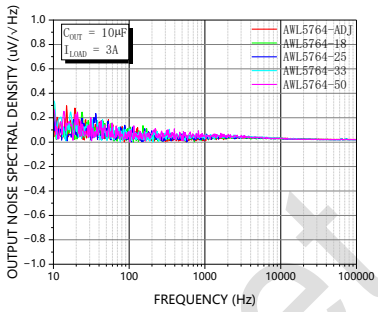


Fig.41 Output Noise Spectral Density

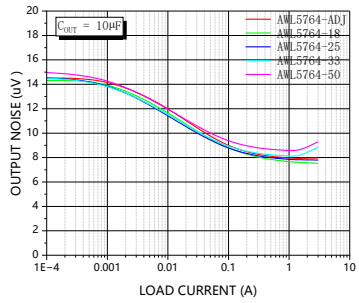


Fig.42 RMS Output Noise vs I_{Load} Current (10Hz to 100kHz)

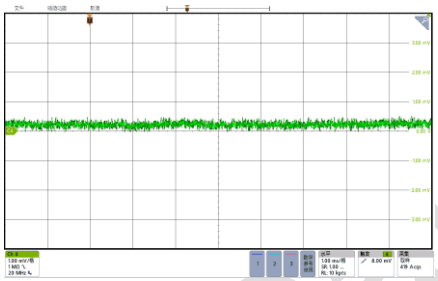


Fig.43 AWL5764-33 10Hz to 100kHz Output Noise

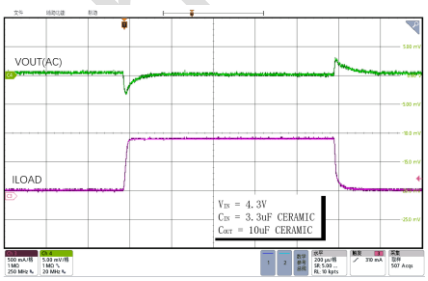


Fig.44 AWL5764-33 Transient Response

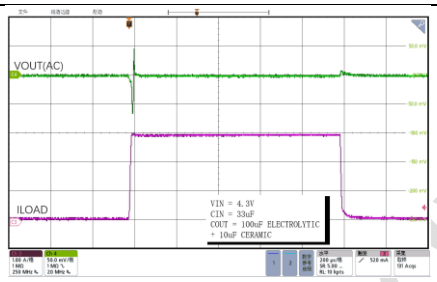


Fig.45 AWL5764-33 Transient Response

BLOCK DIAGRAM

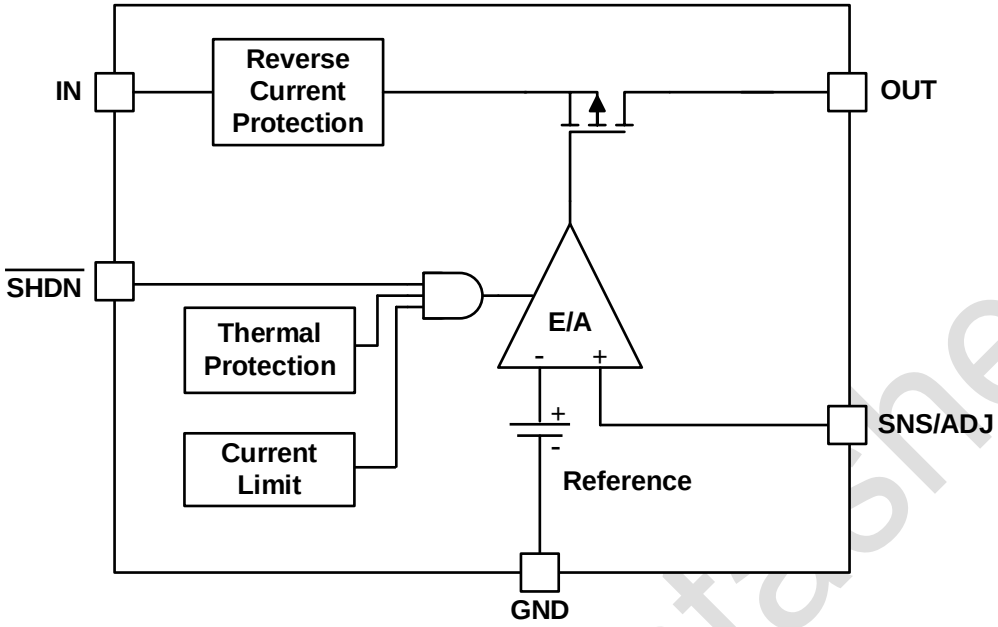


Fig.46 AWL5764 Block Diagram

PRODUCT OVERVIEW

The AWL5764 is an adjustable or fixed, low noise, low dropout linear regulator optimized for fast transient response. The input voltage range is 2.7V to 20V and it can deliver up to 3A of output current with a dropout voltage of 300 mV. Typical shutdown current consumption is less than 1μA. In addition to the low quiescent current, the AWL5764 incorporates several protections 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 AWL5764 can act as if it has a diode in series with its output and prevents reverse-current flow.

Current Limit and Thermal Overload Protection

The AWL5764 is protected against damage due to excessive power dissipation by current and thermal overload protection circuits. When the output load exceeds 4 A (typical), the output voltage is reduced to maintain a constant current limit.

When the junction temperature starts to rise above 150℃ (typical), the output is turned off, reducing the output current to zero. When the junction temperature drops below 145℃, the output is turned on again, and output current is restored to its operating value.

Reverse Voltage Protection

The input of the device will withstand reverse voltages of 20V and the output can be pulled below ground by 20V. The ADJ pin of the adjustable device can be pulled above or below ground by as much as 5.5V without damaging the device.

APPLICATION

Fig.47 shows an adjustable output voltage AWL5764 application circuit.

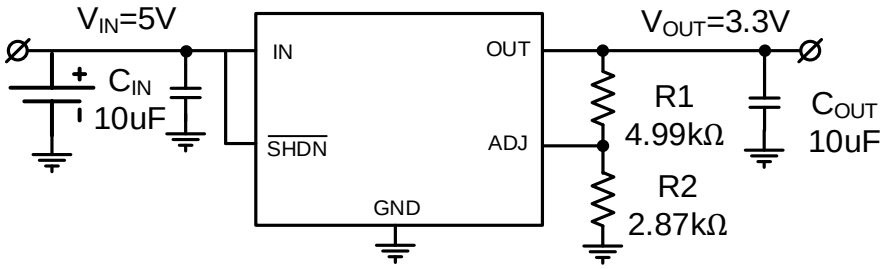


Fig.47 Adjustable Output Voltage Application Circuit

Fig.48 shows a fixed output voltage AWL5764 application circuit.

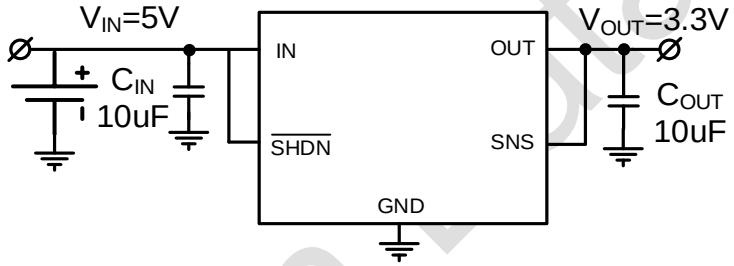


Fig.48 Fixed Output Voltage Application Circuit

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 AWL5764 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 AWL5764. The most common dielectrics used are Z5U, Y5V, X5R and X7R.

Application Waveforms

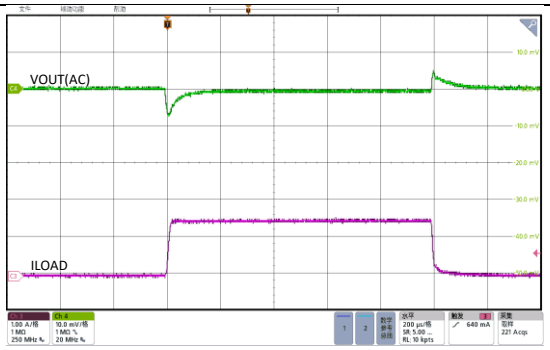


Fig.49 Load Transient @ I_{OUT}=10mA<->1.5A (0.3A/us)

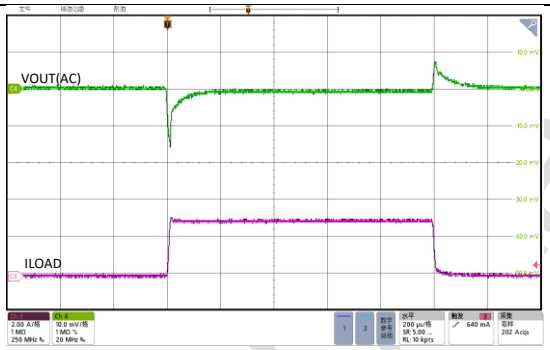


Fig.50 Load Transient @ I_{OUT}=10mA<->3A (0.3A/us)

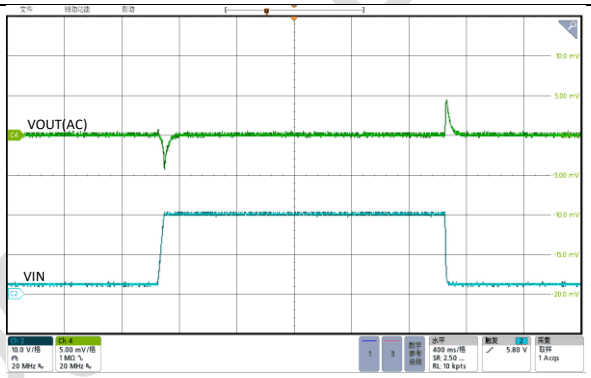


Fig.51 Line Transient @ V_{OUT}=2.21V<->20V

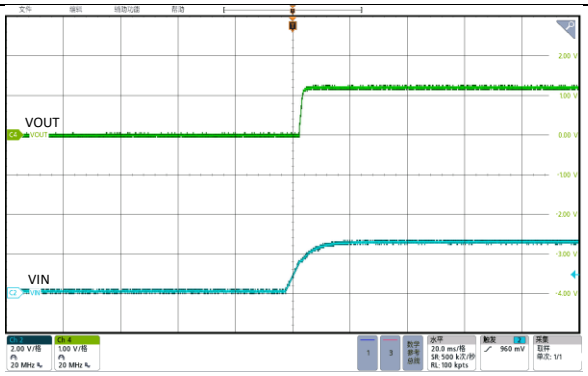


Fig.52 Start With Load(3A) @ V_{IN}=0V<->2.7V

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.

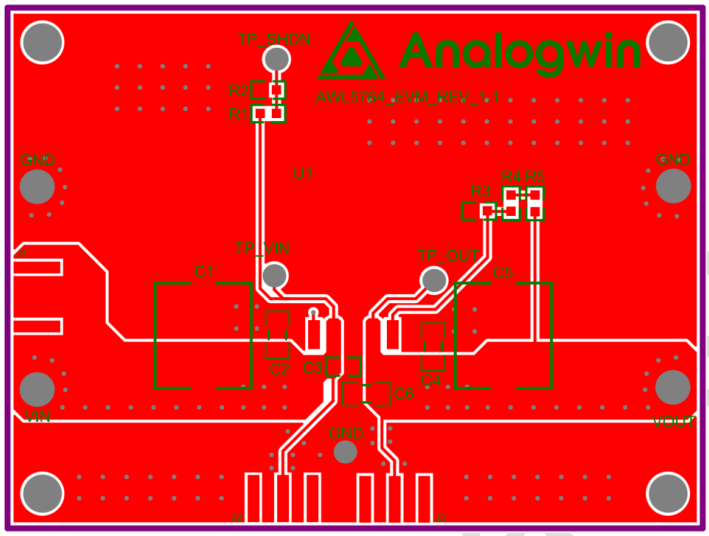


Fig.53 AWL5764 EVM Board Top Layer

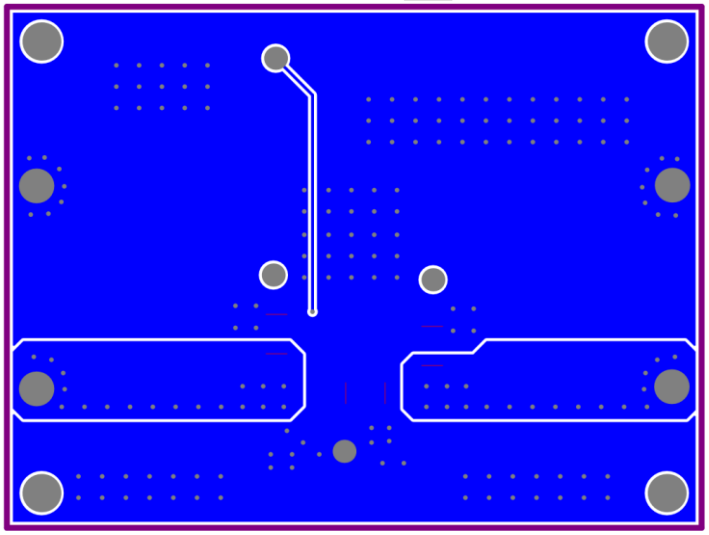


Fig.54 AWL5764 EVM Board Bottom Layer

PACKAGE INFORMAGION

Package Top marking

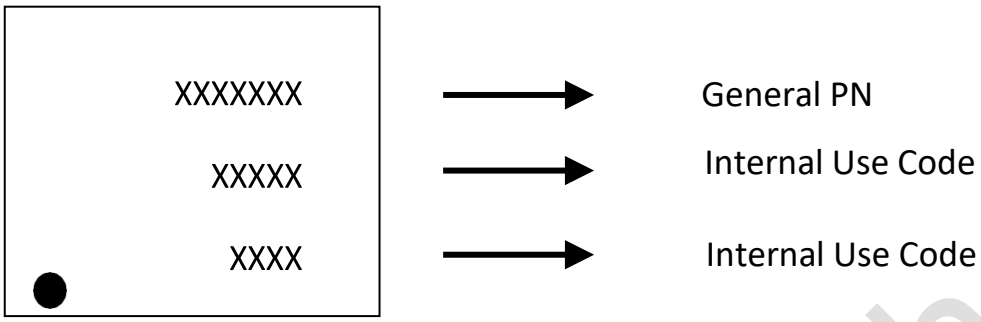


Fig.55 Package Top Marking

Tape and Reel Box Information

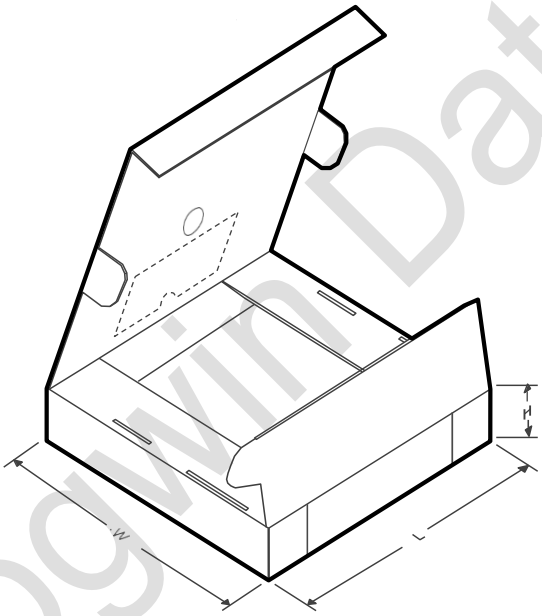


Fig.56 Tape and Reel Box Information

Device（mm）	PACKAGE TYPE	PACKAGE DRAWING	PINS	SPQ	LENG (mm)	WIDTH (mm)	HEIGHT (mm)
AWL5764KAR	TO263-5	KA	5	800	370.0	340.0	65.0

Tape and Reel Information

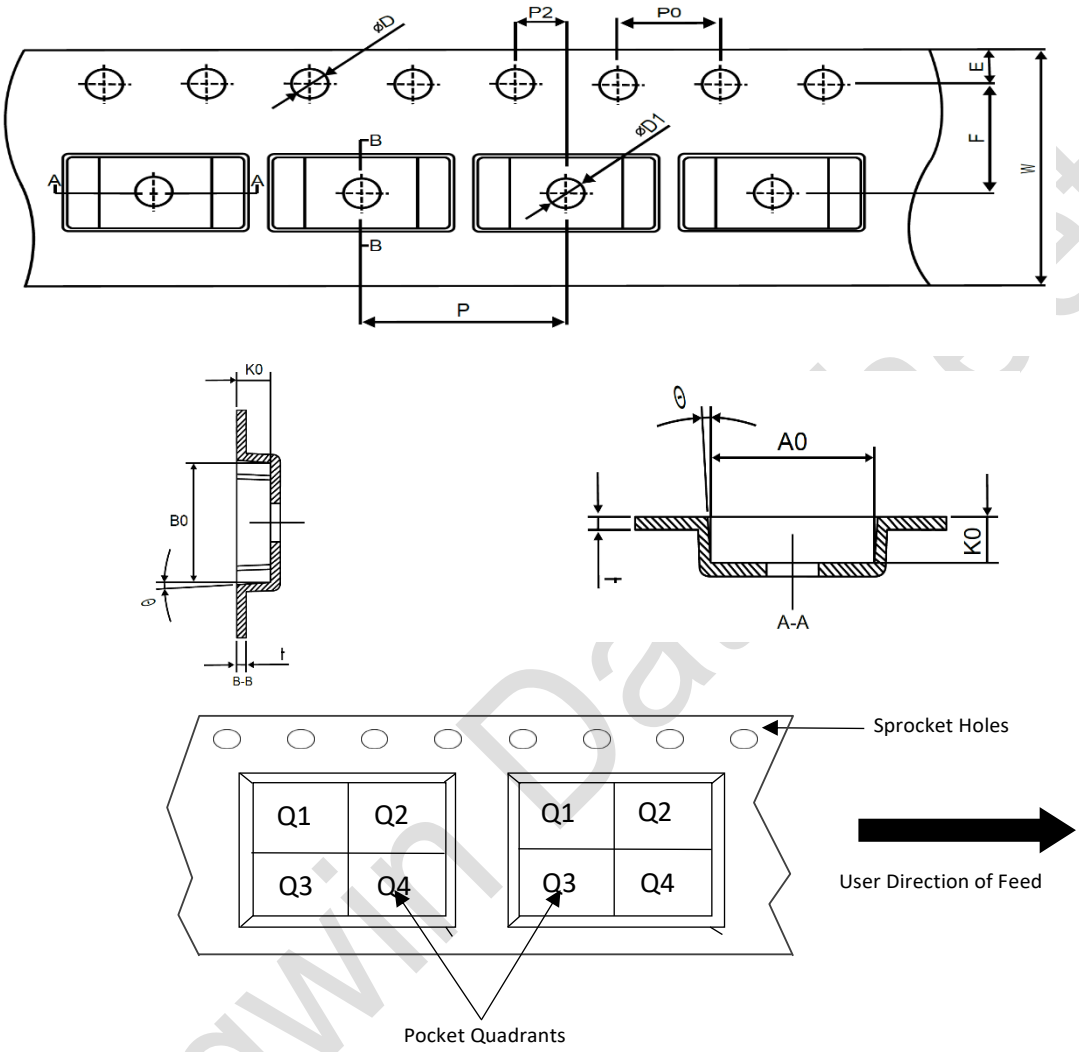


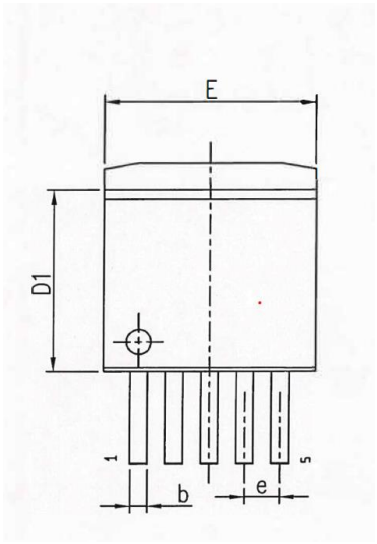
Fig.57 Tape and Reel Information

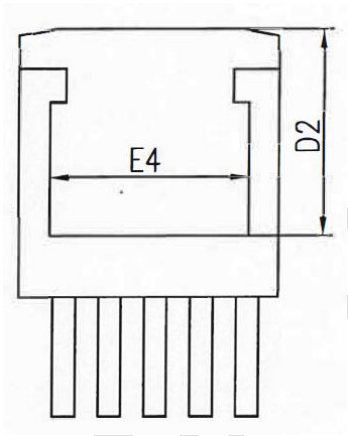
DIMENSIONS AND PIN1 ORIENTATION

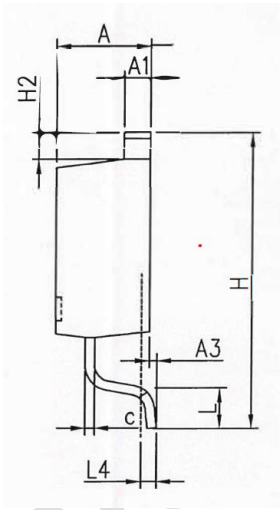
Device	Package Type	W (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P (mm)	P0 (mm)	Pin1 Quadrant	Quantity
AWL5764KAR	TO263-5L	24.00	10.80	16.30	4.85	16.0	4.00	Q1	800

All dimensions are nominal

Package Outlines







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.58 TO263-5 Package

ORDERING INFORMATION

Order Part No.	ADJ/FIXED	Package	QTY
AWL5764KAR-ADJ	ADJ	TO263-5L, Pb-Free	800
AWL5764KAR-18	1.8V		
AWL5764KAR-25	2.5V		
AWL5764KAR-33	3.3V		
AWL5764KAR-50	5V		

REVISION HISTORY

DATE	REVISION	NOTES
Feb., 2025	1.0	Initial release