



#### FEATURES

- Wide Input Voltage Range: **2.3V to 20V**
- Maximum Output Current: **1.5A**
- Low Dropout Voltage: **320mV** at 1.5A Load
- Low Noise: **15 $\mu$ V<sub>RMS</sub>** (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: **<1 $\mu$ A**
- Excellent Load/Line Transient Response
- Stable with 10 $\mu$ F 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 regulate 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 1 $\mu$ A 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 10 $\mu$ F. 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

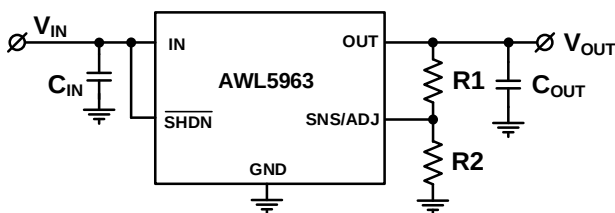


Fig.1 Schematic Diagram

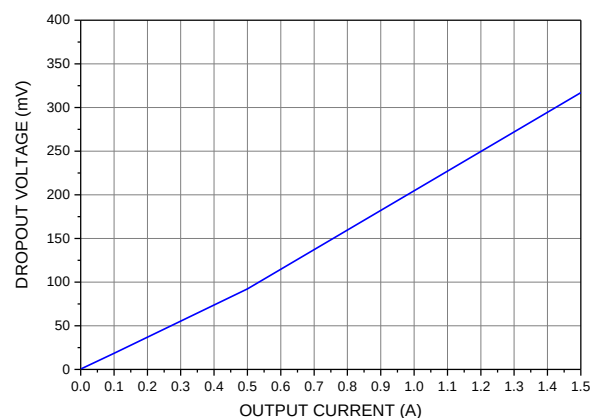


Fig.2 Dropout Voltage vs. Output Current

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# PIN CONFIGURATION

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

**PIN DESCRIPTION**

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

Table 1. AWL5963 SOP8L Pin Description

| No. | Pin                      | Description                                                                                               |
|-----|--------------------------|-----------------------------------------------------------------------------------------------------------|
| 1   | $\overline{\text{SHDN}}$ | Shutdown                                                                                                  |
| 2   | IN                       | Input Voltage                                                                                             |
| 3   | GND                      | Ground                                                                                                    |
| 4   | OUT                      | Output Voltage                                                                                            |
| 5   | SNS/ADJ                  | SNS: Sense Pin for Fixed Output Voltage Version;<br>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     |
|                | $\overline{\text{SHDN}}$ to GND | -20  | 20  |       |
| Output         | OUT to GND                      | -20  | 20  | V     |
|                | SNS to GND                      | -20  | 20  |       |
|                | ADJ to GND                      | -5.5 | 5.5 |       |
| T <sub>J</sub> | Junction temperature            | -40  | 150 | °C    |
| T <sub>S</sub> | Storage temperature             | -55  | 150 |       |

## RECOMMENDED OPERATING CONDITIONS

|                |                          | Min                               | Max | Units |
|----------------|--------------------------|-----------------------------------|-----|-------|
| Input          | VIN                      | V <sub>OUT</sub> +V <sub>DO</sub> | 20  | V     |
|                | $\overline{\text{SHDN}}$ | 0                                 | 20  |       |
| Output         | OUT                      | 0                                 | 20  |       |
|                | SNS                      | 0                                 | 20  |       |
|                | ADJ                      | 0                                 | 5.5 |       |
| T <sub>J</sub> | Junction temperature     | -40                               | 125 | °C    |

## ESD RATINGS

| Symbol           | Definition | Value | Units |
|------------------|------------|-------|-------|
| V <sub>ESD</sub> | HBM        | ±4000 | V     |
|                  | CDM        | ±2000 |       |

## THERMAL INFORMATION

| Symbol          | Definition                             | Value |     |    |    | Units |
|-----------------|----------------------------------------|-------|-----|----|----|-------|
|                 |                                        | AA    | KA  | SD | DF |       |
| θ <sub>JA</sub> | Junction to ambient thermal resistance | 70    | 30  | 50 | 65 | °C/W  |
| θ <sub>JC</sub> | Junction to case thermal resistance    | 16    | 1.2 | 3  | 3  |       |

## ELECTRICAL CHARACTERISTICS

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

| Symbol                 | Parameter             | Condition                                                                               | Min  | Typ  | Max   | Unit |
|------------------------|-----------------------|-----------------------------------------------------------------------------------------|------|------|-------|------|
| $V_{IN}$               | Minimum Input Voltage | $I_{OUT}=0.5\text{A}$                                                                   |      | 1.7  |       | V    |
|                        |                       | $I_{OUT}=1.5\text{A}$                                                                   |      | 2.0  | 2.3   |      |
| $V_{ADJ}$              | ADJ Pin Voltage       | $V_{IN}=2.3\text{V}$ , $I_{OUT}=1\text{mA}$                                             | 1.18 | 1.21 | 1.246 | V    |
| $V_O$                  | Fixed Output Voltage  | $V_{IN}=2.8\text{V}$ , $I_{OUT}=1\text{mA}$ ,<br>AWL5963-18                             | 1.74 | 1.8  | 1.86  | V    |
|                        |                       | $V_{IN}=3.5\text{V}$ , $I_{OUT}=1\text{mA}$ ,<br>AWL5963-25                             | 2.42 | 2.5  | 2.58  |      |
|                        |                       | $V_{IN}=4.3\text{V}$ , $I_{OUT}=1\text{mA}$ ,<br>AWL5963-33                             | 3.20 | 3.30 | 3.40  |      |
| $\Delta V_{OUT\_LOAD}$ | Load Regulation       | $V_{IN}=2.3\text{V}$ ,<br>$\Delta I_{OUT}=1\text{mA}$ to $1.5\text{A}$ ,<br>AWL5963-ADJ |      | 3    | 15    | mV   |
|                        |                       | $V_{IN}=2.8\text{V}$ ,<br>$\Delta I_{OUT}=1\text{mA}$ to $1.5\text{A}$ ,<br>AWL5963-18  |      | 4    | 18    |      |
|                        |                       | $V_{IN}=3.5\text{V}$ ,<br>$\Delta I_{OUT}=1\text{mA}$ to $1.5\text{A}$ ,<br>AWL5963-25  |      | 5    | 21    |      |
|                        |                       | $V_{IN}=4.3\text{V}$ ,<br>$\Delta I_{OUT}=1\text{mA}$ to $1.5\text{A}$ ,<br>AWL5963-33  |      | 7    | 25    |      |
| $\Delta V_{OUT\_LINE}$ | Line Regulation       | $\Delta V_{IN}=2.3\text{V}$ to $20\text{V}$ ,<br>$I_{OUT}=1\text{mA}$ , AWL5963-ADJ     |      | 3    |       | mV   |
|                        |                       | $\Delta V_{IN}=2.8\text{V}$ to $20\text{V}$ ,<br>$I_{OUT}=1\text{mA}$ , AWL5963-18      |      | 4    |       |      |
|                        |                       | $\Delta V_{IN}=3.5\text{V}$ to $20\text{V}$ ,<br>$I_{OUT}=1\text{mA}$ , AWL5963-25      |      | 5    |       |      |
|                        |                       | $\Delta V_{IN}=4.3\text{V}$ to $20\text{V}$ ,<br>$I_{OUT}=1\text{mA}$ , AWL5963-33      |      | 7    |       |      |

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

TYPICAL CHARACTERISTICS

$V_{IN}$ =2.3V to 20V,  $C_{OUT}$ =10 $\mu$ F,  $T_J$  =25 $^{\circ}$ C unless otherwise specified. All min and max specifications are at  $T_J$  = -40 $^{\circ}$ C to 125 $^{\circ}$ C

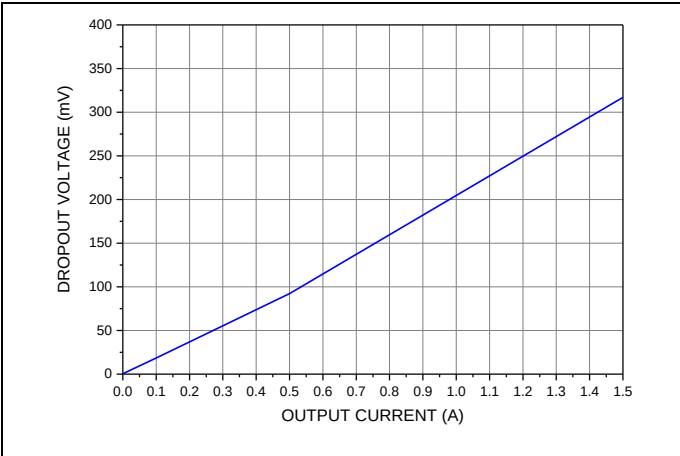


Fig.3 Dropout Voltage VS. Output Current

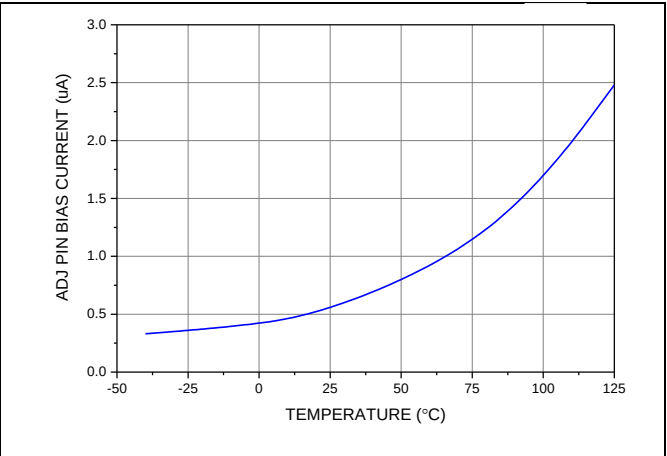


Fig.4 ADJ Pin Bias Current VS. Temperature

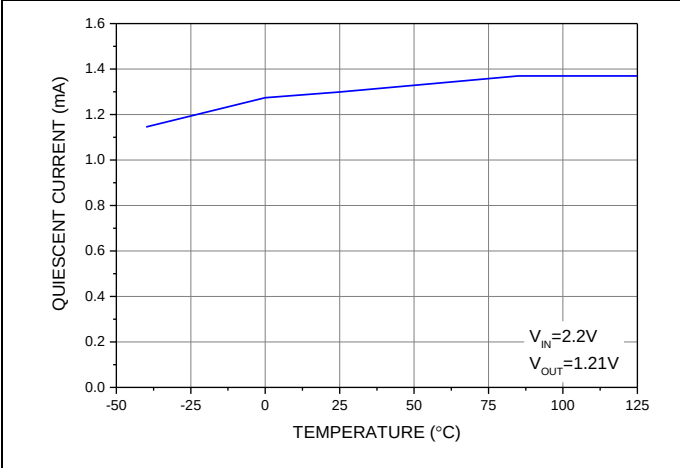


Fig.5 Quiescent Current VS. Temperature

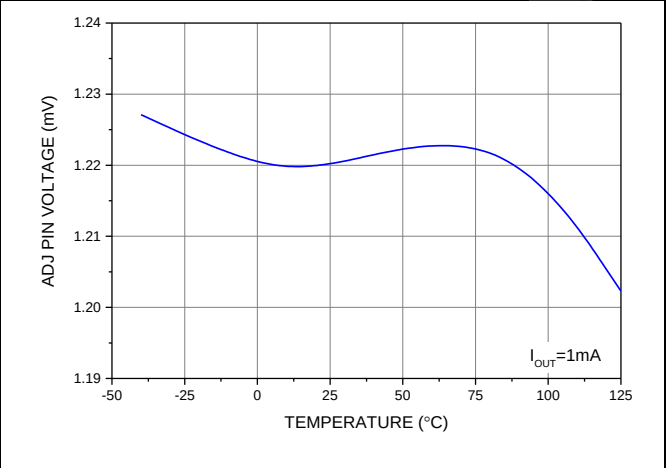


Fig.6 ADJ PIN Voltage VS. Temperature

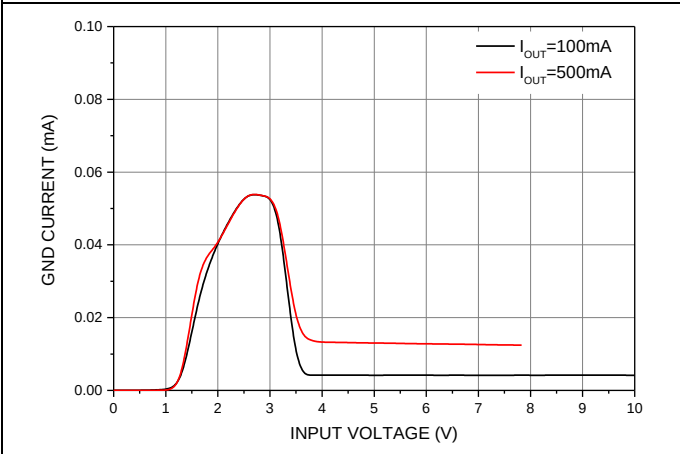


Fig.7 Ground Current VS. Input Voltage

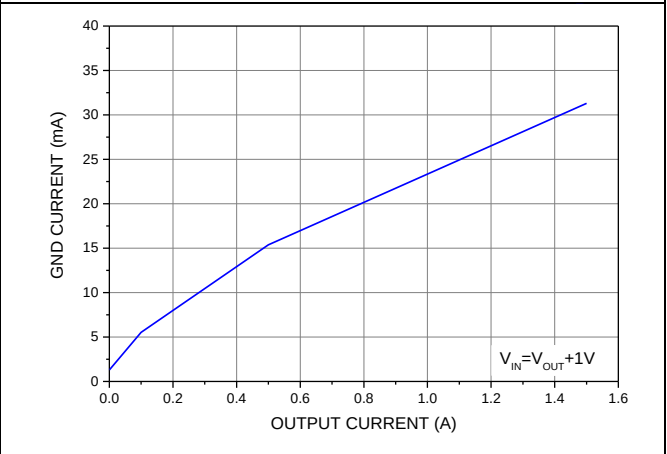


Fig.8 Ground Current VS. Output Current



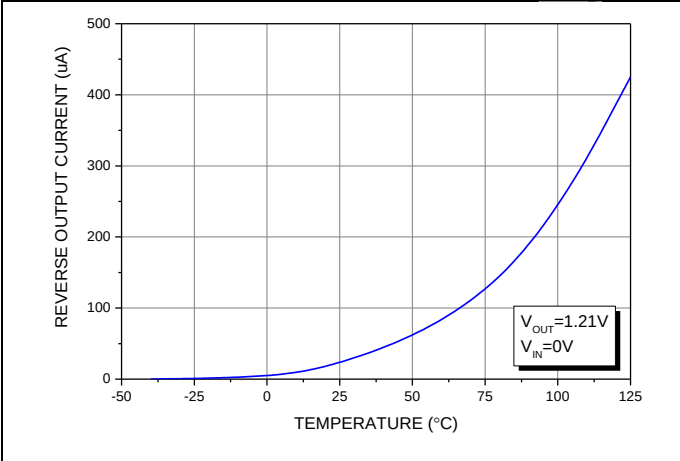


Fig.9 Reverse Output Current VS. Temperature

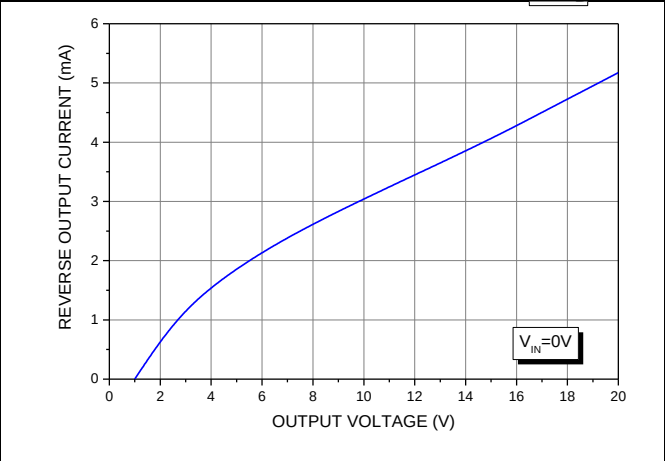


Fig.10 Reverse Output Current VS. Output Voltage

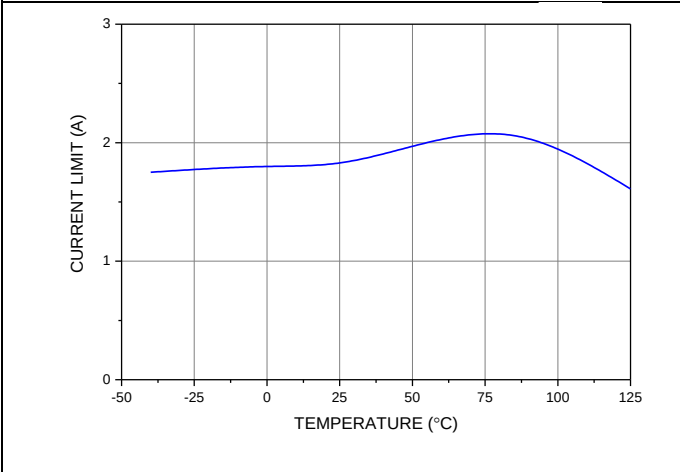


Fig.11 Current Limit VS. Temperature

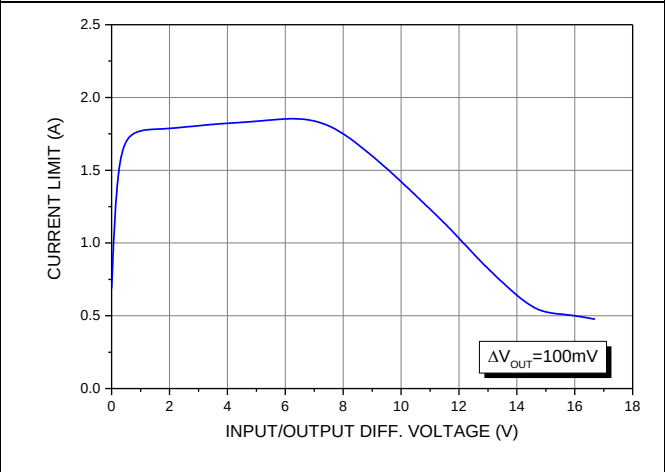


Fig.12 Current Limit VS. Input/Output Differential Voltage

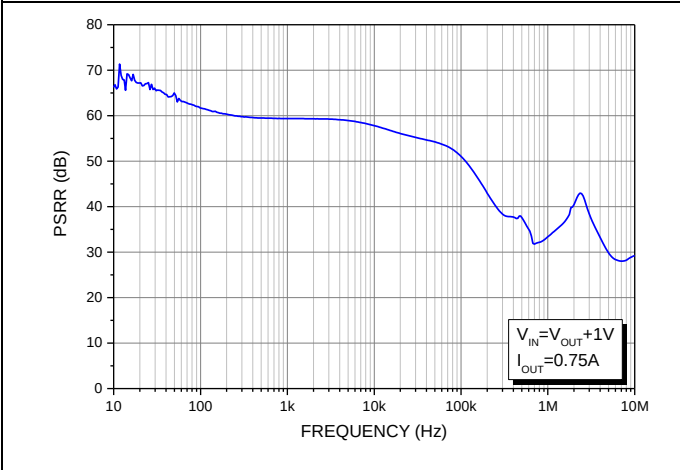


Fig.13 PSRR VS. Frequency

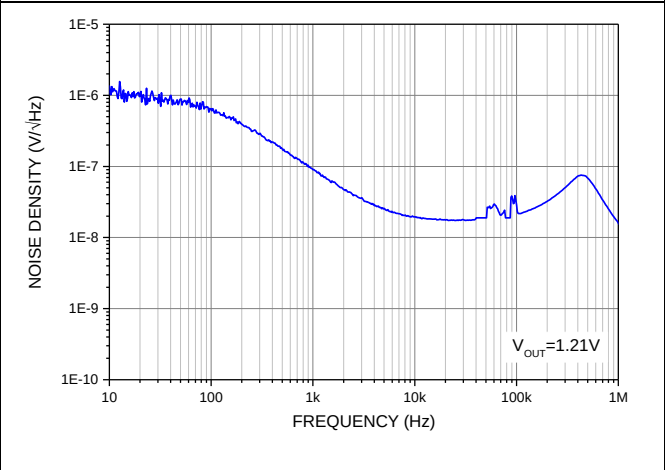


Fig.14 Output Noise VS. Frequency

## BLOCK DIAGRAM

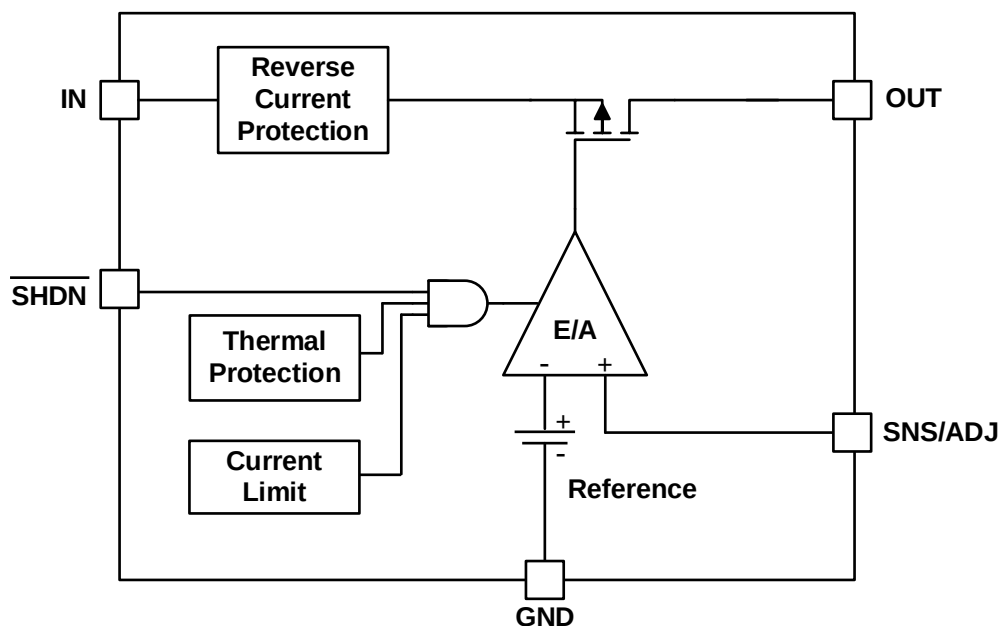


Fig.15 AWL5963 Block Diagram

## 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.

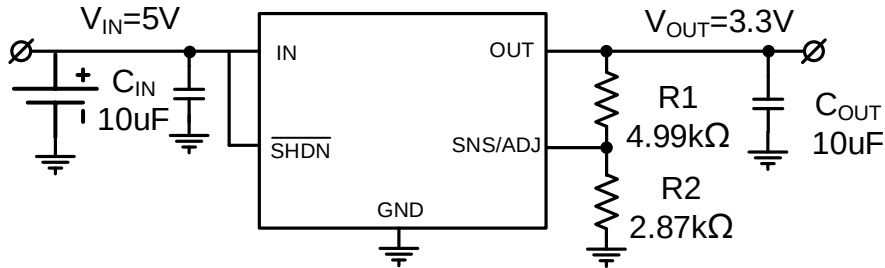


Fig.16 Adjustable Output Voltage Application Circuit

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

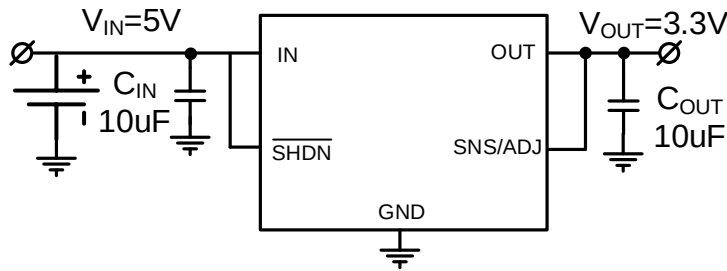


Fig.17 Fixed Output Voltage Application Circuit

### 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.

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

While  $R1=4.99k\Omega$ ,  $V_{REF}=1.21V$ ,  $V_{OUT}=3.3V$

Calculate  $R2=2.87k\Omega$

### Output Capacitor Selection

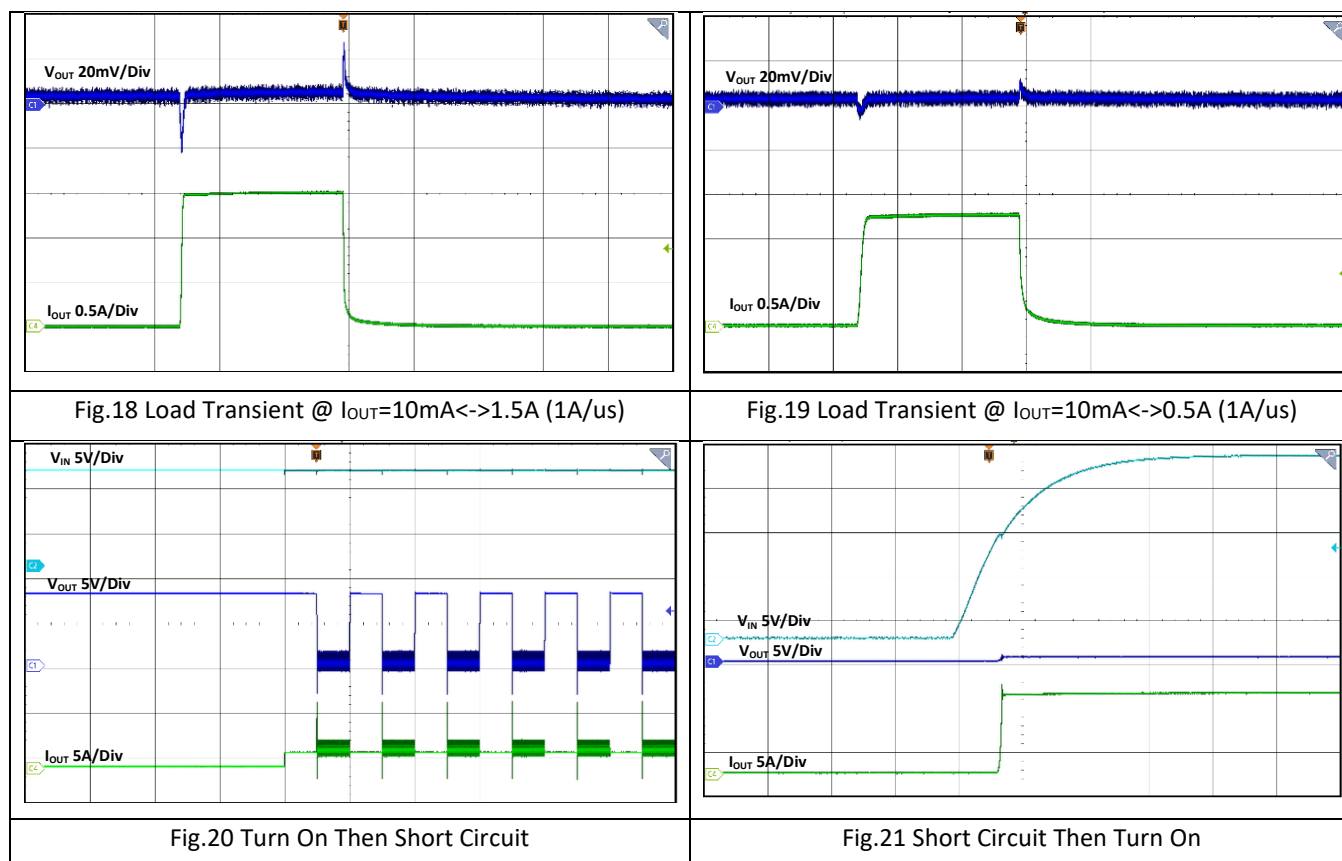
The AWL5963 can operate with most types capacitors as long as care is taken with regard to the effective series resistance (ESR) value. The ESR of the output capacitor affects the stability of the LDO control loop. A minimum of  $10\mu F$  capacitance with an ESR of  $0.2\Omega$  or less is recommended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



## PCB LAYOUT GUIDELINES

For best results, please follow the guidelines below.

1. Use wide traces for IN, OUT and GND.
2. Place a minimum 10 $\mu$ F 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.

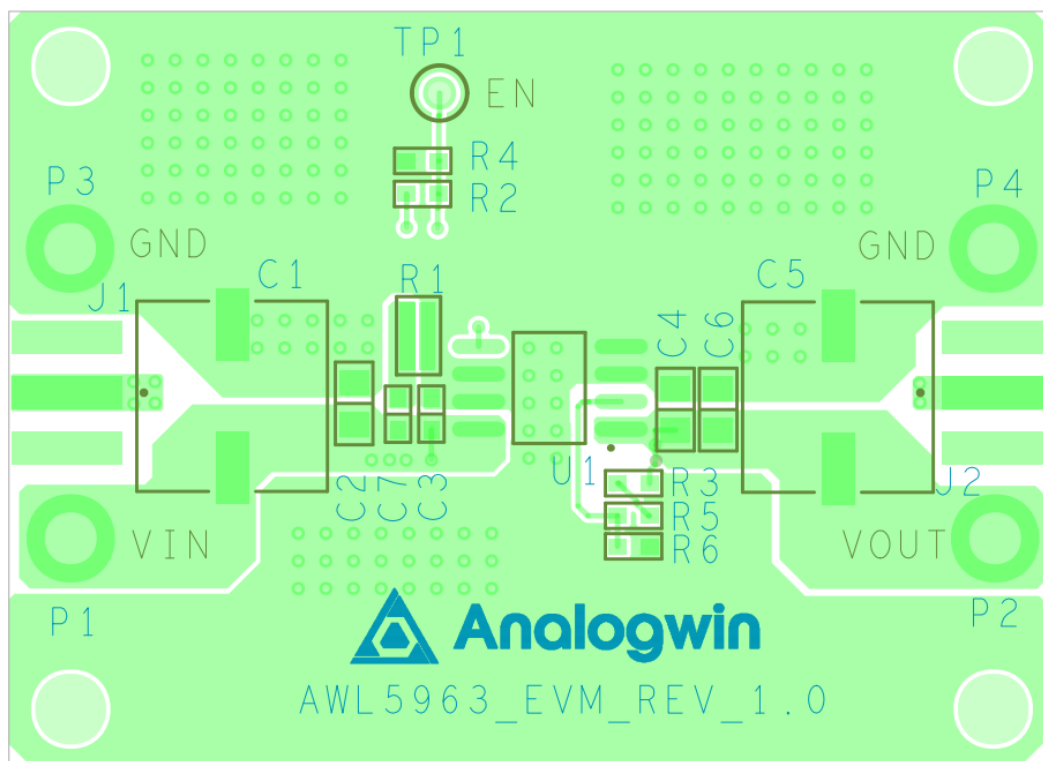


Fig.22 SOP8L Package Layout Example

## PACKAGE INFORMATION

### Package Top marking

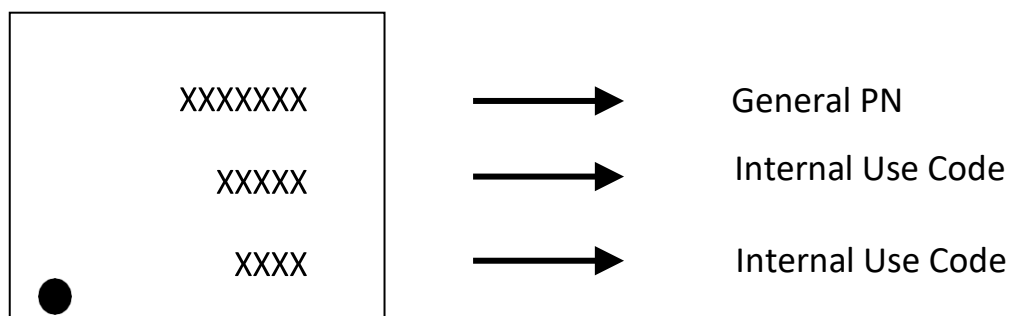


Fig.23 Package Top Marking

### Tape and Reel Box Information

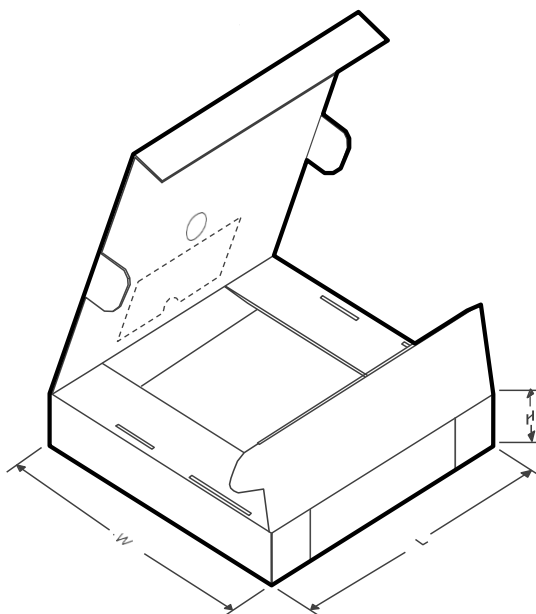


Fig.24 Tape and Reel Box Information

| Device<br>(mm) | PACKAGE TYPE | PACKAGE<br>DRAWING | PINS | SPQ  | LENG<br>(mm) | WIDTH<br>(mm) | HEIGHT<br>(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

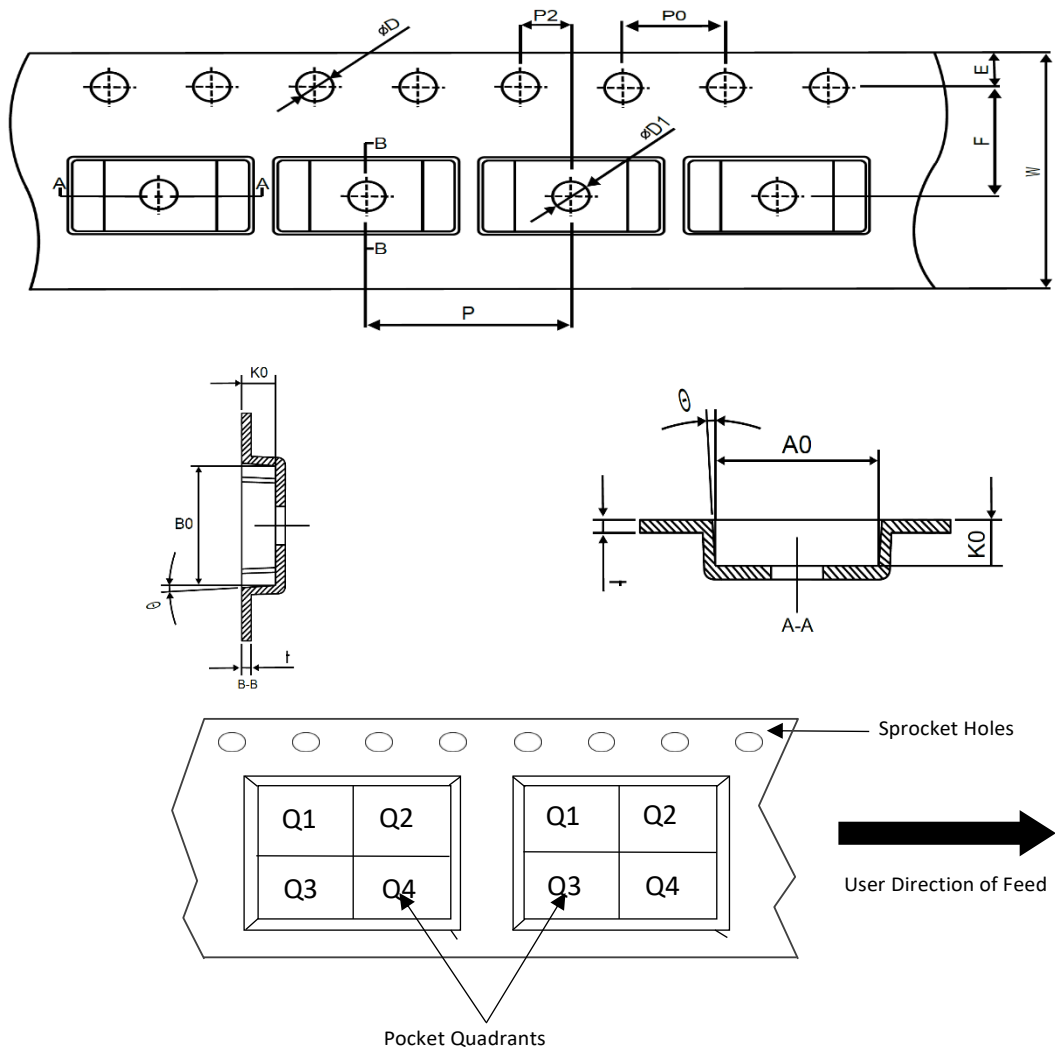


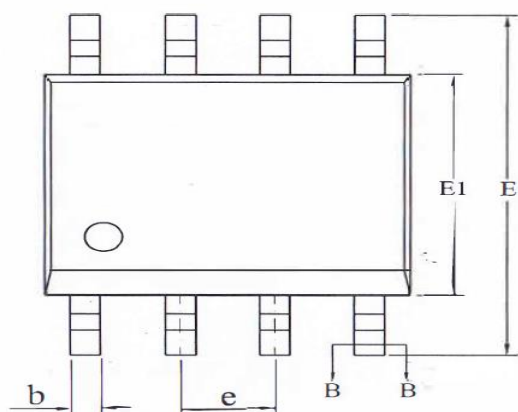
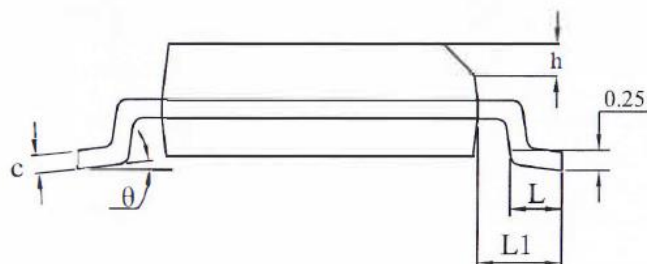
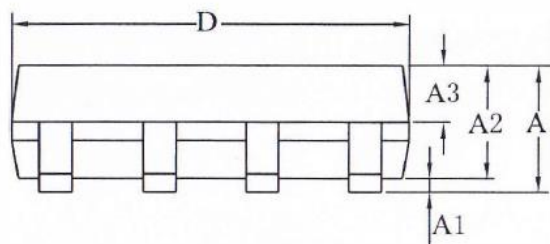
Fig.25 Tape and Reel Information

DIMENSIONS AND PIN1 ORIENTATION

| Device     | Package Type | W<br>(mm) | A0<br>(mm) | B0<br>(mm) | K0<br>(mm) | P<br>(mm) | P0<br>(mm) | Pin1<br>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



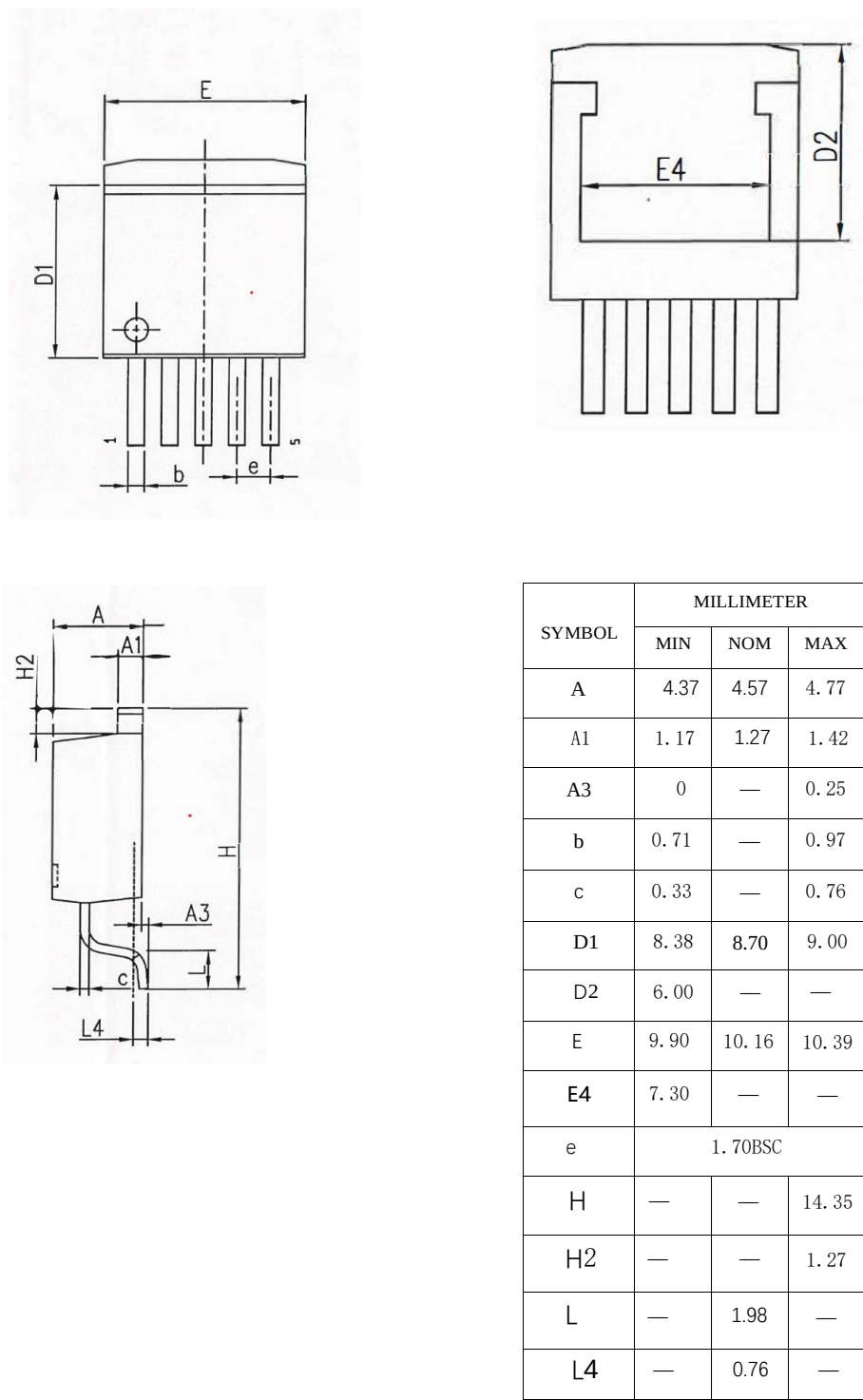


Fig.27 TO263-5 Package

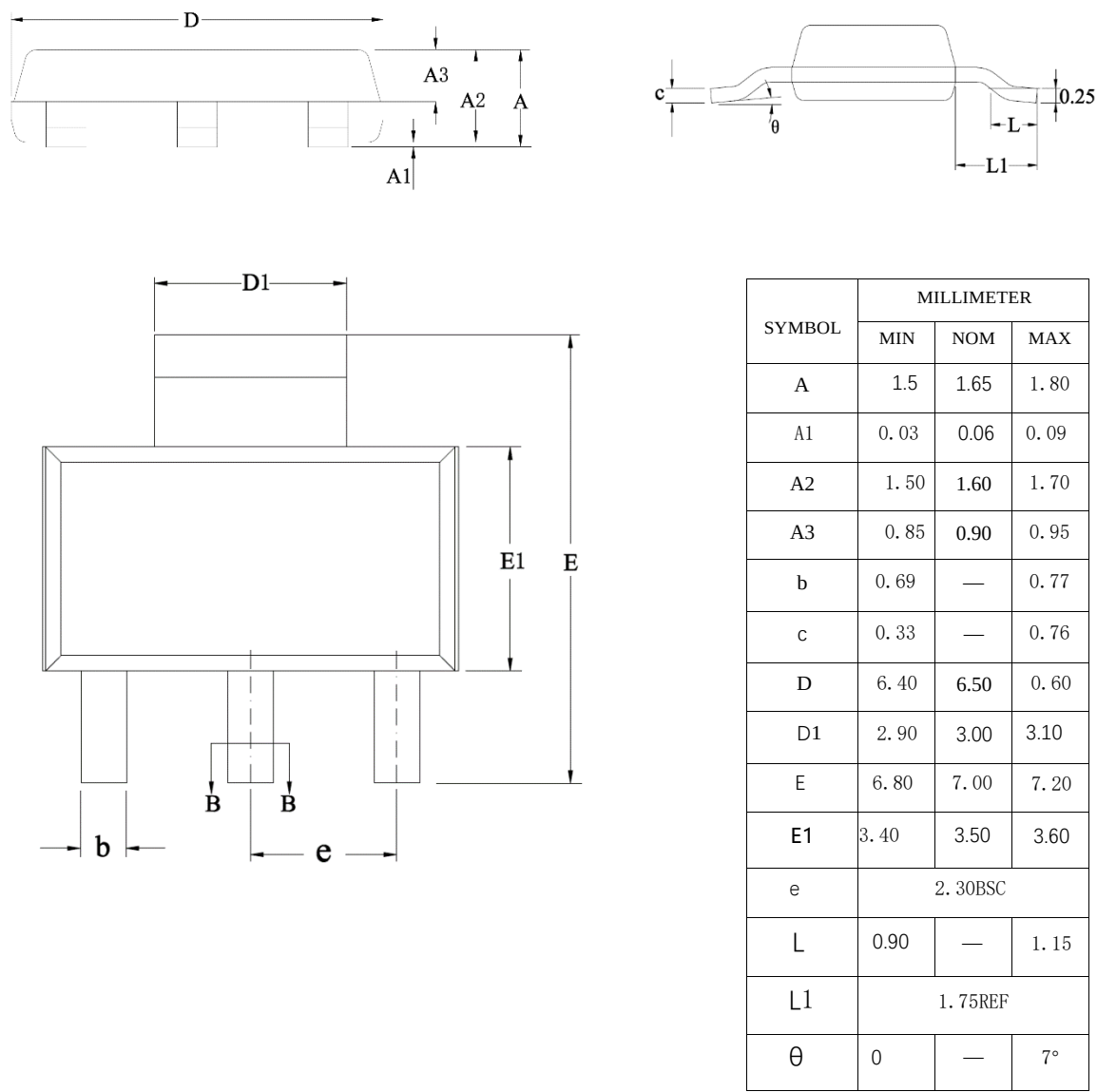


Fig.28 SOT223-3L Package

**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      | <ol style="list-style-type: none"> <li>1. In Page 6, add -1.8V,-2.5V line regulation values in Typ. and Max.</li> <li>2. In Page 6, change ADJ and -3.3V line regulation from “15” to “35” and from “65” to “85”, respectively.</li> </ol>                                                                                                                                                     |
| Jan., 2024   | 1.2      | <ol style="list-style-type: none"> <li>1. In Page 7, change Input Reverse Leakage Current from “500” to “800”.</li> </ol>                                                                                                                                                                                                                                                                      |
| March., 2024 | 1.3      | <ol style="list-style-type: none"> <li>1. In Page 14 &amp; 15&amp;19, Change the Quantity of SOP8L package from “3000” to “4000”.</li> <li>2. Translate Fig.22 into a clearer source.</li> </ol>                                                                                                                                                                                               |
| June., 2024  | 1.4      | <ol style="list-style-type: none"> <li>1. Delate the package about DFN.</li> <li>2. In Page 14 &amp;15 &amp;19, Change the Quantity of SDR package from “2500” to “4000”.</li> </ol>                                                                                                                                                                                                           |
| July, 2024   | 1.5      | <ol style="list-style-type: none"> <li>1. In Page 6, Add 1.8V and 2.5V load regulation values in Typ. and Max.</li> <li>2. In Page6, Delate ADJ,1.8V,2.5V and 3.3V line regulation Max. values.</li> <li>3. In Page 6, Add 1.8V and 2.5V fixed output voltage values in Min., Typ. and Max.</li> <li>4. In Page 7, Add 1.8V and 2.5V reverse output current values in Typ. And Max.</li> </ol> |