

1.5 μ A Low I_Q 300mA Low Noise LDO Regulator

DESCRIPTION

The EUP7138 is a low-dropout regulator with fixed output voltage 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V. It provides up to 300mA output current with input voltage range from 1.7V to 5.5V. It has 1.5 μ A very low quiescent current and is suitable for battery powered equipment with longer application life. EUP7138 is designed to work with low ESR ceramic capacitors to reduce the amount of the PCB area. The EUP7138 is available in DFN1x1-4L and SOT23-5 RoHS compliant packages.

FEATURES

- 1.5 μ A Quiescent Current Typically
- 70dB PSRR at 1kHz
- Up to 300mA Output Current
- Low Shutdown Current: <0.1 μ A
- Output Voltage Accuracy: $\pm 2\%$
- Output Current Limit Protection
- Fixed Output Voltage 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V.
- Stable with Ceramic Output Capacitors
- Thermal Shutdown
- Output Auto-Discharge when EN Shutdown
- Available in DFN1x1-4L and SOT23-5 Package

APPLICATIONS

- IP Camera
- Wearable Devices
- Battery Powered Equipment

Typical Application Circuit

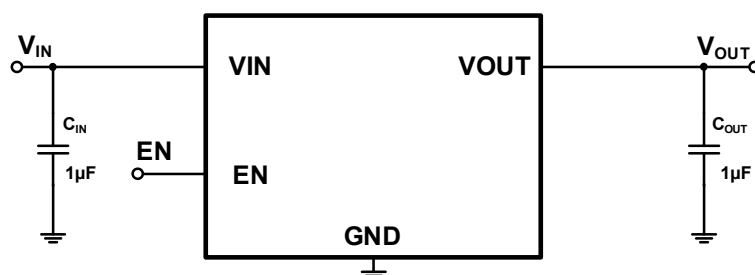
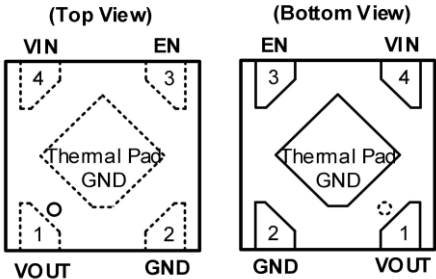
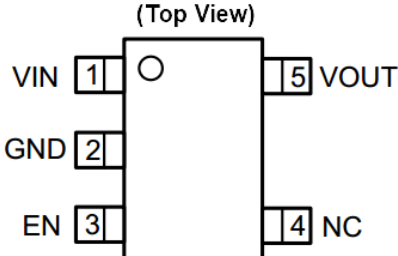


Figure 1. fixed output Circuit

Pin Configurations

Package Type	Pin Configurations	Package Type	Pin Configurations
DFN1x1-4L		SOT23-5	

Pin Description

NAME	DFN1x1-4L PIN No.	SOT23-5 PIN No.	DESCRIPTION
VOUT	1	5	Output of the LDO.
GND	2	2	Signal Ground.
EN	3	3	Enable Pin. Connect this pin to ground or less than 0.4V to disable the device, connect EN to 1.5V or above to enable the device. This pin should not be floated.
VIN	4	1	Input Supply of the LDO.
NC	N/A	4	No connection.
Thermal Pad	5	N/A	Recommended to connect to GND.

Ordering Information

Order Number	Package Type	Marking	Quantity per Reel	Operating Temperature Range
EUP7138-12JIR1	DFN1x1-4L	XXX L1T	10000	-40 °C to +85°C
EUP7138-15JIR1	DFN1x1-4L	XXX L1C	10000	-40 °C to +85°C
EUP7138-18JIR1	DFN1x1-4L	XXX L1D	10000	-40 °C to +85°C
EUP7138-25JIR1	DFN1x1-4L	XXX L1B	10000	-40 °C to +85°C
EUP7138-28JIR1	DFN1x1-4L	XXX L1E	10000	-40 °C to +85°C
EUP7138-30JIR1	DFN1x1-4L	XXX L1G	10000	-40 °C to +85°C
EUP7138-33JIR1	DFN1x1-4L	XXX L1H	10000	-40 °C to +85°C
EUP7138-12VIR1	SOT23-5	XXXXX DU1T	3000	-40 °C to +85°C
EUP7138-15VIR1	SOT23-5	XXXXX DU1C	3000	-40 °C to +85°C
EUP7138-18VIR1	SOT23-5	XXXXX DU1D	3000	-40 °C to +85°C
EUP7138-25VIR1	SOT23-5	XXXXX DU1B	3000	-40 °C to +85°C
EUP7138-28VIR1	SOT23-5	XXXXX DU1E	3000	-40 °C to +85°C
EUP7138-30VIR1	SOT23-5	XXXXX DU1G	3000	-40 °C to +85°C
EUP7138-33VIR1	SOT23-5	XXXXX DU1H	3000	-40 °C to +85°C

EUP7138 - □□ □□□□

 Lead Free Code
 1: Lead Free, Halogen-Free

 Packing
 R: Tape & Reel

 Operating Temperature Range
 I: Industry Standard

 Package Type
 J: DFN1x1-4L
 V: SOT23-5

 Output Voltage
 12: 1.2V 28: 2.8V
 15: 1.5V 30: 3.0V
 18: 1.8V 33: 3.3V
 25: 2.5V

Functional Block Diagram

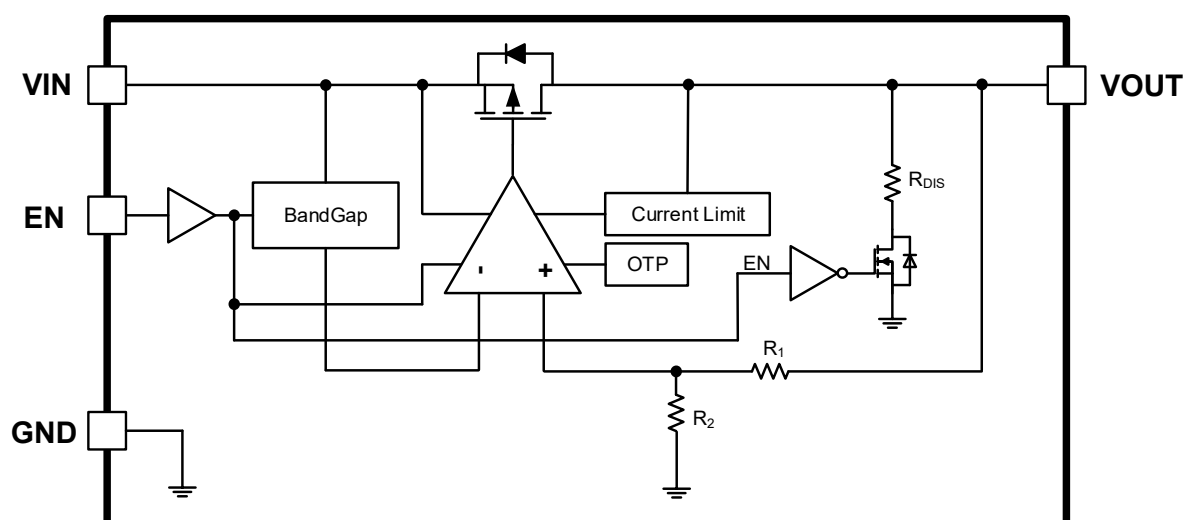


Figure 2. Block Diagram

Absolute Maximum Ratings (Note 1)

■ Input Supply Voltage and EN -----	-0.3 ~6.5V
■ All Other Pins Voltage -----	-0.3V ~Vin
■ Storage Temperature Range -----	-65 ~ +150°C
■ Junction Temperature (Note 2) -----	+150°C
■ Power Dissipation, PD @ TA=25°C (DFN1x1-4L)-----	600mW
■ Power Dissipation, PD @ TA=25°C (SOT23-5)-----	560mW
■ Lead Temperature (Soldering, 10s) -----	260°C

ESD Ratings

■ ESD Voltage Protection, HBM (Human Body Model) -----	±2kV
■ ESD Voltage Protection, CDM (Charged Device Model) -----	±1kV

Recommend Operating Conditions

■ Supply Voltage (VIN) -----	1.7V to 5.5V
■ Operating Junction Temperature (TJ) -----	-40 ~ +125°C
■ Operating Ambient Temperature (TA) -----	-40 ~ +85°C

Thermal Resistance (Note 3)

■ Junction-to-Ambient Thermal Resistance (θ_{JA}) (DFN1x1-4L)-----	232°C/W
■ Junction-to-Ambient Thermal Resistance (θ_{JA}) (SOT23-5)-----	223°C/W
■ Junction-to-Case(top) Thermal Resistance (θ_{JC}) (DFN1x1-4L)-----	86°C/W
■ Junction-to-Case(top) Thermal Resistance (θ_{JC}) (SOT23-5)-----	123°C/W

Note 1 : Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2 : TJ is calculated from the ambient temperature TA and power dissipation PD according to the following formula:

$$T_J = T_A + P_D \times \theta_{JA}.$$

Note 3 : Measured on JESD51-7, 4-layer PCB.

Electrical Characteristics

$V_{IN}=V_{OUT}+1V$ or $V_{IN}=2.5V$ (whichever is greater), $T_A = 25^{\circ}C$, unless otherwise noted.

Parameters	Symbols	Conditions	EUP7138			Units
			Min.	Typ.	Max.	
Input Voltage						
Input Voltage Range (Note 4)	V _{IN}		1.7		5.5	V
Quiescent Current	I _q	V _{EN} =2V, No load	0.5	1.5	3.5	μA
Shutdown Current	I _{SD}	V _{IN} =5V, V _{EN} =0V			0.1	μA
Power Supply Ripple Rejection	PSRR	V _{IN} =3.3V, V _{OUT} =2.8V, I _{OUT} =10mA		70		dB
Enable						
Enable Input High Voltage	V _{EN_H}		1.5			V
Enable Input Low Voltage	V _{EN_L}				0.4	V
EN Input Current	I _{EN}	V _{EN} =V _{IN} =5V	-0.1		0.1	μA
Output Voltage						
Output Voltage Accuracy	V _{OUT} %	V _{IN} =V _{OUT} +1V, I _{OUT} =10mA	-2		2	%
Output Line Regulation	V _{LNR}	V _{OUT} +0.5V<V _{IN} <5.5V, I _{OUT} =10mA		0.01		%/V
Output Load Regulation	V _{LDR}	1mA<I _{OUT} <300mA, V _{IN} =V _{NOM} +1.0V		3		mV
Dropout Voltage (Note 5) at I _{OUT} =300mA	V _{DROP}	V _{OUT} =1.2V , I _{OUT} =50mA		350		mV
		V _{OUT} =1.2V , I _{OUT} =150mA		800		mV
		V _{OUT} =1.2V , I _{OUT} =300mA		1300		mV
		V _{OUT} =2.5V		600		mV
		V _{OUT} =3.3V		520		mV
Output Noise Voltage	V _{NOISE}	BW=20Hz to 20kHz, V _{IN} =3.3V, V _{OUT} =2.8V, I _{OUT} =10mA		50		μV _{RMS}
Maximum Output Current	I _{OUTMAX}	V _{IN} > V _{OUT} +V _{DROP}	300			mA
		V _{IN} =1.7V, V _{OUT} =1.2V		100		mA
Resistance of Auto-Discharge	R _{DIS}			100		Ω
Protection						
Output Current Limit	I _{LIMIT}	V _{OUT} = 90% V _{NOR}	350	600		mA
Thermal Shutdown Temperature (Note 6)	T _{SD}			160		°C
Thermal Shutdown Hysteresis (Note 6)	T _{SDHYS}			20		°C

Note 4: The load condition and dropout voltage should be considered in low input voltage application to ensure input voltage have enough headroom for expected load current.

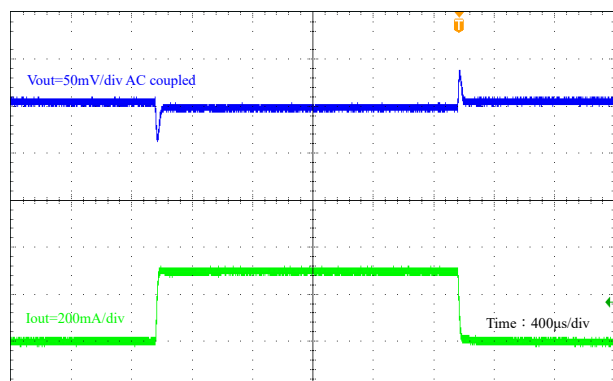
Note 5: The dropout voltage is defined as $V_{IN}-V_{OUT}$, when V_{OUT} is 98% of the normal value of V_{OUT} .

Note 6: Guaranteed by design.

Typical Performance Characteristics

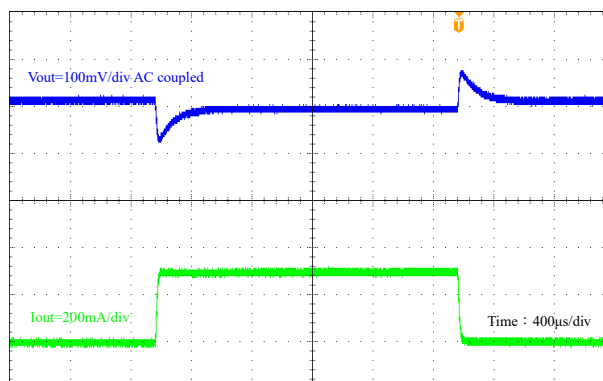
Load Transient

$V_{IN}=EN=3.3V, V_{OUT}=1.2V, I_{OUT}=0mA \text{ to } 300mA$



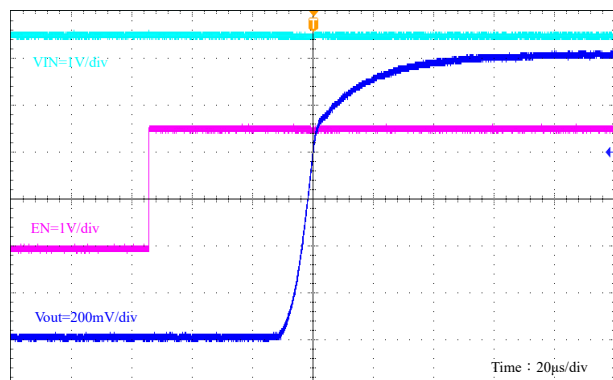
Load Transient

$V_{IN}=EN=5.0V, V_{OUT}=3.3V, I_{OUT}=0mA \text{ to } 300mA$



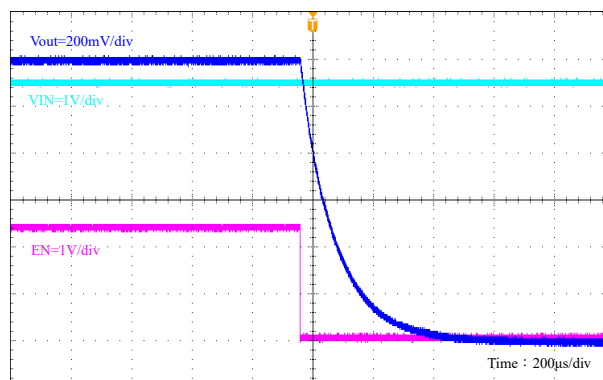
EN POWER ON

$V_{IN}=2.5V, EN=2.5V, V_{OUT}=1.2V, T_A=25^{\circ}C$



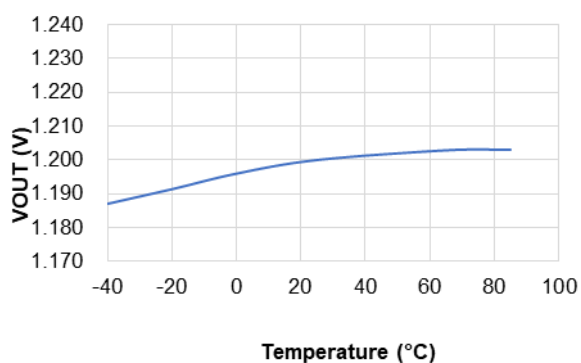
EN POWER OFF

$V_{IN}=2.5V, EN=2.5V, V_{OUT}=1.2V, T_A=25^{\circ}C$



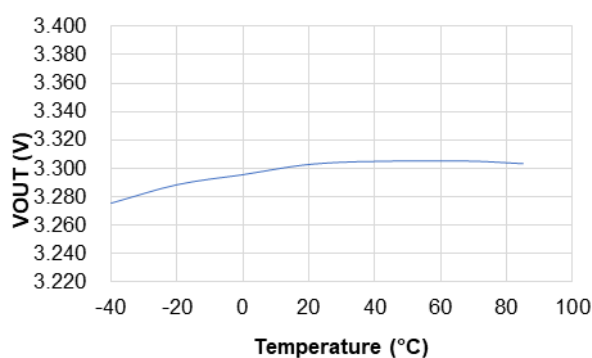
Temperature vs. VOUT

$V_{IN}=3.3V, V_{OUT}=1.2V, I_{OUT}=0A$



Temperature vs. VOUT

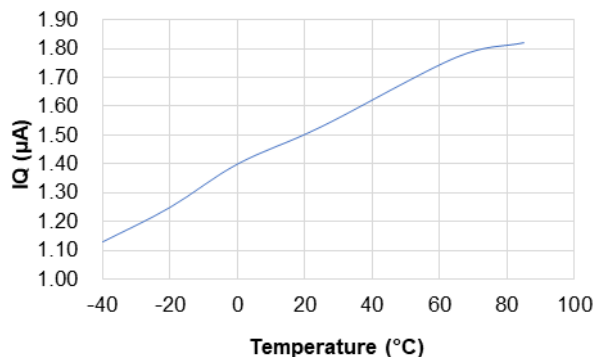
$V_{IN}=4.3V, V_{OUT}=3.3V, I_{OUT}=0A$



Typical Performance Characteristics (continued)

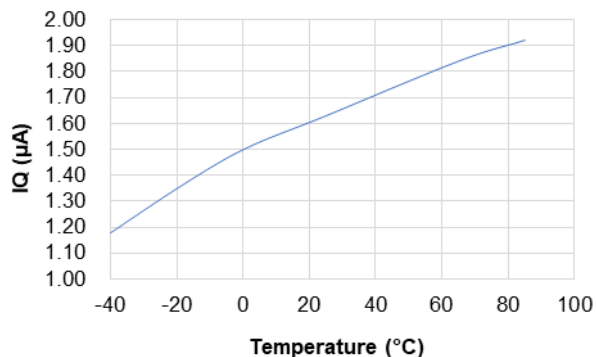
Temperature vs. IQ

$V_{IN}=3.3V, V_{OUT}=1.2V.$



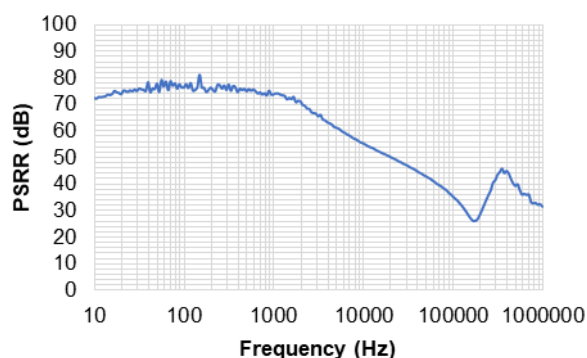
Temperature vs. IQ

$V_{IN}=5V, V_{OUT}=1.2V.$



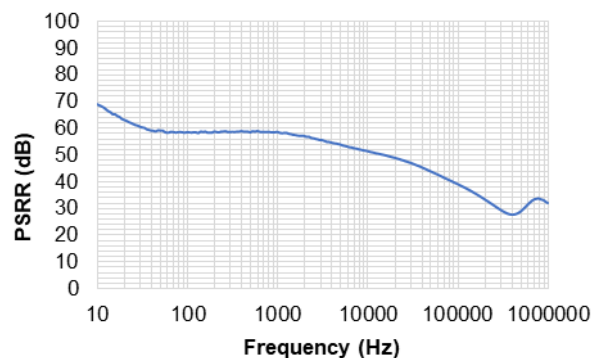
PSRR vs. Frequency

$V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=10mA, T_A=25^{\circ}C$



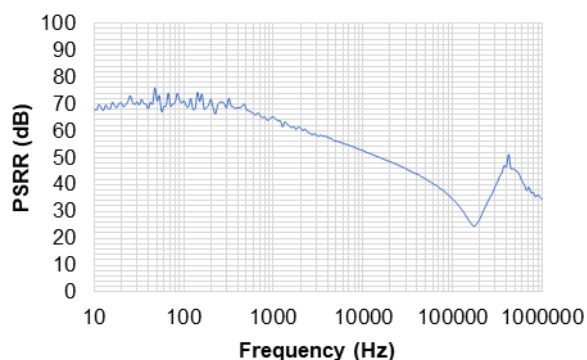
PSRR vs. Frequency

$V_{IN}=3.3V, V_{OUT}=1.8V, I_{OUT}=150mA, T_A=25^{\circ}C$



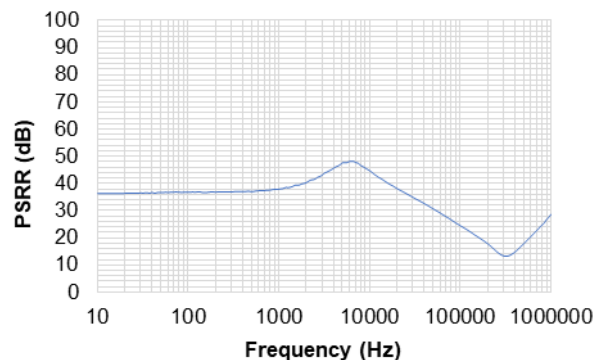
PSRR vs. Frequency

$V_{IN}=3.3V, V_{OUT}=2.8V, I_{OUT}=10mA, T_A=25^{\circ}C$



PSRR vs. Frequency

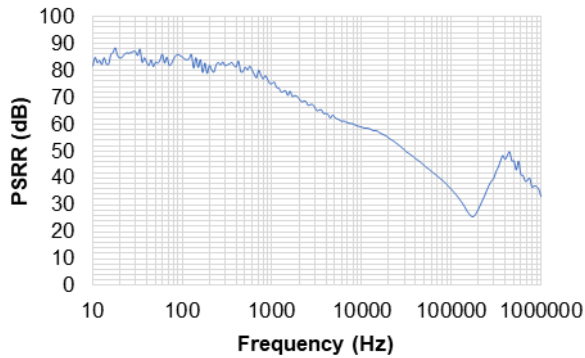
$V_{IN}=3.3V, V_{OUT}=2.8V, I_{OUT}=150mA, T_A=25^{\circ}C$



Typical Performance Characteristics (continued)

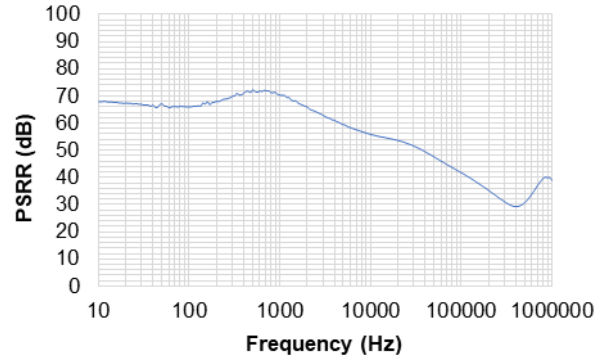
PSRR vs. Frequency

$V_{IN}=3.3V$, $V_{OUT}=1.2V$, $I_{OUT}=10mA$, $T_A=25^{\circ}C$



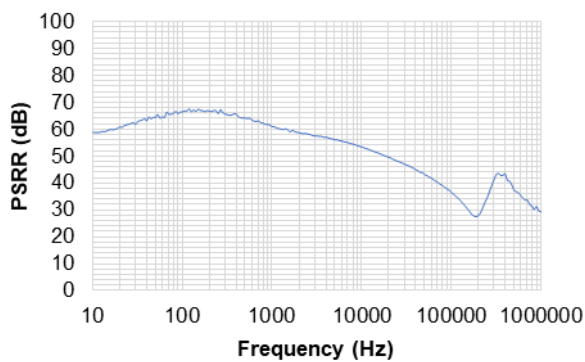
PSRR vs. Frequency

$V_{IN}=3.3V$, $V_{OUT}=1.2V$, $I_{OUT}=150mA$, $T_A=25^{\circ}C$



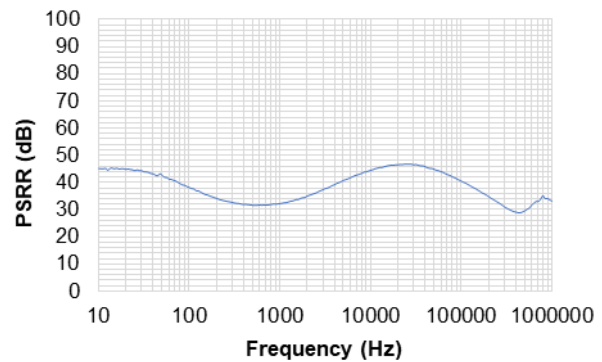
PSRR vs. Frequency

$V_{IN}=5.0V$, $V_{OUT}=3.3V$, $I_{OUT}=10mA$, $T_A=25^{\circ}C$



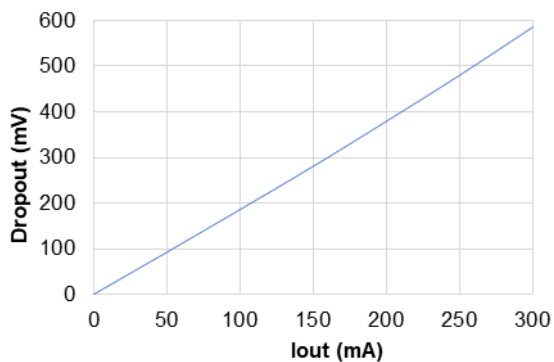
PSRR vs. Frequency

$V_{IN}=5.0V$, $V_{OUT}=3.3V$, $I_{OUT}=150mA$, $T_A=25^{\circ}C$



Dropout vs. Iout

$V_{IN}=3.8V$, $V_{OUT}=2.8V$, $T_A=25^{\circ}C$



Functional Description

Overall

The EUP7138 is a low quiescent current, 300mA output current, low dropout linear regulator with high PSRR and low Noise performance. EUP7138 provide fixed output voltage with 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V. It is designed to work with low-ESR ceramic capacitor, reducing the amount of the PCB area. The ceramic output capacitance in 1 μ F 0402 package enables the device to remain stable over the entire load range.

As shown in the function block diagram, the EUP7138 is composed of the bandgap reference voltage, the error amplifier, P-channel MOSFET pass transistor, internal resistor divider and some additional protection circuits. The reference voltage, connected to the cathode terminal of the error amplifier, compares with the feedback voltage to regulate the output voltage to make it constant over the whole load current range. If the feedback voltage is lower than the reference voltage, the pass transistor gate is pulled lower to increase its conductivity. This allows more current to flow to the output and increase the output voltage. If the feedback voltage is higher than the reference voltage, the pass transistor gate is pulled higher to decrease its conductivity. This allows less current to flow to the output and decrease the output voltage. The feedback point is the output of the internal resistor divider connected to the VOUT pin.

Enable/Shutdown

The EUP7138 is disabled when the EN pin is connected to ground or the voltage less than 0.4V, and the shutdown current is less than 0.1 μ A. Connect EN pin to 1.5V or higher voltage to enable the device. This EN pin cannot be floated.

Output Auto Discharge

When the regulator is disabled, an internal 100 Ω resistor is connected between VOUT and GND to discharge output capacitor C_{OUT} .

Current Limit

The EUP7138 includes a current limit circuit to monitor the gate voltage of the pass transistor to limit the output current. When the output current is higher than the over-current limit, the circuit will clamp the gate voltage of the pass transistor to limit the output current.

Thermal Shutdown

The EUP7138 monitors internal temperature. When the junction temperature exceeds 160°C, the over temperature protection (OTP) circuit turn off the pass transistor until the device is cooled down by 20°C. Then the pass transistor resumes. For continue operation, do not exceed absolute maximum junction temperature.

Application Information

Input capacitor

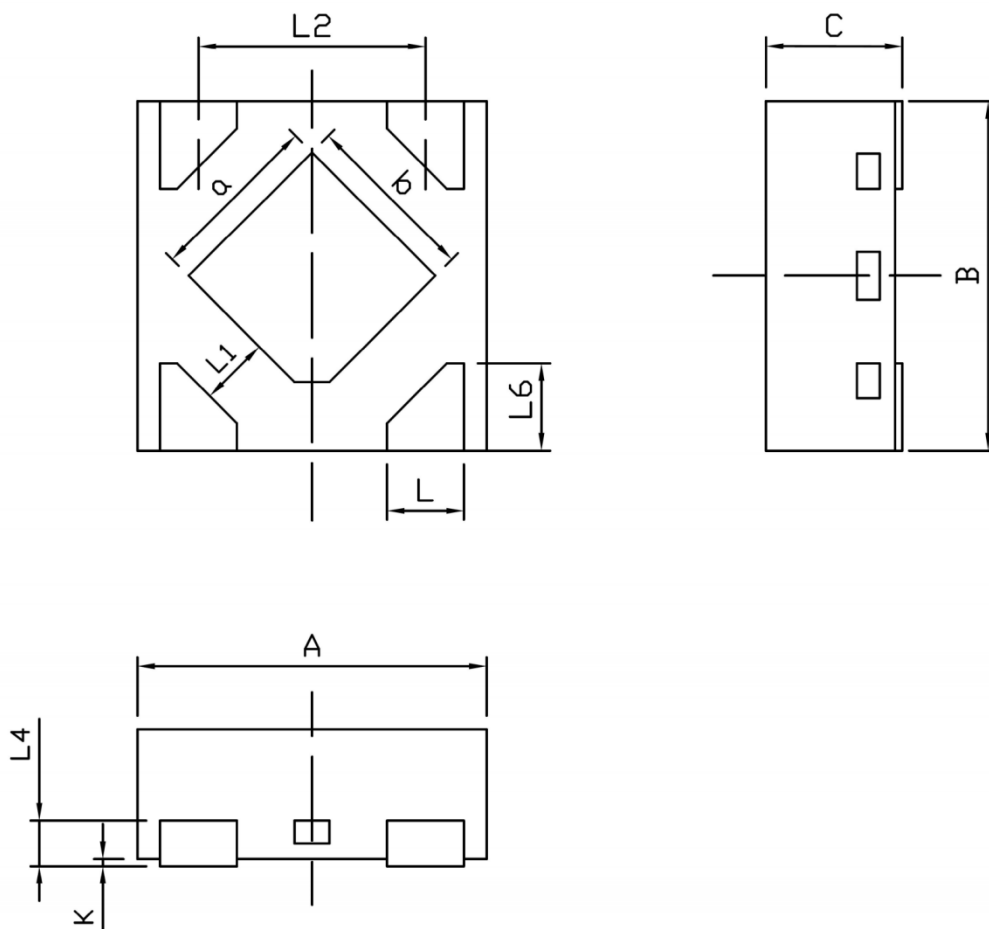
A 1 μ F or higher capacitance value ceramic capacitor is required between the VIN pin and the GND pin. Place it as close as possible to the device. There are no requirements for the ESR on the input capacitor, but the tolerance and temperature coefficient must be considered. The ceramic capacitor with 1 μ F or larger rating capacitance, X5R or X7R type dielectrics and 0402 or larger size is recommended as input capacitor.

Output capacitor

An output capacitor (C_{OUT}) is needed to improve transient response and maintain stability. The EUP7138 is stable with very small ceramic output capacitors. A 1 μ F to 10 μ F capacitor is suitable for the most EUP7138 applications. For typical application, the ceramic capacitor with 1 μ F or larger rating capacitance, X5R or X7R type dielectrics and 0402 or larger size is recommended as output capacitor.

Packaging Information

DFN1x1-4L



Unit: mm

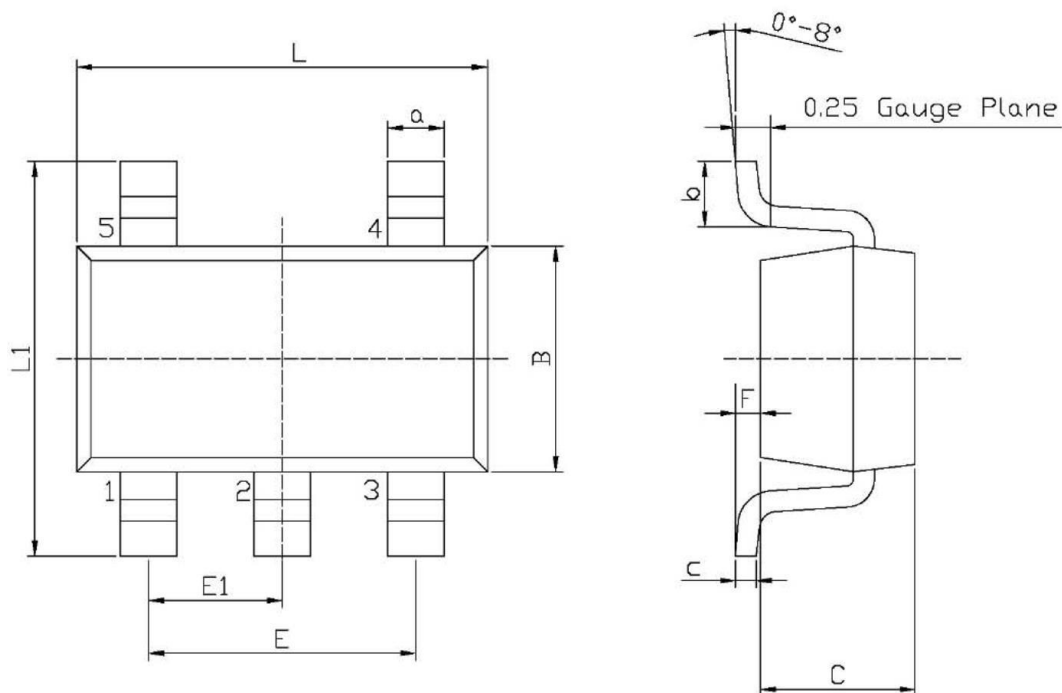
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX		MIN	TYP	MAX
A	0.950	1.000	1.050	L4	-	0.100	-
B	0.950	1.000	1.050	L6	0.200	0.250	0.300
C	0.340	0.370	0.400	K	0.000	0.020	0.050
L	0.170	0.220	0.270	a	0.430	0.480	0.530
L1	0.150	-	-	b	0.430	0.480	0.530
L2	-	0.650	-				

Note:

1) All dimensions are in millimeters.

Packaging Information

SOT23-5



Unit: mm

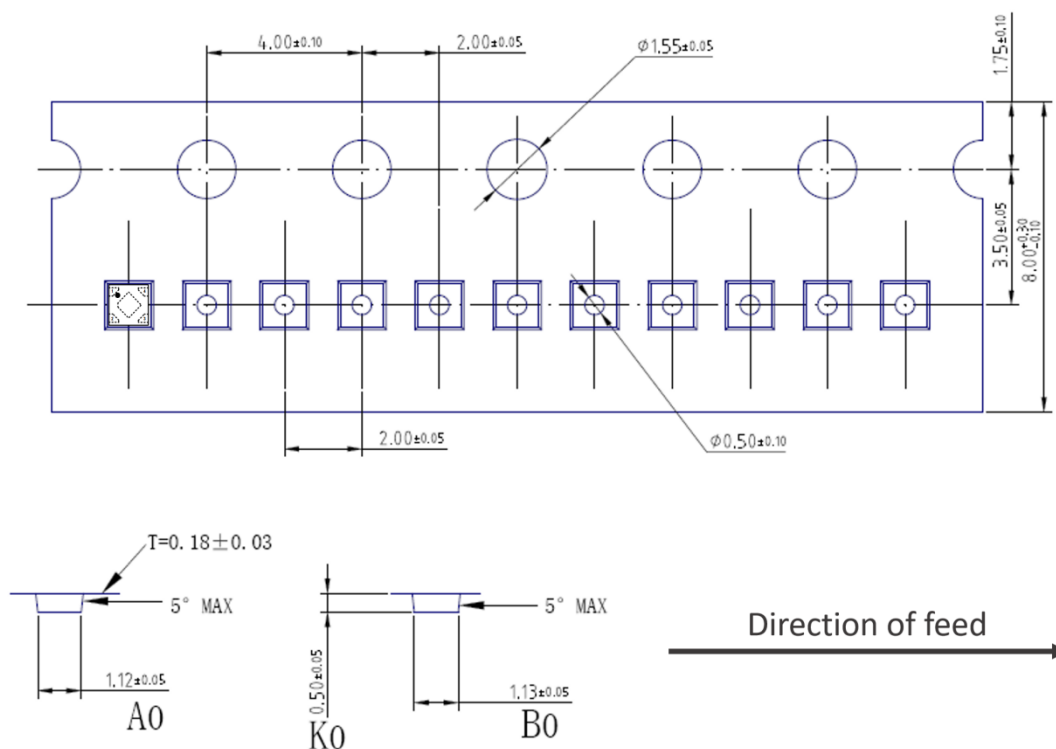
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	MIN	MAX		MIN	MAX
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

Note:

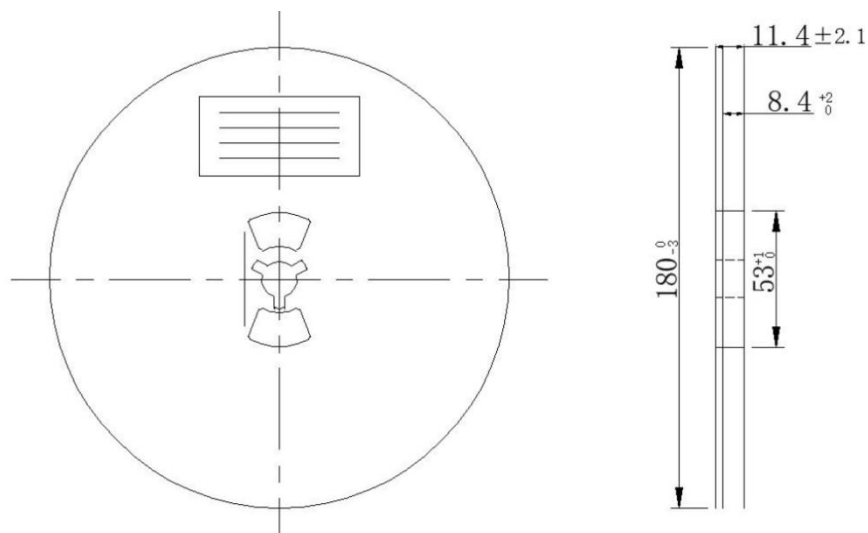
- 1) All dimensions are in millimeters.
- 2) Package length does not include mold flash, protrusion or gate burr.
- 3) Package width does not include inter lead flash or protrusion.
- 4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
- 5) Pin 1 is lower left pin when reading top mark from left to right.

Tape and Reel Information

TAPE DIMENSIONS: DFN1x1-4L



REEL DIMENSIONS: DFN1x1-4L

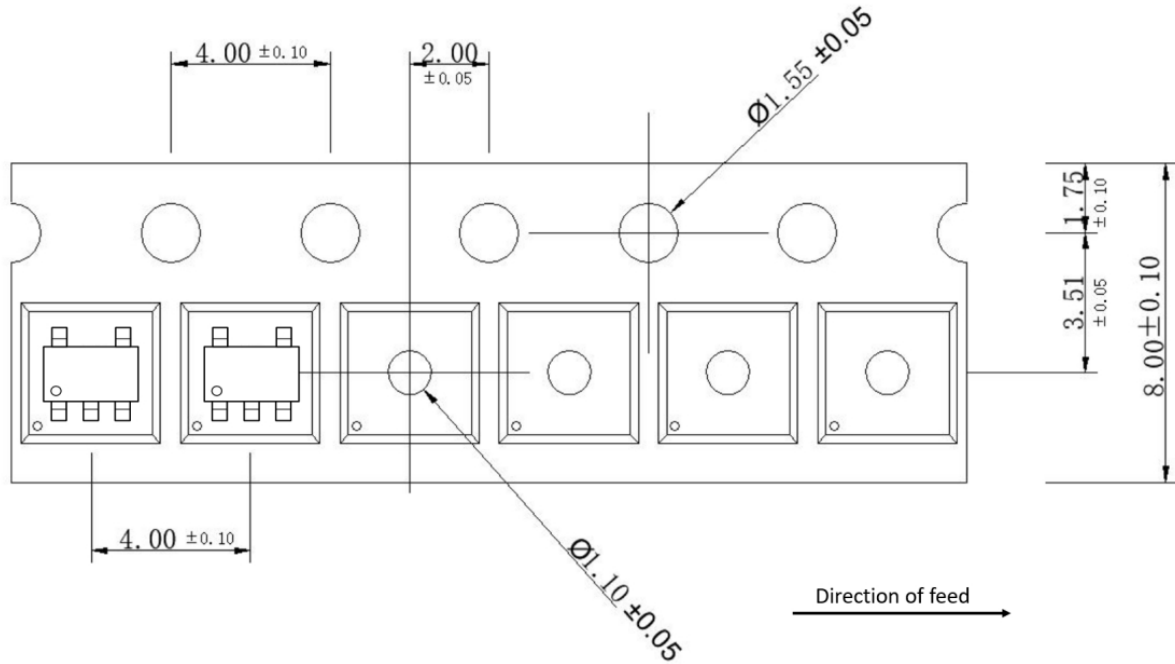


Note:

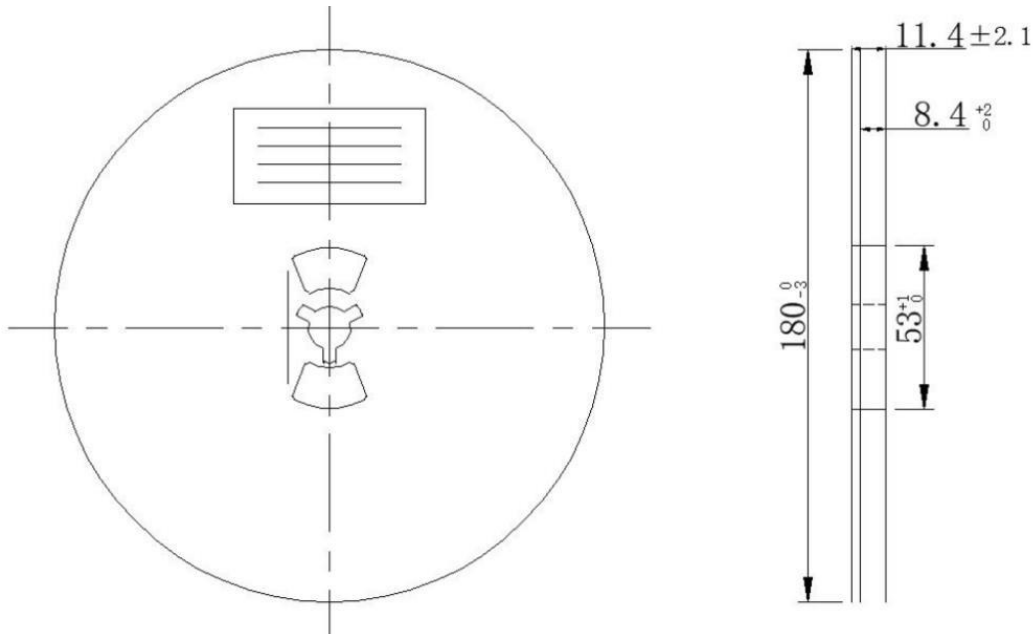
- 1) All Dimensions are in Millimeter
- 2) Quantity of Units per Reel is 10000
- 3) MSL level is level 3.

Tape and Reel Information

TAPE DIMENSIONS: SOT23-5



REEL DIMENSIONS: SOT23-5



Note:

- 1) All Dimensions are in Millimeter
- 2) Quantity of Units per Reel is 3000
- 3) MSL level is level 3.