6V, 600mA, 2uA Low Dropout Voltage Linear Regulator

Features

- 600mA Output Current
- 1.2V to 6.0V Input Voltage Range
- 2uA Ground Current at no Load
- 100nA Disable Current (By option)
- ±1% Output Accuracy
- Dropout Voltage: 0.36V at 600mA/V_{OUT} 3.3V
- Current Limit Protection
- Support Fixed Output Voltage:1.2V, 1.5V, 1.6V, 1.8V, 2.5V, 2.8V, 3.0V and 3.3V
- Stable with Ceramic or Tantalum Capacitor
- Over-Temperature Protection
- SOT23-3, SOT23-5, DFN-1X1-4L and DFN-2X2-6L Packages Available

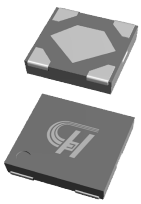
Applications

- Portable, Battery Powered Equipment
- Low Power Microcontrollers
- Laptop, Palmtops and PDAs
- Wireless Communication Equipment
- Audio/Video Equipment
- Car Navigation Systems

General Description

The HCR2162 series are a group of low-dropout(LDO) voltage regulators offering the benefits of wide input voltage range from 1.2V to 6.0V, low dropout voltage low power consumption, and miniaturized packaging Quiescent current of only 2μA makes these devices ideal for powering the battery-powered, always-on systems that require very little idle-state power dissipation to a longer service life.There is an option of shutdown mode by selecting the parts with the EN pin and pulling it low. The shutdown current in this mode goes down to only 100nA (typical).

The HCR2162 series of linear regulators are stable with the ceramic output capacitor over its wide input range from 1.2V to 6.0V and the entire range of output load current (0mA to 600mA).
It is rated over the -40'C to +85'C temperature range.


DFN-1X1-4L


DFN-2X2-6L


SOT23-3

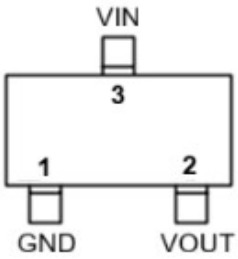

SOT23-5

Figure 1. Package Type of HCR2162

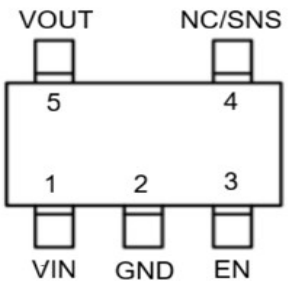
6V, 600mA, 2uA Low Dropout Voltage Linear Regulator

Pin Configuration

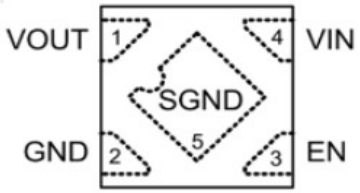
SOT23-3 Top View



SOT23-5 Top View



DFN1x1-4L Top View



DFN2x2-6L Top View

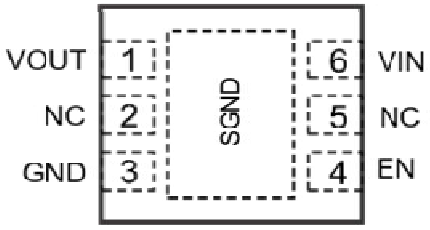


Figure 2. Pin Configuration of SWLD2162 (Top View)

Pin Function Table

HCR2162				Name	Function
DFN-1X1-4L	DFN2X2-6L	SOT-23-5	SOT23-3		
1	1	5	2	Vout	Output of the regulator
2	3	2	1	GND	Ground Pin
3	4	3	-	EN	Enable Control Input
4	6	1	3	VIN	Input of Supply Voltage
-	2,5	4	-	NC	No internal Connection
-	-	4	-	SNS[2]	Sense of Output Voltage, the SNS as Adjustable vout voltage "VOUT= (R1+R2)/R2x1.2V, And R2<24KΩ.
Exposed Pad	Exposed Pad	-	-	SGND	Substrate of Chip. Leave floating or tie to GND

Note [2]. The SNS as Adjustable vout voltage "VOUT=(R1+R2)/R2x1.2V, And R2<24KΩ.

Typical Application Circuit

-Fixed Vout Circuit and with EN control function

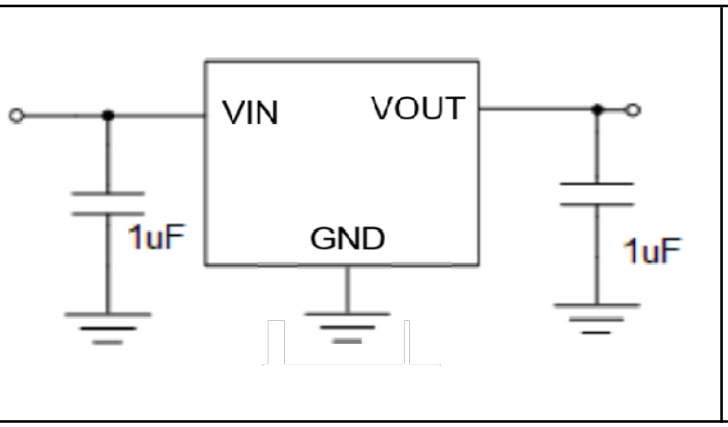


Figure 3. Fixed VOUT LDO

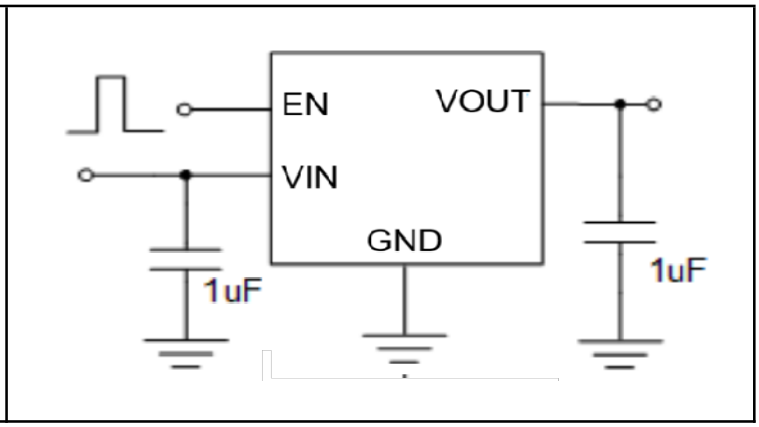


Figure 4: Fixed VOUT LDO with enable function

-Fixed and Adjustable Vout Circuit with EN and SNS function

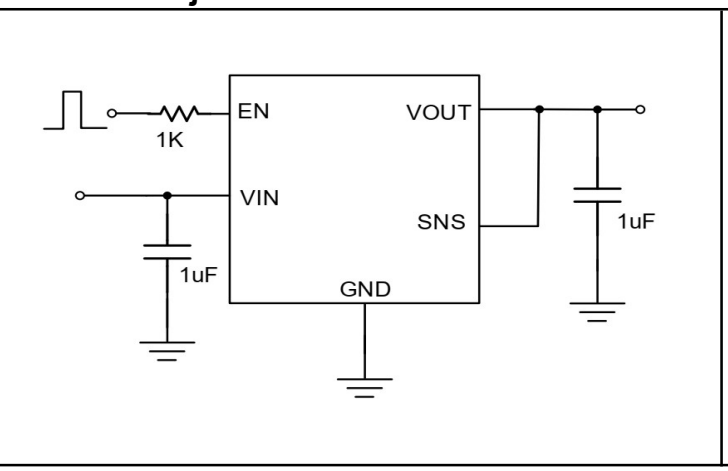


Figure 5.1. Fixed VOUT LDO with EN and SNS functions

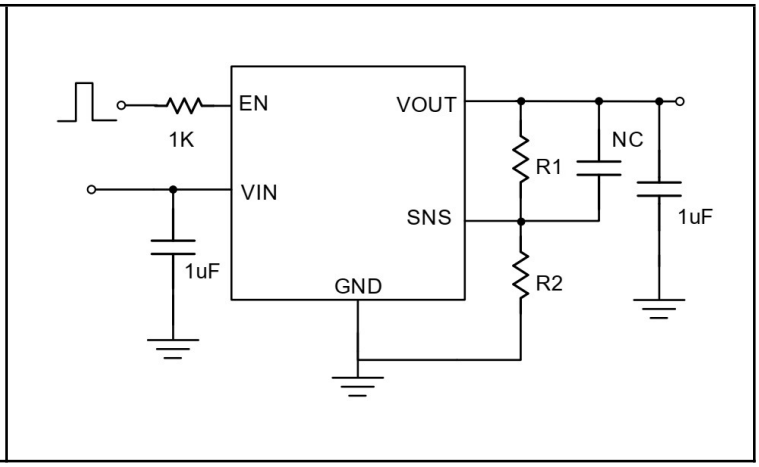


Figure 5.2. Adjustable VOUT LDO with EN and SNS functions

Function Block Diagram

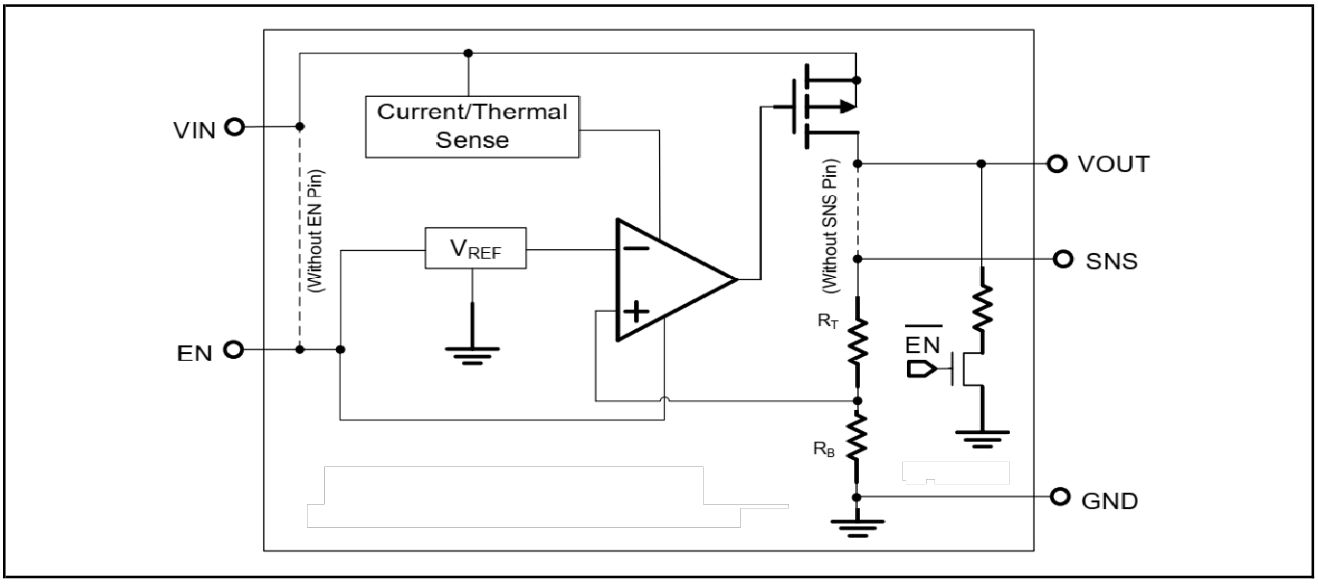


Figure 6. Function Block Diagram

6V, 600mA, 2uA Low Dropout Voltage Linear Regulator

Ordering Information

Circuit Type — [ ] [ ] [ ]

Type:

TR : Tape and Reel

Voltage:
1V2:1.2V, 1V5:1.5V, 1V6:1.6V,
1V8:1.8V, 2V5:2.5V, 2V8:2.8V, 3V0:3.0V,
3V3:3.3V, ADJ:Adjustable

Package:
DN14L: DFN1X1-4L
DN26L: DFN2X2-6L
M3: SOT23-3
M5: SOT-23-5

Ordering Code

Part Number	Marking ID	Temperature Range	Package	Package Type
HCR2162-1V2DN14LTR	*A	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-1V5DN14LTR	*B	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-1V6DN14LTR	*C	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-1V8DN14LTR	*D	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-2V5DN14LTR	*E	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-2V8DN14LTR	*F	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-3V0DN14LTR	*J	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-3V3DN14LTR	*H	-40'C to +85'C	UTDFN1X1-4L	10000pcs/TR
HCR2162-1V2DN26LTR	H12	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-1V5DN26LTR	H15	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-1V6DN26LTR	H16	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-1V8DN26LTR	H18	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-2V5DN26LTR	H25	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-2V8DN26LTR	H28	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-3V0DN26LTR	H30	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-3V3DN26LTR	H33	-40'C to +85'C	DFN2X2-6L	3000pcs/TR
HCR2162-ADJM5TR	AAC2	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-1V2M5TR	AAC2	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-1V5M5TR	AAC5	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-1V6M5TR	AAC6	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-1V8M5TR	AAC8	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-2V5M5TR	AACA	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-2V8M5TR	AACB	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-3V0M5TR	AACC	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-3V3M5TR	AACD	-40'C to +85'C	SOT-23-5	3000pcs/TR
HCR2162-1V2M3TR	AAM1	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-1V5M3TR	AAM2	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-1V6M3TR	AAM3	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-1V8M3TR	AAM4	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-2V5M3TR	AAM5	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-2V8M3TR	AAM6	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-3V0M3TR	AAM7	-40'C to +85'C	SOT23-3	3000pcs/TR
HCR2162-3V3M3TR	AAM8	-40'C to +85'C	SOT23-3	3000pcs/TR

6V, 600mA, 2uA Low Dropout Voltage Linear Regulator

Absolute Maximum Ratings Note 1

Parameter		Symbol	Value	Unit
Supply Voltage VIN Pin		VIN	-0.3 to 7.0	V
Supply Voltage VOUT, EN Pin to GND		VOUT, VEN	-0.3 to 6.0	V
Output Voltage VOUT to VIN		VOUT	-6 to 0.3	V
Thermal Resistance Junction to Ambient @TA=+25'C note 2	SOT-23-5	θJA	200	'C/W
	SOT23-3	θJA	200	'C/W
	DFN-1X1-4L	θJA	195	'C/W
	DFN2X2-6L	θJA	95	'C/W
Thermal Resistance Junction to Case @TA=+25'C	SOT-23-5	θJC	90	'C/W
	SOT23-3	θJC	90	'C/W
	DFN-1X1-4L	θJC	60	'C/W
	DFN2X2-6L	θJC	28	'C/W
Storage Temperature Range		TSTG	-60 to +150	'C
Operating Temperature Range		TOPR	-40 to +85	'C
Junction Temperature		TJ	+150	'C
Lead Temperature (Soldering, 10s)		TLEAD	260	'C
Human Body Model ESD Protection		ESD HBM	2000	V
Machine Model ESD Protection		ESD MM	200	V

Note 1: Stresses above those listed under"Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

2: θJA is measured at TA=25'C on a HCRSEMI EVB board

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Unit
Operating Voltage Range	VIN	1.2	5.5	V
Junction Temperature Range	TC	-40	+125	'C
Operating Temperature Range	TA	-40	+85	'C

6V, 600mA, 2uA Low Dropout Voltage Linear Regulator

Electrical Characteristics

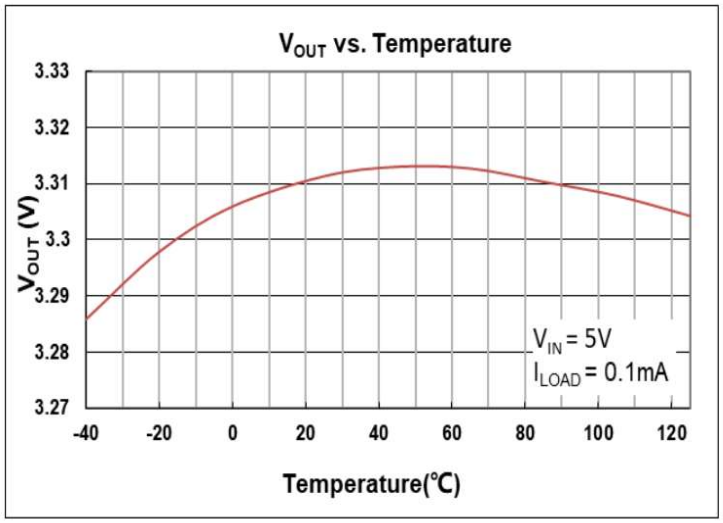
(at TA=25 `C, VIN=5V, VEN=5V, unless otherwise noted.)

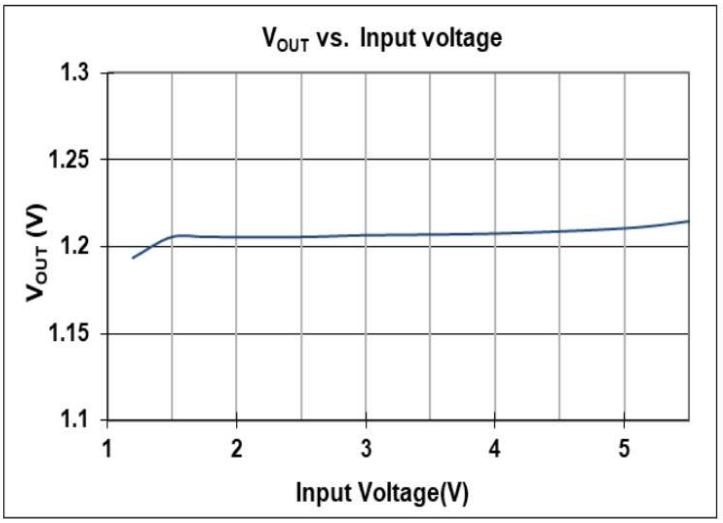
Parameter	Symbol	Conditions		Min	Type	Max	Unit
Input Voltage Range	V_{IN}			1.2	-	5.5	V
V_{OUT} Voltage Accuracy	R_{ACC}	I_{OUT}=0.1mA		-1	-	+1	%
SNS Input Current	I_{SNS}	SNS=V_{OUT}		-	0.5	-	uA
Dropout Voltage note 3	V_{DROP_3V}	I_{OUT}=600mA, V_{OUT}>=3V		-	0.36	-	V
	$V_{DROP\_2.8V}$	I_{OUT}=600mA, V_{OUT}=2.8V		-	0.45	-	V
	$V_{DROP\_2.5V}$	I_{OUT}=600mA, V_{OUT}=2.5V		-	0.45	-	V
	$V_{DROP\_1.8V}$	I_{OUT}=600mA, V_{OUT}=1.8V		-	0.57	-	V
	$V_{DROP\_1.5V}$	I_{OUT}=600mA, V_{OUT}=1.5V		-	0.71	-	V
	$V_{DROP\_1.2V}$	I_{OUT}=600mA, V_{OUT}=1.2V		-	0.9	-	V
Ground Current	I_Q	I_{LOAD}=0mA		-	2	-	uA
Shutdown Ground Current	I_{SD}	V_{EN}=0V, V_{OUT}=0V		-	0.1	0.5	uA
V_{OUT} Shutdown Leakage Current	I_{LEAK}			-	0.1	0.5	
Enable Threshold Voltage	V_{ENL}	EN Falling		-	-	0.4	V
	V_{ENH}	EN Rising		1.0	-	-	V
EN Input Current	I_{EN}	V_{EN}=5V		-	10	100	nA
Continuous Output Current	I_O	-		-	-	600	mA
Output Current Limit	I_{LIM}	V_{OUT}=0V		601	1100	-	mA
Line Regulation	ΔLINE	I_{LOAD}=30mA, 1.5V<=V_{IN}<=5.5V or (VOUT+0.2V)<=VIN<=5.5V		-	0.2	-	%
Load Regulation	ΔLOAD	10mA<=I_{OUT}<=600mA		-	0.2	-	%
Power Supply Rejection Ratio	PSRR	V_{OUT}=1.2V, V_{IN}=2V, I_{OUT}=5mA	f=100Hz	-	80	-	dB
			f=1KHz	-	75	-	
Output Voltage Noise(10Hz to 100KHz)	V_{NOISE}	V_{IN}=3.5V, I_{LOAD}=0.1A	V_{OUT}=1.2V	-	80	-	uV_{RMS}
			V_{OUT}=2.8V	-	120	-	
Thermal Shutdown Temperature	T_{SD}	I_{LOAD}=10mA		-	155	-	'C
Thermal Shutdown Temperature	ΔT_{SD}			-	15	-	'C
Discharge Resistance	R_{DC}	EN=0V, V_{OUT}=0.1V		-	30	-	Ω

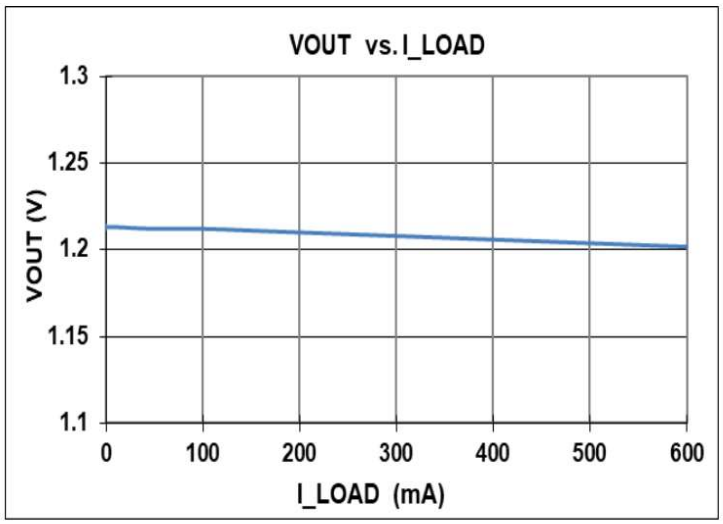
Note3: VDROP=VIN-VOUT when the VOUT is 98% of its target value.

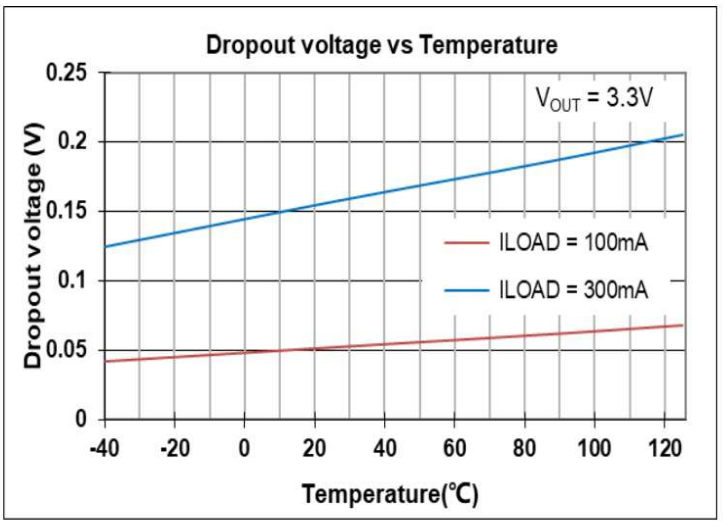
6V, 600mA, 2uA Low Dropout Voltage Linear Regulator

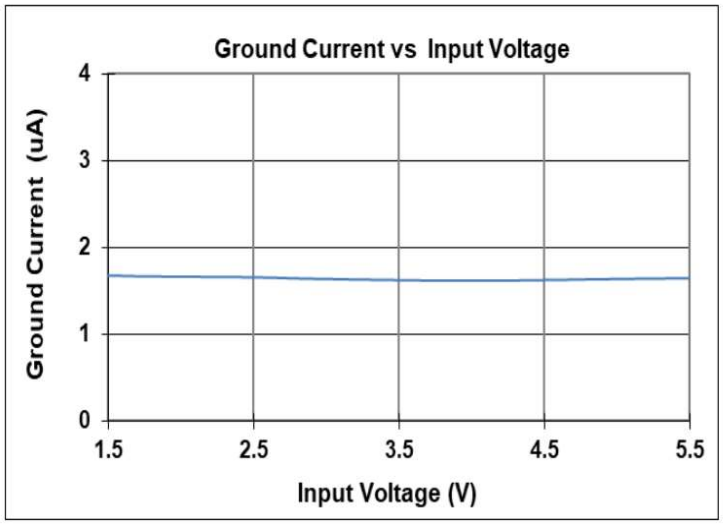
Typical Performance Characteristics (Unless Otherwise Specified.)

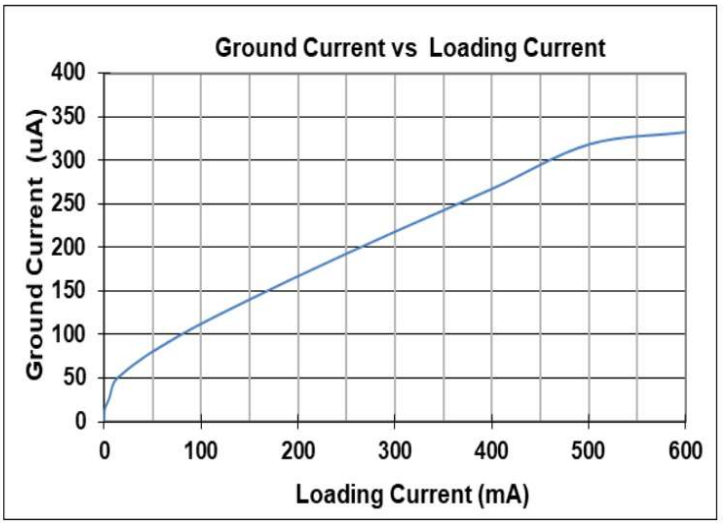




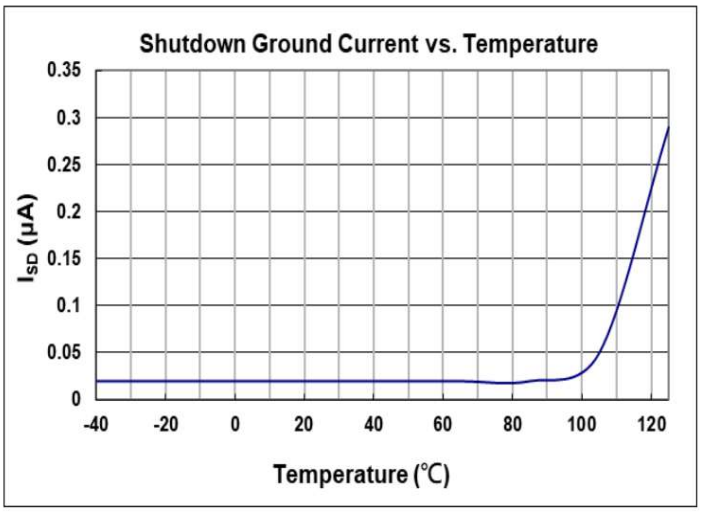


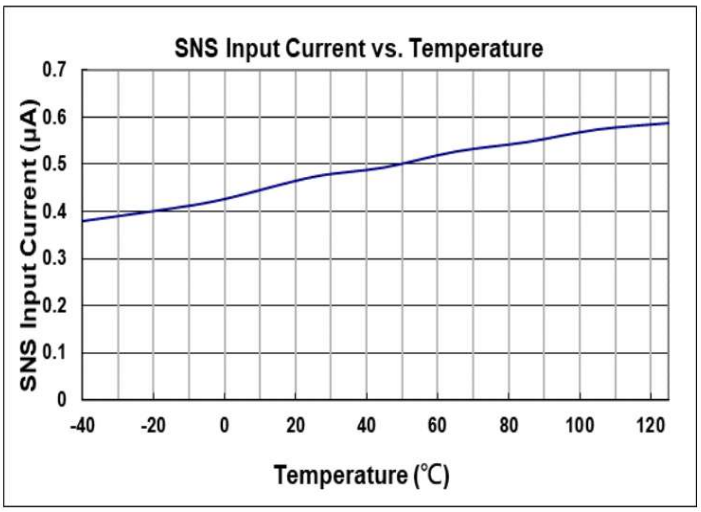


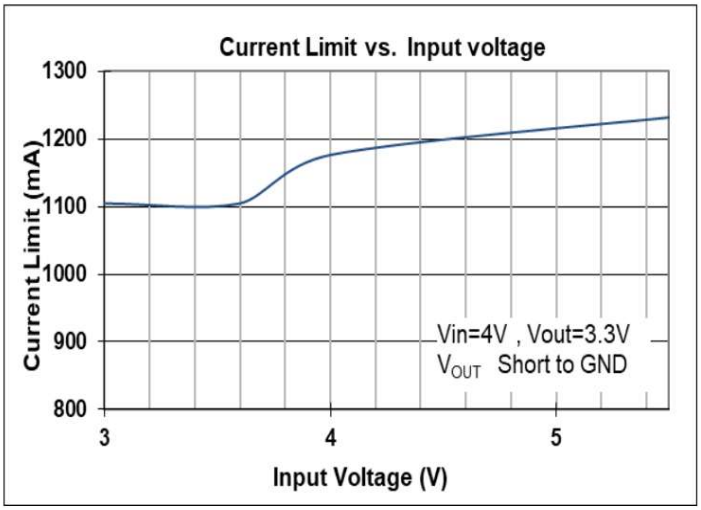




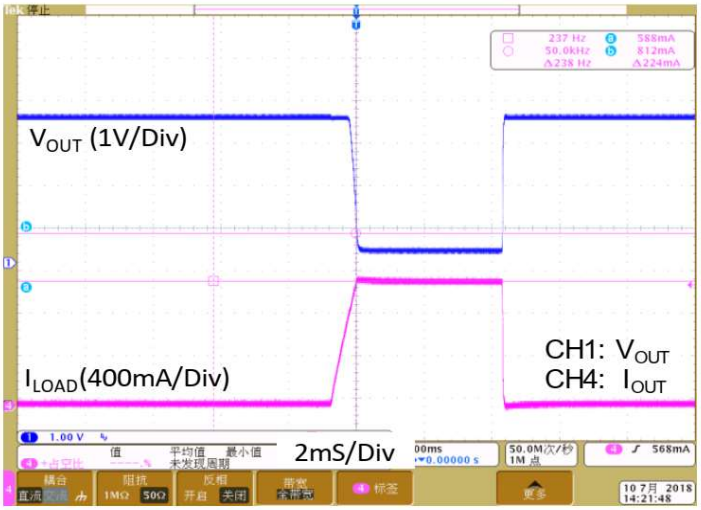
Typical Performance Characteristics (continued)



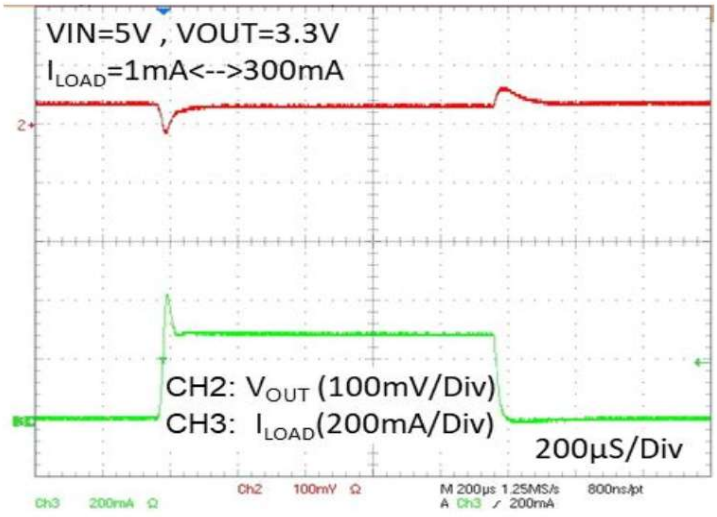




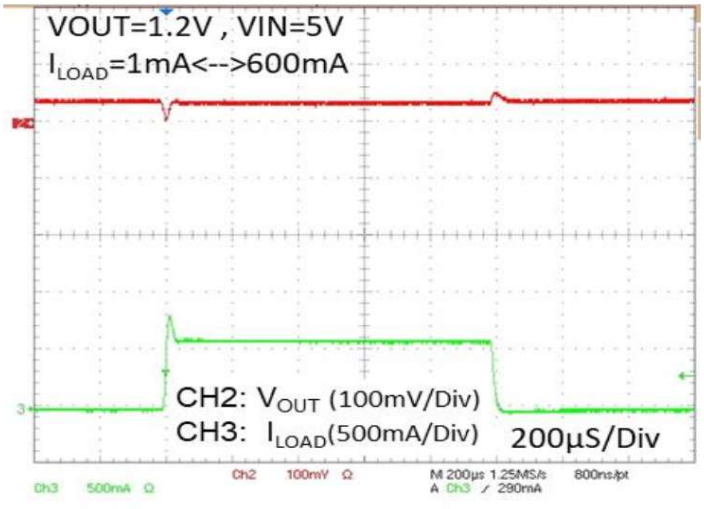
Current Limit Response



Load Transient Response I

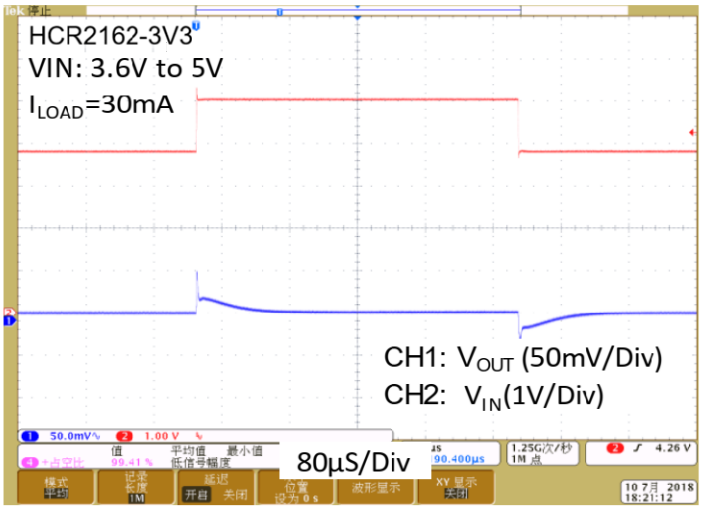


Load Transient Response II

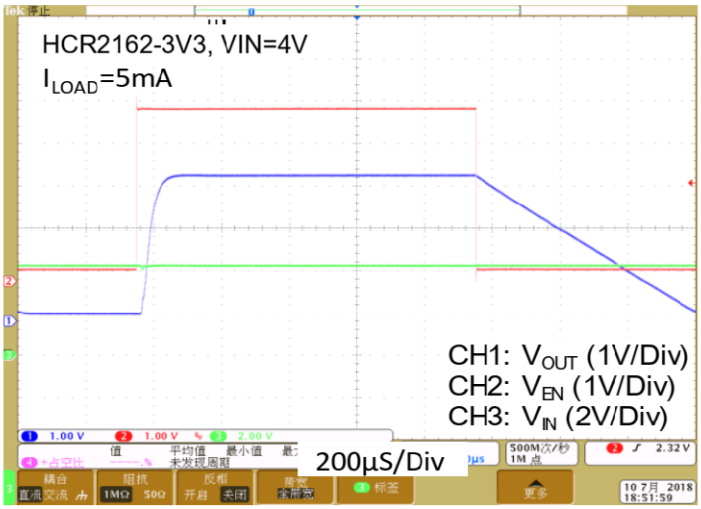


Typical Performance Characteristics (continued)

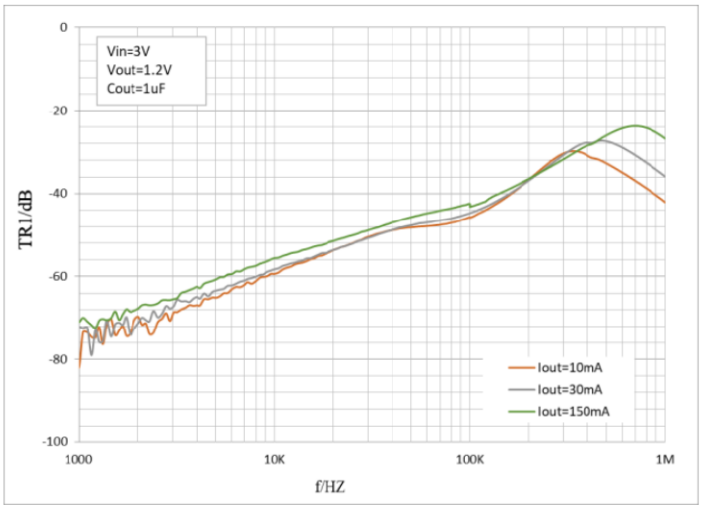
Line Transient Response



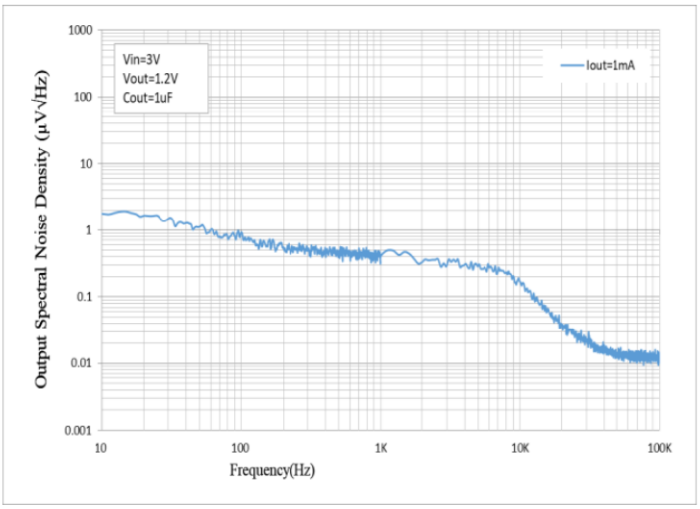
V_{OUT} Turn On/Off by EN



PSRR vs. Frequency



Noise Density Spectrum



Application Guideline

Input and Output Capacitor Requirements

The external input and output capacitors of HCR2162 series must be properly selected for stability and performance. Use a 1μF or larger input capacitor and place it close to the IC's VIN and GND pins. Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) and effective capacitance between 1μF and 22μF requirement may be used. Place the output capacitor close to the IC's VOUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

Current Limit

The HCR2162 series contain the current limiter of output power transistor,which monitors and controls the transistor, limiting the output current to 1100mA (typical). The output can be shorted to ground indefinitely without damaging the part.

Dropout Voltage

The HCR2162 series use a PMOS pass transistor to achieve low dropout. When (VIN – VOUT) is less than the dropout voltage (VDROP), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the RDS(ON) of the PMOS pass element. VDROP scales approximately with the output current because the PMOS device behaves as a resistor in dropout condition.

As any linear regulator, PSRR and transient response are degraded as (VIN – VOUT) approaches dropout condition.

Adjustable Output Voltage Application

The HCR2162 by SNS pin also can work as an adjustable output voltage LDO. Figure 5 gives the connections for the adjustable output voltage application. The resistor divider from VOUT to SNS sets the output voltage when in regulation.

The voltage on the SNS pin sets the output voltage and is determined by the values of R1 and R2. To keep a good temperature coefficient of output voltage, the values of R1 and R2 should be selected carefully to ignore the temperature effect of input current at the SNS pin. A current greater than 50μA in the resistor divider is recommended to meet the above requirement. The adjustable output voltage can be calculated using the formula given in equation 1:

$$V_{OUT} = \frac{R1+R2}{R2} \times V_{SNS} \qquad (1)$$

where VSNS is determined by the output voltage selections in the ordering information of HCR2162-1V2 The minimum recommended 50μA in the resistor divider makes the application no longer a 2μA low quiescent LDO.

OTP (Over Temperature Protection)

The over temperature protection function of HCR2162 series will turn off the P-MOSFET when the junction temperature exceeds 155°C (typ.). Once the junction temperature cools down by approximately 15°C, the regulator will automatically resume operation.

Application Guideline(con.)

Thermal Application

For continuous operation, do not exceed the absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated as below:

TA=25°C, HCR-Tech PCB

The max PD(Max) = (125°C − 25°C) / (200°C/W) = 0.5W for SOT-23-3 / SOT-23-5 packages.

The max PD (Max) = (125°C - 25°C) / (195°C/W) = 0.51W for DFN1x1-4L package.

The max PD (Max) = (125°C - 25°C) / (95°C/W) = 1.05W for DFN2x2-6L package.

Power dissipation (PD) is equal to the product of the output current and the voltage drop across the output pass element, as shown in the equation below:

$$PD = (VIN – VOUT) \times IOUT$$

Layout Consideration

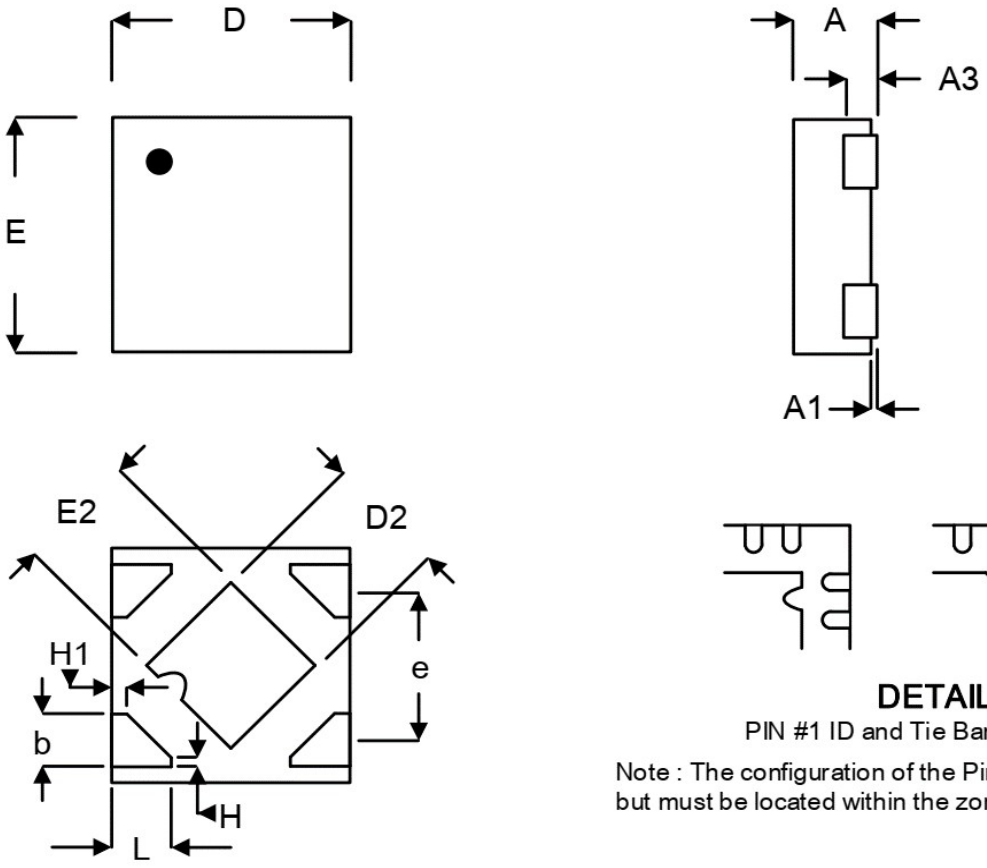
By placing input and output capacitors on the same side of the PCB as the LDO, and placing them as close as is practical to the package can achieve the best performance. The ground connections for input and output capacitors must be back to the HCR2162 ground pin using as wide and as short of a copper trace as is practical.

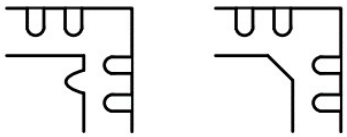
Connections using long trace lengths, narrow trace widths, and/or connections through via must be avoided.These add parasitic inductances and resistance that results in worse performance especially during transient conditions.

Mechanical Dimensions

PKG: DFN1X1-4L (DN14L)

Unit: mm





DETAILA

PIN #1 ID and Tie Bar Mark Options

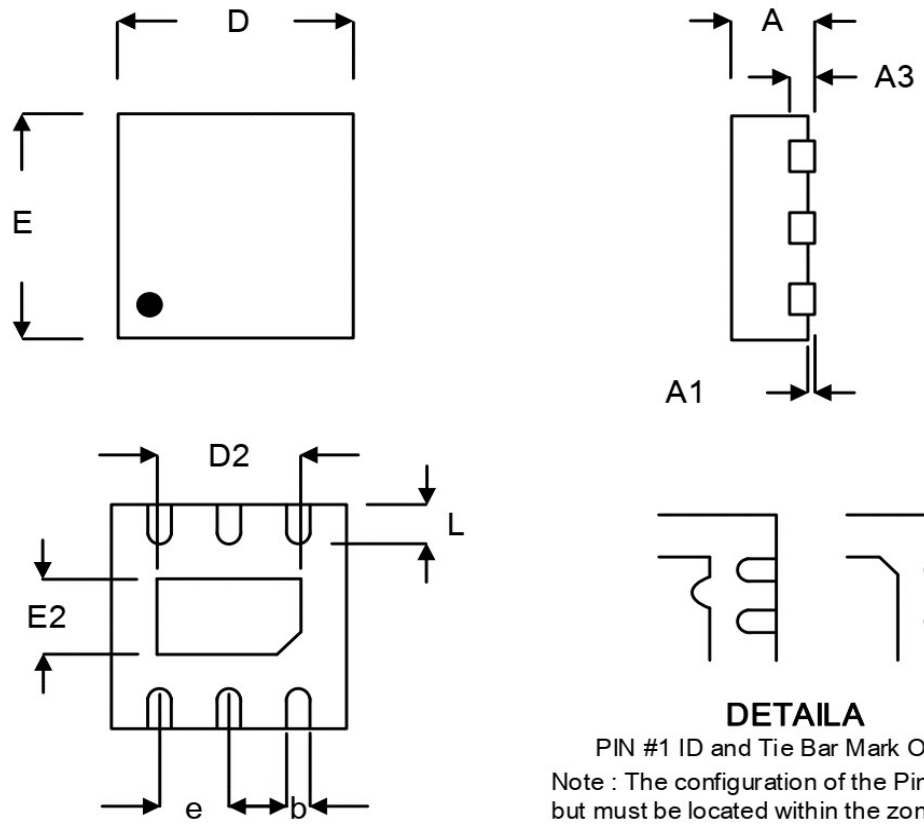
Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

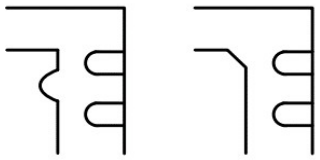
Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.300	0.400	0.012	0.016
A1	0.000	0.050	0.000	0.002
A3	0.117	0.162	0.005	0.006
b	0.175	0.280	0.007	0.011
D	0.900	1.100	0.035	0.043
D2	0.430	0.550	0.017	0.022
E	0.900	1.100	0.035	0.043
E2	0.430	0.550	0.017	0.022
e	0.650		0.026	
L	0.200	0.300	0.008	0.012
H	0.039		0.002	
H1	0.064		0.003	

Mechanical Dimensions (Con.)

PKG: DFN2X2-6L (DN26L)

Unit: mm





DETAILA

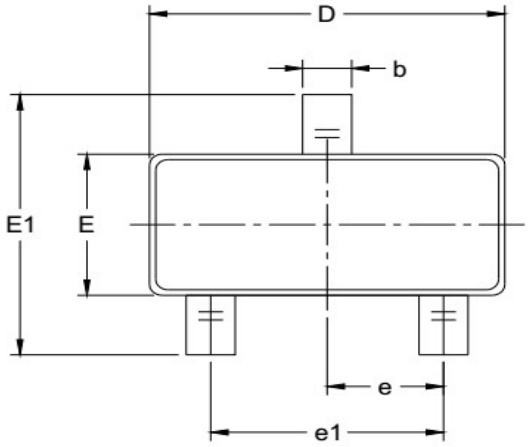
PIN #1 ID and Tie Bar Mark Options

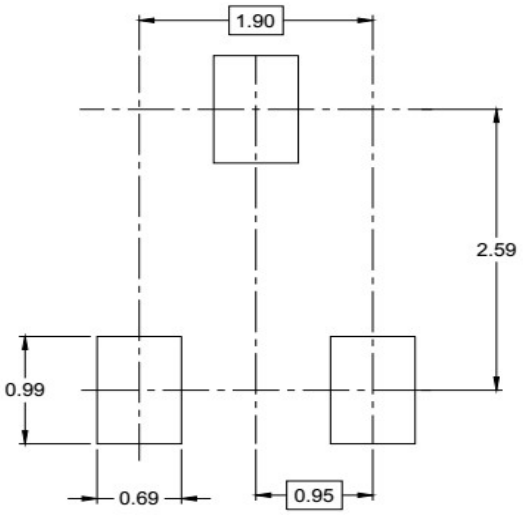
Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.200	0.350	0.008	0.014
D	1.950	2.050	0.077	0.081
D2	1.000	1.450	0.039	0.057
E	1.950	2.050	0.077	0.081
E2	0.500	0.850	0.020	0.033
e	0.650		0.026	
L	0.300	0.400	0.012	0.016

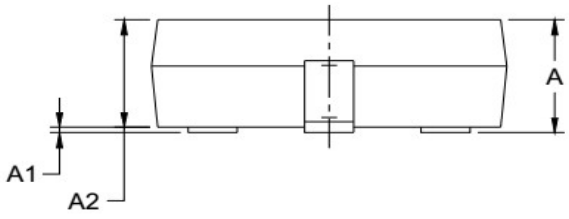
Mechanical Dimensions (Con.)

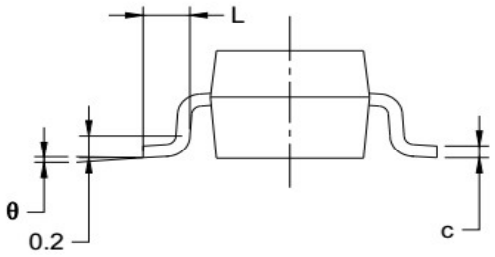
PKG:SOT23-3 (M3) **Unit: mm (inch)**





RECOMMENDED LAND PATTERN (Unit: mm)

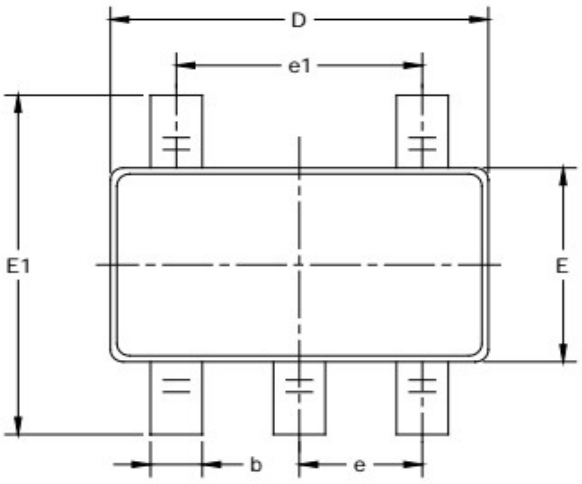


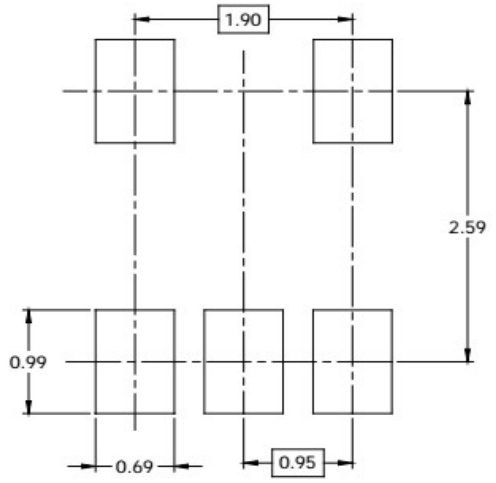


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

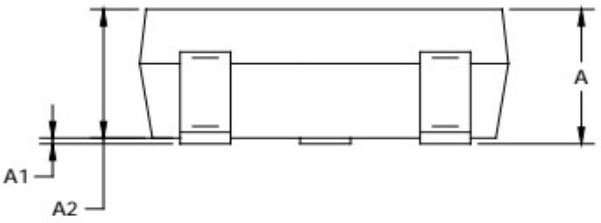
Mechanical Dimensions (Con.)

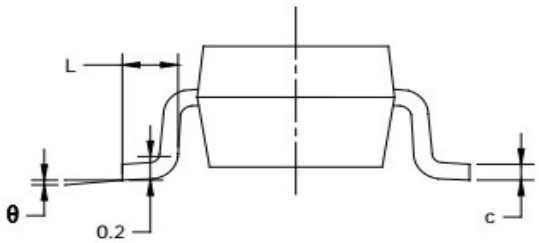
PKG:SOT-23-5 (M5) **Unit: mm (inch)**





RECOMMENDED LAND PATTERN (Unit: mm)

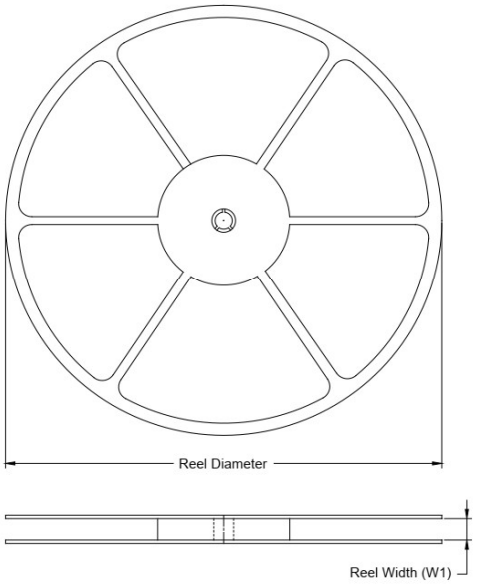




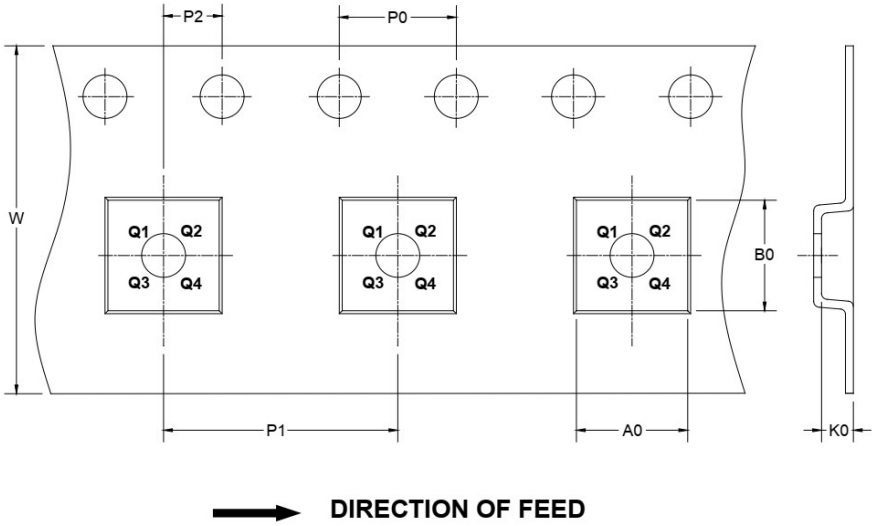
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



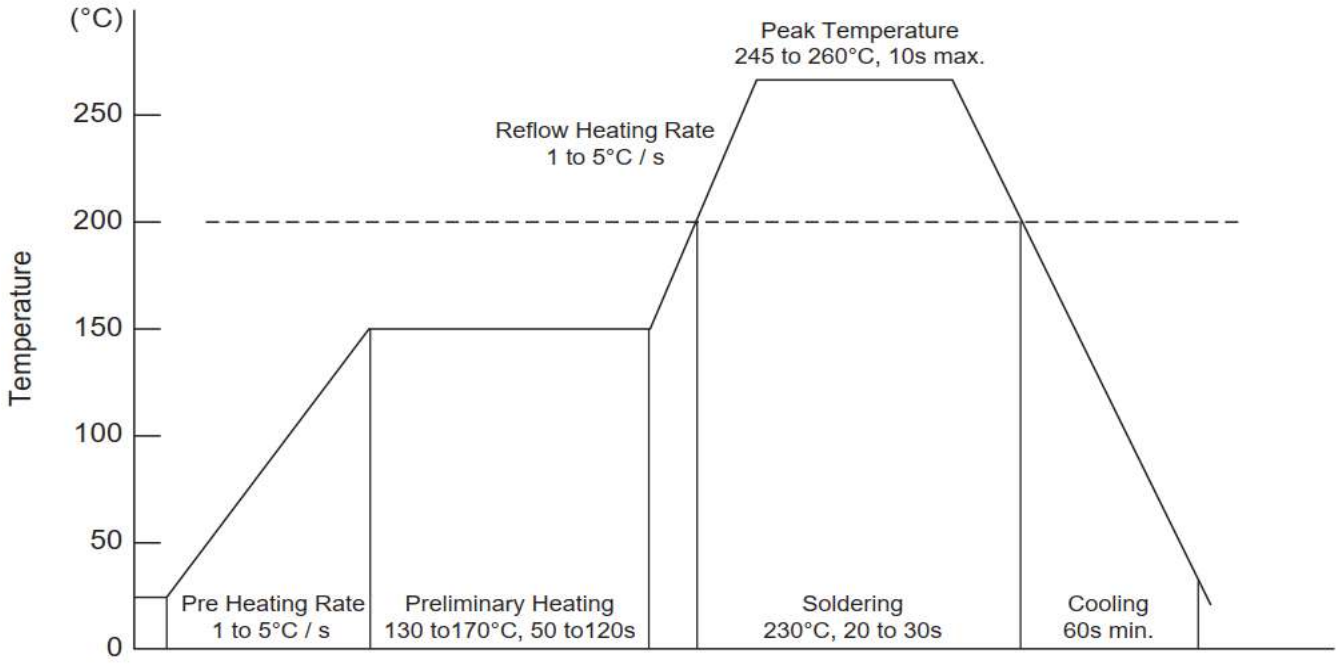
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOT23-3	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
DFN-1x1-4L	7"	9.0	1.20	1.20	0.60	4.0	2.0	2.0	8.0	Q1
DFN-2x2-4L	7"	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q1

Conditins of Soldering and Storage

- **Recommended condition of reflow soldering**



Recommended peak temperature is over 245'C, if peak temperature is below 245'C, you may adjust the following parameters:

* Time length of peak temperature (longer)
* Time length of soldering (longer)
* Thickness of solder paste (thicker)

- **Conditions of hand soldering**

* Temperature : 300'C
* Time : 3s max
* Times : one time

- **Storage conditions**

* Temperature

  5 to 40'C

* Humidity

  30 to 80% RH

* Recommended period

  One year after manufacturing