6V, 500mA, Ultra-Low Noise, High PSRR RF-Linear Regulators

Features

- 500mA Guaranteed Output Current
- 1.5V to 5.5V Input Voltage Range
- Ultra-Low Noise: 9uVRMS(TYP.)
- High PSRR: 90dB(TYP) at 1KHz and 85dB(TYP) at 10KHz
- 13μA(TYP) Low Quiescent Current
- Low Dropout Voltage: 95mV (TYP) at VOUT= 5V
- Fixed Output Voltage from 0.6V to 4.2V
- Adjustable Output Voltage from 0.8V to 5V
- Low Start-Up Current
- Current Limiting and Thermal Protection
- Excellent Load and Line Transient Responses
- With Output Automatic Discharge
- Shutdown Supply Current: 0.03uA (TYP)
- -40'C to +125'C Operating Temperature Range
- Available in Green SOT-23-5 Packages

General Description

The HCR2120 is an ultra-low noise, low VIN, high PSRR and low dropout voltage linear regulator. It is capable of supplying 500mA output current with typical dropout voltage of only 95mV. The operating input voltage range is from 1.5V to 5.5V and output voltage range is from 0.6V to 5.0V.

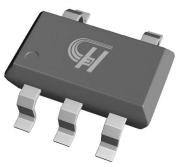
Other features include logic-controlled shutdown mode, current limit and thermal shutdown protection. The HCR2120 has automatic discharge function to quickly discharge VOUT in the disabled status.

The HCR2120 is suitable for applications which need low noise and fast transient response power supply, such as power supply of camera module in smart phone, etc.

The HCR2120 is available in Green SOT-23-5 packages. It operates over an operating temperature range of -40°C to +125°C

Applications

- Portable Electronic Devices
- Smoke Detectors and IP Cameras
- Wireless LAN Devices
- Battery-Powered Equipment
- Smartphones and Tablets
- Digital Cameras and Audio Devices



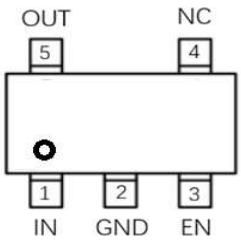
SOT-23-5

Figure 1. Package Type of HCR2120

6V, 500mA, Ultra-Low Noise, High PSRR RF-Linear Regulators

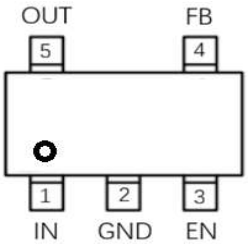
Pin Configuration

HCR2120-FIX (Top View)



SOT-23-5

HCR2120-ADJ (Top View)



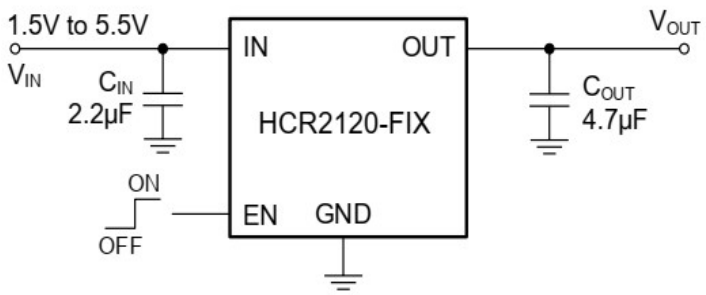
SOT-23-5

Figure 2. Pin Configuration of HCR2120 (Top View)

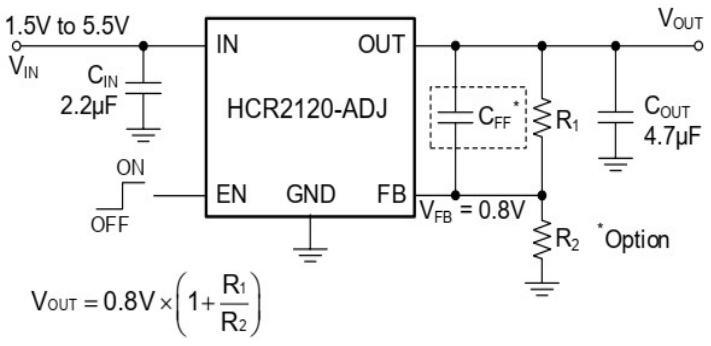
Pin Function Table

Pin		Function
SOT-23-5	Name	
1	IN	Input Voltage Supply Pin. It is recommended to use a 2.2μF or larger ceramic capacitor from IN pin to ground to get good power supply decoupling
2	GND	Ground
3	EN	Enable Pin. Drive EN high to turn on the regulator. Drive EN low to turn off the regulator. The EN pin has an internal pull-down resistance which ensures that the device is turned off when the EN pin is floated.
4	FB	Feedback Input Pin (adjustable voltage version only). Connect this pin to the external resistor divider to adjust the output voltage. Place the resistors as close as possible to this pin.
	NC	Not Connected.
5	OUT	Regulator Output Pin. It is recommended to use an output capacitor with effective capacitance in the range of 0.5μF to 100μF to ensure stability. This ceramic capacitor should be placed as close as possible to OUT pin.

Typical Application



Fixed Output Voltage Version

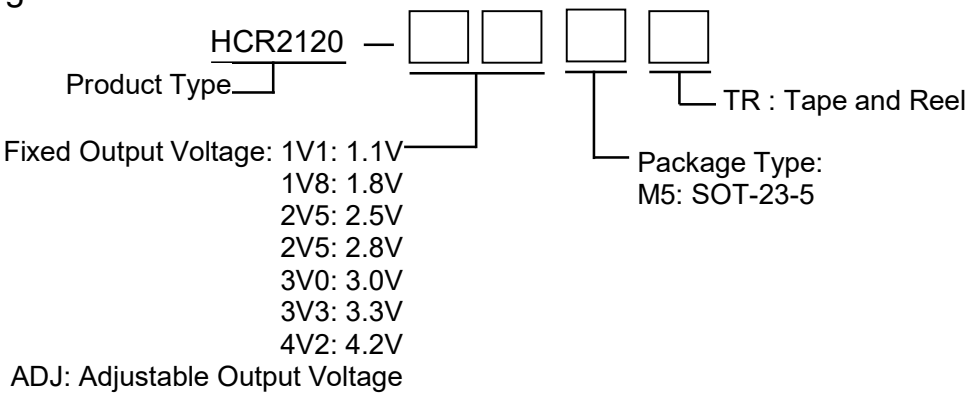


Adjustable Output Voltage Version

Figure 3. Typical Application Circuits

6V, 500mA, Ultra-Low Noise, High PSRR RF-Linear Regulators

Ordering Information



Ordering Code

Part Number	VOUT(V)	Package	Marking[1]	Package Type
HCR2120-1V1M5TR	1.1V	SOT-23-5	20Axxxx	3000, Tape and Reel
HCR2120-1V8M5TR	1.8V	SOT-23-5	20Bxxxx	3000, Tape and Reel
HCR2120-2V5M5TR	2.5V	SOT-23-5	20Cxxxx	3000, Tape and Reel
HCR2120-2V8M5TR	2.8V	SOT-23-5	20Dxxxx	3000, Tape and Reel
HCR2120-3V0M5TR	3.0V	SOT-23-5	20Exxxx	3000, Tape and Reel
HCR2120-3V3M5TR	3.3V	SOT-23-5	20Fxxxx	3000, Tape and Reel
HCR2120-4V2M5TR	4.2V	SOT-23-5	27Fxxxx	3000, Tape and Reel
HCR2120-ADJM5TR	ADJ V	SOT-23-5	20Gxxxx	3000, Tape and Reel

Note [1]. The 20A…20G and 27F are product type. and "x" is Date Code-Year, and "xxx" is Trace Code

Absolute Maximum Ratings [2,3]

Parameter		Symbol	Value	Unit
Supply Voltage, IN to GND		V_{IN}	-0.3 to 6	V
Enable Input Voltage		V_{EN}	-0.3 to 6	V
OUT, FB to GND Voltage		V_{OUT}, V_{FB}	-0.3 to (V_{IN}+0.3)	V
Package Thermal Resistance	SOT-23-5	θ_{JA}	175.9	'C/W
	SOT-23-5	θ_{JB}	40.5	'C/W
	SOT-23-5	θ_{JC}	65.7	'C/W
Junction Temperature		T_J	+150	'C
Power Dissipation at TA=25'C [4]		P_D	0.5	W
Storage Temperature Range		T_{STG}	-65 to +150	'C
Lead Temperature (Soldering, 10s)		T_{LEAD}	+260	'C
Human Body Model ESD Protection		ESD HBM	±8000	V
Machine Model ESD Protection		ESD MM	±600	V

Note 2: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

3. All voltages are with respect to the GND pin.

4. Internal thermal shutdown circuitry protects the device from permanent damage.

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Unit
Input Supply Voltage Range	V_{IN}	1.5	5.5	V
Enable Input Voltage	V_{EN}	0	5.5	V
Input Effective Capacitance	C_{IN}	0.1	-	uF
Output Effective Capacitance	C_{OUT}	0.5	100	uF
Output Current	I_{OUT}	0	500	mA
Operating Junction Temperature Range	T_A	-40	+125	'C

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Electrical Characteristics

(VIN=VOUT+0.5V, or 1.5V(whichever is greater), for HCR2120-ADJ, VOUT=0.8V, VADJ=VOUT, CIN=1uF, VOUT=1uF. Full=-40'C to +125'C, typical values are at TJ=+25'C, unless otherwise noted.)

Parameter	Symbol	Conditions		TEMP	Min	Type	Max	Unit
Input Voltage Range	VIN			+25'C	1.5	-	5.5	V
Output Voltage Range	VOUT			+25'C	0.6	-	5	V
Output Voltage Accuracy	VOUT	IOUT=0.1mA, VOUT >=1.2V		+25'C	-1	-	+1	%
		IOUT=0.1mA, VOUT >=1.2V VIN=(VOUT +0.5V) to 5.5V		Full	-2.5	-	+2.5	
Feedback Voltage	VFB	IOUT=0.1mA VIN=(VOUT+0.5V) to 5.5V		+25'C	0.792	0.80	0.808	V
				Full	0.78	-	0.82	
ADJ Pin Input Bias Current	IFB	VOUT=0.9V		+25'C	-	0	20	nA
Output Current Limit	ILIM	VOUT=0.9xVOUT, VIN=1.7V		+25'C	550	980	-	mA
Short-Circuit Current	ISHORT	VOUT=0V, VIN=1.7V		+25'C	-	560	-	mA
Ground Pin Current	IQ	No load, VEN=VIN=5.5V		+25'C	-	13	40	uA
Shutdown Current	ISHDN	VEN=0V, VIN=5.5V		+25'C	-	0.03	2.5	uA
Dropout Voltage (5)	VDROP	IOUT=500mA	VOUT=1.1V	+25'C	-	360	430	mV
			VOUT=1.8V		-	165	250	
			VOUT=5V		-	95	160	
Line Regulation	ΔVLNR	VIN=(VOUT+0.5V) to 5.5V, IOUT=0.1mA		+25'C	-	0.05	2	mV
Load Regulation	ΔVOUT /ΔIOUT	IOUT=0.1mA to 500mA, COUT=1uF		+25'C	-	0.001	0.005	mV/mA
Power Supply Rejection Ratio	PSRR	VIN=2.8V, VOUT=1.8V, IOUT=50mA	f= 217Hz	+25'C	-	88	-	dB
			f= 1KHz	+25'C	-	90	-	
			f= 10KHz	+25'C	-	86	-	
Output Voltage Noise	en	VOUT=1.8V, f=10Hz to 100KHz	IOUT= 2mA	+25'C	-	13	-	uVRMS
			IOUT= 50mA	+25'C	-	10	-	
			IOUT= 300mA	+25'C	-	9	-	
EN Input Threshold	VIH	VIN=1.5V to 5.5V		FULL	0.7	-	5.5	V
	VIL				-	-	0.3	
EN Input Bias Current	IENH	EN=VIN=5.5V		+25'C	-	0.03	1.0	uA
EN Input Bias Current	IENL	EN=0V, VIN=5.5V		+25'C	-	0.01	1.0	
Output Discharge Resistance	RDIS	VEN=0V, VOUT=0.5V, VIN=1.5V		Full	-	60	-	Ω
Turn-On Time (3)	tON	From EN rising and from 0V to VIN to 0.9VxVOUT, VOUT=1.8V		+25'C	-	260	550	us
Thermal Shutdown Temperature	TSHDN	TJ rising			-	170	-	'C
Thermal Shutdown Hysteresis	ΔTSHDN	Hysteresis			-	25	-	'C

note 5. The dropout voltage is defined as the difference between VIN and VOUT when VOUT falls to VOUT(NOM) - 50mV.

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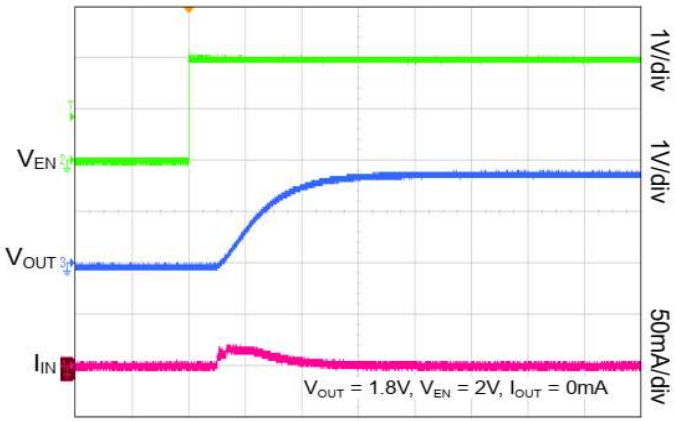
Typical Performance Characteristics

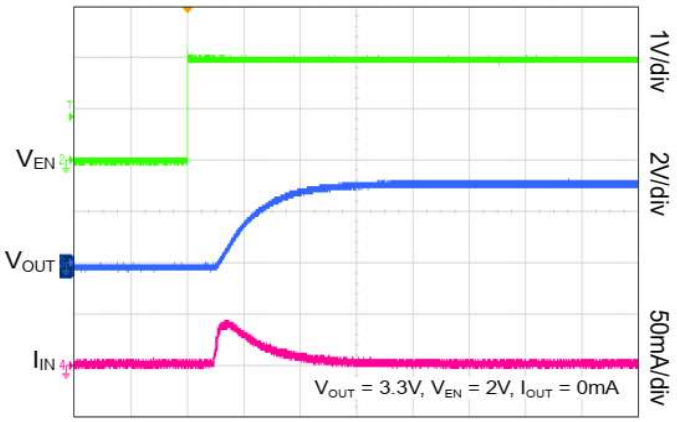
TJ = +25°C, VIN = VOUT + 0.5V, VEN = VIN, CIN = 1μF, COUT = 1μF, unless otherwise noted.

Enable Turn-On Response



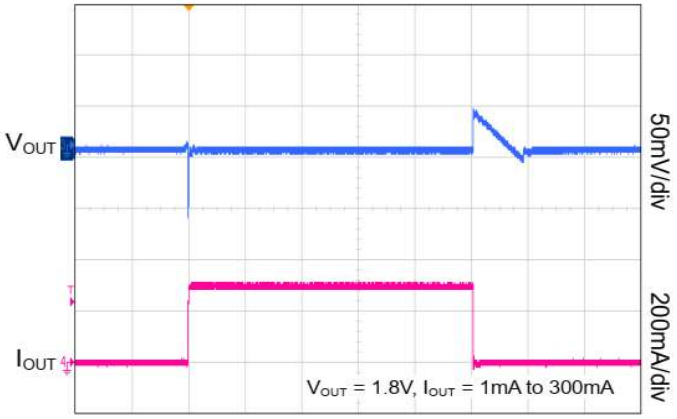
Time (100μs/div)

Enable Turn-On Response



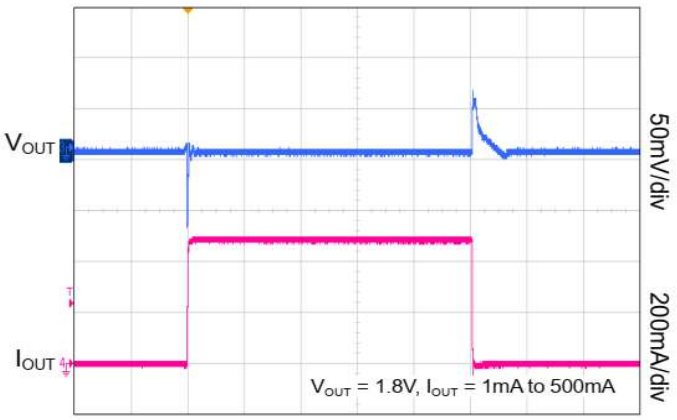
Time (100μs/div)

Load Transient Response



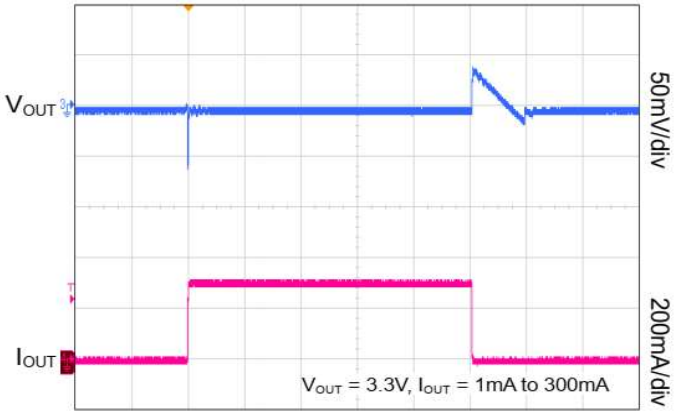
Time (50μs/div)

Load Transient Response



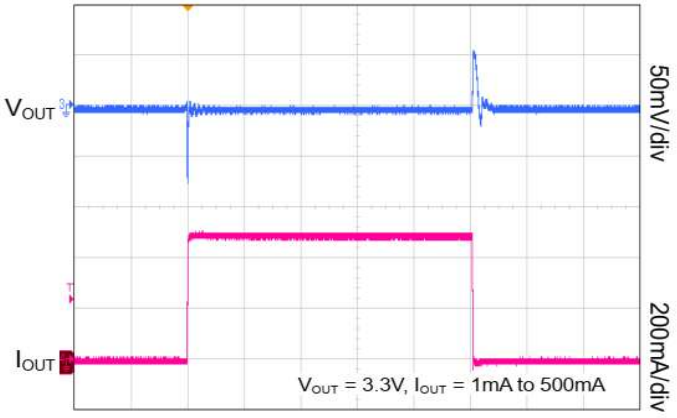
Time (50μs/div)

Load Transient Response



Time (50μs/div)

Load Transient Response

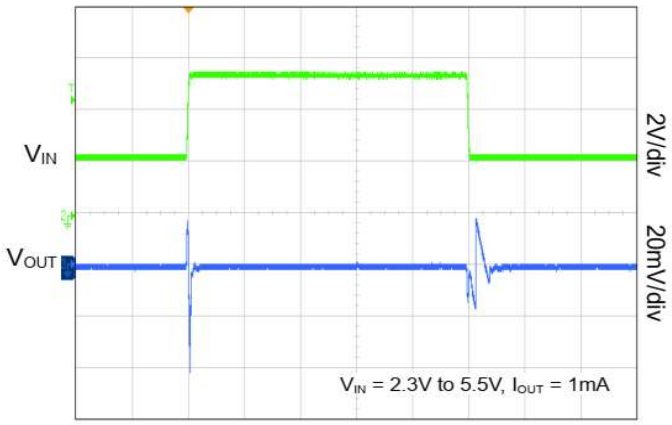


Time (50μs/div)

Typical Performance Characteristics(con.)

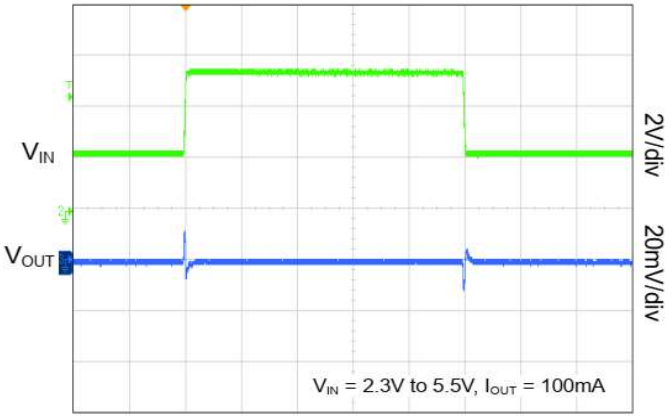
TJ = +25°C, VIN = VOUT + 0.5V, VEN = VIN, CIN = 1μF, COUT = 1μF, unless otherwise noted.

Line Transient Response



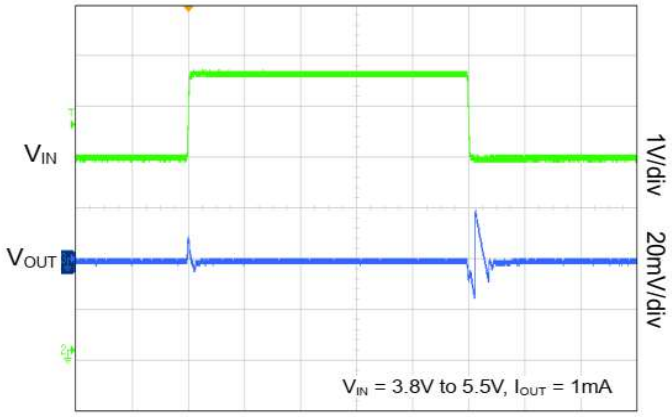
Time (100μs/div)

Line Transient Response



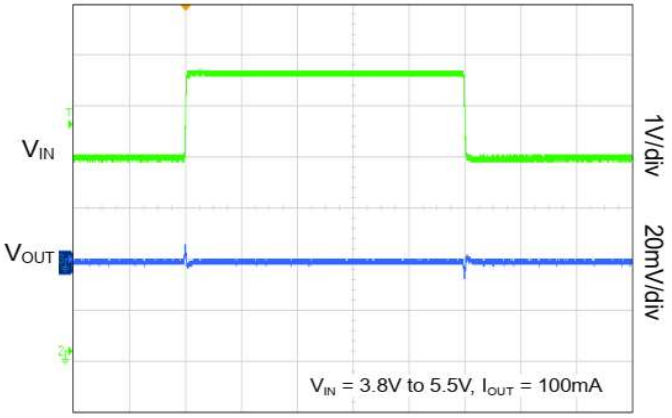
Time (100μs/div)

Line Transient Response



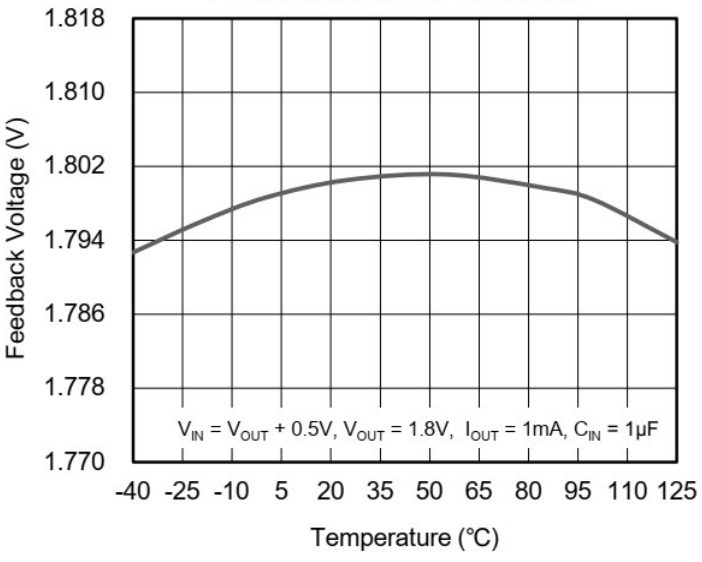
Time (100μs/div)

Line Transient Response

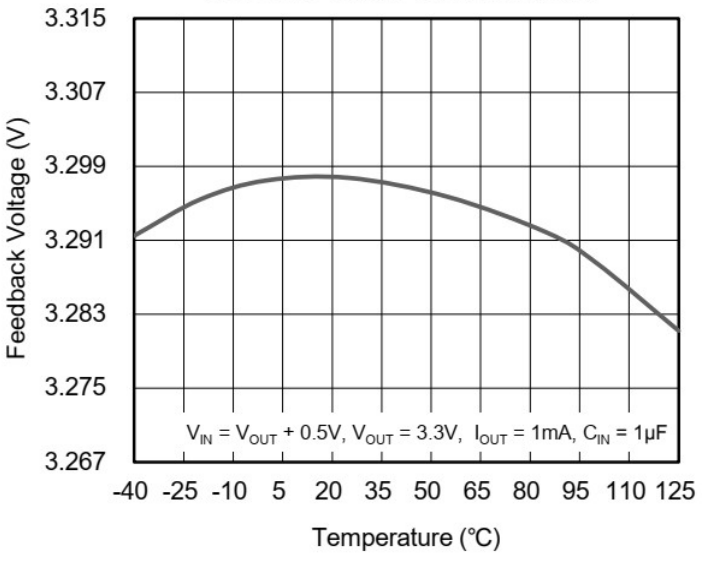


Time (100μs/div)

Feedback Voltage vs. Temperature



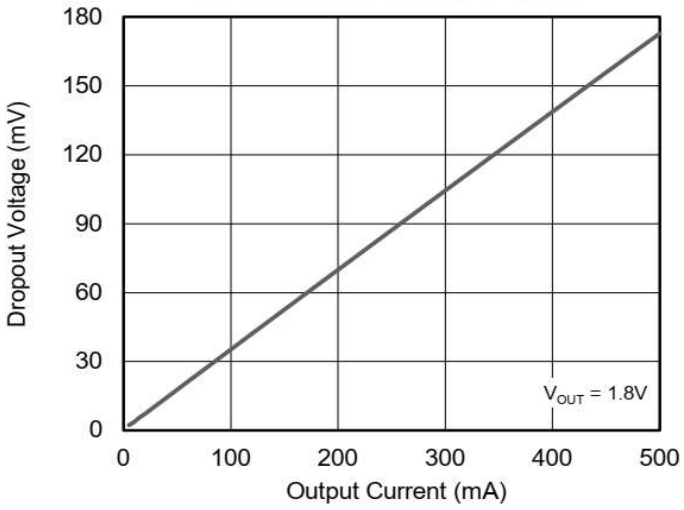
Feedback Voltage vs. Temperature



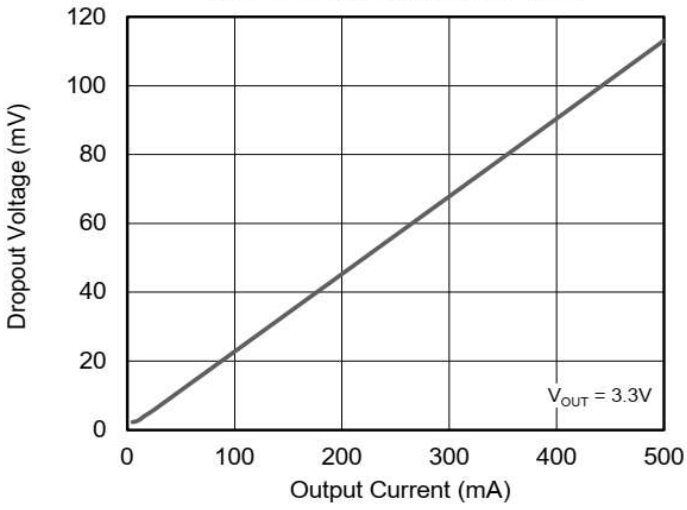
Typical Performance Characteristics(con.)

TJ = +25°C, VIN = VOUT + 0.5V, VEN = VIN, CIN = 1μF, COUT = 1μF, unless otherwise noted.

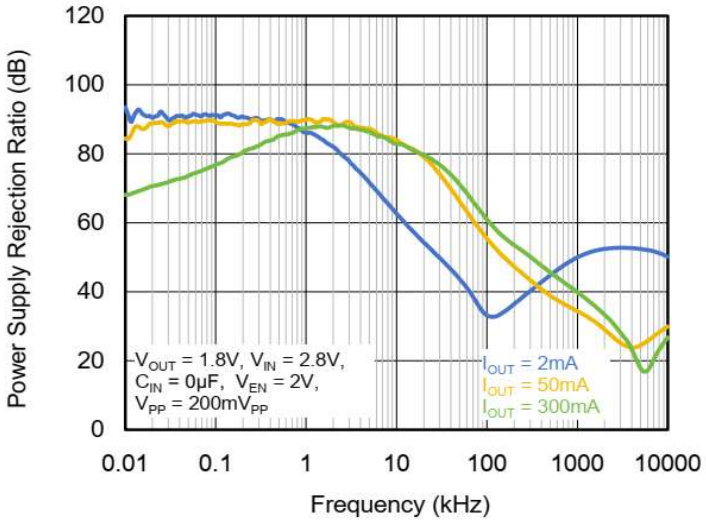
Dropout Voltage vs. Output Current



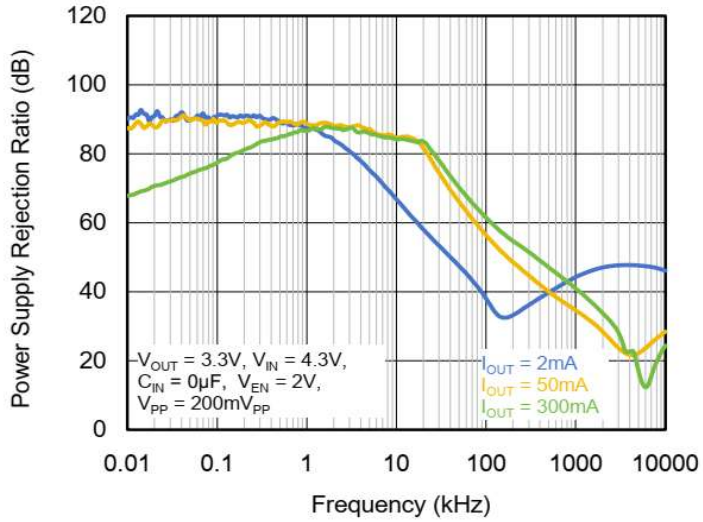
Dropout Voltage vs. Output Current



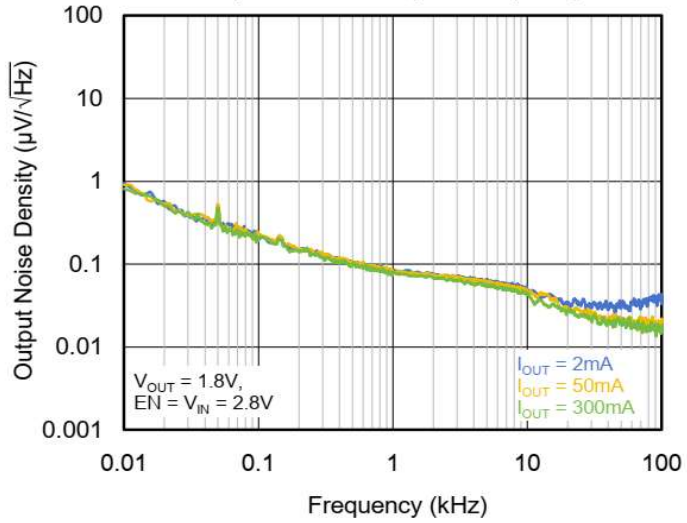
Power Supply Rejection Ratio vs. Frequency



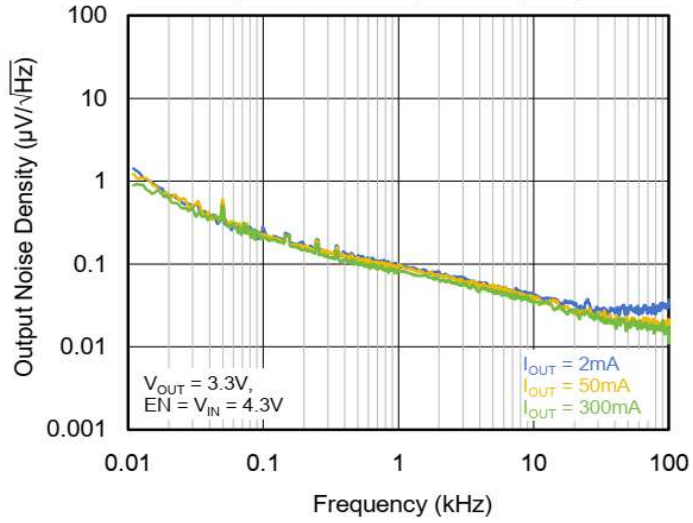
Power Supply Rejection Ratio vs. Frequency



Output Noise Density vs. Frequency

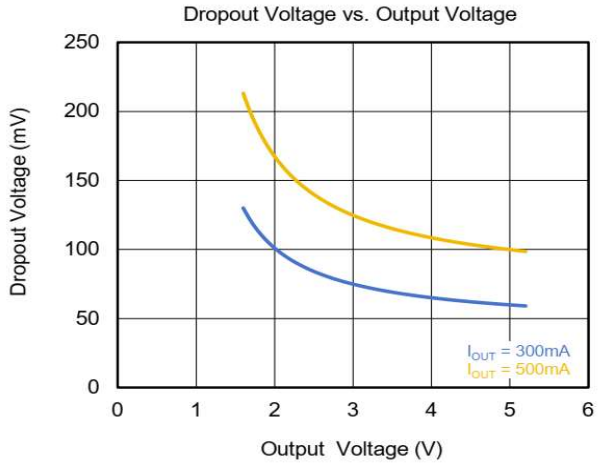


Output Noise Density vs. Frequency



Typical Performance Characteristics(con.)

TJ = +25°C, VIN = VOUT + 0.5V, VEN = VIN, CIN = 1μF, COUT = 1μF, unless otherwise noted.



Functional Block Diagrams

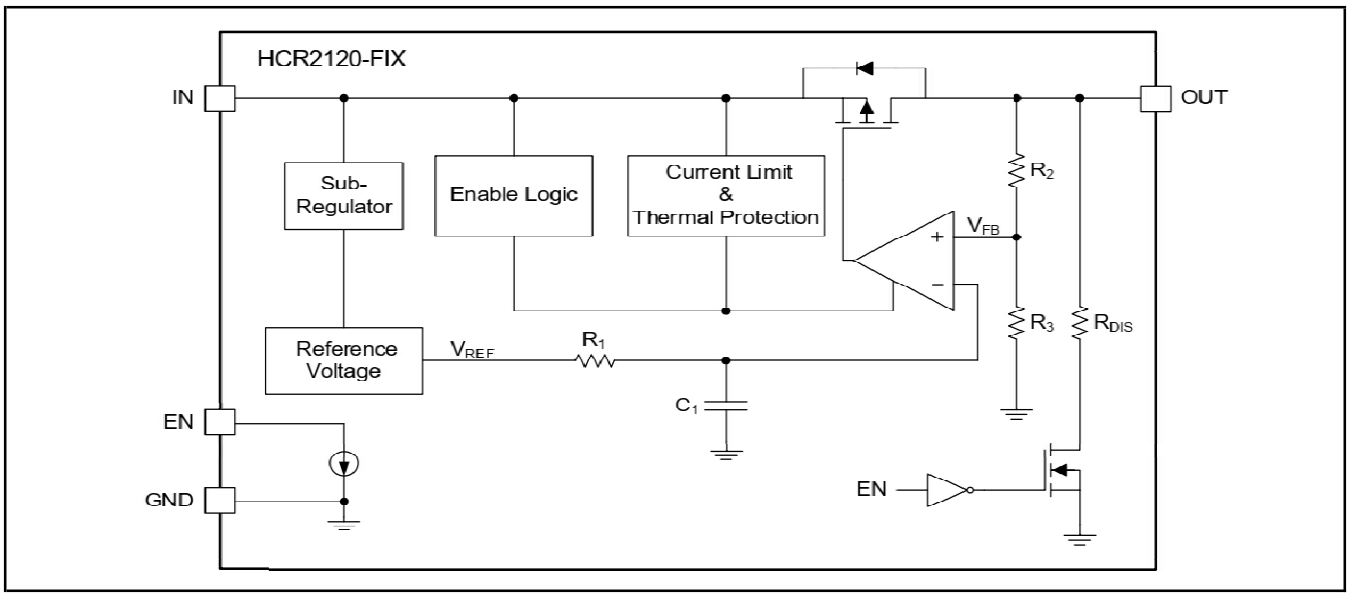


Figure 4. Fixed Output Regulator Block Diagram

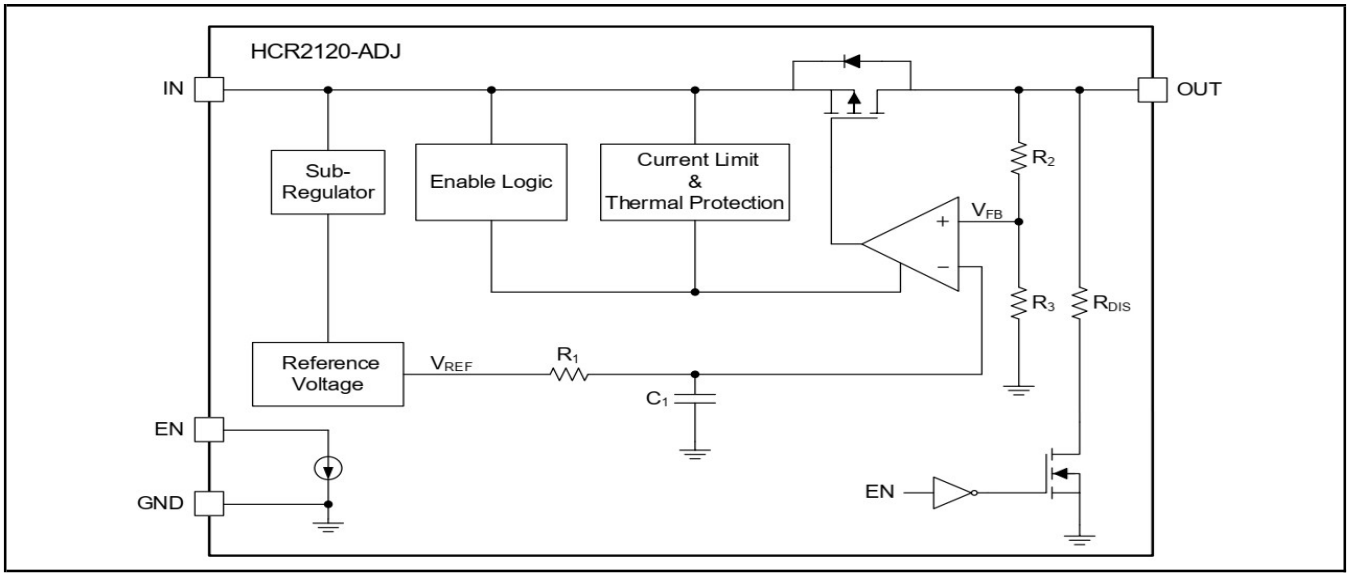


Figure 5. Adjustable Output Regulator Block Diagram

Application Information

The HCR2120 is a low VIN, ultra-low noise and low dropout LDO and provides 500mA output current. These features make the device a reliable solution to solve many challenging problems in the generation of clean and accurate power supply.The high performance also makes the HCR2120 useful in a variety of applications. The HCR2120 provides the protection functions for output overload and overheating.

The HCR2120 provides an EN pin as an external chip enable control to enable/disable the device. When the regulator is in shutdown state, the shutdown current consumes as low as 0.03μA (TYP).

Input Capacitor Selection (CIN)

The input decoupling capacitor should be placed as close as possible to the IN pin for ensuring the device stability. CIN = 2.2μF or larger X7R or X5R ceramic capacitor is selected to get good dynamic performance.

When VIN is required to provide large current instantane -ously, a large effective input capacitor is required. Multiple input capacitors can limit the input tracking inductance. Adding more input capacitors is available to restrict the ringing and to keep it below the device absolute maximum ratings. For COUT with larger capacitance, it is recommended to choose the larger capacitance CIN.

Output Capacitor Selection (COUT)

One or more output capacitors are required to maintain the stability of the LDO, and the output capacitors should be placed as close as possible to the OUT pin. In addition, in order to obtain the best transient performance, it is recommended to use X7R and X5R ceramic capacitors as output capacitors.Ceramic capacitors have low equivalent series resistance (ESR), excellent temperature and DC bias characteristics. However, it cannot be ignored that the effective capacitance of ceramic capacitors is affected

Output Capacitor Selection (COUT)(con.)

by temperature, DC bias and package size.

For example, Figure 4 shows the capacitance and DC bias and temperature characteristics of 0805, 10V, 10uF±10%, X7R capacitor. Therefore, it is necessary to evaluate whether the effective capacitance of the output capacitor can meet the stability requirements of the LDO in practical applications. In general, a capacitor in higher voltage rating and a larger package exhibits better stability, and the effective capacitance can be obtained from the manufacturer datasheet.

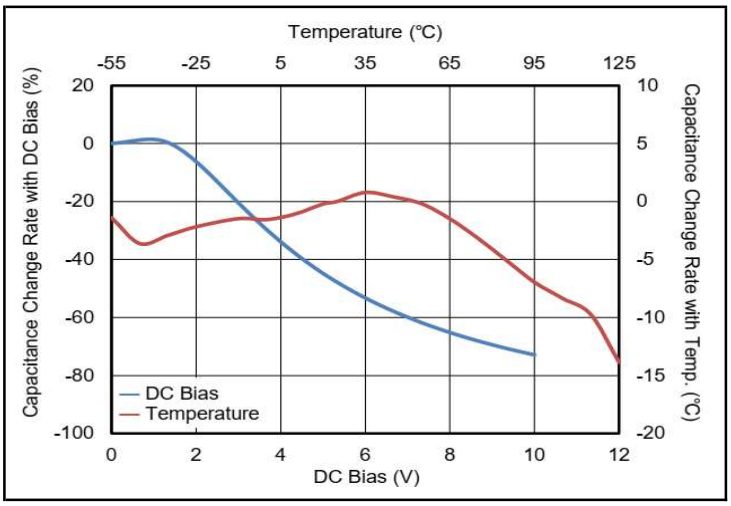


Figure 6. Capacitance vs. DC Bias and Temperature Characteristics

The HCR2120 requires a minimum effective capacitance of 0.5μF for COUT to ensure stability Additionally, COUT with larger capacitance and lower ESR will help increase the high frequency PSRR and improve the load transient response.

Enable Operation

The EN pin of the HCR2120 is used to enable/disable its device and to deactivate/activate the output automatic discharge function.

When the EN pin voltage is lower than 0.3V, the device is in shutdown state. There is no current flowing from IN to OUT pins. In this state, the automatic discharge transistor is active to discharge the output voltage through a 60Ω (TYP) resistor.

Application Information(con.)

Enable Operation(con.)

When the EN pin voltage is higher than 0.7V, the device is in active state. The output voltage is regulated to the expected value and the automatic discharge transistor is turned off.

The EN pin is pulled down by internal 0.03μA (TYP) current source when the EN pin is floated. This current source will ensure the HCR2120 in shutdown state and reduce the power dissipation in system.

Adjustable Regulator

For the HCR2120-ADJ, set the output voltage by using a resistor divider as shown in Figure 7. Capacitance C_{FF}=10nF can be added to improve stability and reduce noise. Choose R2 ≤ 40kΩ to maintain a 20μA minimum load. Calculate the value for R1 using the following equation:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{0.8V} - 1 \right) \quad (1)$$

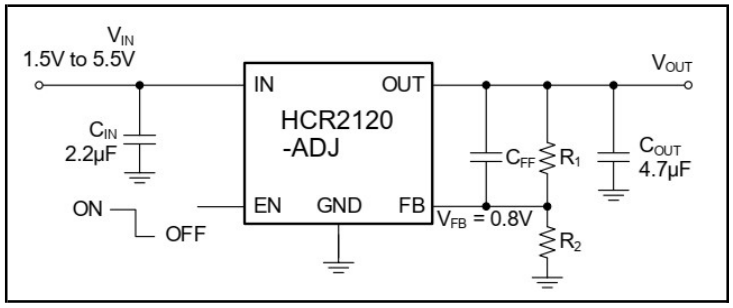


Figure 7. Adjustable Output Voltage Application

Negatively Biased Output

When the output voltage is negative, the chip may not start up due to parasitic effects. Ensure that the output is greater than -0.3V under all conditions. If negatively biased output is excessive and expected in the application, a Schottky diode can be added between the OUT pin and GND pin.

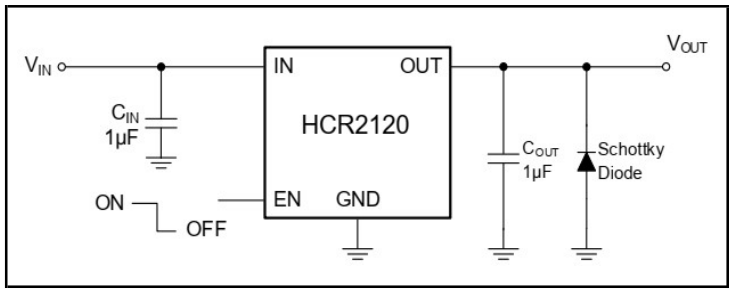


Figure 8. Negatively Biased Output Application

Output Current Limit Protection

When overload events happen, the output current is internally limited to 980mA (TYP). When the OUT pin is shorted to ground, the output current is internally limited to 560mA (TYP).

Thermal Shutdown

The HCR2120 can detect the temperature of die. When the die temperature exceeds the threshold value of thermal shutdown, the HCR2120 will be in shutdown state and it will remain in this state until the die temperature decreases to +145°C.

Power Dissipation (PD)

Power dissipation(PD) of the HCR2120 can be calculated by the equation PD = (VIN - VOUT) × IOUT.

The maximum allowable power dissipation (PD(MAX)) of the HCR2120 is affected by many factors, including the difference between junction temperature and ambient temperature (TJ(MAX) - TA), package thermal resistance from the junction to the ambient environment (θJA), the rate of ambient airflow and PCB layout. PD(MAX) can be approximated by the following equation:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A)/\theta_{JA} \quad (2)$$

where $T_{J(MAX)}$ is the maximum junction temperature, TA is the ambient temperature, and θJA is the junction-to-ambient thermal resistance.

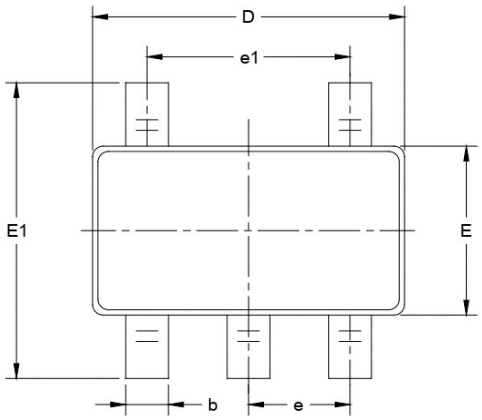
Layout Guidelines

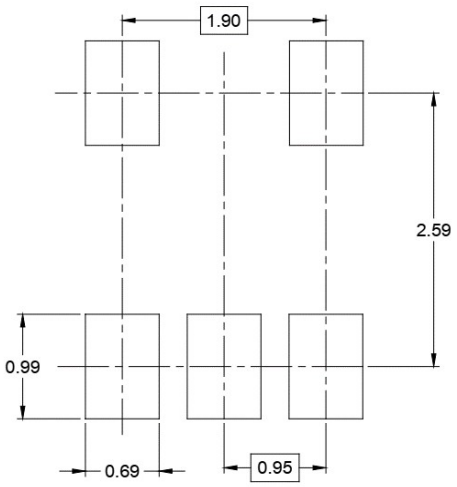
To get good PSRR, low output noise and high transient response performance, the input and output bypass capacitors must be placed as close as possible to the IN pin and OUT pin separately.

Mechanical Dimensions

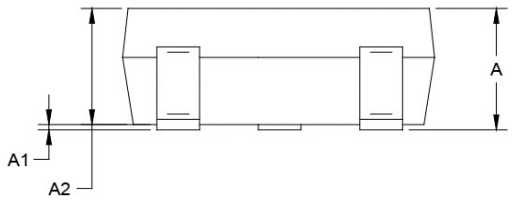
PKG:SOT-23-5 (M5)

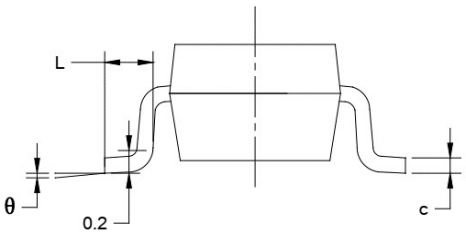
Unit: mm (inch)





RECOMMENDED LAND PATTERN (Unit: mm)

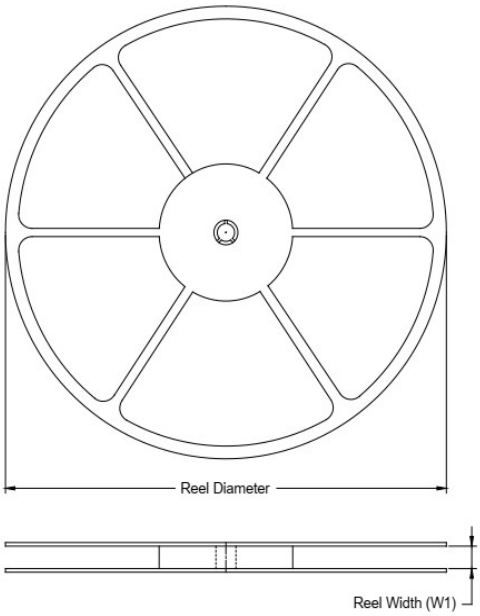




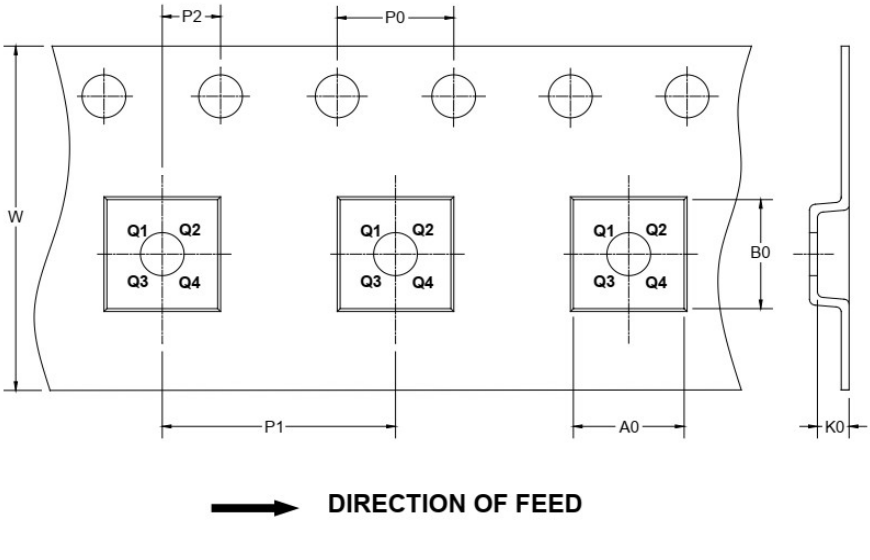
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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



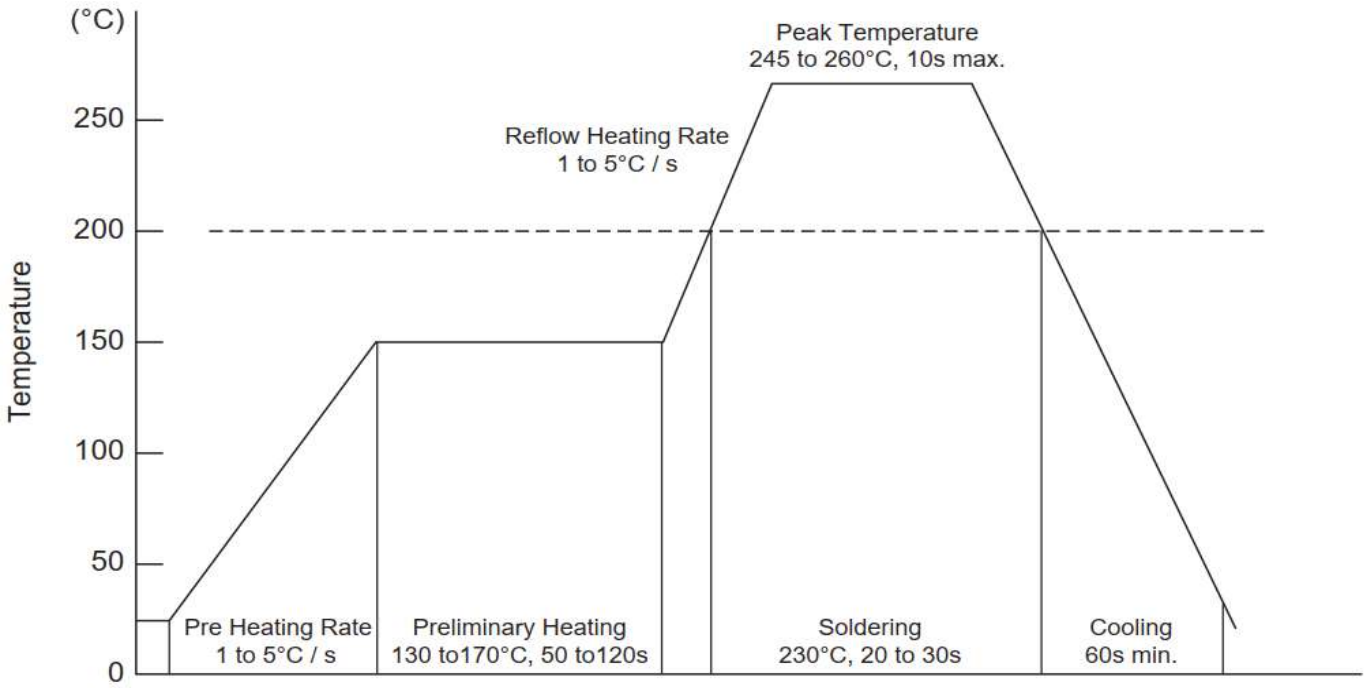
NOTE: The picture is only for reference. Please make the object as the standard.

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

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