30V, 400mA, Low Dropout Voltage Linear Regulator

Features

- Input Voltage Range: 2V to 30V
- 400mA Output Current
- 2.2uA Ground Current at no Load
- Output Voltage Accuracy: ±2% at +25'C
- 10nA Disable Current
- Dropout Voltage: 0.15V(Type) at 100mA/V_{out} 5V
- Fixed Outputs of 1.2V, 1.8V, 2.5V, 3.3V, 5V 9V and 12V
- Adjustable Output Voltage: 1.2V to 12V
- Stable with Ceramic or Tantalum Capacitor
- Current Limit Protect
- Over-Temperature Production
- SOT23-5 Package Available
- -40'C to +125'C Operating Temperature Range

General Description

The HCR2423 series are a group of low-dropout (LDO) voltage regulators offering the benefits of wide input voltage range, low dropout voltage, low power consumption, and miniaturized packaging.

Quiescent current of only 2.2μA 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 a shutdown mode by pulling the EN pin low. The shutdown current in this mode goes down to only 10nA(typical).

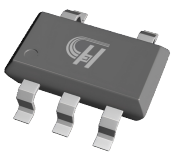
The HCR2423 series of linear regulators are stable with the ceramic output capacitor over its wide input range from 2V to 30V and the entire range of output load current (0mA to 400mA)

Applications

- Portable, Battery Powered Equipment
- Low Power Microcontrollers
- Laptop, Palmtops and PDAs
- Wireless Communication Equipment
- Audio/Video Equipment
- Car Navigation Systems
- Industrial Controls
- Weighting Scales
- Home Automation and Meters

Packages

- SOT23-5



SOT23-5

Figure 1. Package Type of HCR2423

30V, 400mA, Low Dropout Voltage Linear Regulator

Pin Configuration

Package : SOT23-5 (M5)

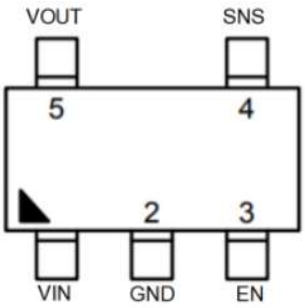


Figure 2. Pin Configuration of HCR2423 (Top View)

Pin Function Table

Pin No	NAME	Function
1	VIN	Input of Supply Voltage.
2	GND	Ground
3	EN	Enable Control Input.
4	SNS	Sense of Output Voltage
5	VOUT	Output of the Regulator.

Ordering Information

Circuit Type / □ □ □

Type:
HCR2423

TR : Tape and Reel

Package:
M5: SOT23-5

Output Voltage:
ADJ: Adjustable output voltage
1V2 : 1.2V, 1V8 : 1.8V
3V3 : 3.3V, 5V0 : 5.0V
9V0 : 9.0V, 12V0: 12.0V

Ordering Code

Part Number	VOUT(V)	Temperature Range	Package	Package Type
HCR2423/ADJM5TR	ADJ	-40'C to +125'C	SOT23-5	3000pcs/TR
HCR2423/1V2M5TR	1.2V	-40'C to +125'C	SOT23-5	3000pcs/TR
HCR2423/1V8M5TR	1.8V	-40'C to +125'C	SOT23-5	3000pcs/TR
HCR2423/3V3M5TR	3.3V	-40'C to +125'C	SOT23-5	3000pcs/TR
HCR2423/5V0M5TR	5.0V	-40'C to +125'C	SOT23-5	3000pcs/TR
HCR2423/9V0M5TR	9.0V	-40'C to +125'C	SOT23-5	3000pcs/TR
HCR2423/12V0M5TR	12.0V	-40'C to +125'C	SOT23-5	3000pcs/TR

Absolute Maximum Ratings Note 1

Parameter		Symbol	Value	Unit
Input Voltage from VIN to GND		V_{IN}	-0.3 to 36	V
Input Voltage from EN to GND		V_{EN}	-0.3 to 36	V
SNS to GND Voltage Range		V_{SNS}	-0.3 to 6	V
Output to GND	HCR2423-12V/9V	V_{OUT1}	-0.3 to 14	V
	HCR2423-1V2&1V8&3V3&5V0	V_{OUT2}	-0.3 to 6	V
VOUT to VIN		$V_{O/I}$	-36 to 0.3	mA
Thermal Resistance Junction to Ambient	SOT23-5	θ_{JA}	200	'C/W
Storage Temperature Range		T_{STG}	-60 to +150	'C
Operating Temperature Range note 2		T_{OTR}	-40 to +125	'C
Junction Temperature		T_J	150	'C
Lead Temperature (Soldering, 10s)		T_{LEAD}	260	'C
ESD(Machine Mode)		MM	200	V
ESD(Human Body Mode)		HBM	2000	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.

Recommended Work Conditions

Parameter	Symbol	Min	Max	Unit
Input Voltage Range	V_{IN}	2.0	30	V
Output Capacitor Range	C_{OUT}	2.2	22	uF
Junction Temperature Range	T_J	-40	+125	'C
Ambient Temperature Range	T_A	-40	+85	'C

Electrical Characteristics

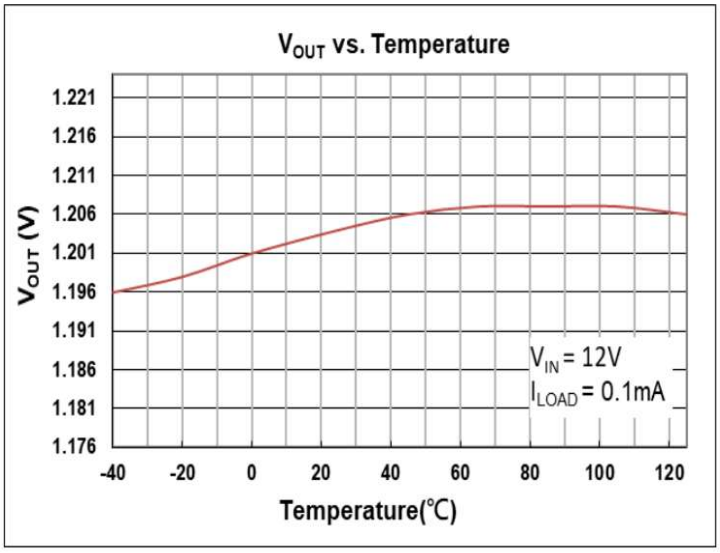
(V_{IN} =15V, V_{EN} =5V, T_A=25°C unless otherwise specified)

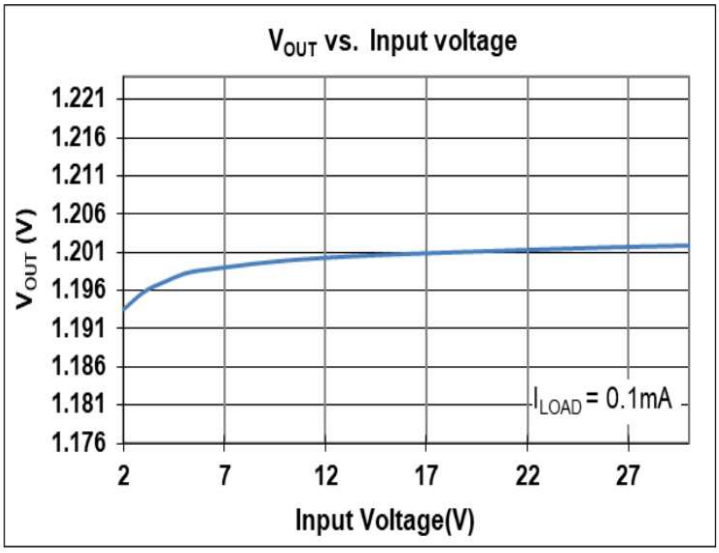
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{IN}		2	--	30	V
DC Output Voltage Accuracy		I_{LOAD} =0.1mA	-2		2	%
Dropout Voltage (I_{LOAD} =100mA)	V_{DROP}	V_{OUT} ≥ 5V	--	0.15		V
	$V_{DROP\_3.3V}$	V_{OUT} = 3.3V		0.15		
	$V_{DROP\_1.8V}$	V_{OUT} = 1.8V		0.25		
Dropout Voltage (V_{OUT} =1.8V)	$V_{DROP\_1.8V}$	I_{LOAD}=200mA	--	0.47		V
		I_{LOAD}=300mA		0.69		
		I_{LOAD}=400mA		0.93		
Ground Current (I_{LOAD} = 0mA)	I_Q	V_{OUT} ≤ 5V		2.2		μA
	I_{QH}	5V < V_{OUT} ≤ 12V		4.2		
Shutdown Ground Current	I_{SD}	V_{EN} = 0V, V_{OUT} = 0V		0.01	0.5	μA
V_{OUT} Shutdown Leakage Current	I_{LEAK}			0.01	0.5	μA
SNS Input Current	I_{SNS}	SNS = V_{OUT} V_{OUT} ≤ 5V		0.9		μA
Enable Threshold Voltage	V_{IH}	EN Rising			2	V
	V_{IL}	EN Falling	0.6			
EN Input Current	I_{EN}	V_{EN} = 30V		10	100	nA
Line Regulation	ΔLINE	I_{LOAD} =1mA, 5 ≤ V_{IN} ≤ 30V	--	0.3		%
Load Regulation	ΔLOAD	1mA≤ I_{LOAD} ≤ 0.2A		0.1		%
Output Current Limit	I_{LIM}	V_{OUT} =0	401	600		mA
Power Supply Rejection Ratio	PSRR	V_{OUT} =5V, I_{LOAD} =1mA, V_{IN} = 12V, f = 100Hz		70		dB
Thermal Shutdown Temperature	T_{SD}	I_{LOAD} =10mA	--	160	--	°C
Thermal Shutdown Hysteresis	ΔT_{SD}			15		°C

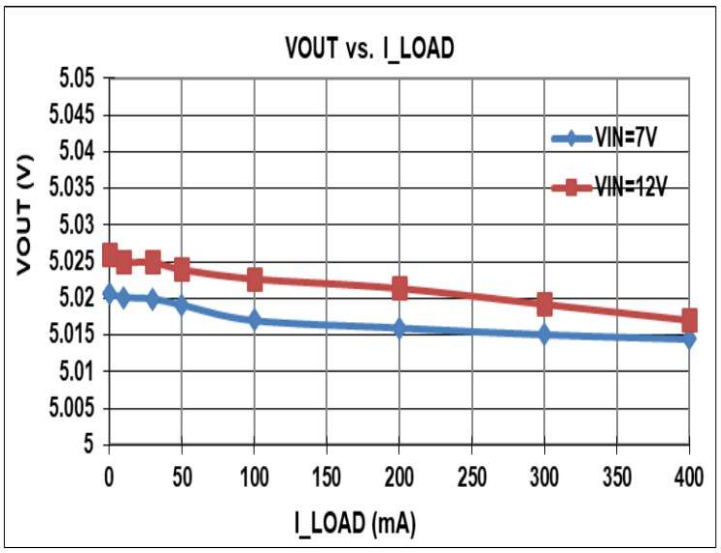
Note 1. Stresses beyond those listed "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

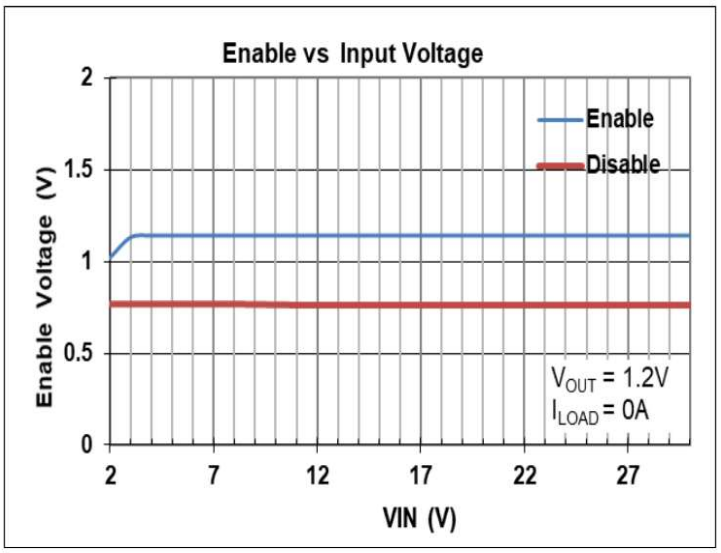
Note 2. θ_{JA} is measured at T_A = 25°C on a HCR-SEMI EVB board.

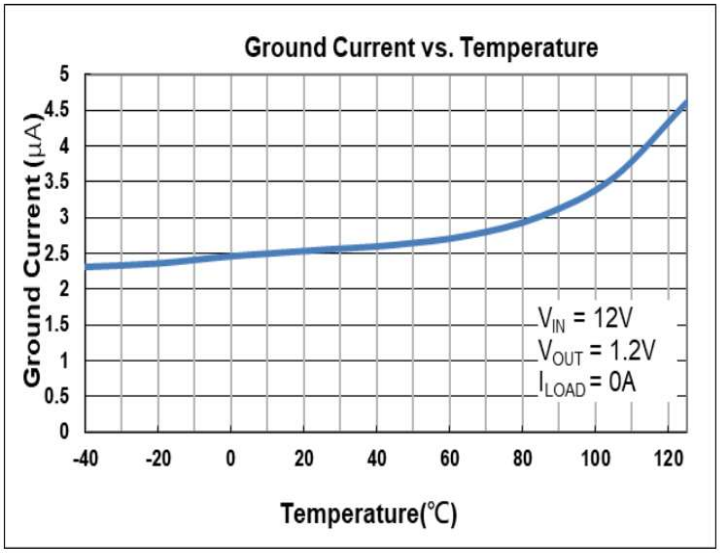
Typical Characteristics

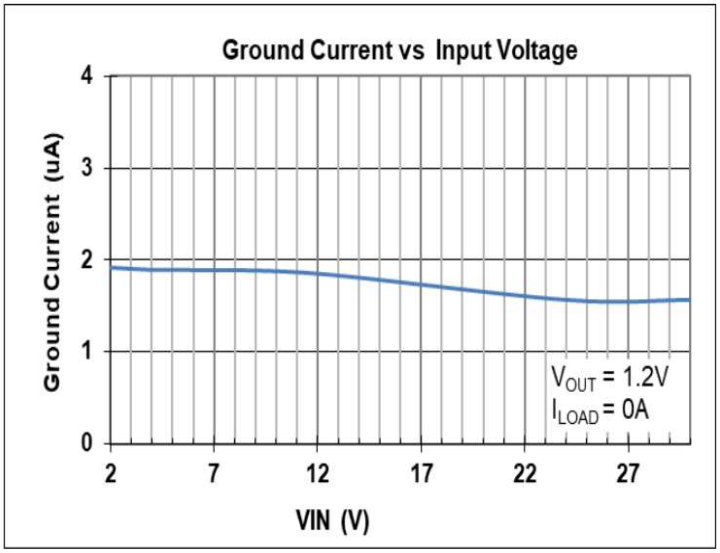






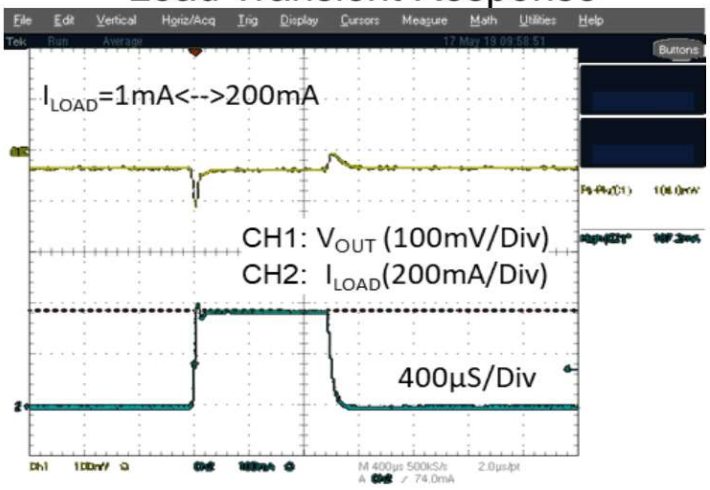




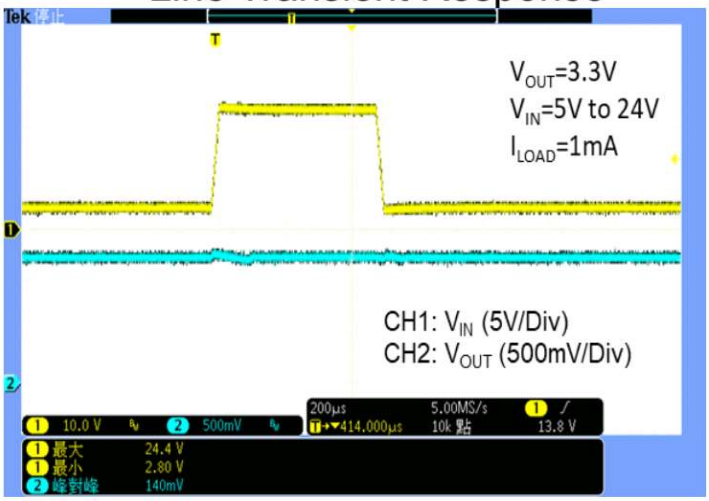


Typical Characteristics (Con.)

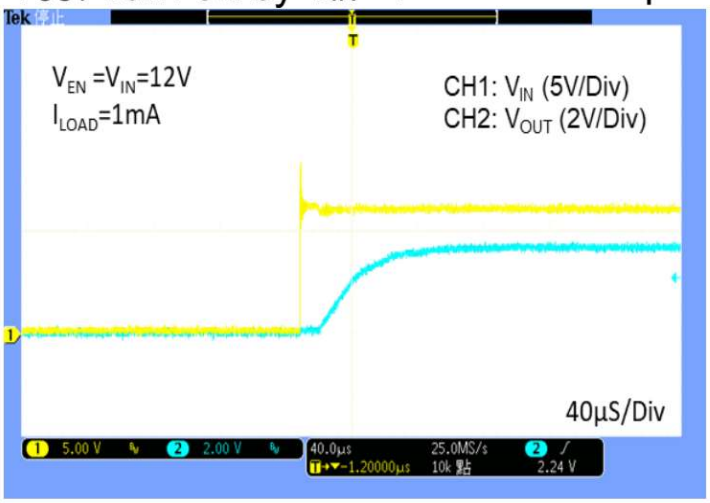
Load Transient Response



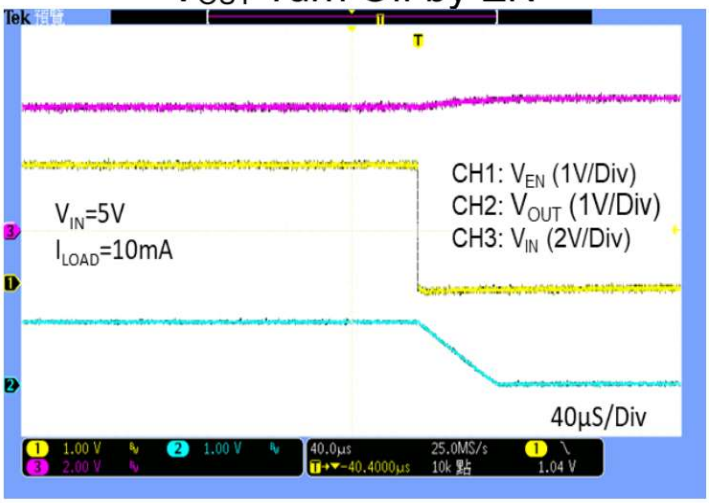
Line Transient Response



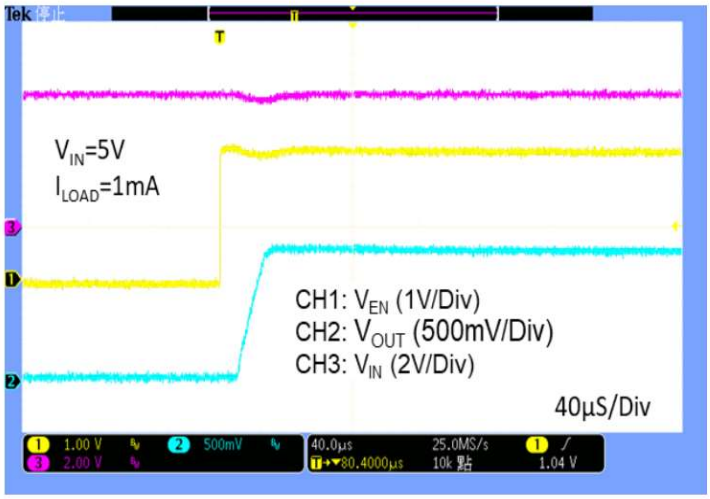
V_{OUT} Turn on by V_{IN} Quick Power Up



V_{OUT} Turn Off by EN



V_{OUT} Turn On by EN



Function Block Diagram

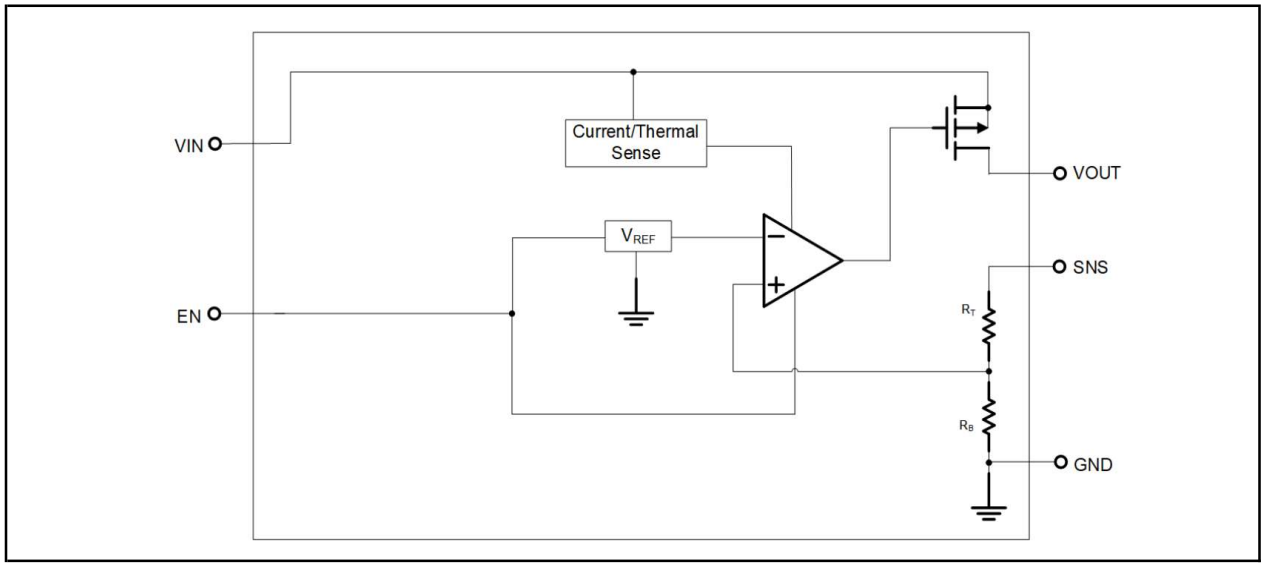


Figure 3. Function Block Diagram

Typical Application Circuits

Fixed Vout LDO with enable and sense functions

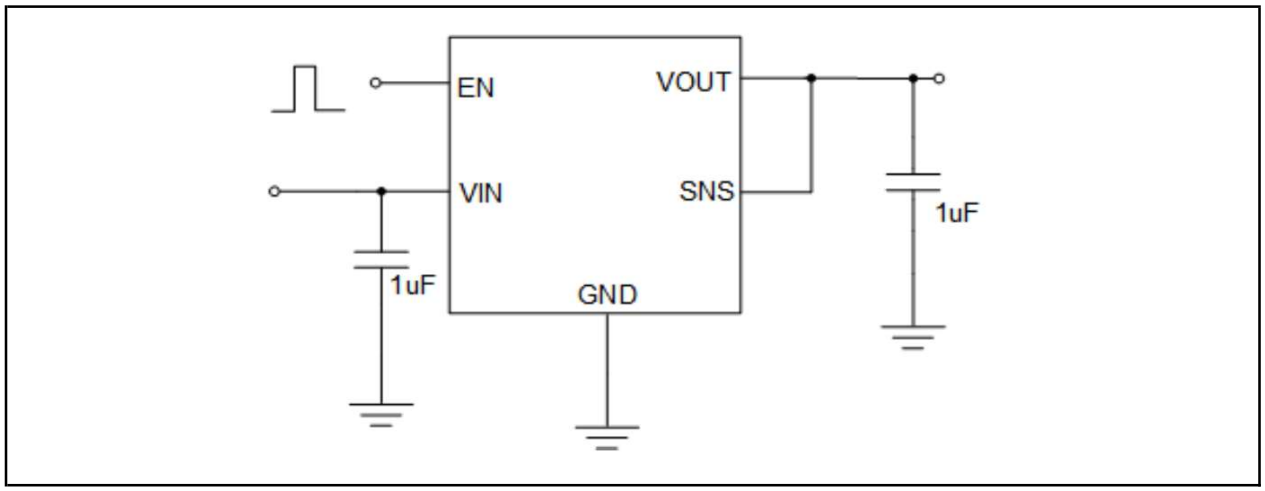


Figure 4. Fixed Vout LDO with enable and sense functions

Adjustable Vout LDO with enable and sense functions

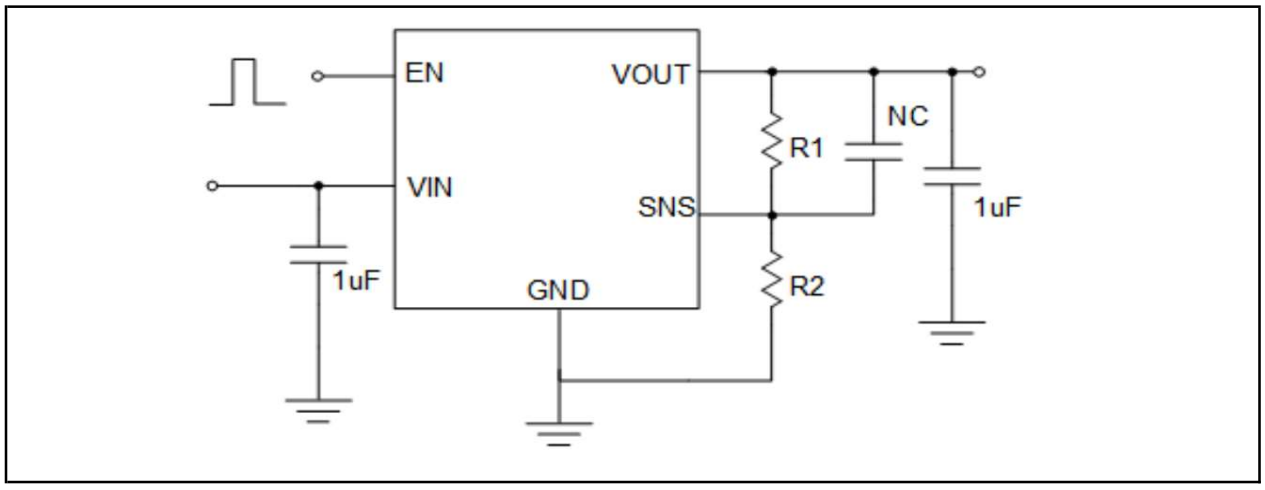


Figure 5. Adjustable Vout LDO with enable and sense functions

Applications Information

Input and Output Capacitor Requirements

The external input and output capacitors of HCR2423 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 HCR2423 series contain the current limiter of output power transistor, which monitors and controls the transistor, limiting the output current to 300mA (typical). The output can be shorted to ground indefinitely without damaging the part.

Dropout Voltage

The HCR2423 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 HCR2423 with 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. In order 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 HCR2423

The maximum adjustable output voltage is 12V.

Generally, maximize the available adjustable output voltage range, HCR2423-1V8 is recommended (VSNS is 1.8V in formula 1 now).

The minimum recommended 50μA in the resistor divider makes the application no longer a 2.2μA low quiescent LDO.

OTP (Over Temperature Protection)

The over temperature protection function of the HCR2423 series will turn off the P-MOSFET when the junction temperature exceeds 160°C (typ.). Once the junction temperature cools down by approximately 15°C, the regulator will automatically resume operation.

Applications Information(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, DS-Tech PCB,

The max PD(max)=(125'C-25'C)/(200'C/W)=0.5W for SOT23-5 packages.

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) × IOUT

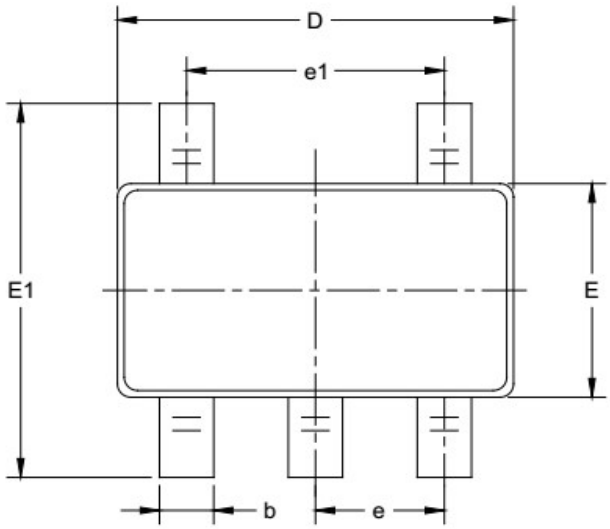
Layout Consideration

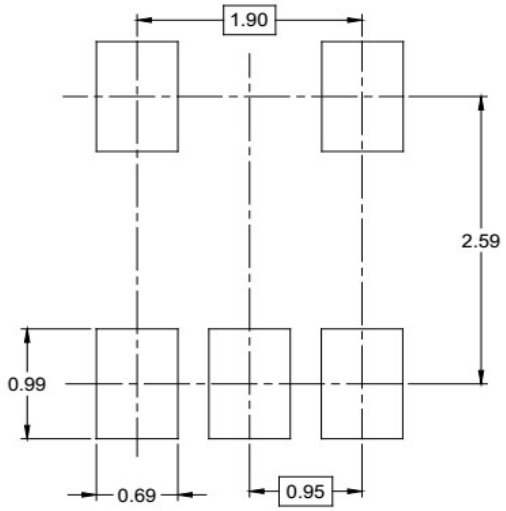
By placing input and output capacitors on the same side of the PCB as the LDO, and placing them as close as is practical to the package can achieve the best performance. The ground connections for input and output capacitors must be back to the HCR2423 ground pin using as wide and as short of a copper 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.

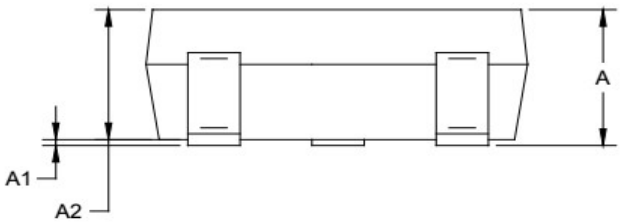
Mechanical Dimensions

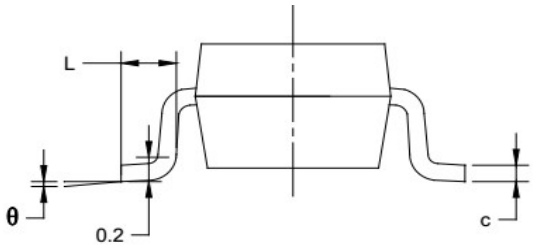
PKG:SOT23-5 (M5) **Unit: mm (inch)**





RECOMMENDED LAND PATTERN (Unit: mm)

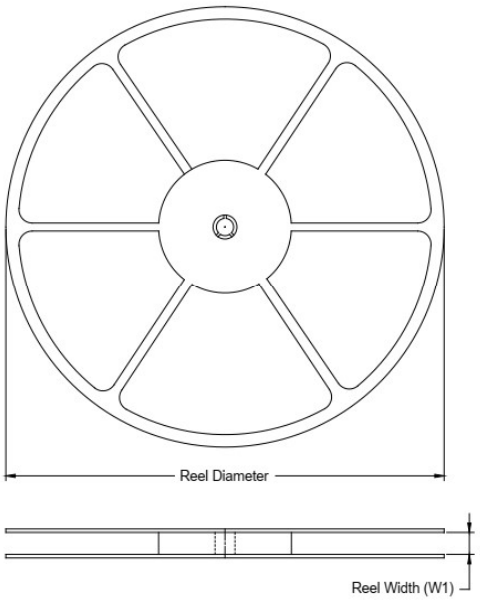




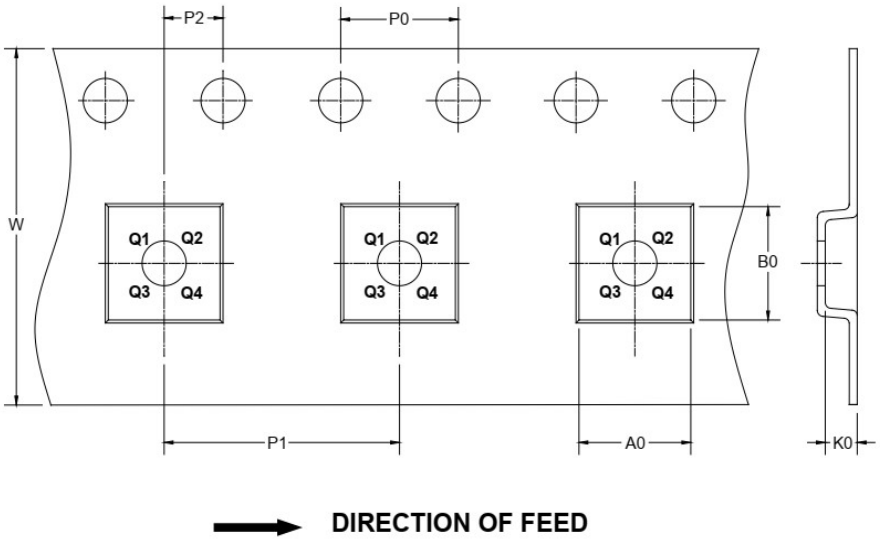
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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



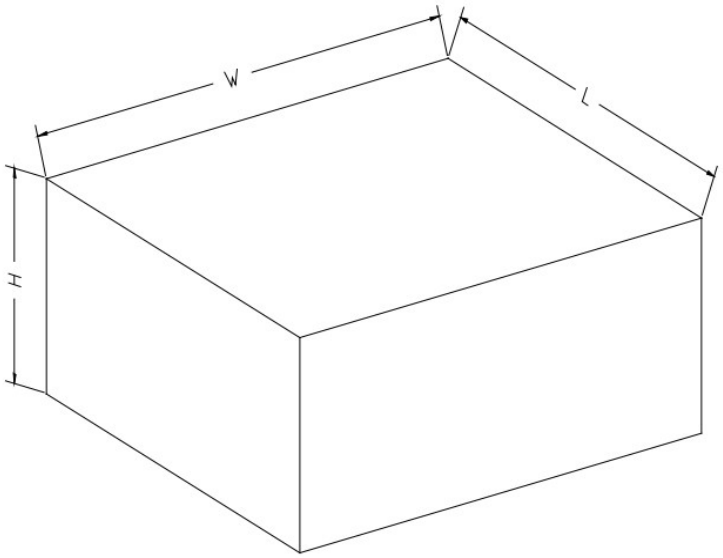
DIRECTION OF FEED

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

CARTON BOX DIMENSIONS



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

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″	442	410	224	18