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## **MSXC6210BxxxMR**

**Product specification**

## GENERAL DESCRIPTION

The MSXC6210BxxxMR is a low-dropout (LDO) voltage regulators with enable function that operates from 1.2V to 5.5V. It provides up to 600mA of output current and offers lowpower operation in miniaturized packaging. The features of low quiescent current as low as 2A and almost zero disable current is ideal for powering the battery equipment to a longer service life. The MSXC6210BxxxMR is stable with the ceramic output capacitor over its wide input range from 1.2V to 5.5V and the entire range of output load current.

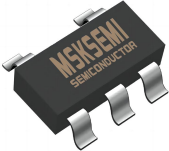
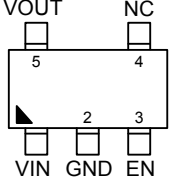
## FEATURES

- 2μA Ground Current at no Load
- PSRR = 75dB at 1kHz
- Adjustable Output Voltage Available by Specific Application
- ±2% Output Accuracy
- 600mA (VIN ≥ 2.3V) Output Current with EN
- Low (0.1μA) Disable Current
- 1.2V to 5.5V Operating Input Voltage
- Dropout Voltage : 0.31V at 600mA when VOUT ≥ 3V
- Support Fixed Output Voltage 0.8V to 3.3V
- Stable with Ceramic or Tantalum Capacitor
- Current-Limit Protection
- Over-Temperature Protection
- SOT-23-5 Packages Available




## APPLICATIONS

- Portable, Battery Powered Equipment
- Ultra Low Power Microcontrollers
- Notebook Computers

## Reference News

SOT-23-5	PIN CONFIGURATION
	

## MARKING

MSXC6210B122MR	MSXC6210B152MR	MSXC6210B182MR	MSXC6210B252MR
			
MSXC6210B282MR	MSXC6210B302MR	MSXC6210B332MR	
			

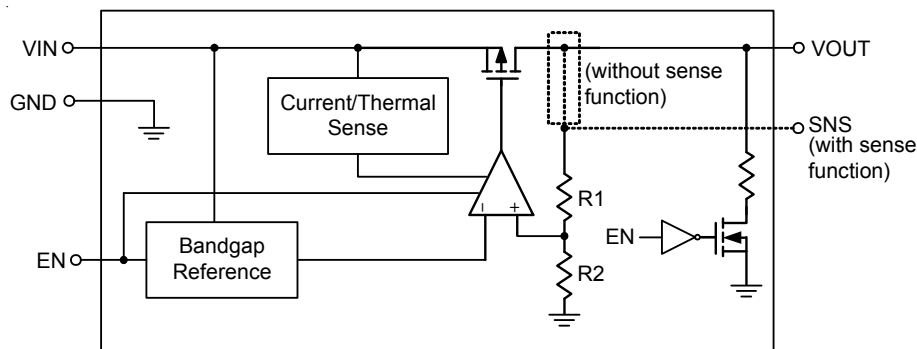
## Functional Pin Description

Pin No.	Pin Name	Pin Function
SOT-23-5		
1	VIN	Supply voltage input.
2	GND	Ground.
3	EN	Enable control input.
4	NC	No internal connection.
5	VOUT	Output of the regulator.

## ORDER INFORMATION

P/N	PKG	QTY
MSXC6210BxxxMR	SOT-23-5	3000

## FunctionalBlockDiagram



## Operation

### Basic Operation

The MSXC6210BxxxMR is a low quiescent current linear regulator designed especially for low external components system. The input voltage range is from 1.2V to 5.5V.

The minimum required output capacitance for stable operation is 1 $\mu$ F effective capacitance after consideration of the temperature and voltage coefficient of the capacitor.

### Output Transistor

The MSXC6210BxxxMR builds in a P-MOSFET output transistor which provides a low switch-on resistance for low drop out voltage applications.

### Error Amplifier

The Error Amplifier compares the internal reference voltage with the output feedback voltage from the internal divider, and controls the Gate voltage of P-MOSFET to support good line regulation and load regulation at output voltage.

### Enable

The MSXC6210BxxxMR delivers the output power when it is set to enable state. When it works in disable state, there is no output power and the operation quiescent current is almost zero.

### Current-Limit Protection

The MSXC6210BxxxMR provides current limit function to prevent the device from damages during over-load or shorted-circuit condition. This current is detected by an internal sensing transistor.

### Over-Temperature Protection

The over-temperature protection function will turn off the P-MOSFET when the junction temperature exceeds 150°C (typ.), and the output current exceeds 80mA. Once the junction temperature cools down by approximately 20°C, the regulator will automatically resume operation.

## Absolute Maximum Ratings (Note 1)

- VIN, VOUT, EN to GND ----- -0.3V to 6.5V
- VOUT to VIN ----- -6.5V to 0.3V
- Power Dissipation,  $P_D$  @  $T_A = 25^\circ\text{C}$ 
  - SOT-23-5 ----- 0.43W
- Package Thermal Resistance (Note 2)
  - TSOT-23-5,  $\theta_{JA}$  ----- 230.6°C/W
  - TSOT-23-5,  $\theta_{JC}$  ----- 21.8°C/W
- Lead Temperature (Soldering, 10 sec.) ----- 260°C
- Junction Temperature ----- 150°C
- Storage Temperature Range ----- -65°C to 150°C
- ESD Susceptibility (Note 3)
  - HBM (Human Body Model) ----- 2kV

## Recommended Operating Conditions (Note 4)

- Input Voltage, VIN ----- 1.2V to 5.5V
- Junction Temperature Range ----- -40°C to 125°C
- Ambient Temperature Range ----- -40°C to 85°C

## Electrical Characteristics

( $V_{OUT} + 1 < V_{IN} < 5.5\text{V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage Range	$V_{OUT}$		0.8	--	3.3	V
DC Output Accuracy		$I_{LOAD} = 1\text{mA}$	-2	--	2	%
Dropout Voltage ( $I_{LOAD} = 600\text{mA}$ ) (Note 5)	$V_{DROP}$	$0.8\text{V} \leq V_{OUT} < 1.05\text{V}$ (TSOT-23-5)	--	1.05	1.33	V
		$1.05\text{V} \leq V_{OUT} < 1.2\text{V}$	--	0.8	1.13	
		$1.2\text{V} \leq V_{OUT} < 1.5\text{V}$	--	0.71	1.03	
		$1.5\text{V} \leq V_{OUT} < 1.8\text{V}$	--	0.57	0.93	
		$1.8\text{V} \leq V_{OUT} < 2.1\text{V}$	--	0.57	0.83	
		$2.1\text{V} \leq V_{OUT} < 2.5\text{V}$	--	0.41	0.73	
		$2.5\text{V} \leq V_{OUT} < 3\text{V}$	--	0.36	0.63	
		$3\text{V} \leq V_{OUT}$	--	0.31	0.53	
$V_{CC}$ Consumption Current	$I_Q$	$I_{LOAD} = 0\text{mA}$ , $V_{OUT} \leq 5.5\text{V}$ $V_{IN} \geq V_{OUT} + V_{DROP}$	--	2	4	$\mu\text{A}$
Shutdown GND Current (Note 6)		$V_{EN} = 0\text{V}$	--	0.1	0.5	$\mu\text{A}$
Shutdown Leakage Current (Note 6)		$V_{EN} = 0\text{V}$ , $V_{OUT} = 0\text{V}$	--	0.1	0.5	$\mu\text{A}$

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
EN Input Current	$I_{EN}$	$V_{EN} = 5.5V$	--	--	0.1	$\mu A$	
Line Regulation	$\Delta LINE$	$I_{LOAD} = 1mA$	$1.2V \leq V_{IN} < 1.5V$	--	0.3	0.6	%
			$1.5V \leq V_{IN} < 1.8V$	--	0.15	0.3	
			$1.8V \leq V_{IN} < 5.5V$	--	0.13	0.35	
Load Regulation	$\Delta LOAD$	$1mA < I_{LOAD} < 600mA$	--	0.5	1	%	
Power Supply Rejection Ratio	PSRR	$V_{IN} = 3V, I_{LOAD} = 50mA,$ $C_{OUT} = 1\mu F, V_{OUT} = 2.5V, f = 1kHz$	--	75	--	dB	
Output Voltage Noise		$C_{OUT} = 1\mu F,$ $I_{LOAD} = 150mA,$ $BW = 10Hz \text{ to } 100kHz,$ $V_{IN} = V_{OUT} + 1V$	$V_{OUT} = 0.8V$	--	26	--	$\mu VRMS$
			$V_{OUT} = 1.2V$	--	37	--	
			$V_{OUT} = 1.8V$	--	39	--	
			$V_{OUT} = 3.3V$	--	42	--	
Output Current Limit	$I_{LIM}$	$V_{OUT} = 90\%V_{OUT(Normal)}$	610	1100	--	mA	
Enable Input Voltage	Logic-High	$V_{IH}$	$V_{IN} = 5V$	0.9	--	--	V
	Logic-Low	$V_{IL}$	$V_{IN} = 5V$	--	--	0.4	
Thermal Shutdown Temperature	$T_{SD}$	$I_{LOAD} = 30mA, V_{IN} \geq 1.5V$	--	150	--	$^{\circ}C$	
Thermal Shutdown Hysteresis	$\Delta T_{SD}$		--	20	--	$^{\circ}C$	
Discharge Resistance		$EN = 0V, V_{OUT} = 0.1V$	--	80	--	$\Omega$	

**Note 1.** 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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Note 2.**  $\theta_{JA}$  is measured at  $T_A = 25^{\circ}C$  on a high effective thermal conductivity four-layer test board per JEDEC 51-7 for TSOT-23-5 Package.

**Note 3.** Devices are ESD sensitive. Handling precaution is recommended.

**Note 4.** The device is not guaranteed to function outside its operating conditions.

**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.** The specification is tested at wafer stage and guarantee by design after assembly.

## Typical Application Circuit

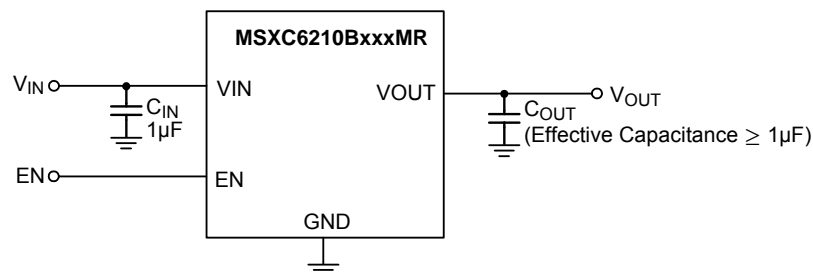
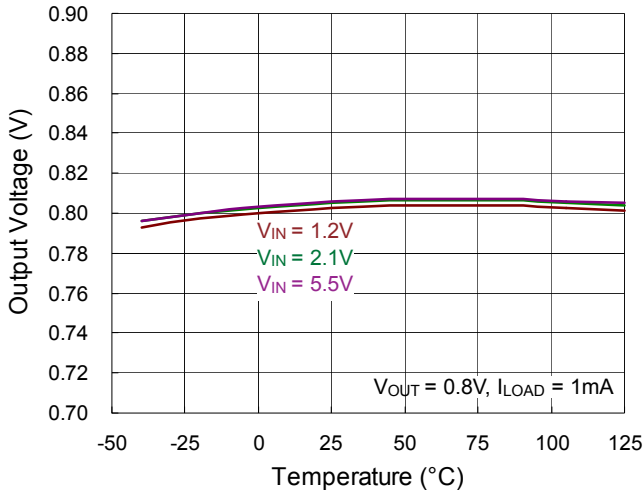


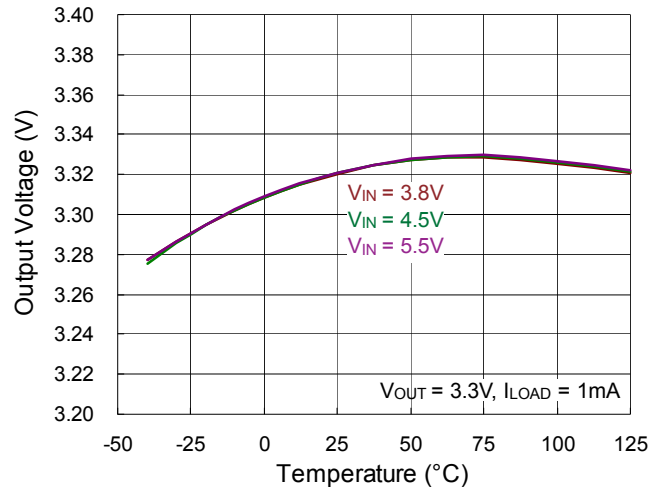
Figure 1 . Application without Sense Function

**Typical Operating Characteristics**

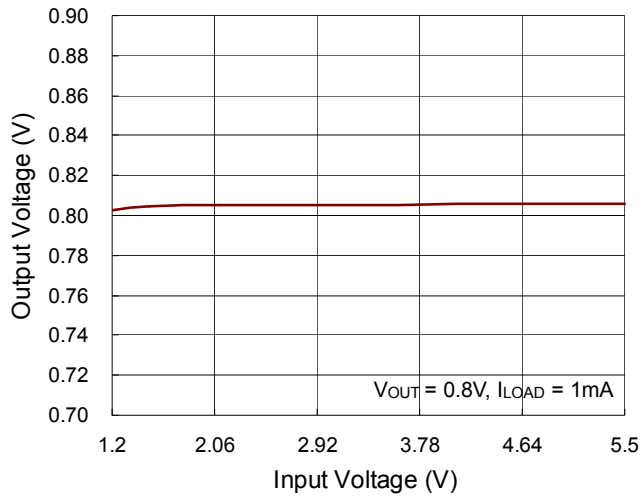
**Output Voltage vs. Temperature**



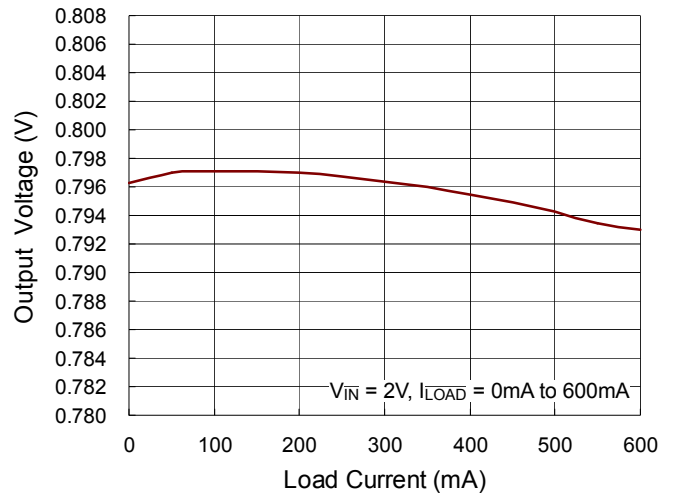
**Output Voltage vs. Temperature**



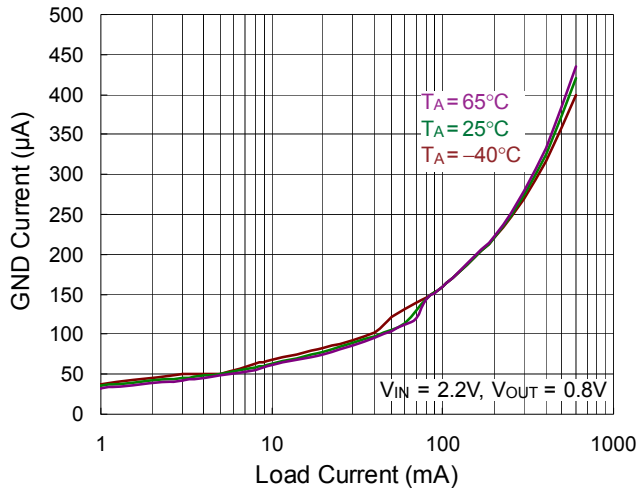
**Output Voltage vs. Input Voltage**



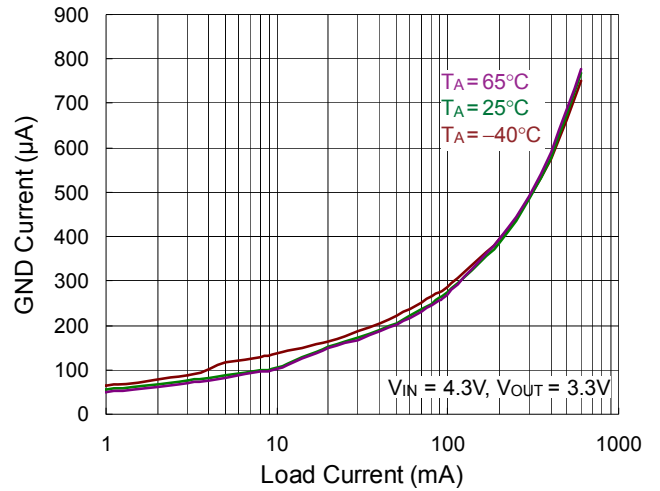
**Output Voltage vs. Load Current**



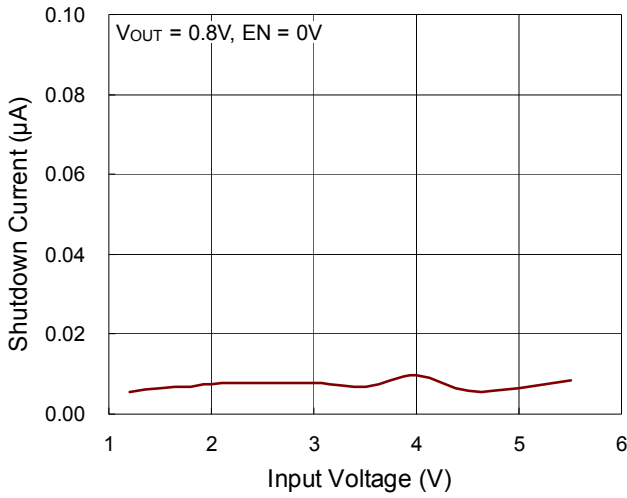
**Ground Current vs. Load Current**



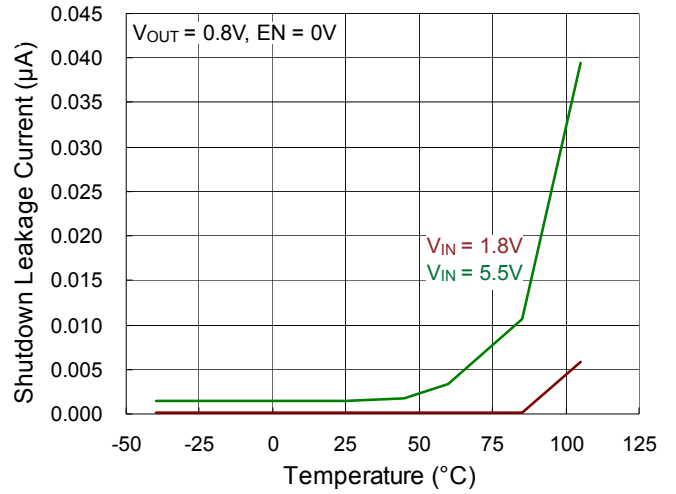
**Ground Current vs. Load Current**



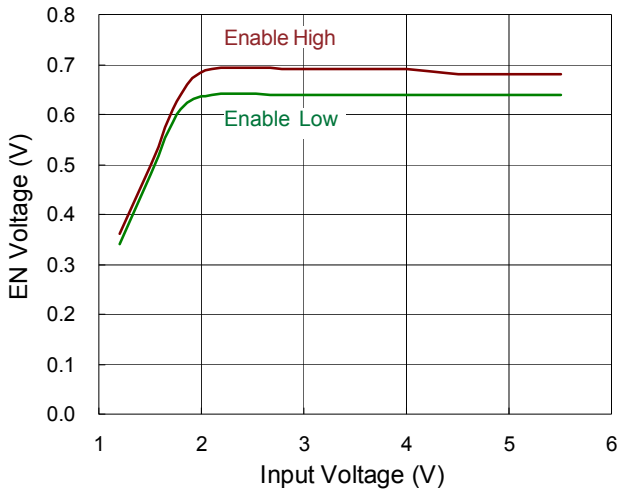
**Shutdown Current vs. Input Voltage**



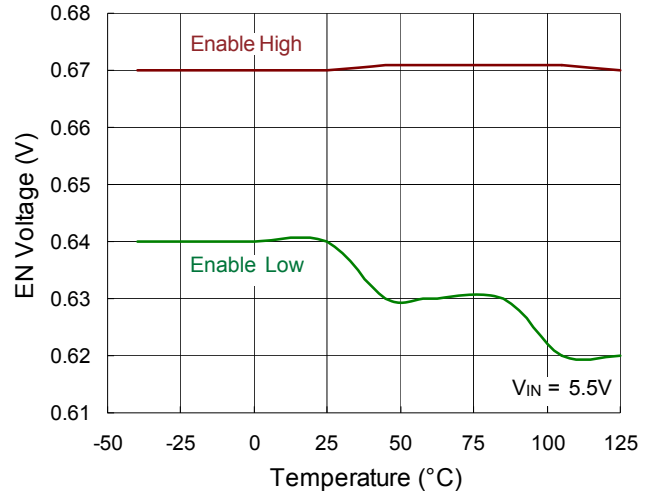
**Shutdown Leakage Current vs. Temperature**



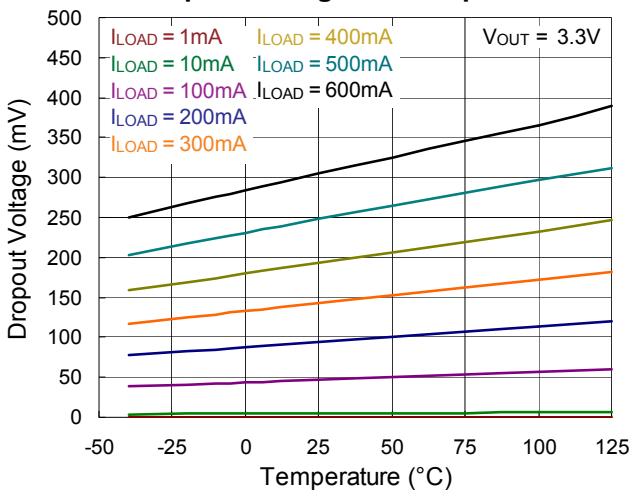
**Enable Threshold vs. Input Voltage**



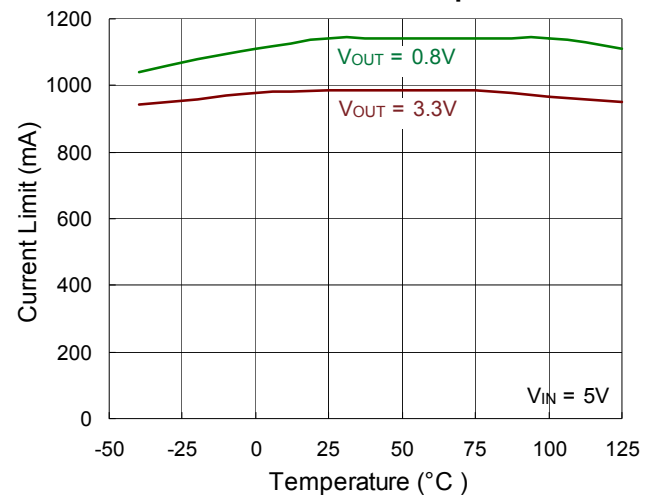
**Enable Threshold vs. Temperature**



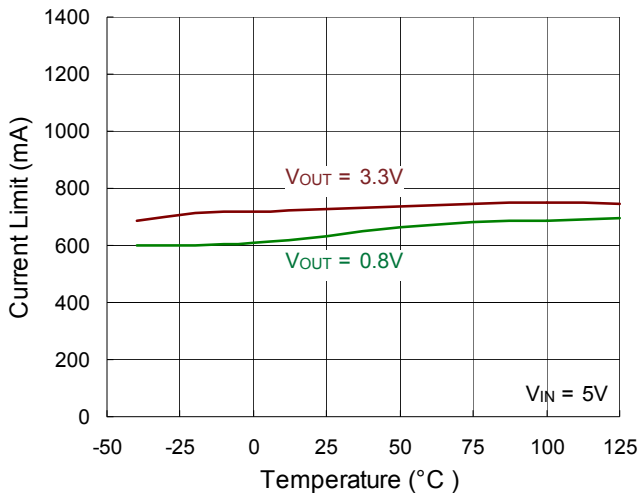
**Dropout Voltage vs. Temperature**



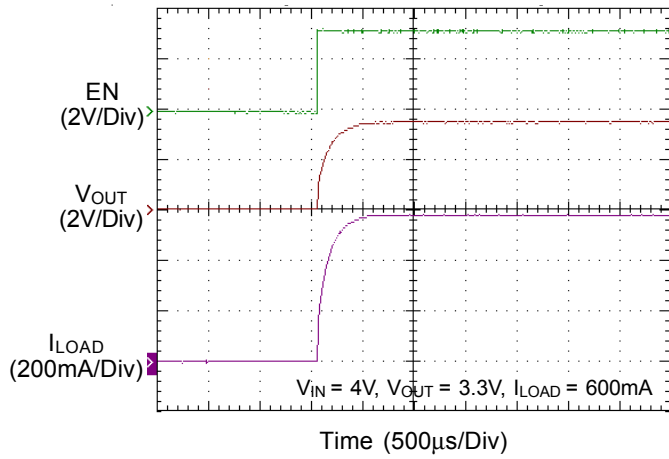
**Current Limit vs. Temperature**



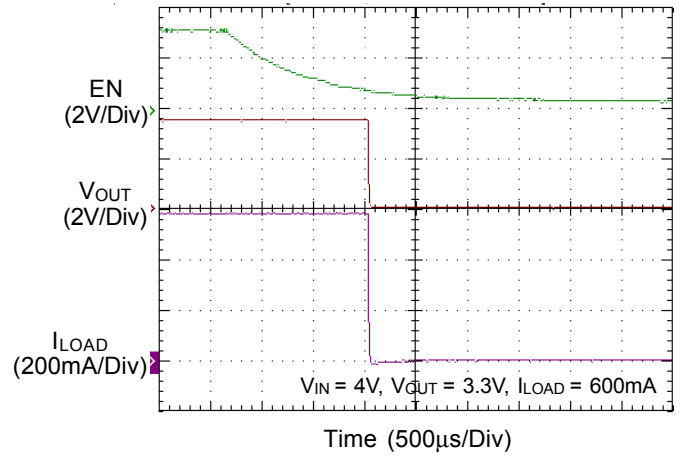
**Fold-Back Current Limit vs. Temperature**



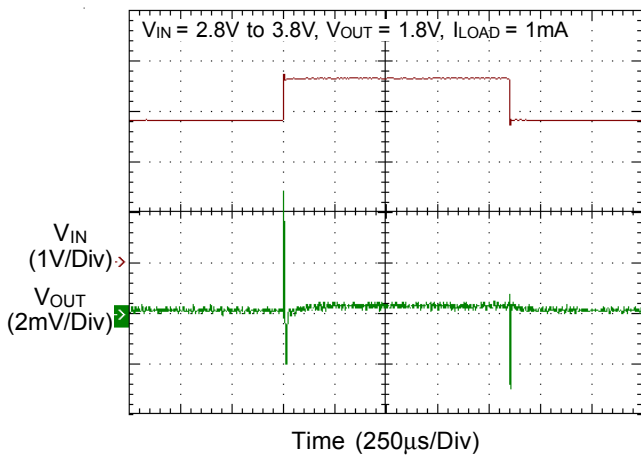
**Power On from EN**



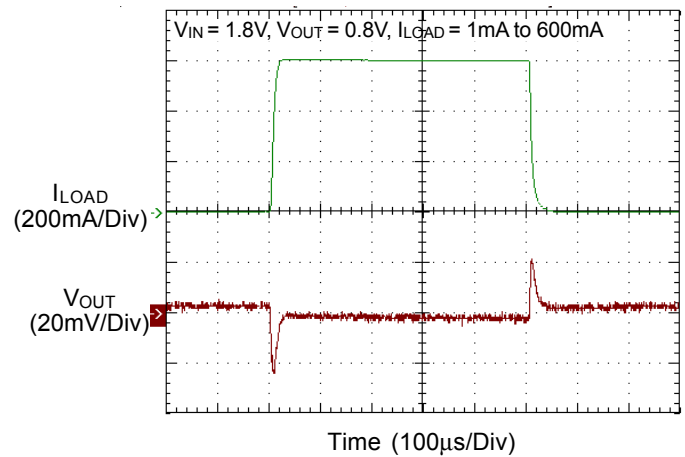
**Power Off from EN**



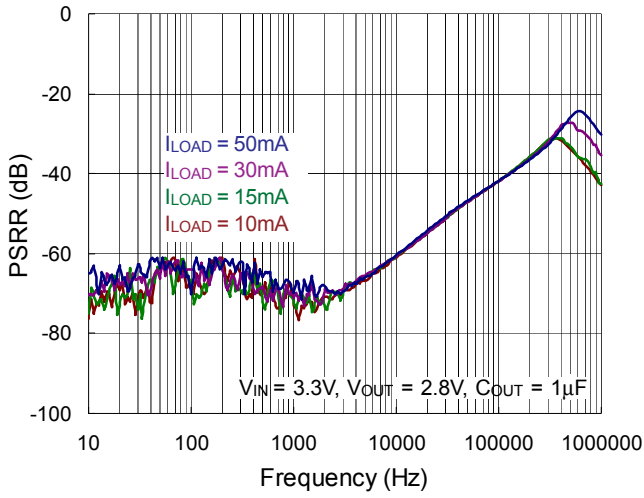
**Line Transient**



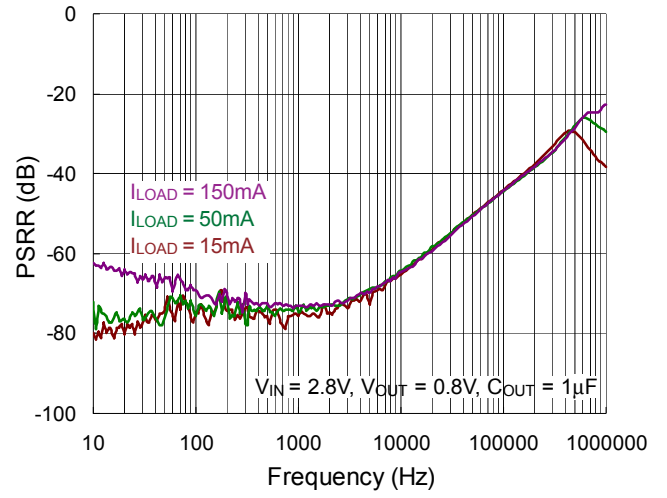
**Load Transient**



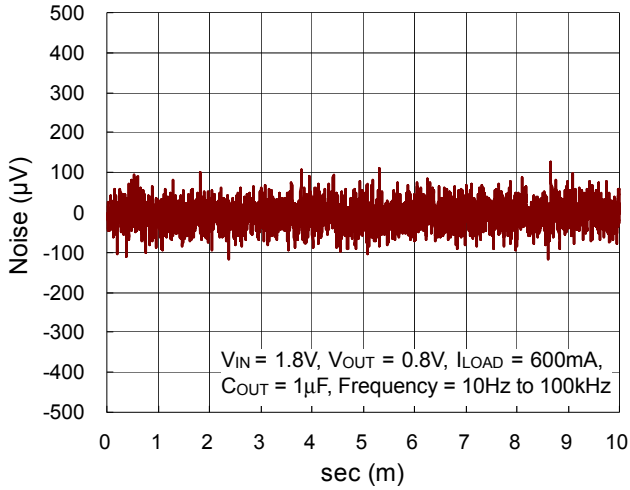
**PSRR vs. Frequency**



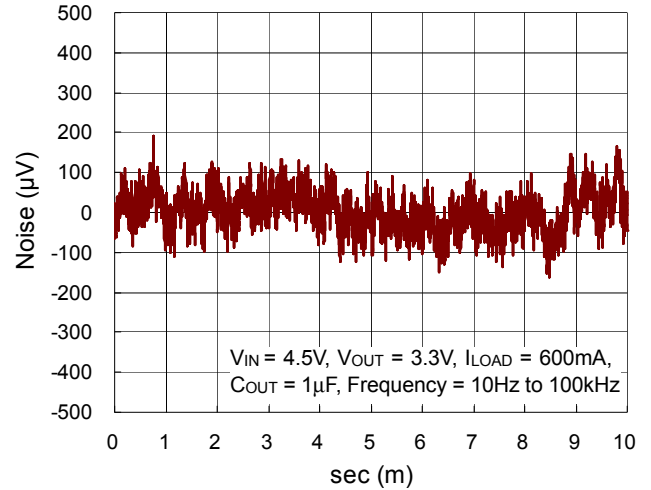
**PSRR vs. Frequency**



**Output Noise**



**Output Noise**



## Application Information

Like any low dropout linear regulator, the MSXC6210BxxxMR's external input and output capacitors 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 larger than 1µF 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.

### Enable

The MSXC6210BxxxMR has an EN pin to turn on or turn off the regulator. When the EN pin is in logic high, the regulator will be turned on. The shutdown current is almost 0µA typical. The EN pin may be directly tied to VIN to keep the part on. The Enable input is CMOS logic and cannot be left floating.

### Current Limit

The MSXC6210BxxxMR contains an independent current limiter, which monitors and controls the pass transistor's gate voltage, limiting the output current to 1.1A (typ.). The current limiting level is reduced to around 0.6A named fold-back current limit when the output voltage is further decreased. The output can be shorted to ground indefinitely without damaging the part.

### Thermal Considerations

For continuous operation, do not exceed 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 by the following formula :

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

where  $T_{J(MAX)}$  is the maximum junction temperature,  $T_A$  is the ambient temperature, and  $\theta_{JA}$  is the junction to ambient thermal resistance.

For recommended operating condition specifications the maximum junction temperature is 125°C and  $T_A$  is the ambient temperature. The junction to ambient thermal resistance,  $\theta_{JA}$ , is layout dependent. For SOT-23-5 package, the thermal resistance,  $\theta_{JA}$ , is 230.6°C/W on a standard JEDEC 51-7 four-layer thermal test board evaluation board. The maximum power dissipation at  $T_A = 25^\circ\text{C}$  can be calculated by the following formula :

$$P_{D(MAX)} = (125^\circ\text{C} - 25^\circ\text{C}) / (230.6^\circ\text{C}/\text{W}) = 0.43\text{W}$$

for SOT-23-5 package

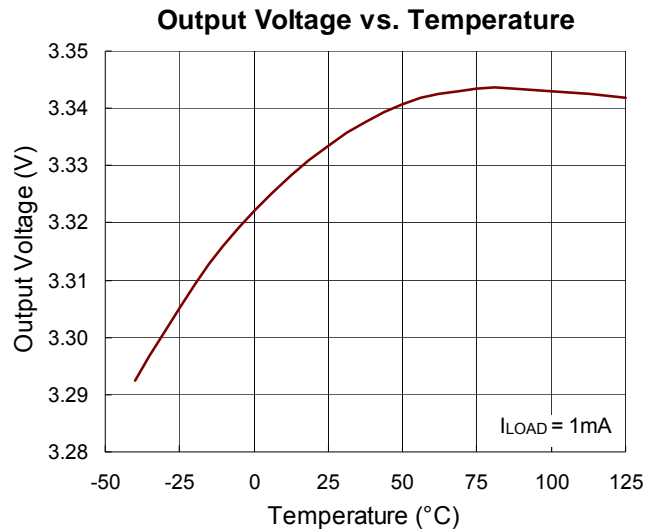


Figure 2 . Temperature Coefficient of Output Voltage

The maximum power dissipation depends on the operating ambient temperature for fixed  $T_{J(MAX)}$  and thermal resistance,  $\theta_{JA}$ . The derating curve in Figure 3 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

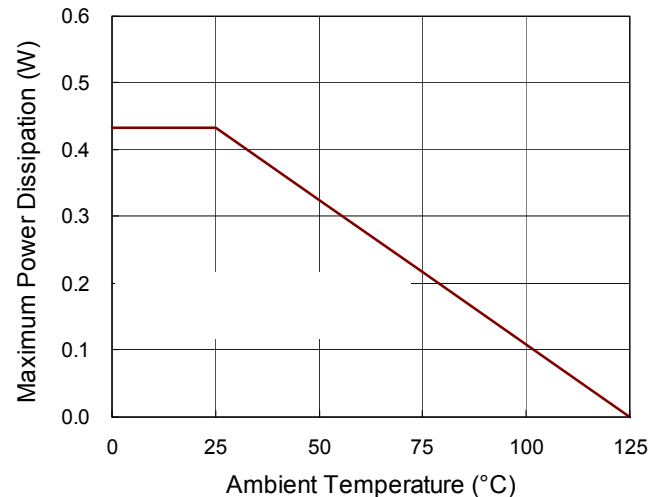


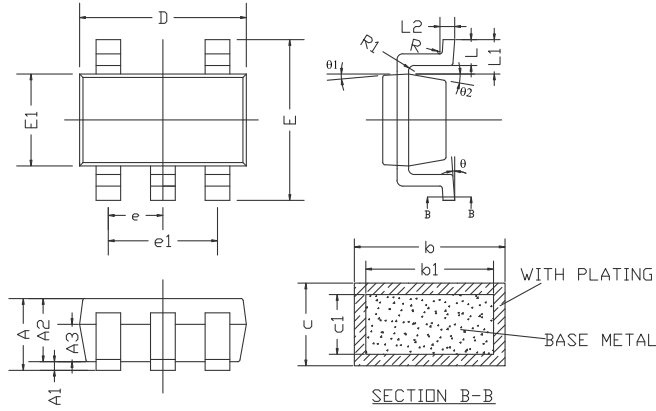
Figure 3 . Derating Curve of Maximum Power Dissipation

**Package Outline**

Package SOT-23-5

Devices per reel

Package dimension (mm):



Symbol	MIN	NORM	MAX
A	-	-	1.25
A1	0.00	-	0.15
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.36	-	0.50
b1	0.36	0.38	0.45
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.826	2.926	3.026
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.35	0.45	0.60
L1	0.59 REF		
L2	0.25 BSC		
R	0.05	-	-
R1	0.05	-	0.20
$\theta$	0°	-	8°
$\theta$ 1	3°	5°	7°
$\theta$ 2	6°	-	14°

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