

## OVERVIEW

The SM6702 series are step-up DC/DC converter ICs, fabricated using NPC's Molybdenum-gate CMOS process. They incorporate reference voltage source, error amplifier, oscillator, start-up circuit, PFM (Pulse Frequency Modulation) control circuit into a single chip. The only external components required are a Coil, Diode and output smoothing capacitors to form a step-up DC/DC converter. They employ PFM voltage control circuits to achieve high efficiency, stable constant-voltage output.

## FEATURES

- Power dissipation : 24  $\mu$ W at  $V_{IN} = 1.5$  V,  $V_{OUT} = 3.0$  V,  $I_{OUT} = 100$   $\mu$ A
- Start-up input voltage : 0.9 V (max) at  $R_L = 30$  k $\Omega$
- Output voltage : 2.2 V to 3.3 V, available in 0.1 Vstep
- High efficiency : 85% at  $V_{IN} = 1.5$  V,  $V_{OUT} = 3.0$  V,  $I_{OUT} = 1$  mA
- Low ripple voltage
- Package : SOT23-3, SOT89-3

## APPLICATIONS

- PDA, Mobile IT equipment
- Digital Still Camera
- Pager
- Constant-voltage sources for battery-operated equipment
- Local voltage sources

## ORDERING INFORMATION

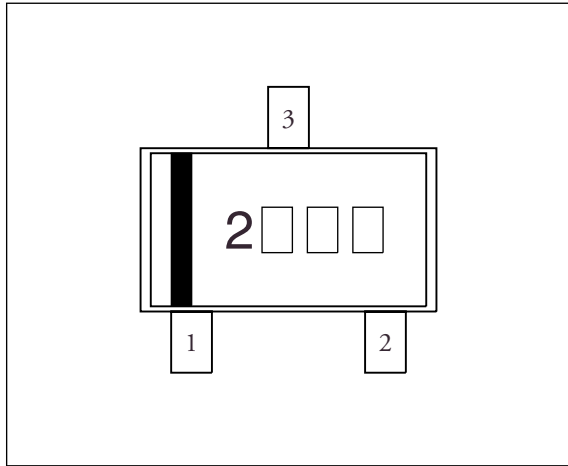
Device	Output voltage <sup>1</sup>	Package
SM6702-33HB	3.3 V	SOT89-3
SM6702-30HA	3.0 V	SOT23-3
SM6702-30HB	3.0 V	SOT89-3
SM6702-27HA	2.7 V	SOT23-3
SM6702-27HB	2.7 V	SOT89-3
SM6702-24HA	2.4 V	SOT23-3

1. Stepwise setting with a step of 0.1V in the range of 2.2V to 3.3V is available.

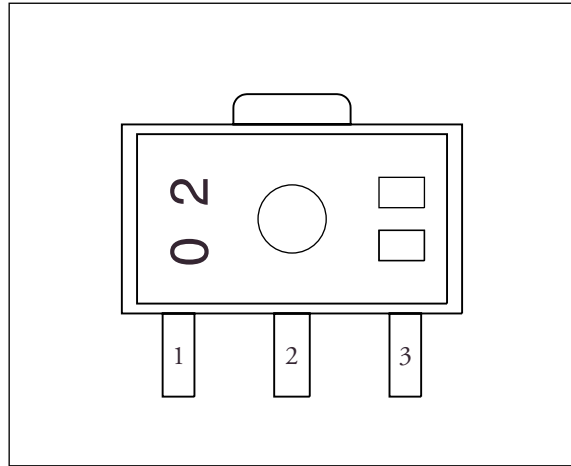
**PINOUT**

(Top view)

**SM6702-xxHA(SOT23-3)**



**SM6702-xxHB(SOT89-3)**



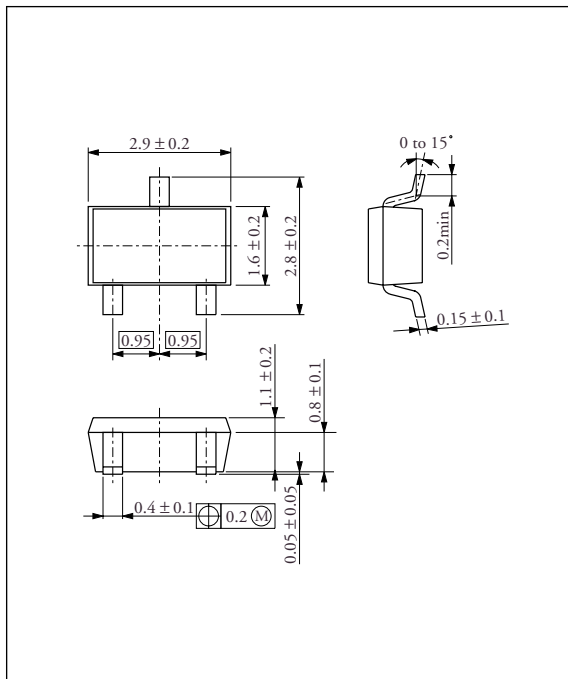
**PIN DESCRIPTION**

Number		Name	Description
SM6702-xxHA	SM6702-xxHB		
1	1	VSS	Ground
2	3	LX	Switching pin
3	2	OUT	Output (device supply pin)

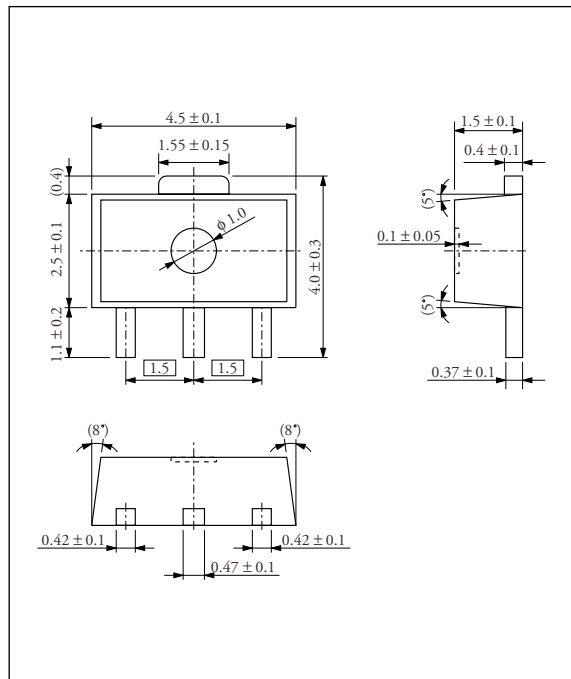
**PACKAGE DIMENSIONS**

(Unit : mm)

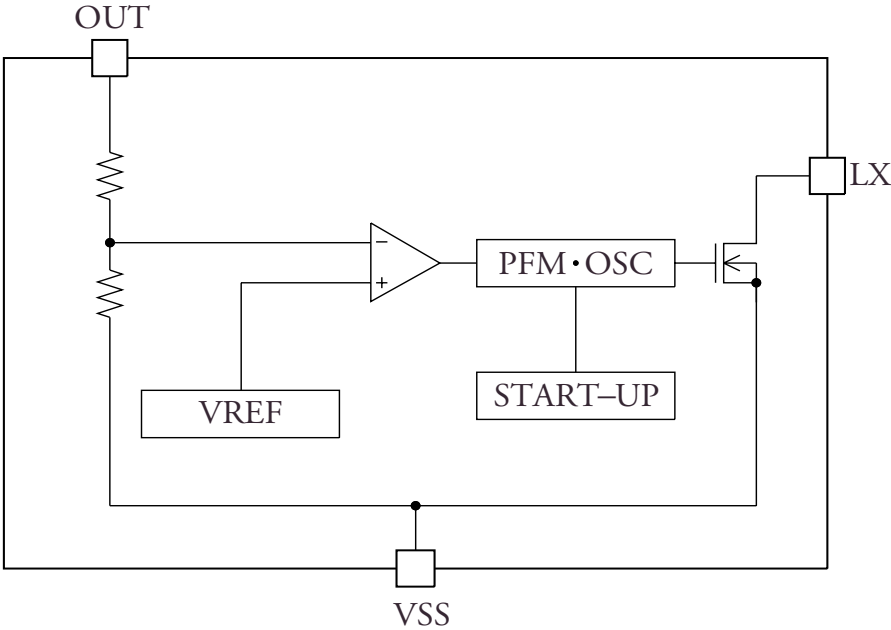
**SM6702-xxHA(SOT23-3)**



**SM6702-xxHB(SOT89-3)**



**BLOCK DIAGRAM**



## SPECIFICATIONS

### Absolute Maximum Ratings

$T_a = 25\text{ }^\circ\text{C}$

Parameter	Symbol	Condition	Rating	Unit
LX impressed voltage	$V_{LX}$		5	V
OUT impressed voltage	$V_{OUT}$		4	V
LX output current	$I_{LX}$		200	mA
Power dissipation	$P_D$	SM6702- $\times\times$ HA	150	mW
		SM6702- $\times\times$ HB	500	
Operating temperature	$T_{opr}$		- 20 to 70	$^\circ\text{C}$
Storage temperature	$T_{stg}$		- 40 to 125	$^\circ\text{C}$

### Electrical Characteristics

$L = 330\text{ }\mu\text{H}$ ,  $C = 22\text{ }\mu\text{F}$ ,  $T_a = 25\text{ }^\circ\text{C}$ ,  $V_{SS} = 0\text{ V}$

Parameter	Symbol	Condition	Rating			Unit	
			min	typ	max		
Start-up voltage	$V_{st}$	$R_L = 30\text{ k}\Omega$	-	-	0.9	V	
Holding voltage	$V_{hold}$	$R_L = 3\text{ k}\Omega$	-	-	0.7	V	
Current consumption	$I_{SS}$	$V_{IN} = 1.5\text{ V}$ , $R_L = 30\text{ k}\Omega$	-	8	16	$\mu\text{A}$	
Output voltage	$V_{OUT}$	$V_{IN} = 1.5\text{ V}$ , $R_L = 3\text{ k}\Omega$	$V_{target} \times 0.975$	$V_{target}$	$V_{target} \times 1.025$	V	
LX output current	$I_{LX}$	$V_{OUT} = V_{target} - 0.1$ , $V_{LX} = 0.4\text{ V}$	$2.2 \leq V_{target} \leq 2.7$	60	-	-	mA
			$2.8 \leq V_{target} \leq 3.3$	80	-	-	
LX leakage current	$I_{LXL}$	$V_{OUT} = V_{LX} = 3.5\text{ V}$	-	-	1	$\mu\text{A}$	
Maximum oscillator frequency	$f_{OSC}$	$V_{OUT} = V_{target} - 0.1$	80	100	120	kHz	
Switch ON duty cycle	Duty	$V_{OUT} = V_{target} - 0.1$	65	75	85	%	
Input voltage range	$V_{IN}$		-	-	$V_{target} + 0.2$	V	

$V_{target}$  : Setting output voltage

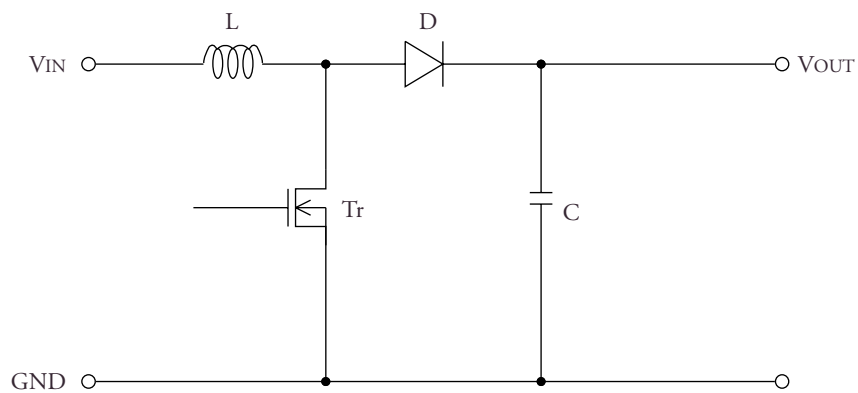
## FUNCTIONAL DESCRIPTION

### Step-up Principle

The SM6702 series use a transistor to switch the input supply in a non-isolated chopper switching regulator configuration. The figure below shows the basic step-up switching regulator circuit.

If the transistor is ON for an interval  $t_{ON}$  and then instantly turned OFF, the energy stored in the coil  $L$  during the interval  $t_{ON}$  generates a voltage  $V_L$  across the coil. This voltage is superimposed on the input voltage such that the peak voltage reaches  $V_{IN} + V_L$  which forces the diode  $D$  to conduct and release the stored energy into the output.

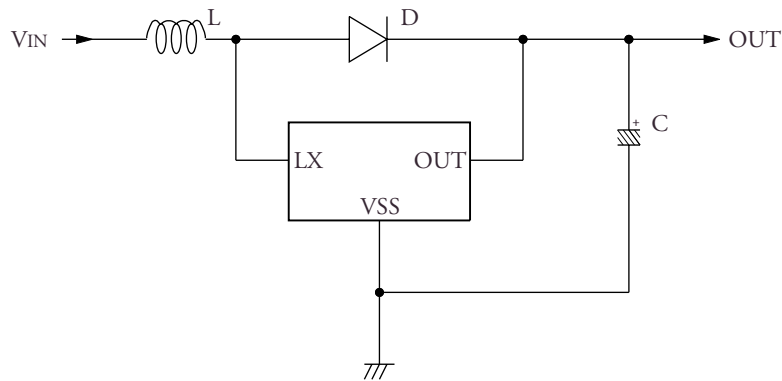
During normal operation, the above switching occurs repeatedly at a frequency controlled by an oscillator (which can change depending on the input and output load conditions), generating a square wave output which is then smoothed by the output capacitor  $C$ . Thus the output voltage ( $V_{OUT} > V_{IN}$ ) has been stepped up.



### PFM Control

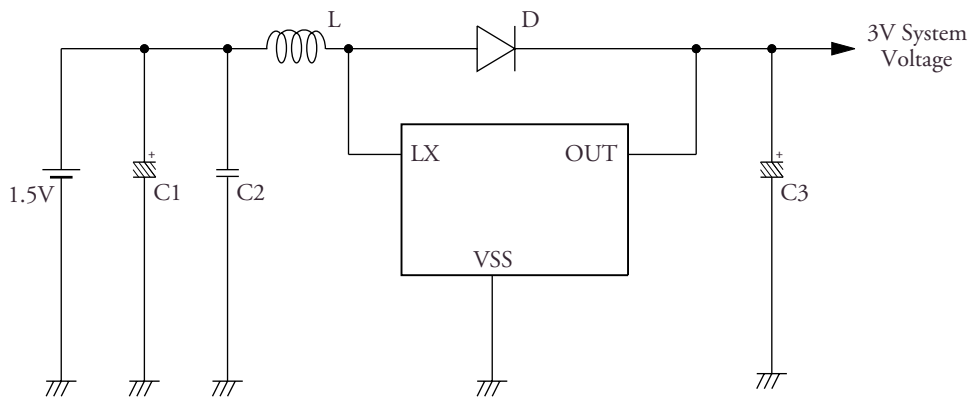
In SM6702 series, the LX transistor ON interval is fixed, and the OFF interval varies in response to the input voltage and load changes. Thus the resulting switching cycle frequency varies, called pulse frequency modulation.

**BASIC CIRCUIT**



Coil (L) : 330  $\mu$ H  
 Diode (D) : MA721 (Matsushita Schottky diode)  
 Capacitor (C<sub>L</sub>) : 22  $\mu$ F tantalum

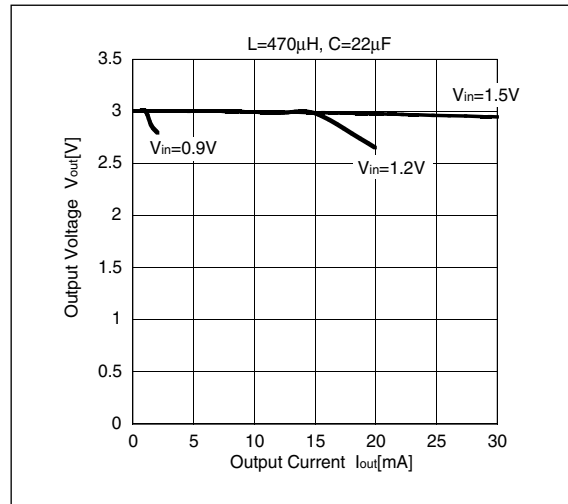
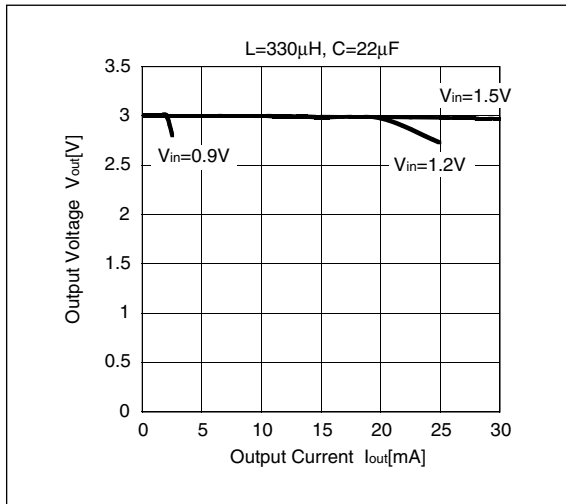
**TYPICAL APPLICATION CIRCUIT**



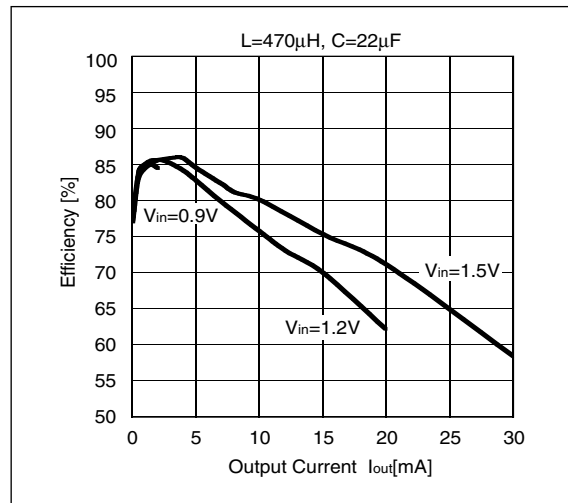
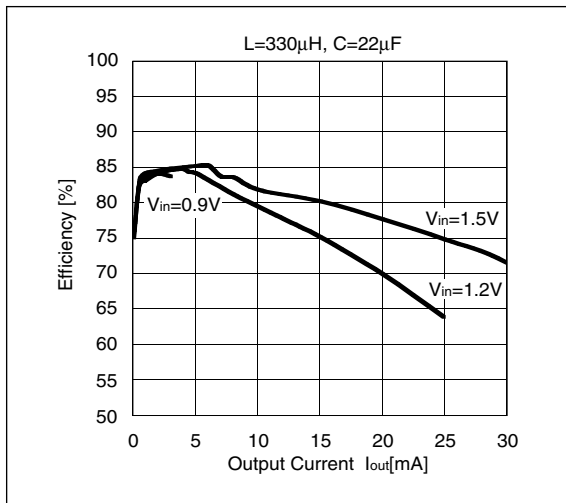
Coil (L) : 330  $\mu$ H  
 Schottky Diode (D)  
 Capacitor (C1) : 22  $\mu$ F tantalum  
 Capacitor (C2) : 0.22  $\mu$ F ceramic  
 Capacitor (C3) : 22  $\mu$ F tantalum

**BASIC CHARACTERISTICS SM6702-30HA ( $V_{out} : 3.0V$ )**

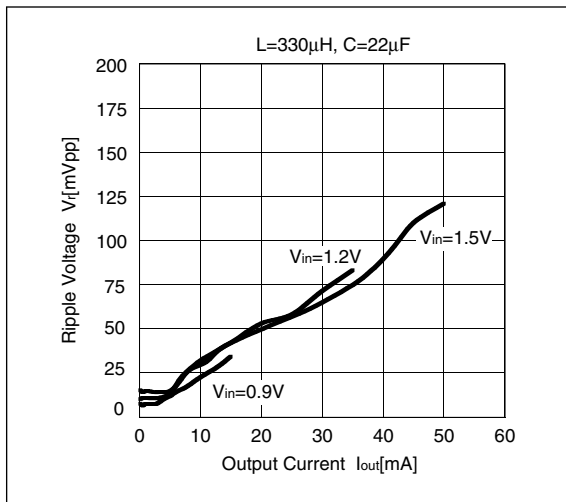
**Output voltage vs. Output current**



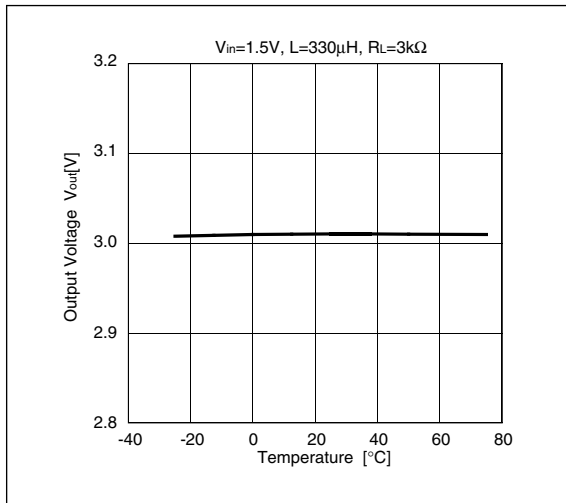
**Efficiency vs. Output current**



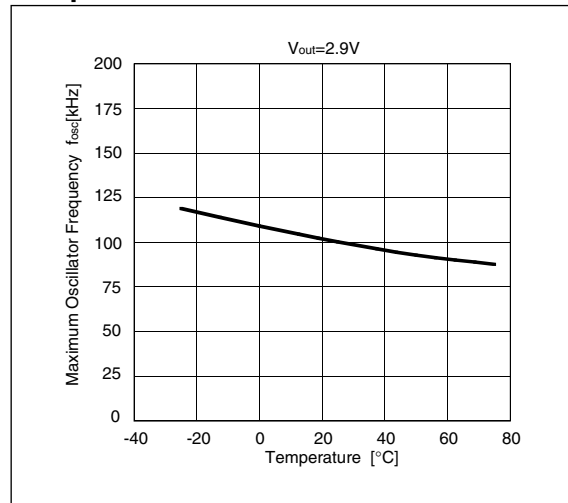
**Ripple voltage vs. Output current**



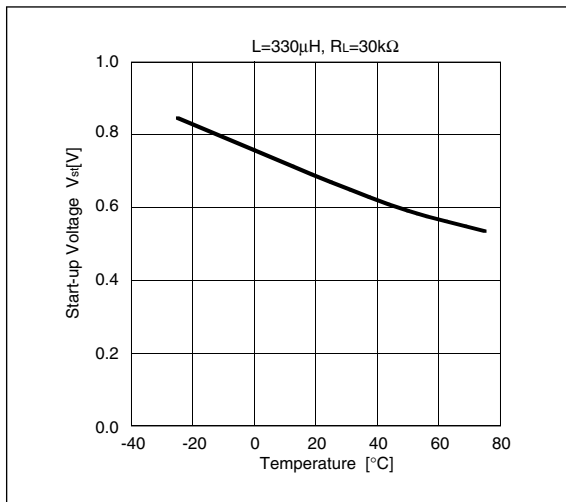
**Output voltage vs. Temperature**



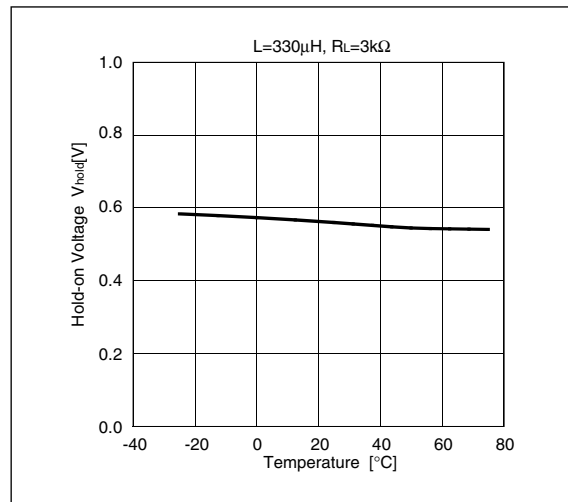
**Maximum oscillator frequency vs. Temperature**



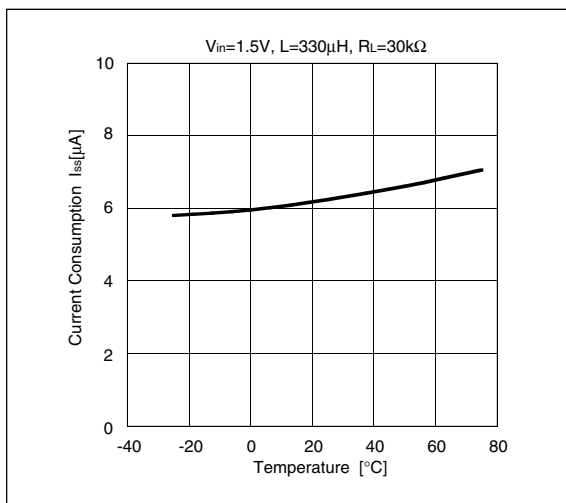
**Start-up voltage vs. Temperature**



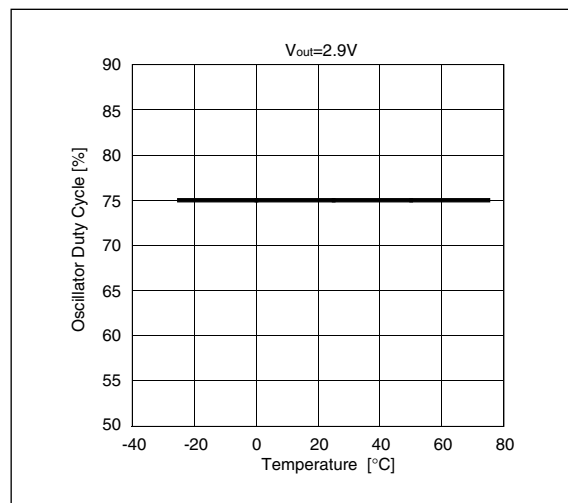
**Hold-on voltage vs. Temperature**



**Current consumption vs. Temperature**

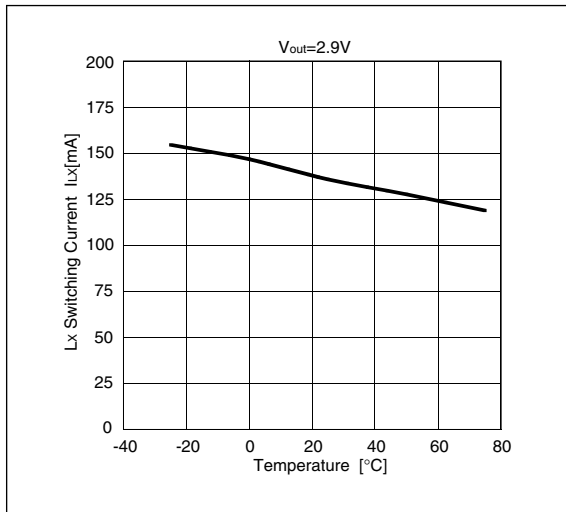


**Oscillator duty cycle vs. Temperature**

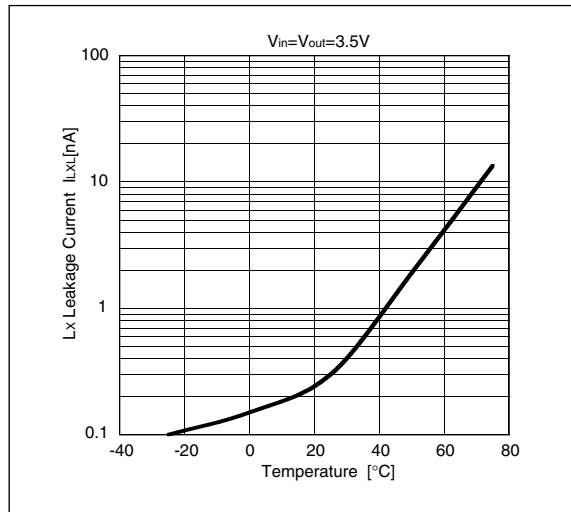




**LX switching current vs. Temperature**



**LX leakage current vs. Temperature**



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