

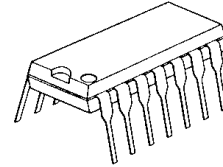
## DC/DC CONVERTER CONTROL IC WITH CURRENT SENSE AMPLIFIER

### ■GENERAL DESCRIPTION

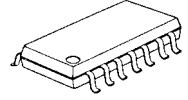
The **NJM2384** is a low voltage operation DC/DC converter control IC featuring high side current protection and soft start functions.

It is suitable for battery charger, power module application and on-board regulators.

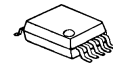
### ■PACKAGE OUTLINE



**NJM2384D**



**NJM2384M**

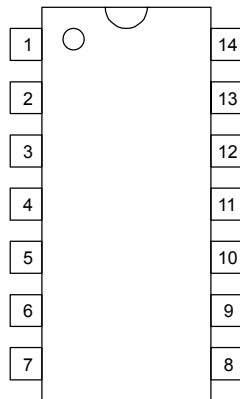


**NJM2384V**

### ■FEATURES

- PWM switching control
- Operating Voltage                      3.6V to 32V
- Wide Oscillator Range                5kHz to 500 kHz
- Current Sensing Amplifier
- Soft-Start Function
- UVLO (Under Voltage Lockouts)
- Bipolar Technology
- Package Outline      DIP14, DMP14, SSOP10

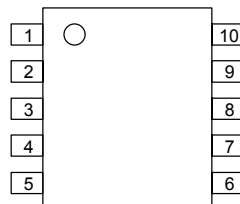
### ■PIN CONFIGURATION



**NJM2384D**  
**NJM2384M**

#### PIN FUNCTION

1.NC	8.NC
2.IN <sup>-</sup> 1	9. V <sup>+</sup>
3.IN <sup>-</sup> 2	10.CS
4.F.B	11.CT
5.GND	12.REF
6.OUT	13.IN <sup>+</sup>
7.NC	14.NC



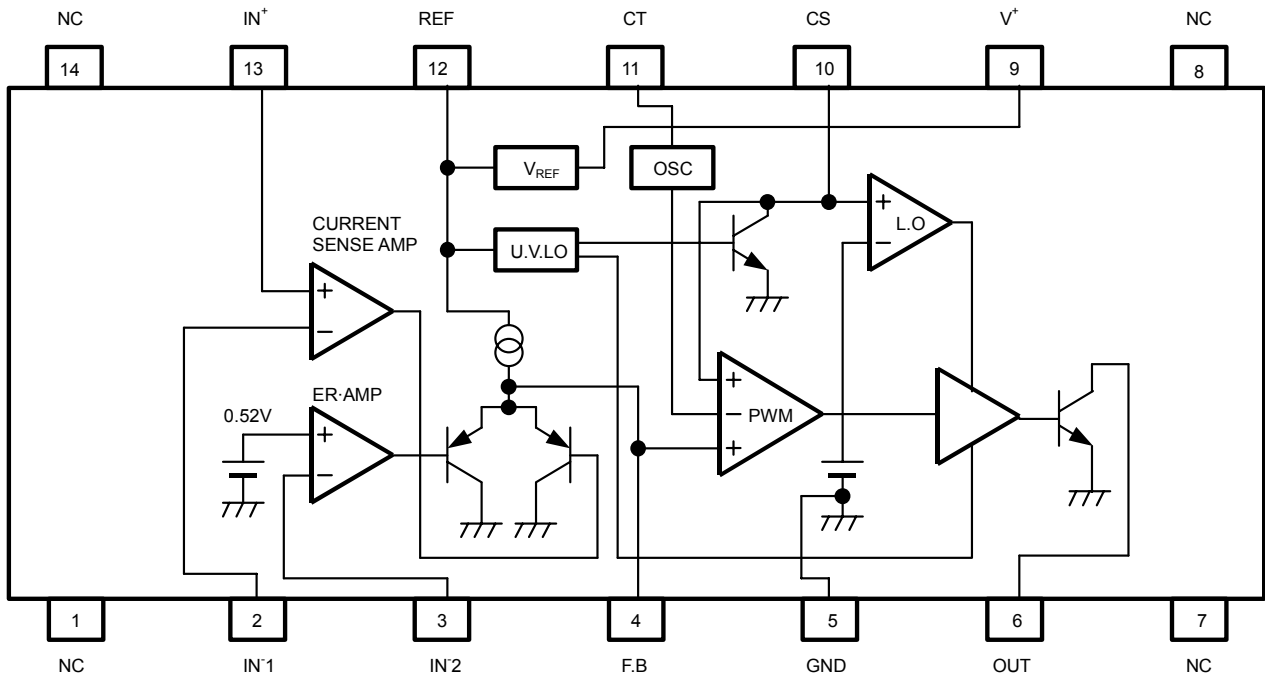
**NJM2384V**

#### PIN FUNCTION

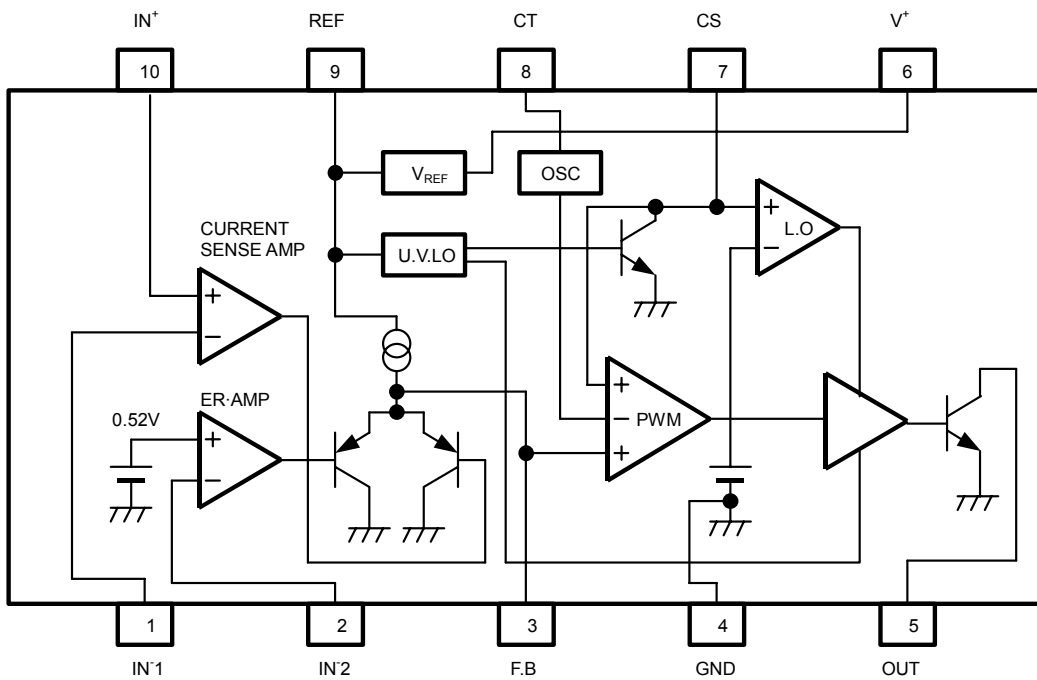
1.IN <sup>-</sup> 1	6. V <sup>+</sup>
2.IN <sup>-</sup> 2	7.CS
3.F.B	8.CT
4.GND	9.REF
5.OUT	10.IN <sup>+</sup>

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## ■BLOCK DIAGRAM



(Package: DIP14, DMP14)



(Package: SSOP10)

■ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	MAXIMUM RATINGS	UNIT
Input Voltage	V <sup>+</sup>	36	V
Reference Output Current	I <sub>OR</sub>	10	mA
Output Sink Current	I <sub>SINK</sub>	200	mA
Differential Input Voltage	V <sub>ID</sub>	2.5	V
Common Mode Input Voltage	V <sub>IC</sub>	-0.3 ~ 2.5	V
Power Dissipation	P <sub>D</sub>	(DIP 14) 700 (DMP 14) 300 (SSOP 10) 250	mW
Operating Temperature Range	T <sub>OPR</sub>	-40 ~ +85	°C
Storage Temperature Range	T <sub>STG</sub>	-50 ~ +150	°C

■ELECTRICAL CHARACTERISTICS (V<sup>+</sup>=6V, R<sub>T</sub>=33kΩ, C<sub>T</sub>=1000pF, Ta=25°C)

REFERENCE VOLTAGE BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	V <sub>REF</sub>	I <sub>OR</sub> =1mA	2.45	2.50	2.55	V
Line Regulation	L <sub>LINE</sub>	V <sup>+</sup> =3.6 ~ 32V, I <sub>OR</sub> =1mA	-	6.8	20.7	mV
Load Regulation	L <sub>LOAD</sub>	I <sub>OR</sub> =0.1 ~ 5.0mA	-	5	30	mV

OSCILLATOR BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Oscillation Frequency	f <sub>OSC</sub>	R <sub>T</sub> =33kΩ, C <sub>T</sub> =1000pF	85	105	125	kHz
Oscillate Fluctuations1 (Line Fluctuations)	f <sub>dV</sub>	V <sup>+</sup> =3.6 ~ 32V	-	1	-	%
Oscillate Fluctuations2 (Temp Fluctuations)	f <sub>dT</sub>	Ta=-40°C ~ 85°C	-	5	-	%

CURRENT SENSE AMPLIFIER BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Offset Voltage1	V <sub>IO1</sub>		-	2	7	mV
Input Offset Current1	I <sub>IO1</sub>		-	5	50	nA
Input Bias Current1	I <sub>B1</sub>		-	5	100	nA
Open Loop Gain1	A <sub>V1</sub>		-	90	-	dB
Gain Bandwidth Product1	G <sub>B1</sub>		-	0.6	-	MHz
Input Common Mode Voltage Ratio1	V <sub>ICM1</sub>		-	0 ~ V <sub>REF</sub> -0.8	-	V
Maximum Output Voltage1 (F.B Pin)	V <sub>OM-1</sub>	R <sub>NF</sub> =100kΩ	-	-	1	V
Maximum Source Current1 (F.B Pin)	I <sub>OM+1</sub>	V <sub>OM</sub> =0.5V	40	85	200	μA

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■ ELECTRICAL CHARACTERISTICS ( $V^+=6V, R_T=33k\Omega, C_T=1000pF, T_a=25^\circ C$ )

## ERROR AMPLIFIER BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Voltage <sub>2</sub>	$V_{B2}$		0.51	0.52	0.53	V
Input Bias Current <sub>2</sub>	$I_{B2}$		–	5	100	nA
Open Loop Gain <sub>2</sub>	$A_{V2}$		–	90	–	dB
Gain Bandwidth Product <sub>2</sub>	$G_{B2}$		–	0.6	–	MHz
Maximum Output Voltage <sub>2</sub> (F.B Pin)	$V_{OM-2}$	$R_{NF}=100k\Omega$	–	–	1	V
Maximum Source Current <sub>2</sub> (F.B Pin)	$I_{OM+2}$	$V_{OM}=0.5V$	40	85	200	$\mu A$

## PWM COMPARE BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Threshold Voltage (F.B Pin)	$V_{TH0}$	duty·cycle=0% (note)	–	1.65	1.75	V
Input Threshold Voltage (F.B Pin)	$V_{TH100}$	duty·cycle=100% (note)	–	2.10	–	V

## SOFT START CIRCUIT BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Bias Current (CS Pin)	$I_{BCS}$	CS Pin=1.8V	–	250	650	nA
Input Threshold Voltage (CS Pin)	$V_{THCS0}$	duty·cycle=0% (note)	–	0.25	0.35	V
Input Threshold Voltage (CS Pin)	$V_{THCS50}$	duty·cycle=100% (note)	–	0.7	–	V

## UNDER VOLTAGE LOCKOUT BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
ON Threshold Voltage	$V_{THON}$		–	2.70	–	V
OFF Threshold Voltage	$V_{THOFF}$		–	2.52	–	V
Hysteresis Voltage	$V_{HYS}$		60	180	–	mV

## OUTPUT BLOCK

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
L Output Voltage (OUT Pin)	$V_{OL}$	Output Sink Current=100mA	–	0.25	0.65	V

## GENERAL CHARACTERISTICS

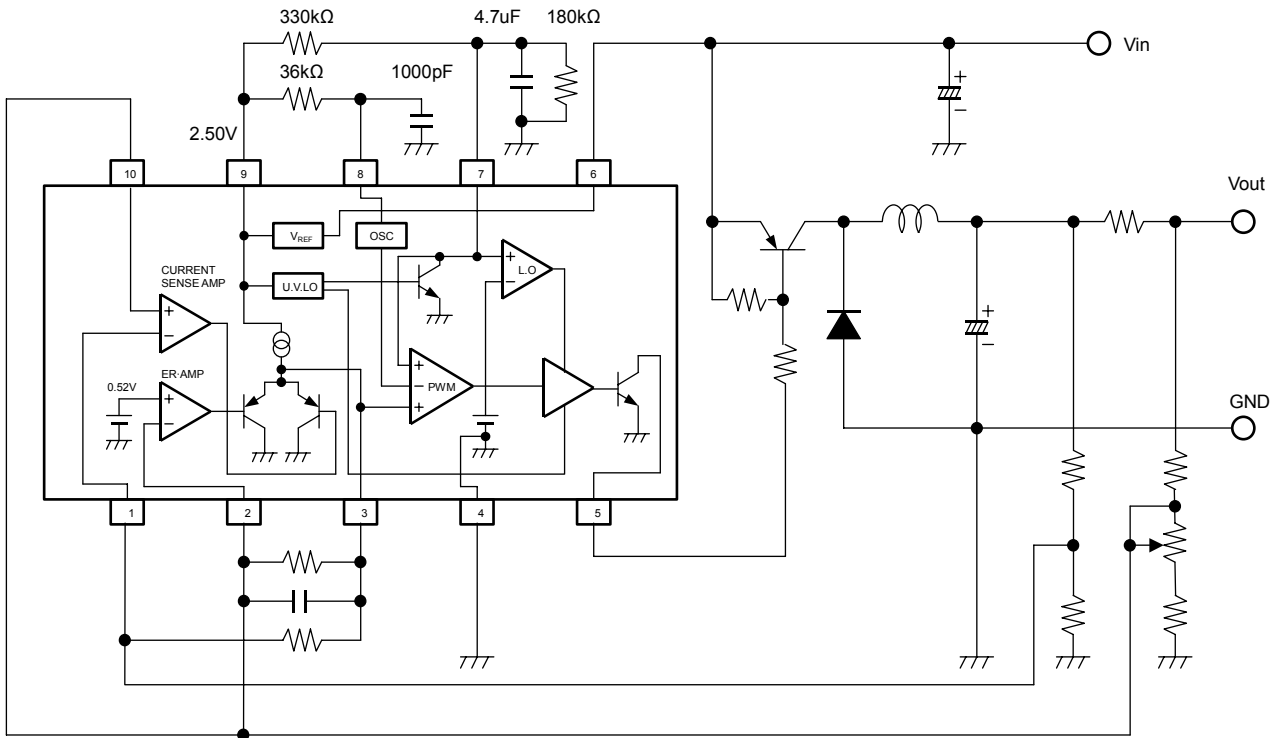
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Latch Mode Threshold Voltage (CS Pin)	$V_{THLA}$		1.2	1.5	1.8	V
Quiescent Current	$I_{CCLA}$	Latch Mode	–	1.6	2.2	mA
Average Quiescent Current	$I_{CCAV}$	$R_L = \infty$ , duty·cycle=50%	–	5.5	10	mA

(note) Duty·Cycle is defined as follows:

Duty·Cycle=0%: IC output transistor is OFF.

Duty·Cycle=100%: IC output transistor is ON.

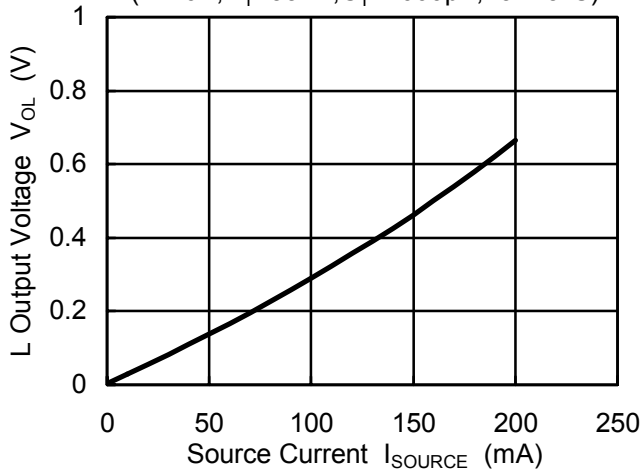
## ■ TYPICAL APPLICATIONS



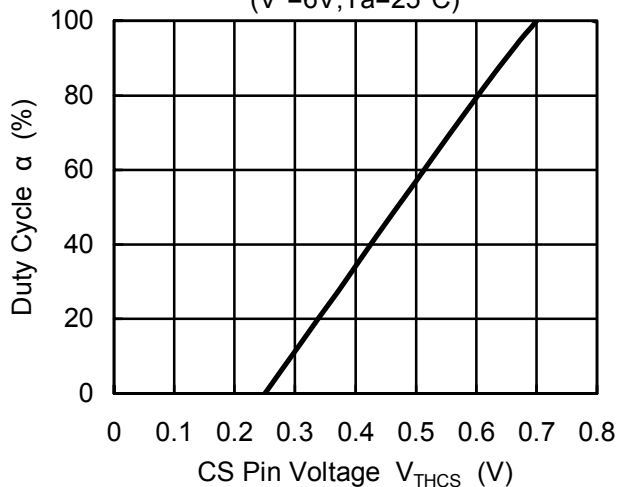
(Package:SSOP10)

## ■ TYPICAL CHARACTERISTICS

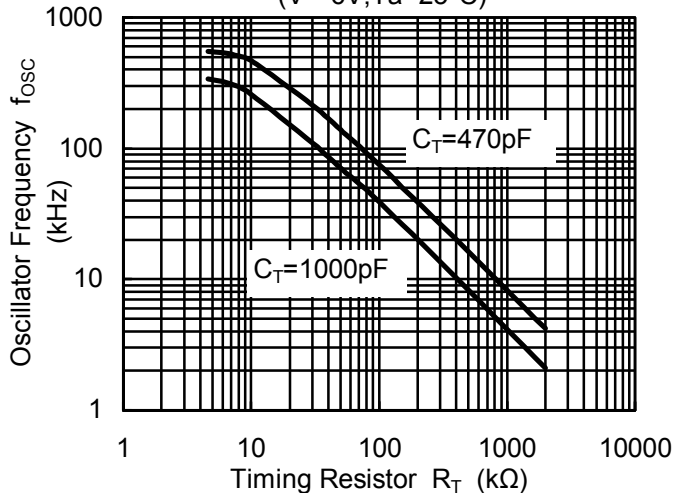
L Output Voltage vs. Source Current  
( $V^+=6V, R_T=33k\Omega, C_T=1000pF, T_a=25^\circ C$ )



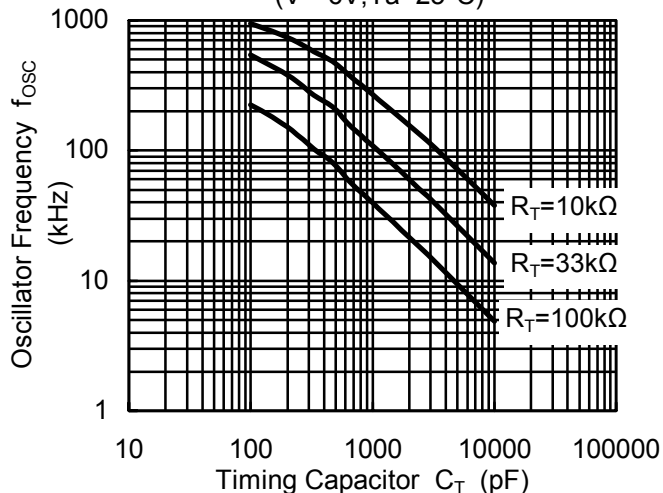
Duty Cycle vs. CS Pin Voltage  
( $V^+=6V, T_a=25^\circ C$ )



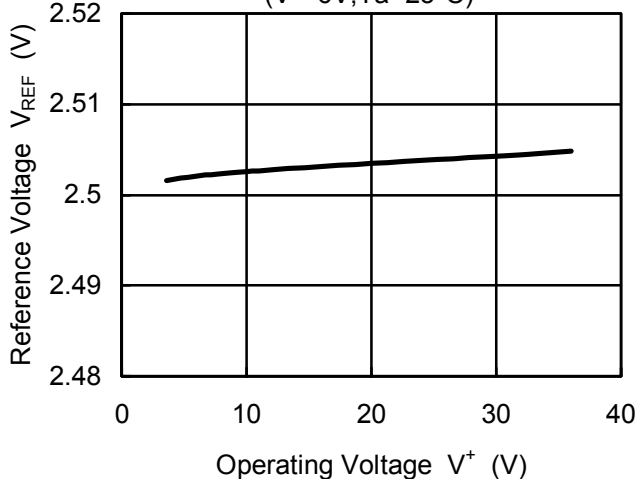
Oscillator Frequency vs. Timing Resistor  
( $V^+=6V, T_a=25^\circ C$ )



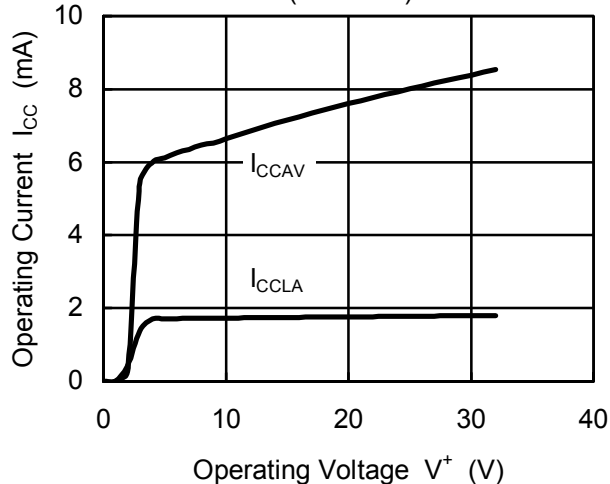
Oscillator Frequency vs. Timing Capacitor  
( $V^+=6V, T_a=25^\circ C$ )



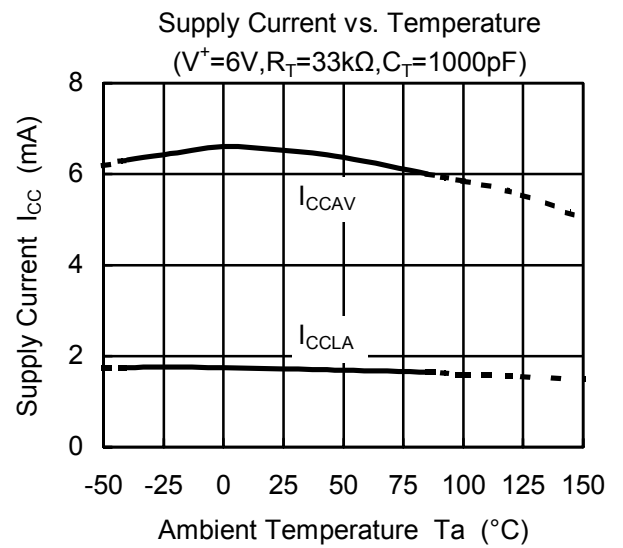
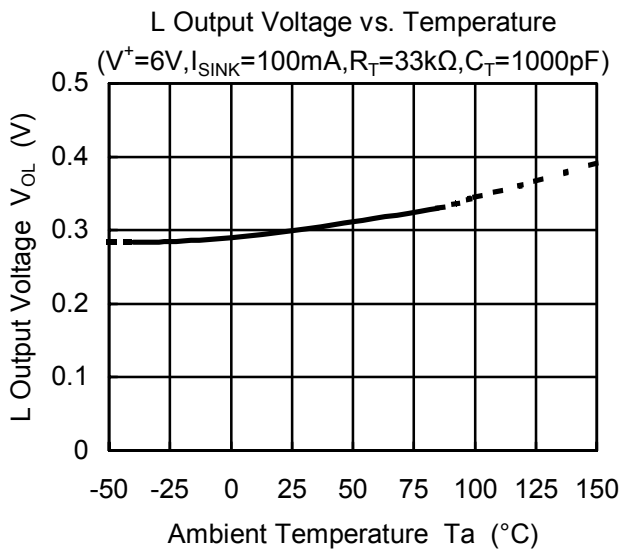
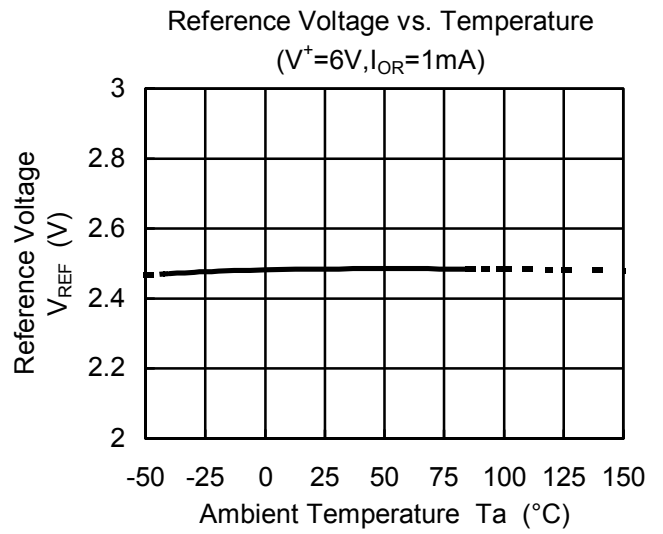
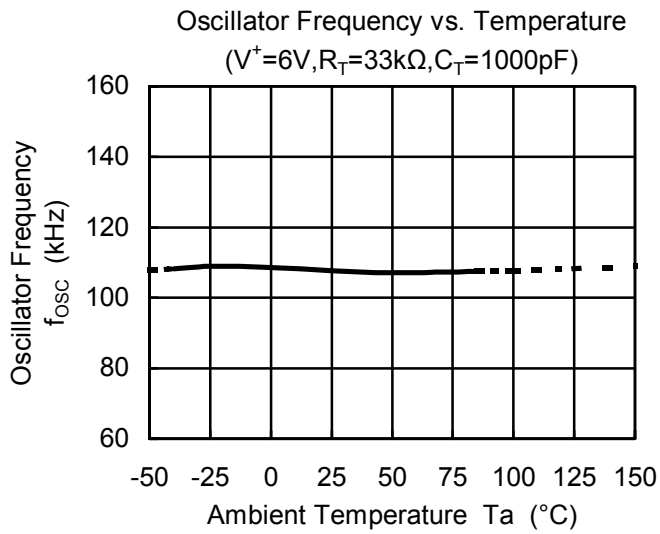
Reference Voltage vs. Operating Voltage  
( $V^+=6V, T_a=25^\circ C$ )



Operating Current vs. Operating Voltage  
( $T_a=25^\circ C$ )



## ■ TYPICAL CHARACTERISTICS



**[CAUTION]**

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