

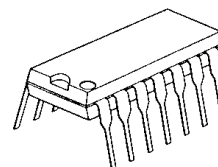
## DC/DC CONVERTER CONTROL IC WITH CURRENT SENSE AMPLIFIER

### ■GENERAL DESCRIPTION

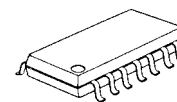
The **NJM2384** is a low voltage operation DC/DC converter control IC featuring high side current protection and soft start functions.

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

### ■PACKAGE OUTLINE



**NJM2384D**



**NJM2384M**

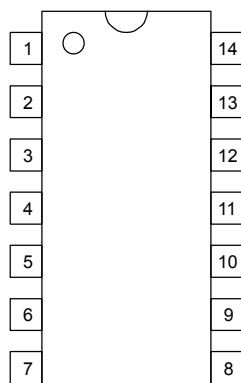
### ■FEATURES

- 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



**NJM2384V**

### ■PIN CONFIGURATION

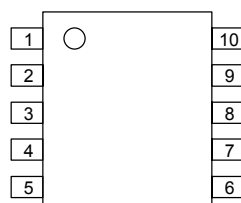


**NJM2384D**

**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              |



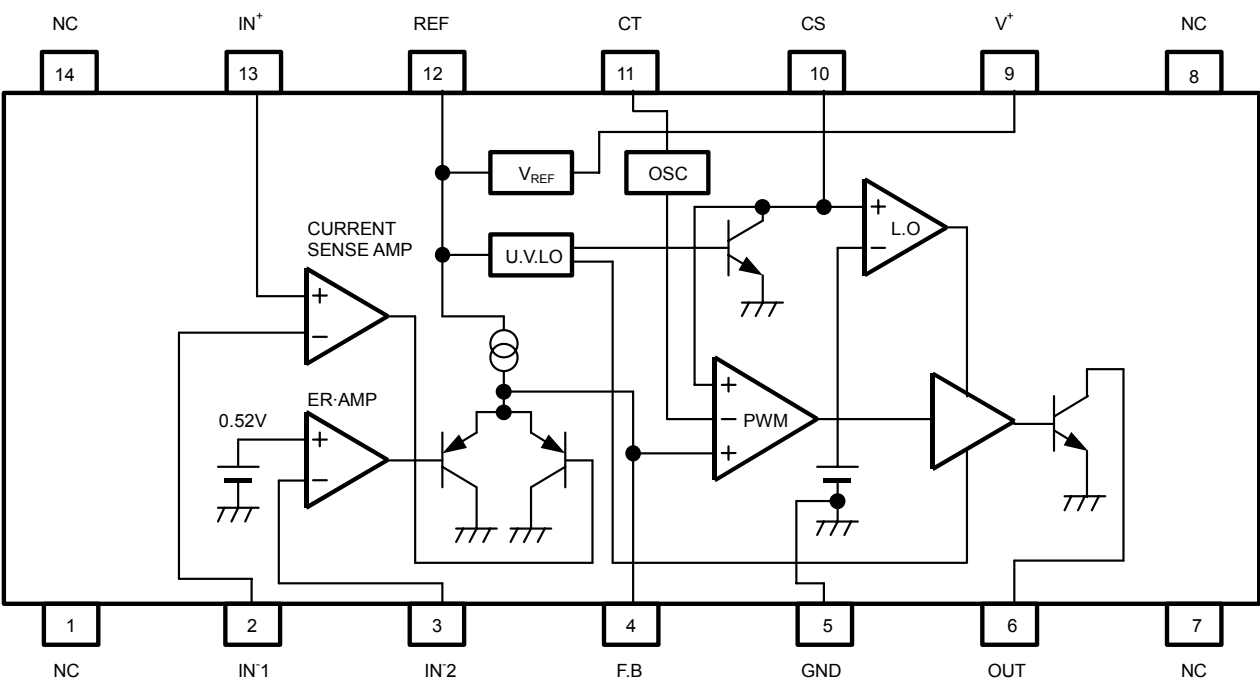
**NJM2384V**

#### PIN FUNCTION

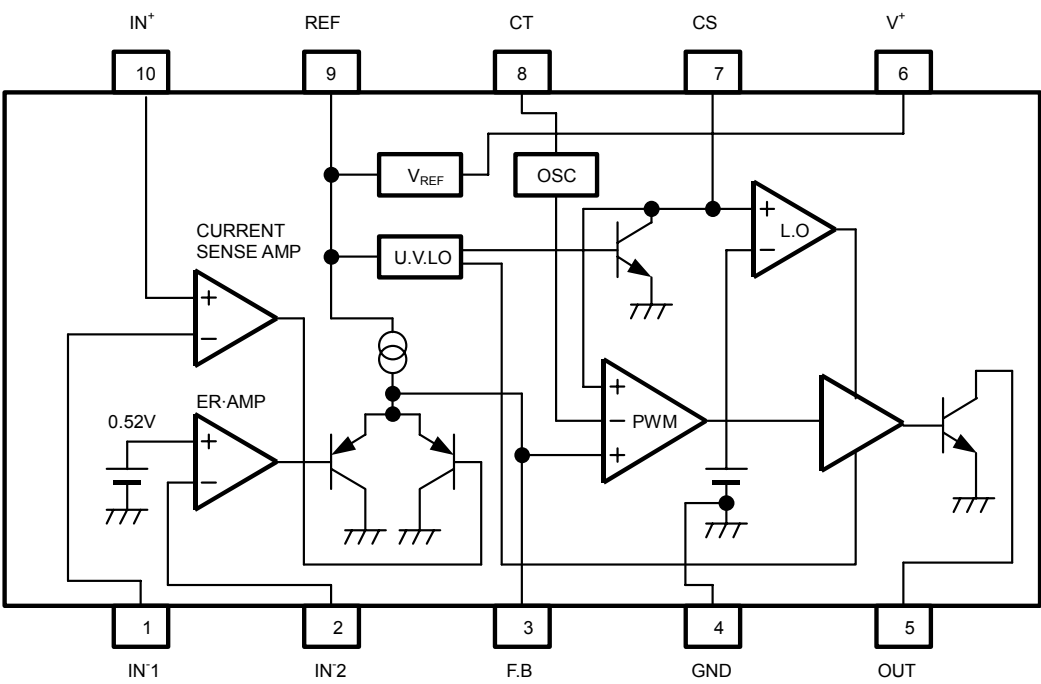
|                     |                    |
|---------------------|--------------------|
| 1.IN <sup>-</sup> 1 | 6. V <sup>+</sup>  |
| 2.IN <sup>-</sup> 2 | 7.CS               |
| 3.F.B               | 8.CT               |
| 4.GND               | 9.REF              |
| 5.OUT               | 10.IN 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

# NJM2384

## ■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<br>(DMP 14) 300<br>(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>INE</sub> | V <sup>+</sup> =3.6 ~ 32V, I <sub>OR</sub> =1mA | —    | 6.8  | 20.7 | mV   |
| Load Regulation | L <sub>OAD</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<br>(Line Fluctuations) | f <sub>dV</sub>  | V <sup>+</sup> =3.6 ~ 32V                    | —    | 1    | —    | %    |
| Oscillate Fluctuations2<br>(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<br>Voltage Ratio1  | V <sub>ICM1</sub> |                        | —    | 0 ~<br>V <sub>REF</sub> -0.8 | —    | V    |
| Maximum Output Voltage1<br>(F.B Pin) | V <sub>OM-1</sub> | R <sub>NF</sub> =100kΩ | —    | —                            | 1    | V    |
| Maximum Source Current1<br>(F.B Pin) | I <sub>OM+1</sub> | V <sub>OM</sub> =0.5V  | 40   | 85                           | 200  | μA   |

# NJM2384

■ 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><br>(F.B Pin) | $V_{OM-2}$ | $R_{NF}=100k\Omega$ | –    | –    | 1    | V       |
| Maximum Source Current <sub>2</sub><br>(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<br>(F.B Pin) | $V_{TH0}$   | duty·cycle=0% (note)   | –    | 1.65 | 1.75 | V    |
| Input Threshold Voltage<br>(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<br>(CS Pin)      | $I_{BCS}$    | CS Pin=1.8V            | –    | 250  | 650  | nA   |
| Input Threshold Voltage<br>(CS Pin) | $V_{THCS0}$  | duty·cycle=0% (note)   | –    | 0.25 | 0.35 | V    |
| Input Threshold Voltage<br>(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

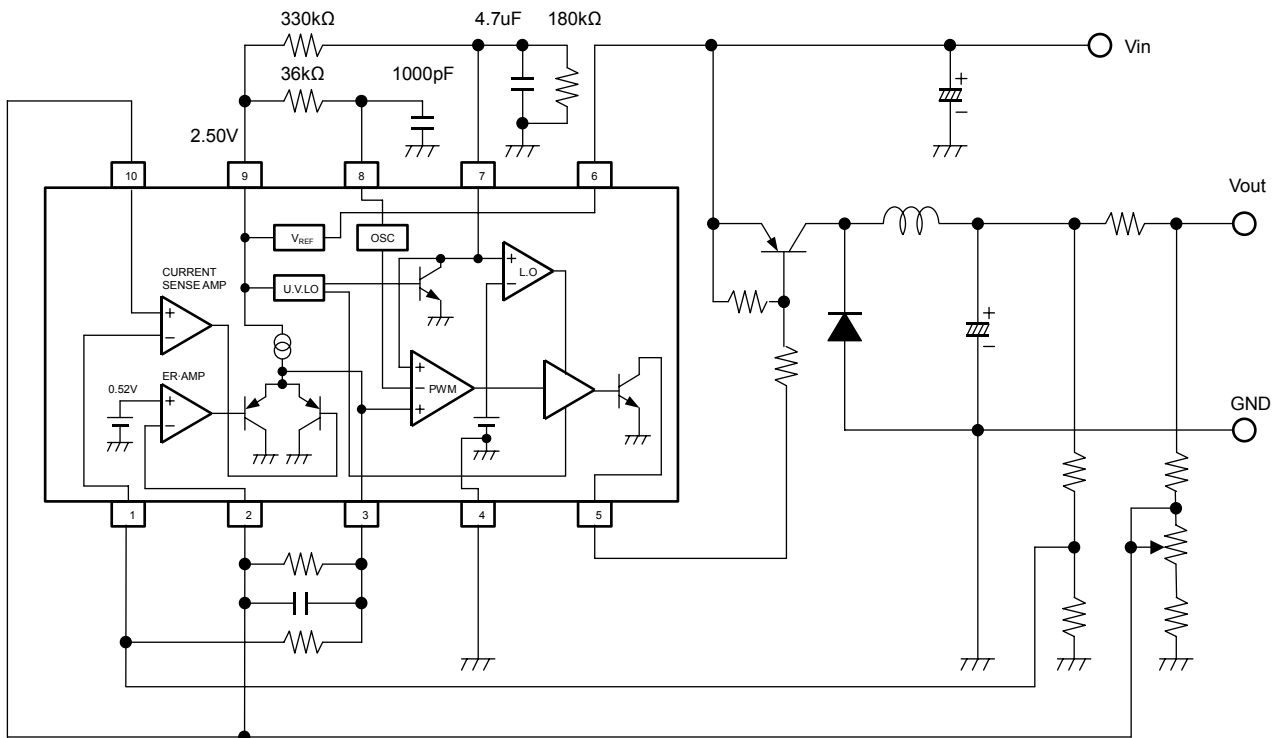
| PARAMETER                                | SYMBOL     | TEST CONDITION                 | MIN. | TYP. | MAX. | UNIT |
|------------------------------------------|------------|--------------------------------|------|------|------|------|
| Latch Mode<br>Threshold Voltage (CS Pin) | $V_{THLA}$ |     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

(note) Duty·Cycle is defined as follows:

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

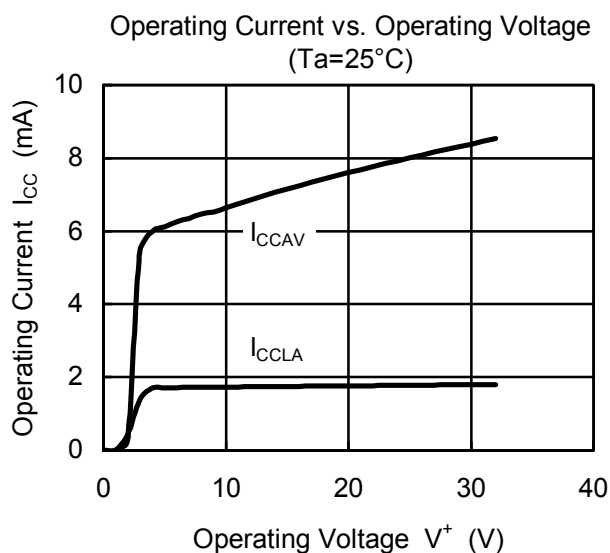
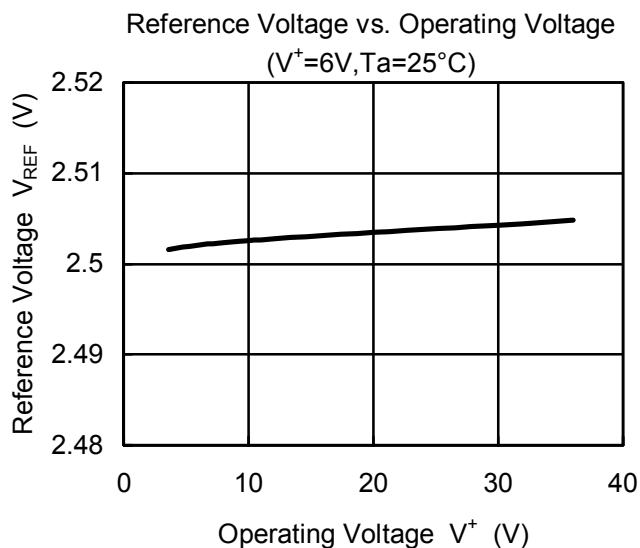
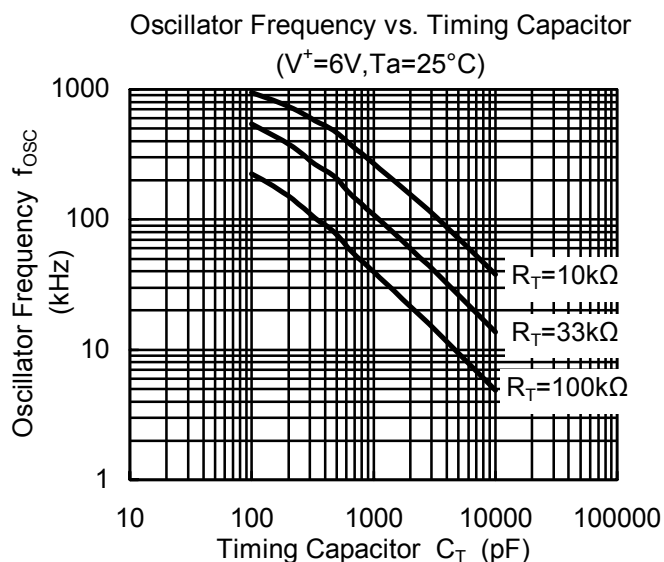
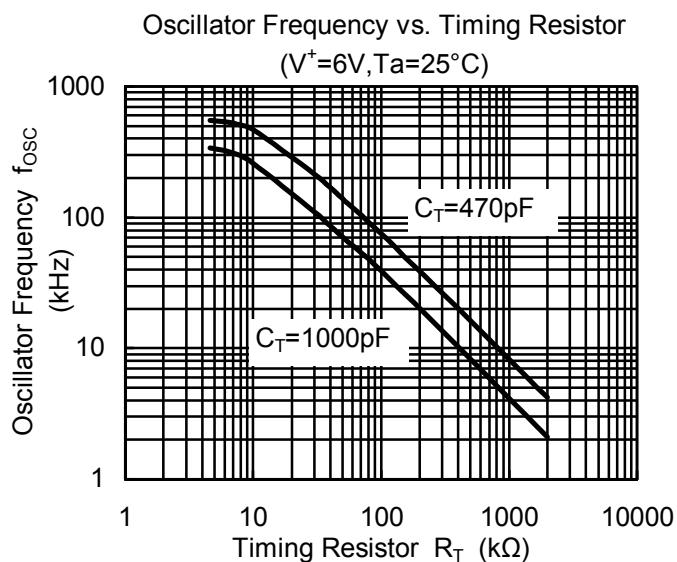
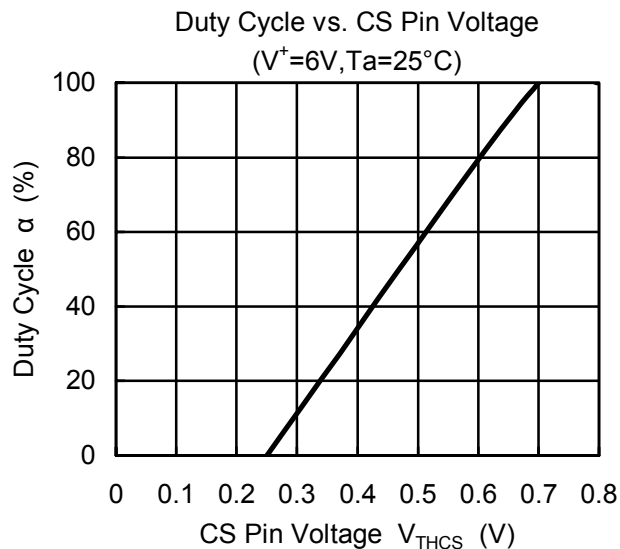
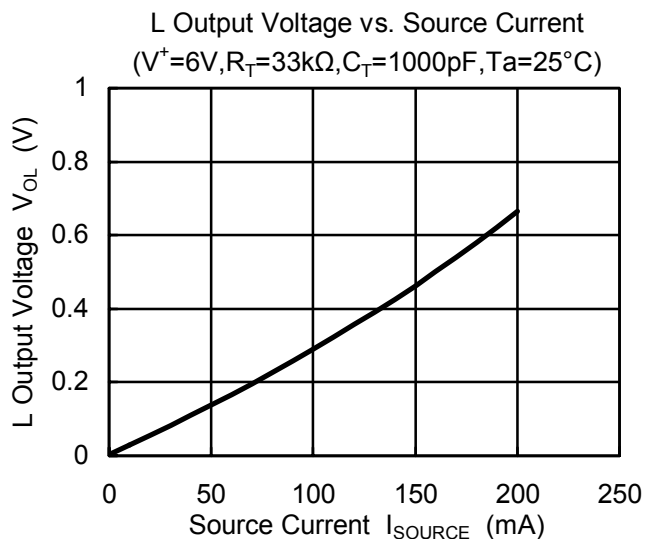
Duty·Cycle=100%: IC output transistor is ON.

## ■ TYPICAL APPLICATIONS

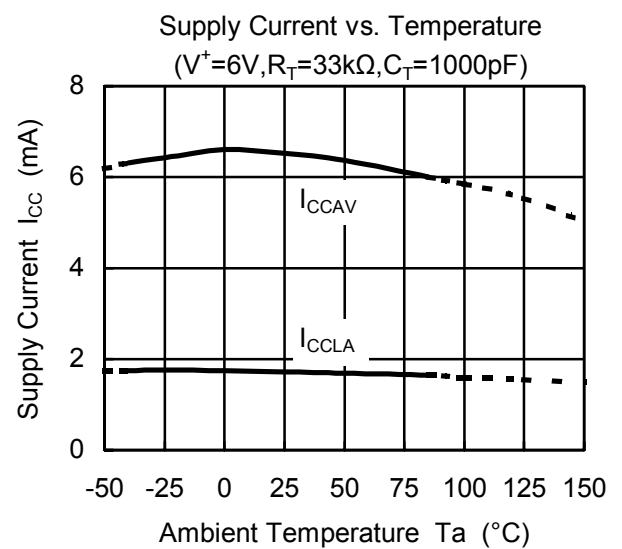
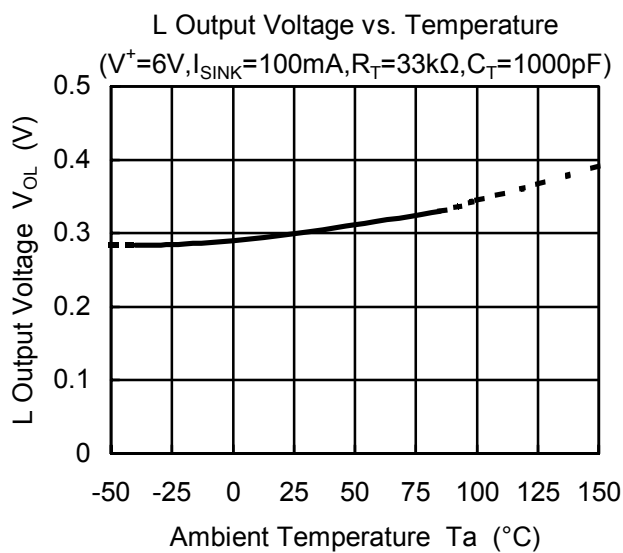
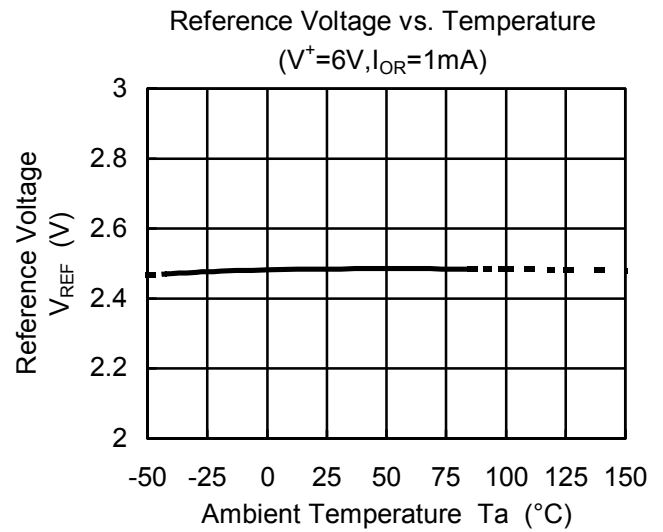
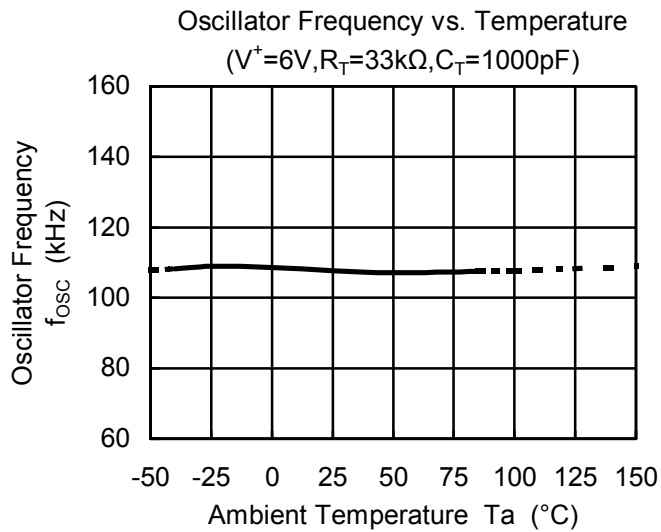


(Package:SSOP10)

## ■ TYPICAL CHARACTERISTICS



## ■ TYPICAL CHARACTERISTICS



### [CAUTION]

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.