

# Step-Down switching regulator IC with Constant Current Control

## ■ GENERAL DESCRIPTION

The **NJU7650** is a low voltage operation high-speed switching regulator control IC for step-down converter, with a constant current control. It incorporates a totem pole output, which can drive an external MOS-FET easily. It also incorporates error amplifier and current sense amplifier, which can allow the constant voltage/current control for output voltage. Therefore the NJU7650 is suitable for a LED driving, battery charger and other CCCV applications. The NJU7650 is available in a small and thin 8-lead MSOP (TVSP) package.

## ■ FEATURES

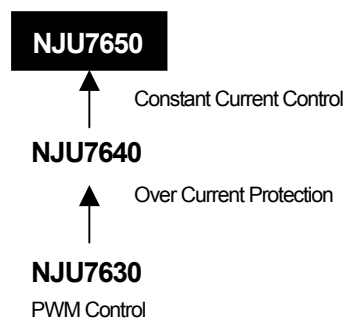
- PWM switching control
  - Constant Current Control
  - Operating Voltage           2.2V to 8V
  - Wide Oscillator Range    300kHz to 1MHz
  - Maximum Duty Cycle     100%
  - Quiescent Current        800 $\mu$ A typ.
  - Soft-Start Function       Internal : 16ms typ. or adjustable
  - Dead Time Control
  - C-MOS Technology
  - Package Outline           NJU7650RB1 : MSOP8 (TVSP8)\*
- \*MEET JEDEC MO-187-DA/ THIN TYPE

## ■ PACKAGE OUTLINE

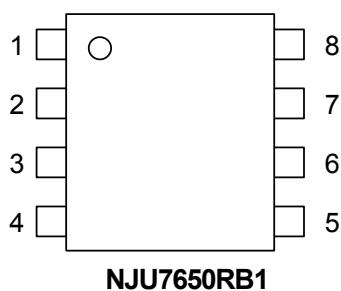


**NJU7650RB1**  
(MSOP8 (TVSP8))

## ■ PRODUCT VARIATION



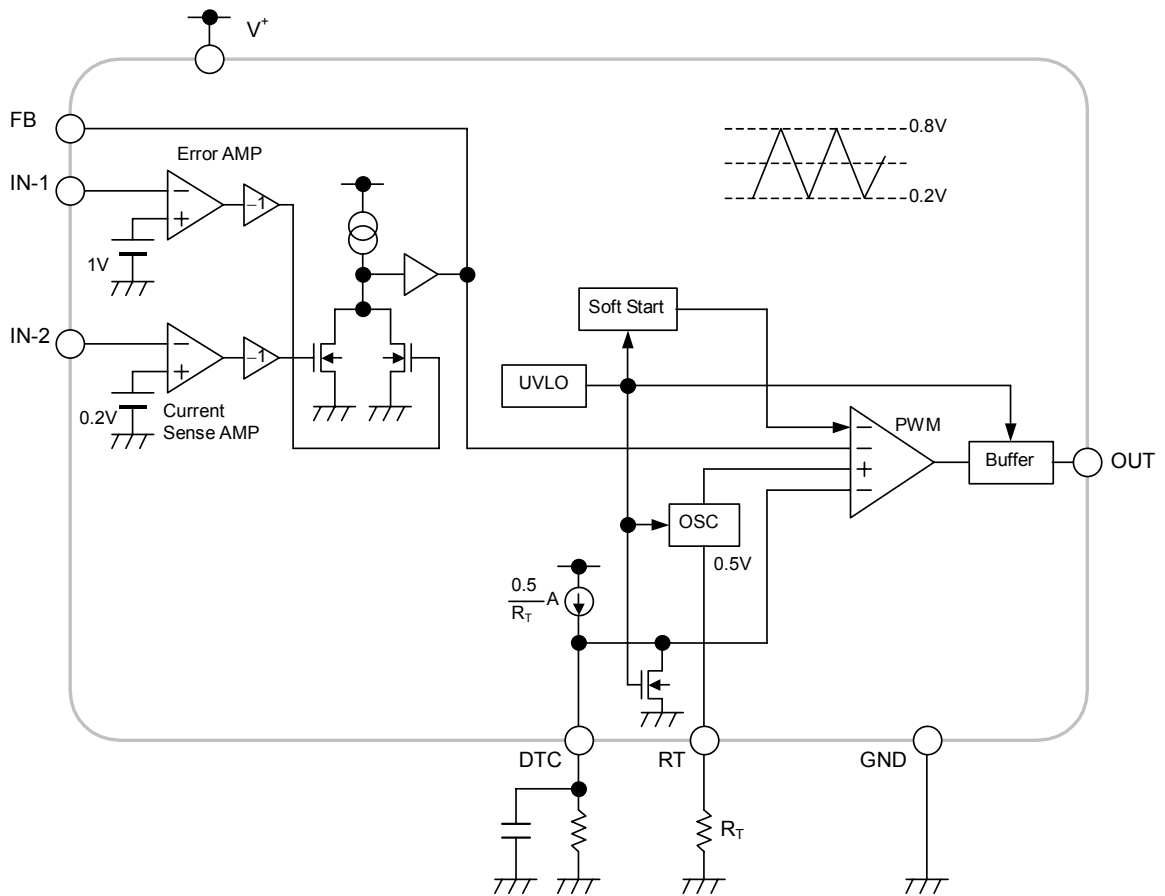
## ■ PIN CONFIGURATION



### PIN FUNCTION

1. OUT
2. V<sup>+</sup>
3. FB
4. IN-1
5. IN-2
6. DTC
7. RT
8. GND

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

| PARAMETER                   | SYMBOL    | MAXIMUM RATINGS    | UNIT |
|-----------------------------|-----------|--------------------|------|
| Supply Voltage              | $V^+$     | +9                 | V    |
| Output Pin Current          | $I_O$     | ±50                | mA   |
| Power Dissipation           | $P_D$     | MSOP8 (TVSP8) :320 | mW   |
| Operating Temperature Range | $T_{OPR}$ | -40 to +85         | °C   |
| Storage Temperature Range   | $T_{STG}$ | -40 to +125        | °C   |

## ■ RECOMMENDED OPERATING CONDITIONS

(Ta=25°C)

| PARAMETER                  | SYMBOL    | MIN. | TYP. | MAX.  | UNIT |
|----------------------------|-----------|------|------|-------|------|
| Operating Voltage          | $V^+$     | 2.2  | —    | 8     | V    |
| Oscillator Timing Resistor | $R_T$     | 30   | 47   | 120   | kΩ   |
| Oscillation Frequency      | $f_{OSC}$ | 300  | 700  | 1,000 | kHz  |

## ■ ELECTRICAL CHARACTERISTICS

( $V^+=3.3V$ ,  $R_T=47k\Omega$ , Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------|--------|----------------|------|------|------|------|
|-----------|--------|----------------|------|------|------|------|

### Under Voltage Lockout Block

|                       |              |                         |     |     |     |    |
|-----------------------|--------------|-------------------------|-----|-----|-----|----|
| ON Threshold Voltage  | $V_{T\_ON}$  | $V^+ = L \rightarrow H$ | 1.9 | 2.0 | 2.1 | V  |
| OFF Threshold Voltage | $V_{T\_OFF}$ | $V^+ = H \rightarrow L$ | 1.8 | 1.9 | 2.0 | V  |
| Hysteresis Voltage    | $V_{HYS}$    |                         | 60  | 100 | —   | mV |

### Soft Start Block

|                 |          |                                          |   |    |    |    |
|-----------------|----------|------------------------------------------|---|----|----|----|
| Soft Start Time | $T_{SS}$ | $V_{T\_ON} \rightarrow \text{Duty}=80\%$ | 8 | 16 | 24 | ms |
|-----------------|----------|------------------------------------------|---|----|----|----|

### Oscillator Block

|                                       |           |                   |     |     |     |     |
|---------------------------------------|-----------|-------------------|-----|-----|-----|-----|
| RT Pin Voltage                        | $V_{RT}$  |                   | -5% | 0.5 | +5% | V   |
| Oscillation Frequency                 | $f_{OSC}$ |                   | 630 | 700 | 770 | kHz |
| Oscillate Supply Voltage Fluctuations | $f_{DV}$  | $V^+=2.2V$ to 8V  | —   | 1   | —   | %   |
| Oscillate Temperature Fluctuations    | $f_{DT}$  | Ta=-40°C to +85°C | —   | 3   | —   | %   |

## ■ ELECTRICAL CHARACTERISTICS

( $V^+=3.3V$ ,  $R_T=47k\Omega$ ,  $T_a=25^\circ C$ )

| PARAMETER | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-----------|--------|----------------|------|------|------|------|
|-----------|--------|----------------|------|------|------|------|

### Error Amplifier Block

|                          |              |                                                                 |       |      |       |         |
|--------------------------|--------------|-----------------------------------------------------------------|-------|------|-------|---------|
| Reference Voltage 1      | $V_{B1}$     |                                                                 | -1.0% | 1.00 | +1.0% | V       |
| Input Bias Current 1     | $I_{B1}$     |                                                                 | -0.1  | —    | 0.1   | $\mu A$ |
| Open Loop Gain 1         | $A_{V1}$     |                                                                 | —     | 80   | —     | dB      |
| Gain Bandwidth Product 1 | $G_{B1}$     |                                                                 | —     | 1    | —     | MHz     |
| Output Source Current 1  | $I_{OM+\_1}$ | $V_{FB}=1V$ , $V_{IN-1}=0.9V$ , $V_{IN-2}=0.1V$                 | 25    | 55   | 95    | mA      |
|                          | $I_{OM+\_2}$ | $V_{FB}=1V$ , $V_{IN-1}=0.9V$ , $V_{IN-2}=0.1V$ ,<br>$V^+=2.2V$ | 4     | 9    | 16    | mA      |
| Output Sink Current 1    | $I_{OM-}$    | $V_{FB}=1V$ , $V_{IN-1}=1.1V$ , $V_{IN-2}=0.1V$                 | 0.10  | 0.16 | 0.22  | mA      |

### Current Sense Amplifier Block

|                          |            |                                                 |      |      |      |         |
|--------------------------|------------|-------------------------------------------------|------|------|------|---------|
| Reference Voltage 2      | $V_{B2}$   |                                                 | -10% | 0.2  | +10% | V       |
| Input Bias Current 2     | $I_{B2}$   |                                                 | -0.1 | —    | 0.1  | $\mu A$ |
| Open Loop Gain 2         | $A_{V2}$   |                                                 | —    | 70   | —    | dB      |
| Gain Bandwidth Product 2 | $G_{B2}$   |                                                 | —    | 1    | —    | MHz     |
| Output Sink Current 2    | $I_{OM2-}$ | $V_{FB}=1V$ , $V_{IN-1}=0.9V$ , $V_{IN-2}=0.3V$ | 0.10 | 0.16 | 0.22 | mA      |

### PWM Compare Block

|                         |                    |                                     |      |      |      |   |
|-------------------------|--------------------|-------------------------------------|------|------|------|---|
| Input Threshold Voltage | $V_{T\_0}$         | Duty=0%                             | 0.16 | 0.22 | 0.28 | V |
|                         | $V_{T\_50}$        | Duty=50%                            | 0.44 | 0.5  | 0.56 | V |
| Maximum Duty Cycle      | $M_{AX}D_{UTY\_1}$ | $V_{FB}=0.9V$                       | 100  | —    | —    | % |
|                         | $M_{AX}D_{UTY\_2}$ | $V_{FB}=0.9V$ , $R_{DTC}=47k\Omega$ | 40   | 50   | 60   | % |

### Output Block

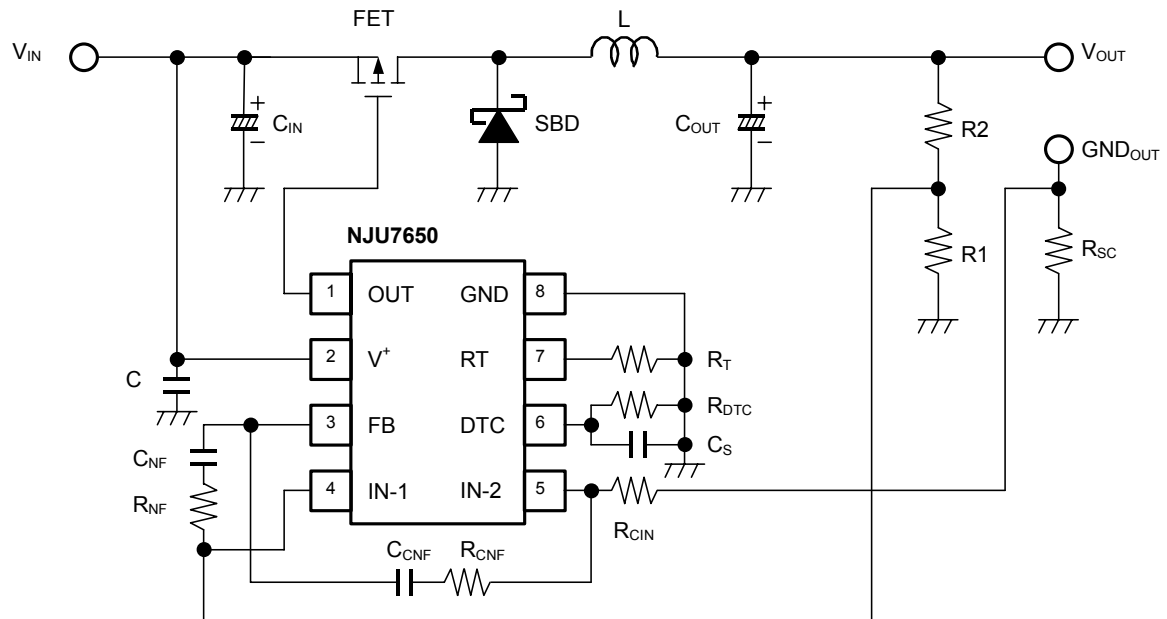
|                                 |          |             |   |    |    |          |
|---------------------------------|----------|-------------|---|----|----|----------|
| Output High Level ON Resistance | $R_{OH}$ | $I_O=-20mA$ | — | 10 | 20 | $\Omega$ |
| Output Low Level ON Resistance  | $R_{OL}$ | $I_O=+20mA$ | — | 5  | 10 | $\Omega$ |

### General Characteristics

|                   |          |                 |   |     |      |         |
|-------------------|----------|-----------------|---|-----|------|---------|
| Quiescent Current | $I_{DD}$ | $R_L=Non\ Load$ | — | 800 | 1200 | $\mu A$ |
|-------------------|----------|-----------------|---|-----|------|---------|

## ■ TYPICAL APPLICATIONS

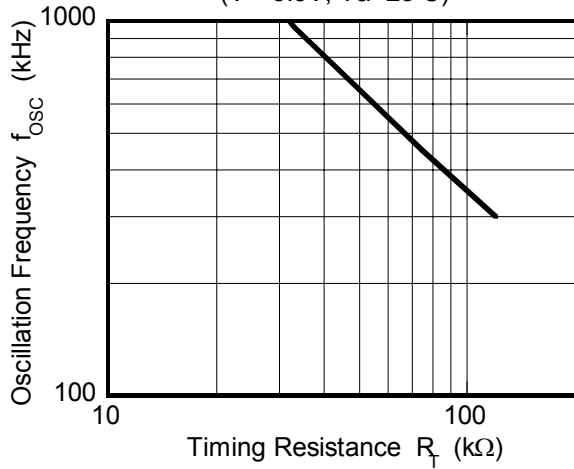
### Step-Down Converter



## ■ TYPICAL CHARACTERISTICS

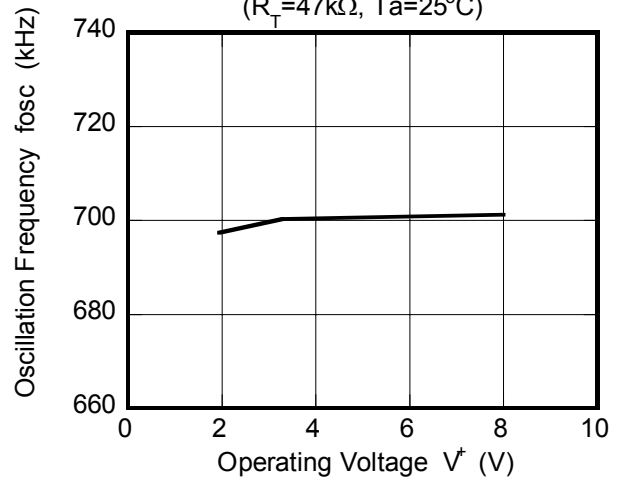
Oscillation Frequency vs. Timing Resistance

( $V^+ = 3.3\text{V}$ ,  $T_a = 25^\circ\text{C}$ )



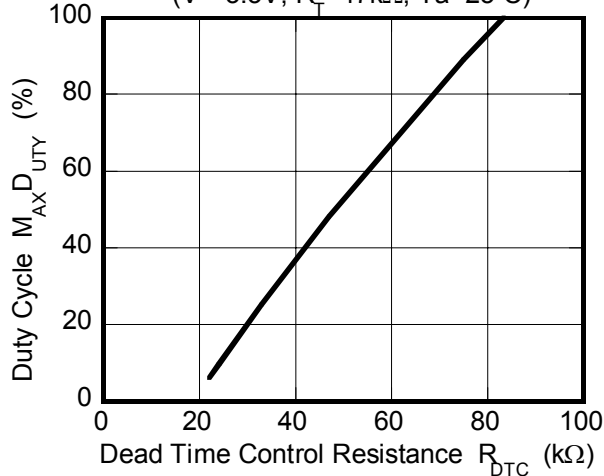
Oscillation Frequency vs. Operating Voltage

( $R_T = 47\text{k}\Omega$ ,  $T_a = 25^\circ\text{C}$ )



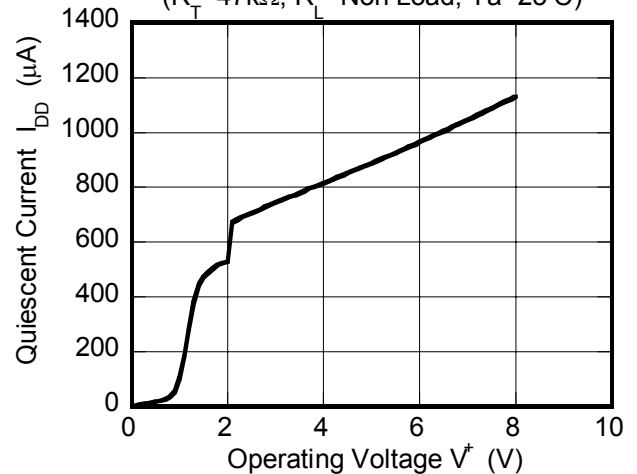
Duty Cycle vs.  $R_{DTC}$

( $V^+ = 3.3\text{V}$ ,  $R_T = 47\text{k}\Omega$ ,  $T_a = 25^\circ\text{C}$ )



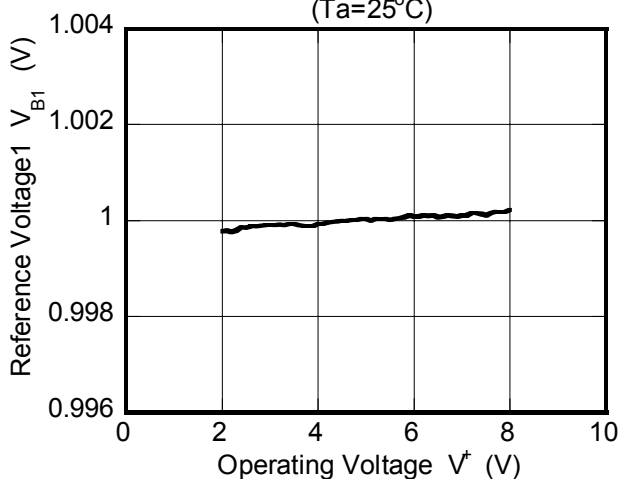
Quiescent Current vs. Operating Voltage

( $R_T = 47\text{k}\Omega$ ,  $R_L = \text{Non Load}$ ,  $T_a = 25^\circ\text{C}$ )



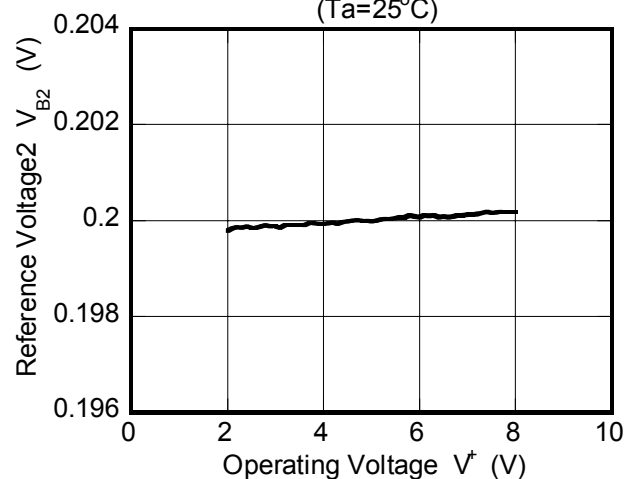
Error Amplifier Block  
Reference Voltage1 vs. Operating Voltage

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

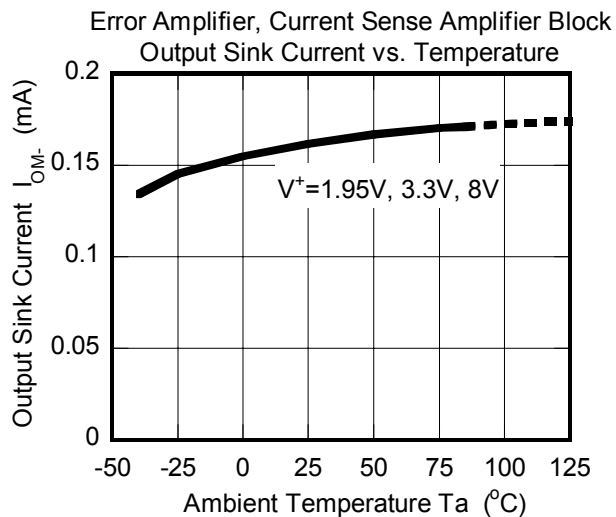
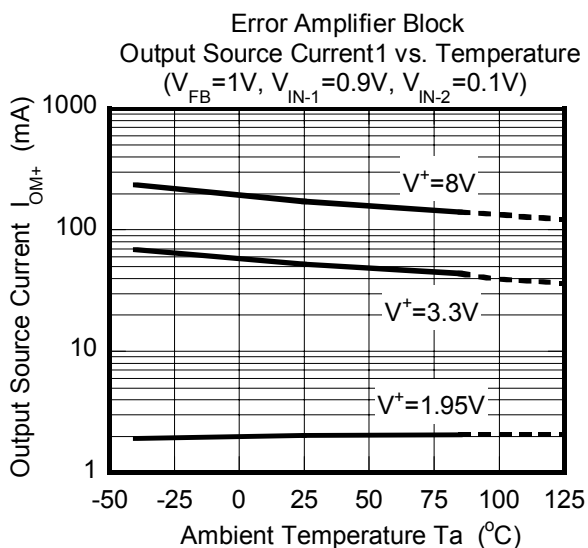
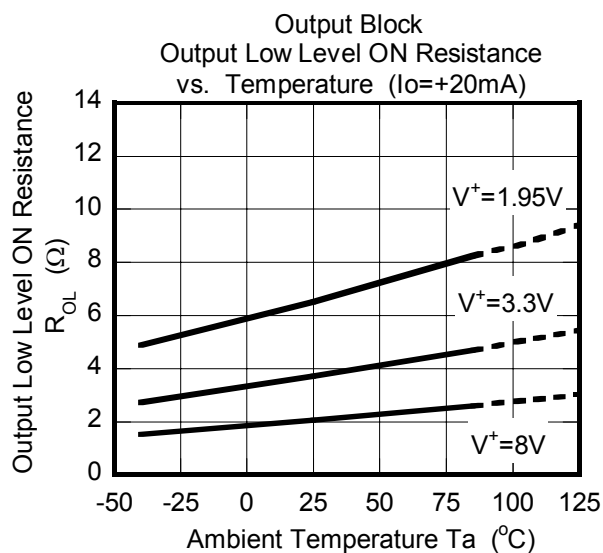
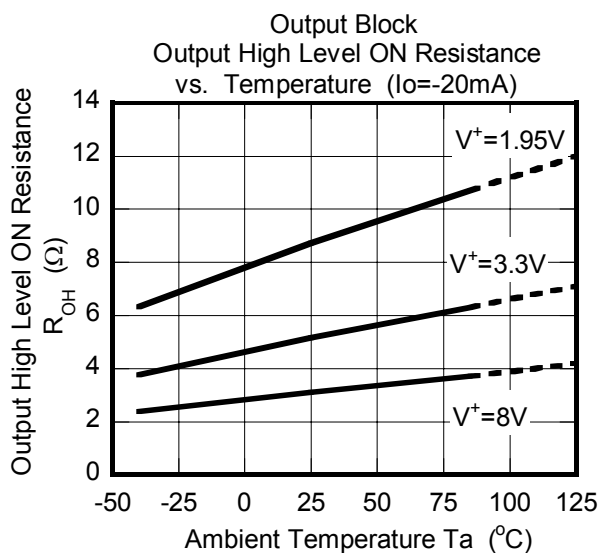
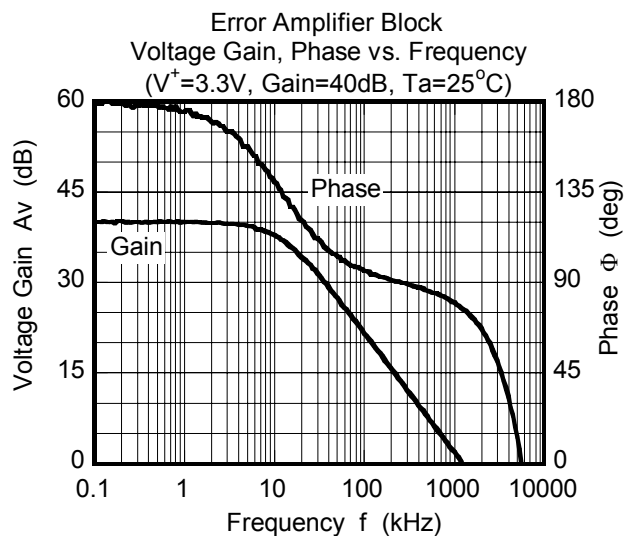


Current Sense Amplifier Block  
Reference Voltage2 vs. Operating Voltage

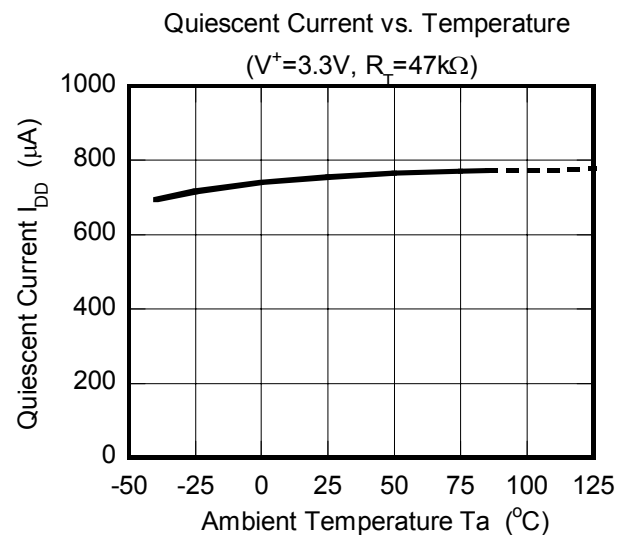
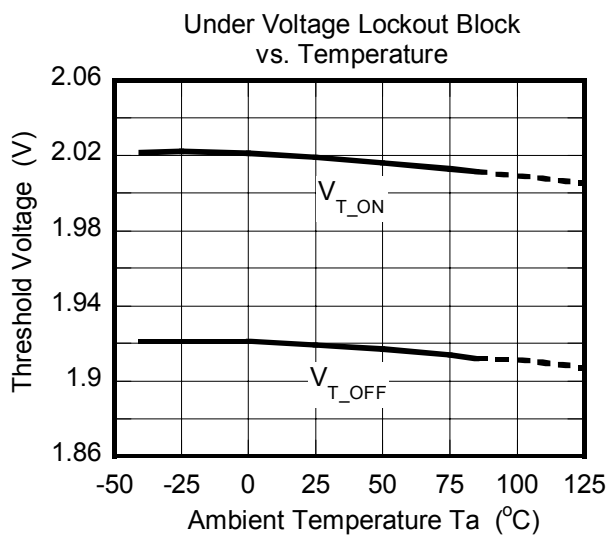
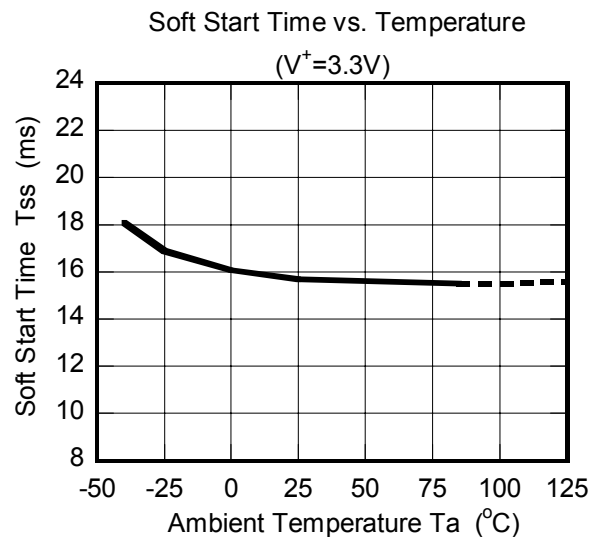
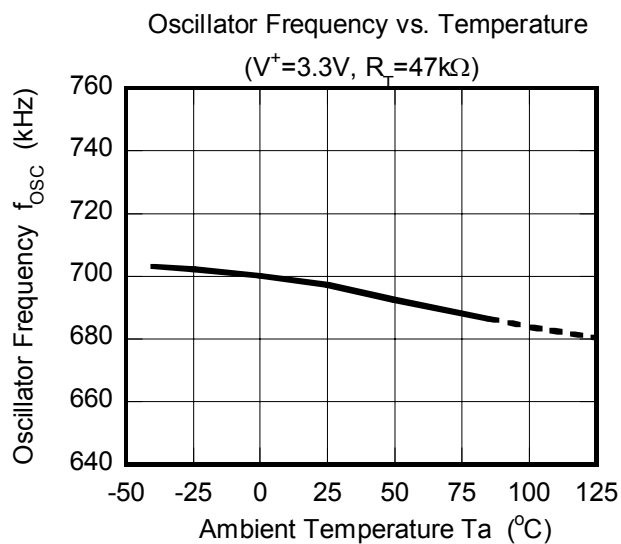
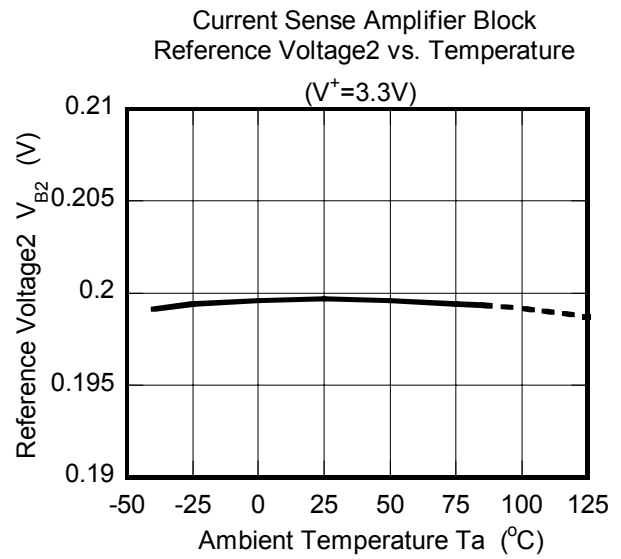
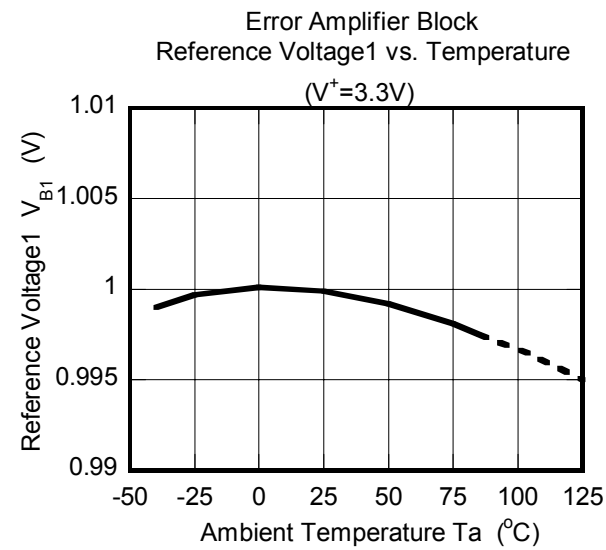
( $T_a = 25^\circ\text{C}$ )



■ TYPICAL CHARACTERISTICS



## ■ TYPICAL CHARACTERISTICS



## MEMO

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