



## P3596

## LINEAR INTEGRATED CIRCUIT

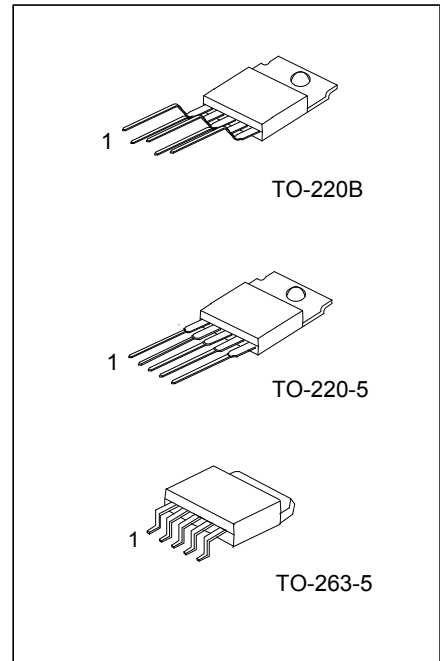
### 150KHZ, 3A PWM STEP-DOWN DC/DC CONVERTER

#### ■ DESCRIPTION

The UTC **P3596** series is a step-down switching regulator able to provide 3A output current. The available output voltages are 2.5V, 3.3V, 5V, 12V, and an adjustable output version.

#### ■ FEATURES

- \*Output load current: 3A
- \*Adjustable version output voltage range, 1.23V ~ 32V±4%
- \*Operating voltage can be up to 35V
- \*Low power standby mode
- \*High efficiency
- \*Internal current and thermal limit



#### ■ ORDERING INFORMATION

| Ordering Number |                 | Package  | Packing   |
|-----------------|-----------------|----------|-----------|
| Lead Free       | Halogen Free    |          |           |
| P3596L-xx-TB5-T | P3596G-xx-TB5-T | TO-220B  | Tube      |
| P3596L-xx-TA5-T | P3596G-xx-TA5-T | TO-220-5 | Tube      |
| P3596L-xx-TQ5-R | P3596G-xx-TQ5-R | TO-263-5 | Tape Reel |
| P3596L-xx-TQ5-T | P3596G-xx-TQ5-T | TO-263-5 | Tube      |

Note: xx: Output Voltage, refer to Marking Information.

|                                                                                                                   |                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>P3596L-xx-TA5-T</p> <p>(1)Packing Type<br/>(2)Package Type<br/>(3)Output Voltage Code<br/>(4)Green Package</p> | <p>(1) R: Tape Reel, T: Tube<br/>(2) TB5: TO-220B, TA5: TO-220-5, TQ5: TO-263-5<br/>(3) xx: refer to Marking Information<br/>(4) L: Lead Free, G: Halogen Free and Lead Free</p> |
|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

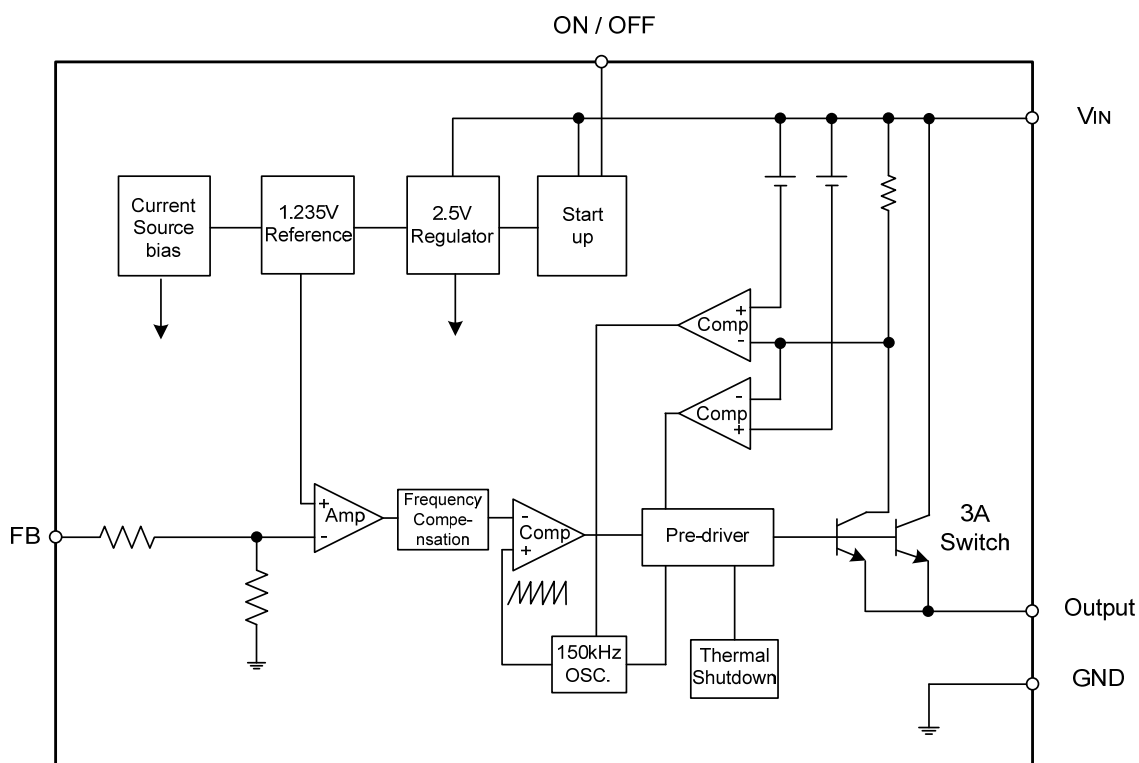
## MARKING INFORMATION

| PACKAGE                         | VOLTAGE CODE                                      | MARKING                                                                                      |
|---------------------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------|
| TO-220-5<br>TO-220B<br>TO-263-5 | 25:2.5V<br>33:3.3V<br>50:5.0V<br>12:12V<br>AD:ADJ | <p>UTC<br/>P3596</p> <p>Lot Code → Voltage Code → Lead Free → Date Code</p> <p>1 2 3 4 5</p> |

## PIN DESCRIPTION

| PIN NO. | PIN NAME        | DESCRIPTION                     |
|---------|-----------------|---------------------------------|
| 1       | V <sub>IN</sub> | Operating voltage input         |
| 2       | Output          | Switching output                |
| 3       | GND             | Circuit Ground                  |
| 4       | FB (Feedback)   | Output voltage feedback control |
| 5       | SD (Shutdown)   | ON/OFF shutdown                 |

## BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER                               | SYMBOL       | RATINGS            | UNIT |
|-----------------------------------------|--------------|--------------------|------|
| Maximum Supply Voltage                  | $V_{CC}$     | 40                 | V    |
| Operating Voltage                       | $V_{OPR}$    | 4.5 ~ 35           | V    |
| ON/OFF Pin Input Voltage                | $V_{ON/OFF}$ | -0.3 ~ +20         | V    |
| Feedback Pin Voltage                    | $V_{FB}$     | -0.3 ~ +20         | V    |
| Output Voltage to Ground (Steady State) | $V_{OUT}$    | -1                 | V    |
| Power Dissipation                       | $P_D$        | Internally limited | mW   |
| Junction Temperature                    | $T_J$        | +150               | °C   |
| Ambient Operating Temperature           | $T_{OPR}$    | -40 ~ +125         | °C   |
| Storage Temperature                     | $T_{STG}$    | -65 ~ +150         | °C   |

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ THERMAL DATA

| PARAMETER           | SYMBOL   | RATINGS | UNIT |
|---------------------|----------|---------|------|
| Junction to Ambient | TO-220B  | 45      | °C/W |
|                     | TO-220-5 | 45      |      |
|                     | TO-263-5 | 55      |      |
| Junction to Case    | TO-220B  | 3       | °C/W |
|                     | TO-220-5 | 3       |      |
|                     | TO-263-5 | 4       |      |

## ■ ELECTRICAL CHARACTERISTICS

( $T_J=25^{\circ}\text{C}$ ,  $V_{IN}=12\text{V}$  for the 3.3V, 5V, and Adjustable version and  $V_{IN}=24\text{V}$  for the 12V version,  $I_{LOAD}=500\text{mA}$ .)

| PARAMETER      | SYMBOL | TEST CONDITIONS                                                                         | MIN   | TYP  | MAX   | UNIT |
|----------------|--------|-----------------------------------------------------------------------------------------|-------|------|-------|------|
| Output Voltage | 2.5V   | $3.8\text{V} \leq V_{IN} \leq 35\text{V}$ , $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$  | 2.4   | 2.5  | 2.6   | V    |
|                | 3.3V   | $4.75\text{V} \leq V_{IN} \leq 35\text{V}$ , $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$ | 3.168 | 3.3  | 3.432 | V    |
|                | 5.0V   | $7\text{V} \leq V_{IN} \leq 35\text{V}$ , $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$    | 4.8   | 5.0  | 5.2   | V    |
|                | 12V    | $15\text{V} \leq V_{IN} \leq 35\text{V}$ , $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$   | 11.52 | 12.0 | 12.48 | V    |
| Efficiency     | 2.5V   | $V_{IN}=12\text{V}$ , $I_{LOAD}=3\text{A}$                                              |       | 73   |       | %    |
|                | 3.3V   | $V_{IN}=12\text{V}$ , $I_{LOAD}=3\text{A}$                                              |       | 73   |       | %    |
|                | 5.0V   | $V_{IN}=12\text{V}$ , $I_{LOAD}=3\text{A}$                                              |       | 80   |       | %    |
|                | 12V    | $V_{IN}=24\text{V}$ , $I_{LOAD}=3\text{A}$                                              |       | 90   |       | %    |

## FOR P3596-ADJ

|                  |          |                                                                                                                       |       |       |       |   |
|------------------|----------|-----------------------------------------------------------------------------------------------------------------------|-------|-------|-------|---|
| Feedback Voltage | $V_{FB}$ | $4.5\text{V} \leq V_{IN} \leq 35\text{V}$ , $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$<br>$V_{OUT}$ programmed for 3V | 1.193 | 1.230 | 1.267 | V |
| Efficiency       | $\eta$   | $V_{IN}=12\text{V}$ , $V_{OUT}=3\text{V}$ , $I_{LOAD}=3\text{A}$                                                      |       | 73    |       | % |

## ALL OUTPUT VOLTAGE

|                           |             |                                               |     |      |     |               |
|---------------------------|-------------|-----------------------------------------------|-----|------|-----|---------------|
| Feedback Bias Current     | $I_{BIAS}$  | Adjustable Version Only, $V_{FB}=1.3\text{V}$ |     | 10   | 50  | nA            |
| Oscillator Frequency      | $f_{OSC}$   | (Note 1)                                      | 127 | 150  | 173 | kHz           |
| Saturation Voltage        | $V_{SAT}$   | $I_{OUT}=3\text{A}$ (Note 2, 3)               |     | 1.16 | 1.4 | V             |
| Duty Cycle                | Min         | ON (Note 3)                                   |     | 100  |     | %             |
|                           | Max         | OFF (Note 4)                                  |     | 0    |     |               |
| Current Limit             | $I_{LIMIT}$ | Peak Current (Notes 2, 3)                     | 3.6 | 4.5  | 6.9 | A             |
| Output Leakage Current    | $I_{LEAK}$  | Output=0V (Notes 2, 4)                        |     |      | 50  | $\mu\text{A}$ |
|                           |             | Output=-1V, $V_{IN}=40\text{V}$               |     | 2    | 30  | mA            |
| Quiescent Current         | $I_Q$       | (Note 4)                                      |     | 5    | 10  | mA            |
| Standby Quiescent Current | $I_{STBY}$  | ON/OFF pin=5V (OFF), $V_{IN}=40\text{V}$      |     | 80   | 200 | $\mu\text{A}$ |

## ■ ELECTRICAL CHARACTERISTICS(Cont.)

| PARAMETER                                |      | SYMBOL   | TEST CONDITIONS                  | MIN | TYP  | MAX | UNIT    |
|------------------------------------------|------|----------|----------------------------------|-----|------|-----|---------|
| <b>ON/OFF CONTROL</b>                    |      |          |                                  |     |      |     |         |
| ON/OFF Pin Logic Input Threshold Voltage | Low  | $V_{IH}$ | Regulator ON                     | 0.6 | 1.3  |     | V       |
|                                          | High | $V_{IL}$ | Regulator OFF                    | 2.0 |      |     |         |
| ON/OFF Pin Input Current                 |      | $I_H$    | $V_{LOGIC}=2.5V$ (Regulator OFF) |     | 5    | 15  | $\mu A$ |
|                                          |      | $I_L$    | $V_{LOGIC}=0.5V$ (Regulator ON)  |     | 0.02 | 5   | $\mu A$ |

Notes: 1.The switching frequency is reduced when the second stage current limit is activated.

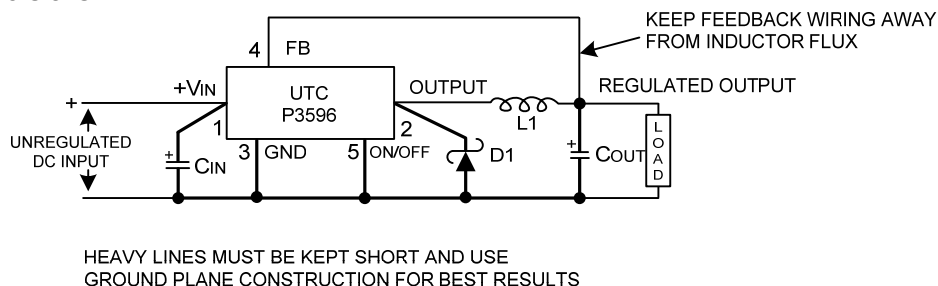
2.No diode, inductor or capacitor connected to output pin.

3.Feedback pin removed from output and connected to 0V to force the output transistor switch ON.

4.Feedback pin removed from output and connected to 15V for the 12V version, and 12V for others to force the output transistor switch OFF.

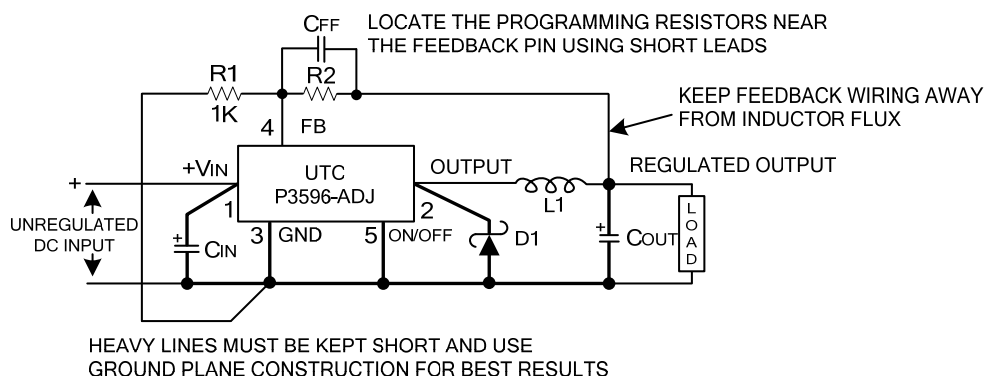
## TYPICAL APPLICATION

### For Fixed Versions



CIN: 470  $\mu$ F, 50V, Aluminum Electrolytic Nichicon "PL Series"  
 COUT: 220  $\mu$ F, 25V Aluminum Electrolytic, Nichicon "PL Series"  
 D1: 5A, 40V Schottky Rectifier, 1N5825  
 L1: 68  $\mu$ H, L38

### For Adjustable Version



$$V_{OUT} \times \left( \frac{R1}{R1 + R2} \right) = V_{REF}$$

$$V_{OUT} = V_{REF} \left( 1 + \frac{R2}{R1} \right)$$

Where  $V_{REF} = 1.23V$

$$R2 = R1 \left( \frac{V_{OUT}}{V_{REF}} - 1 \right)$$

- Note: 1. Select R1 to be approximately 1 K $\Omega$ , use a 1% resistor for best stability.  
 2. CIN: 470  $\mu$ F, 50V, Aluminum Electrolytic Nichicon "PL Series"  
 3. COUT: 220  $\mu$ F, 35V Aluminum Electrolytic, Nichicon "PL Series"  
 4. D1: 5A, 40V Schottky Rectifier, 1N5825  
 5. L1: 68  $\mu$ H, L38  
 6. R1: 1 K $\Omega$ , 1%  
 7. CFF: See Application Information Section

## TYPICAL CHARACTERISTICS

Fig. 1 Normalized Output Voltage

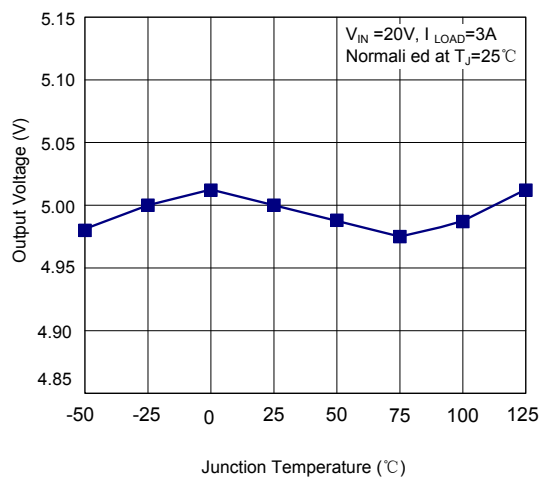


Fig. 2 Line Regulation

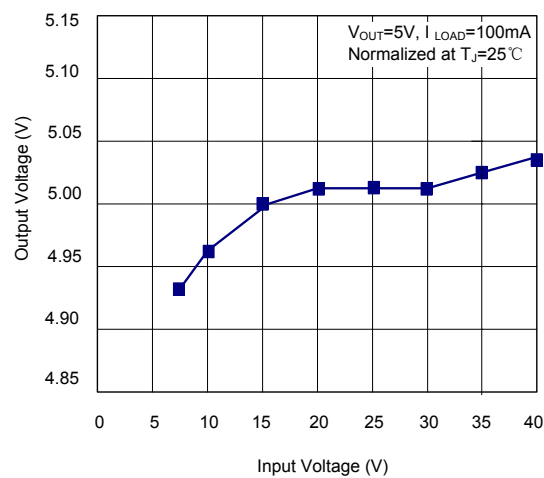


Fig. 3 Efficiency

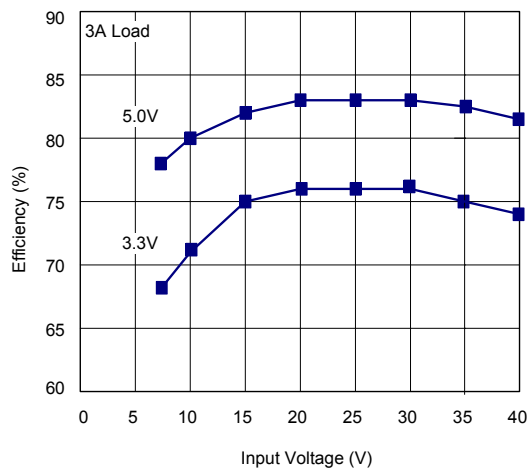


Fig. 4 Switch Saturation Voltage

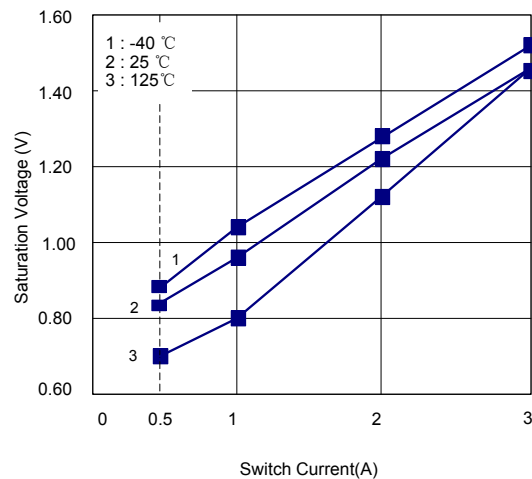


Fig. 5 Switch Current Limit

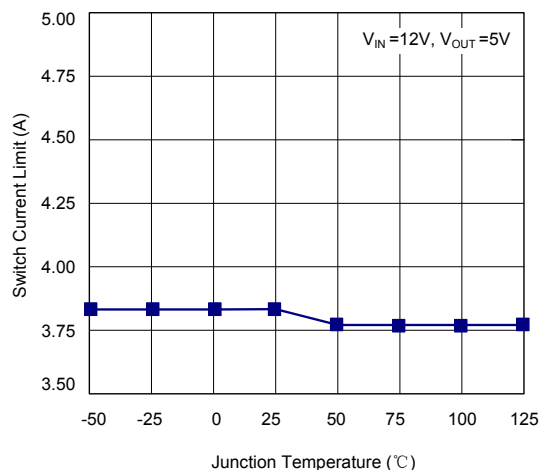
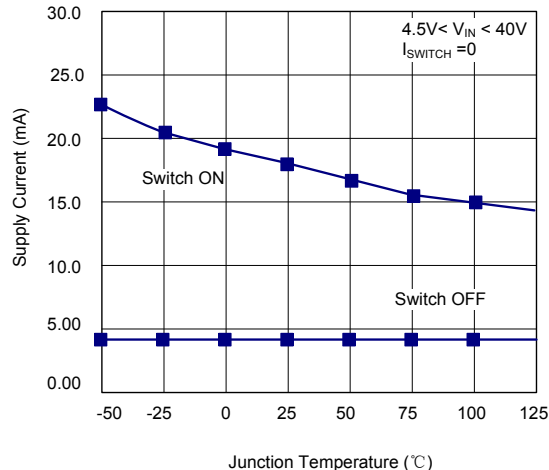


Fig. 6 Operating Quiescent Current



# TYPICAL CHARACTERISTICS (Cont.)

Fig. 7 Shutdown Quiescent Current

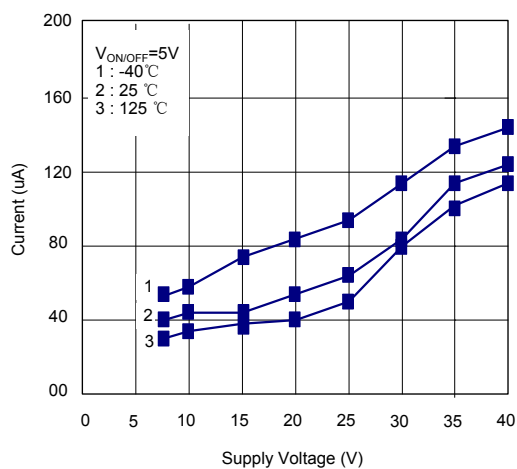


Fig. 8 Minimum Operating Supply Voltage

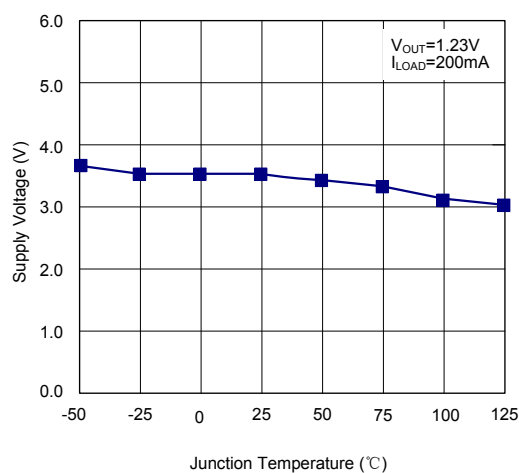


Fig. 9 ON/OFF Threshold Voltage

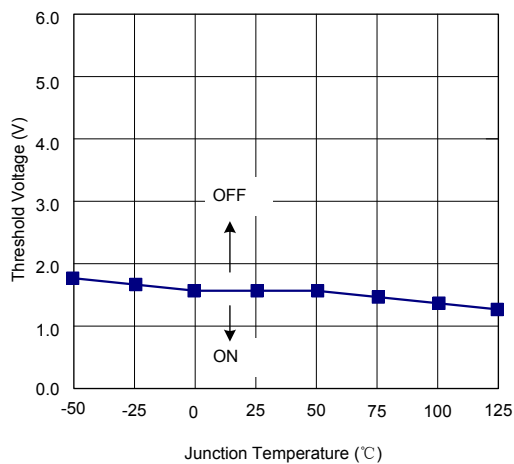


Fig. 10 ON/OFF Pin Current (Sinking)

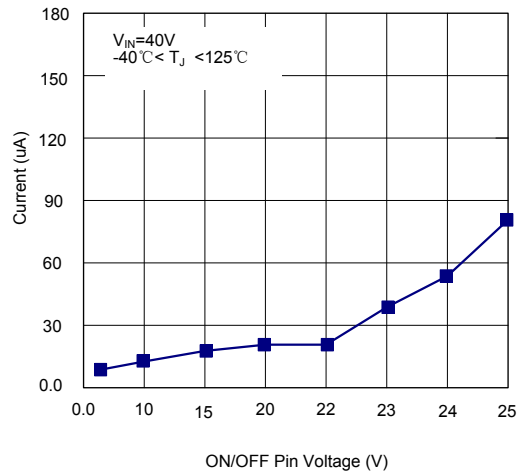


Fig. 11 Switch Frequency

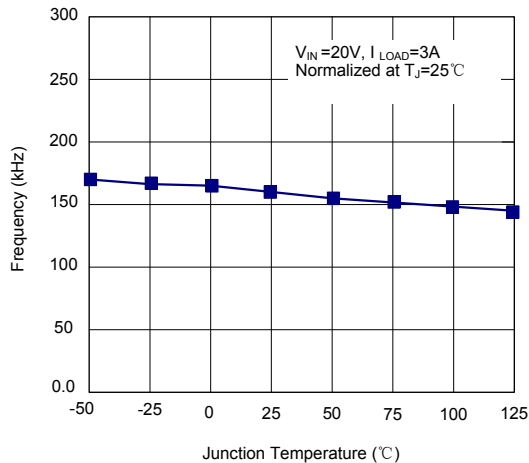
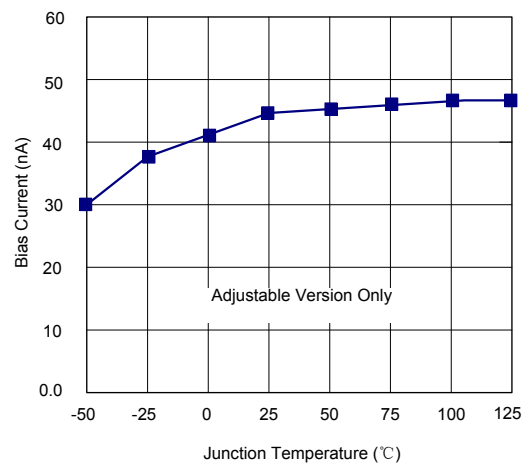


Fig. 12 Feedback Pin Bias Current



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