

**UR5516****LINEAR INTEGRATED CIRCUIT****3A BUS TERMINATION  
REGULATOR****DESCRIPTION**

The UTC **UR5516** is designed to provide a regulated voltage with bi-directional output current for DDR-SDRAM termination.

Current-limit work to limit the short-circuit current, on-chip thermal shutdown provides protection against any combination of overload that would create excessive junction temperature. The output voltage tracks the voltage at  $V_{REF}$  pin. A resistor divider connected to  $V_{IN}$ , GND and  $V_{REF}$  pins is used to provide a half voltage of  $V_{IN}$  to  $V_{REF}$  pin. In addition, an external ceramic capacitor and an open-drain transistor connected to  $V_{REF}$  pin provides soft-start and shutdown control respectively. Pulling and holding the  $V_{REF}$  to GND shuts off the output. The output of UTC **UR5516** will be high impedance after being shut down by  $V_{REF}$  or thermal shutdown function.

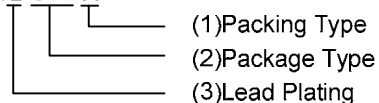
**FEATURES**

- \* Provide bi-direction current
  - Sourcing or sinking current up to 3A
- \* 1.25V/0.9V output for DDR I/O applications
- \* Fast transient response
- \* High output accuracy
  - $\pm 20\text{mV}$  over load,  $V_{OUT}$  offset and temperature
- \* Adjustable output voltage by external resistors
- \* Current-limit protection
- \* On-chip thermal shutdown
- \* Shutdown for standby or suspend mode

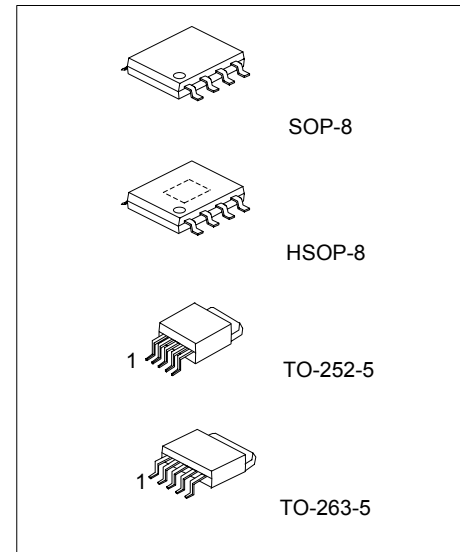
**ORDERING INFORMATION**

| Ordering Number |                   | Package  | Packing   |
|-----------------|-------------------|----------|-----------|
| Normal          | Lead Free Plating |          |           |
| UR5516-S08-R    | UR5516L-S08-R     | SOP-8    | Tape Reel |
| UR5516-S08-R    | UR5516L-S08-R     | SOP-8    | Tube      |
| UR5516-SH2-R    | UR5516L-SH2-R     | HSOP-8   | Tape Reel |
| UR5516-SH2-R    | UR5516L-SH2-R     | HSOP-8   | Tube      |
| UR5516-TN5-R    | UR5516L-TN5-R     | TO-252-5 | Tape Reel |
| UR5516-TN5-T    | UR5516L-TN5-T     | TO-252-5 | Tube      |
| UR5516-TQ5-R    | UR5516L-TQ5-R     | TO-263-5 | Tape Reel |
| UR5516-TQ5-T    | UR5516L-TQ5-T     | TO-263-5 | Tube      |

U5516L-S08-R

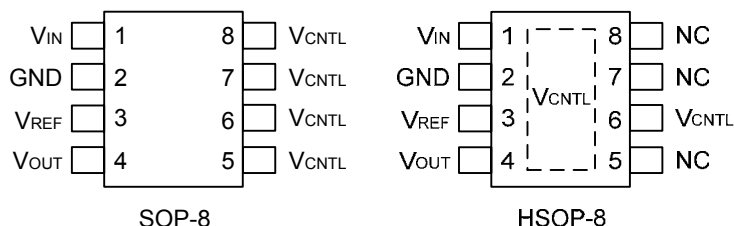


- (1) R: Tape Reel, T: Tube  
(2) S08: SOP-8, SH2: HSOP-8, TN5: TO-252-5,  
TQ5: TO-263-5  
(3) L: Lead Free Plating, Blank: Pb/Sn

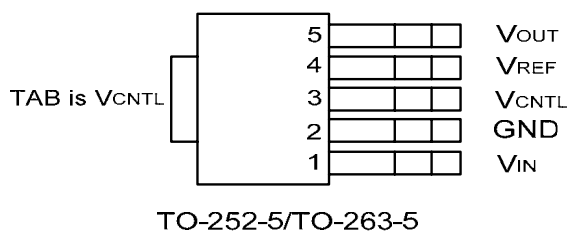


\*Pb-free plating product number: UR5516L

## PIN CONFIGURATION



NC: No Connection



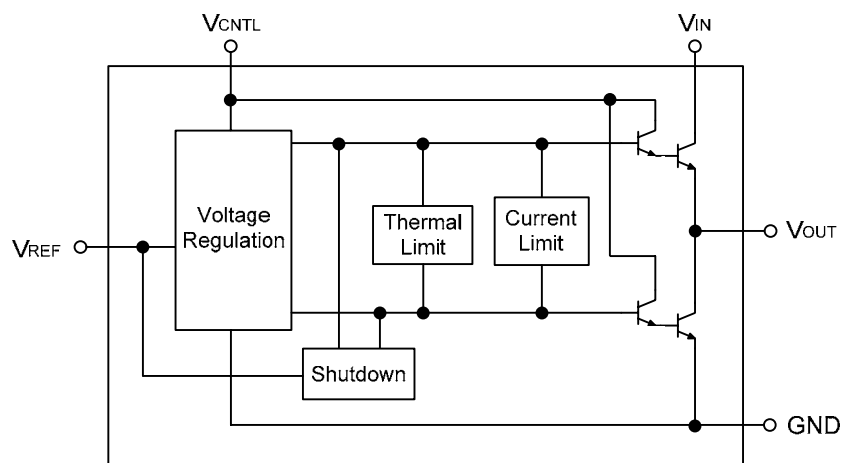
## PIN DESCRIPTION

| PIN NAME          | I/O | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                              |
|-------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>IN</sub>   | I   | Main power input pin. Connect this pin to a voltage source and an input capacitor. The UTC <b>UR5516</b> sources current to V <sub>OUT</sub> pin by controlling the upper NPN pass transistor, providing a current path from VIN pin.                                                                                                                                    |
| GND               | O   | Power and signal ground. Connect this pin to system ground plane with shortest traces. The UTC <b>UR5516</b> sinks current from V <sub>OUT</sub> pin by controlling the lower NPN pass transistor, providing a current path to GND pin. This pin is also the ground path for internal control circuitry.                                                                 |
| V <sub>CNTL</sub> | I   | Power input pin for internal control circuitry. Connect this pin to a voltage source, providing a bias for the internal control circuitry. A bypass capacitor is usually connected near this pin.                                                                                                                                                                        |
| V <sub>REF</sub>  | I   | Reference voltage input and active-low shutdown control pin. Apply a voltage to this pin as a reference voltage for the UTC <b>UR5516</b> . Connect this pin to a resistor divider, between V <sub>IN</sub> and GND, and a capacitor for soft-start and filtering noise purposes. Applying and holding this pin low by an open-drain transistor to shut down the output. |
| V <sub>OUT</sub>  | O   | Output pin of the regulator. Connect this pin to load. Output capacitors connected this pin improves stability and transient response. The output voltage tracks the reference voltage and is capable of sourcing or sinking current up to 3A.                                                                                                                           |

## THERMAL DATA

| PARAMETER          | SYMBOL   | RATINGS | UNIT |
|--------------------|----------|---------|------|
| Thermal Resistance | SOP-8    | 160     | °C/W |
|                    | HSOP-8   | 80      |      |
|                    | TO-252-5 | 80      |      |
|                    | TO-263-5 | 50      |      |

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER                                                  | SYMBOL            | RATINGS            | UNIT |
|------------------------------------------------------------|-------------------|--------------------|------|
| V <sub>CNTL</sub> Supply Voltage, V <sub>CNTL</sub> to GND | V <sub>CNTL</sub> | -0.2 ~ 7           | V    |
| V <sub>IN</sub> Supply Voltage, V <sub>IN</sub> to GND     | V <sub>IN</sub>   | -0.2 ~ 3.9         | V    |
| Power Dissipation                                          | P <sub>D</sub>    | Internally Limited | W    |
| Junction Temperature                                       | T <sub>J</sub>    | +150               | °C   |
| Storage Temperature                                        | T <sub>STG</sub>  | -40 ~ +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.

## ■ RECOMMENDED OPERATING CONDITIONS

| PARAMETER                                  | SYMBOL            | RANGES                  | UNIT |
|--------------------------------------------|-------------------|-------------------------|------|
| V <sub>CNTL</sub> Supply Voltage (Note 1)  | V <sub>CNTL</sub> | 3.1 ~ 6                 | V    |
| V <sub>IN</sub> Supply Voltage (Note 2)    | V <sub>IN</sub>   | 1.2 ~ 3.5               | V    |
| V <sub>REF</sub> Input Voltage             | V <sub>REF</sub>  | 0.85 ~ 1.75             | V    |
| V <sub>OUT</sub> Output Voltage (Note 3)   | V <sub>OUT</sub>  | V <sub>REF</sub> ± 0.02 | V    |
| V <sub>OUT</sub> Output Current (Note 4,5) | I <sub>OUT</sub>  | -3 ~ +3                 | A    |
| Junction Temperature                       | T <sub>J</sub>    | 0 ~ +125                | °C   |

Note: 1. Please always keep V<sub>CNTL</sub>-V<sub>OUT</sub>>1.9V for good regulation.

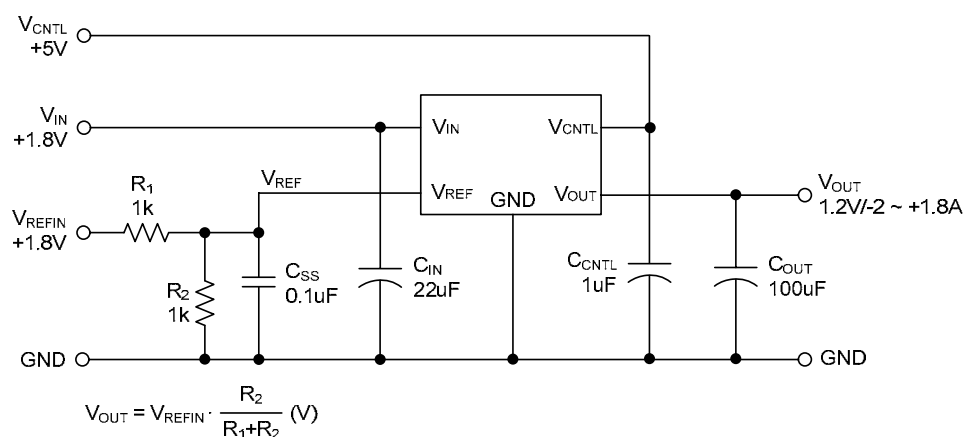
2. Please supply enough voltage to V<sub>IN</sub> for sourcing desired maximum output current. Please refer to the V<sub>IN</sub> Dropout Voltage vs. Output Current in the Typical Characteristics.
3. The V<sub>OUT</sub> is regulated to the V<sub>REF</sub> with additional voltage offset and load regulation except over-load conditions.
4. The symbol “+” means the V<sub>OUT</sub> sources current to load; the symbol “-” means the V<sub>OUT</sub> sinks current to GND.
5. The max. I<sub>OUT</sub> varies with the T<sub>J</sub> and the voltages of V<sub>IN</sub>-V<sub>OUT</sub> and V<sub>OUT</sub>. Please refer to the Typical Characteristics.

- ELECTRICAL CHARACTERISTICS ( $T_J=25^\circ\text{C}$ ,  $V_{\text{CNTL}}=3.3\text{V}$ ,  $V_{\text{IN}}=2.5\text{V}/1.8\text{V}$ ,  $V_{\text{REF}}=0.5V_{\text{IN}}$ , unless otherwise specified)

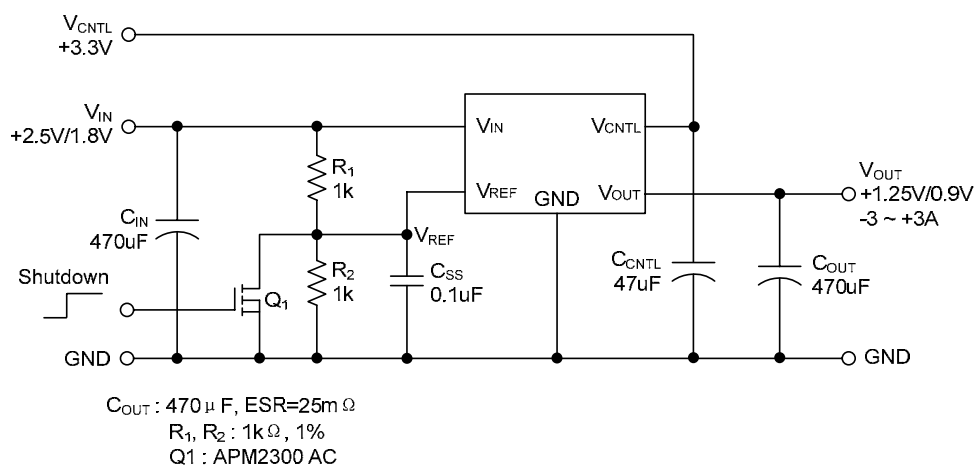
| PARAMETER                                                                  | SYMBOL                  | TEST CONDITIONS                                                                                | MIN                                               | TYP              | MAX    | UNIT             |
|----------------------------------------------------------------------------|-------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------|------------------|--------|------------------|
| Output Voltage                                                             | $V_{\text{OUT}}$        | $I_{\text{OUT}}=0\text{A}$                                                                     |                                                   | $V_{\text{REF}}$ |        | V                |
| System Accuracy                                                            |                         | Over temperature, $V_{\text{OUT}}$ offset, and load regulation                                 | -20                                               |                  | 20     | mV               |
| Offset Voltage ( $V_{\text{OUT}}-V_{\text{REF}}$ )                         | $V_{\text{O(OFF)}}$     | $I_{\text{OUT}}=+10\text{mA}$<br>$I_{\text{OUT}}=-10\text{mA}$                                 | -20                                               |                  | 20     | mV               |
| Load Regulation                                                            | $\Delta V_{\text{OUT}}$ | $I_{\text{OUT}}=+10\text{mA} \sim +3\text{A}$<br>$I_{\text{OUT}}=-10\text{mA} \sim -3\text{A}$ |                                                   |                  | 2<br>2 | %                |
| Current Limit                                                              | $I_{\text{LIMIT}}$      | Sourcing Current ( $V_{\text{IN}}=2.5\text{V}$ )                                               | $T_J=25^\circ\text{C}$<br>$T_J=125^\circ\text{C}$ | +3<br>+3.1       | +3.6   | A                |
|                                                                            |                         | Sinking Current ( $V_{\text{IN}}=2.5\text{V}$ )                                                | $T_J=25^\circ\text{C}$<br>$T_J=125^\circ\text{C}$ | -3<br>-3.1       | -3.6   |                  |
|                                                                            |                         | Sourcing Current ( $V_{\text{IN}}=1.8\text{V}$ )                                               | $T_J=25^\circ\text{C}$<br>$T_J=125^\circ\text{C}$ | +2.9<br>+2.6     | +3.2   |                  |
|                                                                            |                         | Sinking Current ( $V_{\text{IN}}=1.8\text{V}$ )                                                | $T_J=25^\circ\text{C}$<br>$T_J=125^\circ\text{C}$ | -2.9<br>-2.6     | -3.2   |                  |
|                                                                            |                         |                                                                                                |                                                   |                  |        |                  |
|                                                                            |                         |                                                                                                |                                                   |                  |        |                  |
| Thermal Shutdown Temperature                                               | $T_{\text{SHDN}}$       | Rising $T_J$                                                                                   |                                                   | 183              |        | $^\circ\text{C}$ |
| Thermal Shutdown Hysteresis                                                | $T_{\text{HYS}}$        |                                                                                                |                                                   | 42               |        | $^\circ\text{C}$ |
| $V_{\text{CNTL}}$ Supply Current                                           | $I_{\text{CNTL}}$       | $I_{\text{OUT}}=0\text{A}$                                                                     | 1                                                 | 2                | 3      | mA               |
|                                                                            |                         | $I_{\text{OUT}}=\pm 3\text{A}$ (Normal Operation)                                              |                                                   | 50               | 110    |                  |
|                                                                            |                         | $V_{\text{REF}}=\text{GND}$ (Shutdown)                                                         |                                                   | 2.0              |        |                  |
| $V_{\text{REF}}$ Bias Current (The current flows out of $V_{\text{REF}}$ ) | $I_{\text{BIAS}}$       | $V_{\text{REF}}=1.25\text{V}/0.9\text{V}$ (Normal Operation)                                   |                                                   | 200              | 500    | nA               |
|                                                                            |                         | $V_{\text{REF}}=\text{GND}$ (Shutdown)                                                         |                                                   | 20               | 40     | $\mu\text{A}$    |
| Shutdown Threshold Voltage                                                 | $V_{\text{SHDN}}$       |                                                                                                | 0.2                                               | 0.35             | 0.65   | V                |

## ■ APPLICATIONS CIRCUIT

### 1. General Application

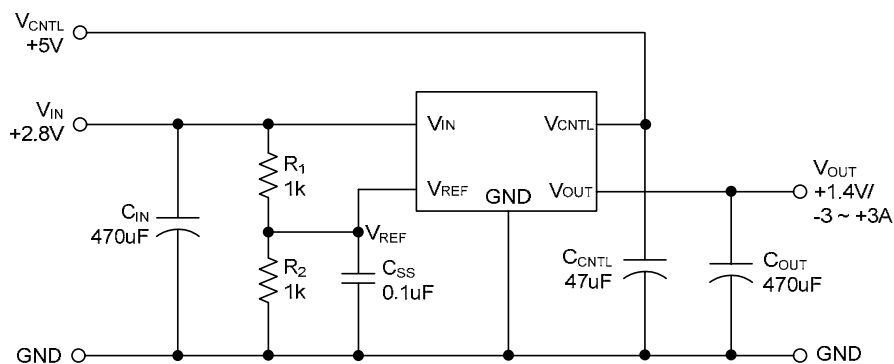


### 2. For $V_{OUT}=1.25V/0.9V$



Note : Since R1 and R2 are very small, the voltage offset caused by the bias current of VREF can be ignore.

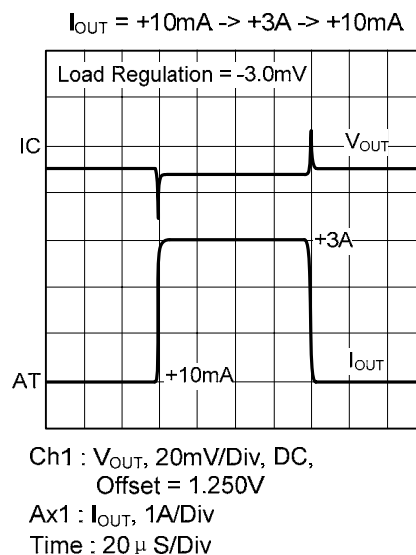
### 3. For $V_{OUT}=1.4V$



## ■ OPERATING WAVEFORMS

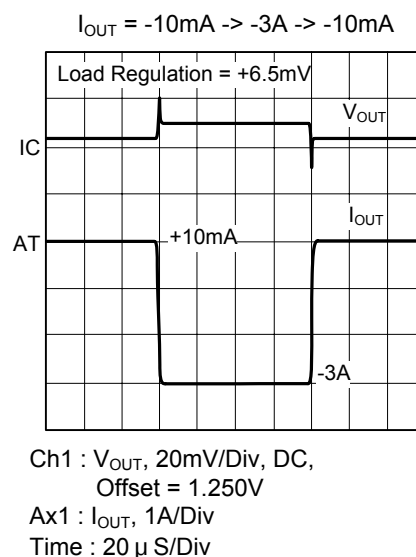
### 1. Load Transient Response: $I_{OUT} = +10mA \rightarrow +3A \rightarrow +10mA$

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$
- $V_{REF}$  is 1.250V supplied by a regulator
- $C_{OUT} = 470\mu F/10V$ ,  $ESR = 30m\Omega$
- $I_{OUT}$  slew rate =  $\pm 3A/\mu S$



### 2. Load Transient Response: $I_{OUT} = -10mA \rightarrow -3A \rightarrow -10mA$

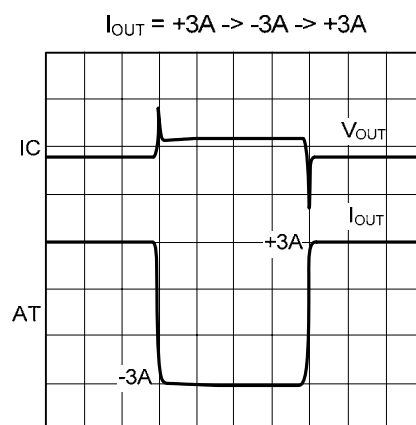
- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$
- $V_{REF}$  is 1.250V supplied by a regulator
- $C_{OUT} = 470\mu F/10V$ ,  $ESR = 30m\Omega$
- $I_{OUT}$  slew rate =  $\pm 3A/\mu S$



## ■ OPERATING WAVEFORMS(Cont.)

### 3. Load Transient Response: $I_{OUT} = +3A \rightarrow -3A \rightarrow +3A$

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$
- $V_{REF}$  is 1.250V supplied by a regulator
- $C_{OUT} = 470\mu F/10V$ ,  $ESR = 30m\Omega$
- $I_{OUT}$  slew rate =  $\pm 3A/\mu S$

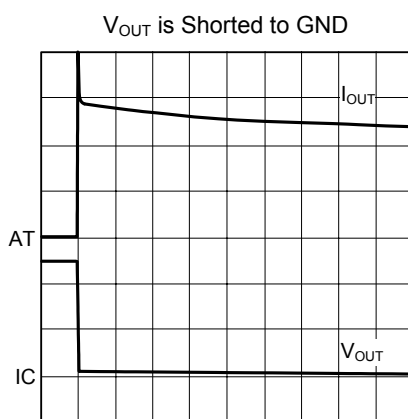


Ch1 :  $V_{OUT}$ , 50mV/Div, DC,  
Offset = 1.250V

Ax1 :  $I_{OUT}$ , 2A/Div  
Time : 20  $\mu$  S/Div

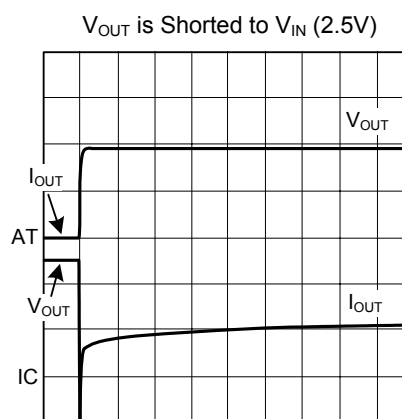
### 4. Short-Circuit Test

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$



Ch1 :  $V_{OUT}$ , 500mV/Div, DC,  
Offset = 1.250V

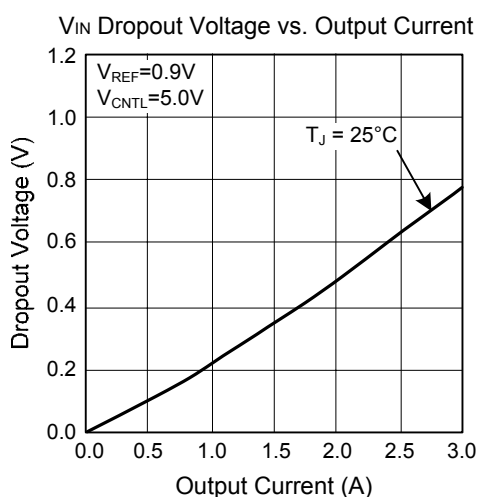
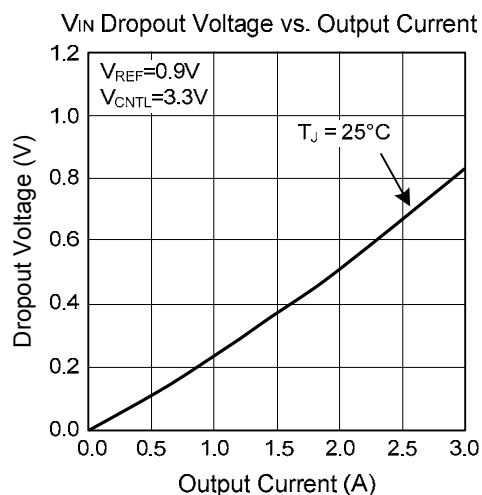
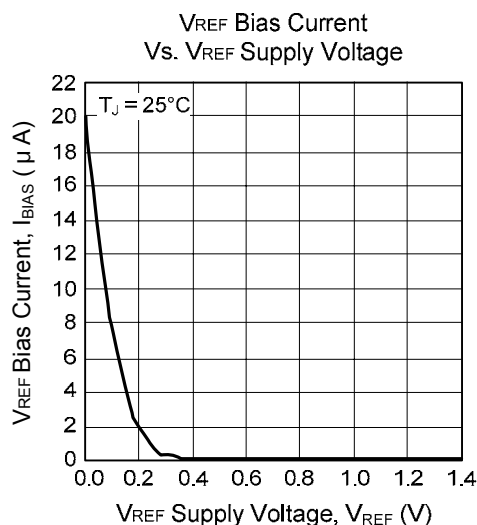
Ax1 :  $I_{OUT}$ , 2A/Div  
Time : 5mS/Div



Ch1 :  $V_{OUT}$ , 500mV/Div, DC,  
Offset = 1.250V

Ax1 :  $I_{OUT}$ , 2A/Div  
Time : 5mS/Div

# TYPICAL CHARACTERISTICS



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