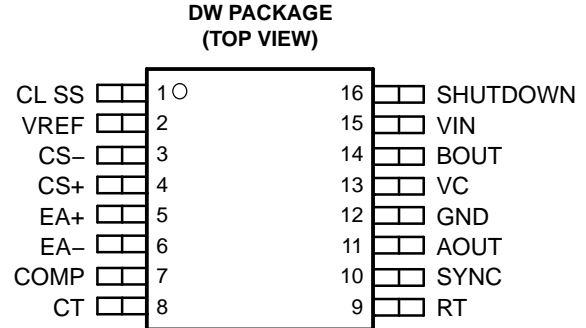


## IMPROVED CURRENT MODE PWM CONTROLLER

### FEATURES

- Pin-for-Pin Compatible With the UC2846
- 65-ns Typical Delay From Shutdown to Outputs and 50-ns Typical Delay From Sync to Outputs
- Improved Current Sense Amplifier With Reduced Noise Sensitivity
- Differential Current Sense With 3-V Common Mode Range
- Trimmed Oscillator Discharge Current for Accurate Deadband Control
- Accurate 1-V Shutdown Threshold
- High Current Dual Totem Pole Outputs (1.5-A peak)
- TTL Compatible Oscillator SYNC Pin Thresholds
- 4-kV ESD Protection



P0008-01

### DESCRIPTION

The UC2856 is a high performance version of the popular UC2846 series of current mode controllers, and is intended for both design upgrades and new applications where speed and accuracy are important. All input to output delays have been minimized, and the current sense output is slew rate limited to reduce noise sensitivity. Fast 1.5-A peak output stages have been added to allow rapid switching of power FETs.

A low impedance TTL compatible sync output has been implemented with a 3-state function when used as a sync input.

Internal chip grounding has been improved to minimize internal *noise* caused when driving large capacitive loads. This, in conjunction with the improved differential current sense amplifier, results in enhanced noise immunity.

Other features include a trimmed oscillator current (8%) for accurate frequency and dead time control; a 1 V, 5% shutdown threshold; and 4 kV minimum ESD protection on all pins.

### ORDERING INFORMATION<sup>(1)</sup>

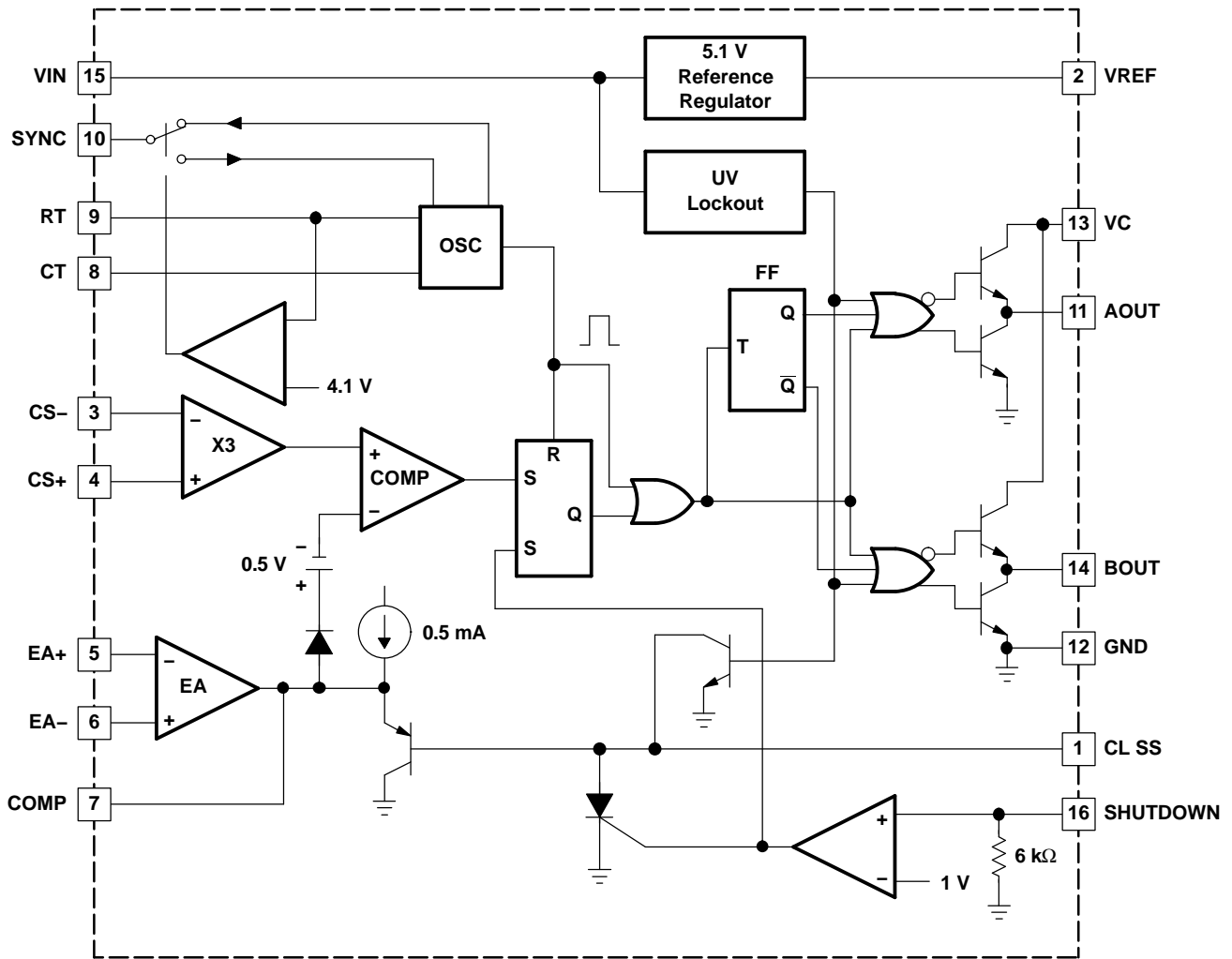
| $T_A$          | PACKAGE |               | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|---------|---------------|-----------------------|------------------|
| -40°C to 125°C | SOP-DW  | Tape and reel | UC2856QDWR            | UC2856Q          |

- (1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

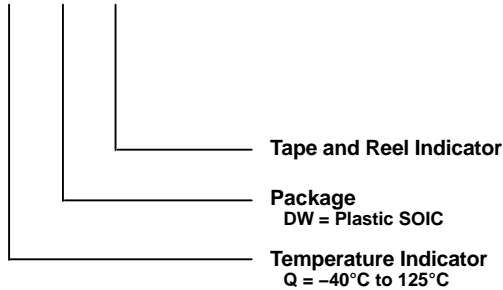
BLOCK DIAGRAM



B0010-01

ORDERING INFORMATION

UC 285 6 Q DW R



## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)<sup>(1)(2)</sup>

|  |                                      | UNIT           |
|--|--------------------------------------|----------------|
| Supply voltage   |                                      | 40 V           |
| Collector supply voltage   |                                      | 40 V           |
| I <sub>O</sub>   | Output current (sink or source)      | DC             |
|  |                                      | Pulse (0.5 ms) |
|  |                                      | 0.5 A          |
|  |                                      | 2 A            |
| Error amplifier input voltage  |                                      | –0.3 V to VIN  |
| Shutdown input voltage   |                                      | –0.3 V to 10 V |
| Current sense input voltage  |                                      | –0.3 V to 3 V  |
| SYNC output current  |                                      | ±10 mA         |
| Error amplifier output current   |                                      | –5 mA          |
| Soft start sink current  |                                      | 50 mA          |
| Oscillator charging current  |                                      | 5 mA           |
| Power dissipation  | T <sub>A</sub> = 25°C                | 1 W            |
|  | T <sub>C</sub> = 25°C                | 2 W            |
| T <sub>J</sub>   | Operating junction temperature range | –55°C to 150°C |
| T <sub>stg</sub>   | Storage temperature range            | –65°C to 150°C |
| Lead temperature soldering 1,6 mm (1/16 inch) from case for 10 seconds |                                      | 300°C          |

- Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- Unless otherwise indicated, voltages are reference to ground and currents are positive into and negative out of the specified terminals.

## ELECTRICAL CHARACTERISTICS

T<sub>A</sub> = –40°C to 125°C, VIN = 15 V, RT = 10 kΩ, CT = 1 nF, and T<sub>A</sub> = T<sub>J</sub> (unless otherwise stated)<sup>(1)</sup>

| PARAMETER                      | TEST CONDITIONS                                      | MIN  | TYP | MAX  | UNIT |
|--------------------------------|--|------|-----|------|------|
| <b>REFERENCE SECTION</b>       |  |      |     |      |      |
| Output voltage                 | I <sub>O</sub> = 1 mA, T <sub>J</sub> = 25°C         | 5.05 | 5.1 | 5.15 | V    |
| Line regulation voltage        | VIN = 8 V to 40 V                                    |      |     | 20   | mV   |
| Load regulation voltage        | I <sub>O</sub> = –1 mA to –10 mA                     |      |     | 15   | mV   |
| Total output variation         | Line, Load, and Temperature                          | 5    |     | 5.2  | V    |
| Output noise voltage           | f = 10 Hz to 10 kHz, T <sub>J</sub> = 25°C           |      | 50  |      | μV   |
| Long term stability            | 1000 hours, <sup>(2)</sup> T <sub>J</sub> = 25°C     |      | 5   | 25   | mV   |
| Short circuit current          | VREF = 0 V   | –25  | –45 | –65  | mA   |
| <b>OSCILLATOR SECTION</b>      |  |      |     |      |      |
| Initial accuracy               | T <sub>J</sub> = 25°C                                | 180  | 200 | 220  | kHz  |
|                                | T <sub>J</sub> = Full range                          | 170  |     | 230  |      |
| Voltage stability              | VIN = 8 V to 40 V                                    |      |     | 2%   |      |
| Discharge current              | VCT = 2 V, T <sub>J</sub> = 25°C                     | 7.5  | 8   | 8.8  | mA   |
|                                | VCT = 2 V  | 6.7  | 8   | 8.8  |      |
| Sync output high level voltage | I <sub>O</sub> = –1 mA                               | 2.4  | 3.6 |      | V    |
| Sync output low level voltage  | I <sub>O</sub> = 1 mA                                |      | 0.2 | 0.4  | V    |
| Sync input high level voltage  | CT = 0 V, RT = VREF                                  | 2    | 1.5 |      | V    |
| Sync input low level voltage   | CT = 0 V, RT = VREF                                  |      | 1.5 | 0.8  | V    |
| Sync input current             | CT = 0 V, RT = VREF, V <sub>SYNC</sub> = 5 V         |      | 1   | 10   | μA   |
| Sync delay to outputs          | CT = 0 V RT = VREF, V <sub>SYNC</sub> = 0.8 V to 2 V |      | 50  | 100  | ns   |

- All voltages are with respect to GND. Currents are positive into, negative out of the specified terminal.
- This parameter, although specified over the recommended operating conditions, is not 100% tested in production.

**ELECTRICAL CHARACTERISTICS (continued)**
 $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ,  $V_{IN} = 15\text{ V}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 1\text{ nF}$ , and  $T_A = T_J$  (unless otherwise stated)

| PARAMETER   | TEST CONDITIONS   | MIN              | TYP                | MAX        | UNIT          |
|---|---|------------------|--------------------|------------|---------------|
| <b>ERROR AMPLIFIER SECTION</b>                            |   |                  |                    |            |               |
| Input offset voltage                                      | $V_{CM} = 2\text{ V}$   |                  |                    | 5          | mV            |
| Input bias current  |   |                  |                    | -1         | $\mu\text{A}$ |
| Input offset current                                      |   |                  |                    | 500        | nA            |
| Common mode range   | $V_{IN} = 8\text{ V}$ to $40\text{ V}$  | 0                |                    | $V_{IN}-2$ | V             |
| Open loop gain  | $V_O = 1.2\text{ V}$ to $3\text{ V}$  | 80               | 100                |            | dB            |
| Unity gain bandwidth                                      | $T_J = 25^{\circ}\text{C}$  | 1                | 1.5                |            | MHz           |
| CMRR  | $V_{CM} = 0\text{ V}$ to $38\text{ V}$ , $V_{IN} = 40\text{ V}$                       | 75               | 100                |            | dB            |
| PSRR  | $V_{IN} = 8\text{ V}$ to $40\text{ V}$  | 80               | 100                |            | dB            |
| Output sink current                                       | $V_{ID} = -15\text{ mV}$ , $V_{COMP} = 1.2\text{ V}$                                  | 5                | 10                 |            | mA            |
| Output source current                                     | $V_{ID} = 15\text{ mV}$ , $V_{COMP} = 2.5\text{ V}$                                   | -0.4             | -0.5               |            | mA            |
| High-level output voltage                                 | $V_{ID} = 50\text{ mV}$ , $R_L(\text{COMP}) = 15\text{ k}\Omega$                      | 4.3              | 4.6                | 4.9        | V             |
| Low-level output voltage                                  | $V_{ID} = -50\text{ mV}$ , $R_L(\text{COMP}) = 15\text{ k}\Omega$                     |                  | 0.7                | 1          | V             |
| <b>CURRENT SENSE AMPLIFIER SECTION</b>                    |   |                  |                    |            |               |
| Amplifier gain  | $V_{CS-} = 0\text{ V}$ , CL SS Open <sup>(3)(4)</sup>                                 | 2.5              | 2.75               | 3          | V/V           |
| Maximum differential input signal ( $V_{CS+} - V_{CS-}$ ) | CL SS Open 3, $R_L(\text{COMP}) = 15\text{ k}\Omega$                                  | 1.1              | 1.2                |            | V             |
| Input offset voltage                                      | $V_{CL\text{ SS}} = 0.5\text{ V}$ , COMP open <sup>(5)</sup>                          |                  | 5                  | 35         | mV            |
| CMRR  | $V_{CM} = 0\text{ V}$ to $3\text{ V}$   | 60               |                    |            | dB            |
| PSRR  | $V_{IN} = 8\text{ V}$ to $40\text{ V}$  | 60               |                    |            | dB            |
| Input bias current  | $V_{CL\text{ SS}} = 0.5\text{ V}$ , COMP open <sup>(5)</sup>                          |                  |                    | -1         | $\mu\text{A}$ |
| Input offset current                                      | $V_{CL\text{ SS}} = 0.5\text{ V}$ , COMP open <sup>(5)</sup>                          |                  |                    | 1          | mA            |
| Input common mode range                                   |   | 0                |                    | 3          | V             |
| Delay to outputs  | $V_{EA+} = V_{REF}$ , $EA- = 0\text{ V}$ , $CS+ - CS- = 0\text{ V}$ to $1.5\text{ V}$ |                  | 120                | 250        | ns            |
| <b>CURRENT LIMIT ADJUST SECTION</b>                       |   |                  |                    |            |               |
| Current limit offset                                      | $V_{CS-} = 0\text{ V}$ , $V_{CS+} = 0\text{ V}$ , COMP Open <sup>(5)</sup>            | 0.4              | 0.5                | 0.6        | V             |
| Input bias current  | $V_{EA+} = V_{REF}$ , $V_{EA-} = 0\text{ V}$  |                  | -10                | -30        | $\mu\text{A}$ |
| <b>SHUTDOWN TERMINAL SECTION</b>                          |   |                  |                    |            |               |
| Threshold voltage   |   | 0.95             | 1.00               | 1.05       | V             |
| Input voltage range                                       |   | 0                |                    | 5          | V             |
| Minimum latching current ( $I_{CL\text{ SS}}$ )           |   | <sup>(6)</sup> 3 | 1.5                |            | mA            |
| Maximum non-latching current ( $I_{CL\text{ SS}}$ )       |   |                  | <sup>(7)</sup> 1.5 | 0.8        | mA            |
| Delay to outputs  | $V_{SHUTDOWN} = 0\text{ V}$ to $1.3\text{ V}$   |                  | 65                 | 110        | ns            |
| <b>OUTPUT SECTION</b>                                     |   |                  |                    |            |               |
| Collector-emitter voltage                                 |   | 40               |                    |            | V             |
| Off-state bias current                                    | $V_C = 40\text{ V}$   |                  |                    | 250        | $\mu\text{A}$ |
| Output low level voltage                                  | $I_{OUT} = 20\text{ mA}$  |                  | 0.1                | 0.5        | V             |
|   | $I_{OUT} = 200\text{ mA}$   |                  | 0.5                | 2.6        |               |
| Output high level voltage                                 | $I_{OUT} = -20\text{ mA}$   | 12.5             | 13.2               |            | V             |
|   | $I_{OUT} = -200\text{ mA}$  | 12               | 13.1               |            |               |
| Rise time   | $C_1 = 1\text{ nF}$   |                  | 40                 | 80         | ns            |
| Fall time   | $C_1 = 1\text{ nF}$   |                  | 40                 | 80         | ns            |

(3) Parameter measured at trip point of latch with  $V_{EA+} = V_{REF}$ ,  $V_{EA-} = 0\text{ V}$ .

$$G = \frac{\Delta V_{COMP}}{\Delta V_{CS+}}; \Delta V_{CS-} = 0\text{ V } 1\text{ V.}$$

(4) Amplifier gain defined as:

(5) Parameter measured at trip point of latch with  $V_{EA+} = V_{REF}$ ,  $V_{EA-} = 0\text{ V}$ .

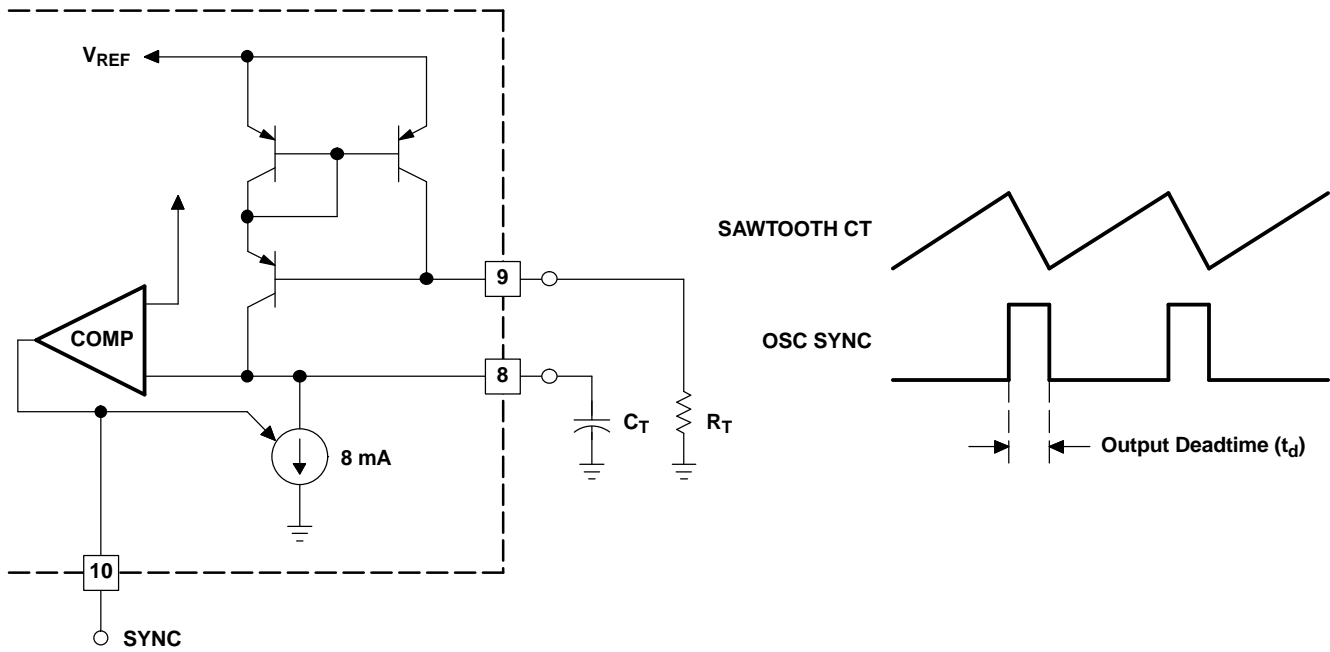
(6) Current into CL SS assured to latch circuit into shutdown state.

(7) Current into CL SS assured not to latch circuit into shutdown state.

**ELECTRICAL CHARACTERISTICS (continued)**
 $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$ ,  $V_{IN} = 15\text{ V}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 1\text{ nF}$ , and  $T_A = T_J$  (unless otherwise stated)

| PARAMETER                           | TEST CONDITIONS                                     | MIN | TYP | MAX | UNIT |
|-------------------------------------|---|-----|-----|-----|------|
| UVLO low saturation                 | $V_{IN} = 0\text{ V}$ ,<br>$I_{OUT} = 20\text{ mA}$ |     | 0.8 | 1.5 | V    |
| <b>PWM SECTION</b>                  |   |     |     |     |      |
| Maximum duty cycle                  |   | 45% | 47% | 50% |      |
| Minimum duty cycle                  |   |     |     | 0%  |      |
| <b>UNDERVOLTAGE LOCKOUT SECTION</b> |   |     |     |     |      |
| Startup threshold                   |   |     | 7.7 | 8   |      |
| Threshold hysteresis                |   |     | 0.7 |     |      |
| <b>TOTAL STANDBY CURRENT</b>        |   |     |     |     |      |
| Supply current                      |   |     | 18  | 23  | mA   |

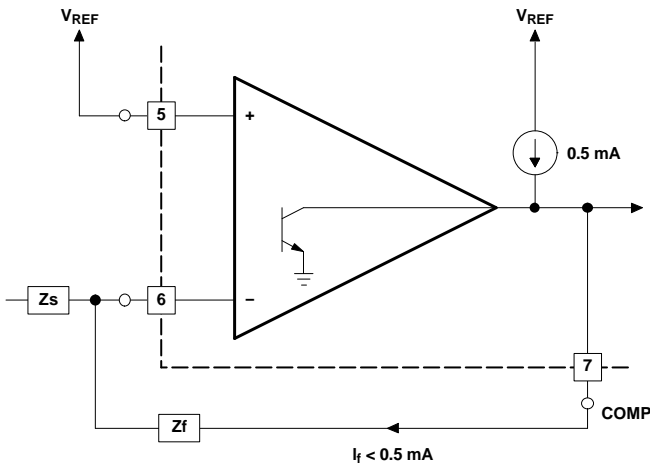
APPLICATION AND OPERATION INFORMATION



NOTE: Output deadtime is determined by the size of the external capacitor,  $C_T$ , according to the formula:  $T_d = \frac{2C_T}{8 \text{ mA} - \frac{3.6}{R_T}}$   
 For large values of  $R_T$ :  $T_d = 250 C_T$   
 Oscillator frequency is approximated by the formula:  $f_T = \frac{2}{R_T \times C_T}$

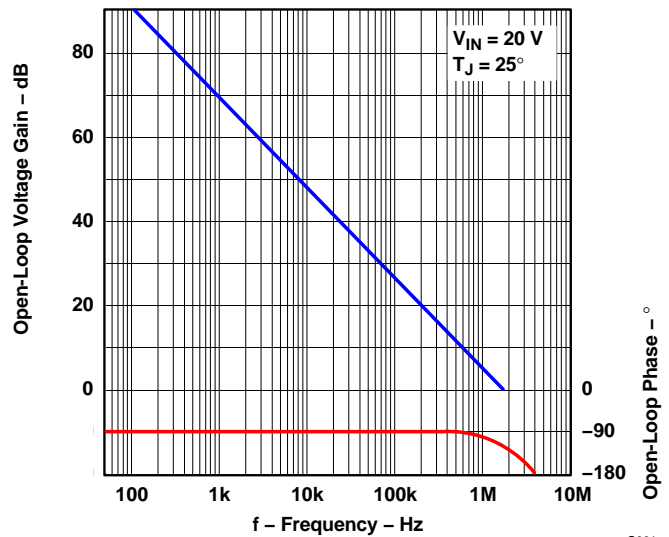
S0019-01

Figure 1. Oscillator Circuit



S0020-01

NOTE: Error Amplifier can source up to 0.5 mA.  
 Figure 2. Error Amplifier Output Configuration



G001

Figure 3. Error Amplifier Gain and Phase vs Frequency

APPLICATION AND OPERATION INFORMATION (continued)

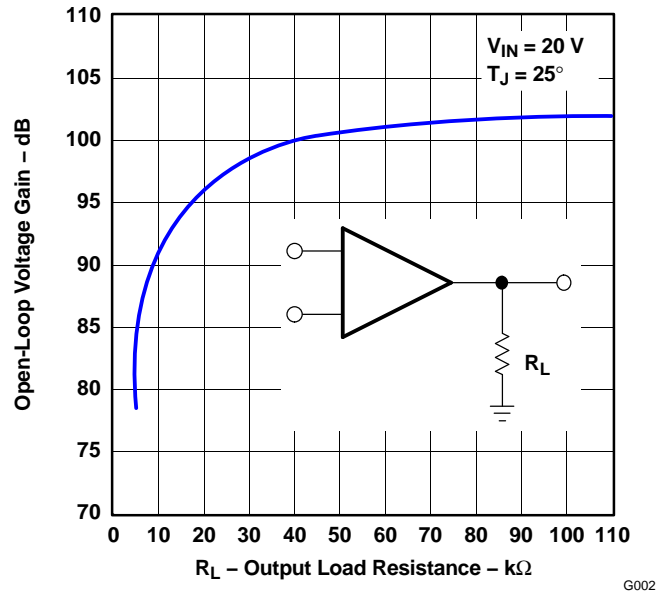
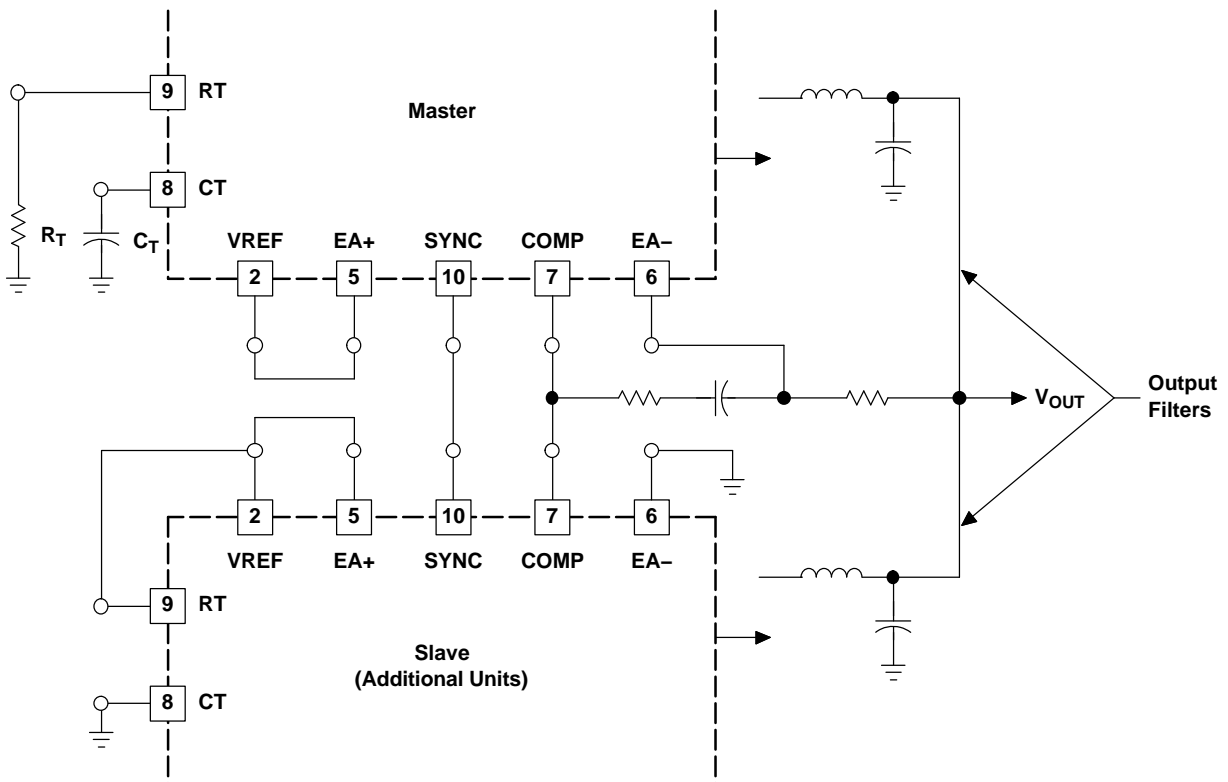


Figure 4. Error Amplifier Open-Loop DC Gain vs Load Resistance

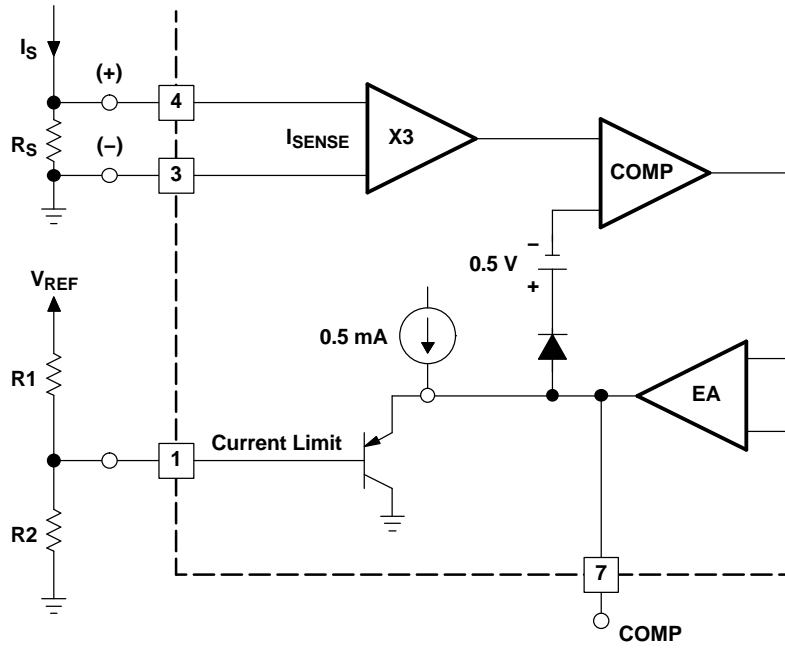


NOTE: Slaving allows parallel operation of two or more units with equal current sharing.

Figure 5. Parallel Operation

S0021-01

APPLICATION AND OPERATION INFORMATION (continued)



S0022-01

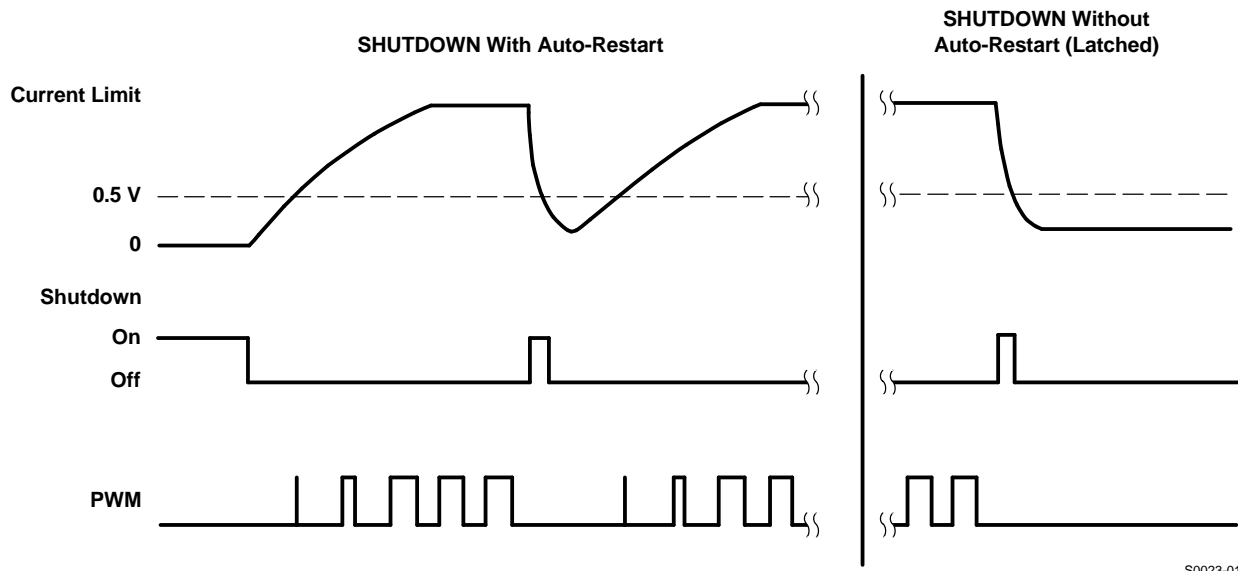
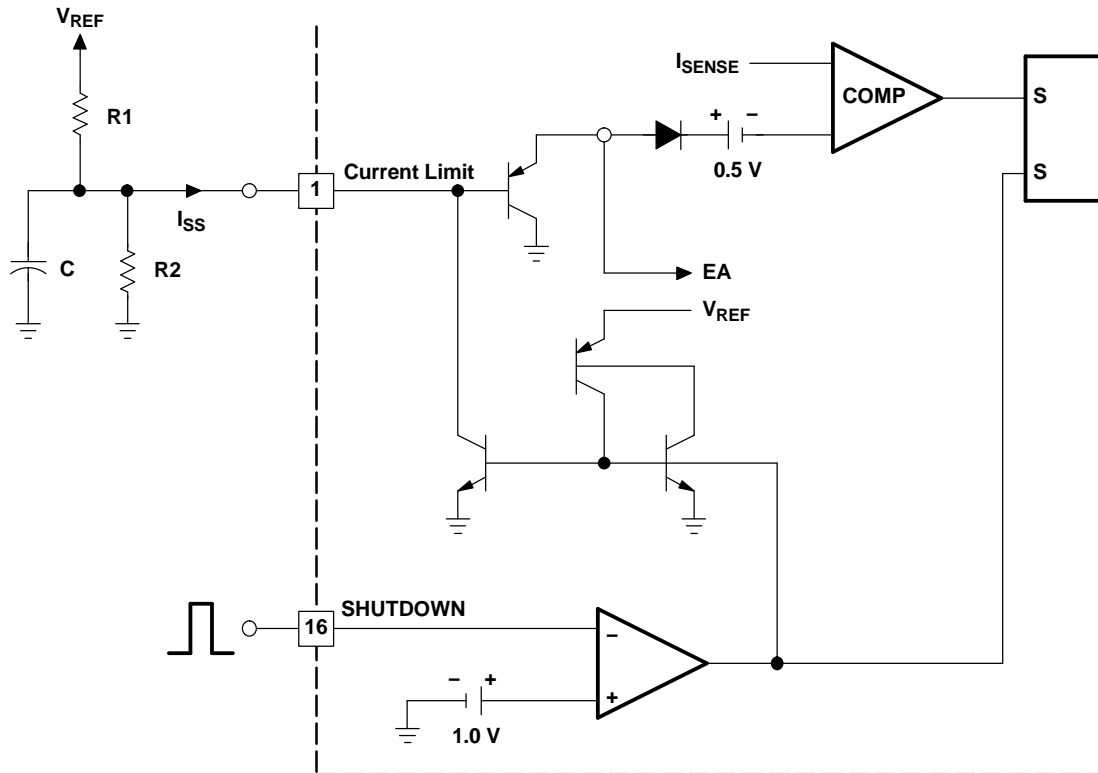
$$I_S = \frac{\left( R_2 \times \frac{V_{REF}}{R_1 + R_2} \right) - 0.5}{3R_S}$$

NOTE: Peak current ( $I_S$ ) is determined by the formula:

Figure 6. Pulse by Pulse Current Limiting



APPLICATION AND OPERATION INFORMATION (continued)



S0023-01

NOTE: If  $V_{REF} / R1 < 0.8\text{ mA}$ , the shutdown latch commutates when  $I_{SS} = 0.8\text{ mA}$  and a restart cycle will be initiated. If  $V_{REF} / R1 > 3\text{ mA}$ , the device will latch off until power is recycled.

Figure 7. Shutdown

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| UC2856QDWR       | ACTIVE                | SOIC         | DW              | 16   | 2000        | TBD                     | CU NIPDAU        | Level-2-220C-1 YEAR          |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

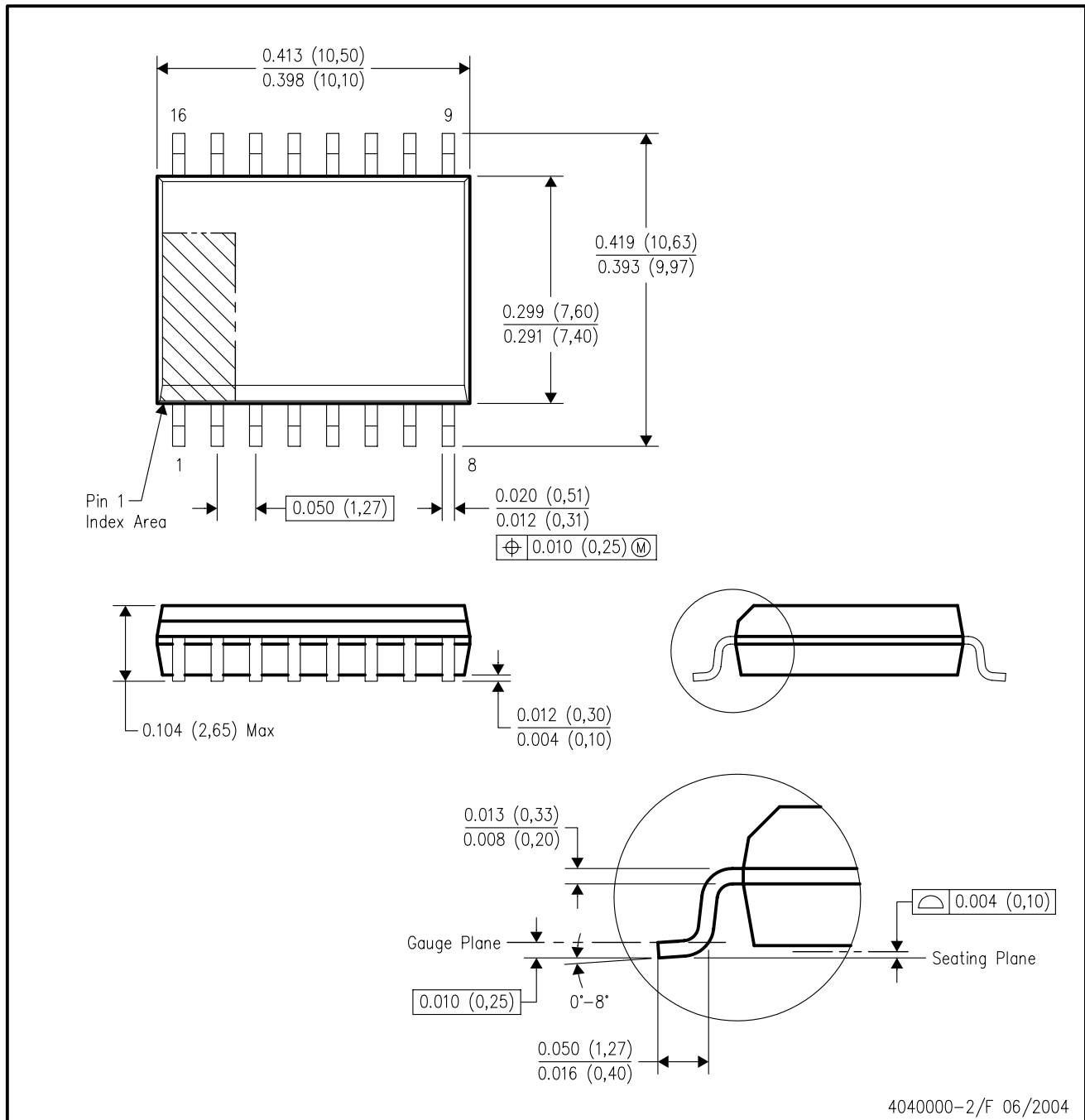
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DW (R-PDSO-G16)

PLASTIC SMALL-OUTLINE PACKAGE



4040000-2/F 06/2004

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-013 variation AA.

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| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           |
| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
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| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

|                    |  |
|--------------------|--|
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| Automotive         | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| Broadband          | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Digital Control    | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
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