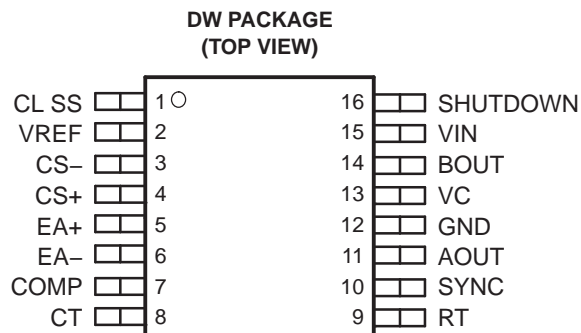


IMPROVED CURRENT MODE PWM CONTROLLER

Check for Samples: [UC2856Q](#)

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⁽¹⁾

| 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.



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.

UC2856Q

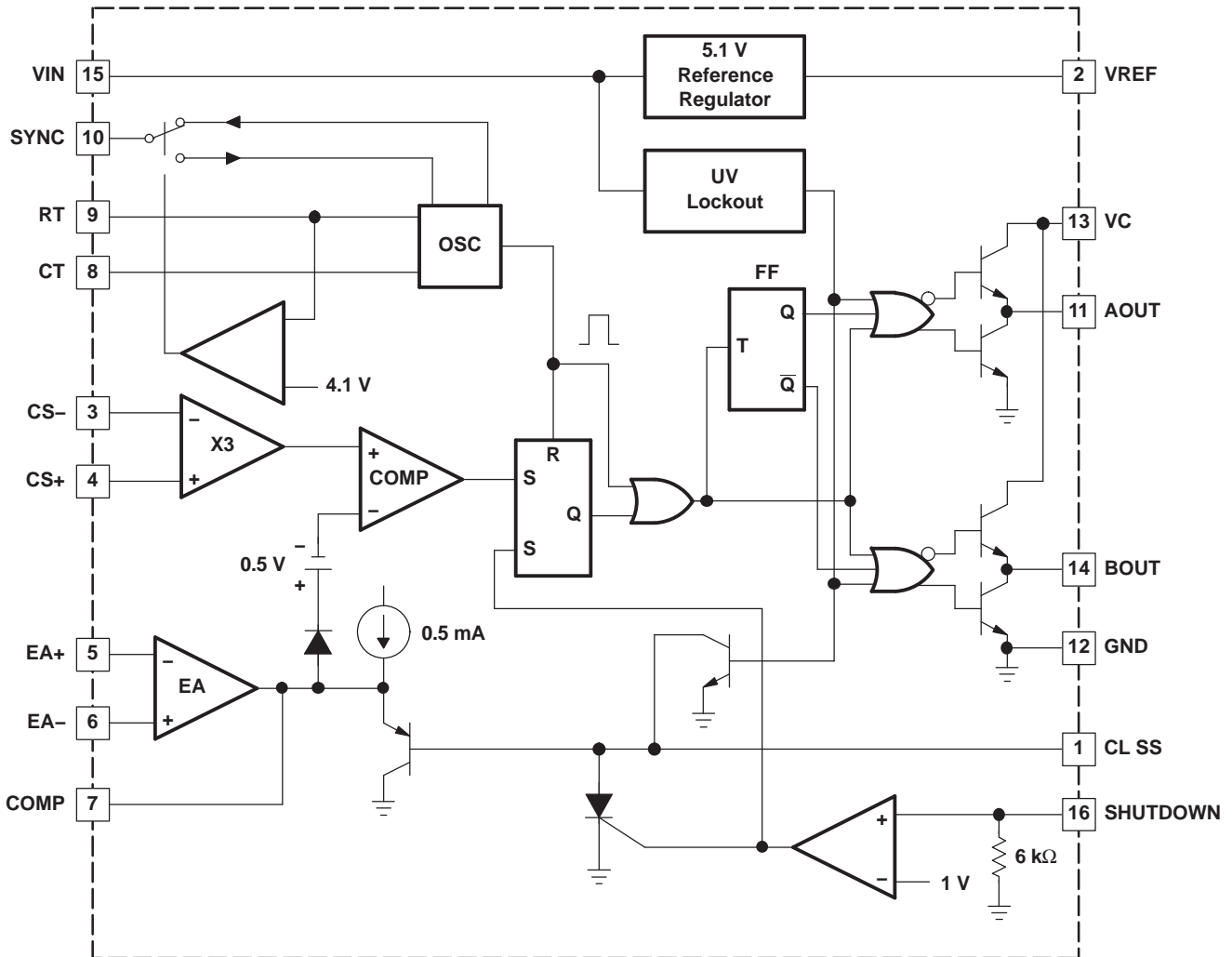
SGLS265A –NOVEMBER 2004–REVISED MAY 2011

www.ti.com



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

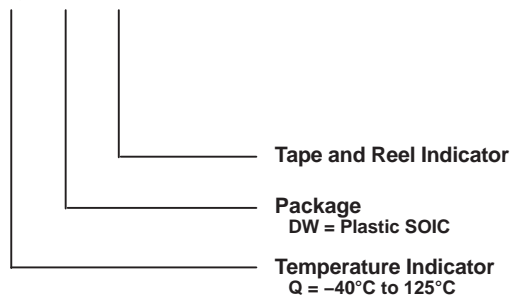
BLOCK DIAGRAM



B0010-01

ORDERING INFORMATION

UC 285 6 Q DW R



ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)^{(1) (2)}

| | | UNIT |
|--------------------------------|--------------------------------------|----------------|
| Supply voltage | | 40 V |
| Collector supply voltage | | 40 V |
| I _O | 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 _A = 25°C | 1 W |
| | T _C = 25°C | 2 W |
| T _J | Operating junction temperature range | –55°C to 150°C |
| T _{stg} | Storage temperature range | –65°C to 150°C |

- (1) 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.
- (2) Unless otherwise indicated, voltages are reference to ground and currents are positive into and negative out of the specified terminals.

ELECTRICAL CHARACTERISTICS

T_A = –40°C to 125°C, VIN = 15 V, RT = 10 kΩ, CT = 1 nF, and T_A = T_J (unless otherwise stated)⁽¹⁾

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------------------|--|------|-----|------|------|
| REFERENCE SECTION | | | | | |
| Output voltage | I _O = 1 mA, T _J = 25°C | 5.05 | 5.1 | 5.15 | V |
| Line regulation voltage | VIN = 8 V to 40 V | | | 20 | mV |
| Load regulation voltage | I _O = –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 _J = 25°C | | 50 | | μV |
| Long term stability | 1000 hours, ⁽²⁾ T _J = 25°C | | 5 | 25 | mV |
| Short circuit current | VREF = 0 V | –25 | –45 | –65 | mA |
| OSCILLATOR SECTION | | | | | |
| Initial accuracy | T _J = 25°C | 180 | 200 | 220 | kHz |
| | T _J = Full range | 170 | | 230 | |
| Voltage stability | VIN = 8 V to 40 V | | | 2% | |
| Discharge current | VCT = 2 V, T _J = 25°C | 7.5 | 8 | 8.8 | mA |
| | VCT = 2 V | 6.7 | 8 | 8.8 | |
| Sync output high level voltage | I _O = –1 mA | 2.4 | 3.6 | | V |
| Sync output low level voltage | I _O = 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 _{SYNC} = 5 V | | 1 | 10 | μA |
| Sync delay to outputs | CT = 0 V RT = VREF, V _{SYNC} = 0.8 V to 2 V | | 50 | 100 | ns |

- (1) All voltages are with respect to GND. Currents are positive into, negative out of the specified terminal.
- (2) 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°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)⁽¹⁾

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|------------------|--------------------|------------|---------------|
| ERROR AMPLIFIER SECTION | | | | | |
| Input offset voltage | $V_{CM} = 2\text{ V}$ | | | 5 | mV |
| Input bias current | | | | -1 | μA |
| Input offset current | | | | 500 | nA |
| Common mode range | $V_{IN} = 8\text{ V}$ to 40 V | 0 | | $V_{IN}-2$ | V |
| Open loop gain | $V_O = 1.2\text{ V}$ to 3 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 V , $V_{IN} = 40\text{ V}$ | 75 | 100 | | dB |
| PSRR | $V_{IN} = 8\text{ V}$ to 40 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 |
| CURRENT SENSE AMPLIFIER SECTION | | | | | |
| Amplifier gain | $V_{CS-} = 0\text{ V}$, CL SS Open ⁽³⁾ ⁽⁴⁾ | 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 ⁽³⁾ | | 5 | 35 | mV |
| CMRR | $V_{CM} = 0\text{ V}$ to 3 V | 60 | | | dB |
| PSRR | $V_{IN} = 8\text{ V}$ to 40 V | 60 | | | dB |
| Input bias current | $V_{CL\text{ SS}} = 0.5\text{ V}$, COMP open ⁽³⁾ | | | -1 | μA |
| Input offset current | $V_{CL\text{ SS}} = 0.5\text{ V}$, COMP open ⁽³⁾ | | | 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 V | | 120 | 250 | ns |
| CURRENT LIMIT ADJUST SECTION | | | | | |
| Current limit offset | $V_{CS-} = 0\text{ V}$, $V_{CS+} = 0\text{ V}$, COMP Open ⁽³⁾ | 0.4 | 0.5 | 0.6 | V |
| Input bias current | $V_{EA+} = V_{REF}$, $V_{EA-} = 0\text{ V}$ | | -10 | -30 | μA |
| SHUTDOWN TERMINAL SECTION | | | | | |
| Threshold voltage | | 0.95 | 1.00 | 1.05 | V |
| Input voltage range | | 0 | | 5 | V |
| Minimum latching current ($I_{CL\text{ SS}}$) | | ⁽⁵⁾ 3 | 1.5 | | mA |
| Maximum non-latching current ($I_{CL\text{ SS}}$) | | | ⁽⁶⁾ 1.5 | 0.8 | mA |
| Delay to outputs | $V_{SHUTDOWN} = 0\text{ V}$ to 1.3 V | | 65 | 110 | ns |
| OUTPUT SECTION | | | | | |
| Collector-emitter voltage | | 40 | | | V |
| Off-state bias current | $V_C = 40\text{ V}$ | | | 250 | μA |
| 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 |
| UVLO low saturation | $V_{IN} = 0\text{ V}$, $I_{OUT} = 20\text{ mA}$ | | 0.8 | 1.5 | V |

(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:

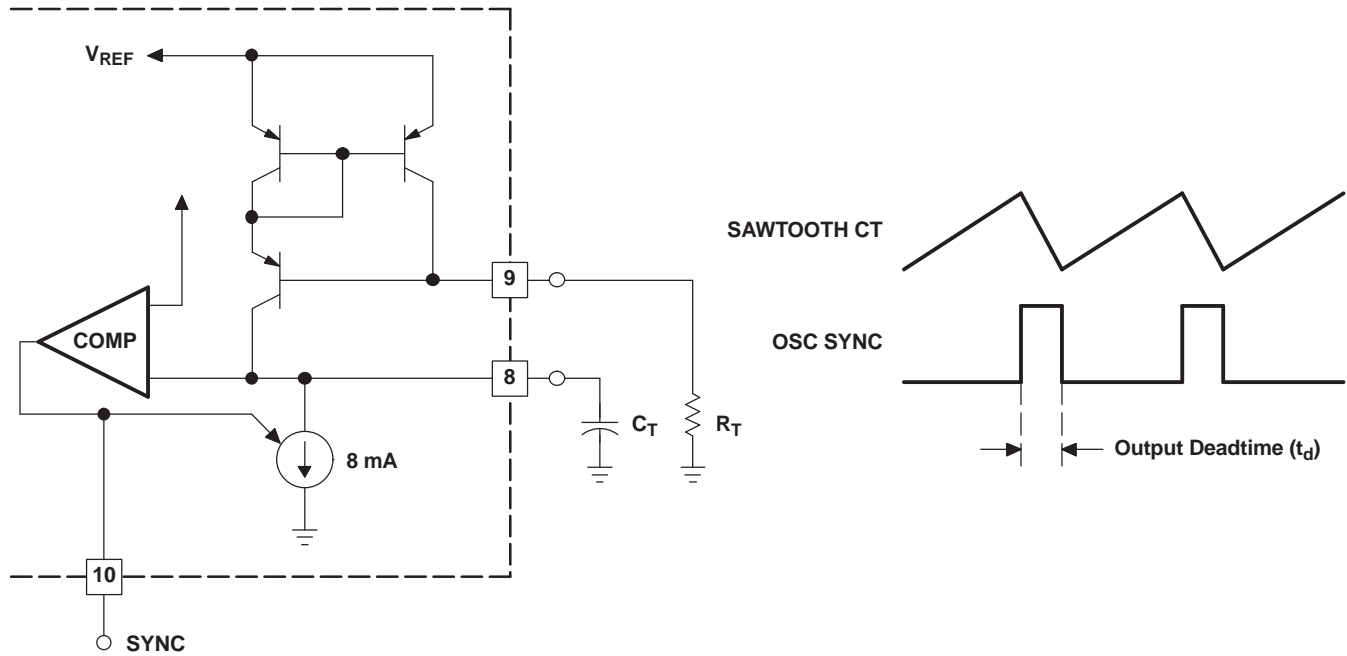
(5) Current into CL SS assured to latch circuit into shutdown state.

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

ELECTRICAL CHARACTERISTICS (continued)
 $T_A = -40^{\circ}\text{C}$ to 125°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)⁽¹⁾

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------------------------------|-----------------|-----|-----|-----|------|
| PWM SECTION | | | | | |
| Maximum duty cycle | | 45% | 47% | 50% | |
| Minimum duty cycle | | | | 0% | |
| UNDERVOLTAGE LOCKOUT SECTION | | | | | |
| Startup threshold | | | 7.7 | 8 | |
| Threshold hysteresis | | | 0.7 | | |
| TOTAL STANDBY CURRENT | | | | | |
| Supply current | | | 18 | 23 | mA |

APPLICATION AND OPERATION INFORMATION

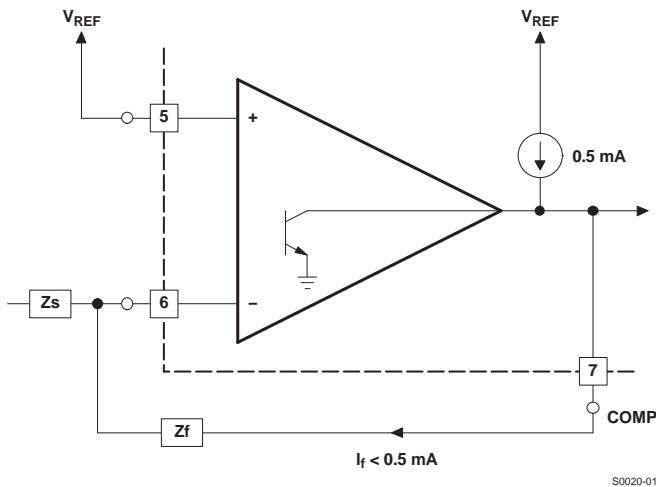


NOTE: Output deadtime is determined by the size of the external capacitor, C_T , according to the formula: $T_d = \frac{2C_T}{8 \text{ mA} - \frac{3.6}{R_T}}$
 For large values of R_T : $T_d = 250 C_T$
 Oscillator frequency is approximated by the formula: $f_T = \frac{2}{R_T \times C_T}$

S0019-01

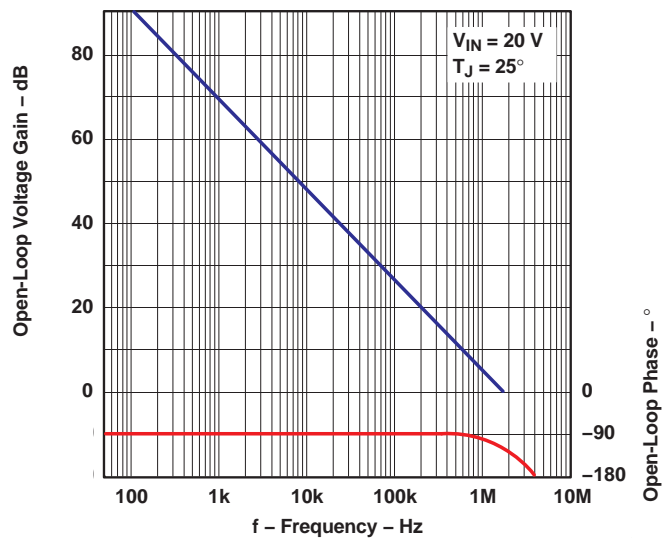
Figure 1. Oscillator Circuit

NOTE: Error Amplifier can source up to 0.5 mA.



S0020-01

Figure 2. Error Amplifier Output Configuration



G001

Figure 3. Error Amplifier Gain and Phase vs Frequency

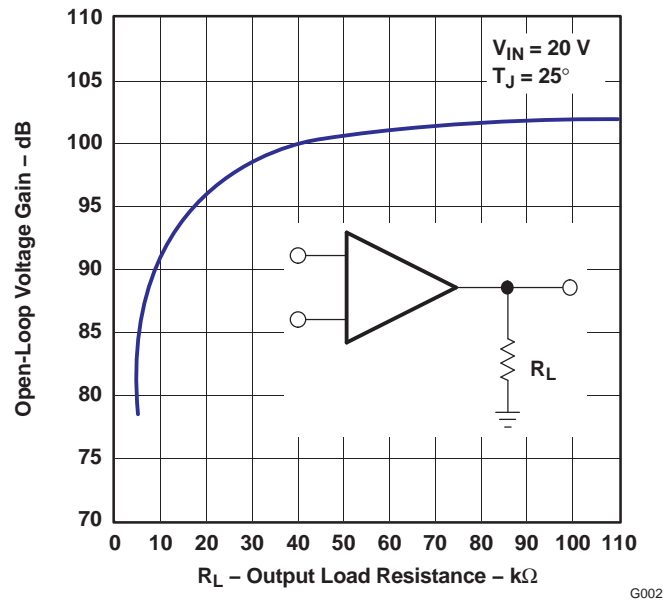
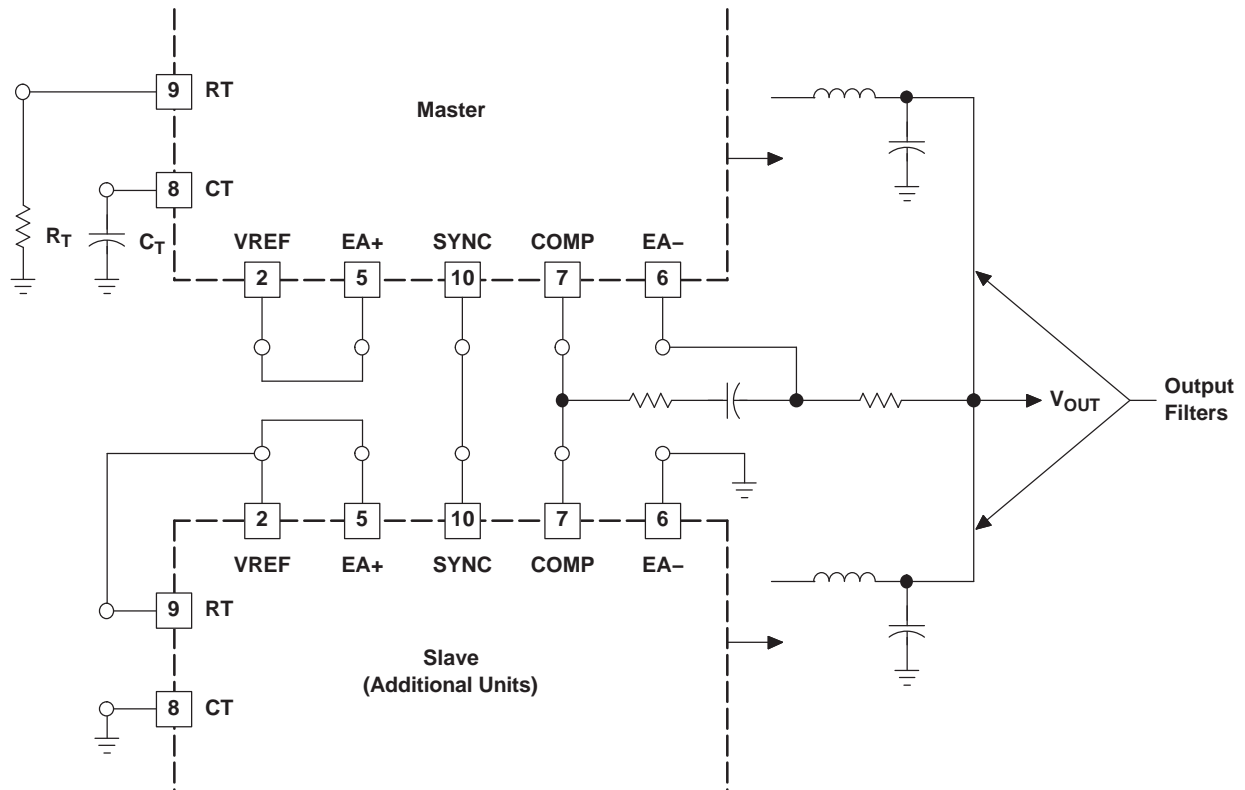


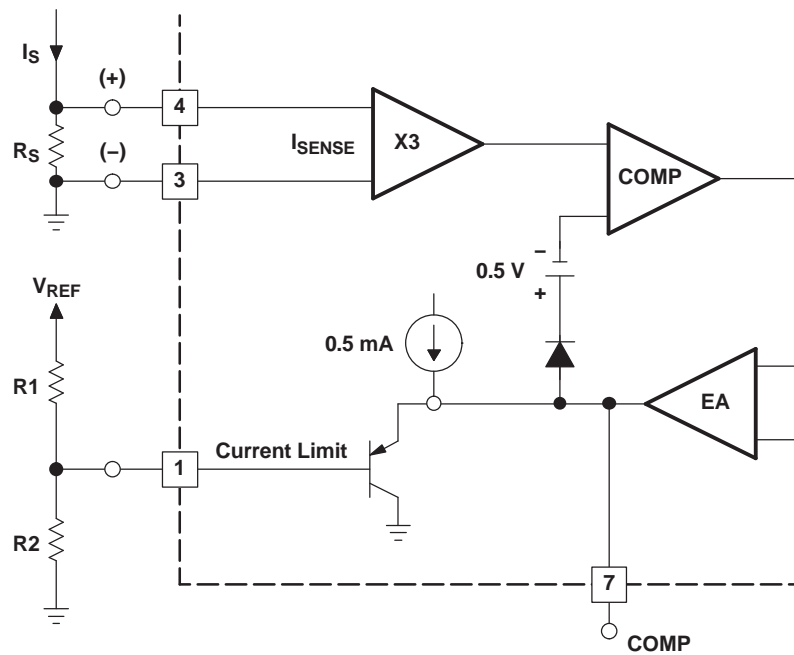
Figure 4. Error Amplifier Open-Loop DC Gain vs Load Resistance



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

Figure 5. Parallel Operation

S0021-01

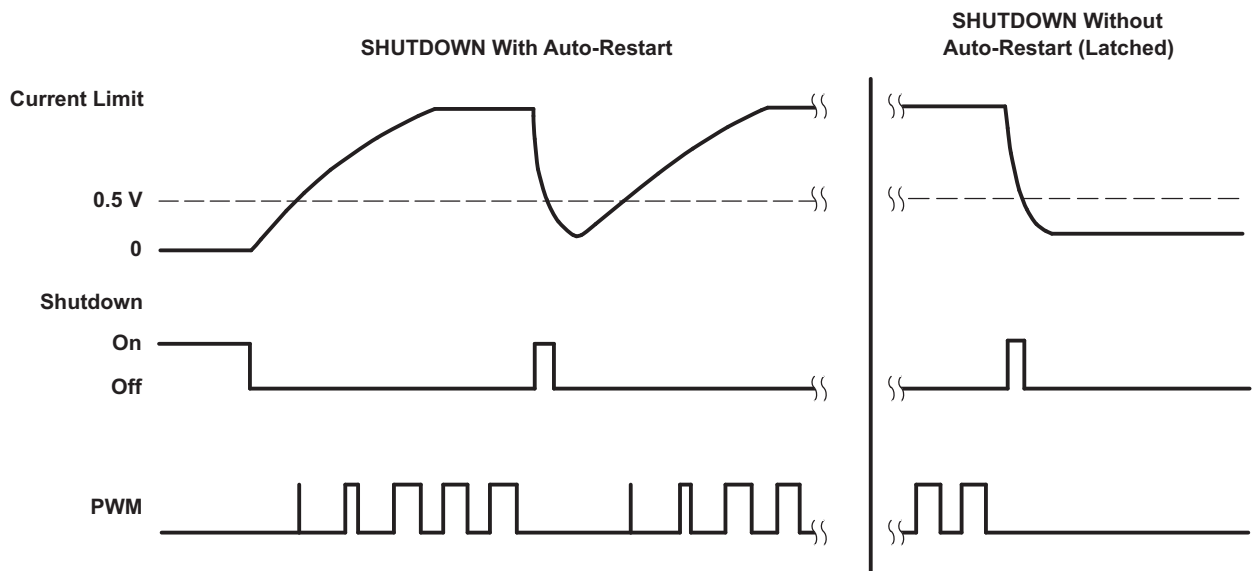
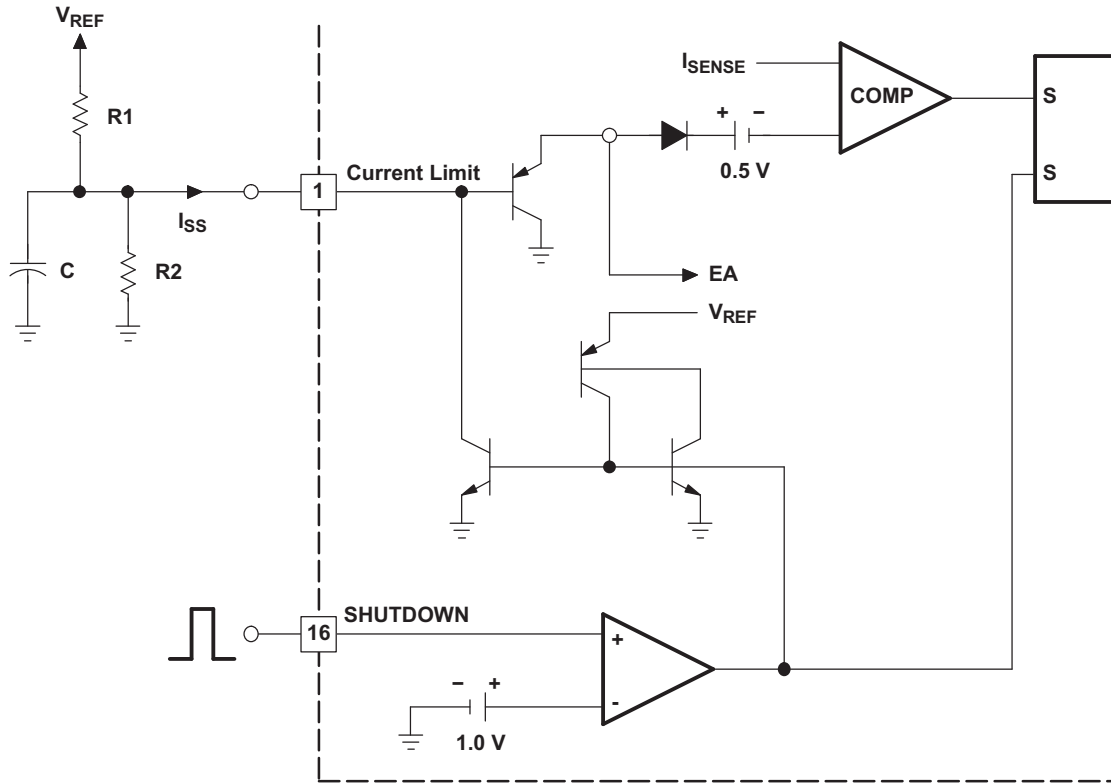


S0022-01

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

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

Figure 6. Pulse by Pulse Current Limiting



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

REVISION HISTORY

| Changes from Original (November 2004) to Revision A | Page |
|--|-------------|
| • Changed the polarity of the comparator connected to pin 16 in Figure 7 | 9 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| UC2856QDWR | ACTIVE | SOIC | DW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | UC2856Q | Samples |

(1) 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.

OBSOLETE: TI has discontinued the production of the device.

(2) 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)

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

(4) Only one of markings shown within the brackets will appear on the physical device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-013 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

| | |
|------------------------------|--|
| Audio | www.ti.com/audio |
| Amplifiers | amplifier.ti.com |
| Data Converters | dataconverter.ti.com |
| DLP® Products | www.dlp.com |
| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
| Logic | logic.ti.com |
| Power Mgmt | power.ti.com |
| Microcontrollers | microcontroller.ti.com |
| RFID | www.ti-rfid.com |
| OMAP Applications Processors | www.ti.com/omap |
| Wireless Connectivity | www.ti.com/wirelessconnectivity |

Applications

| | |
|-------------------------------|--|
| Automotive and Transportation | www.ti.com/automotive |
| Communications and Telecom | www.ti.com/communications |
| Computers and Peripherals | www.ti.com/computers |
| Consumer Electronics | www.ti.com/consumer-apps |
| Energy and Lighting | www.ti.com/energy |
| Industrial | www.ti.com/industrial |
| Medical | www.ti.com/medical |
| Security | www.ti.com/security |
| Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Video and Imaging | www.ti.com/video |

TI E2E Community

e2e.ti.com