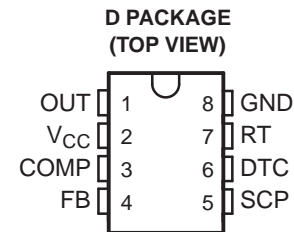


PULSE-WIDTH-MODULATION CONTROL CIRCUITS

FEATURES

- Qualified for Automotive Applications
- Complete PWM Power Control
- 3.6-V to 40-V Operation
- Internal Undervoltage-Lockout Circuit
- Internal Short-Circuit Protection
- Oscillator Frequency . . . 20 kHz to 500 kHz
- Variable Dead Time Provides Control Over Total Range
- $\pm 3\%$ Tolerance on Reference Voltage
- Available in Q-Temp Automotive
 - HighRel Automotive Applications
 - Configuration Control / Print Support
 - Qualification to Automotive Standards



DESCRIPTION

The TL5001A incorporates on a single monolithic chip all the functions required for a pulse-width-modulation (PWM) control circuit. Designed primarily for power-supply control, the TL5001A contains an error amplifier, a regulator, an oscillator, a PWM comparator with a dead-time-control input, undervoltage lockout (UVLO), short-circuit protection (SCP), and an open-collector output transistor. The TL5001A has a typical reference voltage tolerance of $\pm 3\%$.

The error-amplifier common-mode voltage ranges from 0 V to 1.5 V. The noninverting input of the error amplifier is connected to a 1-V reference. Dead-time control (DTC) can be set to provide 0% to 100% dead time by connecting an external resistor between DTC and GND. The oscillator frequency is set by terminating RT with an external resistor to GND. During low V_{CC} conditions, the UVLO circuit turns the output off until V_{CC} recovers to its normal operating range.

The TL5001A is characterized for operation from -40°C to 125°C .

AVAILABLE OPTIONS⁽¹⁾

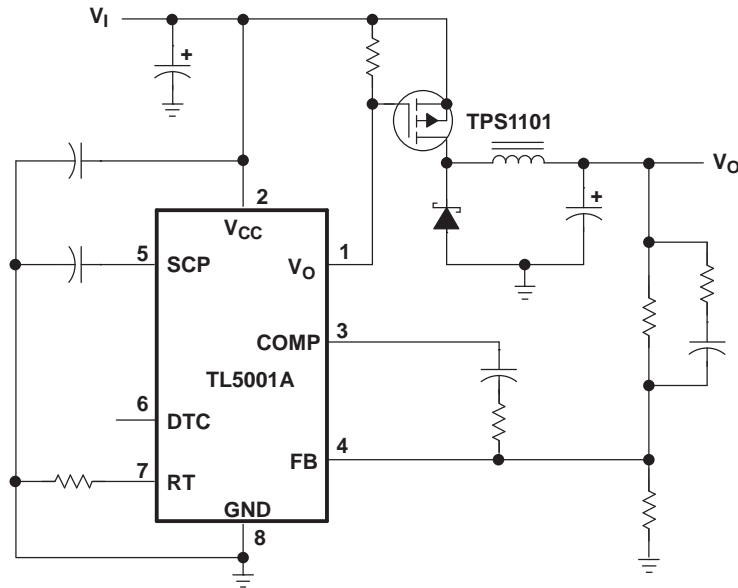
T _A	PACKAGED DEVICES ⁽²⁾
	SMALL OUTLINE (D) ⁽³⁾
-40°C to 125°C	TL5001AQDRQ1

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
- (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
- (3) The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL5001ADR).

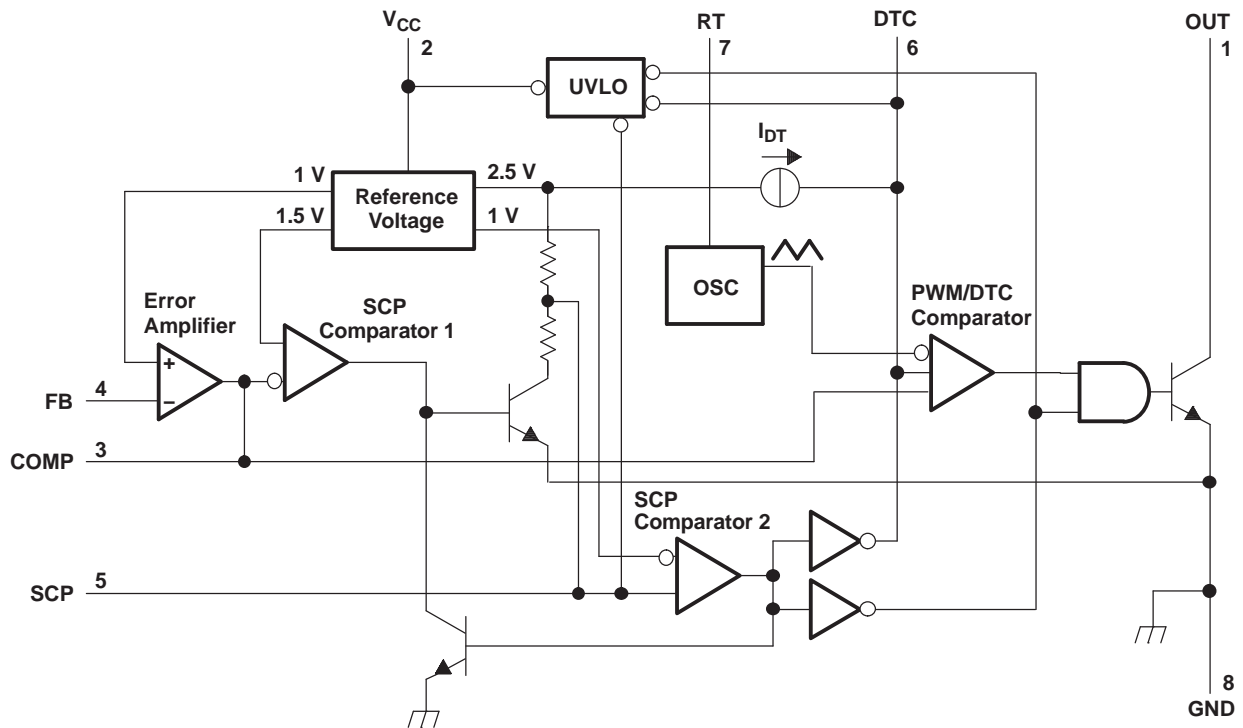


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

SCHEMATIC FOR TYPICAL APPLICATION



FUNCTIONAL BLOCK DIAGRAM



DETAILED DESCRIPTION

VOLTAGE REFERENCE

A 2.5-V regulator operating from V_{CC} is used to power the internal circuitry of the TL5001A and as a reference for the error amplifier and SCP circuits. A resistive divider provides a 1-V reference for the error amplifier noninverting input which typically is within 2% of nominal over the operating temperature range.

ERROR AMPLIFIER

The error amplifier compares a sample of the dc-to-dc converter output voltage to the 1-V reference and generates an error signal for the PWM comparator. The dc-to-dc converter output voltage is set by selecting the error-amplifier gain (see Figure 1), using the following expression:

$$V_O = (1 + R1/R2) (1 \text{ V})$$

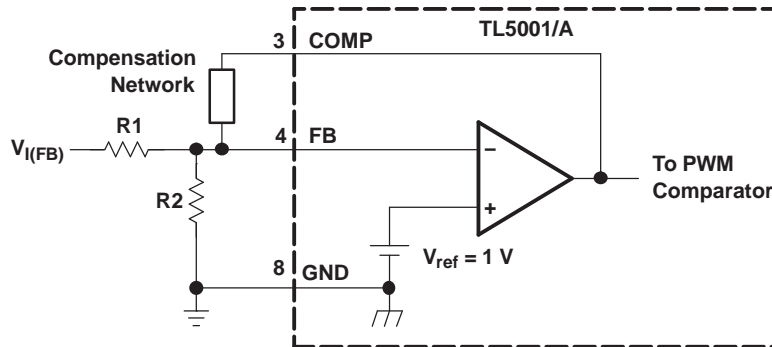


Figure 1. Error-Amplifier Gain Setting

The error-amplifier output is brought out as COMP for use in compensating the dc-to-dc converter control loop for stability. Because the amplifier can only source 45 μA , the total dc-load resistance should be 100 k Ω or more.

OSCILLATOR/PWM

The oscillator frequency (f_{osc}) can be set between 20 kHz and 500 kHz by connecting a resistor between RT and GND. Acceptable resistor values range from 15 k Ω to 250 k Ω . The oscillator frequency can be determined by using the graph shown in Figure 5.

The oscillator output is a triangular wave with a minimum value of approximately 0.7 V and a maximum value of approximately 1.3 V. The PWM comparator compares the error-amplifier output voltage and the DTC input voltage to the triangular wave and turns the output transistor off whenever the triangular wave is greater than the lesser of the two inputs.

DEAD-TIME CONTROL (DTC)

DTC provides a means of limiting the output-switch duty cycle to a value less than 100%, which is critical for boost and flyback converters. A current source generates a reference current (I_{DT}) at DTC that is nominally equal to the current at the oscillator timing terminal (RT). Connecting a resistor between DTC and GND generates a dead-time reference voltage (V_{DT}), which the PWM/DTC comparator compares to the oscillator triangle wave as described in the previous section. Nominally, the maximum duty cycle is 0% when V_{DT} is 0.7 V or less and 100% when V_{DT} is 1.3 V or greater. Because the triangle wave amplitude is a function of frequency and the source impedance of RT is relatively high (1250 Ω), choosing R_{DT} for a specific maximum duty cycle (D) is accomplished using the following equation and the voltage limits for the frequency in question as found in Figure 11 ($V_{\text{osc,max}}$ and $V_{\text{osc,min}}$ are the maximum and minimum oscillator levels):

$$R_{\text{DT}} = (R_t + 1250) [D(V_{\text{osc,max}} - V_{\text{osc,min}}) + V_{\text{osc,min}}]$$

Where

$$R_{\text{DT}} \text{ and } R_t \text{ are in ohms, } D \text{ in decimal} \tag{1}$$

Soft start can be implemented by paralleling the DTC resistor with a capacitor (C_{DT}) as shown in Figure 2. During soft start, the voltage at DTC is derived by the following equation:

$$V_{SCP} = (2.5 - 0.185)\left(1 - e^{-t/\tau}\right) + 0.185$$

Where

$$\tau = R_{SCP}C_{SCP} \tag{2}$$

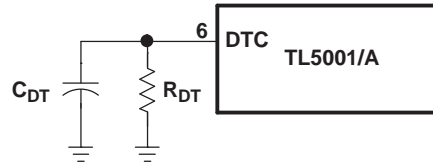


Figure 2. Soft-Start Circuit

If the dc-to-dc converter must be in regulation within a specified period of time, the time constant $R_{DT}C_{DT}$ should be $t_0/3$ to $t_0/5$. The TL5001A remains off until $V_{DT} \approx 0.7$ V, the minimum ramp value. C_{DT} is discharged every time UVLO or SCP becomes active.

UNDERVOLTAGE-LOCKOUT (UVLO) PROTECTION

The undervoltage-lockout circuit turns the output transistor off and resets the SCP latch whenever the supply voltage drops too low (approximately 3 V at 25°C) for proper operation. A hysteresis voltage of 200 mV eliminates false triggering on noise and chattering.

SHORT-CIRCUIT PROTECTION (SCP)

The TL5001A includes short-circuit protection (see Figure 3), which turns the power switch off to prevent damage when the converter output is shorted. When activated, the SCP prevents the switch from being turned on until the internal latching circuit is reset. The circuit is reset by reducing the input voltage until UVLO becomes active or until the SCP terminal is pulled to ground externally.

When a short circuit occurs, the error-amplifier output at COMP rises to increase the power-switch duty cycle in an attempt to maintain the output voltage. SCP comparator 1 starts an RC timing circuit when COMP exceeds 1.5 V. If the short is removed and the error-amplifier output drops below 1.5 V before time out, normal converter operation continues. If the fault is still present at the end of the time-out period, the timer sets the latching circuit and turns off the TL5001/A output transistor.

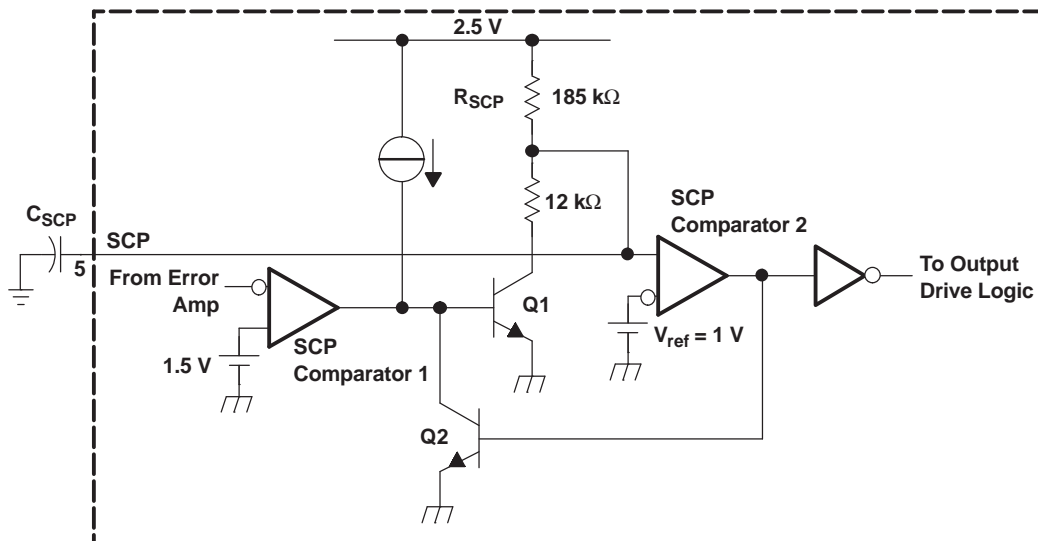


Figure 3. SCP Circuit

The timer operates by charging an external capacitor C_{SCP} , connected between the SCP terminal and ground, towards 2.5 V through a 185-k Ω resistor R_{SCP} . The circuit begins charging from an initial voltage of approximately 185 mV and times out when the capacitor voltage reaches 1 V. The output of SCP comparator 2 then goes high, turns on Q2, and latches the timer circuit. The expression for setting the SCP time period is derived from the following equation:

$$C_{SCP} = 12.46 \times t_{SCP}$$

Where

$$t \text{ is in seconds, } C \text{ in } \mu\text{F.} \quad (3)$$

The end of the time-out period, t_{SCP} , occurs when $V_{SCP} = 1$ V. Solving for C_{SCP} yields:

$$V_{DT} \approx I_{DT} R_{DT} \left(1 - e^{-t/R_{DT} C_{DT}} \right) \quad (4)$$

t_{SCP} must be much longer (generally 10 to 15 times) than the converter start-up period or the converter will not start.

OUTPUT TRANSISTOR

The output of the TL5001A is an open-collector transistor with a maximum collector current rating of 21 mA and a voltage rating of 51 V. The output is turned on under the following conditions: the oscillator triangle wave is lower than both the DTC voltage and the error-amplifier output voltage, the UVLO circuit is inactive, and the short-circuit protection circuit is inactive.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

		UNIT
V_{CC}	Supply voltage ⁽²⁾	41 V
$V_{I(FB)}$	Amplifier input voltage	20 V
V_O	Output voltage, OUT	51 V
I_O	Output current, OUT	21 mA
$I_{O(peak)}$	Output peak current, OUT	100 mA
	Continuous total power dissipation	See Dissipation Rating Table
T_A	Operating ambient temperature range, TL5001AQDRQ1	–40°C to 125°C
T_{stg}	Storage temperature range	–65°C to 150°C
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°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) All voltage values are with respect to network ground terminal.

DISSIPATION RATINGS

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{CC}	Supply voltage	3.6	40	V
$V_{I(FB)}$	Amplifier input voltage	0	1.5	V
V_O	Output voltage, OUT		50	V
I_O	Output current, OUT		20	mA
	COMP source current		45	μ A
	COMP dc load resistance	100		k Ω
R_t	Oscillator timing resistor	15	250	k Ω
f_{OSC}	Oscillator frequency	20	500	kHz
T_A	Operating ambient temperature			$^{\circ}$ C
	TL5001AQDRQ1	-40	125	

ELECTRICAL CHARACTERISTICS

 over recommended operating free-air temperature range, $V_{CC} = 6\text{ V}$, $f_{osc} = 100\text{ kHz}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TL5001AQ			UNIT
			MIN	TYP ⁽¹⁾	MAX	
REFERENCE						
Output voltage	$T_A = 25^\circ\text{C}$	COMP connected to FB	0.97	1	1.03	V
	$T_A = \text{MIN to MAX}$		0.94	0.98	1.06	
Input regulation	$T_A = \text{MIN to MAX}$,	$V_{CC} = 3.6\text{ V to }40\text{ V}$		2	12.5	mV
Output voltage change with temperature	$T_A = \text{MIN to MAX}$		-6% ⁽²⁾	2%	6% ⁽²⁾	
UNDERVOLTAGE LOCKOUT						
Upper threshold voltage	$T_A = \text{MIN}, 25^\circ\text{C}$			3		V
	$T_A = \text{MAX}$			2.55		
Lower threshold voltage	$T_A = \text{MIN}, 25^\circ\text{C}$			2.8		V
	$T_A = \text{MAX}$			2.0		
Hysteresis	$T_A = \text{MIN to MAX}$		80	200		mV
Reset threshold voltage	$T_A = \text{MIN}, 25^\circ\text{C}$		2.1	2.55		V
	$T_A = \text{MAX}$		0.35	0.63		
SHORT-CIRCUIT PROTECTION						
SCP threshold voltage	$T_A = \text{MIN}, 25^\circ\text{C}$		0.97	1	1.03	V
	$T_A = \text{MAX}$		0.94	0.98	1.06	
SCP voltage, latched	$T_A = \text{MIN to MAX}$	No pullup	140	185	230	mV
SCP voltage, UVLO standby	$T_A = \text{MIN to MAX}$	No pullup		60	120	mV
Equivalent timing resistance	$T_A = \text{MIN to MAX}$			185		k Ω
SCP comparator 1 threshold voltage	$T_A = \text{MIN to MAX}$			1.5		V
OSCILLATOR						
Frequency	$T_A = \text{MIN to MAX}$	$R_t = 100\text{ k}\Omega$		100		kHz
Standard deviation of frequency	$T_A = \text{MIN to MAX}$			2		kHz
Frequency change with voltage	$T_A = \text{MIN to MAX}$	$V_{CC} = 3.6\text{ V to }40\text{ V}$		1		kHz
Frequency change with temperature	$T_A = \text{MIN to MAX}$	Q suffix	-9 ⁽²⁾	5	9 ⁽²⁾	kHz
		M suffix	-9 ⁽²⁾	5	9 ⁽²⁾	
Voltage at RT	$T_A = \text{MIN to MAX}$			1		V
DEAD-TIME CONTROL						
Output (source) current	$T_A = \text{MIN to MAX}$	$V_{(DT)} = 1.5\text{ V}$	$0.9 \times I_{RT}^{(3)}$		$1.1 \times I_{RT}^{(3)}$	μA
Input threshold voltage	$T_A = 25^\circ\text{C}$	Duty cycle 0%	0.5	0.7		V
		Duty cycle 100%		1.3	1.5	
	$T_A = \text{MIN to MAX}$	Duty cycle 0%	0.4	0.7		
		Duty cycle 100%		1.3	1.7	

 (1) All typical values are at $T_A = 25^\circ\text{C}$.

(2) Not production tested.

(3) Output source current at RT

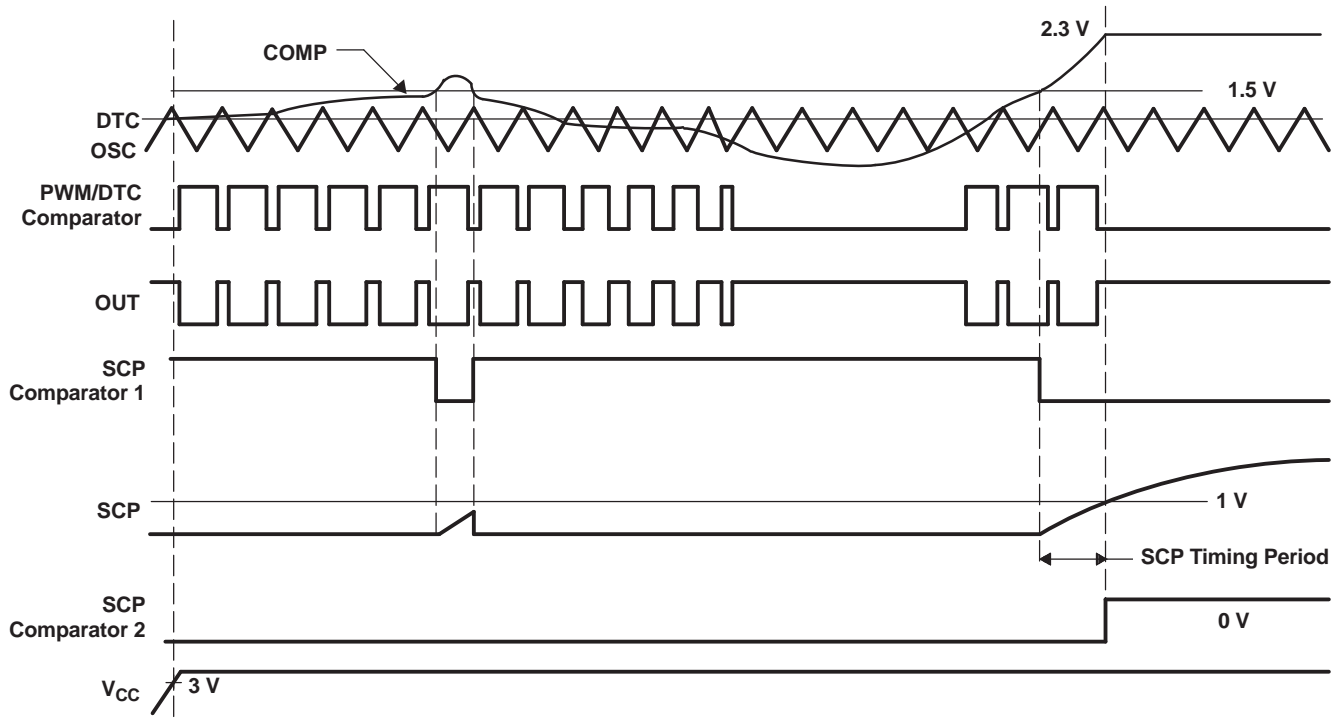
ELECTRICAL CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC} = 6\text{ V}$, $f_{osc} = 100\text{ kHz}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		TL5001AQ			UNIT
			MIN	TYP ⁽¹⁾	MAX	
ERROR AMPLIFIER						
Input bias current	$T_A = \text{MIN to MAX}$		-160	-500		nA
Output voltage swing	Positive	$T_A = \text{MIN to MAX}$	1.5	2.3		V
	Negative		0.3	0.4		V
Open-loop voltage amplification	$T_A = \text{MIN to MAX}$			80		dB
Unity gain bandwidth	$T_A = \text{MIN to MAX}$			1.5		MHz
Output (sink) current	$T_A = \text{MIN to MAX}$		$V_{I(\text{FB})} = 1.2\text{ V}$, $\text{COMP} = 1\text{ V}$			μA
Output (source) current	$T_A = \text{MIN}, 25^\circ\text{C}$		$V_{I(\text{FB})} = 0\text{ V}$, $\text{COMP} = 1\text{ V}$			μA
	$T_A = \text{MAX}$		-30	-45		
OUTPUT						
Output saturation voltage	$T_A = \text{MIN to MAX}$		$I_O = 10\text{ mA}$			V
Off-state current	$T_A = \text{MIN to MAX}$		$V_O = 50\text{ V}$, $V_{CC} = 0$			μA
			$V_O = 50\text{ V}$			10
Short-circuit output current	$T_A = \text{MIN to MAX}$		$V_O = 6\text{ V}$			mA
TOTAL DEVICE						
Standby supply current	Off state	$T_A = \text{MIN to MAX}$				mA
Average supply current	$T_A = \text{MIN to MAX}$		$R_L = 100\text{ k}\Omega$			mA

(1) All typical values are at $T_A = 25^\circ\text{C}$.

PARAMETER MEASUREMENT INFORMATION



A. The waveforms show timing characteristics for an intermittent short circuit and a longer short circuit that is sufficient to activate SCP.

Figure 4. PWM Timing Diagram

TYPICAL CHARACTERISTICS

OSCILLATOR FREQUENCY
vs
TIMING RESISTANCE

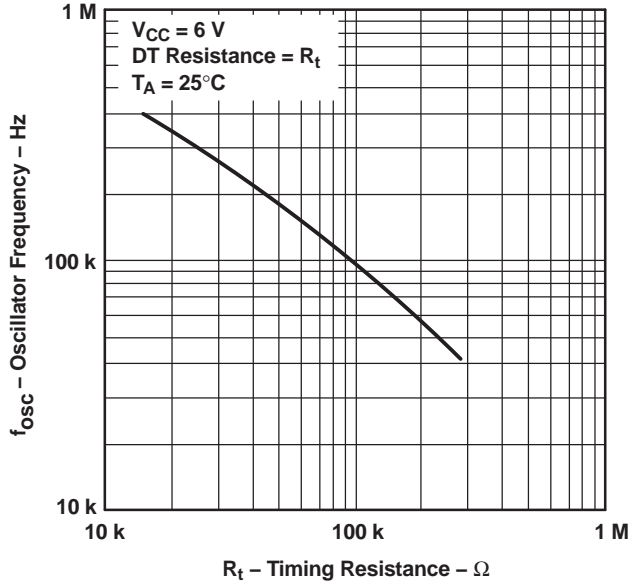


Figure 5.

OSCILLATION FREQUENCY
vs
AMBIENT TEMPERATURE

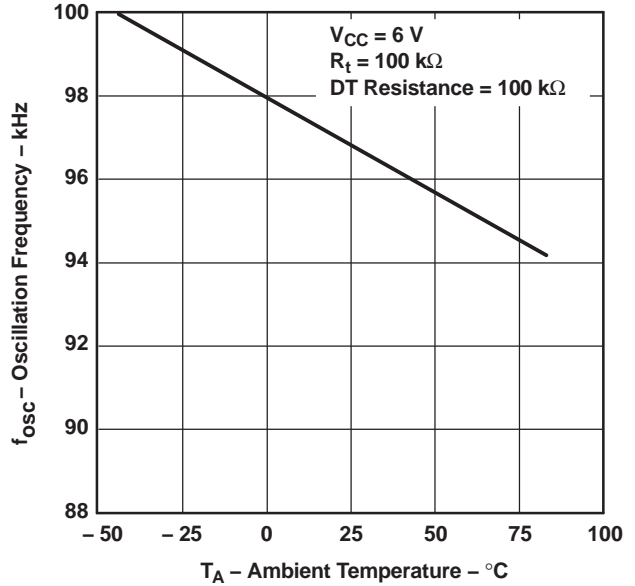


Figure 6.

REFERENCE OUTPUT VOLTAGE
vs
POWER-SUPPLY VOLTAGE

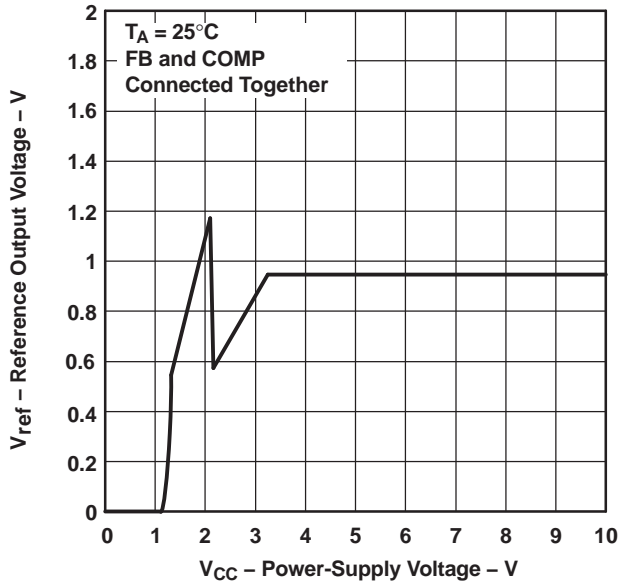


Figure 7.

REFERENCE OUTPUT VOLTAGE FLUCTUATION
vs
AMBIENT TEMPERATURE

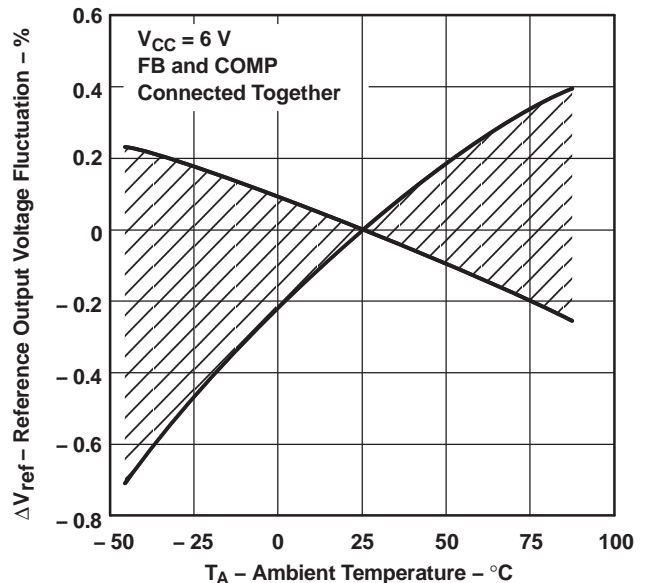
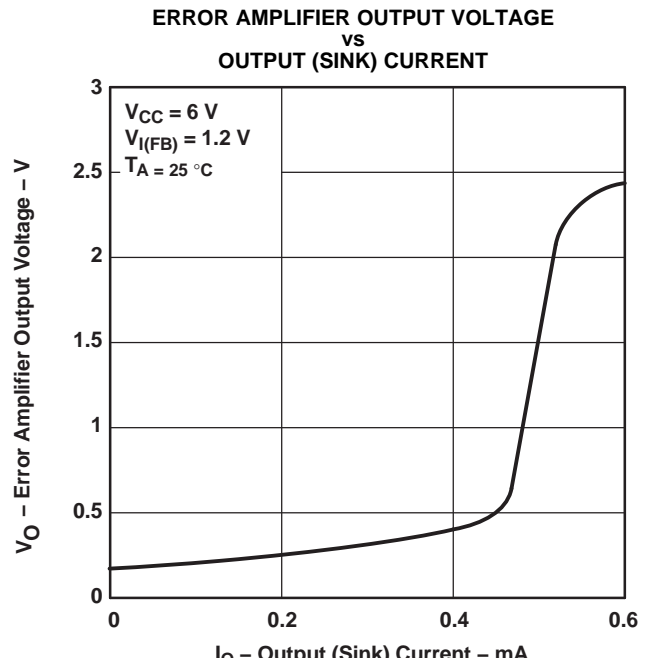
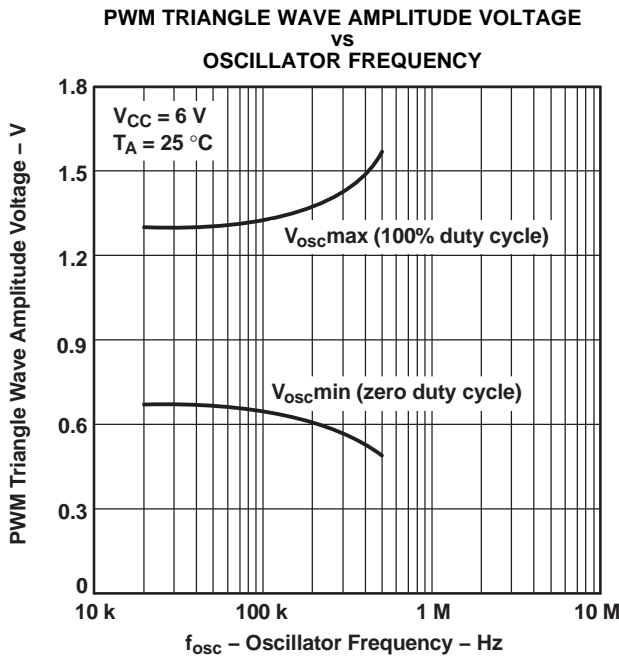
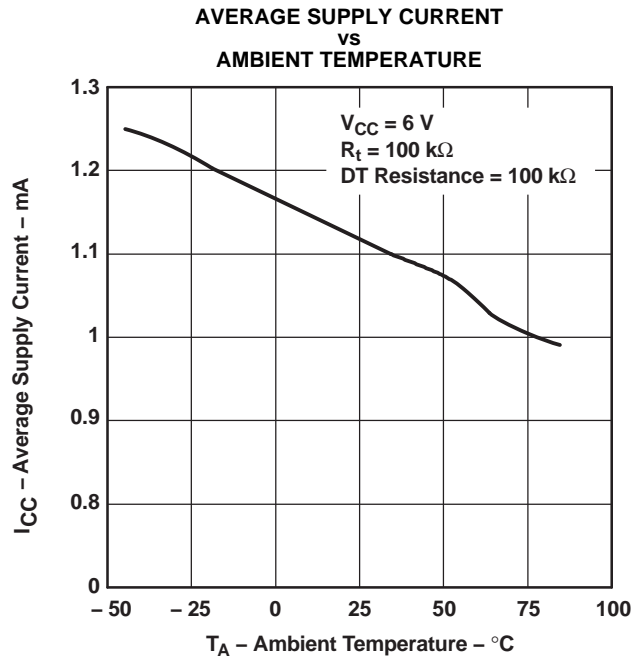
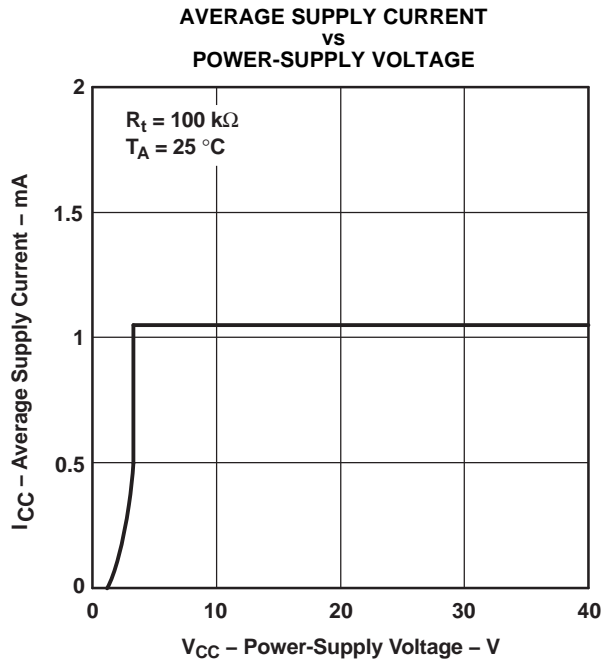


Figure 8.

TYPICAL CHARACTERISTICS (continued)



TYPICAL CHARACTERISTICS (continued)

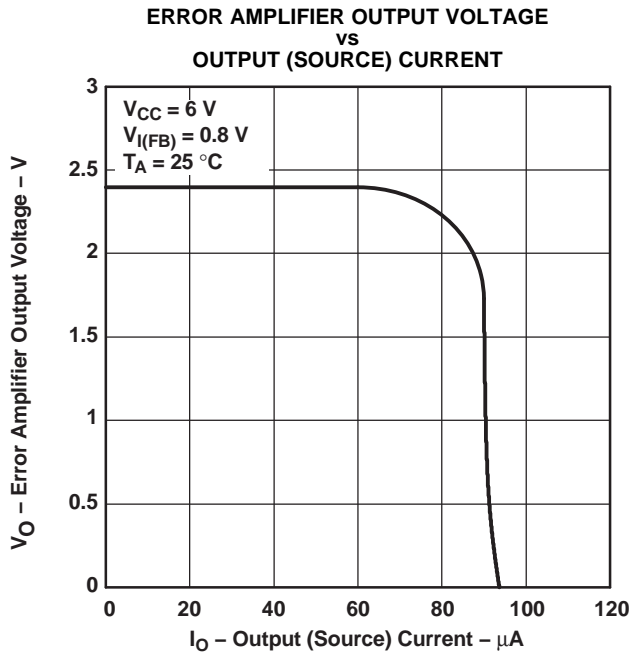


Figure 13.

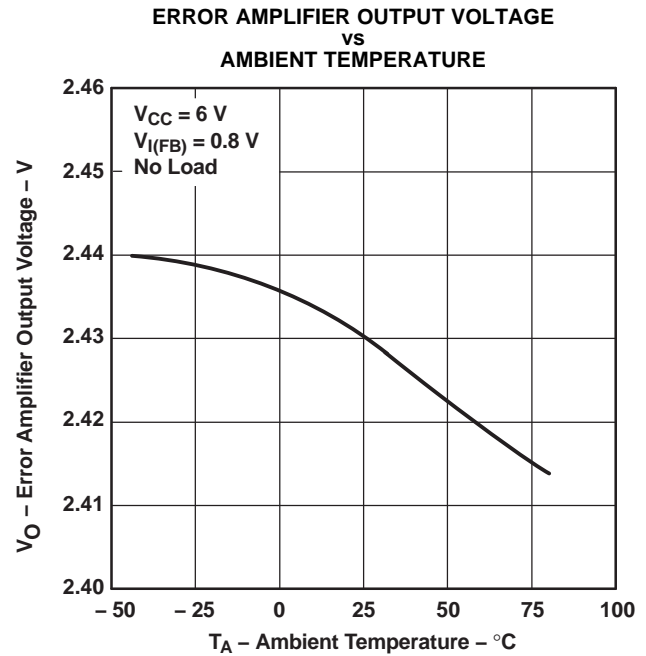


Figure 14.

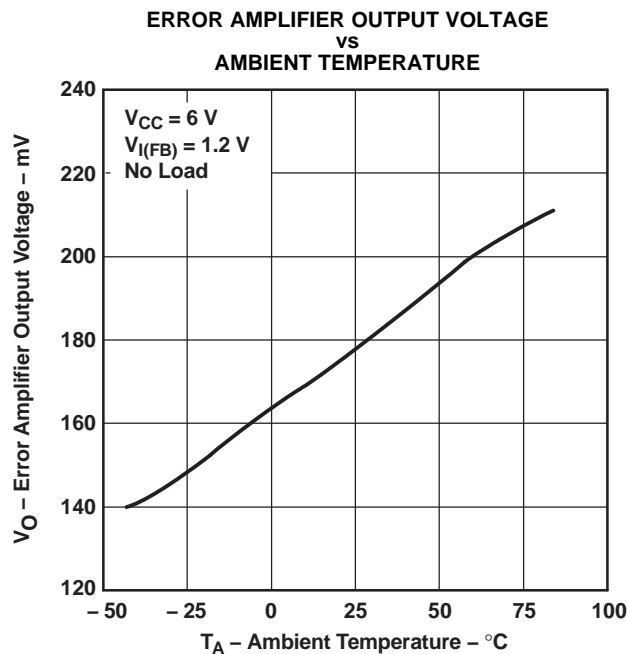


Figure 15.

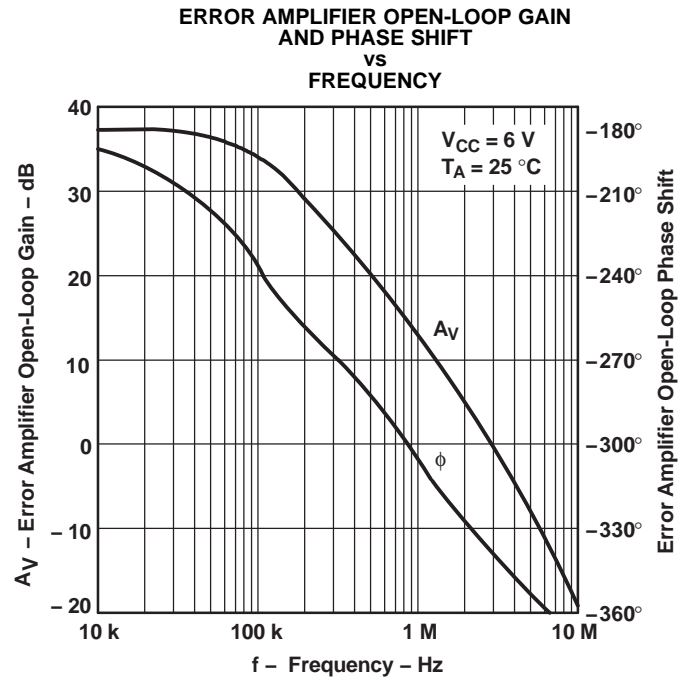


Figure 16.

TYPICAL CHARACTERISTICS (continued)

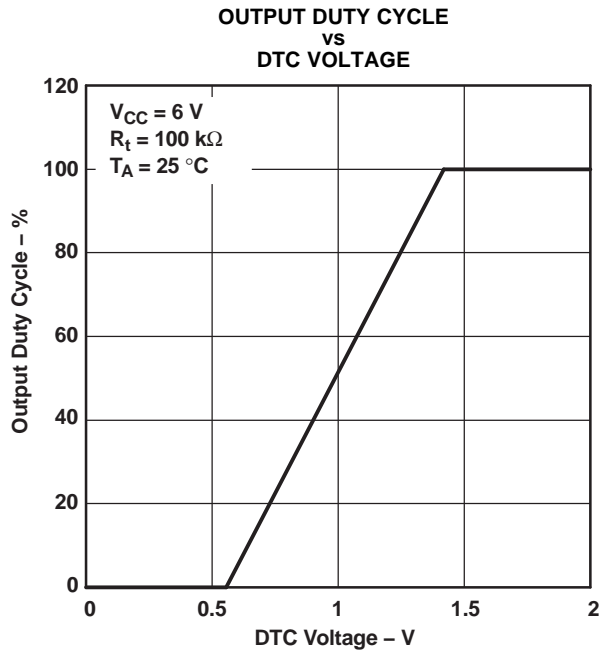


Figure 17.

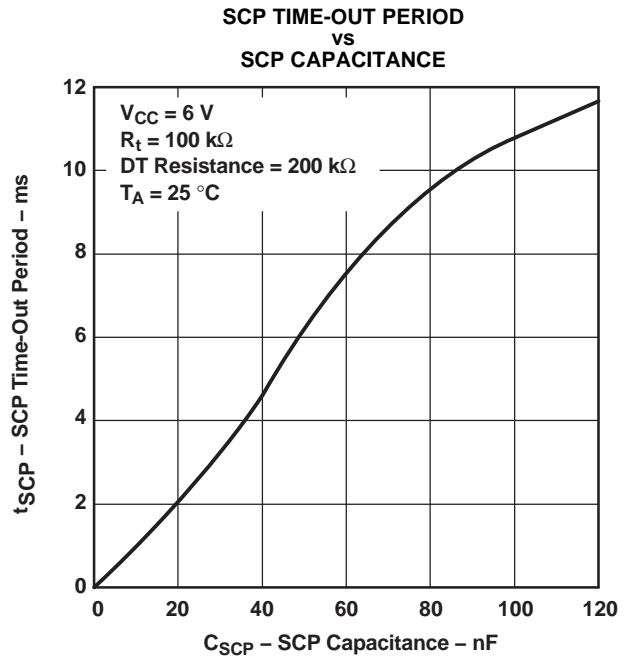


Figure 18.

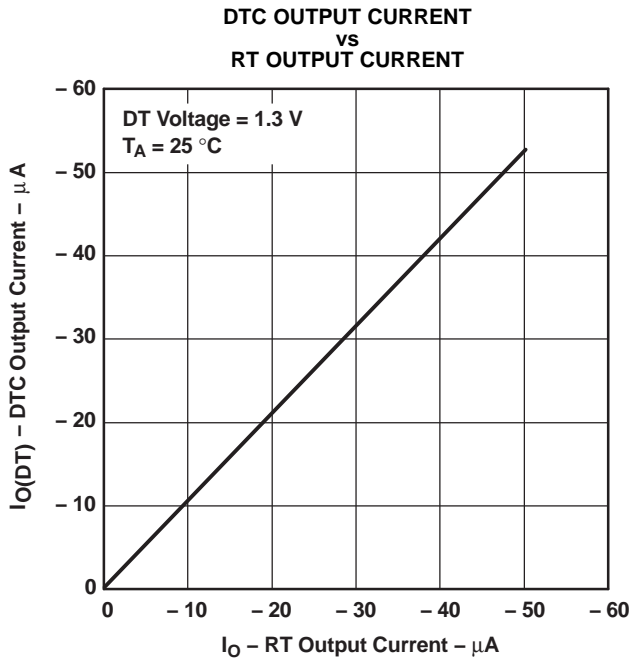


Figure 19.

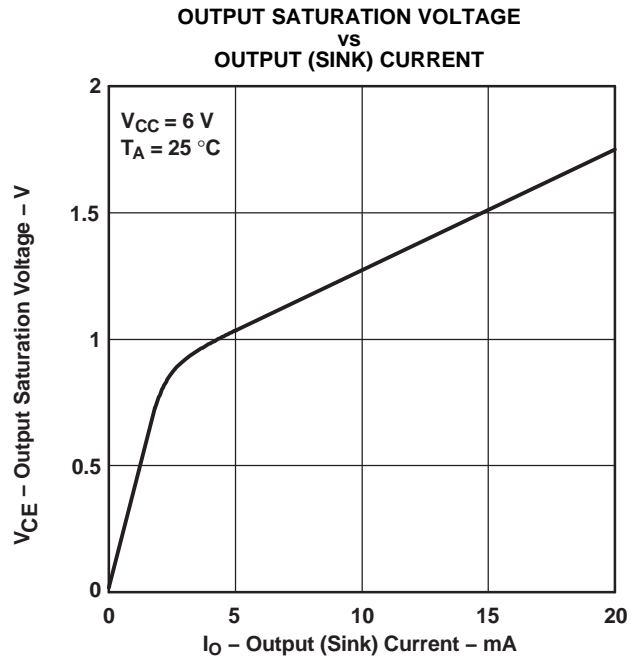
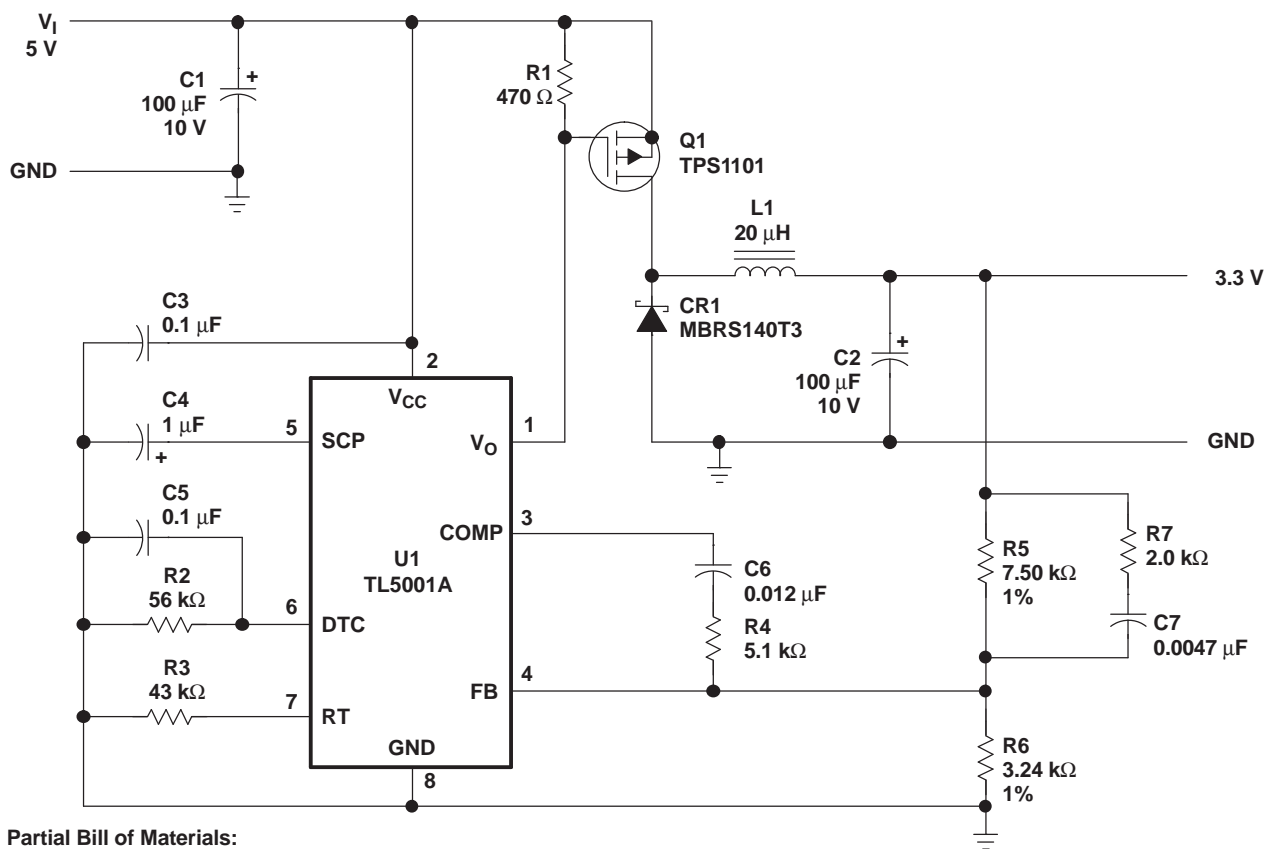


Figure 20.

APPLICATION INFORMATION



Partial Bill of Materials:

U1	TL5001A	Texas Instruments
Q1	TPS1101	Texas Instruments
LI	CTX20-1 or 23 turns of #28 wire on Micrometals No. T50-26B core	Coiltronics
C1	TPSD107M010R0100	AVX
C2	TPSD107M010R0100	AVX
CR1	MBRS140T3	Motorola

- A. Frequency = 200 kHz
- B. Duty cycle = 90% max
- C. Soft-start time constant (TC) = 5.6 ms
- D. SCP TC = 70 ms

Figure 21. Step Down Converter

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TL5001AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL5001AQDRQ1	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM

⁽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.

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.

OTHER QUALIFIED VERSIONS OF TL5001A-Q1 :

- Catalog: [TL5001A](#)
- Military: [TL5001AM](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.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
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated