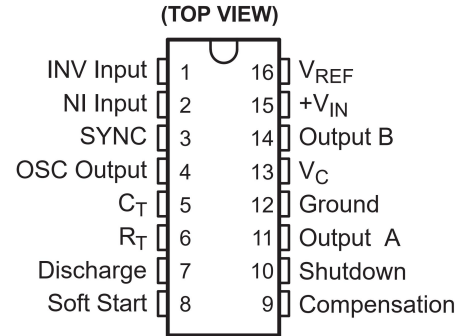


Features

- 8-V to 35-V Operation
- 5.1-V Reference Trimmed to 1%
- 100-Hz to 500-kHz Oscillator Range
- Separate Oscillator Sync Terminal
- Adjustable Dead-Time Control
- Internal Soft Start
- Pulse-by-Pulse Shutdown
- Input Undervoltage Lockout With Hysteresis
- Latching PWM to Prevent Multiple Pulses
- Dual Source and Sink Output Drivers



Applications

- Off-Line and DC/DC Power Supplies
- Converters Using Voltage Mode
- Single-Ended or Two-Switch Topology Designs
- Solar Inverters
- Welding Inverters
- Motor Control
- Battery Chargers

Part Number	Package	Body Size
UC3525AN	PDIP16	19.5 X 6.6
UC3525ADW	SOIC16	10.3 X 7.5

Name	Pin		Description
	DIP	SOP	
INV Input	1		Inverting input to the error amplifier
NI Input	2		Noninverting input to the error amplifier
SYNC	3		Oscillator sync terminal
OSC Output	4		Oscillator frequency output
C _T	5		Timing capacitor connection pin for oscillator frequency programming. The timing capacitor should be connected to the device ground using minimal trace length
R _T	6		Timing resistor connection pin for oscillator frequency programming
Discharge	7		A single resistor between C _T and the discharge terminals provides dead-time adjustment
Soft Star	8		Soft-start input pin
Compensation	9		Output of the error amplifier for compensation
Shutdown	10		Pull this pin high to shut down PWM output

Output A	11	output A of the on-chip drive stage
Ground	12	Ground return pin
VC	13	Power supply pin for the output stage. This pin should be bypassed with a 0.1- μ F monolithic ceramic low ESL capacitor with minimal trace lengths.
Output B	14	Output B of the on-chip drive stage
+VIN	15	Input voltage
VREF	16	5.1-V reference. For stability, the reference should be bypassed with a 0.1- μ F monolithic ceramic low ESL capacitor and minimal trace length to the ground plane

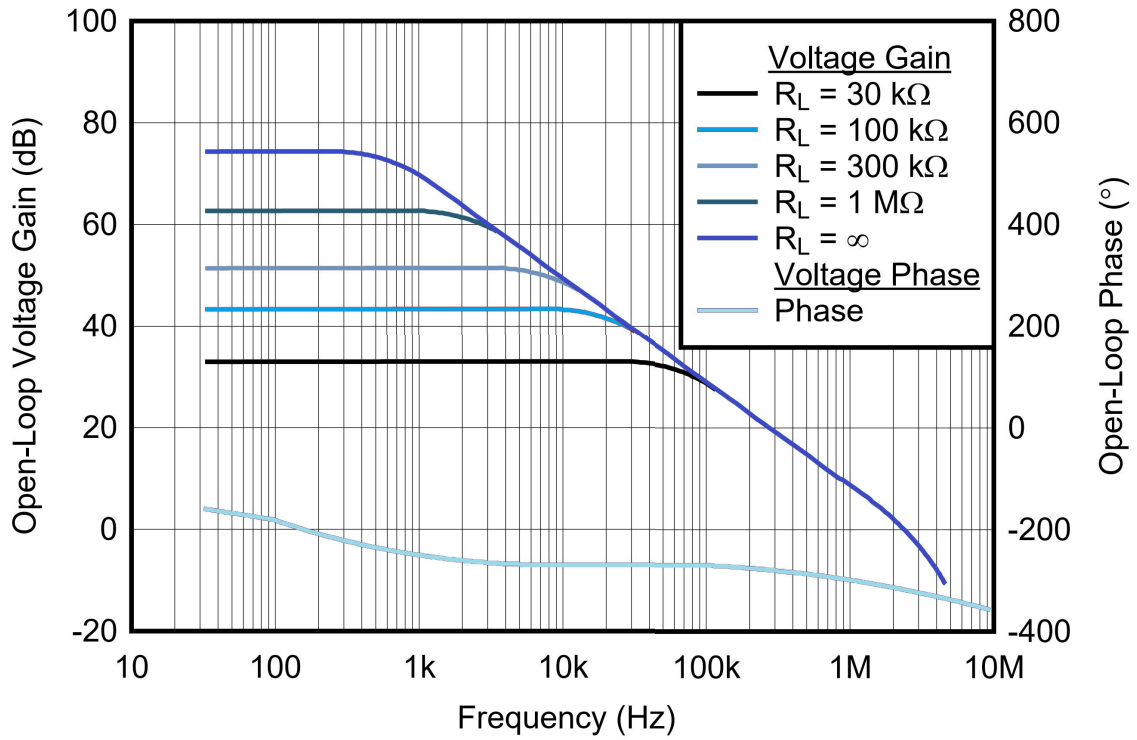
	Min.	Max.	Unit
Supply voltage		40	V
Collector supply voltage		40	
Logic inputs -0.3 5.5 V	-0.3	5.5	
Analog inputs	-0.3	+VIN	
Output current, source or sink		500	mA
Reference output current		50	
Oscillator charging current		5	
Power dissipation at TA = +25°C		1000	mW
Power dissipation at TC = +25°C		2000	
Operating junction temperature	-55	150	°C
Lead temperature (soldering, 10 seconds)		300	
Storage temperature	-55	150	
Input voltage	8	35	V
Collector supply voltage	4.5	35	
Sink/source load current (steady state)	0	100	mA
Sink/source load current (peak)	0	400	
Reference load current	0	20	
Oscillator frequency range	100	400	Hz
Oscillator timing resistor	2	150	k Ω
Oscillator timing capacitor	0.001	0.01	μ F
Dead time resistor range	0	500	Ω
Operating ambient temperature	0	70	°C

Electrical Characteristics

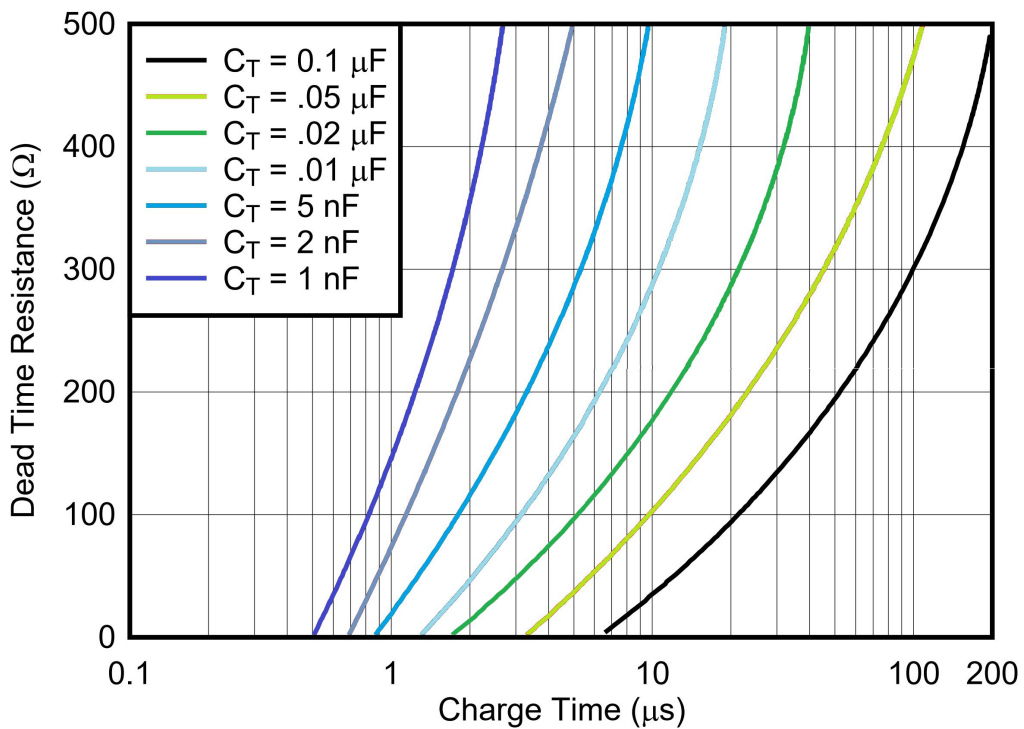
Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Input bias current			1	10	uA
Input offset current				1	
DC open loop gain	$R_L \geq 10 \text{ M}\Omega$	60	75		dB
Gain-bandwidth product	$A_V = 0 \text{ dB}$, $T_J = 25^\circ\text{C}$	1	2		MHz
DC transconductance	$T_J = 25^\circ\text{C}$, $30 \text{ k}\Omega \leq R_L \leq 1 \text{ M}\Omega$	1.1	1.5		mS
Low-level output voltage			0.2	0.5	V
High-level output voltage		3.8	5.6		
Common mode rejection	$V_{CM} = 1.5 \text{ V to } 5.2 \text{ V}$	60	75		dB
Supply voltage rejection	$V_{IN} = 8 \text{ V to } 35 \text{ V}$	50	60		
PWM Comparator					
Minimum duty-cycle		0%	0%	0%	
Maximum duty-cycle		45%	49%		
Input threshold	Zero duty-cycle	0.7	0.9		V
	Maximum duty-cycle		3.3	3.6	
Input bias current			0.05	1	uA
Shutdown					
Soft-start current	$V_{SD} = 0 \text{ V}$, $V_{SS} = 0 \text{ V}$	25	50	80	uA
Soft-start low level	$V_{SD} = 2.5 \text{ V}$		0.4	0.7	V
Shutdown threshold	outputs, $V_{SS} = 5.1 \text{ V}$, $T_J = 25^\circ\text{C}$	0.6	0.8	1	
Shutdown input current	$V_{SD} = 2.5 \text{ V}$		0.4	1	mA
Shutdown Delay	$V_{SD} = 2.5 \text{ V}$, $T_J = 25^\circ\text{C}$		0.2	0.5	uS
Output Drivers [$V_C=20\text{V}$]					
Low-level output voltage	$I_{SINK} = 20 \text{ mA}$		0.2	0.4	V
	$I_{SINK} = 100 \text{ mA}$		1	2	
High-level output voltage	$I_{SOURCE} = 20 \text{ mA}$	18	19		
	$I_{SOURCE} = 100 \text{ mA}$	17	18		
Undervoltage lockout	V_{COMP} and $V_{SS} = \text{High}$	6	7	8	
VC OFF current	$V_C = 35 \text{ V}$			200	uA
Rise time	$C_L = 1 \text{ nF}$, $T_J = 25^\circ\text{C}$		100	600	nS
Fall time	$C_L = 1 \text{ nF}$, $T_J = 25^\circ\text{C}$		50	300	
Total Standby Current					
Supply Current	$V_{IN} = 35 \text{ V}$		14	20	mA

Typical Characteristics

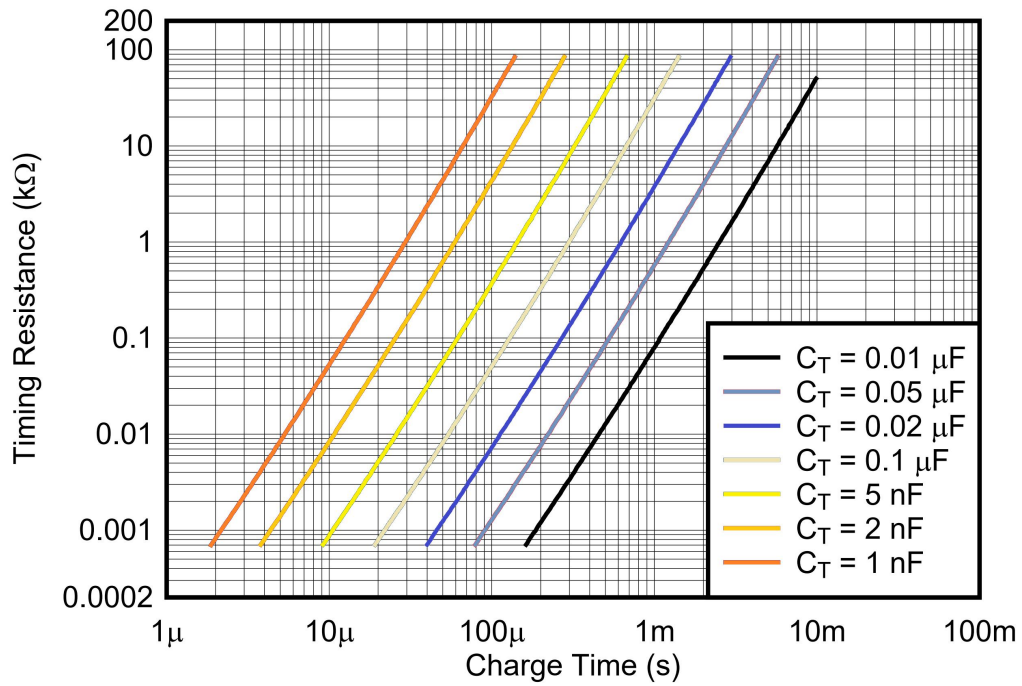
Error Amplifier Voltage Gain and Phase vs. Frequency



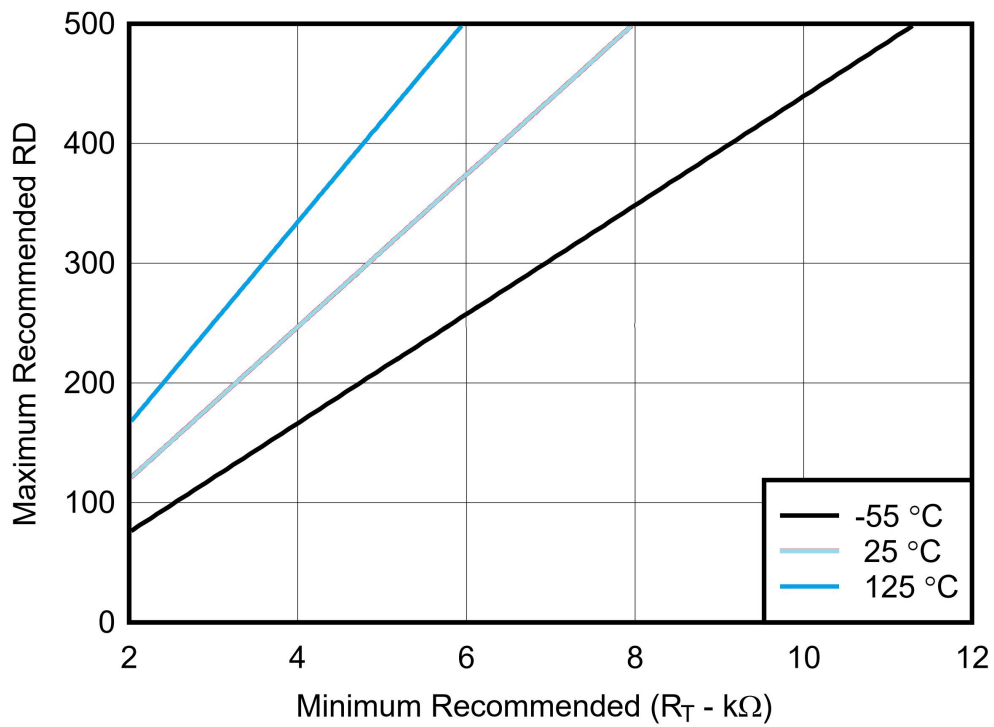
Oscillator Discharge Time vs. $R_T C_T$



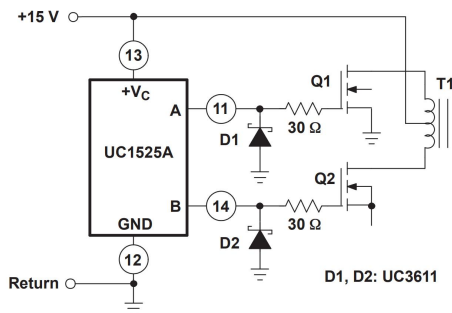
Oscillator Charge Time vs. R_T and C_T



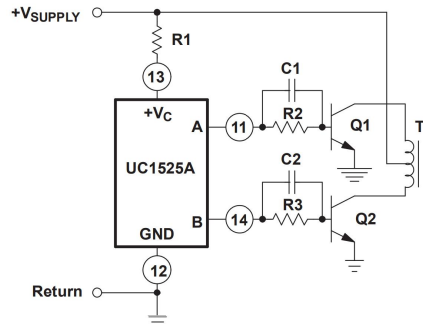
Maximum Value R_D vs. Minimum Value R_T



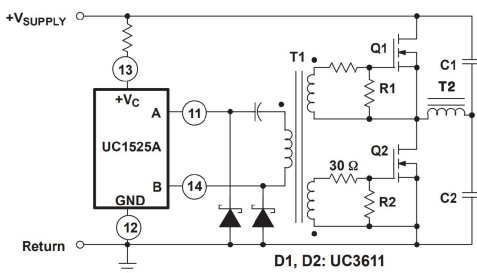
Typical Application



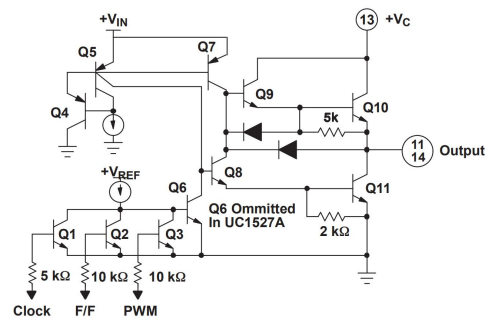
Output Drivers With Low Source Impedance



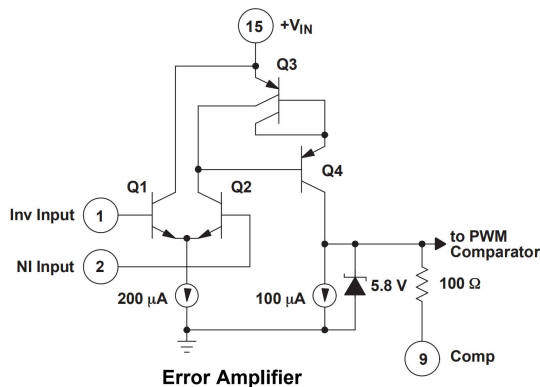
Conventional Push-Pull Bipolar Design



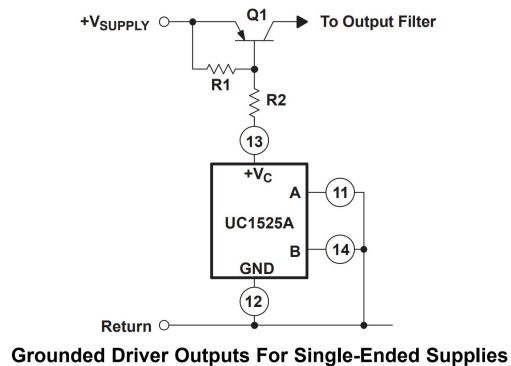
Low Power Transformers



Output Circuit (1/2 circuit shown)



Error Amplifier



Grounded Driver Outputs For Single-Ended Supplies

Detailed Design Procedure

- **Timing Resistor and Capacitor Selection**

Generally, higher switching frequency gives smaller size but have higher switching loss. Operation at 100 kHz was selected in this example as a reasonable compromise between size and efficiency. The value of $R_T = 10 \text{ k}\Omega$, $C_T = 1.37 \text{ nF}$ and $R_D = 100 \Omega$ were chosen for 100-kHz oscillator frequency based on equation:

$$F = 1/[C_T(0.7R_T + 3R_D)]$$

- **Turns Ratio Selection**

The maximum primary-to-secondary turns ratio N_{MAX} can be determined by the target output voltage, minimum input voltage, and the estimated maximum duty cycle. $D_{LIM} = 0.35$ was selected for this example. N_{MAX} can be calculated using Equation 1

$$N_{MAX} = [2 * D_{LIM} * V_{IN(MIN)}] / (V_{OUT} + V_F) = 2 * 0.35 * 25V / (5V + 0.3V)$$

Rounding N_{MAX} down to the next lowest integer results in a turns ratio of $N = 3$

- **Inductor Selection**

The maximum inductor ripple current occurs at the maximum input voltage. Typically, 20% to 40% of the full load current ripple is a good compromise between core loss and copper loss of the inductor. Higher ripple current allows for a smaller inductor size, but places more burden on the output capacitor to smooth the ripple voltage on the output. In this example, a ripple current of 25% of 10 A was chosen. The inductor value can be calculated as:

$$L_O = [(V_{OUT} + V_F) / \Delta I_L * f_{SW}] * [0.5 - N * (V_{OUT} + V_F) / 2 * V_{IN(MAX)}]$$

- **Rectification Diode Selection**

A rectification diode should always possess low-forward voltage drop. When used in high-frequency switching applications, the diode must also possess a short recovery time. Schottky diodes meet both requirements and are therefore strongly recommended in push-pull converter designs

- **VC Capacitor Selection**

The primary purpose of the VC capacitor is to supply the peak transient currents of the drivers as well as provide stability for the VC regulator. These peak currents can be several amperes. The recommended value of VC capacitor should be no smaller than 0.1 μ F, and should be a good quality, low ESR, ceramic capacitor. VC capacitor should be placed as close as possible to the VC pin to minimize potentially damaging voltage transients caused by trace inductance

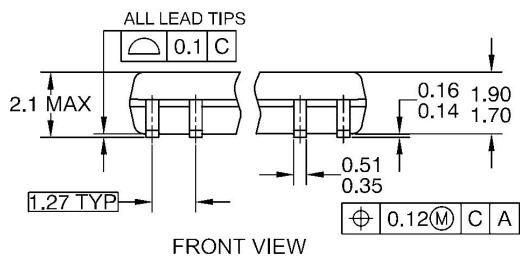
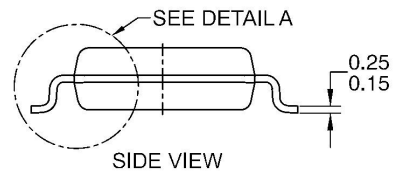
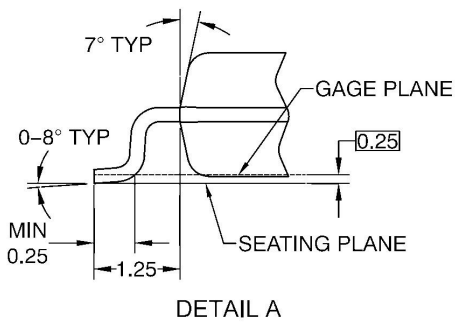
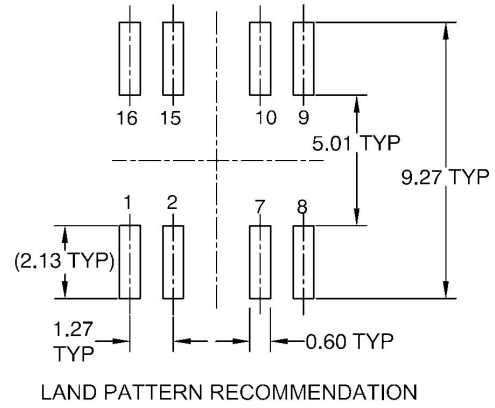
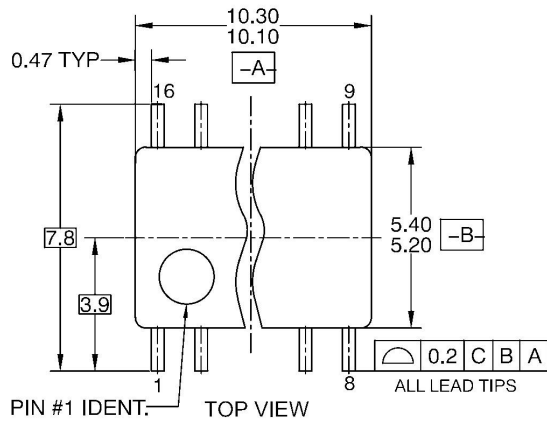
- **Output Capacitor Selection**

The output capacitors smooth the output voltage ripple caused by inductor ripple current and provide a source of charge during load transient conditions

- **Input Capacitor Selection**

The input supply voltage typically has high source impedance at the switching frequency. Good quality input capacitors are necessary to limit the ripple voltage at the VIN pin while supplying most of the switch current during the on-time. The input capacitor should be selected for RMS current rating and minimum ripple voltage

Package outline dimension



SOP16

