INTEGRATED CIRCUITS
UNITRODE

UC1525B UC1527B
UC2525B UC2527B
UC3525B UC3527B

Regulating Pulse Width Modulators

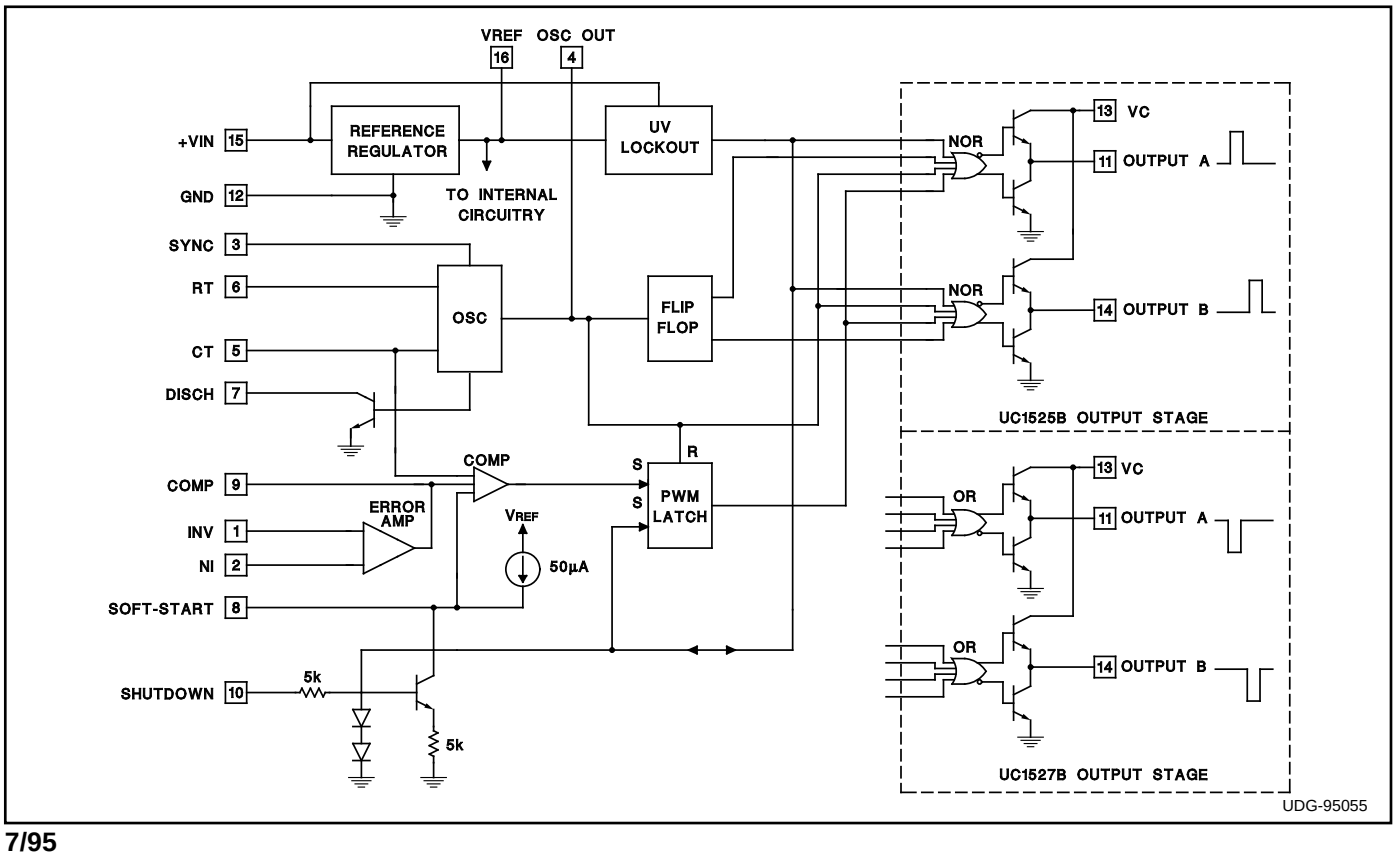
FEATURES

- 8 to 35V Operation
- 5.1V Buried Zener Reference Trimmed to ±0.75%
- 100Hz to 500kHz Oscillator Range
- Separate Oscillator Sync Terminal
- Adjustable Deadtime Control
- Internal Soft-Start
- Pulse-by-Pulse Shutdown
- Input Undervoltage Lockout with Hysteresis
- Latching PWM to Prevent Multiple Pulses
- Dual Source/Sink Output Drivers
- Low Cross Conduction Output Stage
- Tighter Reference Specifications

DESCRIPTION

The UC1525B/1527B series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip +5.1V buried zener reference is trimmed to ±0.75% and the input common-mode range of the error amplifier includes the reference voltage, eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the CT and the discharge terminals provide a wide range of dead time adjustment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuitry and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for sub-normal input voltages. This lockout circuitry includes approximately 500mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200mA. The UC1525B output stage features NOR logic, giving a LOW output for an OFF state. The UC1527B utilizes OR logic which results in a HIGH output level when OFF.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage, (+VIN) . . . . . .+40V
Collector Supply Voltage (VC) . . . . . .+40V
Logic Inputs . . . . . .–0.3V to +5.5V
Analog Inputs . . . . . .–0.3V to VIN
Output Current, Source or Sink 500mA
Reference Output Current 50mA
Oscillator Charging Current 5mA
Power Dissipation at T_A = +25°C 1000mW
Power Dissipation at T_C = +25°C 2000mW
Operating Junction Temperature . . . . . .–55°C to +150°C
Storage Temperature Range . . . . . .–65°C to +150°C
Lead Temperature (Soldering, 10 sec.) . . . . . .+300°C

All currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.

RECOMMENDED OPERATING CONDITIONS

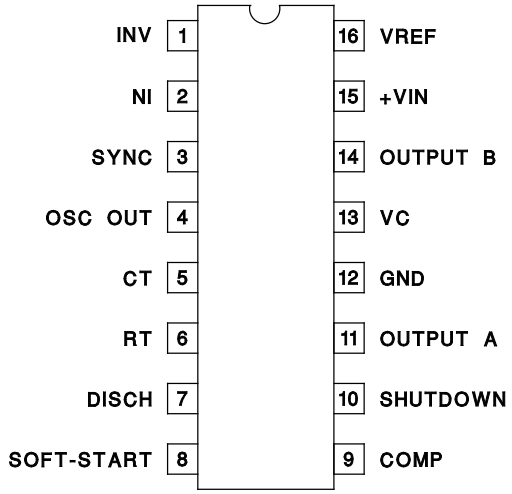
(Note 1)

Input Voltage (+VIN) . . . . . .+8V to +35V
Collector Supply Voltage (VC) . . . . . .+4.5V to +35V
Sink/Source Load Current (steady state) . . . . . .0 to 100mA
Sink/Source Load Current (peak) . . . . . .0 to 400mA
Reference Load Current . . . . . .0 to 20mA
Oscillator Frequency Range . . . . . .100Hz to 400kHz
Oscillator Timing Resistor . . . . . .2kΩ to 150kΩ
Oscillator Timing Capacitor . . . . . .0.001µF to 0.1µF
Dead Time Resistor Range . . . . . .0Ω to 500Ω

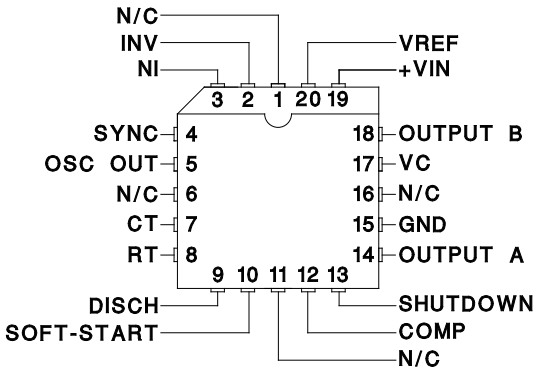
Note 1: Range over which the device is functional and parameter limits are guaranteed.

CONNECTION DIAGRAMS

DIL-16, SOIC-16 (Top View)
J or N Package, DW Package



PLCC-20, LCC-20 (Top View)
Q or L Package



ELECTRICAL CHARACTERISTICS Unless otherwise stated, these specifications apply for T_A = –55°C to +125°C for the UC1525B and UC1527B; –40°C to +85°C for the UC2525B and UC2527B; 0°C to +70°C for the UC3525B and UC3527B; +VIN = 20V, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1525B/UC2525B UC1527B/UC2527B			UC3525B UC3527B			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
Reference Section								
Output Voltage	T_J = 25°C	5.062	5.10	5.138	5.036	5.10	5.164	V
Line Regulation	VIN = 8V to 35V		5	10		5	10	mV
Load Regulation	I_L = 0mA to 20mA		7	15		7	15	mV
Temperature Stability (Note 2)	Over Operating Range		10	50		10	50	mV
Total Output Variation	Line, Load, and Temperature	5.036		5.164	5.024		5.176	V
Short Circuit Current	VREF = 0, T_J =25°C		80	100		80	100	mA
Output Noise Voltage (Note 2)	10Hz ≤ f ≤ 10kHz, T_J = 25°C		40	200		40	200	µVrms
Long Term Stability (Note 2)	T_J = 125°C, 1000 Hrs.		3	10		3	10	mV

ELECTRICAL CHARACTERISTICS (cont.) Unless otherwise stated, these specifications apply for T_A = –55°C to +125°C for the UC1525B and UC1527B; –40°C to +85°C for the UC2525B and UC2527B; 0°C to +70°C for the UC3525B and UC3527B; +VIN = 20V, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1525B/UC2525B UC1527B/UC2527B			UC3525B UC2527B			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
Oscillator Section (Note 3)								
Initial Accuracy (Notes 2 & 3)	T_J = 25°C		±2	±6		±2	±6	%
Voltage Stability (Notes 2 & 3)	VIN = 8V to 35V		±0.3	±1		±1	±2	%
Temperature Stability (Note 2)	Over Operating Range		±3	±6		±3	±6	%
Minimum Frequency	RT = 200kΩ, CT = 0.1µF			120			120	Hz
Maximum Frequency	RT = 2kΩ, CT = 470pF	400			400			kHz
Current Mirror	I_{RT} = 2mA	1.7	2.0	2.2	1.7	2.0	2.2	mA
Clock Amplitude (Notes 2 & 3)		3.0	3.5		3.0	3.5		V
Clock Width (Notes 2 & 3)	T_J = 25°C	0.3	0.5	1.0	0.3	0.5	1.0	µs
Sync Threshold		1.2	2.0	2.8	1.2	2.0	2.8	V
Sync Input Current	Sync Voltage = 3.5V		1.0	2.5		1.0	2.5	mA
Error Amplifier Section (VCM = 5.1V)								
Input Offset Voltage			0.5	5		2	10	mV
Input Bias Current			1	10		1	10	µA
Input Offset Current				1			1	µA
DC Open Loop Gain	RL ≥ 10 MegΩ	60	75		60	75		dB
Gain-Bandwidth Product (Note 2)	Av = 0dB, T_J = 25°C	1	2		1	2		MHz
Output Low Level			0.2	0.5		0.2	0.5	V
Output High Level		3.8	5.6		3.8	5.6		V
Common Mode Rejection	V_{CM} = 1.5V to 5.2V	60	75		60	75		dB
Supply Voltage Rejection	VIN = 8V to 35V	50	60		50	60		dB
PWM Comparator								
Minimum Duty Cycle				0			0	%
Maximum Duty Cycle		45	49		45	49		%
Input Threshold (Note 3)	Zero Duty Cycle	0.7	0.9		0.7	0.9		V
Input Threshold (Note3)	Maximum Duty Cycle		3.3	3.6		3.3	3.6	V
Input Bias Current (Note 2)			0.05	1.0		0.05	1.0	µA
Shutdown Section								
Soft Start Current	$V_{SHUTDOWN}$ = 0V, $V_{SOFTSTART}$ = 0V	25	50	80	25	50	80	µA
Soft Start Low Level	$V_{SHUTDOWN}$ = 2.5V		0.4	0.7		0.4	0.7	V
Shutdown Threshold	To outputs, $V_{SOFTSTART}$ = 5.1V, T_J =25°C	0.6	0.8	1.0	0.6	0.8	1.0	V
Shutdown Input Current	$V_{SHUTDOWN}$ = 2.5V		0.4	1.0		0.4	1.0	mA
Shutdown Delay (Note 2)	$V_{SHUTDOWN}$ = 2.5V, T_J = 25°C		0.2	0.5		0.2	0.5	µs
Output Drivers (Each Output) (VC = 20V)								
Output Low Level	I_{SINK} = 20mA		0.2	0.4		0.2	0.4	V
	I_{SINK} = 100mA		1.0	2.0		1.0	2.0	V
Output HIgh Level	I_{SOURCE} = 20mA	18	19		18	19		V
	I_{SOURCE} = 100mA	17	18		17	18		V
Undervoltage Lockout	V_{COMP} and $V_{SOFTSTART}$ = High	6	7	8	6	7	8	V
Collector Leakage	VC = 35V			200			200	µA

ELECTRICAL CHARACTERISTICS (cont.) Unless otherwise stated, these specifications apply for T_A = –55°C to +125°C for the UC1525B and UC1527B; –40°C to +85°C for the UC2525B and UC2527B; 0°C to +70°C for the UC3525B and UC3527B; +VIN = 20V, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1525B/UC2525B UC1527B/UC2527B			UC3525B UC2527B			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
Output Drivers (Each Output) (VC = 20V) (cont.)								
Rise Time (Note 2)	C_L = 1nF, T_J = 25°C		100	600		100	600	ns
Fall Time (Note 2)	C_L = 1nF, T_J = 25°C		50	300		50	300	ns
Cross conduction charge	Per cycle, T_J = 25°C		30			30		nc
Total Standby Current								
Supply Current	VIN = 35V		14	20		14	20	mA

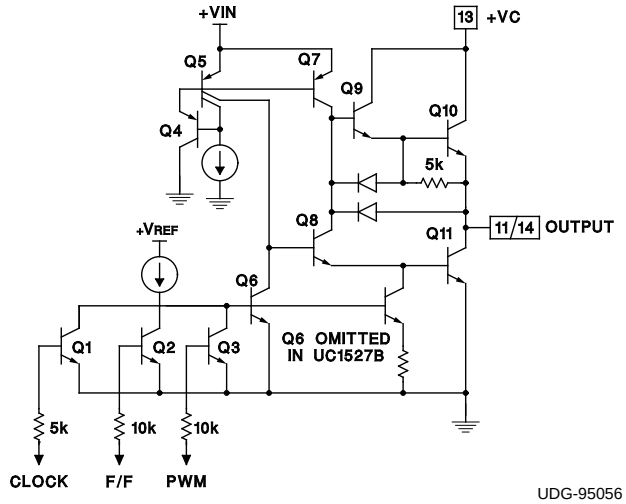
Note 2: Guaranteed by design. Not 100% tested in production.

Note 3. Tested at fosc= 40kHz (R_T = 3.6Ω, C_T = 0.01μF, R_D = 0Ω). Approximate oscillator frequency is defined by:

$$f = \frac{1}{C_T \bullet (0.7 \bullet R_T + 3R_D)}$$

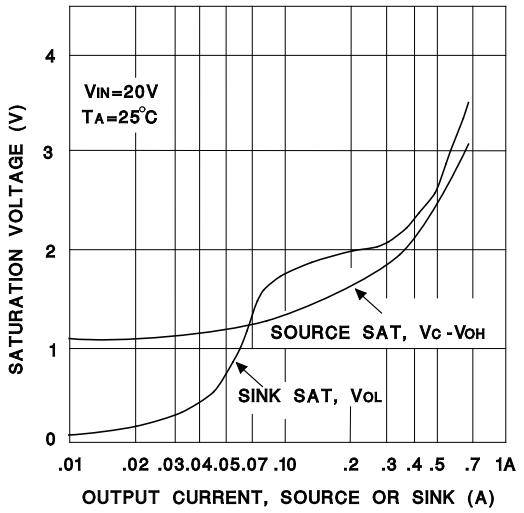
PRINCIPLES OF OPERATION AND TYPICAL CHARACTERISTICS

UC1525B Output Circuit (1/2 Circuit Shown)

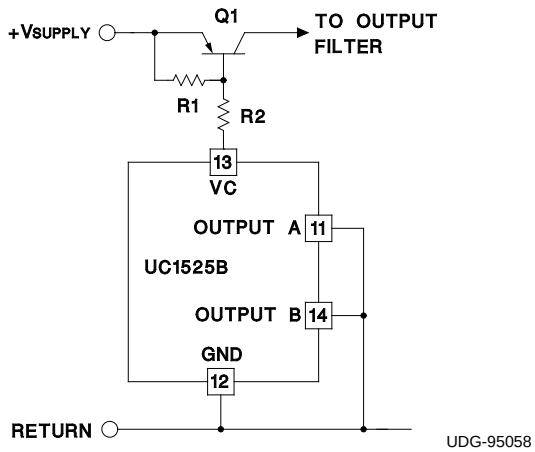


UDG-95056

UC1525B Output Saturation Characteristics

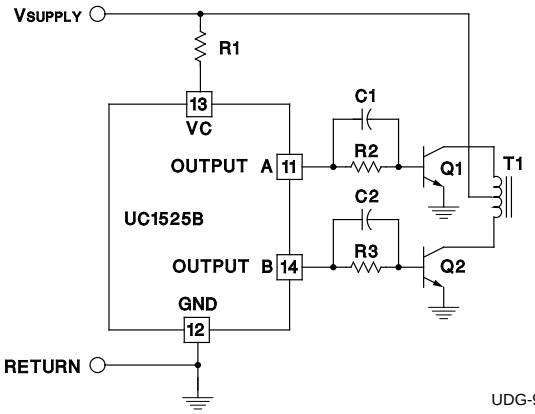


UDG-95057



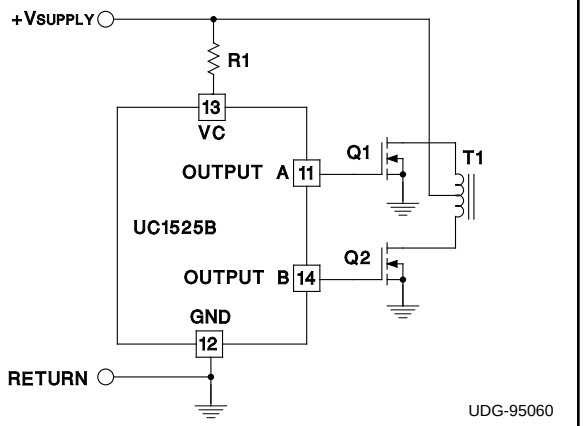
UDG-95058

For single-ended supplies, the driver outputs are grounded. The VC terminal is switched to ground by the totem-pole source transistors on alternate oscillator cycles.

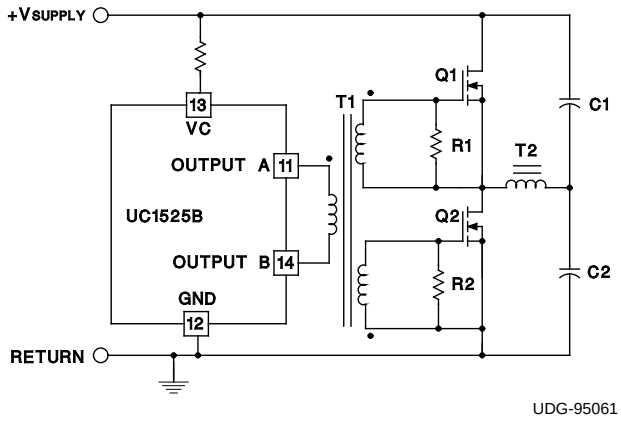


UDG-95059

In conventional push-pull bipolar designs, forward base drive is controlled by R1-R3. Rapid turn-off times for the power devices are achieved with speed-up capacitors C, and C2.



The low source impedance of the output drivers provides rapid charging of power FET input capacitance while minimizing external components.



Low power transformers can be driven directly by the UC1525B. Automatic reset occurs during dead time, when both ends of the primary winding are switched to ground.

PRINCIPLES OF OPERATION AND TYPICAL CHARACTERISTICS

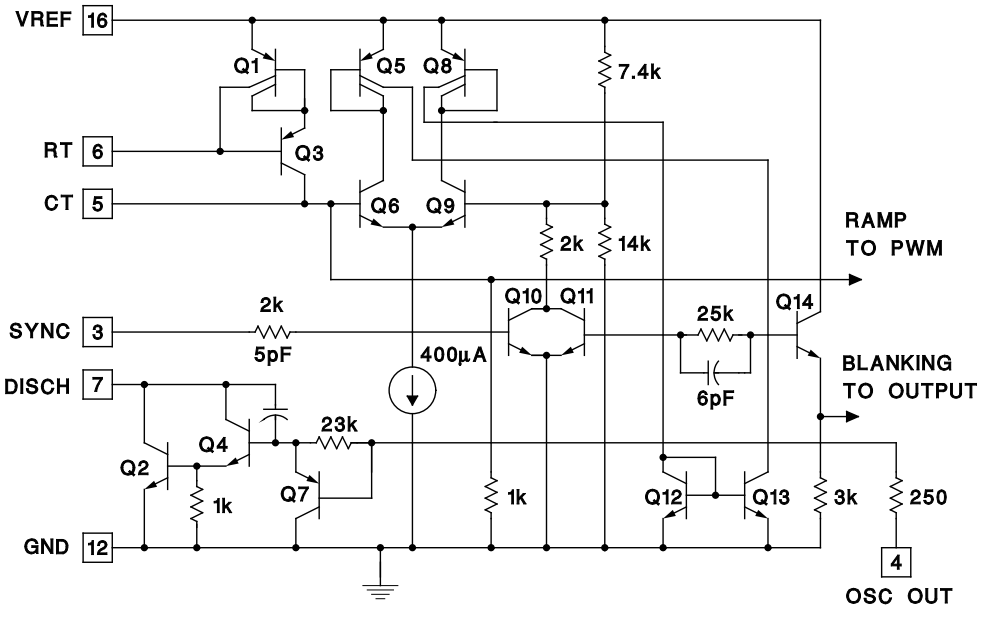
Shutdown Options (See Block Diagram)

Since both the compensation and soft-start terminals (Pins 9 and 8) have current source pull-ups, either can readily accept a pull-down signal which only has to sink a maximum of 100µA to turn off the outputs. This is subject to the added requirement of discharging whatever external capacitance may be attached to these pins.

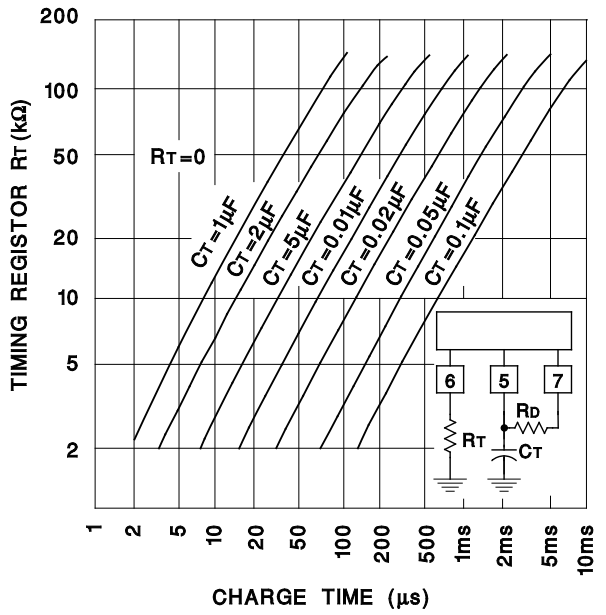
An alternate approach is the use of the shutdown circuitry of Pin 10 which has been improved to enhance the available shutdown options. Activating this circuit by applying a positive signal on Pin 10 performs two functions: the PWM latch is immediately set providing the fastest turn-off signal to the external soft-start capacitor. If the shutdown command is short, the PWM signal is terminated without significant discharge of the soft-start capacitor, thus, allowing, for example, a convenient implementation of pulse-by-pulse current limiting. Holding Pin 10 high for a longer duration, however, will ultimately discharge this external capacitor, recycling slow turn-on upon release.

Pin 10 should not be left floating as noise pickup could conceivably interrupt normal operation.

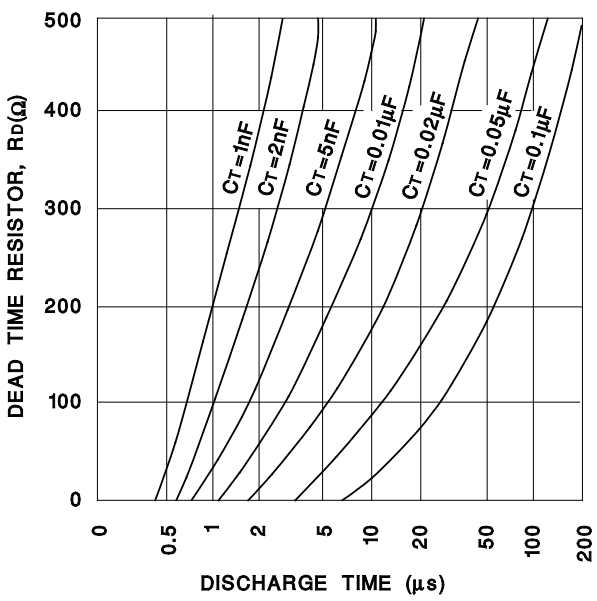
UC1525B Oscillator Schematic



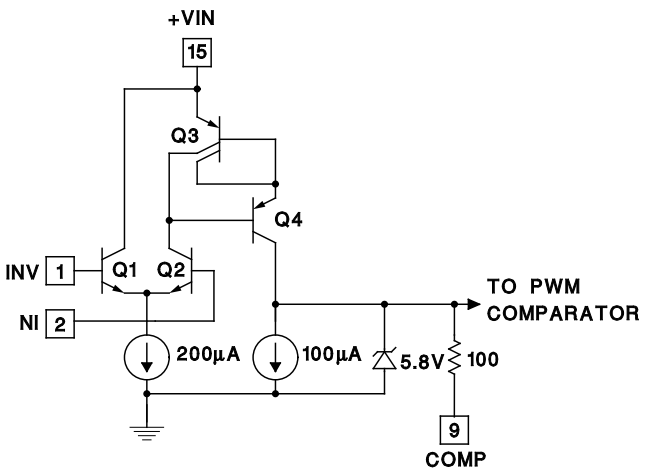
Oscillator Charge Time vs. R_T and C_T



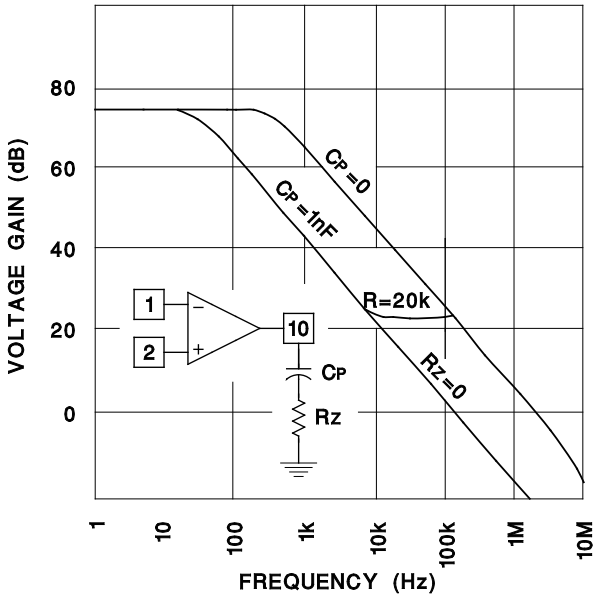
Oscillator Discharge Time vs. R_D and C_T



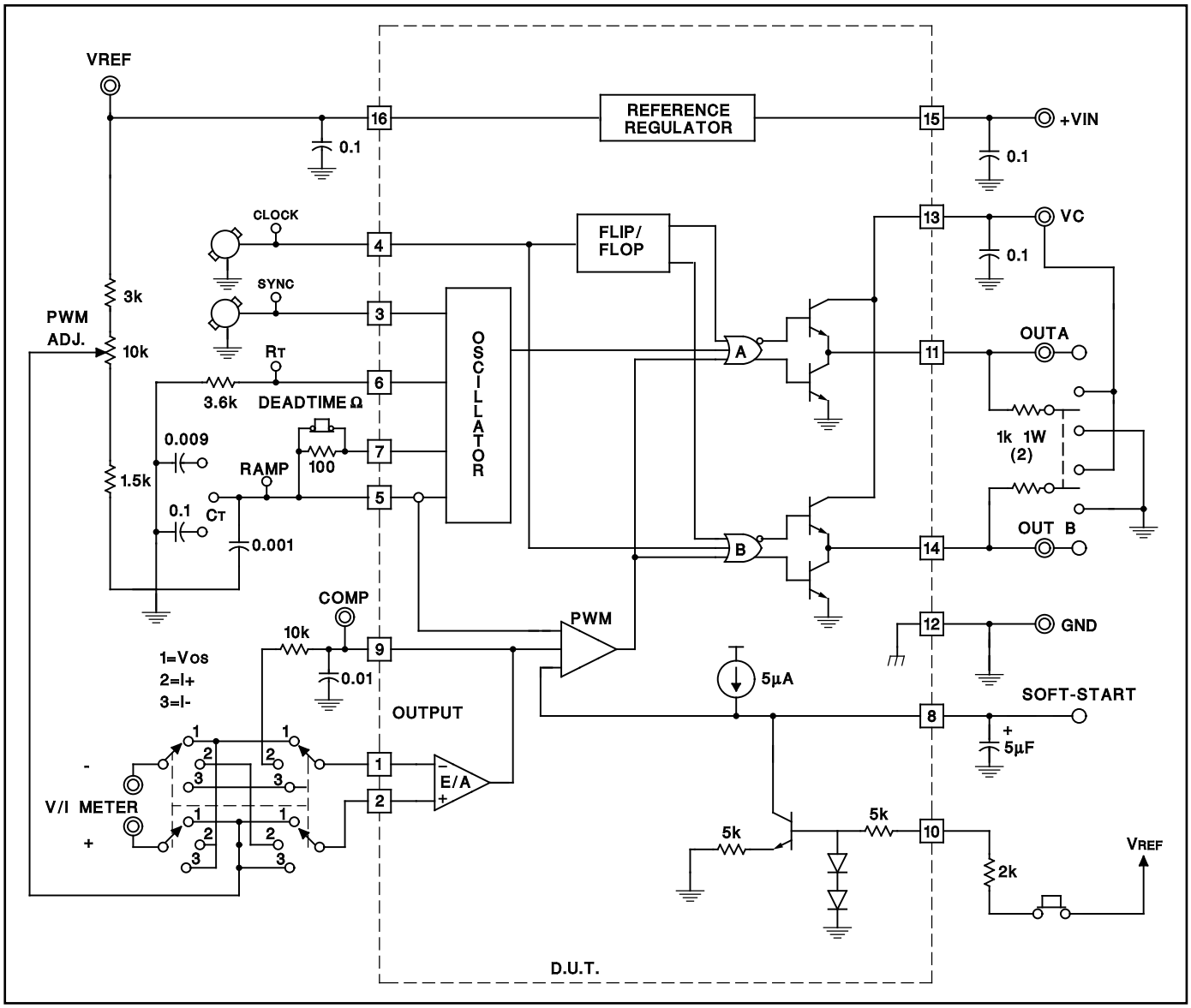
UC1525B Error Amplifier



Error Amplifier Open-Loop Frequency Response



LAB TEST FIXTURE



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UC1525B, REGULATING PULSE WIDTH MODULATORS

Device Status: Active

Parameter Name	UC1525B
Shutdown	Yes
Pulse - by - Pulse Isense	No
Vsupply Operating Range (V)	8 - 35
Output Type	Dual Alternating, Totem Pole
Output Current (mA)	200
Frequency (max) (kHz)	500
Reference Voltage (V)	5.1
Vref tol (%)	0.75
Duty Cycle (max) (%)	50/50
Undervoltage Lockout	Yes
On-board Amplifiers	1
Output Mode Fixed Push - Pull	Yes
Output Mode Single - Ended	No
Programmable Outputs	No
Dead Time Control	Yes

Description

The UC1525B/1527B series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip +5.1V buried zener reference is trimmed to ±0.75% and the input common-mode range of the error amplifier includes the reference voltage, eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the CT and the discharge terminals provide a wide range of dead time adjustment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuitry and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for subnormal input voltages. This lockout circuitry includes approximately 500mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200mA. The UC1525B output stage features NOR logic, giving a LOW output for an OFF state. The UC1527B utilizes OR logic which results in a HIGH output level when OFF.

Features

- 8 to 35V Operation
- 5.1V Buried Zener Reference Trimmed to ±0.75%
- 100Hz to 500kHz Oscillator Range
- Separate Oscillator Sync Terminal
- Adjustable Deadtime Control
- Internal Soft-Start
- Pulse-by-Pulse Shutdown
- Input Undervoltage Lockout with Hysteresis
- Latching PWM to Prevent Multiple Pulses
- Dual Source/Sink Output Drivers
- Low Cross Conduction Output Stage
- Tighter Reference Specifications

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Datasheets

Full datasheet in Acrobat PDF: slus376.pdf (530 KB)

Pricing/Samples/Availability

Orderable Device	Package	Pins	Temp (°C)	Status	Price/unit USD (100-999)	Pack Qty	DSCC Number	Availability / Samples
UC1525BJ	UTR	16	-55 TO 125	ACTIVE	15.75	1		Check stock or order
UC1525BJ883B	UTR	16	-55 TO 125	ACTIVE	20.36	1		Check stock or order

Application Reports

- ANALOG APPLICATIONS JOURNAL, FEBRUARY 2000 (SLYT012A - Updated: 03/23/2000)
- ANALOG APPLICATIONS JOURNAL, NOVEMBER 1999 (SLYT010A - Updated: 03/23/2000)
- DN-36 UC1525B/UC1527B DEVICES - COMPARISON SUMMARY TO UC1525A/27A DEVICES (SLUA170 - Updated: 11/04/1999)
- ELECTROSTATIC DISCHARGE APPLICATION NOTE (SSYA008 - Updated: 05/05/1999)
- THERMAL CHARACTERISTICS OF LINEAR AND LOGIC PACKAGES USING JEDEC PCB DESIGNS (SZZA017A - Updated: 09/15/1999)

Table Data Updated on: 6/8/2000

UC1526A, REGULATING PULSE WIDTH MODULATORS

Device Status: Active

Parameter Name	UC1526A
Shutdown	Yes
Pulse - by - Pulse Isense	No
Vsupply Operating Range (V)	7 - 35
Output Type	Dual Alternating, Totem Pole
Output Current (mA)	200
Frequency (max) (kHz)	600
Reference Voltage (V)	5
Vref tol (%)	1
Duty Cycle (max) (%)	50/50
Undervoltage Lockout	Yes
On-board Amplifiers	1
Output Mode Fixed Push - Pull	Yes
Output Mode Single - Ended	No
Programmable Outputs	No
Current - Sense Amplifiers	1
Dead Time Control	Yes

Description

The UC1526A Series are improved-performance pulse-width modulator circuits intended for direct replacement of equivalent non- “A” versions in all applications. Higher frequency operation has been enhanced by several significant improvements including: a more accurate oscillator with less minimum dead time, reduced circuit delays (particularly in current limiting), and an improved output stage with negligible cross-conduction current. Additional improvements include the incorporation of a precision, band-gap reference generator, reduced overall supply current, and the addition of thermal shutdown protection.

Along with these improvements, the UC1526A Series retains the protective features of under-voltage lockout, soft-start, digital current limiting, double pulse suppression logic, and adjustable deadtime. For ease of interfacing, all digital control ports are TTL compatible with active low logic.

Five volt (5V) operation is possible for “logic level” applications by connecting V_{IN}, V_C and V_{REF} to a precision 5V input supply. Consult factory for additional information.

Features

- Reduced Supply Current
- Oscillator Frequency to 600kHz
- Precision Band-Gap Reference
- 7 to 35V Operation
- Dual 200mA Source/Sink Outputs
- Minimum Output Cross-Conduction
- Double-Pulse Suppression Logic
- Under-Voltage Lockout
- Programmable Soft-Start
- Thermal Shutdown
- TTL/CMOS Compatible Logic Ports
- 5 Volt Operation ($V_{IN} = V_C = V_{REF} = 5.0V$)

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Datasheets

Full datasheet in Acrobat PDF: slus187.pdf (575 KB)

Pricing/Samples/Availability

Orderable Device	Package	Pins	Temp (°C)	Status	Price/unit USD (100-999)	Pack Qty	DSCC Number	Availability / Samples
85515022A	L	20	-55 TO 125	ACTIVE	44.76	1		Check stock or order
8551502VA	J	18	-55 TO 125	ACTIVE	19.06	1		Check stock or order
UC1526AJ	UTR	18	-55 TO 125	ACTIVE	13.28	1		Check stock or order
UC1526AJ883B	UTR	18	-55 TO 125	ACTIVE	19.06	1	5962-8992002VA	Check stock or order
UC1526AL	UTR	20	-55 TO 125	ACTIVE	29.29	1		Check stock or order
UC1526AL883B	UTR	20	-55 TO 125	ACTIVE	44.76	1	5962-8670406XA	Check stock or order

Application Reports

- ANALOG APPLICATIONS JOURNAL, FEBRUARY 2000 (SLYT012A - Updated: 03/23/2000)
- ANALOG APPLICATIONS JOURNAL, NOVEMBER 1999 (SLYT010A - Updated: 03/23/2000)
- ELECTROSTATIC DISCHARGE APPLICATION NOTE (SSYA008 - Updated: 05/05/1999)
- THERMAL CHARACTERISTICS OF LINEAR AND LOGIC PACKAGES USING JEDEC PCB DESIGNS (SZZA017A - Updated: 09/15/1999)

Table Data Updated on: 6/11/2000