

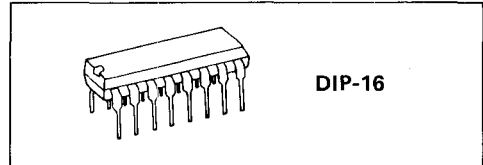
REGULATING PULSE WIDTH MODULATORS

- 8 to 35V OPERATION
- 5.1V REFERENCE TRIMMED TO $\pm 1\%$
- 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

The SG1525A/1527A 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 reference is trimmed to $\pm 1\%$ 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 C_T and the discharge terminals provide a wide range of dead time adjustment. These devices also feature built-in soft-start circuitry

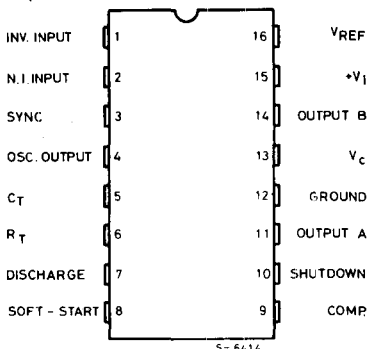
with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuitry and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled 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 SG1525A output stage features NOR logic, giving a LOW output for an OFF state. The SG1527A utilizes OR logic which results in a HIGH output level when OFF.



CONNECTION DIAGRAM AND ORDERING NUMBERS

(top view)



Type	Plastic DIP	Ceramic DIP
SG1525A	—	SG1525AJ
SG1527A	—	SG1527AJ
SG2525A	SG2525AN	SG2525AJ
SG2527A	SG2527AN	SG2527AJ
SG3525A	SG3525AN	SG3525AJ
SG3527A	SG3527AN	SG3527AJ

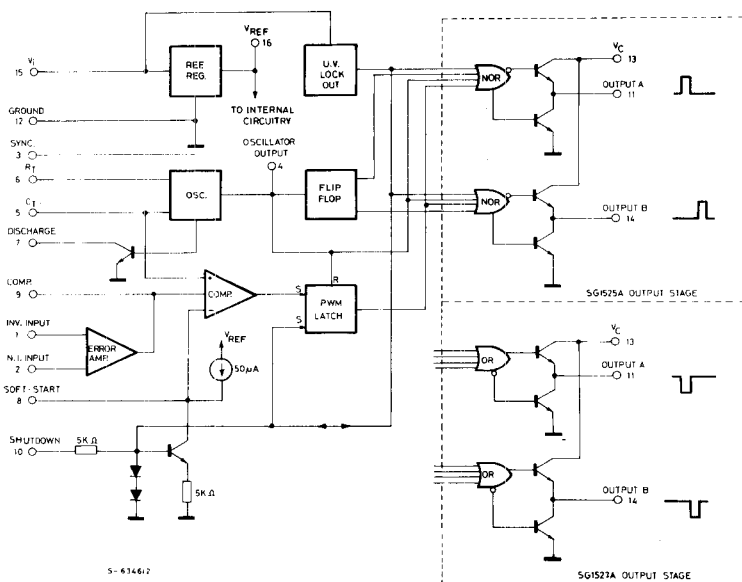
ABSOLUTE MAXIMUM RATINGS

V_I	Supply voltage	40	V
V_C	Collector supply voltage	40	V
I_{OSC}	Oscillator charging current	5	mA
I_o	Output current, source or sink	500	mA
I_R	Reference output current	50	mA
I_T	Current through C_T terminal	5	mA
	Logic inputs	-0.3 to + 5.5	V
	Analog inputs	-0.3 to V_I	V
P_{tot}	Total power dissipation at $T_{amb} = 70^\circ\text{C}$	1000	mW
T_j	Junction temperature range	-55 to 150	$^\circ\text{C}$
T_{stg}	Storage temperature range	-65 to 150	$^\circ\text{C}$
T_{op}	Operating ambient temperature: SG1525A/27A	-55 to 125	$^\circ\text{C}$
	SG2525A/27A	-25 to 85	$^\circ\text{C}$
	SG3525A/27A	0 to 70	$^\circ\text{C}$

THERMAL DATA

$R_{th\ J-amb}$	Thermal resistance junction-ambient	max	80 $^\circ\text{C/W}$
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BLOCK DIAGRAM





ELECTRICAL CHARACTERISTICS ($V_I = 20V$, and over operating temperature, unless otherwise specified)

Parameter	Test conditions	SG1525A/2525A SG1527A/2527A			SG3525A SG3527A			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	

REFERENCE SECTION

V_{REF}	Output voltage	$T_J = 25^\circ C$	5.05	5.1	5.15	5	5.1	5.2	V
ΔV_{REF}	Line regulation	$V_I = 8$ to 35V		10	20		10	20	mV
ΔV_{REF}	Load regulation	$I_L = 0$ to 20 mA		20	50		20	50	mV
$\Delta V_{REF}/\Delta T^*$	Temp. stability	Over operating range		20	50		20	50	mV
*	Total output variation	Line, load and temperature	5		5.2	4.95		5.25	V
	Short circuit current	$V_{REF} = 0$ $T_J = 25^\circ C$		80	100		80	100	mA
*	Output noise voltage	$10Hz \leq f \leq 10kHz$, $T_J = 25^\circ C$		40	200		40	200	μV_{rms}
ΔV_{REF}^*	Long term stability	$T_J = 125^\circ C$, 1000 hrs		20	50		20	50	mV

OSCILLATOR SECTION**

*, •	Initial accuracy	$T_J = 25^\circ C$		± 2	± 6		± 2	± 6	%
*, •	Voltage stability	$V_I = 8$ to 35V		± 0.3	± 1		± 1	± 2	%
$\Delta f/\Delta T^*$	Temp. stability	Over operating range		± 3	± 6		± 3	± 6	%
f_{MIN}	Minim. frequency	$R_T = 200 K\Omega$ $C_T = 0.1 \mu F$			120			120	Hz
f_{MAX}	Maxim. frequency	$R_T = 2 K\Omega$ $C_T = 470 pF$	400			400			KHz
	Current mirror	$I_{RT} = 2$ mA	1.7	2	2.2	1.7	2	2.2	mA
*, •	Clock amplitude		3	3.5		3	3.5		V
*, •	Clock width	$T_J = 25^\circ C$	0.3	0.5	1	0.3	0.5	1	μs
	Sync threshold		1.2	2	2.8	1.2	2	2.8	V
	Sync input current	Sync voltage = 3.5V		1	2.5		1	2.5	mA

ERROR AMPLIFIER SECTION ($V_{CM} = 5.1V$)

V_{OS}	Input offset voltage		0.5	5		2	10	mV
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ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	SG 1525A/2525A SG 1527A/2527A			SG 3525A SG 3527A			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
I_b Input bias current			1	10		1	10	μA
I_{os} Input offset current				1			1	μA
DC open loop gain	$R_L \geq 10 M\Omega$	60	75		60	75		dB
* Gain bandwidth product	$G_V = 0 \text{ dB}$ $T_J = 25^\circ C$	1	2		1	2		MHz
* , ■ DC transconduc.	$30K\Omega \leq R_L \leq 1M\Omega$ $T_J = 25^\circ C$	1.1	1.5		1.1	1.5		mS
Output low level			0.2	0.5		0.2	0.5	V
Output high level		3.8	5.6		3.8	5.6		V
CMR Comm. mode rejec.	$V_{CM} = 1.5 \text{ to } 5.2V$	60	75		60	75		dB
PSR Supply voltage rejection	$V_I = 8 \text{ to } 35V$	50	60		50	60		dB

PWM COMPARATOR

Minim. duty-cycle				0			0	%
Maxim. duty-cycle		45	49		45	49		%
• Input threshold	Zero duty-cycle	0.7	0.9		0.7	0.9		V
	Maximum duty-cycle		3.3	3.6		3.3	3.6	V
* Input bias current			0.05	1		0.05	1	μA

SHUTDOWN SECTION

Soft start current	$V_{SD} = 0V$, $V_{SS} = 0V$	25	50	80	25	50	80	μA
Soft start low level	$V_{SD} = 2.5V$		0.4	0.7		0.4	0.7	V
Shutdown threshold	To outputs, $V_{SS} = 5.1V$ $T_J = 25^\circ C$	0.6	0.8	1	0.6	0.8	1	V
Shutdown input current	$V_{SD} = 2.5V$		0.4	1		0.4	1	mA
* Shutdown delay	$V_{SD} = 2.5V$ $T_J = 25^\circ C$		0.2	0.5		0.2	0.5	μs

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	SG1525A/2525A SG1527A/2527A			SG3525A SG3527A			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	

OUTPUT DRIVERS (Each output) ($V_C = 20V$)

Output low level	$I_{sink} = 20\text{ mA}$		0.2	0.4		0.2	0.4	V
	$I_{sink} = 100\text{ mA}$		1	2		1	2	V
Output high level	$I_{source} = 20\text{ mA}$	18	19		18	19		V
	$I_{source} = 100\text{ mA}$	17	18		17	18		V
Under-voltage lockout	V_{comp} and $V_{SS} = \text{high}$	6	7	8	6	7	8	V
I_C	Collector leakage			200			200	μA
t_r^*	Rise time	$C_L = 1\text{ nF}$, $T_J = 25^\circ\text{C}$	100	600		100	600	ns
t_f^*	Fall time	$C_L = 1\text{ nF}$, $T_J = 25^\circ\text{C}$	50	300		50	300	ns

TOTAL STANDBY CURRENT

I_S	Supply current	$V_I = 35V$		14	20		14	20	mA
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* These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.

• Tested at $f_{osc} = 40\text{ KHz}$ ($R_T = 3.6\text{ K}\Omega$, $C_T = 0.1\text{ }\mu\text{F}$, $R_D = 0\Omega$). Approximate oscillator frequency is defined by:

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

■ DC transconductance (g_M) relates to DC open-loop voltage gain (G_V) according to the following equation: $G_V = g_M R_L$ where R_L is the resistance from pin 9 to ground. The minimum g_M specification is used to calculate minimum G_V when the error amplifier output is loaded.

RECOMMENDED OPERATING CONDITIONS (●)

Input voltage (V_I)	8 to 35 V
Collector supply voltage (V_C)	4.5 to 35 V
Sink/source load current (steady state)	0 to 100 mA
Sink/source load current (peak)	0 to 400 mA
Reference load current	0 to 20 mA
Oscillator frequency range	100 Hz to 400 KHz
Oscillator timing resistor	2 K Ω to 150 K Ω
Oscillator timing capacitor	0.001 μF to 0.1 μF
Dead time resistor range	0 to 500 Ω

(●) Range over which the device is functional and parameter limits are guaranteed.

TEST CIRCUIT

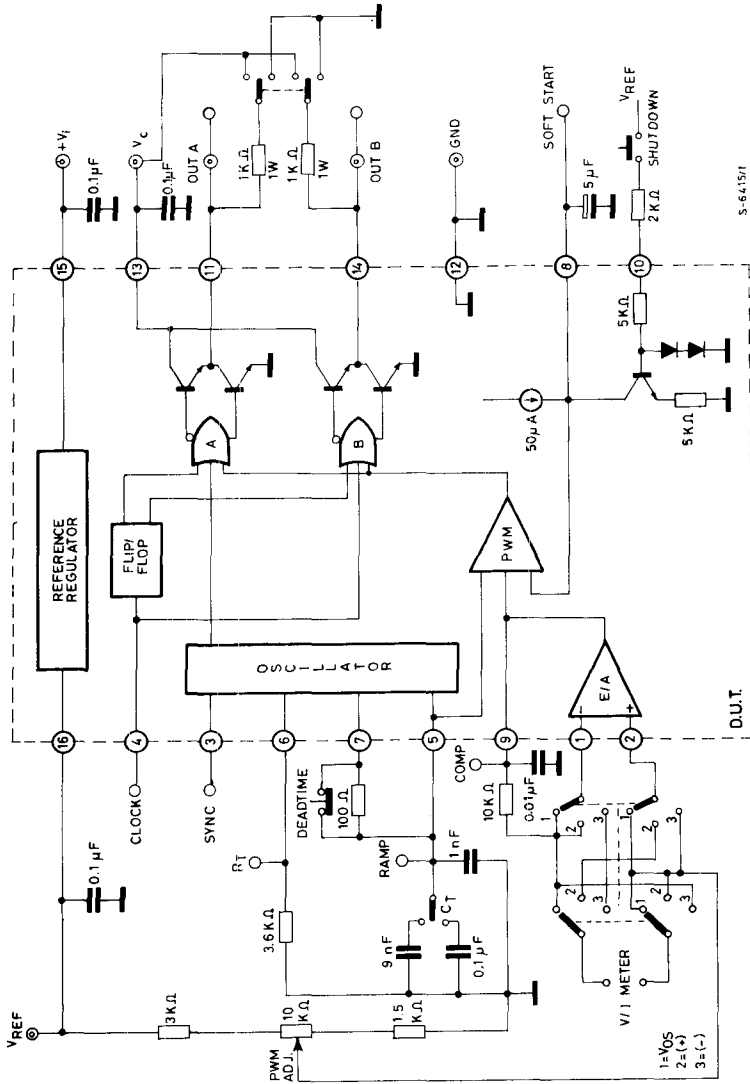
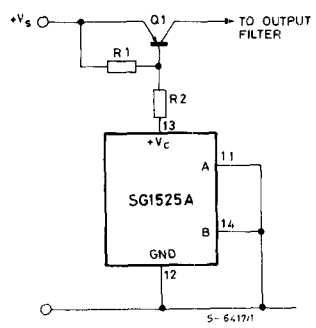
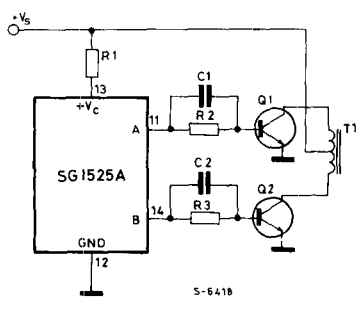


Fig. 7



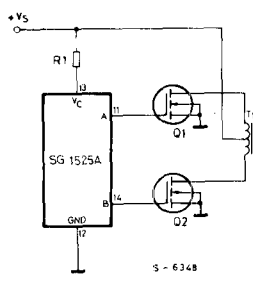
For single-ended supplies, the driver outputs are grounded. The V_c terminal is switched to ground by the totem-pole source transistors on alternate oscillator cycles.

Fig. 8



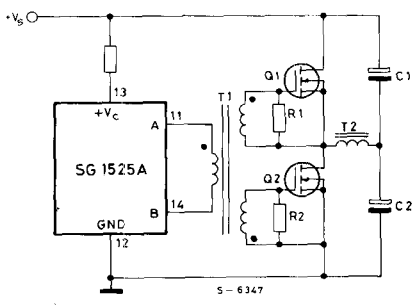
In conventional push-pull bipolar designs, forward base drive is controlled by R_1 - R_3 . Rapid turn-off times for the power devices are achieved with speed-up capacitors C_1 and C_2 .

Fig. 9



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

Fig. 10



Low power transformers can be driven directly by the SG1525A. Automatic reset occurs during dead time, when both ends of the primary winding are switched to ground.

Fig. 6 - SG1525A oscillator schematic

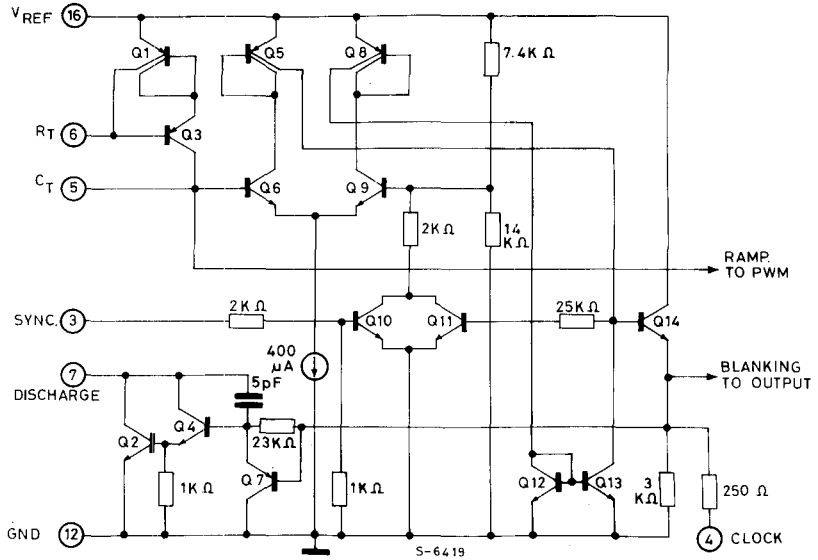


Fig. 7 - SG1525A output circuit (1/2 circuit shown)

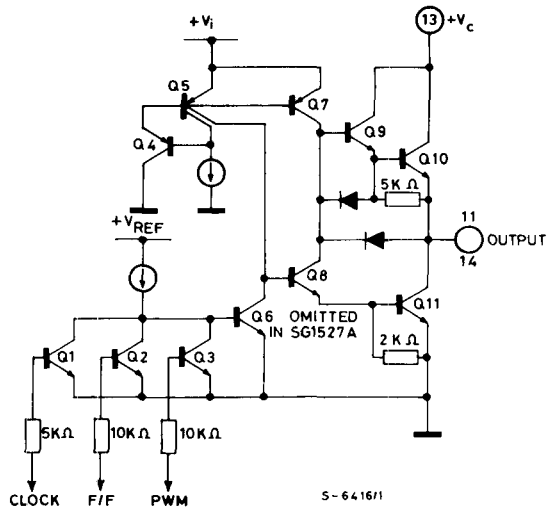


Fig. 1 - Oscillator charge time vs. R_T and C_T

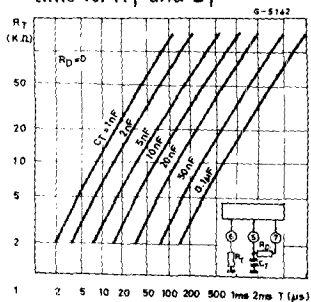


Fig. 2 - Oscillator discharge time vs. R_D and C_T

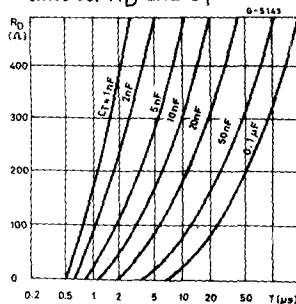


Fig. 3 - SG1525A output saturation characteristics

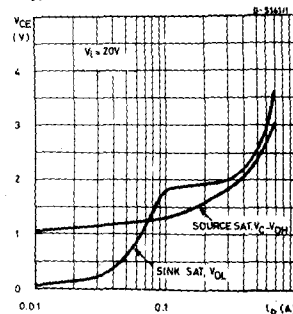


Fig. 4 - Error amplifier voltage gain and phase vs. frequency

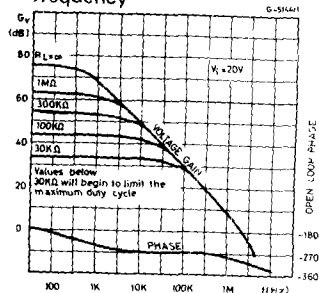
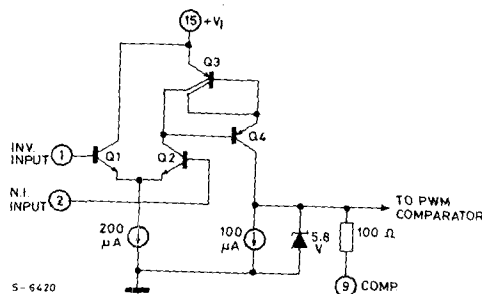


Fig. 5 - SG1525A error amplifier



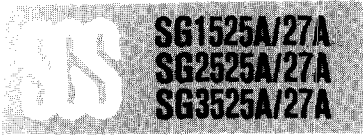
PRINCIPLES OF OPERATION

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 100 μA to turn off the outputs. This is subject to the added requirement of discharging whatever external capacitance may be attached to these pins.

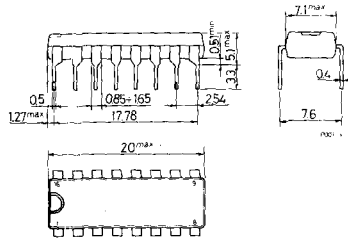
An alternate approach is the use of the shutdown circuitry of Pin 10 which has been improved to enhance the available shutdown options. Activating this circuit by applying a positive signal on Pin 10 performs two functions: the PWM latch is

immediately set providing the fastest turn-off signal to the outputs; and a 150 μA current sink begins to discharge 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

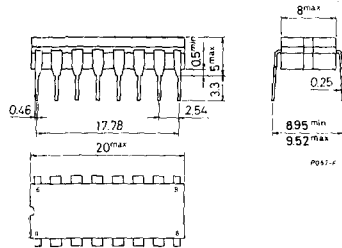


MECHANICAL DATA (Dimensions in mm)

DIP-16 (Plastic)



DIP-16 (Ceramic)



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