

SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

SE/NE5561

DESCRIPTION

The NE5561/SE5561 is a control circuit for use in switched mode power supplies. It contains an internal temperature compensated supply, PWM, sawtooth oscillator, over-current sense latch, and output stage. The device is intended for low cost SMPS applications where extensive housekeeping functions are not required.

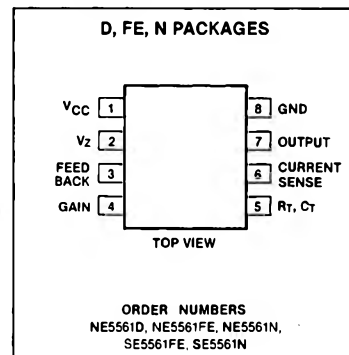
FEATURES

- Micro-miniature (D) package
- Pulse-width modulator
- Current limiting (cycle by cycle)
- Sawtooth generator
- Stabilized power supply
- Double pulse protection
- Internal temperature compensated reference

APPLICATIONS

- Switched mode power supplies
- D/C motor controller inverter
- DC/DC converter

PIN CONFIGURATION

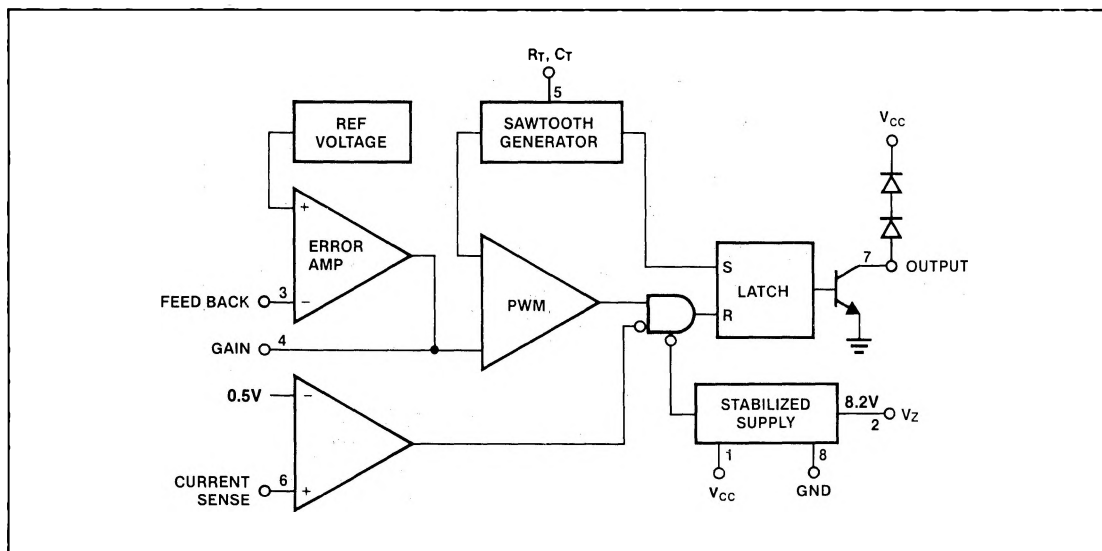


ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNIT
Supply ¹		
Voltage forced mode	+ 18	V
Current fed mode	30	mA
Output transistor (at 20-30V max)		
Output current	40	mA
Output voltage	$V_{CC} + 1.4V$	V
Output duty cycle	98	%
Max. total power dissipation	0.75	W
Operating temperature range		
SE5561	- 55 to + 125	°C
NE5561	0 to 70	°C

NOTE 1: See Voltage/Current fed supply characteristic curve.

BLOCK DIAGRAM



SWITCHED-MODE POWER SUPPLY CONTROL CIRCUIT

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DC ELECTRICAL CHARACTERISTICS $V_{CC} = 12V$, $T_A = 25^\circ C$ unless otherwise specified.

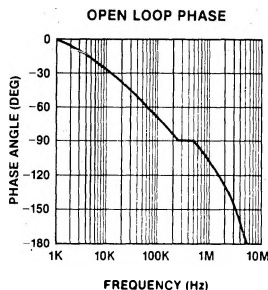
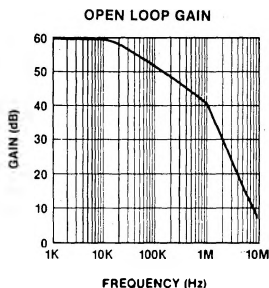
SYMBOL AND PARAMETER	TEST CONDITIONS	SE5561			NE5561			UNIT	
		Min	Typ	Max	Min	Typ	Max		
REFERENCE SECTION									
V _{REF} Internal ref voltage	T _A = 25°C	3.69	3.75	3.84	3.57	3.75	3.96	V	
	Over temp.	3.65		3.88	3.55		3.98	V	
V _Z , Internal zener ref	*I _L = 7mA	7.8	8.2	8.8	7.8	8.2	8.8	V	
Temp coefficient of V _{REF}			± 100			± 100		ppm/°C	
Temp. coefficient of V _Z			± 200			± 200		ppm/°C	
OSCILLATOR SECTION									
Frequency range	Over temp.	50		100k	50		100k	Hz	
Initial accuracy			12			12		%	
Duty cycle range	f _o = 20kHz	0		98	0		98	%	
CURRENT LIMITING (I _{IN})									
	Pin 6 = 250mV	T _A = 25°C		– 2	– 10		– 2	– 10	μA
		Over temp.			– 20			– 20	μA
Single pulse inhibit delay	Inhibit delay time for 20% overdrive at	I _{OUT} = 20mA		0.88	1.10		0.88	1.10	μs
		I _{OUT} = 40mA		0.7	0.8		0.7	0.8	μs
Current limit trip level		.400	.500	.600	.400	.500	.600	V	
ERROR AMPLIFIER									
Open loop gain			60			60		dB	
Feedback resistor		10k			10k			Ω	
Small signal bandwidth			3			3		MHz	
Output voltage swing (V _{OH})		6.2			6.2			V	
Output voltage swing (V _{OL})				0.7			0.7	V	
OUTPUT STAGE									
Output current	Over temp.	20			20			mA	
V _{ce} Sat	I _C = 20mA, Over temp.			0.4			0.4	V	
SUPPLY VOLTAGE/CURRENT									
I _{CC}	I _Z = 0, voltage forced	T _A = 25°C			10.0			10.0	mA
		Over temp.			13.0			13.0	mA
V _{CC}	I _{CC} = 10mA, current fed	20.0	21.0	22.0	19.0	21.0	24.0	V	
	I _{CC} = 30mA current	20.0		30.0	20.0		30.0	V	
LOW SUPPLY PROTECTION									
Pin 1 threshold		8	9	10.5	8	9	10.5	V	

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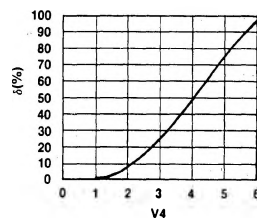
SE/NE5561

TYPICAL PERFORMANCE CHARACTERISTICS

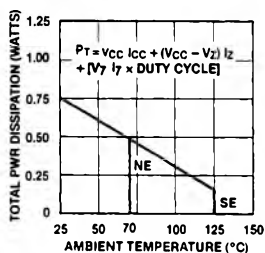
ERROR AMPLIFIER



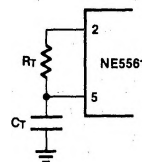
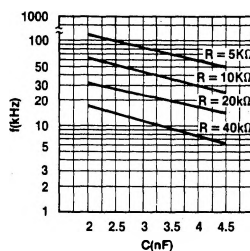
TRANSFER CURVE OF PULSE-WIDTH MODULATOR DUTY CYCLE VS INPUT VOLTAGE



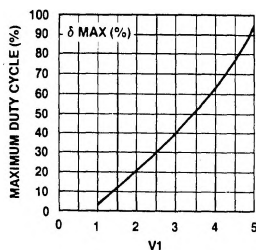
POWER DERATING CURVE



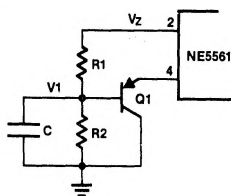
TYPICAL FREQUENCY PLOT VS R_T AND C_T



MAXIMUM DUTY CYCLE VS BASE VOLTAGE ON Q1

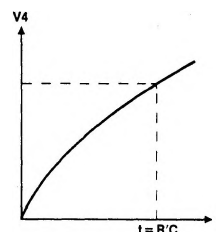


START-UP CIRCUIT



$$\delta \text{ max is a function of } t \left[\frac{R_2}{R_1 + R_2} V_Z + V_{BE Q1} \right]$$

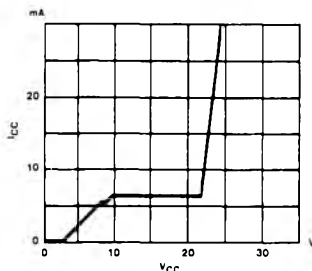
SLOW START VOLTAGE



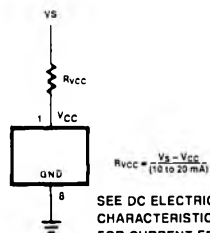
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TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

NE5561 VOLTAGE/CURRENT FED
SUPPLY CHARACTERISTICS

CURRENT FED DROPPING RESISTOR

SEE DC ELECTRICAL
CHARACTERISTICS
FOR CURRENT FED
 V_{cc} RANGE.

NE5561 Start-Up

The start-up, or initial turn on, of this device requires some degree of external protective duty cycle limiting to prevent the duty cycle from initially going to the extreme maximum ($\hat{D} > 90\%$). Either over-current limit or slow start circuitry must be employed to limit duty cycle to a safe value during start-up. Both may be used if desired.

To implement slow-start, the start-up circuit can be used. The divider R1 and R2 sets a voltage, buffered by Q1, such that the output of the error amplifier is clamped to a maximum output voltage, thereby limiting the maximum duty cycle. The addition of capacitor C will cause this voltage to ramp up slowly when power is applied, causing the duty cycle to ramp up simultaneously.

Over-current limit may be used also. To limit duty cycle in this mode, the switch current is monitored at pin 6 and the output of the 5561 is disabled on a cycle by cycle basis when current reaches the programmed limit. With current limit control of slow-start, the duty cycle is limited to that value just allowing maximum switch current to flow. (Approximately 0.50V measured at pin 6.)

APPLICATIONS

5V, 0.5A Buck Regulator Operates from 15V

The converter design shows how simple it is to derive a TTL supply from a system supply of 15V (see Figure 1). The NE5561 drives a 2N4920 PNP transistor directly to provide switching current to the inductor.

Overall line regulation is excellent and covers a range of 12V to 18V with minimal change ($< 10 \text{ mV}$) in the output operating at full load.

As with all NE5561 circuits, the auxiliary slow start and $\hat{D}_{max}$ circuit is required, as evidenced by Q1. The $\hat{D}_{max}$ limit may be calculated by using the relationship (Figure 5a, b).

$$\frac{R_2}{R_1 + R_2} (8.2\text{V}) = V_{\hat{D}_{max}}$$

The maximum duty cycle is then determined from the pulse-width modulator transfer graph, and R1, R2 are defined from the desired conditions.