

Switched-mode power supply control circuit

NE/SE5561

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, overcurrent 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

PIN CONFIGURATION

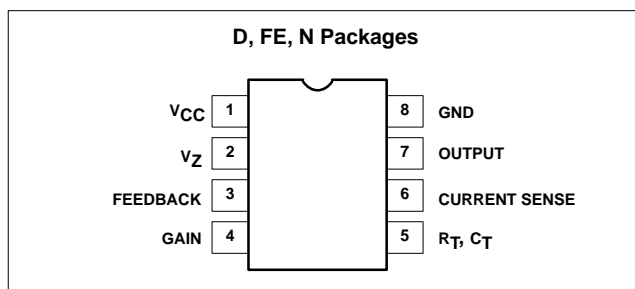


Figure 1. Pin Configuration

APPLICATIONS

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

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	NE5561N	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	-55 to +125°C	SE5561N	SOT97-1
8-Pin Ceramic Dual In-Line Package (CERDIP)	-55 to +125°C	SE5561FE	0580A
8-Pin Small Outline (SO) Package	0 to +70°C	NE5561D	SOT96-1

BLOCK DIAGRAM

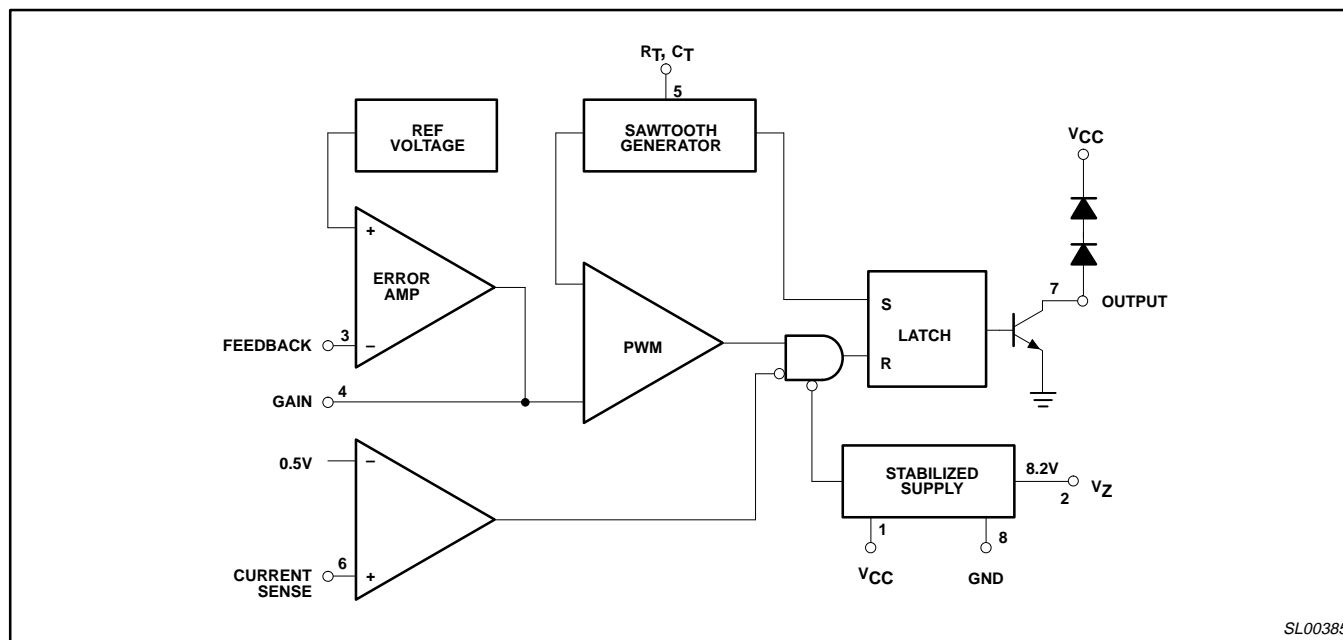


Figure 2. Block Diagram

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ABSOLUTE MAXIMUM RATINGS

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

NOTES:

1. See Voltage-Current-fed supply characteristic curve.

DC ELECTRICAL CHARACTERISTICS

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

SYMBOL	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 temperature	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 temperature	50		100k	50		100k	Hz	
	Initial accuracy	R _T and C _T constant		5			5		%	
	Duty cycle range	f _O =20kHz	0		98	0		98	%	
Current limiting										
I _{IN}	Input current	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	
BW	Small-signal bandwidth			3			3		MHz	
V _{OH}	Output voltage swing		6.2			6.2			V	
V _{OL}	Output voltage swing				0.7			0.7	V	
Output stage										
I _{OUT}	Output current	Over temperature	20			20			mA	
V _{CE}	Sat	I _C =20mA, Over temp.			0.4			0.4	V	

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SYMBOL	PARAMETER	TEST CONDITIONS	SE5561			NE5561			UNIT	
			Min	Typ	Max	Min	Typ	Max		
Supply voltage/current										
I _{CC}	Supply current	I _Z =0, voltage-forced	T _A =25°C			10.0			10.0	mA
			Over temp.			13.0			13.0	
V _{CC}	Supply voltage	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	
Low supply protection										
	Pin 1 threshold		8	9	10.5	8	9	10.5	V	

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TYPICAL PERFORMANCE CHARACTERISTICS

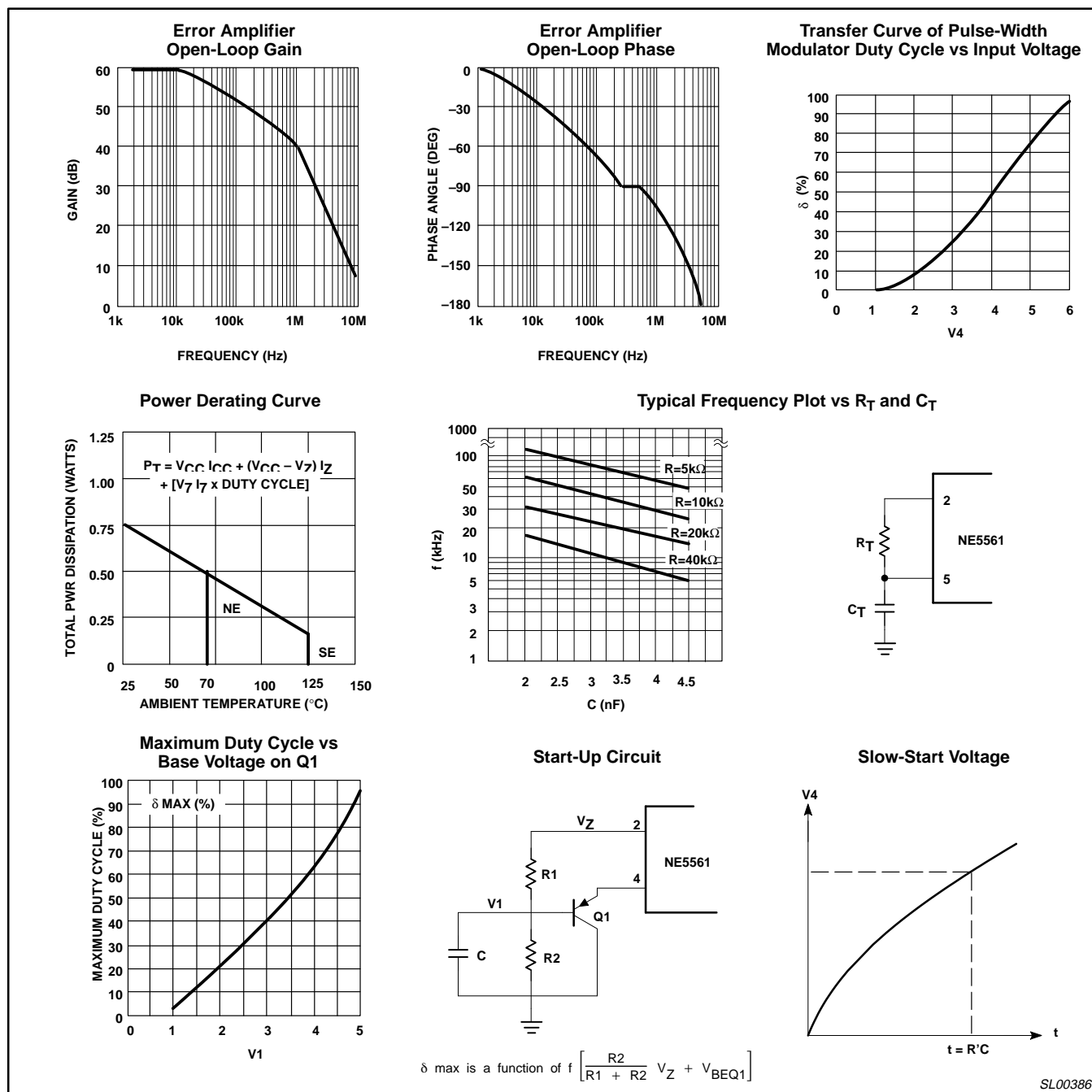


Figure 3. Typical Performance Characteristics

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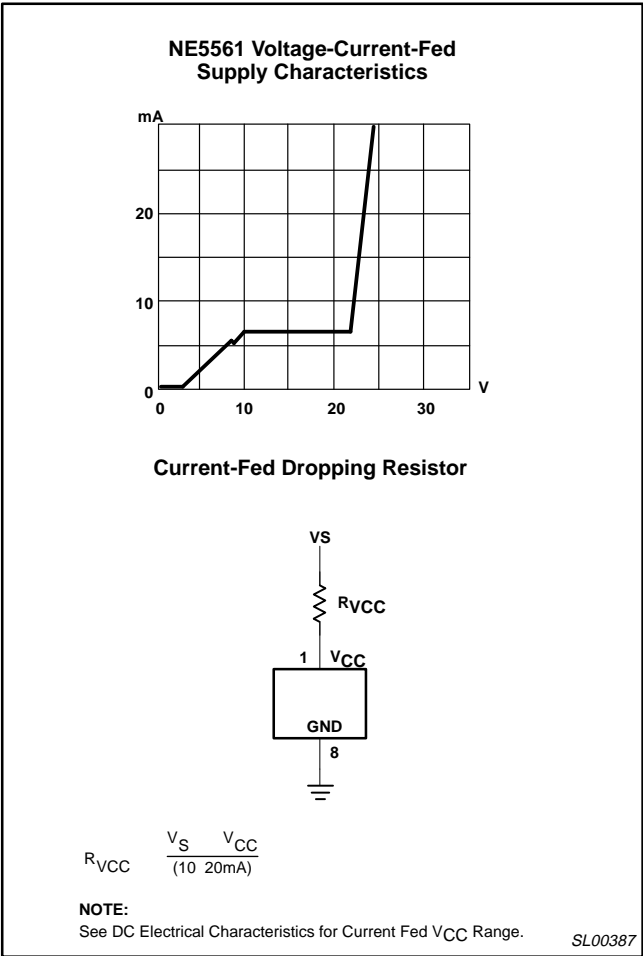


Figure 4. NE5561 Voltage-Current-Fed Supply Characteristics

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 ($\delta > 90\%$). Either overcurrent 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.

Overcurrent 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 δ_{MAX} circuit is required, as evidenced by Q1. The δ_{MAX} limit may be calculated by using the relationship:

$$\frac{R_2}{R_1 + R_2} (8.2\text{V}) = V_{\delta_{MAX}}$$

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