

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

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

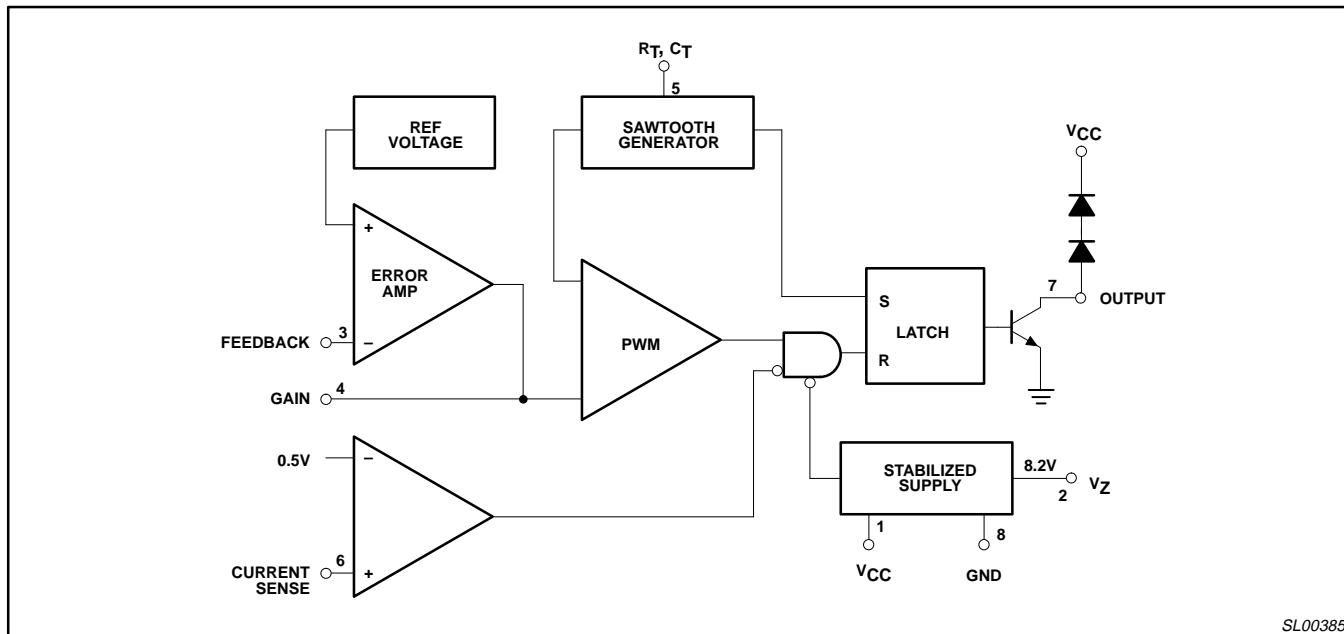


Figure 2. Block Diagram

PIN CONFIGURATION

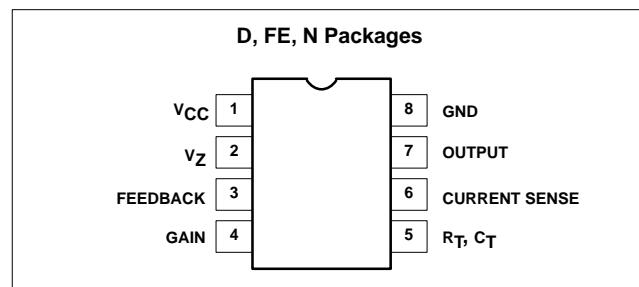


Figure 1. Pin Configuration

APPLICATIONS

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

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ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply ¹ Voltage-forced mode Current-fed mode	+18 30	V mA
I_{OUT}	Output transistor (at 20-30V max)	40	mA
V_{OUT}	Output current Output voltage Output duty cycle	$V_{CC}+1.4V$ 98	V %
P_D	Maximum total power dissipation	0.75	W
T_A	Operating temperature range SE5561 NE5561	-55 to +125 0 to 70	°C °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	$T_A=25^\circ C$	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	$T_A=25^\circ C$		-2	-10		-2	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	μs
			$I_{OUT}=40mA$		0.7	0.8		0.7	μs
	Current limit trip level			.400	.500	.600	.400	.500	.600
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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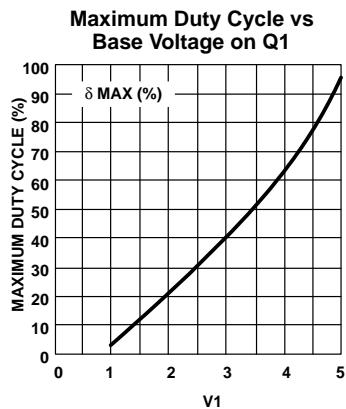
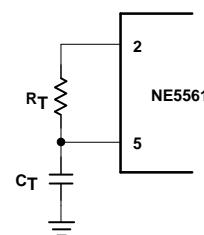
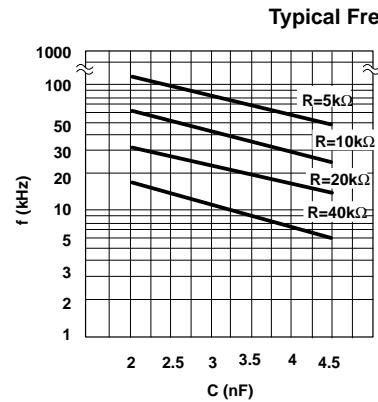
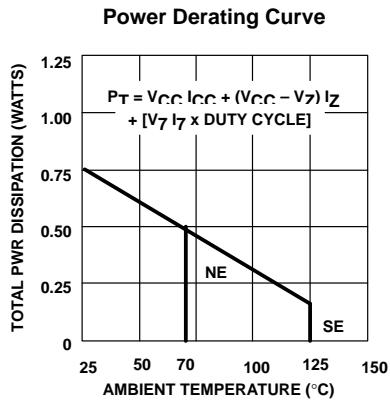
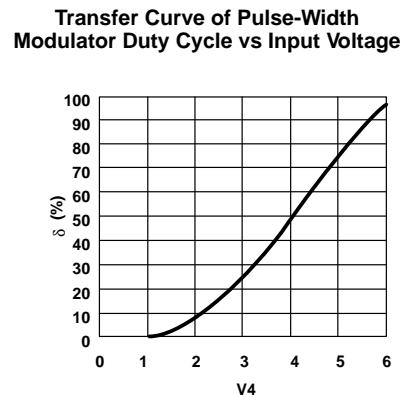
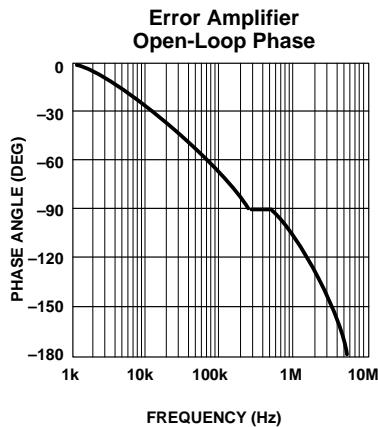
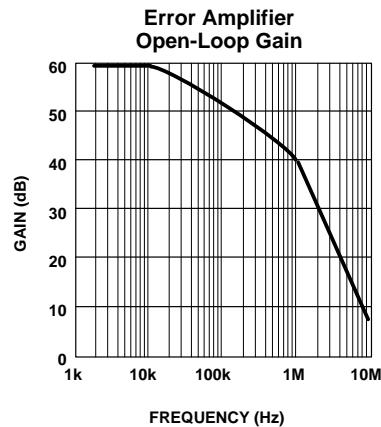
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SYMBOL	PARAMETER	TEST CONDITIONS	SE5561			NE5561			UNIT
			Min	Typ	Max	Min	Typ	Max	
Supply voltage/current									
I_{CC}	Supply current	$I_Z=0$, voltage-forced	$T_A=25^\circ C$			10.0			10.0
V_{CC}	Supply voltage	$I_{CC}=10mA$, current-fed		20.0	21.0	22.0	19.0	21.0	24.0
		$I_{CC}=30mA$ current		20.0		30.0	20.0		30.0
Low supply protection									
	Pin 1 threshold			8	9	10.5	8	9	10.5
									V

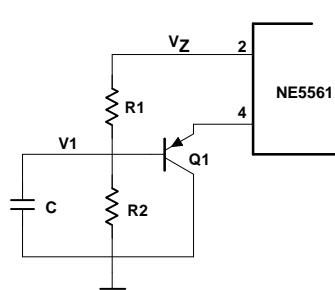
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TYPICAL PERFORMANCE CHARACTERISTICS



Start-Up Circuit



Slow-Start Voltage

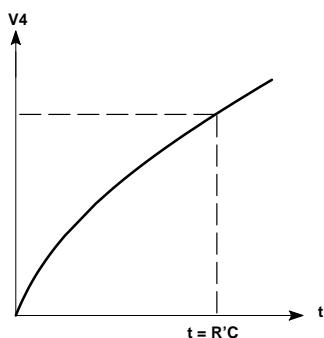


Figure 3. Typical Performance Characteristics

SL00386

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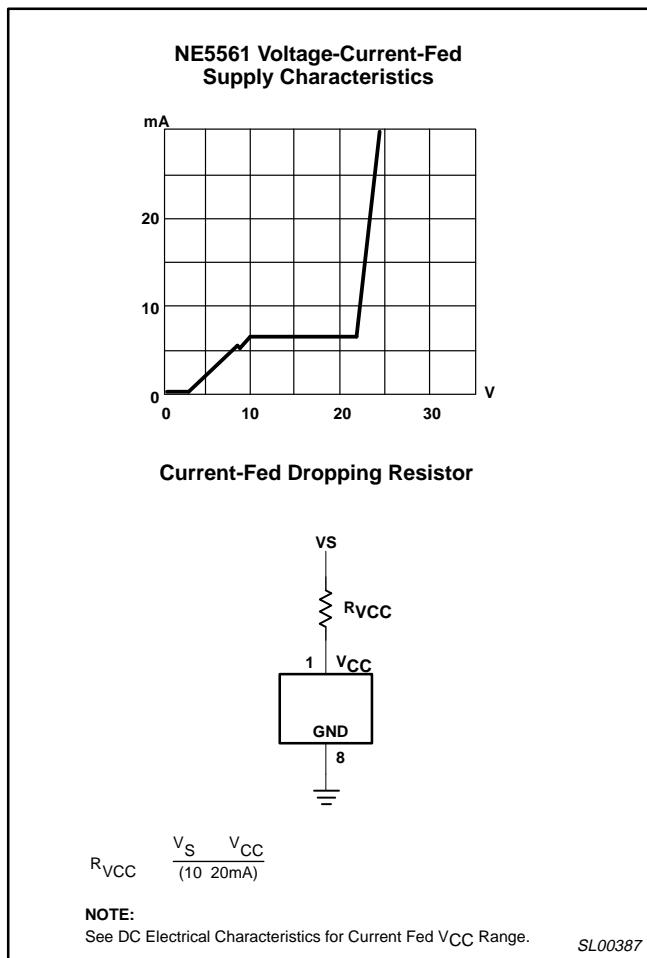


Figure 4. NE5561 Voltage-Current-Fed Supply Characteristics

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 (<10mV) 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:

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

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