

# 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

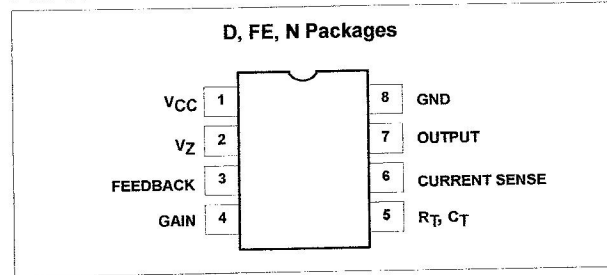


Figure 1. Pin Configuration

## 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

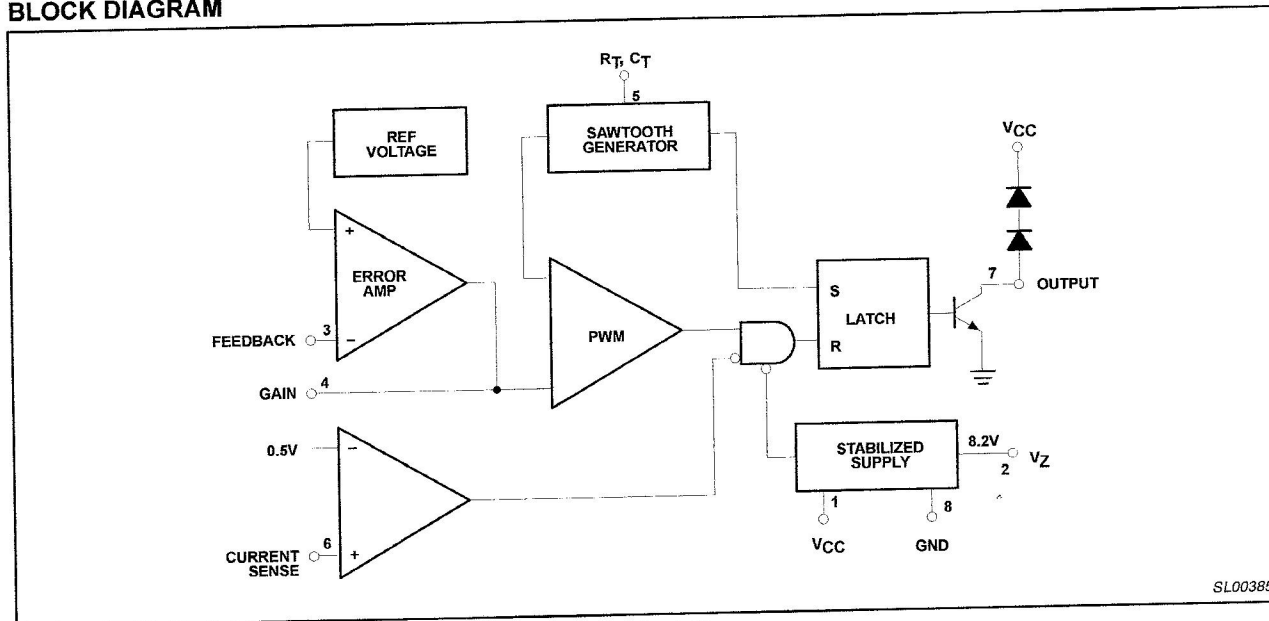


Figure 2. Block Diagram

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## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V <sub>CC</sub>	Supply <sup>1</sup>		
	Voltage-forced mode	+18	V
	Current-fed mode	30	mA
I <sub>OUT</sub> V <sub>OUT</sub>	Output transistor (at 20-30V max)		
	Output current	40	mA
	Output voltage	V <sub>CC</sub> +1.4V	V
	Output duty cycle	98	%
P <sub>D</sub>	Maximum total power dissipation	0.75	W
T <sub>A</sub>	Operating temperature range		
	SE5561	-55 to +125	°C
	NE5561	0 to 70	°C

## NOTES:

- See Voltage-Current-fed supply characteristic curve.

## DC ELECTRICAL CHARACTERISTICS

V<sub>CC</sub>=12V, T<sub>A</sub>=25°C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5561			NE5561			UNIT	
			Min	Typ	Max	Min	Typ	Max		
<b>Reference section</b>										
V <sub>REF</sub>	Internal ref voltage	T <sub>A</sub> =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 <sub>Z</sub>	Internal zener ref	*I <sub>L</sub> =7mA	7.8	8.2	8.8	7.8	8.2	8.8	V	
		Temp. coefficient of V <sub>REF</sub>		±100			±100		ppm/°C	
	Temp. coefficient of V <sub>Z</sub>			±200			±200		ppm/°C	
<b>Oscillator section</b>										
	Frequency range	Over temperature	50		100k	50		100k	Hz	
	Initial accuracy	R <sub>T</sub> and C <sub>T</sub> constant		5			5		%	
	Duty cycle range	f <sub>O</sub> =20kHz	0		98	0		98	%	
<b>Current limiting</b>										
I <sub>IN</sub>	Input current	Pin 6=250mV	T <sub>A</sub> =25°C		-2	-10		-2	-10	µA
			Over temp.			-20			-20	µA
	Single pulse inhibit delay	Inhibit delay time for 20% overdrive at	I <sub>OUT</sub> =20mA		0.88	1.10		0.88	1.10	µs
			I <sub>OUT</sub> =40mA		0.7	0.8		0.7	0.8	µs
	Current limit trip level		.400	.500	.600	.400	.500	.600	V	
<b>Error amplifier</b>										
	Open-loop gain			60			60		dB	
	Feedback resistor		10k			10k			Ω	
BW	Small-signal bandwidth			3			3		MHz	
V <sub>OH</sub>	Output voltage swing		6.2			6.2			V	
V <sub>OL</sub>	Output voltage swing				0.7			0.7	V	
<b>Output stage</b>										
I <sub>OUT</sub>	Output current	Over temperature	20			20			mA	
V <sub>CE</sub>	Sat	I <sub>C</sub> =20mA, Over temp.			0.4			0.4	V	

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**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		
<b>Supply voltage/current</b>										
$I_{CC}$	Supply current	$I_Z=0$ , voltage-forced	$T_A=25^{\circ}C$			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		
<b>Low supply protection</b>										
	Pin 1 threshold		8	9	10.5	8	9	10.5	V	

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TYPICAL PERFORMANCE CHARACTERISTICS

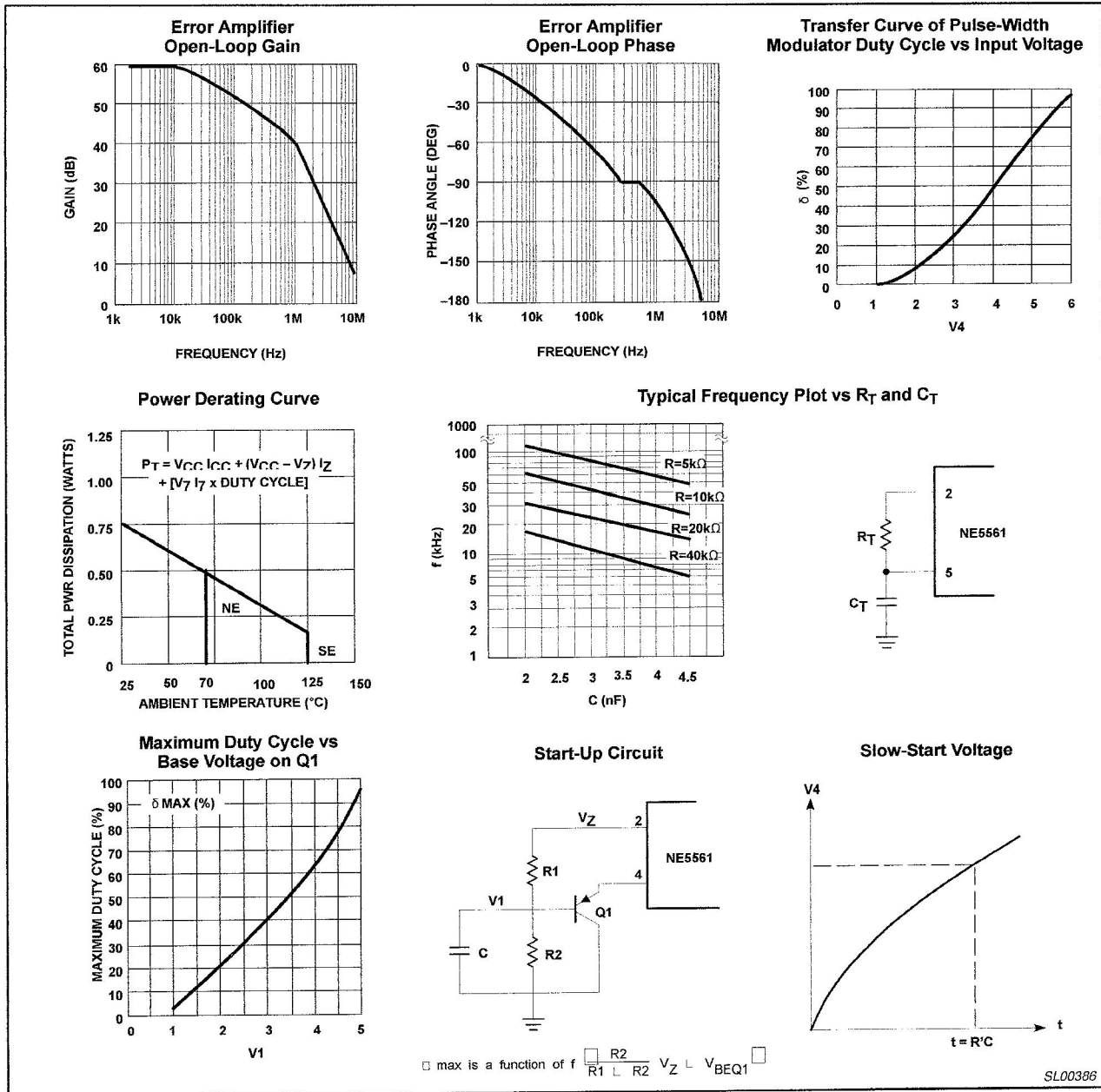


Figure 3. Typical Performance Characteristics

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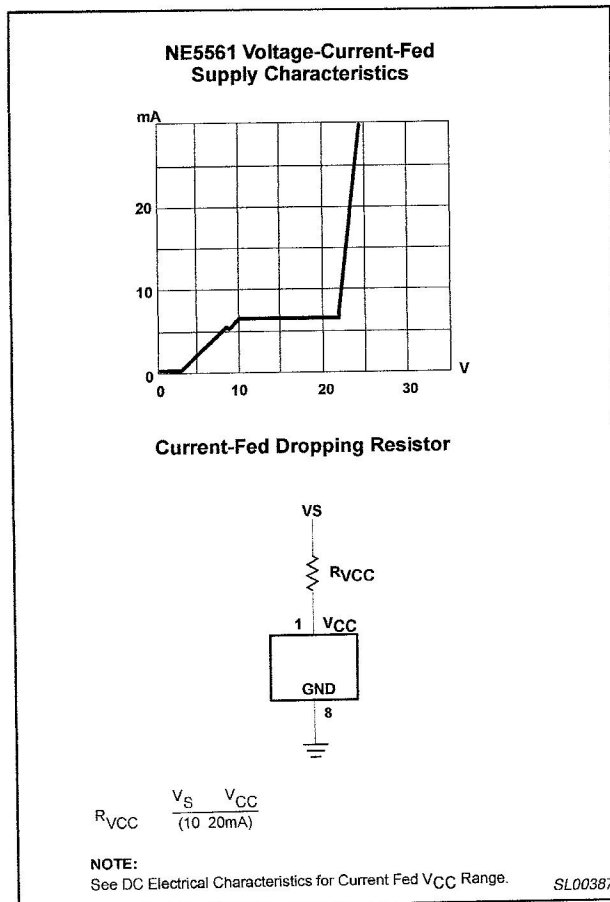


Figure 4. NE5561 Voltage-Current-Fed Supply Characteristics

**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  $R_1$  and  $R_2$  sets a voltage, buffered by  $Q_1$ , 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  $\delta_{MAX}$  circuit is required, as evidenced by  $Q_1$ . The  $\delta_{MAX}$  limit may be calculated by using the relationship:

$$\frac{R_2}{R_1} \approx \frac{R_2}{R_2} (8.2V) \quad V_{\square MAX}$$

The maximum duty cycle is then determined from the pulse-width modulator transfer graph, with  $R_1$  and  $R_2$  being defined from the desired conditions.