

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

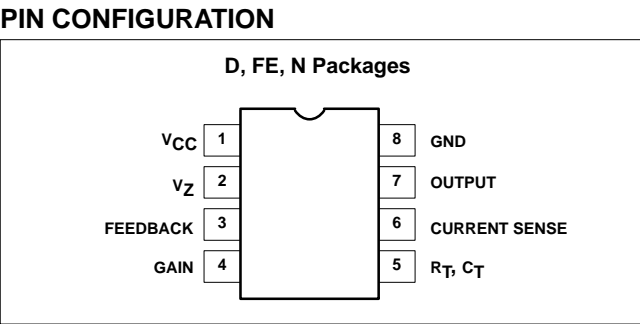


Figure 1. Pin Configuration

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

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

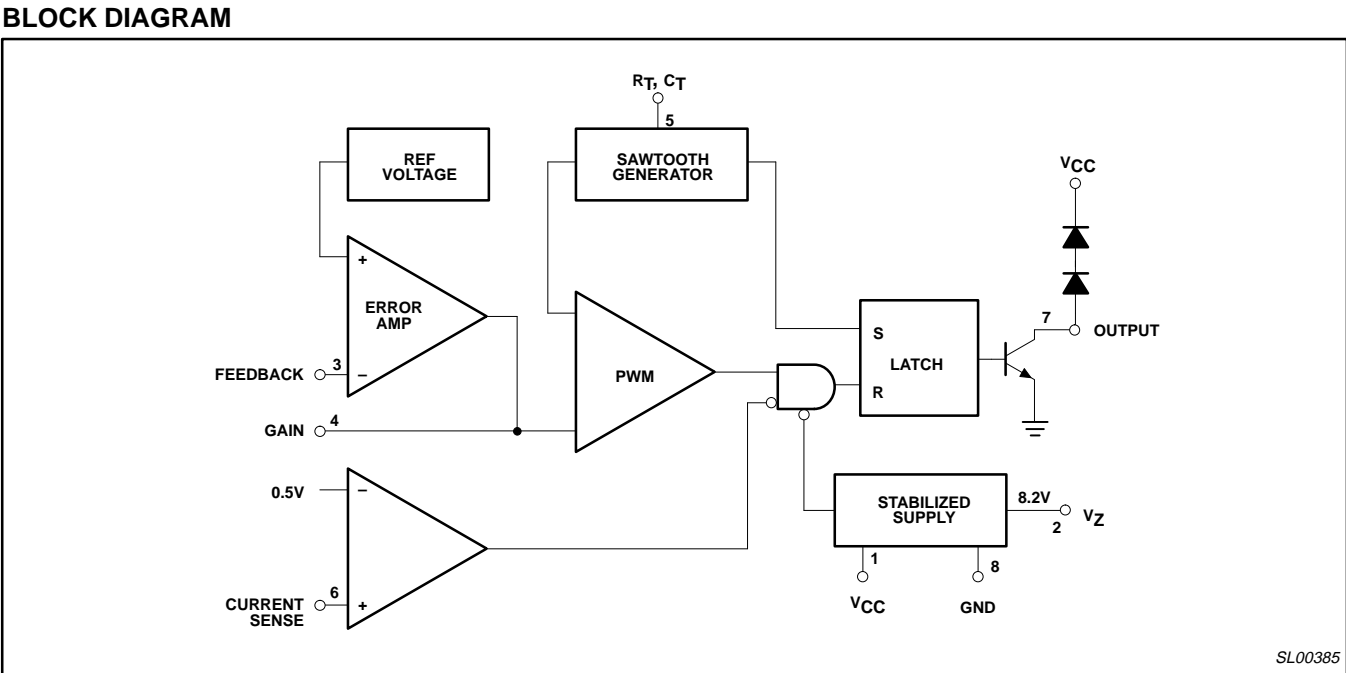


Figure 2. Block Diagram

Switched-mode power supply control circuit

NE/SE5561

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	

Switched-mode power supply control circuit

NE/SE5561

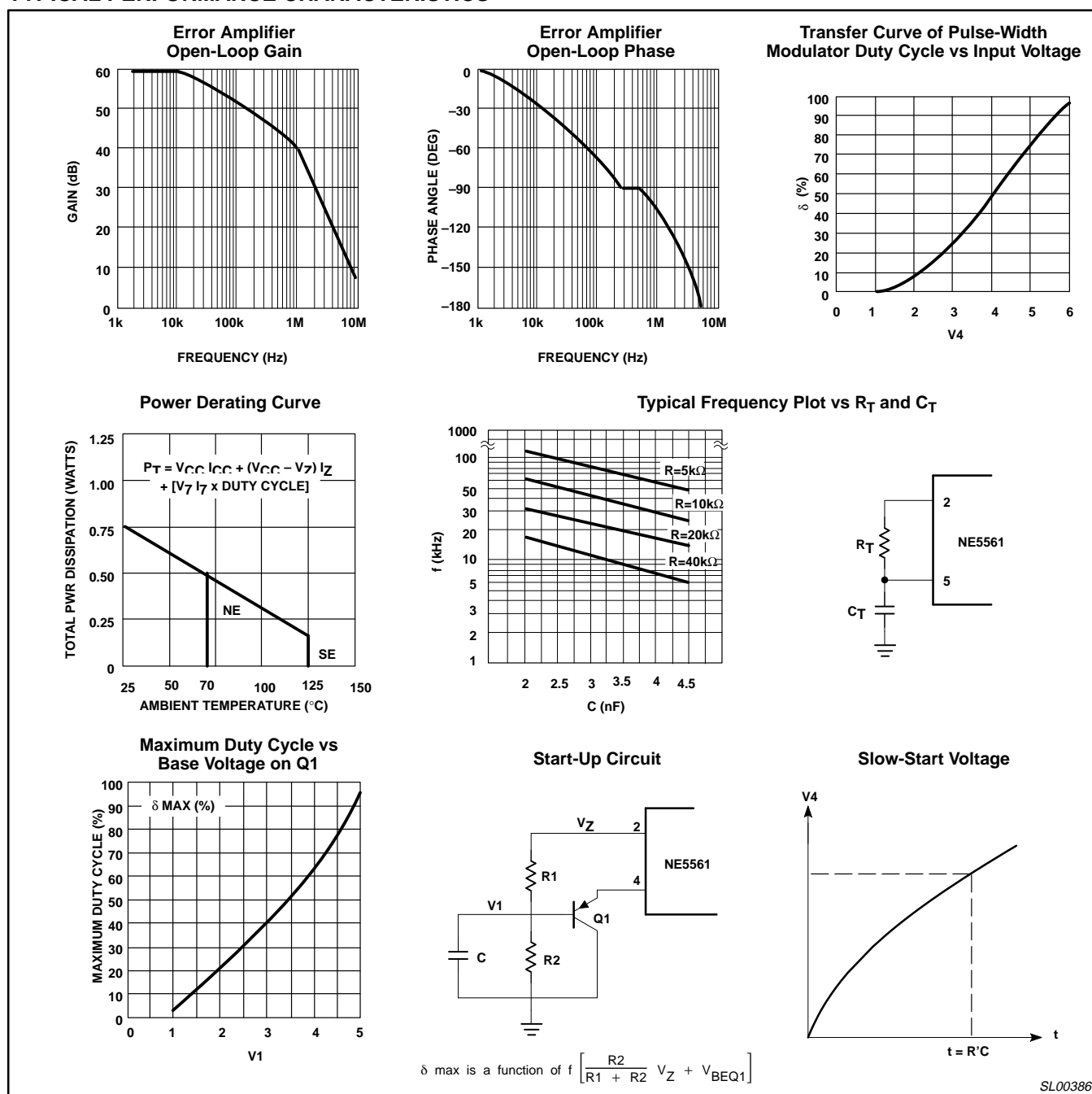
DC ELECTRICAL CHARACTERISTICS $V_{CC}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5561			NE5561			UNIT	
			Min	Typ	Max	Min	Typ	Max		
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	

Switched-mode power supply control circuit

NE/SE5561

TYPICAL PERFORMANCE CHARACTERISTICS



SL00386

Figure 3. Typical Performance Characteristics

Switched-mode power supply control circuit

NE/SE5561

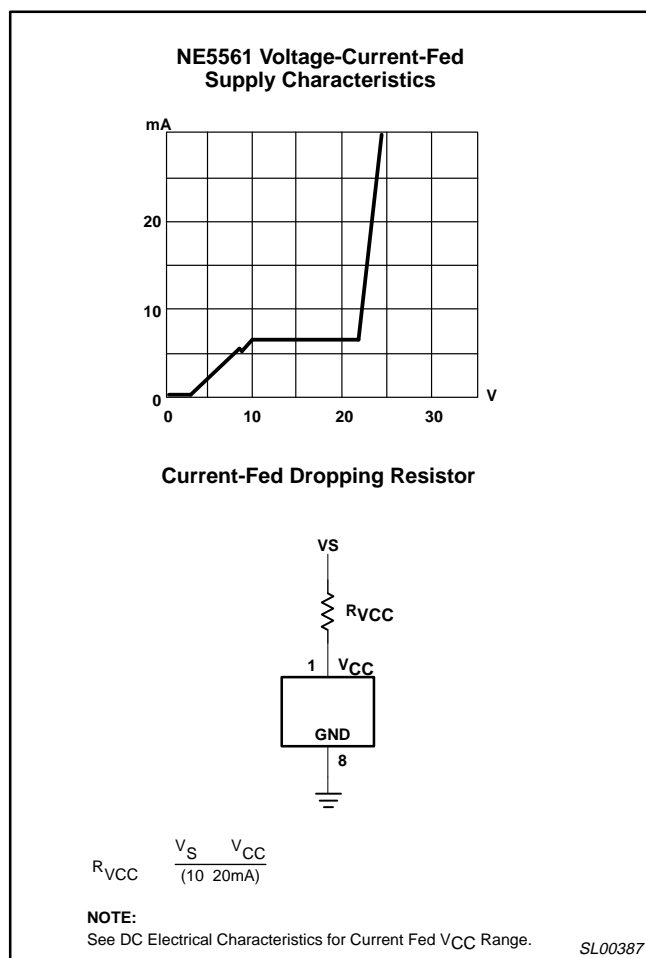


Figure 4. NE5561 Voltage-Current-Fed Supply Characteristics

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.