Signetics

NE/SE5561
Switched-Mode Power Supply Control Circuit

Product Specification

Linear Products

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.

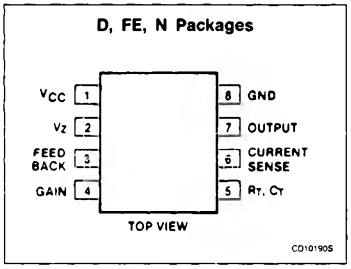
FEATURES

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

APPLICATIONS

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

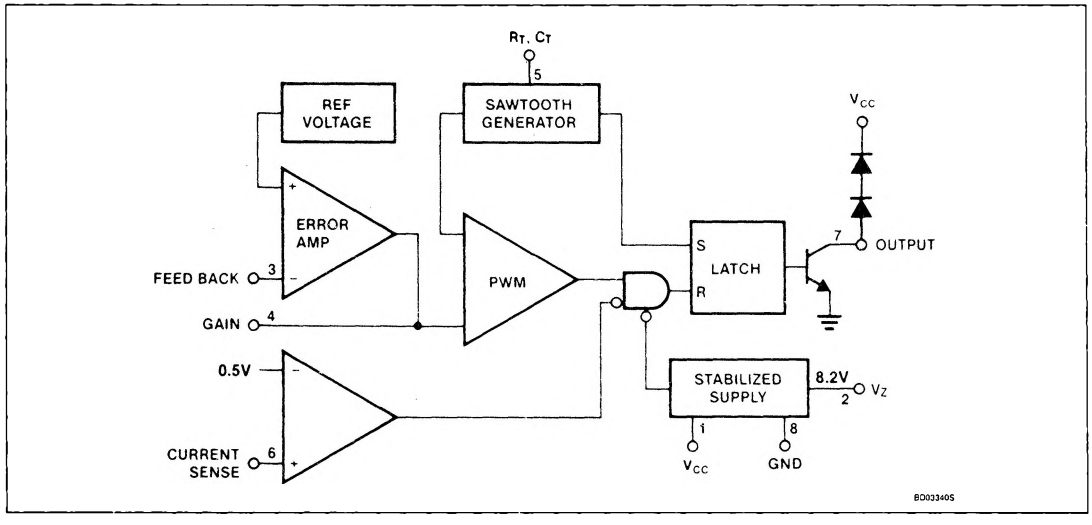
PIN CONFIGURATION



ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
8-Pin Plastic DIP	0 to +70°C	NE5561N
8-Pin Plastic DIP	−55 to +125°C	SE5561N
8-Pin Cerdip	0 to +70°C	NE5561FE
8-Pin Cerdip	−55 to +125°C	SE5561FE
8-Pin SO	0 to +70°C	NE5561D

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply[1]		
	Voltage-forced mode	+18	V
	Current-fed mode	30	mA
	Output transistor (at 20-30V max)		
I_{OUT}	Output current	40	mA
V_{OUT}	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

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

DC ELECTRICAL CHARACTERISTICS V_{CC} = 12V, T_A = 25°C, unless otherwise specified.

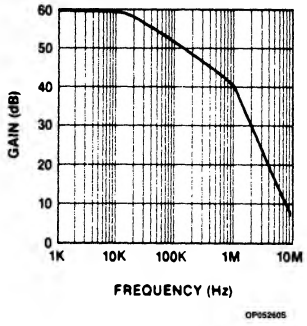
SYMBOL	PARAMETER	TEST CONDITIONS		SE5561			NE5561			UNIT
				Min	Typ	Max	Min	Typ	Max	
Reference section										
V_{REF}	Internal ref voltage	T_A = 25°C		3.69	3.75	3.84	3.57	3.75	3.96	V
		Over temperature		3.65		3.88	3.55		3.98	V
V_Z	Internal zener ref	*I_L = 7mA		7.8	8.2	8.8	7.8	8.2	8.8	V
	Temp. coefficient 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

DC ELECTRICAL CHARACTERISTICS (Continued) V_{CC} = 12V, T_A = 25°C, unless otherwise specified.

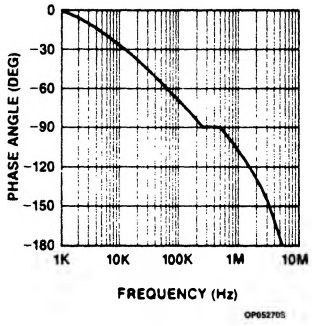
SYMBOL	PARAMETER	TEST CONDITIONS		SE5561			NE5561			UNIT
				Min	Typ	Max	Min	Typ	Max	
Supply voltage/current										
I_{CC}	Supply current	I_Z = 0, voltage-forced	T_A = 25°C			10.0			10.0	mA
			Over temp.			13.0			13.0	mA
V_{CC}	Supply voltage	I_{CC} = 10mA, current-fed		20.0	21.0	22.0	19.0	21.0	24.0	V
		I_{CC} = 30mA current		20.0		30.0	20.0		30.0	V
Low supply protection										
	Pin 1 threshold			8	9	10.5	8	9	10.5	V

TYPICAL PERFORMANCE CHARACTERISTICS

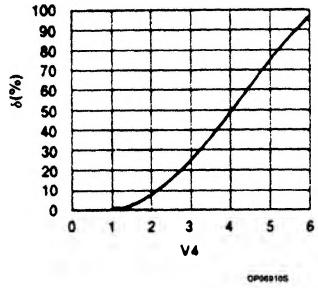
Error Amplifier Open-Loop Gain



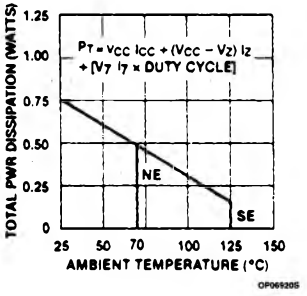
Error Amplifier Open-Loop Phase



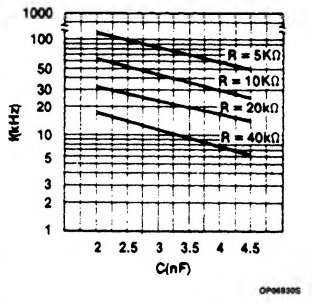
Transfer Curve of Pulse-Width Modulator Duty Cycle vs Input Voltage

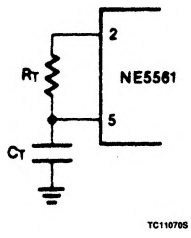


Power Derating Curve

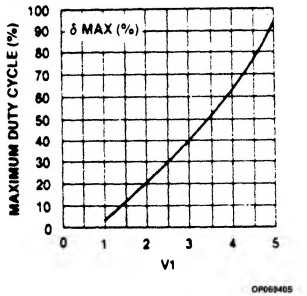


Typical Frequency Plot vs R_T and C_T

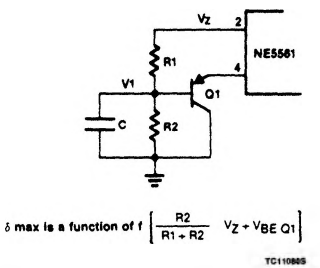




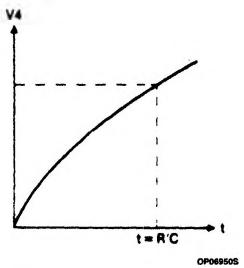
Maximum Duty Cycle vs Base Voltage on Q1



Start-Up Circuit

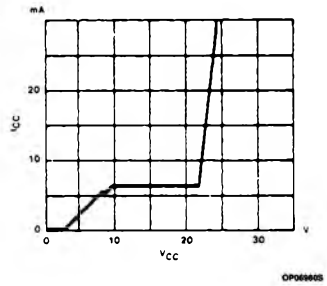


Slow-Start Voltage

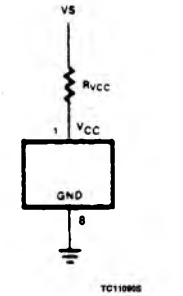


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

NE5561 Voltage-Current-Fed Supply Characteristics



Current-Fed Dropping Resistor



$$R_{VCC} = \frac{V_S - V_{CC}}{(10 \text{ to } 20mA)}$$

NOTE:
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 ($\delta > 90\%$). 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:

$$\frac{R2}{R1 + R2}(8.2V) = V\delta_{MAX}$$

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