

NE/SE5561

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.

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

D, FE, N Packages

Pin	Function
1	VCC
2	VZ
3	FEEDBACK
4	GAIN
5	RT, CT
6	CURRENT SENSE
7	OUTPUT
8	GND

- 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

The block diagram illustrates the control system for a current-mode buck converter. It includes the following components and connections:

- REF VOLTAGE**: Provides a reference voltage to the non-inverting input (+) of the **ERROR AMP**.
- SAWTOOTH GENERATOR**: Receives R_T and C_T inputs and provides a sawtooth signal to the **PWM** block.
- ERROR AMP**: An operational amplifier that compares the reference voltage with the feedback signal. Its output is connected to the **PWM** block.
- FEEDBACK**: A feedback signal (pin 3) is fed into the inverting input (-) of the **ERROR AMP**.
- GAIN**: A gain setting (pin 4) is connected to the **ERROR AMP** and the **PWM** block.
- PWM**: A pulse-width modulation block that receives the error signal and the sawtooth signal. Its output is connected to the **S** (set) input of the **LATCH** block.
- 0.5V**: A 0.5V reference voltage is connected to the inverting input (-) of the **CURRENT SENSE** block.
- CURRENT SENSE**: A current sense block that receives the **0.5V** reference and the **CURRENT SENSE** input (pin 6). Its output is connected to the **R** (reset) input of the **LATCH** block.
- LATCH**: An SR latch that receives signals from the **PWM** and **CURRENT SENSE** blocks. Its output (pin 7) is connected to the base of a transistor.
- STABILIZED SUPPLY**: Provides a stable 8.2V output (pin 2, V_Z) from the V_{CC} (pin 1) and **GND** (pin 8) inputs.
- OUTPUT**: The output of the transistor, which is connected to the **OUTPUT** terminal (pin 7) and the **OUTPUT** terminal through a diode.

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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°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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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

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TYPICAL PERFORMANCE CHARACTERISTICS

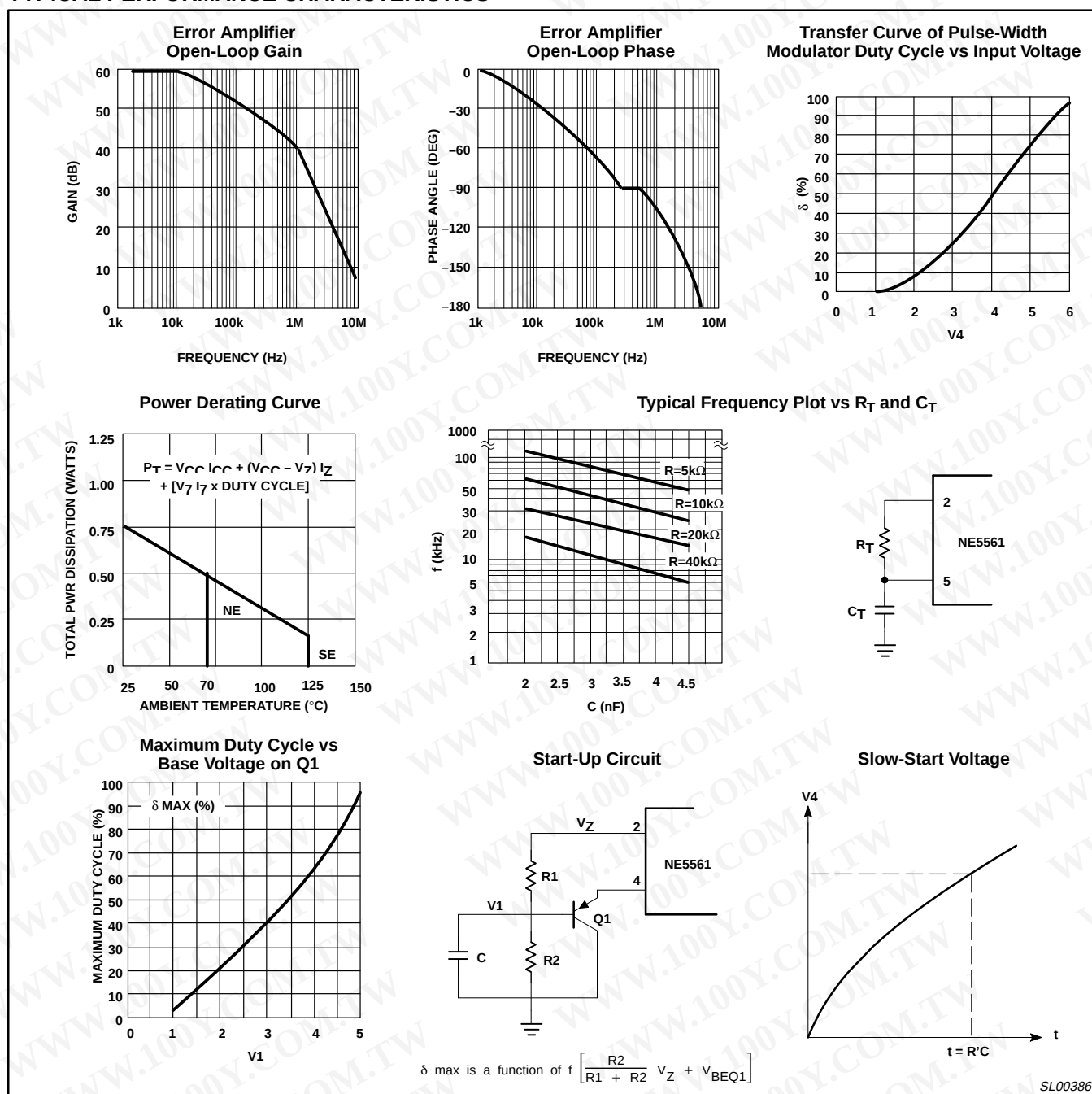


Figure 3. Typical Performance Characteristics

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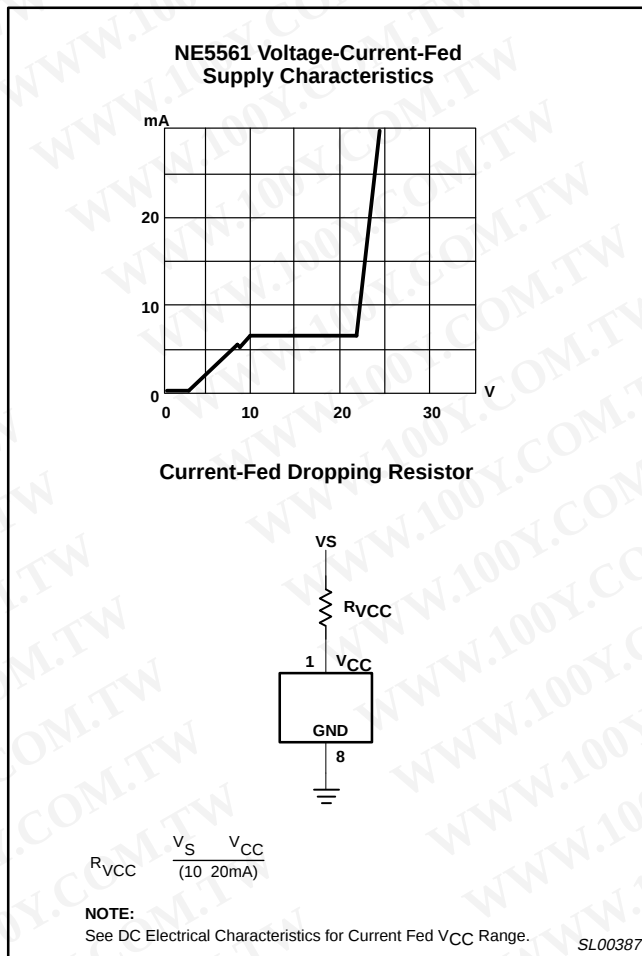


Figure 4. NE5561 Voltage-Current-Fed Supply Characteristics

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:

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

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