Resonant-mode power supply controller NE5580

DESCRIPTION

The NE5580 family of control ICs provides control applications for a variety of resonant mode power supplies, such as zero-current switching, zero-voltage switching, multi-resonant switching, parallel-resonant switching, and series-resonant switching, etc.

Designed with an ASIC approach on a 15V, 5GHz bipolar process, the NE5580 possesses the following features: undervoltage lockout with low start-up current; precision 2.5V reference voltage trimmed to 1% accuracy; frequency-modulated constant ON-time or OFF-time control; 10MHz error amplifier with 10mA source or sink current; automatic overvoltage protection; synchronized undervoltage lockout, remote shutdown and overcurrent protection; programmable soft start and restart delay after shutdown; parallel or alternating output sequence with double pulse suppression; dual 1 Amp peak totem-pole output drivers with no cross conduction current.

FEATURES

- Operation up to 10MHz resonant frequency
- Low start-up current (<2mA)
- Undervoltage lockout with 2V hysteresis
- Frequency-modulated constant ON- or OFF-time control
- VCO with programmable ON- or OFF-time down to 50ns
- 10MHz error amplifier with 10mA source or sink output current
- Automatic overvoltage protection
- Synchronized undervoltage lockout
- Synchronized remote shutdown
- Synchronized overload protection
- Programmable soft start
- Programmable restart delay after shutdown
- Programmable alternating or parallel output sequence
- Double pulse suppression

PIN CONFIGURATION

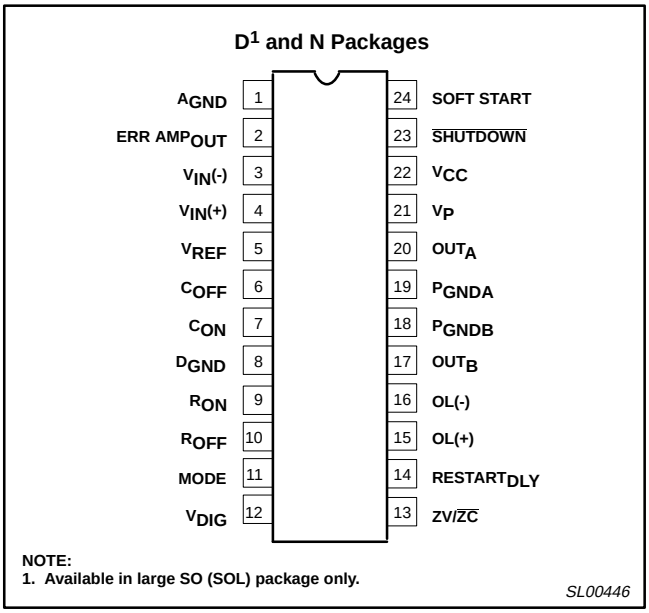

Figure 1. Pin Configuration

APPLICATIONS

- Zero-current switching quasi-resonant converter
- Zero-voltage switching quasi-resonant converter
- Multi-resonant converter
- Series or parallel resonant mode operation
- Single forward, flyback, dual forward, half-bridge, and push-pull operation

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
20-Pin Plastic DIP	0 to +70°C	NE5580N	SOT146-1
20-Pin Plastic SOL	0 to +70°C	NE5580D	SOT163-1

PIN DESCRIPTIONS

PIN NO.	DESCRIPTION	FUNCTION
1	A_{GND}	Analog ground
2	ERR AMP_{OUT}	Error amplifier output
3	$V_{IN(-)}$	Error amplifier inverting input
4	$V_{IN}(+)$	Error amplifier non-inverting input
5	V_{REF}	2.5V reference voltage output
6	C_{OFF}	Capacitor controlling OFF-time
7	C_{ON}	Capacitor controlling ON-time
8	D_{GND}	Digital ground
9	R_{ON}	Resistor controlling ON-time
10	R_{OFF}	Resistor controlling OFF-time
11	MODE	Output sequence mode selection
12	V_{DIG}	5V regulated voltage output
13	$\overline{ZV}/\overline{ZC}$	Synchronization/non-synchronized shutdown
14	$RESTART_{DLY}$	Restart delay control
15	OL(+)	Overload protection comparator positive input
16	OL(-)	Overload protection comparator negative input
17	OUT_B	Output B
18	P_{GNDB}	Power ground B
19	P_{GNDA}	Power ground A
20	OUT_A	Output A
21	V_P	Positive supply for output stages
22	V_{CC}	Positive supply for control circuitry
23	$\overline{SHUTDOWN}$	Remote shutdown
24	SOFT START	Soft start control

BLOCK DIAGRAM

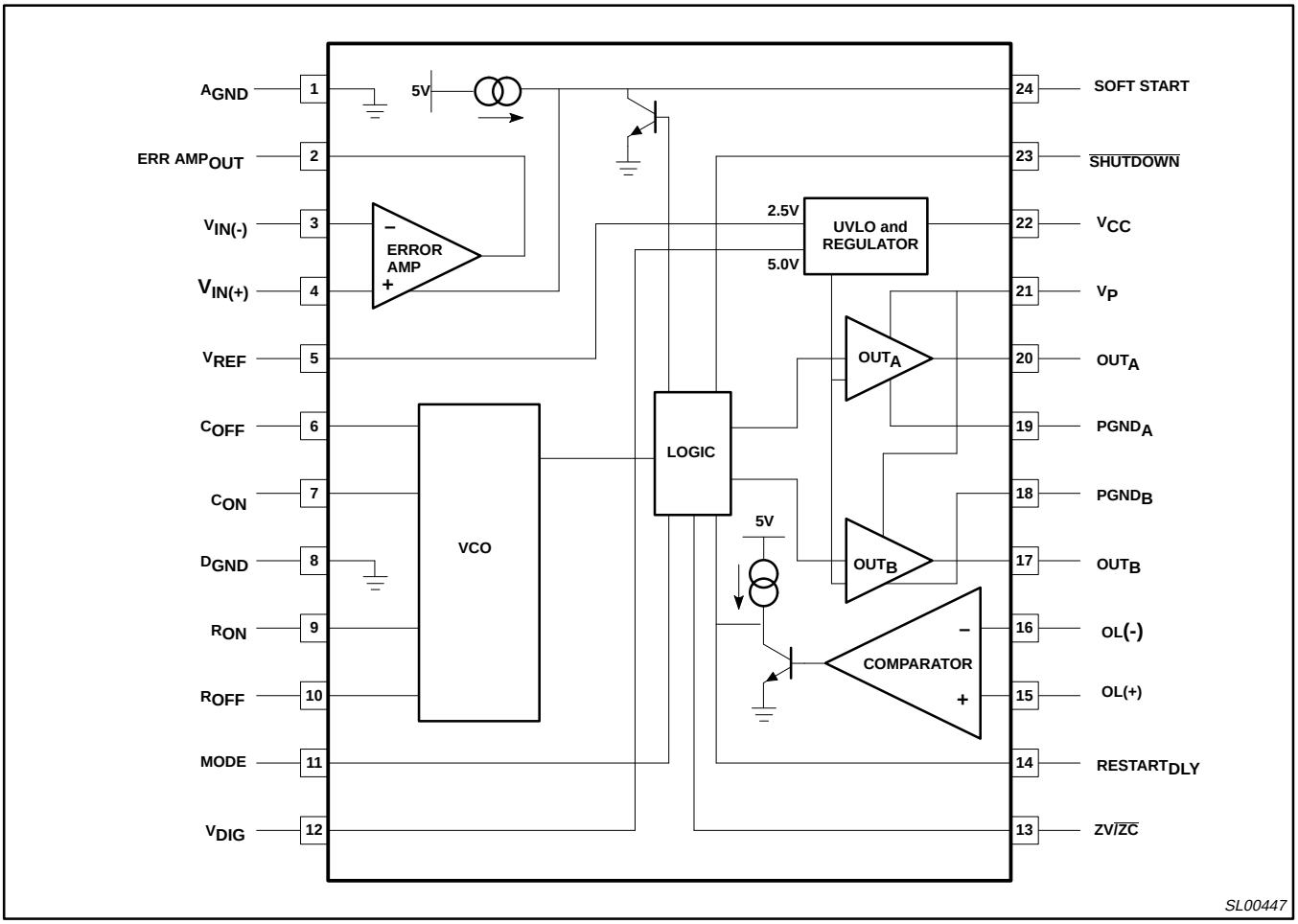

Figure 2. Block Diagram

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
		NE5580	
V_{CC}	Single supply voltage	15	V
V_{OUT}	Voltage at OUT_A or OUT_B	V_{CC}	V
V_{IN}	Voltage at any pin except OUT_A or OUT_B	10	V
V_{ESD}	ESD protection voltage at any pin (human body model)	2000	V
I_{DC}	DC output current at OUT_A or OUT_B	0.5	A
I_{AC}	Pulsed output current, 50% duty cycle	1	A
I_{EA}	DC current at error amplifier output	10	mA
T_J	Recommended maximum junction temperature[1]	150	°C
T_{STG}	Storage temperature range	-65 to +150	°C
θ_{JA}	Thermal resistance D package N package	 68 52	°C/W

NOTE:

1. The output drivers of the controller are designed to drive high frequency power MOSFETs. A large proportion of the power dissipation on the die is, therefore, associated with the current required to charge and discharge the MOSFET input capacitance, and is proportional to input capacitance, operating frequency and the square of the voltage drive. The maximum junction temperature is then calculated from the following approximate expression

$$T_J = T_A + \theta_{JA} [I_{CC} \times V_{CC} + C (V_P \times V_P) f_{MAX}]$$

where

T_A = ambient temperature
θ_{JA} = thermal resistance of package
V_{CC} = normal operating supply voltage of controller, V_{CC}
V_P = normal operating supply voltage of driver, V_P
I_{CC} = normal operating supply current of controller
$f_{MAX} = 1/(t_{ON} + t_{OFF})$MIN = maximum operating frequency
C = input capacitance of power MOSFET

For $V_{CC} = V_P = 12V$, $I_{CC} = 50mA$, C = 1000pF and $\theta_{JA} = 57°C/W$ for a 24 pin plastic package (no heat sink), f_{MAX} can reach 5MHz for $T_J < 150°C$.50

The maximum die temperature is independent of the output mode of the drivers, whether parallel or alternating.

AC ELECTRICAL CHARACTERISTICS

T_A = 0 to 70°C, unless otherwise specified. $V_{CC} = V_P = 12V$; $C_{OFF} = 82pF$; $C_{ON} = 82pF$; $R_{OFF} = 5k$; $R_{ON} = 2k$.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			NE5580			
			MIN	TYP	MAX	
Undervoltage lockout						
	Turn-on threshold		9	10	11	V
	Turn-off threshold		7.5	8	8.5	V
2.5V Reference (Pin 5)						
V_{OUT}	Output voltage	$T_A = 25°C$, no load		2.5		V
	Line regulation	V_{CC} = 10.5 - 13.5V, no load		10		mV
	Load regulation	0 to 10mA load		10		mV
	Temperature stability	Over temperature		100		ppm/°C
	Short circuit current	$T_A = 25°C$, $V_{REF} = A_{GND}$		50		mA
Undervoltage lockout (continued)						
	Total output variation	Line load variation over temp		±37.5		mV
V_{NOISE}	Output noise voltage	f = 10Hz to 100kHz				
	Long-term stability	$T_A = 125°C$, 2000hrs				

DC ELECTRICAL CHARACTERISTICS (continued)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			NE5580			
			MIN	TYP	MAX	
Digital 5V output (Pin 12)						
V_{OUT}	Output voltage	T_A = 25°C, no load		5		V
	Line regulation	V_{CC} = 10.5 - 13.5V, no load		10		mV
	Load regulation	0 to 10mA load		10		mV
	Temperature stability	Over temperature		250		ppm/°C
I_{SC}	Short circuit current	T_A = 25°C, V_{REF} = D_{GND}		50		mA
	Total output variation	Line load variation over temp		±250		mV
Voltage control oscillator						
	Oscillator frequency error	5MHz running frequency		5		%
t_{ONMIN}	Minimum on-time				50	ns
t_{OFFMIN}	Minimum off-time				50	ns
	Variable on-time range					ns
	Variable off-time range					ns
	Temperature stability			5		%
Error amplifier						
V_{OS}	Input offset voltage				10	mV
I_{BIAS}	Input bias current				1	µA
I_{OS}	Input offset current				100	nA
	DC open loop gain			80		dB
CMRR	Common mode rejection			80		dB
V_{CM}	Common mode voltage		2		4	V
PSRR	Power supply rejection			80		dB
I_{SINK}	Output sink current		10			mA
I_{SOURCE}	Output source current		10			mA
V_{OH}	Output high voltage			4		V
V_{OL}	Output low voltage			0.4		V
GBW	Unity gain bandwidth			10		MHz
S/R	Slew rate			5		V/µs
Overload comparator						
	Hysteresis			15		mV
	Input common mode		1.25		3	V
I_{BIAS}	Input bias current				1	µA
	Delay to output			20		ns
Soft start (Pin 24)						
	Charge current		25	50	75	µA
	Soft start threshold			2.5		V
	Saturation voltage				1	V
Restart delay (Pin 14)						
	Charge current		8	10	12	µA
	Restart delay threshold			2.5		V
	Saturation voltage				1	V
Output driver (Pin 17 & 20)						
V_{OL}	Output low voltage	I_{SINK} = 20mA		0.4		V
		I_{SINK} = 500mA		2.5		V
V_{OH}	Output high voltage	I_{SOURCE} = 20mA		10		V
		I_{SOURCE} = 500mA		9		V

DC ELECTRICAL CHARACTERISTICS (continued)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			NE5580			
			MIN	TYP	MAX	
t_R	Rise time	10V swing @ 1nF load		20	25	ns
t_F	Fall time	10V swing @ 1nF load		20	25	ns
Operating voltage and current						
I_{CC}	Operating current	Output disabled		50		mA
I_{START}	Start-up current	$V_{CC} = V_P = 5V$			2	mA
V_{CC}	Recommended supply voltage		10.5		13.5	V
V_P	Recommended supply voltage		10.5		13.5	V

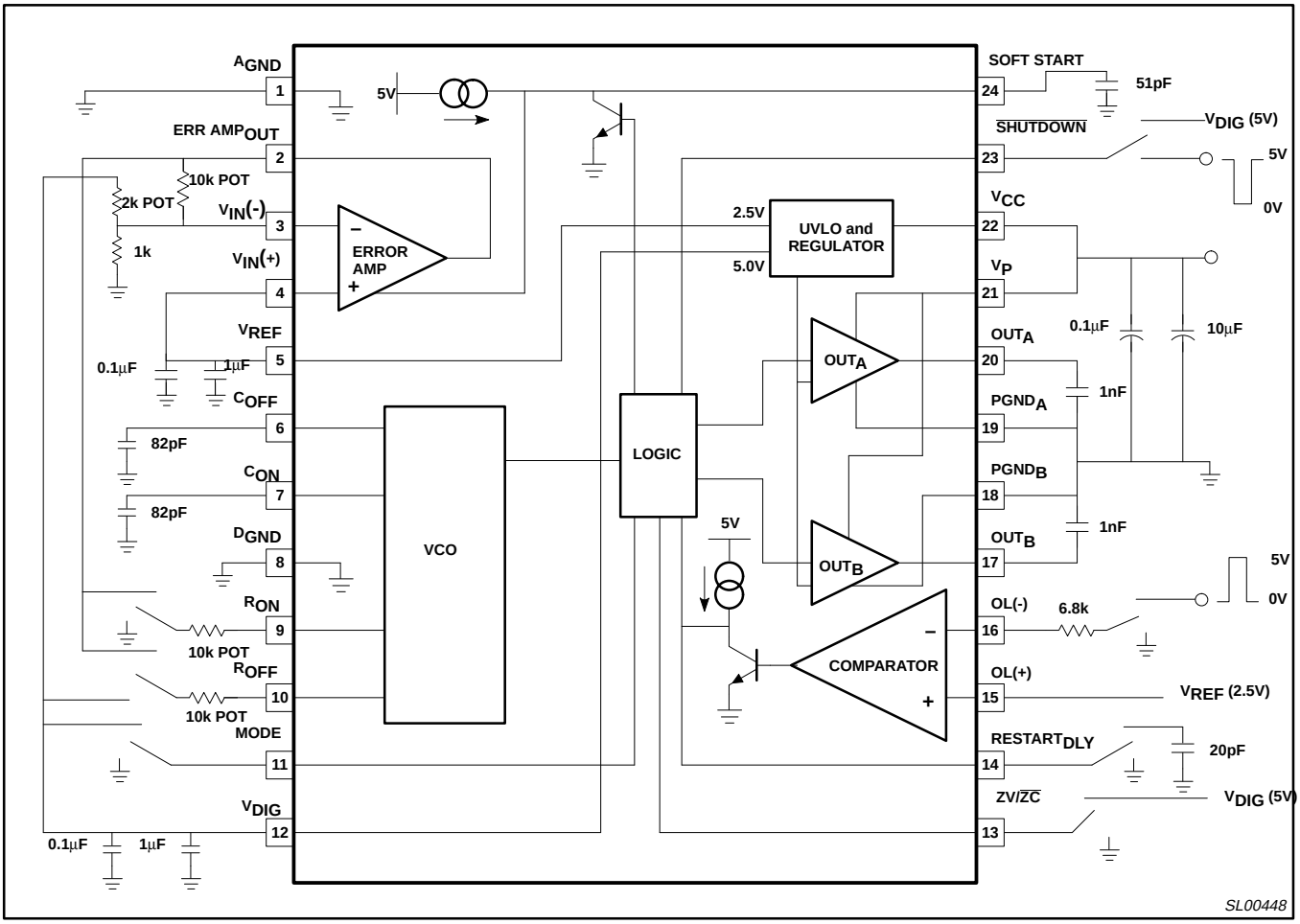

Figure 3. NE5580 Test Circuit