

## **NTE1753 Integrated Circuit Pulse Width Modulator (PWM) Control Circuit**

### **Description:**

The NTE1753 is a fixed-frequency pulse width modulation control circuit in a 14-Lead DIP type package incorporating the primary building blocks required for the control of a switching power supply. An internal-linear sawtooth oscillator frequency is determined by:

$$f_{\text{OSC}} \approx \frac{1.1}{R_T \bullet C_T}$$

Output pulse width modulation is accomplished by comparison of the positive sawtooth waveform across capacitor  $C_T$  to either of two control signals. The output is enabled only during that portion of time when the sawtooth voltage is greater than the control signals. Therefore, an increase in control-signal amplitude causes a corresponding linear decrease of output pulse width.

The control signals are external inputs that can be fed into the dead-time control, the error amplifier inputs, or the feed-back input. The dead-time control comparator has an effective 120mV input offset which limits the minimum output dead time to approximately the first 4% of the sawtooth-cycle time. This would result in a maximum duty cycle of 96%. Additional dead time may be imposed on the output by setting the dead time-control input to a fixed voltage, ranging between 0 to 3.3V.

The pulse width modulator comparator provides a means for the error amplifiers to adjust the output pulse width from the maximum percent on-time, established by the dead time control input, down to zero, as the voltage at the feedback pin varies from 0.5 to 3.5V. Both error amplifiers have a common-mode input range from -0.3V to ( $V_{CC} - 2V$ ), and may be used to sense power supply output voltage and current. The error-amplifier outputs are active high and are 0 red together at the non-inverting input of the pulse-width modulator comparator. With this configuration, the amplifier that demands minimum output on time, dominates control of the loop.

The NTE1753 has an internal 5.0V reference capable of sourcing up to 10mA of load currents for external bias circuits. The reference has an internal accuracy of  $\pm 5\%$  with a typical thermal drift of less than 50mV over an operating temperature range of 0 to +70°C.

### **Features:**

- Complete Pulse Width Modulation Control Circuitry
- On-Chip Oscillator with Master or Slave Operation
- On-Chip Error Amplifiers
- On-Chip 5.0 Volt Reference
- Adjustable Dead Time Control
- Uncommitted Output Transistor for 200mA Source or Sink

**Absolute Maximum Ratings:** ( $T_A = 0^\circ$  to  $+70^\circ\text{C}$  unless otherwise specified)

Power Supply Voltage, $V_{CC}$	42V
Collector Output Voltage, $V_C$	42V
Collector Output Current, $I_C$	250mA
Amplifier Input Voltage, $V_{in}$	$V_{CC} + 0.3V$
Power Dissipation ( $T_A \leq 45^\circ\text{C}$ ), $P_D$	1000mW
Operating Junction Temperature, $T_J$	$+125^\circ\text{C}$
Operating Ambient Temperature Range, $T_A$	$0^\circ$ to $+70^\circ\text{C}$
Storage Temperature Range, $T_{stg}$	$-55^\circ$ to $+125^\circ\text{C}$
Thermal Resistance, Junction to Ambient, $R_{\theta JA}$	$+80^\circ\text{C/W}$
Power Derating Factor, $1/R_{\theta JA}$	12.5mW/ $^\circ\text{C}$
Derating Ambient Temperature, $T_A$	$+45^\circ\text{C}$

**Recommended Operating Conditions:**

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	$V_{CC}$	7.0	15	40	V
Collector Output Voltage	$V_C$	–	30	40	V
Collector Output Current	$I_C$	–	–	200	mA
Amplifier Input Voltage	$V_{in}$	–0.3	–	$V_{CC}-2$	V
Current Into Feedback Terminal	$I_{fb}$	–	–	0.3	mA
Reference Output Current	$I_{ref}$	–	–	10	mA
Timing Resistor	$R_T$	1.8	47	500	k $\Omega$
Timing Capacitor	$C_T$	0.0047	0.001	10	$\mu\text{F}$
Oscillator Frequency	$f_{OSC}$	1.0	25	200	kHz

**Electrical Characteristics:** ( $V_{CC} = 15V$ ,  $C_T = 0.01\mu\text{F}$ ,  $R_T = 12k\Omega$ . For typical values  $T_A = +25^\circ\text{C}$ , for min/max values  $T_A$  is  $0^\circ$  to  $+70^\circ\text{C}$  unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Reference Section</b>						
Reference Voltage	$V_{ref}$	$I_O = 1\text{mA}$	4.75	5.0	5.25	V
Line Regulation	$Reg_{line}$	$V_{CC} = 7V$ to $40V$	–	2	25	mV
Load Regulation	$Reg_{load}$	$I_O = 1\text{mA}$ to $10\text{mA}$	–	3	15	mV
Short-Circuit Output Current	$I_{SC}$	$V_{ref} = 0$	15	35	75	mA
<b>Output Section</b>						
Collector Off-State Current	$I_{C(off)}$	$V_{CE} = 40V$ , $V_{CC} = 40V$	–	2	100	$\mu\text{A}$
Emitter Off-State Current	$I_{E(off)}$	$V_{CC} = V_C = 40V$ , $V_E = 0$	–	–	–100	$\mu\text{A}$
Collector-Emitter Saturation Voltage	$V_{sat(C)}$	$I_C = 200\text{mA}$ , $V_E = 0$ , Common Emitter	–	1.1	1.3	V
	$V_{sat(E)}$	$I_E = 200\text{mA}$ , $V_C = 15V$ , Emitter Follower	–	1.5	2.5	V
Output Voltage Rise Time	$t_r$	$T_A = +25^\circ\text{C}$ , Common Emitter	–	100	200	ns
		$T_A = +25^\circ\text{C}$ , Emitter Follower	–	100	200	ns
Output Voltage Fall Time	$t_f$	$T_A = +25^\circ\text{C}$ , Common Emitter	–	25	100	ns
		$T_A = +25^\circ\text{C}$ , Emitter Follower	–	40	100	ns

**Electrical Characteristics (Cont'd):** ( $V_{CC} = 15V$ ,  $C_T = 0.01\mu F$ ,  $R_T = 12k\Omega$ . For typical values  $T_A = +25^\circ C$ , for min/max values  $T_A$  is  $0^\circ$  to  $+70^\circ C$  unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Error Amplifier Section</b>						
Input Offset Voltage	$V_{IO}$	$V_{O(Pin3)} = 2.5V$	–	2	10	mV
Input Offset Current	$I_{IO}$	$V_{C(Pin3)} = 2.5V$	–	5	250	nA
Input Bias Current	$I_{IB}$	$V_{O(Pin3)} = 2.5V$	–	–0.1	–1.0	$\mu A$
Common Mode Input Voltage Range	Low	$V_{CC} = 40V$ , $T_A = +25^\circ C$	–0.3	–	–	V
	High		$V_{CC}^{-2}$	–	–	V
Open-Loop Voltage Gain	$A_{VOL}$	$\Delta V_O = 3V$ , $V_O = 0.5V$ to $3.5V$ , $R_L = 2k\Omega$	70	95	–	dB
Unity Gain Crossover Frequency	$f_c$	$V_O = 0.5V$ to $3.5V$ , $R_L = 2k\Omega$	–	350	–	kHz
Phase Margin at Unity Gain	$\Phi_m$	$V_O = 0.5V$ to $3.5V$ , $R_L = 2k\Omega$	–	65	–	deg.
Common Mode Rejection Ratio	CMRR	$V_{CC} = 40V$	65	90	–	dB
Power Supply Rejection Ratio	PSRR	$\Delta V_{CC} = 33V$ , $V_O = 2.5V$ , $R_L = 2k\Omega$	–	100	–	dB
Output Sink Current	$I_{O-}$	$V_{O(Pin3)} = 0.7V$	0.3	0.7	–	mA
Output Source Current	$I_{O+}$	$V_{O(Pin3)} = 3.5V$	–2	–4	–	mA
<b>PWM Comparator Section</b>						
Input Threshold Voltage	$V_{TH}$	Zero Duty Cycle	–	3.5	4.5	V
Input Sink Current	$I_{I-}$	$V_{(Pin3)} = 0.7V$	0.3	0.7	–	mA
<b>Dead-Time Control Section</b>						
Input Bias Current (Pin4)	$I_{IB(DT)}$	$V_{IN} = 0$ to $5.25V$	–	–2	–10	$\mu A$
Maximum Output Duty Cycle	DC <sub>max</sub>	$V_{IN} = 0$ , $C_T = 0.01\mu F$ , $R_T = 12k\Omega$	90	96	100	%
		$V_{IN} = 0$ , $C_T = 0.001\mu F$ , $R_T = 47k\Omega$	–	92	100	%
Input Threshold Voltage (Pin4)	$V_{TH}$	Zero Duty Cycle	–	2.8	3.3	V
		Maximum Duty Cycle	0	–	–	V
<b>Oscillator Section</b>						
Frequency	$f_{OSC}$	$C_T = 0.001\mu F$ , $R_T = 47k\Omega$	–	25	–	kHz
Standard Deviation of Frequency	$\alpha f_{OSC}$	$C_T = 0.001\mu F$ , $R_T = 47k\Omega$	–	3	–	%
Frequency Change with Temperature	$\Delta f_{OSC}(\Delta T)$	$0^\circ \leq \Delta T_A \leq +70^\circ C$	–	–	12	%
		$C_T = 0.01\mu F$ , $R_T = 12k\Omega$	–	–	12	%
Frequency Change with Voltage	$\Delta f_{OSC}(\Delta V)$	$V_{CC} = 7V$ to $40V$ , $T_A = +25^\circ C$	–	1	–	%
<b>Total Device</b>						
Standby Supply Current	$I_{CC}$	$V_{CC} = 15V$ , all other inputs and outputs open	–	5.5	10	mA
		$V_{CC} = 40V$ , all other inputs and outputs open	–	7.0	15	mA
Average Supply Current	$I_S$	$V_{(Pin4)} = 2V$ , $C_T = 0.001\mu F$ , $R_T = 47k\Omega$	–	7	–	mA

Note 1. Standard deviation is a measure of the statistical distribution about the mean as derived from the formula:

$$\alpha = \sqrt{\frac{\sum_{n=1}^N (X_n - \bar{X})^2}{N - 1}}$$

### Pin Connection Diagram

