



## Pulse-Width-Modulation Control Circuits

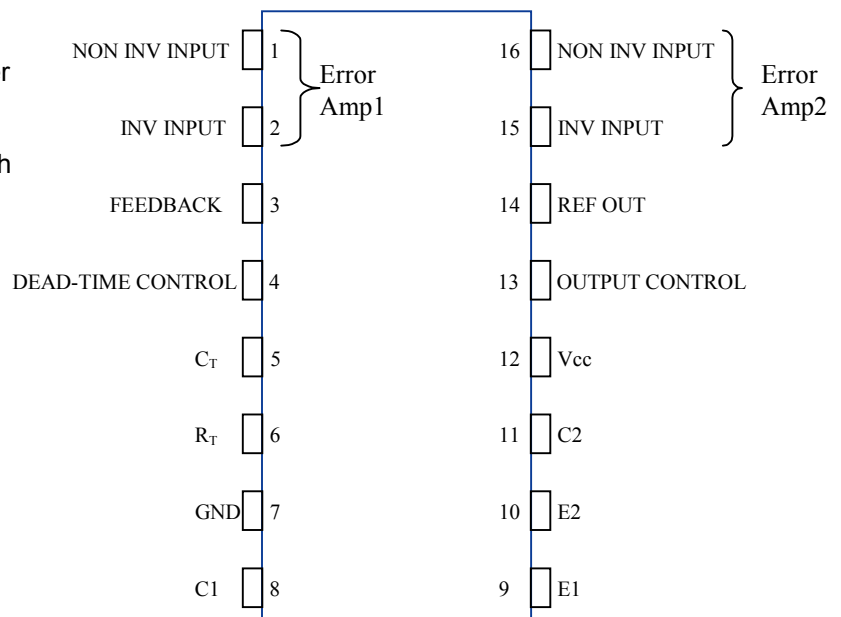
### GENERAL DESCRIPTION

The LND494 incorporate on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control circuit. Designed primarily for power supply control, these devices offer the systems engineer the flexibility to tailor the power supply control circuitry to his application. The LND494 contains an error amplifier, an on-chip adjustable oscillator, a dead time control comparator, pulse –steering control flip-flop, a 5-volt, 5% precision regulator, and output-control circuits. The error amplifier exhibits a common-mode voltage range from  $-0.3$  volts to  $V_{cc}-2$  volts. The dead-time control compactor has a fixed offset that provides approximately 5% dead time when externally altered. The on-chip oscillator may be by passed by terminating  $R_T$  (pin 6) to the reference output and providing a sawtooth input to  $C_T$  (pin 5), or it may be used to drive the common circuits in synchronous multiple-rail power supplies. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Each device provides for push-pull or single-ended output operation, which may be selected through the output-control function. The architecture of these devices prohibits the possibility of either output being pulsed twice during push-pull operation.

### FEATURES

- Complete PWM Circuitry Power Control
- Uncommitted Outputs for 200mA Sink or source current
- Output Control Selects Single-Ended or Push-Pull operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Variable Dead-Time Provides a stable 5-V Reference Supply, 5%
- Circuit Architecture Allows Easy Synchronization

**LND494**  
(Top View)





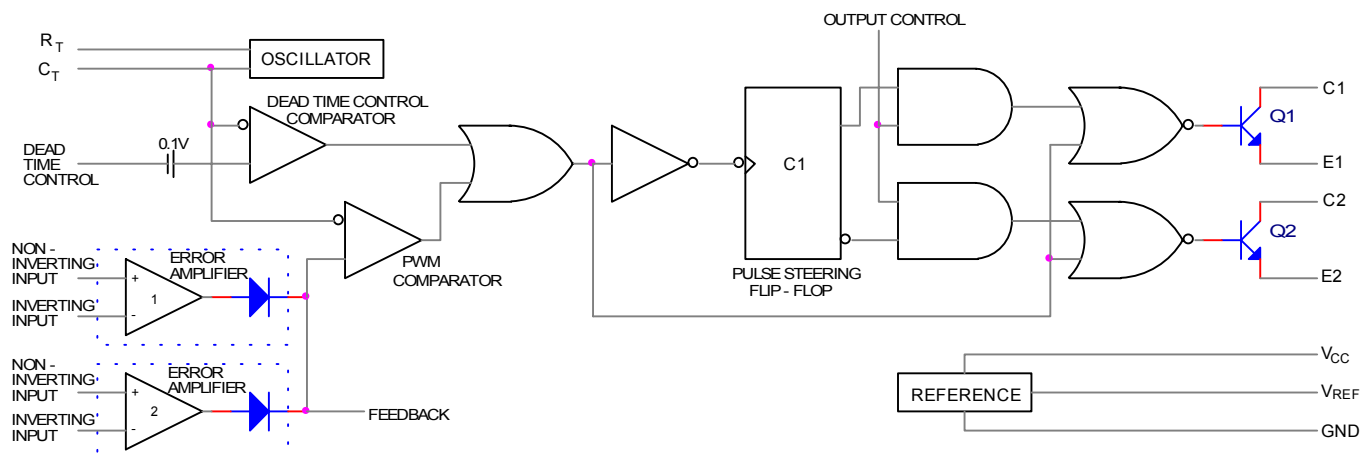
### ABSOLUTE MAXIMUM RATINGS

Rating	Value	Unit
Supply voltage, $V_{cc}$	41	V
Amplifier input voltage	$V_{cc}+0.3$	
Collector output voltage	41	
Collector output current	250	mA
Operating free-air temperature range	0 to 70	°C
Storage temperature range	-65 to 150	
Lead temperature 1,6 mm from case for 10 seconds	260	

### RECOMMENDED OPERATING CONDITIONS

Parameter	Value		Unit
	MIN	MAX	
Supply voltage, $V_{cc}$	7	40	V
Amplifier input voltage, $V_i$	-0.3	$V_{cc}-2$	
Collector output voltage, $V_o$		40	
Collector output current(each transistor)		200	mA
Current into feedback terminal		0.3	
Timing capacitor, $C_T$	0.47	10000	nF
Timing resistor, $R_T$	1.8	500	k $\Omega$
Oscillator Frequency	1	300	kHz
Operating free-air temperature, $T_A$	0	70	°C

### FUNCTIONAL BLOCK DIAGRAM





### PARAMETER MEASUREMENT INFORMATION

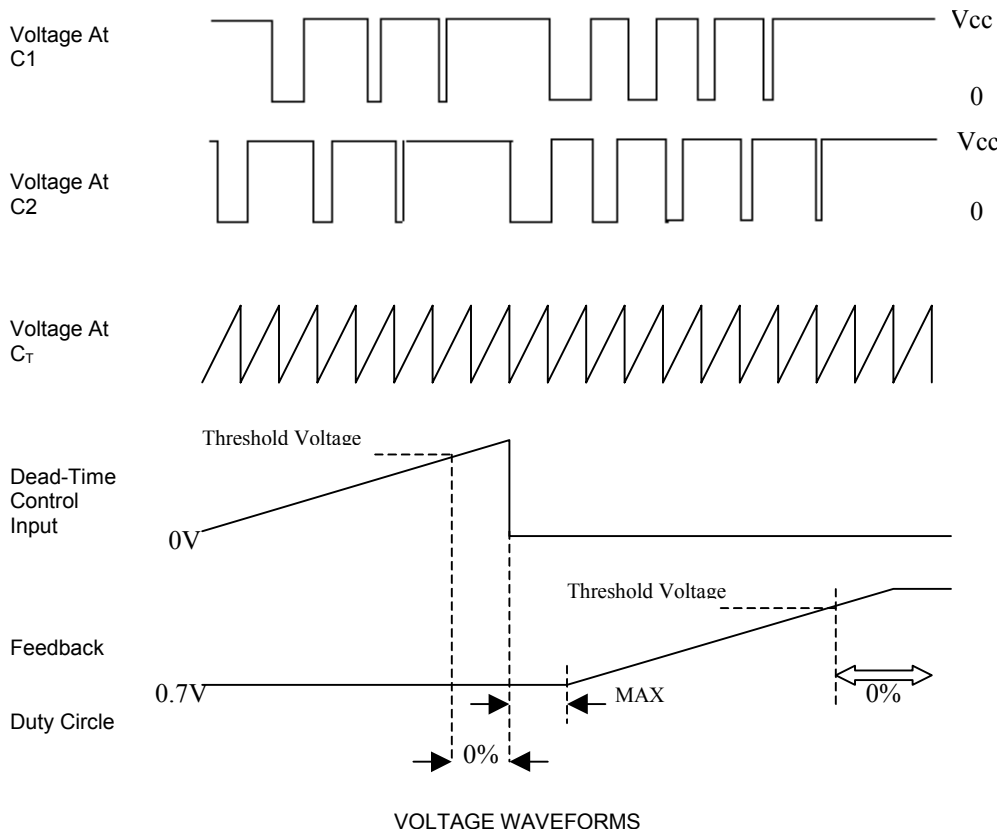
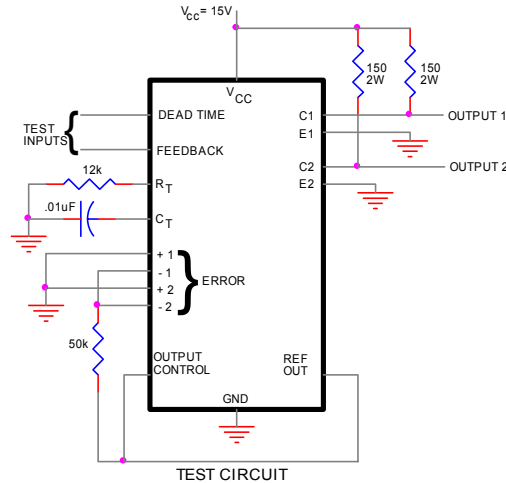


Figure 1: Operational Test Circuit and Waveforms

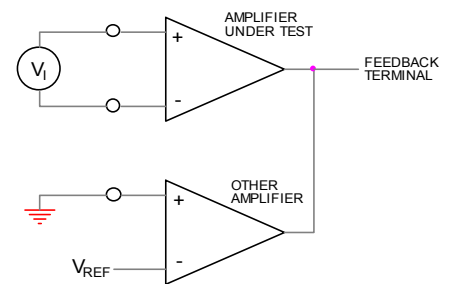


Figure 2: Amplifier Characteristics

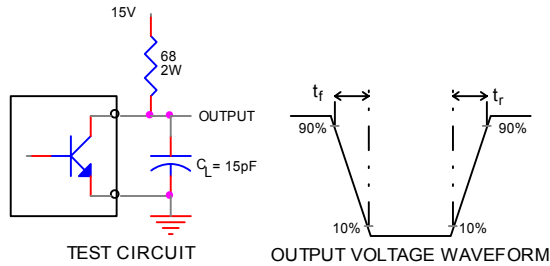


Figure 3: Common-Emitter Configuration

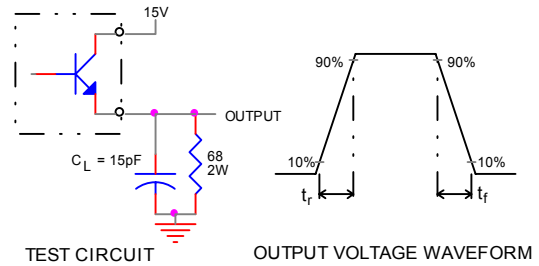


Figure 4: Emitter-Follower Configuration

## ELECTRICAL CHARACTERISTICS

Electrical characteristics over recommended operating free-air temperature range  $V_{cc}=15V$ ,  $f=10kHz$ (unless otherwise noted)

### Reference Section

Parameter	Test conditions*	Value			Unit
		MIN	TYP**	MAX	
Output voltage( $V_{ref}$ )	$I_o=1mA$	4.75	5	5.25	V
Input regulation	$V_{cc}=7V$ to $40V$		2	25	mV
Output regulation	$I_o=1mA$ to $10mA$		1	15	
Output voltage change with temperature	$\Delta T_A = \text{MIN to MAX}$		0.2	1	%
Short-circuit output current <sup>t***</sup>	$V_{ref}=0$		35		mA

### Oscillator Section (See Figure 1)

Parameter	Test conditions*	Value			Unit
		MIN	TYP	MAX	
Frequency	$C_T=0.01\mu F, R_T=12k\Omega$		10		kHz
Standard deviation of frequency****	All values of $V_{cc}$ , $C_T$ , $R_T$ and $T_A$ constant		10		
Frequency change with voltage	$V_{cc}=7V$ to $40V$ , $T_A=25^\circ C$		0.1		%
Frequency change with temperature*****	$C_T=0.01\mu F$ , $R_T=12k\Omega, \Delta T_A=\text{MIN TO MAX}$			1	



**Amplifier Section (See Figure 2)**

Parameter	Test conditions	Value			Unit
		MIN	TYP	MAX	
Input Offset Voltage	$V_o=(pin\ 3)=2.5V$		2	10	mV
Input Offset Current	$V_o=(pin\ 3)= 2.5V$		25	250	nA
Input Bias Current	$V_o=(pin\ 3)=2.5V$		0.2	1	$\mu A$
Common Mode Input Voltage Range	$V_{cc}=7V$ to 40V	-0.3 to $V_{cc}-2$			V
Open Loop Voltage Amplification	$\Delta V_o=3V, R_L=2k\Omega$ $V_o=0.5$ to 3.5V	70	95		DB
Unity Gain Bandwidth	$V_o=0.5$ to 3.5V, $R_L=2k\Omega$		800		KHZ
Common- Mode Rejection Ratio	$\Delta V_o=40V, T_A = 25^\circ C$	65	80		dB
Output Sink Current	$V_{ID}= -15mV$ TO $-5v$ $V_{(PIN3)} =0.7v$	0.3	0.7		mA
Output Source Current	$V_{ID}= -15mV$ TO $-5V$ $V_{(PIN3)} =3.5v$	-2			mA

\*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

\*\* All typical values except for parameter changes with temperature are at  $T_A=25^\circ C$

\*\*\*Duration of the short-circuit should not exceed one second.

\*\*\*\*Standard deviation is a measure of the statistical distribution about the mean as derived from the formula.

$$\sigma = \left[ \sum_{n=1}^N \frac{(x_n - \bar{x})^2}{N-1} \right]^{1/2}$$

\*\*\*\*\*Temperature coefficient of timing capacitor and timing resistor not taken into account

**Output Section**

Parameter	Test conditions	Value			Unit
		MIN	TYP*	MAX	
Collector off-state current	$V_{ce}=40V$ $V_{cc} =40 V$		2	100	$\mu A$
Emitter off-state current	$V_{ce}=V_{cc}=40V$ $V_e=0$			-100	%
Collector-emitter saturation Voltage					V
Common-Emitter Emitter-Follower	$V_e=0, I_c=200mA$ $V_c=15V, I_e=-200mA$		1.1 1.5	1.3 2.5	
Output control input current	$V_I=V_{ref}$			3.5	mA



**Dead-Time Control Section (See figure 1)**

Parameter	Test conditions	Value			Unit
		MIN	TYP*	MAX	
Input Bias current (pin4)	$V_I=0$ to 5.25V		-2	-10	$\mu$ A
Maximum Duty Cycle, Each output	$V_I(\text{pin 4})=0, C_T =0.1\mu\text{F}, R_T =12\text{K}\Omega$		45		%
Input Threshold Voltage (pin4)	Zero duty cycle Maximum Duty Cycle	0	3	3.3	V

**PWM comparator section (see figure 1)**

Parameter	Test Conditions	Value			Unit
		MIN	TYP*	MAX	
Input threshold voltage (pin 3)	Zero duty cycle		4	4.5	V
Input sink current (pin 3)	$V(\text{pin3})= 0.7\text{V}$	0.3	0.7		mA

**Total Device**

Parameter	Test Conditions	Value			Unit
		MIN	TYP	MAX	
Standby supply current	Pin 6 at $V_{ref}$ , all other inputs and outputs open	$V_{cc}=15\text{V}$	6	10	mA
		$V_{cc}=40\text{V}$	9	15	
Average supply current	$V_I(\text{pin 4}) =2\text{V}$ , See figure 1		7.5		

**Switching characteristics,  $T_a=25^\circ\text{C}$**

PARAMETER	TEST CONDITIONS	VALUE			UNIT
		MIN	TYP*	MAX	
Output voltage rise time	Common-emitter configuration		100	200	nS
Output voltage fall time	See figure 3		25	100	
Output voltage rise time	Emitter-follower configuration		100	200	
Output voltage fall time	See Figure 4		40	100	

\*All typical values except for temperature coefficient at  $T_A= 25^\circ\text{C}$