

## PWM Control Circuit

(compatible to TL494)

### Description

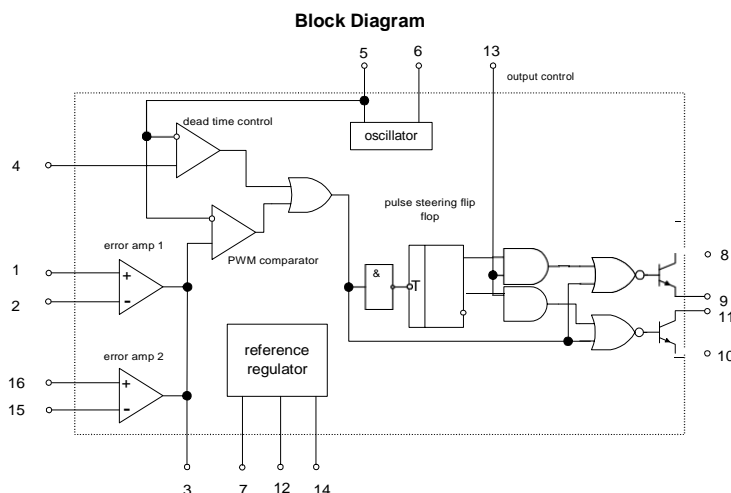
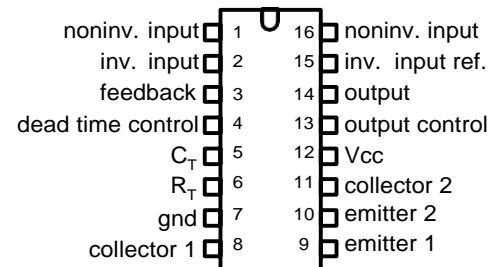
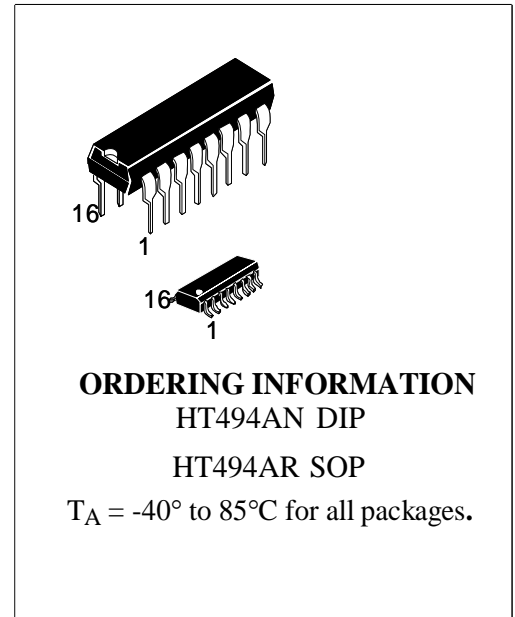
The HT494A incorporates on a single monolithic chip all the function required in the development of a pulse - width modulation control circuits. Designed primarily for power supply control , the HT494A contains an on-chip 5 volt regulator, two error amplifiers, adjustable oscillator, dead time control comparator, pulse-steering flip-flop, and output control circuitry. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Push-pull or single-ended output operation may be selected through the output-control function. The architecture of the HT494A prohibits the possibility of either output being pulsed twice during push-pull operation.

### Features

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200 mA Sink or Source
- Output Control Selects Single-Ended or Push-Pull Operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Internal Regulator Provides a Stable 5V Reference Supply
- Variable Dead-Time Provides Control Over Whole Range

### Function Table

Output Control	Output Function
Grounded	Single-ended or Parallel Output
At $V_{ref}$	Normal Push-Pull Operation



Standard deviation is derived from the formula

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

**RECOMMENDED OPERATION CONDITIONS**

PARAMETER	MIN	MAX	UNIT
Supply Voltage	7	40	V
Amplifier Input Voltage	-0.3	V <sub>cc</sub> -2	V
Collector Output Voltage		40	V
Collector Output Current (Each Transistor)		200	mA
Current Into Feedback Terminal		0.3	mA
Timing Capacitor	0.47	10000	nF
Timing Resistor	1.8	500	kΩ
Oscillator Frequency	1	300	kHz
Operating Free-Air Temperature	-20	85	°C

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage	41V
Amplifier Input Voltage	V <sub>cc</sub> +0.3V
Collector Output Voltage	41V
Continuous Total Dissipation at (or below) 25°C	1000mV
Operating Free-Air Temperature Range	-20 to 85°C
Storage Temperature Range	-65 to 150°C
Collector Output Current	250mA

**Electrical Characteristics (Temperature -20...85°C, V<sub>cc</sub>=15V, f=10kHz)**
**REFERENCE SECTION**

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Output voltage (V <sub>ref</sub> )	I <sub>o</sub> =1mA	4.75	5.25	V
Input regulation	V <sub>cc</sub> =7V to 40V, T <sub>a</sub> =25°C		25	mV
Output regulation	I <sub>o</sub> =1 to 10mA, T <sub>a</sub> =25°C		15	mV
Output voltage change with temperature	T <sub>a</sub> =-20 °C to 85 °C		1	%
Short circuit output current	V <sub>ref</sub>		60	mV

**DEAD TIME CONTROL SECTION**

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Input bias current (pin 4)	V <sub>i</sub> =0V to 5.25V		-10	μA
Maximum duty cycle (each output)	V <sub>i(pin 4)</sub> =0V	45		%
Input threshold voltage (pin 4)	zero duty cycle		3.3	V
	maximum duty cycle	0		V

**ERROR AMPLIFIERS SECTION**

PARAMETER	TEST CONDITIONS		MIN	MAX	UNIT
Input offset voltage	V <sub>o(pin 3)</sub> =2.5			10	mV
Input offset current	V <sub>o(pin 3)</sub> =2.5			250	nA
Input bias current	V <sub>o(pin 3)</sub> =2.5			1	μA
Common mode input voltage range	V <sub>cc</sub> =7 to 40V	LOW	-0.3		V
		HIGH	V <sub>cc</sub> -2		V
Open loop voltage amplification	ΔV <sub>o</sub> =3V, V <sub>o</sub> =0.5 to 3.5V		70		dB
Unity-gain bandwidth			100		kHz
Common mode rejection ratio	V <sub>cc</sub> =40V, T <sub>a</sub> =25°C		65		dB
Output sink current (pin 3)	V <sub>ID</sub> =-15mV to -5V, V <sub>o(pin 3)</sub> =0.7V		0.3		mA
Output source current (pin 3)	V <sub>ID</sub> =15mV to 5V, V <sub>o(pin 3)</sub> =3.5V		-2		mA

**DISSIPATION RATING TABLE**

PACKAGE	T <sub>A</sub> =25°C POWER RATING	OPERATING FACTOR	DERATE ABOVE T <sub>A</sub>	T <sub>A</sub> =70°C POWER RATING	T <sub>A</sub> =85°C POWER RATING
D	900 mW	7.6 mW/°C	25°C	608 mw	494 mW
N	1000 mW	9.2 mW/°C	41°C	736 mW	598 mW

**PWM COMPARATOR SECTION**

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Input threshold voltage (pin 3)	zero duty cycle		4.5	V
Input sink current (pin 3)	$V_{O(\text{pin } 3)}=0.7\text{V}$	0.3		mA

**SWITCHING CHARACTERISTICS**

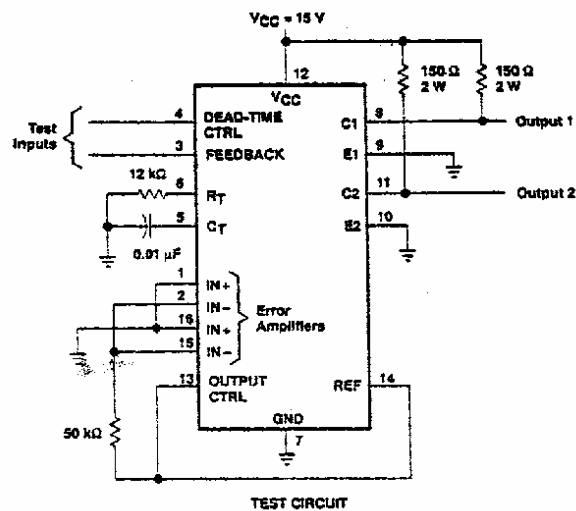
PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Output voltage rise time	Common emitter		200	ns
Output voltage fall time	configuration		100	ns
Output voltage rise time	Emitter-follower		200	ns
Output voltage fall time	configuration		100	ns

**OUTPUT SECTION**

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Collector off-state current	$V_{CE}=40\text{V}, V_{CC}=40\text{V}$		100	$\mu\text{A}$
Emitter off-state current	$V_{CC}=V_C=40\text{V}, V_E=40\text{V}$		-100	$\mu\text{A}$
Collector - Emitter saturation voltage	Common emitter $V_E=0, I_C=200\text{mA}$		1.3	V
	Emitter-follower $V_C=15\text{V}, I_E=-200\text{mA}$		2.5	V
Output control input current	$V_i=V_{ref}$		3.5	mA

**OSCILLATOR SECTION**

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Frequency	$C_T=0.01\mu\text{F}, R_T=12\text{k}\Omega$		30	kHz
Standard deviation of frequency	All Values of $V_{CC}, C_T, R_T, T_a$ are constant		30	%
Frequency change with voltage	$V_{CC}=7\text{V to } 40\text{V}, T_a=25^\circ\text{C}$		10	%
Frequency change with temperature	$C_T=0.01\mu\text{F}, R_T=12\text{k}\Omega,$		2	

**PARAMETER MEASUREMENT INFORMATION**


TEST CIRCUIT

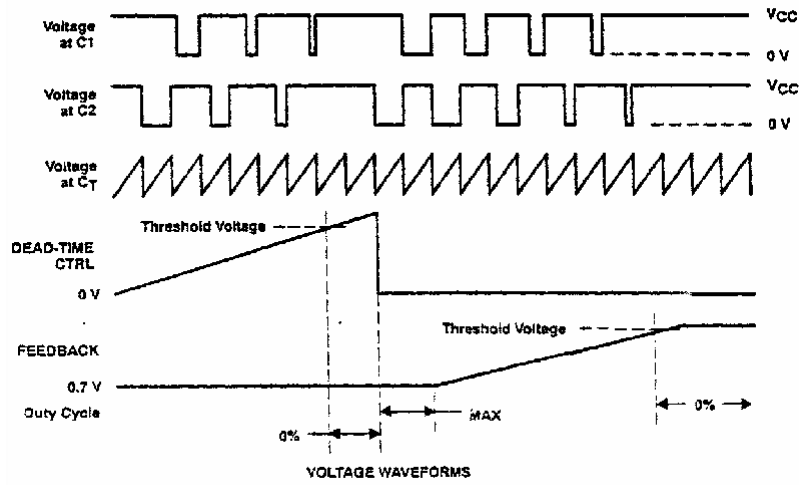


Figure 1. Operational Test Circuit and Waveforms

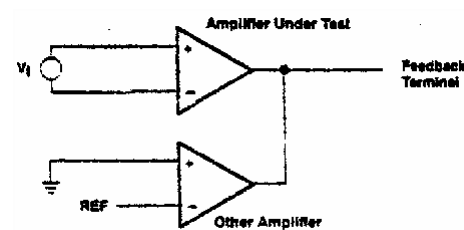


Figure 2. Amplifier Characteristics

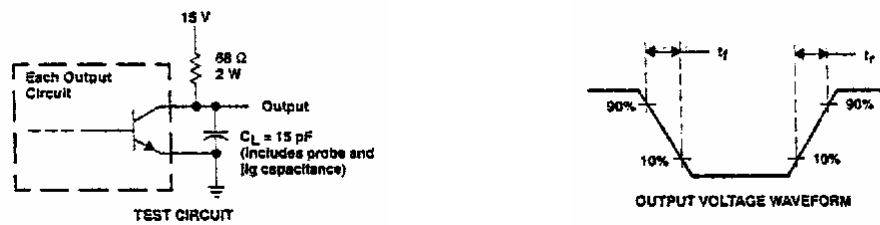


Figure 3. Common-Emitter Configuration

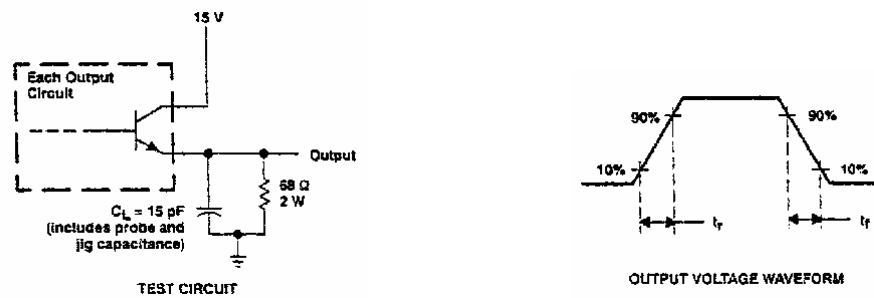


Figure 4. Emitter-Follower Configuration

**TYPICAL CHARACTERISTICS**  
**OSCILLATOR FREQUENCY AND FREQUENCY VARIATION**  
**VS**  
**TIMING RESISTANCE**

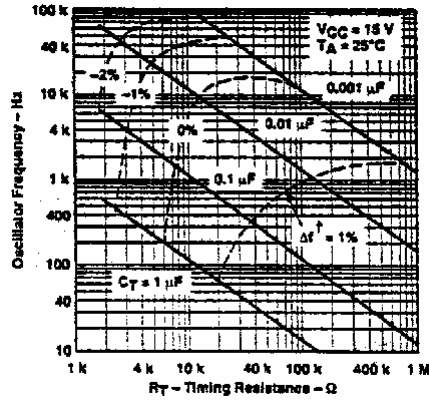


Figure 5

**AMPLIFIER VOLTAGE AMPLIFICATION vs FREQUENCY**

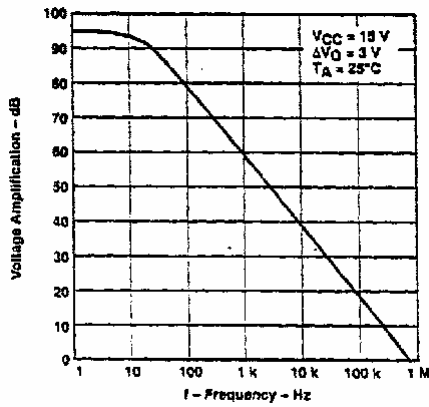


Figure 6