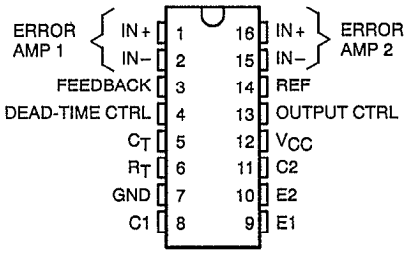
D2535, JANUARY 1983–REVISED SEPTEMBER 1991

- **Complete PWM Power Control Circuitry**
- **Uncommitted Outputs for 200-mA 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 Control Over Total Range**
- **Internal Regulator Provides a Stable 5-V Reference Supply With 5% Tolerance**
- **Circuit Architecture Allows Easy Synchronization**

TL494C, TL494I . . . D OR N PACKAGE
(TOP VIEW)



AVAILABLE OPTIONS

T_A	PACKAGE	
	SURFACE MOUNT (D)	PLASTIC DIP (N)
0°C to 70°C	TL494CD	TL494CN
−40°C to 85°C	TL494ID	TL494IN

The D package is available taped and reeled. Add "R" suffix to device type (e.g., TL494CDR).

FUNCTION TABLE

INPUT OUTPUT CTRL	OUTPUT FUNCTION
$V_I \leq 0$	Single-ended or parallel output
$V_I \leq$ REF	Normal push-pull operation

description

The TL494 incorporates 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, this device offers the systems engineer the flexibility to tailor the power supply control circuitry to a specific application.

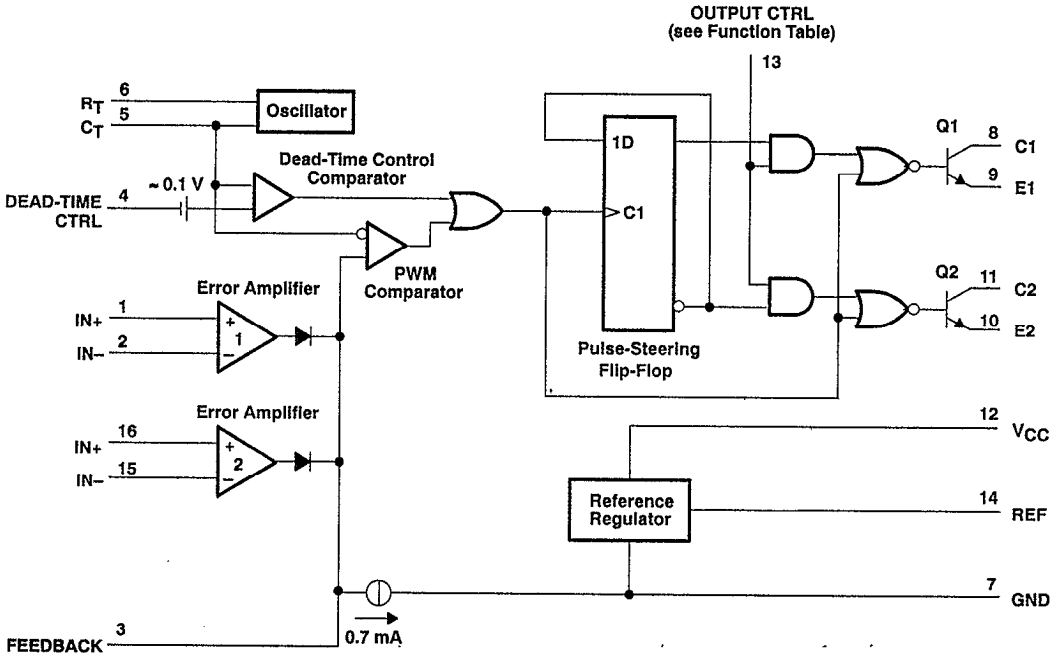
The TL494 contains two error amplifiers, an on-chip adjustable oscillator, a dead-time control comparator, a pulse-steering control flip-flop, a 5-V, 5%-precision regulator, and output-control circuits.

The error amplifiers exhibit a common-mode voltage range from −0.3 V to V_{CC} −2 V. The dead-time control comparator has a fixed offset that provides approximately 5% dead time when externally altered. The on-chip oscillator may be bypassed by terminating R_T to the reference output and providing a sawtooth input to C_T, 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. The TL494 provides for push-pull or single-ended output operation, which may be selected through the output-control function. The architecture of this device prohibits the possibility of either output being pulsed twice during push-pull operation.

The TL494C is characterized for operation from 0°C to 70°C. The TL494I is characterized for operation from −40°C to 85°C.

functional block diagram



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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

	TL494C	TL494I	UNIT
Supply voltage, V_{CC} (see Note 1)	41	41	V
Amplifier input voltage	V_{CC} + 0.3	V_{CC} + 0.3	V
Collector output voltage	41	41	V
Collector output current	250	250	mA
Continuous total dissipation	See Dissipation Rating Table		
Operating free-air temperature range	0 to 70	−40 to 85	°C
Storage temperature range	−65 to 150	−65 to 150	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or N package	260	260	°C

NOTE 1: All voltage values, except differential voltages, are with respect to the network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ 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

recommended operating conditions

	TL494C		TL494I		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC}	7	40	7	40	V
Amplifier input voltage, V_I	−0.3	V_{CC}−2	−0.3	V_{CC}−2	V
Collector output voltage, V_O		40		40	V
Collector output current (each transistor)		200		200	mA
Current into feedback terminal		0.3		0.3	mA
Oscillator frequency	1	300	1	300	kHz
Timing capacitor, C_T	0.47	10000	0.47	10000	nF
Timing resistor, R_T	1.8	500	1.8	500	kΩ
Operating free-air temperature, T_A	0	70	−40	85	°C

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

reference section

PARAMETER	TEST CONDITIONS†	TL494C, TL494I			UNIT
		MIN	TYP‡	MAX	
Output voltage (REF)	I_O = 1 mA	4.75	5	5.25	V
Input regulation	V_{CC} = 7 V to 40 V		2	25	mV
Output regulation	I_O = 1 mA to 10 mA		1	15	mV
Output voltage change with temperature	ΔT_A = MIN to MAX		0.2%	1%	
Short-circuit output current§	REF = 0		35		mA

oscillator section C_T = 0.01 μF, R_T = 12 kΩ (see Figure 1)

PARAMETER	TEST CONDITIONS†	TL494C, TL494I			UNIT
		MIN	TYP‡	MAX	
Frequency	C_T = 0.01 μF, R_T = 12 kΩ		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} = 7 V to 40 V, T_A = 25°C		0.1%		
Frequency change with temperature#	C_T = 0.01 μF, R_T = 12 kΩ, ΔT_A = MIN to MAX			1%	

error amplifier section (see Figure 2)

PARAMETER	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
Input offset voltage	V_O (pin 3) = 2.5 V		2	10	mV
Input offset current	V_O (pin 3) = 2.5 V		25	250	nA
Input bias current	V_O (pin 3) = 2.5 V		0.2	1	μA
Common-mode input voltage range	V_{CC} = 7 V to 40 V	−0.3 to V_{CC}−2			V
Open-loop voltage amplification	ΔV_O = 3 V, R_L = 2 kΩ, V_O = 0.5 V to 3.5 V	70	95		dB
Unity-gain bandwidth	V_O = 0.5 V to 3.5 V, R_L = 2 kΩ		800		kHz
Common-mode rejection ratio	ΔV_O = 40 V, T_A = 25°C	65	80		dB
Output sink current (pin 3)	V_{ID} = −15 mV to −5 V, V (pin 3) = 0.7 V	0.3	0.7		nA
Output source current (pin 3)	V_{ID} = 15 mV to 5 V, V (pin 3) = 3.5 V	−2			nA

† 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°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: $\sigma = \sqrt{\frac{\sum_{n=1}^{N} (x_n - \overline{X})^2}{N-1}}$
# Temperature coefficient of timing capacitor and timing resistor not taken into account.

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

output section

PARAMETER		TEST CONDITIONS		TL494C, TL494I			UNIT
				MIN	TYP†	MAX	
Collector off-state current		V_{CE} = 40 V,	V_{CC} = 40 V		2	100	μA
Emitter off-state current		V_{CC} = V_C = 40 V,	V_E = 0			−100	μA
Collector-emitter saturation voltage	Common emitter	V_E = 0,	I_C = 200 mA		1.1	1.3	V
	Emitter follower	V_C = 15 V,	I_E = −200 mA		1.5	2.5	
Output control input current		V_I = V_{ref}				3.5	mA

dead-time control section (see Figure 1)

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
Input bias current (pin 4)	V_I = 0 to 5.25 V		−2	−10	μA
Maximum duty cycle, each output	V_I (pin 4) = 0, C_T = 0.1 μF, R_T = 12 kΩ		45%		
Input threshold voltage (pin 4)	Zero duty cycle		3	3.3	V
	Maximum duty cycle	0			

pwm comparator section (see Figure 1)

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
Input threshold voltage (pin 3)	Zero duty cycle		4	4.5	V
Input sink current (pin 3)	V (pin 3) = 0.7 V	0.3	0.7		mA

total device

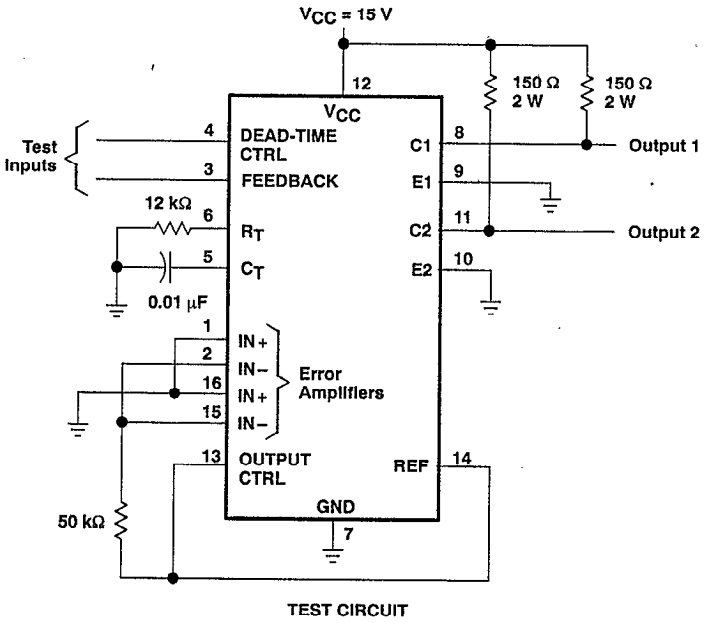
PARAMETER	TEST CONDITIONS		MIN	TYP†	MAX	UNIT
Standby supply current	Pin 6 at REF, All other inputs and outputs open	V_{CC} = 15 V		6	10	mA
		V_{CC} = 40 V		9	15	
Average supply current	V_I (pin 4) = 2 V,	See Figure 1		7.5		mA

switching characteristics, T_A = 25°C

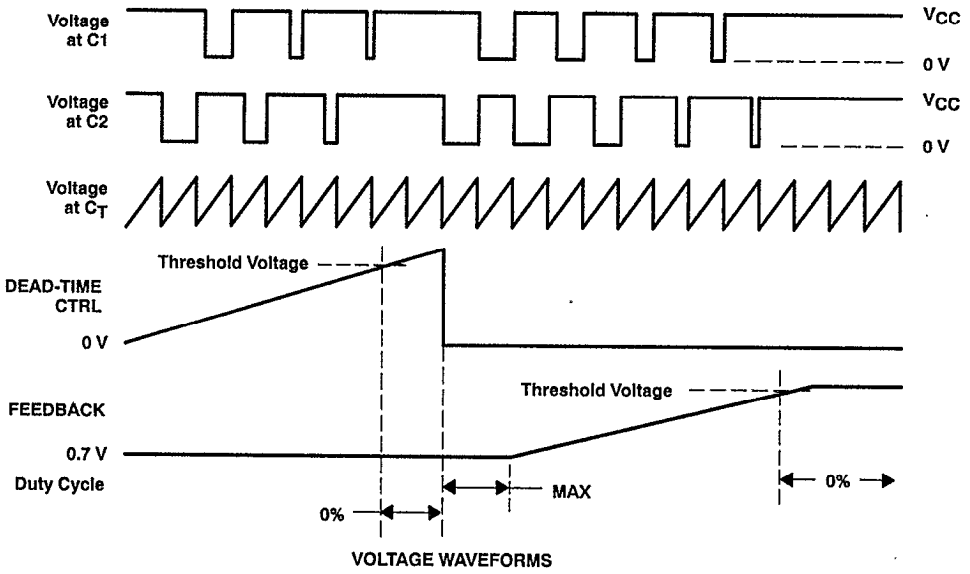
PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
Output voltage rise time	Common-emitter configuration, See Figure 3		100	200	ns
Output voltage fall time			25	100	ns
Output voltage rise time	Emitter-follower configuration, See Figure 4		100	200	ns
Output voltage fall time			40	100	ns

† All typical values except for temperature coefficient are at T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

Figure 1. Operational Test Circuit and Waveforms

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PARAMETER MEASUREMENT INFORMATION

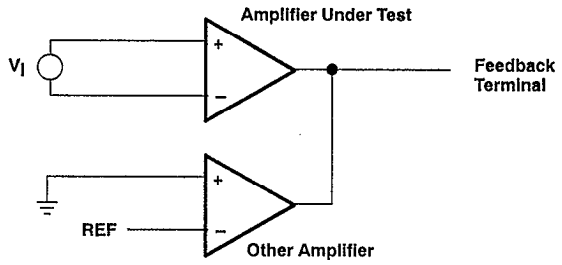

Figure 2. Amplifier Characteristics

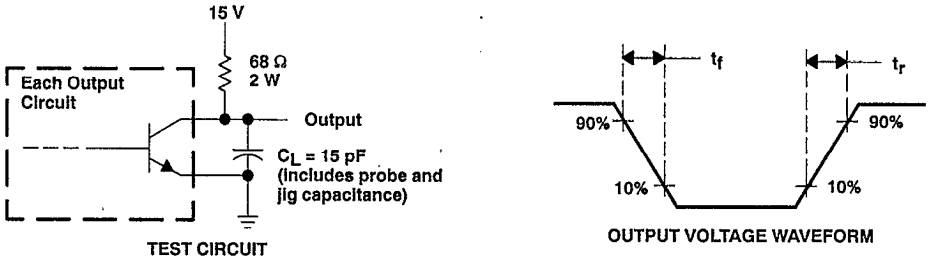

Figure 3. Common-Emitter Configuration

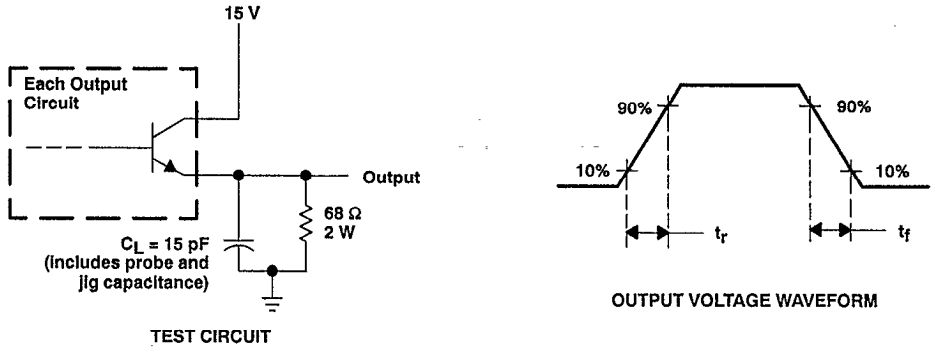

Figure 4. Emitter-Follower Configuration

TYPICAL CHARACTERISTICS

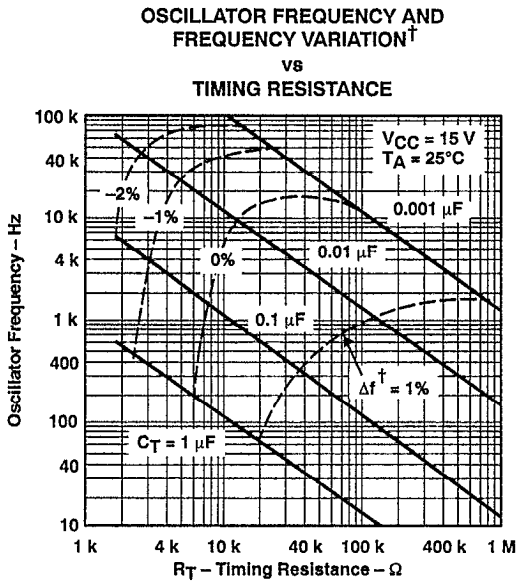

Figure 5

† Frequency variation (Δf) is the change in oscillator frequency that occurs over the full temperature range.

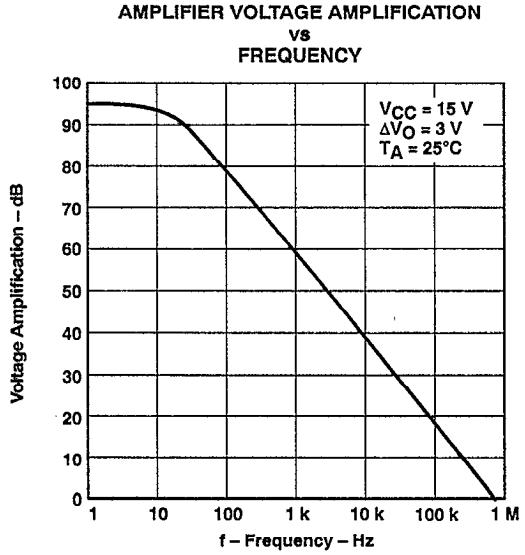

Figure 6