TL494 Pulse-Width-Modulation Control Circuits

FEATURES

- 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

DESCRIPTION

The TL494 device incorporates all the functions required in the construction of a pulse-width-modulation (PWM) control circuit on a single chip. Designed primarily for power-supply control, this device offers the flexibility to tailor the power-supply control circuitry to a specific application.

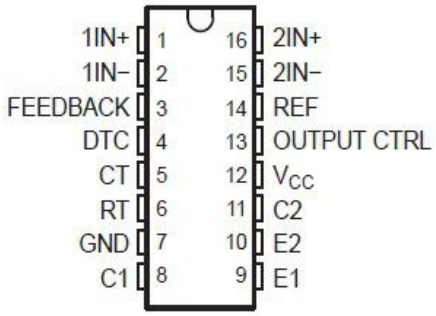
The TL494 device contains two error amplifiers, an on-chip adjustable oscillator, a dead-time control (DTC) comparator, a pulse-steering control flip-flop, a 5-V, 5%-precision regulator, and output-control circuits.

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. The on-chip oscillator can be bypassed by terminating RT to the reference output and providing a sawtooth input to CT, or it can 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 device provides for push-pull or single-ended output operation, which can 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 device is characterized for operation from 0°C to 70°C. The TL494I device is characterized for operation from –40°C to 85°C.

D, DB, N, NS, OR PW PACKAGE
(TOP VIEW)



Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)			41	V
V_I	Amplifier input voltage			V_{CC} + 0.3	V
V_O	Collector output voltage			41	V
I_O	Collector output current			250	mA
θ_{JA}	Package thermal impedance(3)(4)	D package		73	°C/W
		DB package		82	
		N package		67	
		NS package		64	
		PW package		108	
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds			260	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to the network ground terminal.
(3) Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions

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

Electrical Characteristics

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

Reference Section

PARAMETER	TEST CONDITIONS(1)	TL494C, TL494I			UNIT
		MIN	TYP(2)	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		2	10	mV/V
Short-circuit output current(3)	REF = 0 V		25		mA

(1) For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
(2) All typical values, except for parameter changes with temperature, are at T_A = 25°C.
(3) Duration of short circuit should not exceed one second.

Oscillator Section

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

PARAMETER	TEST CONDITIONS(1)	TL494C, TL494I			UNIT
		MIN	TYP(2)	MAX	
Frequency			10		kHz
Standard deviation of frequency(3)	All values of V_{CC}, C_T, R_T, and T_A constant		100		Hz/kHz
Frequency change with voltage	V_{CC} = 7 V to 40 V, T_A = 25°C		1		Hz/kHz
Frequency change with temperature(4)	ΔT_A = MIN to MAX			10	Hz/kHz

(1) For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
(2) All typical values, except for parameter changes with temperature, are at T_A = 25°C.
(3) Standard deviation is a measure of the statistical distribution about the mean as derived from the formula:

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

(4) Temperature coefficient of timing capacitor and timing resistor are not taken into account.

Error-Amplifier Section

See Figure 2

PARAMETER	TEST CONDITIONS	TL494C, TL494I			UNIT
		MIN	TYP(1)	MAX	
Input offset voltage	V_O (FEEDBACK) = 2.5 V		2	10	mV
Input offset current	V_O (FEEDBACK) = 2.5 V		25	250	nA
Input bias current	V_O (FEEDBACK) = 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, V_O = 0.5 V to 3.5 V, R_L = 2 kΩ	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 (FEEDBACK)	V_{ID} = –15 mV to –5 V, V (FEEDBACK) = 0.7 V	0.3	0.7		mA
Output source current (FEEDBACK)	V_{ID} = 15 mV to 5 V, V (FEEDBACK) = 3.5 V	–2			mA

(1) All typical values, except for parameter changes with temperature, are at T_A = 25°C.

Electrical Characteristics

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

Output Section

PARAMETER		TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
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	$V_{O(C1 \text{ or } C2)}$ = 15 V, I_E = –200 mA		1.5	2.5	
Output control input current		V_I = V_{ref}			3.5	mA

(1) All typical values, except for temperature coefficient, are at T_A = 25°C.

Dead-Time Control Section

See Figure 1

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Input bias current (DEAD-TIME CTRL)	V_I = 0 to 5.25 V		–2	–10	μA
Maximum duty cycle, each output	V_I (DEAD-TIME CTRL) = 0, C_T = 0.01 μF, R_T = 12 kΩ		45		%
Input threshold voltage (DEAD-TIME CTRL)	Zero duty cycle		3	3.3	V
	Maximum duty cycle	0			

(1) All typical values, except for temperature coefficient, are at T_A = 25°C.

PWM Comparator Section

See Figure 1

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Input threshold voltage (FEEDBACK)	Zero duty cyle		4	4.5	V
Input sink current (FEEDBACK)	V (FEEDBACK) = 0.7 V	0.3	0.7		mA

(1) All typical values, except for temperature coefficient, are at T_A = 25°C.

Total Device

PARAMETER	TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
Standby supply current	R_T = V_{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 (DEAD-TIME CTRL) = 2 V, See Figure 1			7.5		mA

(1) All typical values, except for temperature coefficient, are at T_A = 25°C.

Switching Characteristics

T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Rise time	Common-emitter configuration, See Figure 3		100	200	ns
Fall time			25	100	ns
Rise time	Emitter-follower configuration, See Figure 4		100	200	ns
Fall time			40	100	ns

(1) All typical values, except for temperature coefficient, are at T_A = 25°C.

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