408-062

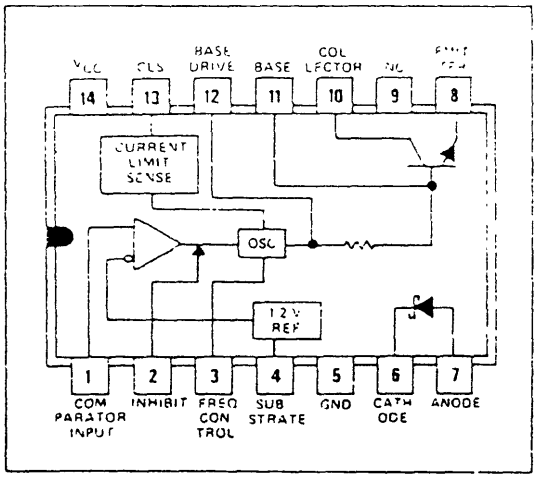
LINEAR INTEGRATED CIRCUITS

TYPES TL497AM, TL497AI, TL497AC SWITCHING VOLTAGE REGULATORS

D2225, JUNE 1976, REVISED JANUARY 1983

- All Monolithic
- High Efficiency . . . 60% or Greater
- Output Current . . . 500 mA
- Input Current Limit Protection
- TTL Compatible Inhibit
- Adjustable Output Voltage
- Input Regulation . . . 0.2% Typ
- Output Regulation . . . 0.4% Typ
- Soft Start-up Capability

TL497AM . . J
TL497AI, TL497AC . . . J OR N
DUAL IN-LINE PACKAGE (TOP VIEW)



NC—No internal connection

description

The TL497A incorporates on a single monolithic chip all the active functions required in the construction of a switching voltage regulator. It can also be used as the control element to drive external components for high-power-output applications. The TL497A was designed for ease of use in step-up, step-down, or voltage inversion applications requiring high efficiency.

A block diagram of the TL497A is shown in the above pinout. The TL497A is a fixed-on-time variable-frequency switching voltage regulator control circuit. The on time is programmed by a single external capacitor connected between the frequency control pin and ground. This capacitor, C_T, is charged by an internal constant-current generator to a predetermined threshold. The charging current and the threshold vary proportionally with V_{CC}, thus the on time remains constant over the specified range of input voltage (5 to 12 volts). Typical on times for various values of C_T are as follows:

TIMING CAPACITOR, C_T (pF)	200	250	350	400	500	750	1000	1500	2000
ON-TIME (μs)	19	22	26	32	44	56	80	120	180

The output voltage is controlled by an external resistor ladder network (R1 and R2 in Figures 1, 2, and 3) that provides a feedback voltage to the comparator input. This feedback voltage is compared to the reference voltage of 1.2 volts (relative to the substrate pin) by the high-gain comparator. When the output voltage decays below the value required to maintain 1.2 V at the comparator input, the comparator enables the oscillator circuit, which charges and discharges C_T as described above. The internal pass transistor is driven on during the charging of C_T. The internal transistor may be used directly for switching currents up to 500 milliamperes. Its collector and emitter are uncommitted and it is current driven to allow operation from the positive supply voltage or ground. An internal Schottky diode matched to the current characteristics of the internal transistor is also available for blocking or commutating purposes. The TL497A also has on-chip current-limit circuitry that senses the peak currents in the switching regulator and protects the inductor against saturation and the pass transistor against overstress. The current limit is adjustable and is programmed by a single sense resistor, R_{CL}, connected between pin 14 and pin 13. The current-limit circuitry is activated when 0.7 volt is developed across R_{CL}. External gating is provided by the inhibit input. When the inhibit input is high, the output is turned off.

Simplicity of design is a primary feature of the TL497A. With only six external components (three resistors, two capacitors, and one inductor), the TL497A will operate in numerous voltage conversion applications (step-up, step-down, invert) with as much as 85% of the source power delivered to the load. The TL497A replaces the TL497 in all applications.

The TL497AM is characterized for operation over the full military temperature range of −55°C to 125°C, the TL497AI is characterized for operation from −25°C to 85°C, and the TL497AC from 0°C to 70°C.

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

Input voltage V_{CC} (see Note 1)	15 V
Output voltage	35 V
Comparator input voltage	5 V
Inhibit input voltage	5 V
Diode reverse voltage	35 V
Power switch current	750 mA
Diode forward current	750 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2)	1000 mW
Operating free-air temperature range TL497AM	−55°C to 125°C
TL497AI	−25°C to 85°C
TL497AC	0°C to 70°C
Storage temperature range	−65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds J package	300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds, N package	260°C

NOTES 1 All voltage values except diode voltages are with respect to network ground terminal
2 Above 28°C free-air temperature, derate the N package at the rate of 9.2 mW/°C. Above 41°C free-air temperature, derate the J glass-mounted package at the rate of 8.2 mW/°C. Above 59°C free-air temperature, derate the J alloy-mounted package at the rate of 11.0 mW/°C. In the J package, TL497AM chips are alloy mounted, TL497AC chips are glass-mounted.

recommended operating conditions

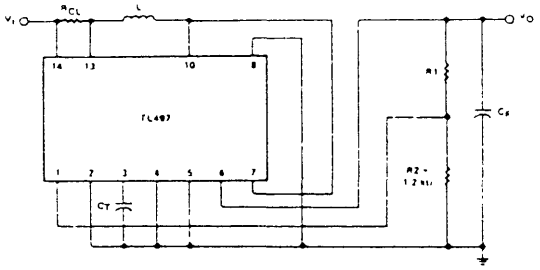
	MIN	MAX	UNIT
Input voltage, V_I	4.5	12	V
Output voltage: step-up configuration (see Figure 1)	$V_I + 2$	30	V
step-down configuration (see Figure 2)	V_{ref}	$V_I - 1$	V
inverting regulator (see Figure 3)	$-V_{ref}$	−25	V
Power switch current		500	mA
Diode forward current		500	mA

electrical characteristics at specified free-air temperature, V_I = 6 V (unless otherwise noted)

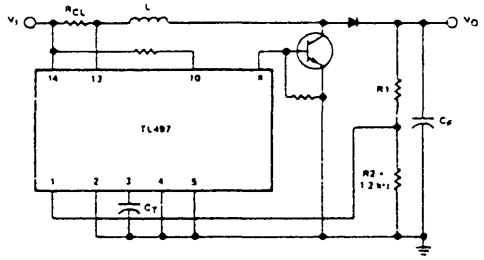
PARAMETER	TEST CONDITIONS†			TL497AM, TL497AI			TL497AC			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
High-level inhibit input voltage			25°C	2.5			2.5			V
Low-level inhibit input voltage			25°C			0.8			0.8	V
High-level inhibit input current	$V_{I(I)}$ = 5 V		Full range		0.8	1.5		0.8	1.5	mA
Low-level inhibit input current	$V_{I(I)}$ = 0 V		Full range		5	20		5	10	μA
Comparator reference voltage	V_I = 4.5 V to 6 V		Full range	1.14	1.20	1.26	1.08	1.20	1.32	V
Comparator input bias current	V_I = 6 V		Full range		40	100		40	100	μA
Switch on-state voltage	V_I = 4.5 V	I_O = 100 mA	25°C		0.13	0.2		0.13	0.2	V
		I_O = 500 mA	Full range			1			0.85	
Switch off-state current	V_I = 4.5 V,	V_O = 30 V	25°C		10	50		10	50	μA
			Full range			500			200	
Current-limit sense voltage	V_I = 6 V		25°C	0.45		1	0.45		1	V
Diode forward voltage	I_O = 10 mA		Full range		0.75	0.95		0.75	0.85	V
	I_O = 100 mA		Full range		0.9	1.1		0.9	1	
	I_O = 500 mA		Full range		1.33	1.75		1.33	1.55	
Diode reverse voltage	I_O = 500 μA		Full range	30						V
	I_O = 200 μA		Full range				30			
On-state supply current			25°C		11	14		11	14	mA
			Full range			16			15	
Off-state supply current			25°C		6	9		6	9	mA
			Full range			11			10	

† Full range is −55°C to 125°C for TL497AM, −25°C to 85°C for TL497AI, and 0°C to 70°C for TL497AC.
‡ All typical values are at T_A = 25°C.

TYPICAL APPLICATION DATA



BASIC CONFIGURATION
(I_{PK} < 500 mA)



EXTENDED POWER CONFIGURATION
(USING EXTERNAL TRANSISTOR)

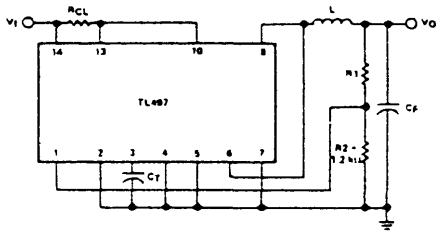
DESIGN EQUATIONS

- $I_{PK} = 2\ I_O\ max \left[\frac{V_O}{V_I}\right]$
- $L\ (\mu H) = \frac{V_I}{I_{PK}}\ t_{on}(\mu s)$

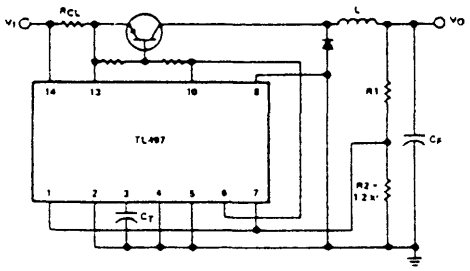
Choose L (50 to 500 μH), calculate t_{on} (25 to 150 μs)

- $C_T(pF) \approx 12\ t_{on}(\mu s)$
- $R1 = (V_O - 1.2)\ k\Omega$
- $R_{CL} = \frac{0.5\ V}{I_{PK}}$
- $C_F\ (\mu F) \approx t_{on} \frac{\left[\frac{V_I}{V_O} I_{PK} + I_O\right]}{V_{ripple\ (PK)}}$

FIGURE 1–POSITIVE REGULATOR, STEP-UP CONFIGURATIONS



BASIC CONFIGURATION
I_{PK} < 500 mA)



EXTENDED POWER CONFIGURATION
(USING EXTERNAL TRANSISTOR)

DESIGN EQUATIONS

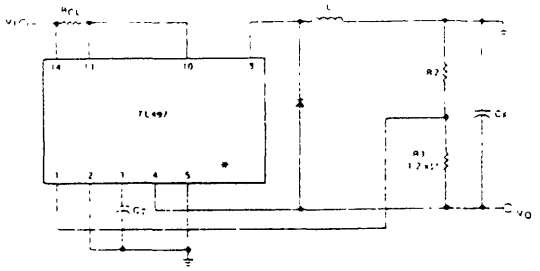
- $I_{PK} = 2\ I_O\ max$
- $L\ (\mu H) = \frac{V_I - V_O}{I_{PK}}\ t_{on}(\mu s)$

Choose L (50 to 500 μH), calculate t_{on} (10 to 150 μs)

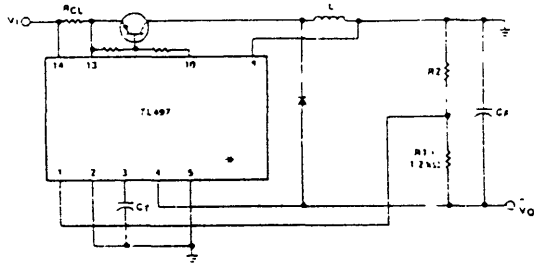
- $C_T(pF) \approx 12\ t_{on}(\mu s)$
- $R1 = (V_O - 1.2)\ k\Omega$
- $R_{CL} = \frac{0.5\ V}{I_{PK}}$
- $C_F\ (\mu F) \approx t_{on} \frac{\left[\frac{V_I}{V_O} I_{PK} + I_O\right]}{V_{ripple\ (PK)}}$

FIGURE 2–POSITIVE REGULATOR, STEP-DOWN CONFIGURATIONS

TYPICAL APPLICATION DATA



BASIC CONFIGURATION
(I_{PK} < 500 mA)



EXTENDED POWER CONFIGURATION
(USING EXTERNAL TRANSISTOR)

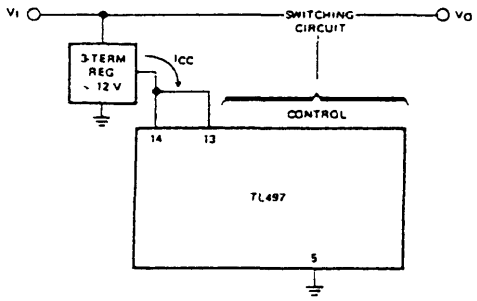
- $I_{PK} = 2\, I_O \max \left[1 + \frac{|V_O|}{V_I}\right]$
- $L\ (\mu H) = \frac{V_I}{I_{PK}}\ t_{on}(\mu s)$

Choose L (50 to 500 μH), calculate t_{on} (25 to 150 μs)

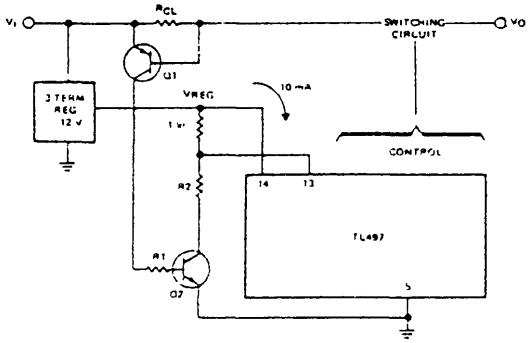
- $C_T(pF) \approx 12\ t_{on}(\mu s)$
- $R2 = (V_O - 1.2)\ k\Omega$
- $R_{CL} = \frac{0.5\ V}{I_{PK}}$
- $C_F\ (\mu F) \approx \frac{\left[\frac{V_I}{V_O}\ I_{PK} + I_O\right]}{V_{ripple\ (PK)}}$

*Use external catch-diode, e.g., 1N4001, when building an inverting supply with the TL497A.

FIGURE 3–INVERTING APPLICATIONS



EXTENDED INPUT CONFIGURATION WITHOUT CURRENT LIMIT



CURRENT LIMIT FOR EXTENDED INPUT CONFIGURATION

DESIGN EQUATIONS

$$R_{CL} = \frac{V_{BE(Q1)}}{I_{limit\ (PK)}}$$

$$R1 = \frac{V_I}{I_{B(Q2)}}$$

$$R2 = (V_{reg} - 1)\ 10\ k\Omega$$

FIGURE 4–EXTENDED INPUT VOLTAGE RANGE (V_I > 15 V)

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