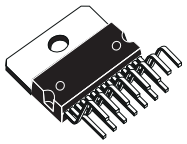
L4970A

10A SWITCHING REGULATOR

- 10A OUTPUT CURRENT
- 5.1V TO 40V OUTPUT VOLTAGE RANGE
- 0 TO 90% DUTY CYCLE RANGE
- INTERNAL FEED-FORWARD LINE REGULATION
- INTERNAL CURRENT LIMITING
- PRECISE 5.1V ± 2% ON CHIP REFERENCE
- RESET AND POWER FAIL FUNCTIONS
- SOFT START
- INPUT/OUTPUT SYNC PIN
- UNDER VOLTAGE LOCK OUT WITH HYSTERETIC TURN-ON
- PWM LATCH FOR SINGLE PULSE PER PERIOD
- VERY HIGH EFFICIENCY
- SWITCHING FREQUENCY UP TO 500KHz
- THERMAL SHUTDOWN
- CONTINUOUS MODE OPERATION

MULTIPOWER BCD TECHNOLOGY



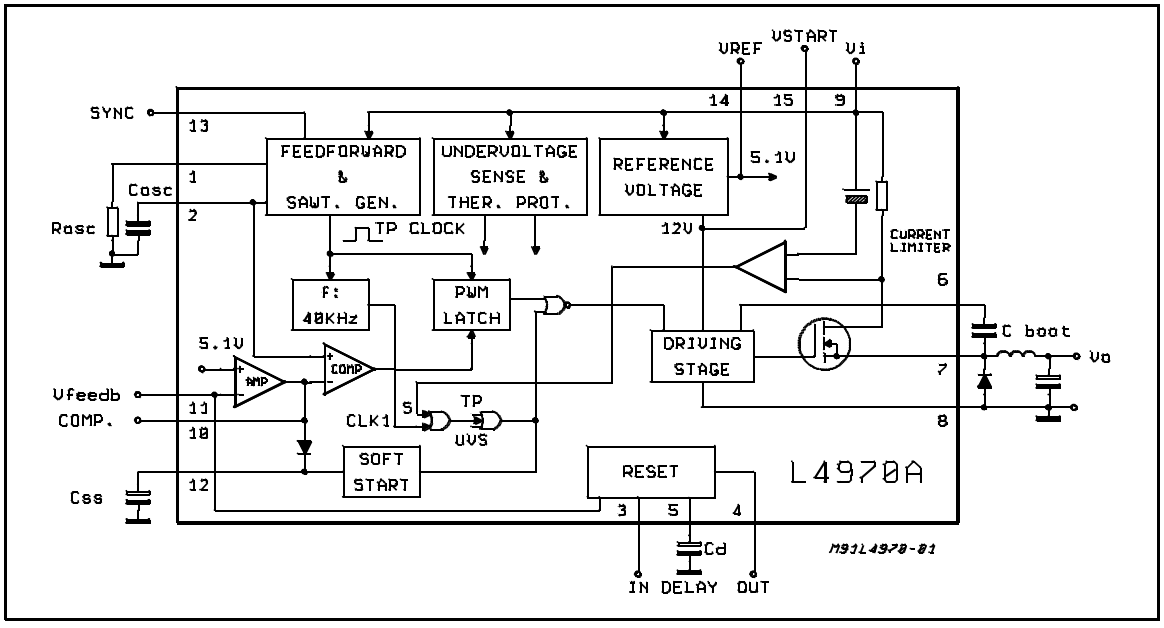
Multiwatt15V
ORDERING NUMBER: L4970A

DESCRIPTION

The L4970A is a stepdown monolithic power switching regulator delivering 10A at a voltage variable from 5.1 to 40V.

Realized with BCD mixed technology, the device uses a DMOS output transistor to obtain very high efficiency and very fast switching times. Features of the L4970A include reset and power fail for microprocessors, feed forward line regulation, soft start, limiting current and thermal protection. The device is mounted in a 15-lead multiwatt plastic power package and requires few external components. Efficient operation at switching frequencies up to 500KHz allows reduction in the size and cost of external filter components.

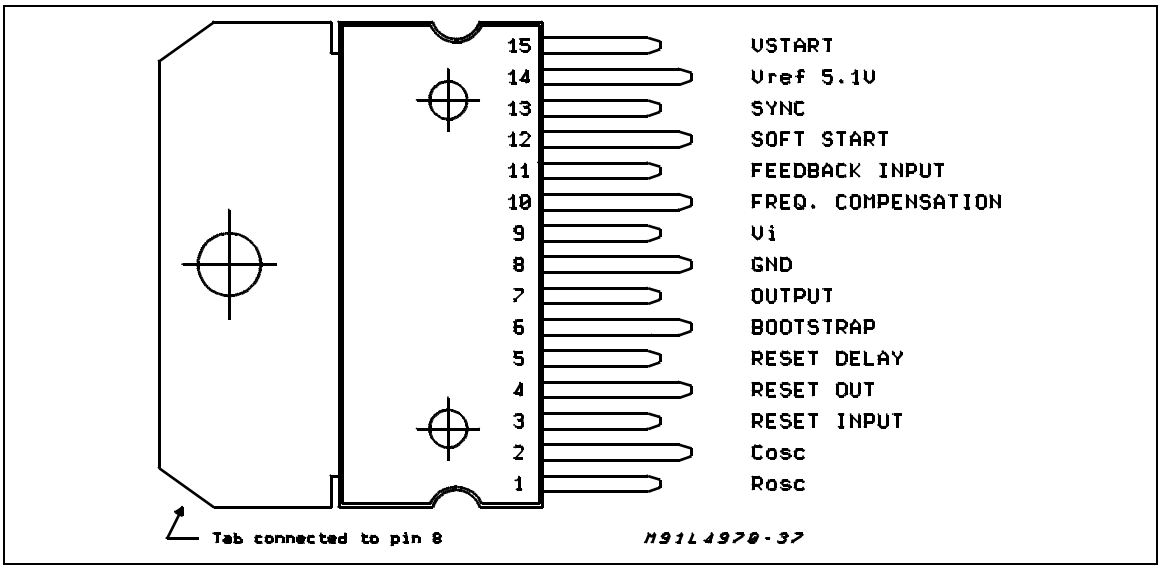
BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_9	Input Voltage	55	V
V_9	Input Operating Voltage	50	V
V_7	Output DC Voltage Output Peak Voltage at t = 0.1µs f = 200KHz	-1 -7	V V
I_7	Maximum Output Current	Internally Limited	
V_6	Bootstrap Voltage Bootstrap Operating Voltage	65 V_9 + 15	V V
V_3, V_{12}	Input Voltage at Pins 3, 12	12	V
V_4	Reset Output Voltage	50	V
I_4	Reset Output Sink Current	50	mA
V_5, V_{10}, V_{11}, V_{13}	Input Voltage at Pin 5, 10, 11, 13	7	V
I_5	Reset Delay Sink Current	30	mA
I_{10}	Error Amplifier Output Sink Current	1	A
I_{12}	Soft Start Sink Current	30	mA
P_{tot}	Total Power Dissipation at T_{case} < 120°C	30	W
T_j, T_{stg}	Junction and Storage Temperature	-40 to 150	°C

PIN CONNECTION (Top view)



THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case	max	1	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	max	35	°C/W

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, T_j = 25°C, V_i = 35V, R_4 = 16KΩ, C_9 = 2.2nF, f_{SW} = 200KHz typ, unless otherwise specified)

DYNAMIC CHARACTERISTICS

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_i	input Voltage Range (pin 9)	$V_o = V_{ref}$ to 40V I_o = 10A	15		50	V	5
V_o	Output Votage	V_i = 15V to 50V I_o = 5A; $V_o = V_{ref}$	5	5.1	5.2	V	5
ΔV_o	Line Regulation	V_i = 15V to 50V I_o = 5A; $V_o = V_{ref}$		12	30	mV	5
ΔV_o	Load Regulation	$V_o = V_{ref}$ I_o = 3A to 6A I_o = 2A to 10A		 10 20	 30 50	 mV mV	5
V_d	Dropout Voltage Between Pin 9 and 7	I_o = 5A I_o = 10A		0.55 1.1	0.8 1.6	V V	5
I_{7L}	Max. Limiting Current	V_i = 15 to 50V	11	13	15	A	5
η	Efficiency	I_o = 5A $V_o = V_{ref}$ V_o = 12V	80	 85 92		 % %	5
		I_o = 10A $V_o = V_{ref}$ V_o = 12V	75	 80 87		 % %	5
SVR	Supply Voltage Ripple Reject.	V_i = 2VRMS; I_o = 5A f = 100Hz; $V_o = V_{ref}$	56	60		dB	5
f	Switching Frequency		180	200	220	KHz	5
$\frac{\Delta f}{\Delta V_i}$	Voltage Stability of Swiching Frequency	V_i = 15V to 45V		2	6	%	5
$\frac{\Delta f}{T_j}$	Temperature Stability of Swiching Frequency	T_j = 0 to 125°C		1		%	5
f_{max}	Maximum Operating Switching Frequency	$V_o = V_{ref}$; R_4 = 10KΩ I_o = 10A; C_9 = 1nF	500			KHz	5

V_{ref} SECTION (pin 14)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_{14}	Reference Voltage		5	5.1	5.2	V	7
ΔV_{14}	Line Regulation	V_i = 15V to 50V		10	25	mV	7
ΔV_{14}	Load Regulation	I_{14} = 0 to 1mA		20	40	mV	7
$\frac{\Delta V_{14}}{\Delta T}$	Average Temperature Coefficient Reference Voltage	T_j = 0°C to 125°C		0.4		mV/°C	7
$I_{14\ short}$	Short Circuit Current Limit	V_{14} = 0		70		mA	7

V_{START} SECTION (pin 15)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_{15}	Reference Voltage		11.4	12	12.6	V	7
ΔV_{15}	Line Regulation	V_i = 15 to 50V		0.6	1.4	V	7
ΔV_{15}	Load Regulation	I_{15} = 0 to 1mA		50	200	mV	7
$I_{15\ short}$	Short Circuit Current Limit	V_{15} = 0V		80		mA	7

ELECTRICAL CHARACTERISTICS (continued)

DC CHARACTERISTICS

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_{9on}	Turn-on Threshold		10	11	12	V	7A
$V_{9\ Hyst}$	Turn-off Hysteresys			1		V	7A
I_{9Q}	Quiescent Current	V_{12} = 0; S1 = D		13	19	mA	7A
I_{9OQ}	Operating Supply Current	V_{12} = 0; S1 = C; S2 = B		16	23	mA	7A
I_{7L}	Out Leak Current	V_i = 55V; S3 = A; V_{12} = 0			2	mA	7A

SOFT START

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
I_{12}	Soft Start Source Current	V_{12} = 3V; V_{11} = 0V	70	100	130	µA	7B
V_{12}	Output Saturation Voltage	I_{12} = 20mA; V_9 = 10V			1	V	7B
		I_{12} = 200µA; V_9 = 10V			0.7	V	7B

ERROR AMPLIFIER

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_{10H}	High Level Out Voltage	I_{10} = -100µA; S1 = C V_{11} = 4.7V	6			V	7C
V_{10L}	Low Level Out Voltage	I_{10} = +100µA; S1 = C V_{11} = 5.3V;			1.2	V	7C
I_{10H}	Source Output Current	V_{10} = 1V; S1 = E V_{11} = 4.7V	100	150		µA	7C
I_{10L}	Sink Output Current	V_{10} = 6V; S1 = D V_{11} = 5.3V	100	150		µA	7C
I_{11}	Input Bias Current	R_S = 10KΩ		0.4	3	µA	–
G_V	DC Open Loop Gain	V_{VCM} = 4V; R_S = 10Ω	60			dB	–
SVR	Supply Voltage Rejection	15 < V_i < 50V; R_S = 10Ω	60	80		dB	–
V_{OS}	Input Offset Voltage	R_S = 50Ω		2	10	mV	–

RAMP GENERATOR (pin 2)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit	Fig.
V_2	Ramp Valley	S1 = C; S2 = B		1.2	1.5		V	7A
V_2	Ramp Peak	S1 = C;	V_i = 15V		2.5		V	7A
		S2 = B;	V_i = 45V		5.5		V	7A
I_2	Min. Ramp Current	S1 = A; I_1 = 100µA			270	300	µA	7A
I_2	Max. Ramp Current	S1 = A; I1 = 1mA		2.4	2.7		mA	7A

SYNC FUNCTION (pin 13)

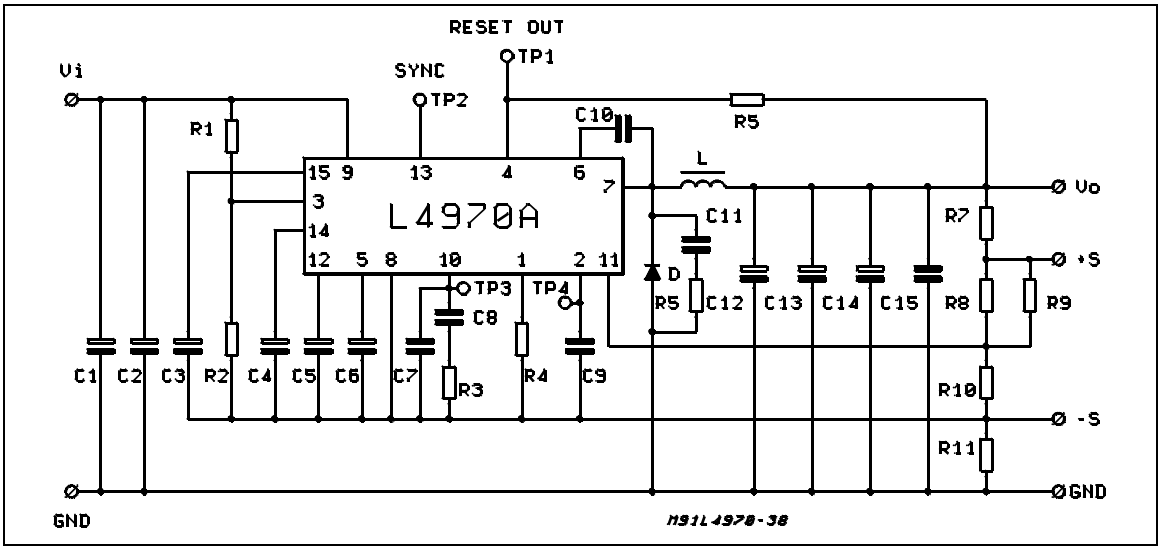
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_{13}	Low Input Voltage	V_i = 15V to 50V; V_{12} = 0; S1 = C; S2 = B; S4 = B	–0.3		0.9	V	7A
V_{13}	High Input voltage	V_{12} = 0; S1 = C; S2 = B; S4 = B	3.5		5.5	V	7A
I_{13L}	Sync Input Current with Low Input Voltage	V_{13} = V_2 = 0.9V; S4 = A; S1 = C; S2 = B			0.4	mA	7A
I_{13H}	Input Current with High Input Voltage	V_{13} = 3.5V; S4 = A; S1 = C; S2 = B			2	mA	7A
V_{13}	Output Amplitude		4	5		V	–
t_W	Output Pulse Width	V_{thr} = 2.5V	0.3	0.5	0.8	µs	–

ELECTRICAL CHARACTERISTICS (continued)

RESET AND POWER FAIL FUNCTIONS

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	Fig.
V_{11R}	Rising Threshold Voltage (pin 11)	V_i = 15 to 50V V_3 = 5.3V	V_{ref} –120	V_{ref} –100	V_{ref} –80	V mV	7D
V_{11F}	Falling Threshold Voltage (pin 11)	Vi = 15 to 50V V_3 = 5.3V	4.77	V_{ref} –200	V_{ref} –160	V mV	7D
V_{5H}	Delay High Threshold Voltage	V_i = 15 to 50V V_{14} = V_{11} V_3 = 5.3V	4.95	5.1	5.25	V	7D
V_{5L}	Delay Low Threshold Voltage	Vi = 15 to 50V V_{14} = V_{11} V_3 = 5.3V	1	1.1	1.2	V	7D
$-I_{5SO}$	Delay Source Current	V_3 = 5.3V; V_5 = 3V	40	60	80	µA	7D
I_{5SI}	Delay Sink Current	V_3 = 4.7V; V_5 = 3V	10			mA	7D
V_{4S}	Out Saturation Voltage	I_4 = 15mA; S1 = B V_3 = 4.7V			0.4	V	7D
I_4	Output Leak Current	V_4 = 50V; S1 = A V_3 = 5.3V			100	µA	7D
V_{3R}	Rising Threshold Voltage	V_{11} = V_{14}	4.95	5.1	5.25	V	7D
V_{3H}	Hysteresys		0.4	0.5	0.6	V	7D
I_3	Input Bias Current			1	3	µA	7D

Figure 5: Test and Evaluation Board Circuit



TYPICAL PERFORMANCES (using evaluation board) :

n = 83% (V_i = 35V ; V_o = V_{REF} ; I_o = 10A ; f_{SW} = 200KHz)

$V_{o\ RIPPLE}$ = 30mV (at 10A) with output filter capacitor ESR ≤ 60mΩ

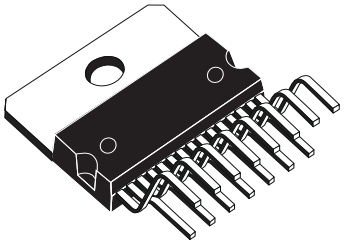
Line regulation = 5mV (V_i = 15 to 50V)

Load regulation = 15mV (I_o = 2 to 10A)

For component values, refer to test circuit part list.

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.66		0.75	0.026		0.030
G	1.02	1.27	1.52	0.040	0.050	0.060
G1	17.53	17.78	18.03	0.690	0.700	0.710
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.870	0.886
L2	17.65		18.1	0.695		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.63	5.08	5.53	0.182	0.200	0.218
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

OUTLINE AND MECHANICAL DATA



Multiwatt15 V