NEC
ELECTRON DEVICE

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC494

SWITCHING REGULATOR CONTROL CIRCUIT
SILICON MONOLITHIC BIPOLAR INTEGRATED CIRCUIT

DESCRIPTION

The μPC494 is an inverter control unit which provides all the control circuitry for PWM type switching regulators. Included in this device is the voltage reference, dual error amplifiers, oscillator, pulse width modulator, pulse steering flip flop, dual alternating output switches and dead time control.

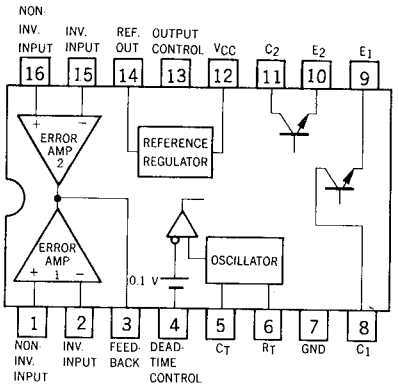
FEATURES

- Complete PWM Power Control Circuit.
- Adjustable Dead-time (0 to 100 %).
- No Double pulsing of same output during load transient condition.
- Dual error amplifiers have wide common mode input voltage capability (−0.3 V to V_{CC}−2 V).
- Circuit architecture provides easy synchronization.
- Uncommitted outputs for 250 mA sink or source.
- With Miss-operation Prevention Circuit for low level supply voltage.
- Full Pin-Compatible TL494C.

ORDERING INFORMATION

Part Number	Package
μPC494C	16 Pin Plastic DIP (300 mil)
μPC494G	16 Pin Plastic SOP (375 mil)
μPC494GS	16 Pin Plastic SOP (300 mil)

CONNECTION DIAGRAM (Top View)



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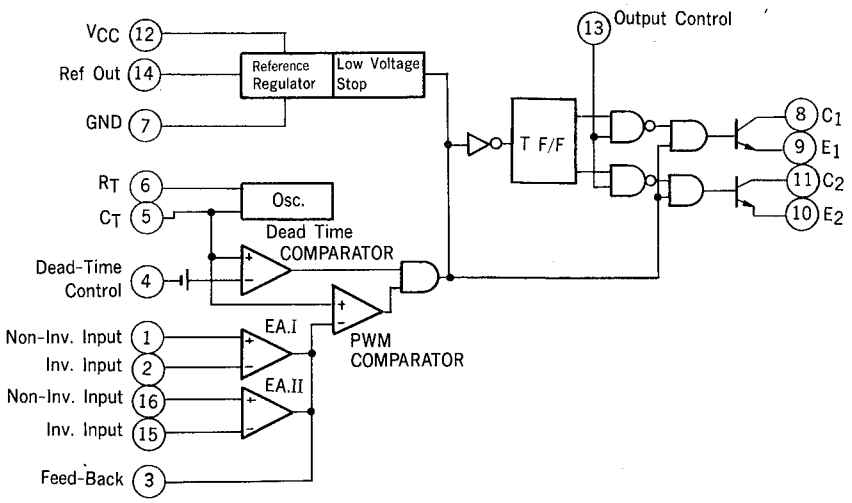
BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25 °C)

Supply Voltage	V_{CC}	41	V
Error Amplifier Input Voltage	V_{ICM}	V_{CC}+0.3	V
Output Voltage	V_{CER}	41	V
Output Current	I_C	250	mA
Total Power Dissipation	$P_{T(T_a=25\,°C)}$	1000	mW
Operating Temperature Range	T_{opt}	−20 to +85	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

RECOMMENDED OPERATING CONDITIONS

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{CC}	7		40	V
Output Voltage	V_{CER}	−0.3		40	V
Output Current	I_C			200	mA
Error Amplifier Sink Current	I_{OAMP}			−0.3	mA
Timing capacitor	C_T	0.47		10 000	nF
Timing Resistance	R_T	1.8		500	kΩ
Oscillation Frequency	f_{osc}	1		300	kHz
Operating Temperature	T_{opt}	−20		+70	°C

ELECTRICAL CHARACTERISTICS (V_{CC}=15 V, f=10 kHz, −20 ≦ T_a ≦ +70 °C, unless otherwise noted)

BLOCK	CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Reference Section	Output Voltage		V_{ref}	4.75	5	5.25	V	I_{ref}=1 mA, T_a=25 °C
	Line Regulation		REG_{IN}		8	25	mV	7 V≦V_{CC}≦40 V I_{ref}=1 mA, Ta=25 °C
	Load Regulation		REG_L		1	15	mV	1 mA≦1_{ref}≦10 mA, T_a=25 °C
	Temperature Coefficient		V_{ref}		0.01	0.03	%/°C	−20 °C = T_a ≦ +85 °C I_{ref}=1 mA
	(Note 2) Short Circuit Output Current		I_{short}		50		mA	V_{ref}=0, T_a=25 °C
Oscillator Section	Frequency		f_{osc}		10		kHz	C_T=0.01 μF, R_T= 12 kΩ, T_a=25 °C
	(Note 1) Standard Deviation of Frequency				10		%	7 V ≦V_{CC}≦ 40 V, C_T, R_T, const. T_a=25 °C
	Frequency Change with Temperature				1	2	%	0 °C≦ T_a ≦ 70 °C, C_T=0.01 μF R_T=12 kΩ
	Frequency Change with Voltage					1	%	7V ≦V_{CC}≦40 V, C_T=0.01 μF T_a=25 °C, R_T=12 kΩ
Dead-time Control Section	Input Bias Current				−2	−10	μA	0≦V_I≦5.25 V
	Maximum Duty Cycle (Each Output)			45	49		%	V_I=0
	Input Threshold Voltage		V_{th}		3	3.3	V	Zero duty cycle
				0				Maximum duty cycle
Error Amplifier Section	Input Offset Voltage		V_{IO}		2	10	mV	V_{OAMP}=2.5 V
	Input Offset Current		I_{IO}		25	250	nA	V_{OAMP}=2.5 V
	Input Bias Current				0.2	1	μA	V_{OAMP}=2.5 V
	Common Mode Input Voltage	Low	V_{ICM}	−0.3			V	7 V ≦V_{CC}≦40 V
		High		V_{CC}−2				
	Open-loop Voltage Amplification		A_V	60	80		dB	V_{OAMP}=0.5 V to 3.5 V, T_a=25 °C
	Unity Gain Bandwidth			500	830		kHz	T_a=25 °C
	Common Mode Rejection Radio		CMR	65	80		dB	V_{CC}=40 V, T_a=25 °C
	Output Sink Current			0.3	0.7		mA	V_{OAMP}=0.7 V
	Output Source Current			−2	−10		mA	V_{OAMP}=3.5 V

Note 1: Standard deviation is a measure of the statistical distribution about the mean as derived from the formula;

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

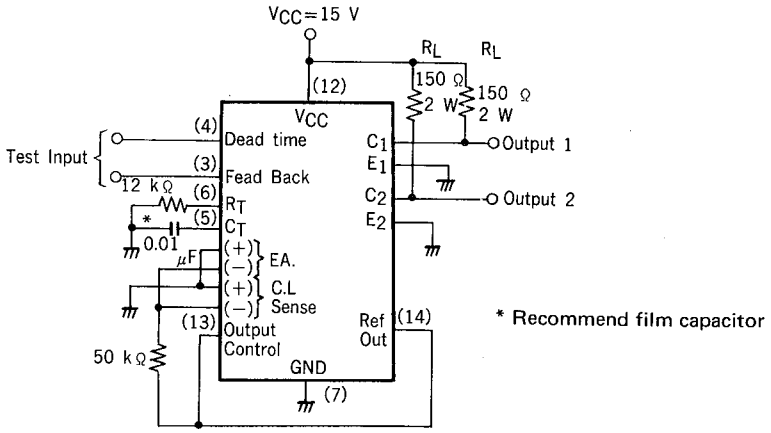
Calculation expression of frequency f_{osc} is as follows

$$f_{osc} \fallingdotseq \frac{1}{0.817\, R_T \cdot C_T + 1.42 \cdot 10^{-6}} \text{ (Hz)} \qquad [R_T] = \Omega,\ [C_T] = F$$

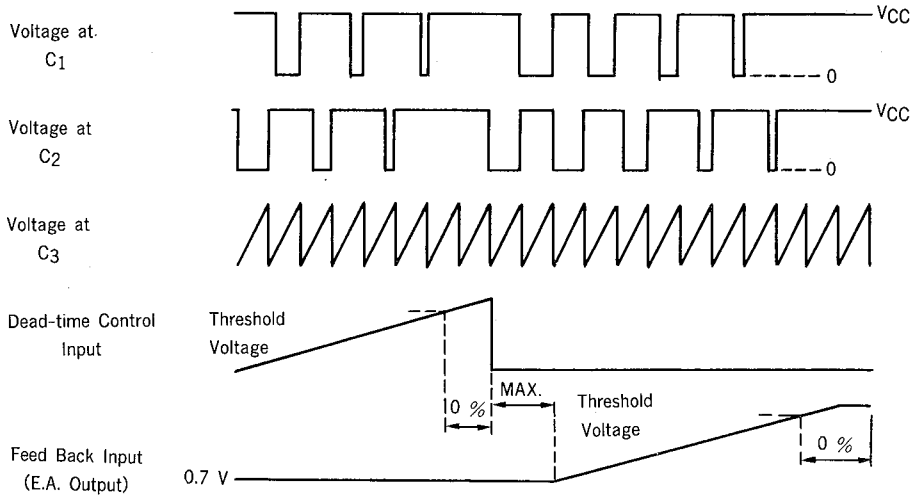
Note 2: Maximum duration of short circuit cond. is one second. (non repetitive)

BLOCK	CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
PWM Section	Input Threshold Voltage				4	4.5	V	Zero Duty Cycle
	Input Sink Current			0.3	0.7		mA	$V_{(pin\ 3)}$=0.7 V
Output Section	Collector Cutoff Current		I_{CER}			100	μA	V_{CE}=40 V, V_{CC}=40 V
	Emitter Cutoff Current					−100	μA	V_{CC}=V_C=40 V
	Collector Saturation Voltage		$V_{CE(sat)}$		0.95	1.3	V	I_C=200 mA, V_E=0, Common Emitter
			$V_{CE(ON)}$		1.6	2.5	V	I_E=200 mA, V_C=15 V Emitter follower
	Output Voltage Rise Time	common Emitter	t_r		100	200	ns	V_{CC}=15 V, R_L=150 Ω I_O=100 mA T_a=25 °C
		Emitter follower			100	200	ns	
	Output Voltage Fall Time	common Emitter	t_f		70	200	ns	
		Emitter follower			70	200	ns	
Total Device	Standby Current		$I_{CC(S.B)}$		8	12.5	mA	V_{CC}=15 V all other inputs and outputs open
	Bias Current		$I_{CC(Bl.)}$		10		mA	$V_{(pin\ 4)}$=2 V, see Fig. 1

Fig. 1 Test Circuit



Voltage Waveform

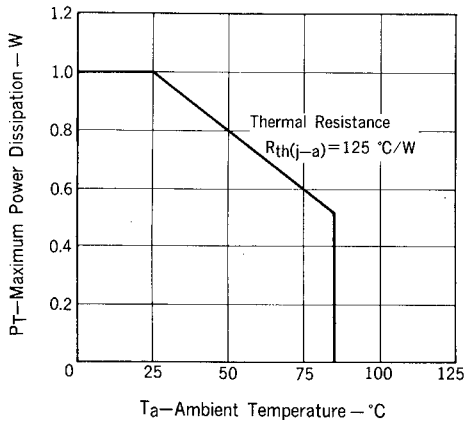


FUNCTION TABLE

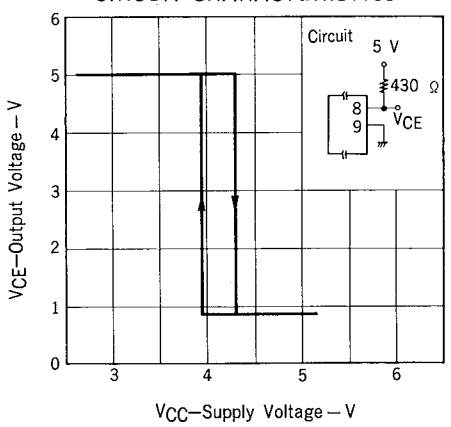
OUTPUT CONTROL INPUT (13 pin)	OUTPUT FUNCTION
At Ref-Out	Normal push-pull operation
Grounded	Single-ended or parallel output

TYPICAL PERFORMANCE CHARACTERISTICS (T_a=25 ± 2 °C, V_{IN}=15 V)

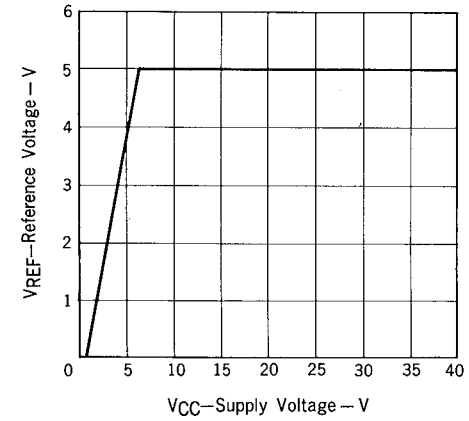
MAXIMUM POWER DISSIPATION



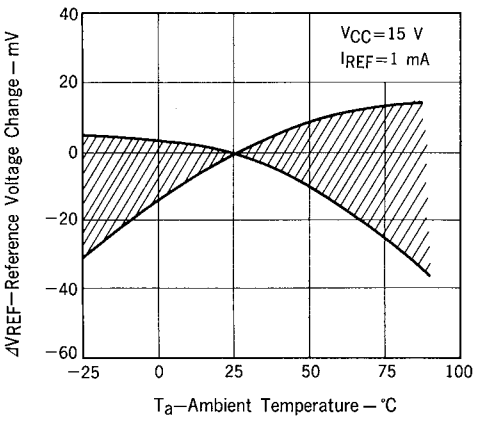
MISS-OPERATION PREVENTION CIRCUIT CHARACTERISTICS



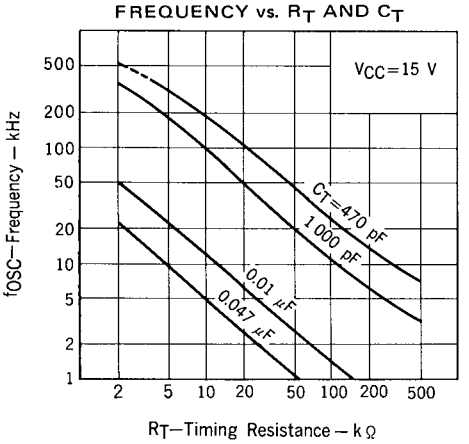
REFERENCE VOLTAGE vs. SUPPLY VOLTAGE



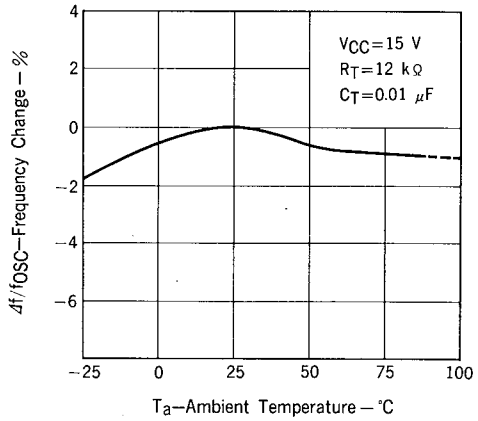
REFERENCE VOLTAGE vs. TEMPERATURE



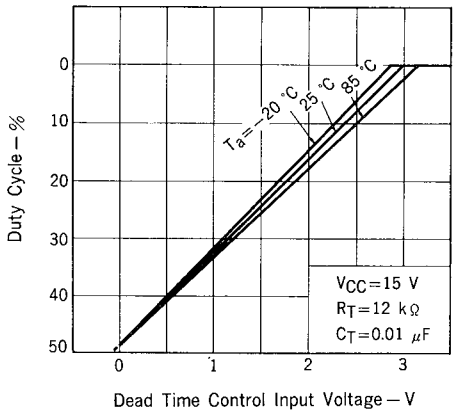
FREQUENCY vs. R_T AND C_T



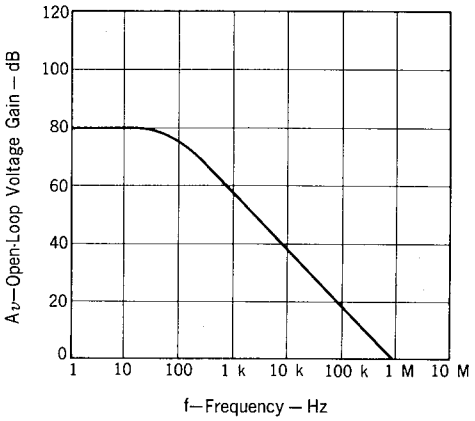
FREQUENCY vs. TEMPERATURE



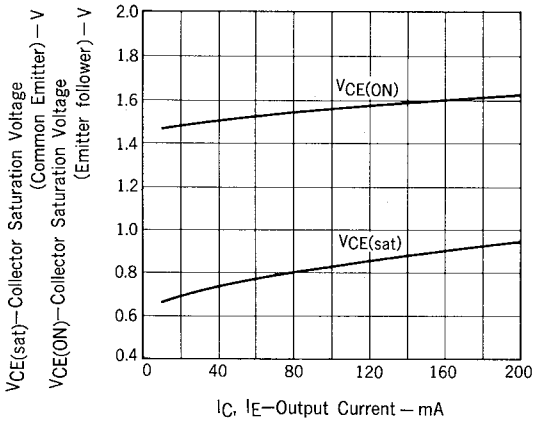
DUTY CYCLE vs. DEAD TIME
CONTROL INPUT VOLTAGE



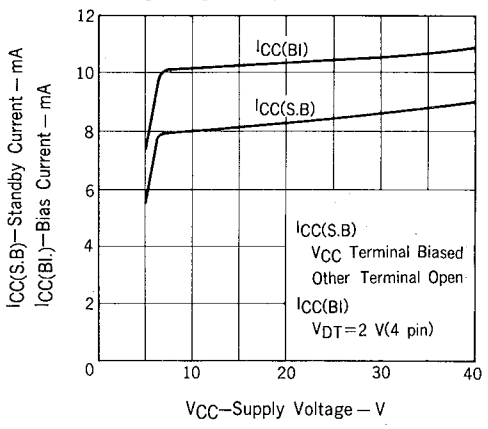
OPEN-LOOP VOLTAGE GAIN vs.
FREQUENCY



COLLECTOR SATURATION VOLTAGE
vs. OUTPUT CURRENT

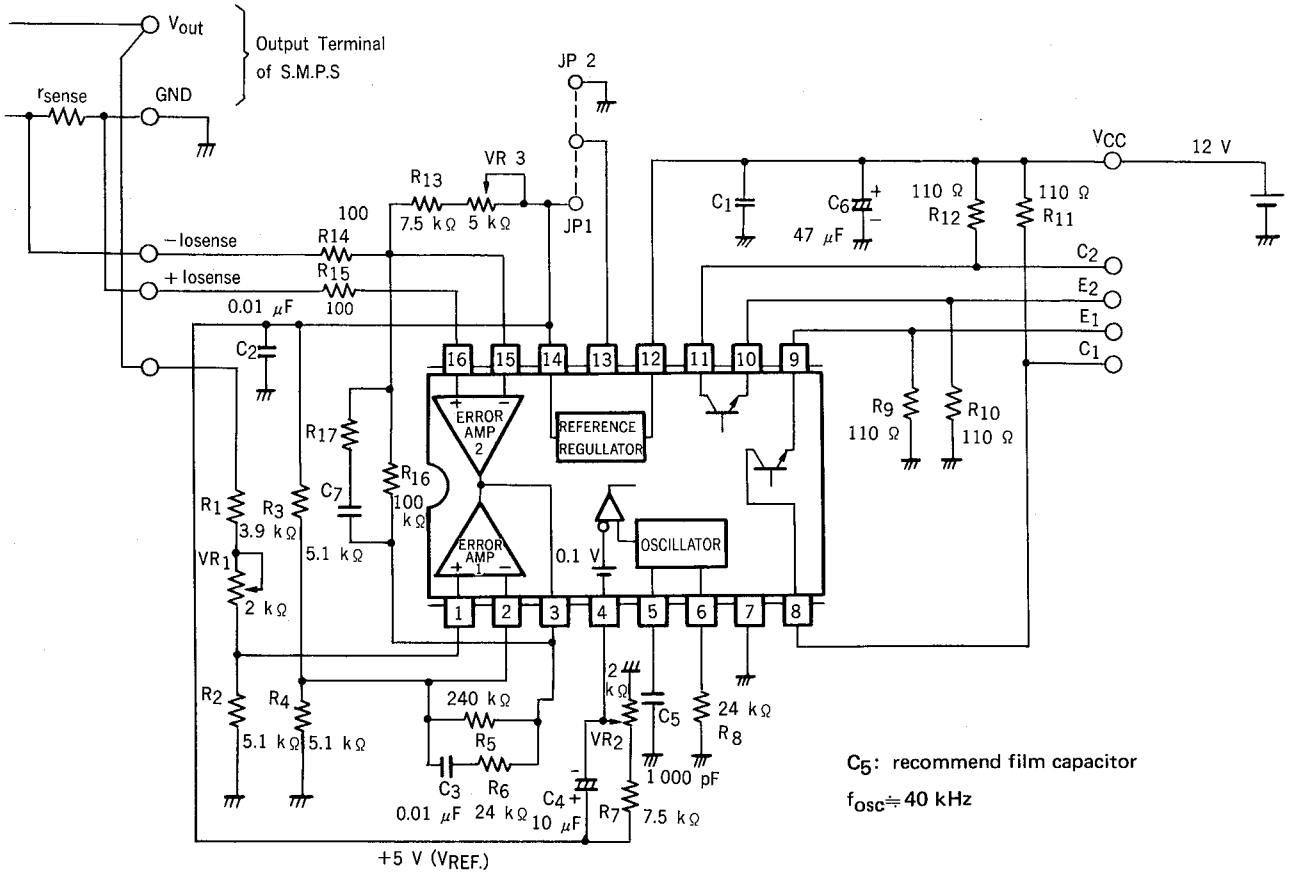


STANDBY AND BIAS CURRENT
vs. SUPPLY VOLTAGE



BASIC APPLICATION CIRCUIT

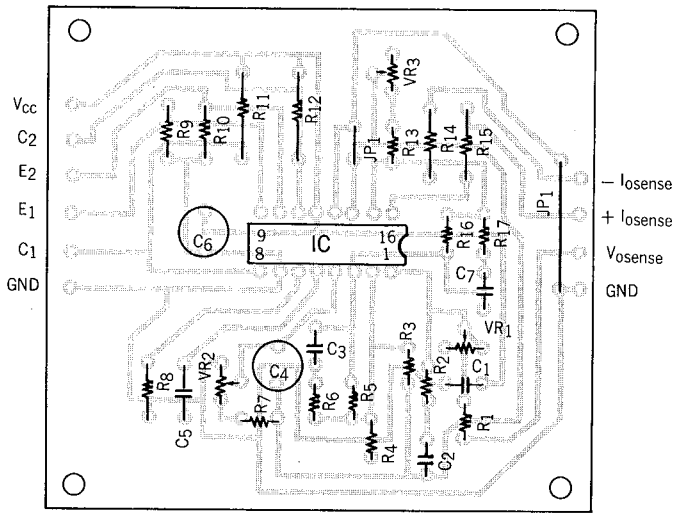
Fig. 2 Circuit



CONNECTION DIAGRAM

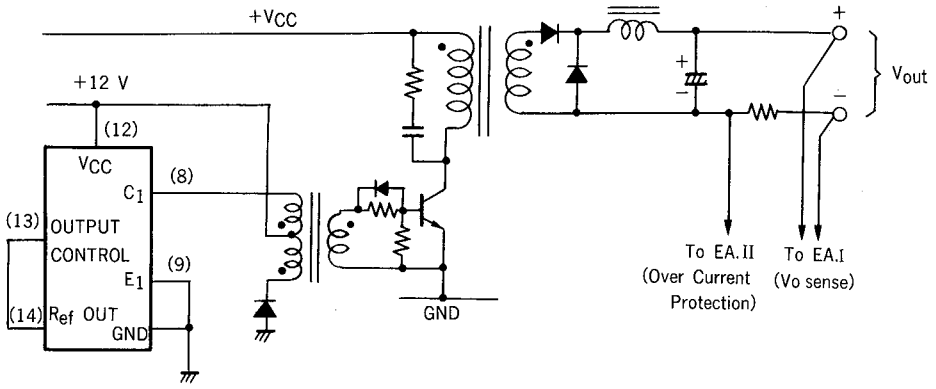
OUTPUT FUNCTION	OUTPUT CONTROL INPUT (13 pin)	OUTPUT MODE	OUTPUT VOLTAGE WAVEFORM
Push-Pull Operation	At Ref-Out (JP1 Wired)	Open Collector (R_9, R_{10} 0 Ω)	C1 C2
		Emitter Follower (R_{11}, R_{12} 0 Ω)	E1 E2
Single-Ended or Parallel Output	Grounded (JP2 Wired)	Open Collector (R_9, R_{10} 0 Ω)	C1,C2
		Emitter Follower (R_{11}, R_{12} 0 Ω)	E1, E2

Printed Pattern (Pattern Side, Actual Size)



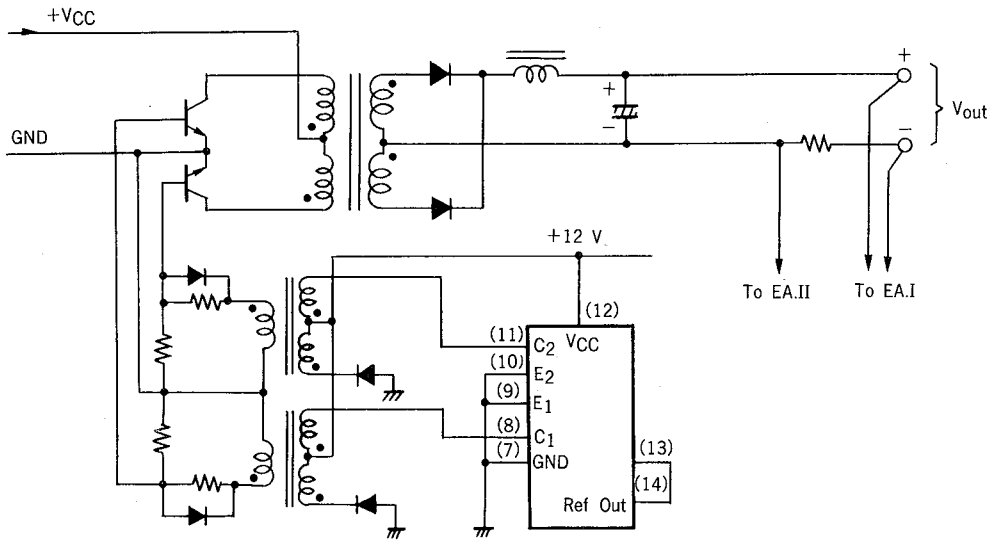
TYPICAL EXAMPLE OF APPLICATION CIRCUITS

1) Forward Type

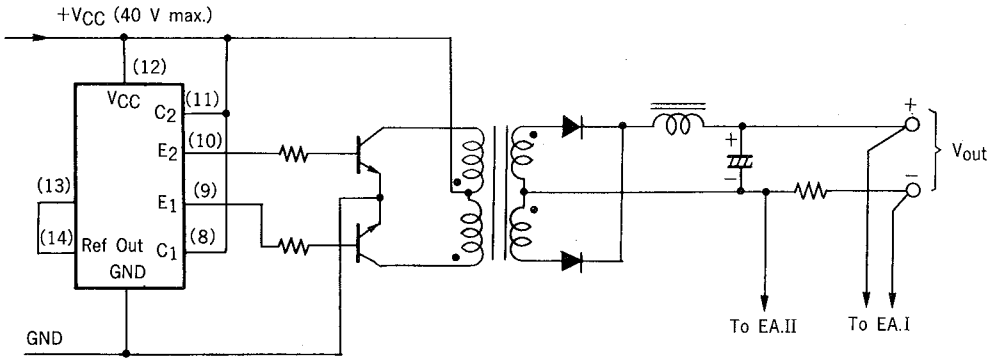


2) Push-pull Type

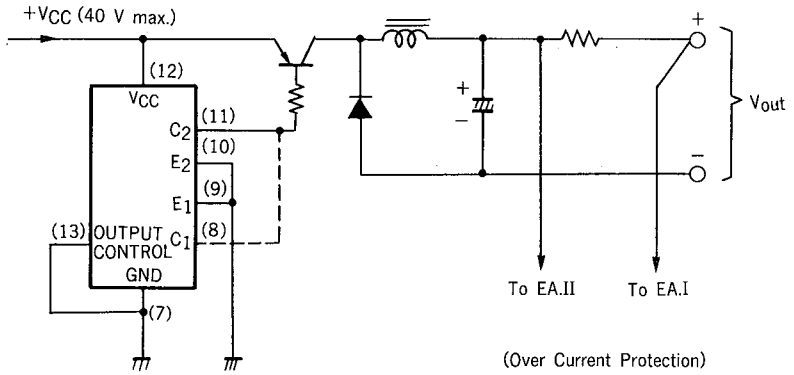
(Isolated)



(Non Isolated)



3) Stepdown Chopper

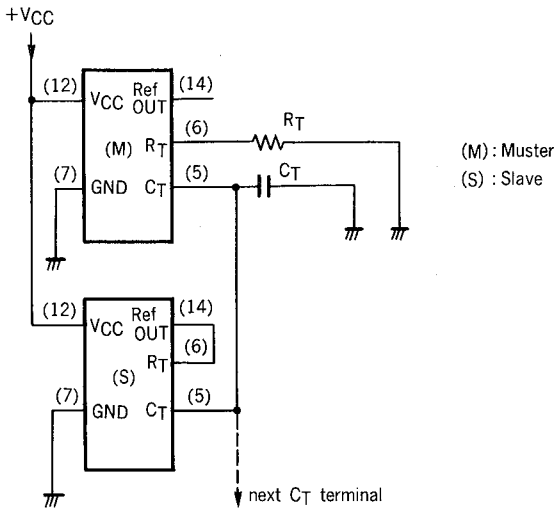


(Over Current Protection)

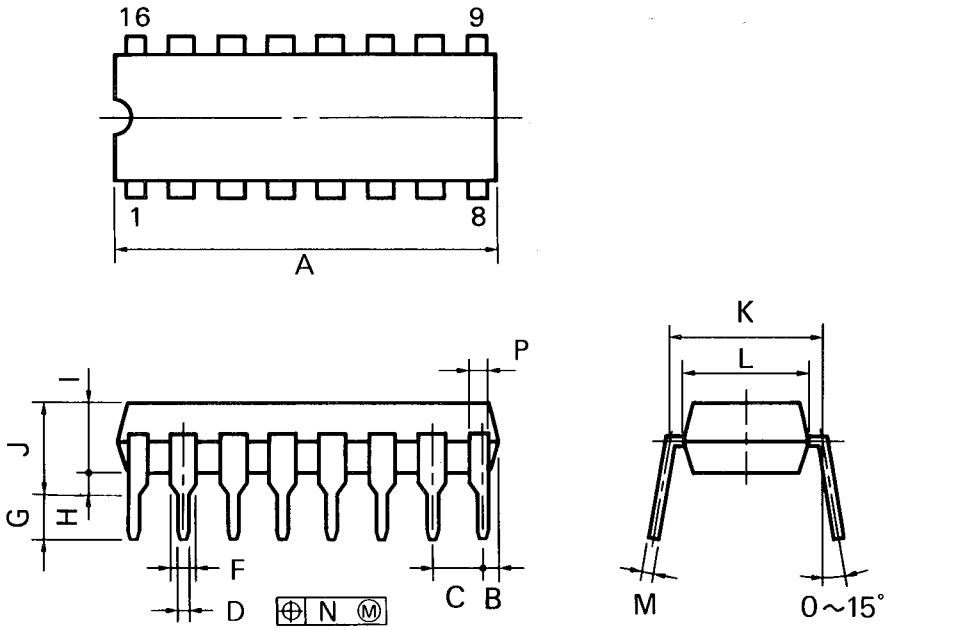
SYNCRONIZED OPERATION

If syncronized operation is needed, muster-slave circuit can be used. This circuit is shown bellow.

Initially, R_T terminal of slave IC is connected to Pin 14 (Ref Out) and internal oscillator is stopped.



16 PIN PLASTIC DIP (300 mil) (μPC494C)



P16C-100-300B

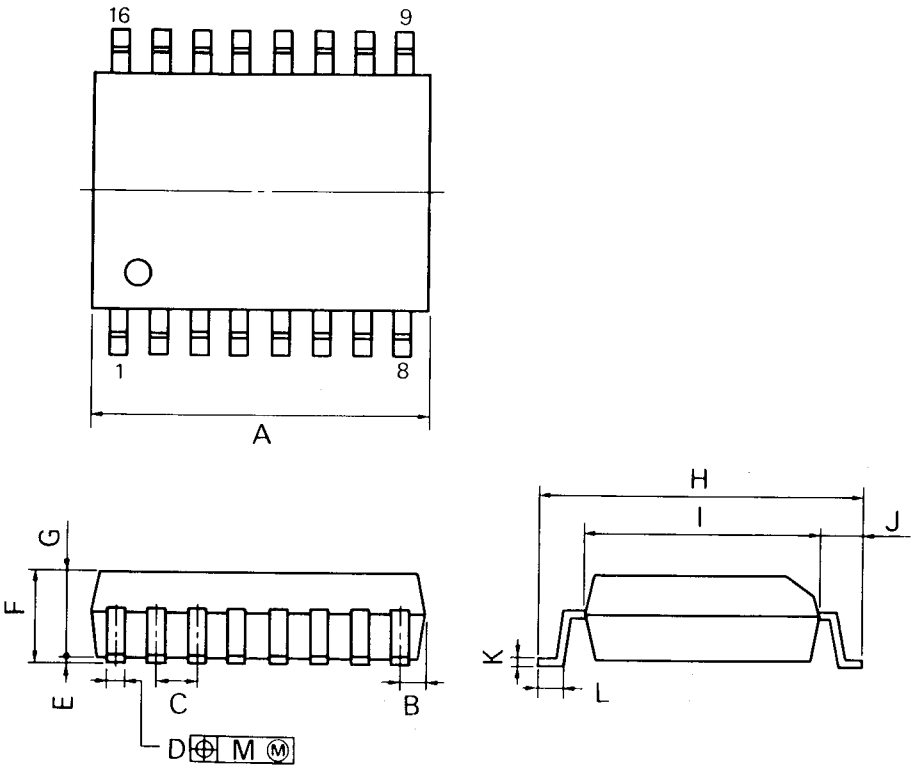
NOTES

1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	20.32 MAX.	0.800 MAX.
B	1.27 MAX.	0.050 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	$0.50^{\pm 0.10}$	$0.020^{+0.004}_{-0.005}$
F	1.1 MIN.	0.043 MIN.
G	$3.5^{\pm 0.3}$	$0.138^{\pm 0.012}$
H	0.51 MIN.	0.020 MIN.
I	4.31 MAX.	0.170 MAX.
J	5.08 MAX.	0.200 MAX.
K	7.62 (T.P.)	0.300 (T.P.)
L	6.5	0.256
M	$0.25^{+0.10}_{-0.05}$	$0.010^{+0.004}_{-0.003}$
N	0.25	0.01
P	1.1 MIN.	0.043 MIN.

16PIN PLASTIC SOP (375 mil) (μPC494G)



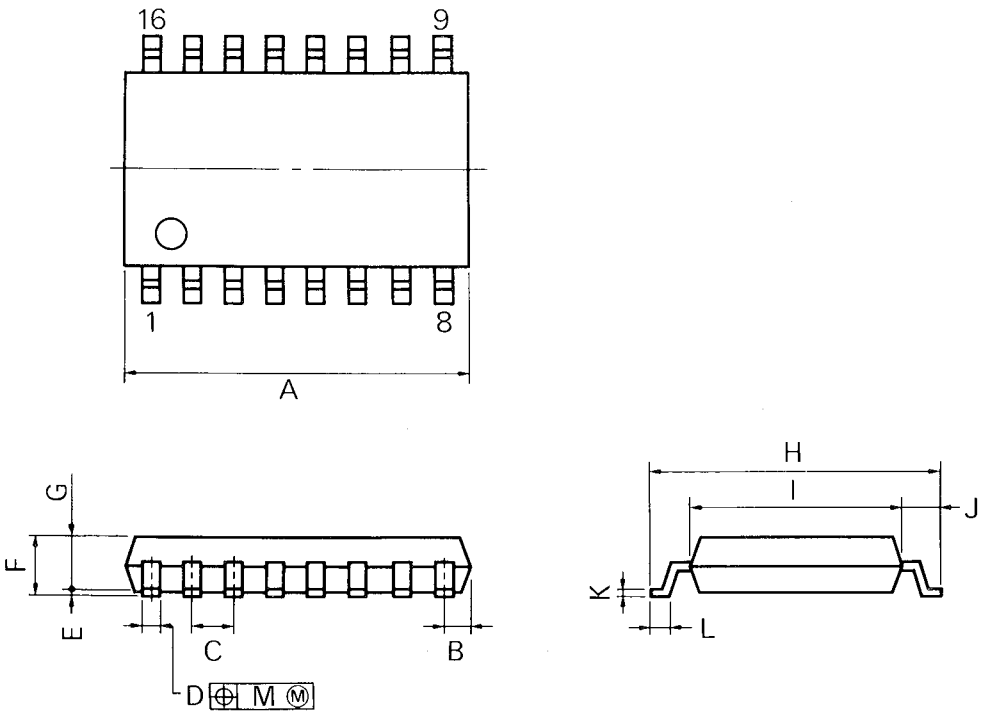
P16GM-50-375B-1

NOTE

Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	10.46 MAX.	0.412 MAX.
B	0.78 MAX.	0.031 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	$0.40^{+0.10}_{-0.05}$	$0.016^{+0.004}_{-0.003}$
E	$0.1^{\pm 0.2}_{-0.1}$	$0.004^{+0.008}_{-0.004}$
F	2.9 MAX.	0.115 MAX.
G	2.50	0.098
H	$10.3^{\pm 0.3}$	$0.406^{+0.012}_{-0.013}$
I	7.2	0.283
J	1.6	0.063
K	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.002}$
L	$0.8^{\pm 0.2}$	$0.031^{+0.009}_{-0.008}$
M	0.12	0.005

16PIN PLASTIC SOP (300 mil) (μPC494GS)



P16GM-50-300B-1

NOTE

Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	10.46 MAX.	0.412 MAX.
B	0.78 MAX.	0.031 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	$0.40^{+0.10}_{-0.05}$	$0.016^{+0.004}_{-0.003}$
E	0.1 ± 0.1	0.004 ± 0.004
F	1.8 MAX.	0.071 MAX.
G	1.55	0.061
H	7.7 ± 0.3	0.303 ± 0.012
I	5.6	0.220
J	1.1	0.043
K	$0.20^{+0.10}_{-0.05}$	$0.008^{+0.004}_{-0.002}$
L	0.6 ± 0.2	$0.024^{+0.008}_{-0.009}$
M	0.12	0.005

[MEMO]