

NEC
ELECTRON DEVICE

BIPOLAR ANALOG INTEGRATED CIRCUIT

μ PC494

SWITCHING REGULATOR CONTROL CIRCUIT

SILICON MONOLITHIC BIPOLAR INTEGRATED CIRCUIT

DESCRIPTION

The μ PC494 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.

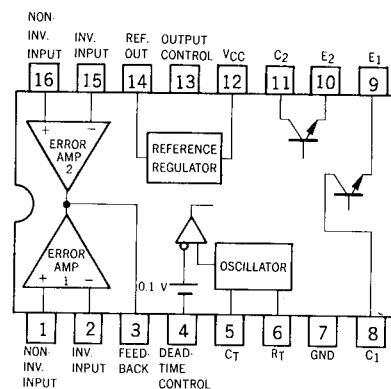
FEATURES

- 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.

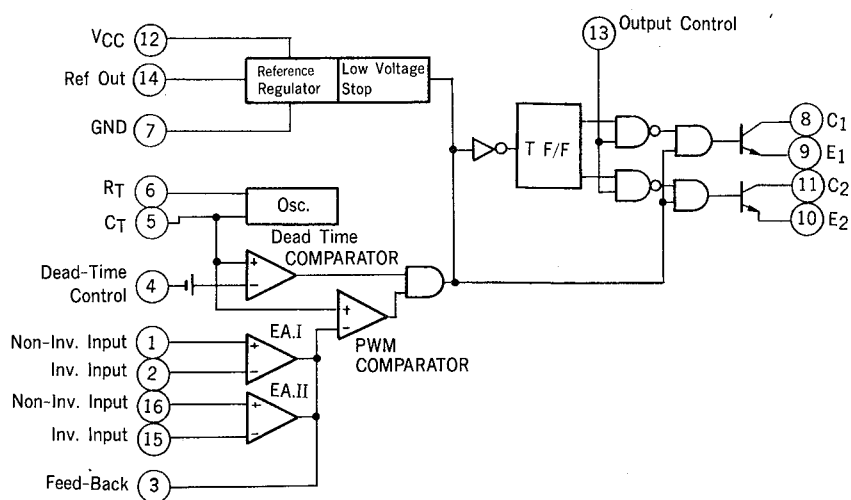
ORDERING INFORMATION

Part Number	Package
μ PC494C	16 Pin Plastic DIP (300 mil)
μ PC494G	16 Pin Plastic SOP (375 mil)
μ PC494GS	16 Pin Plastic SOP (300 mil)

CONNECTION DIAGRAM (Top View)



BLOCK DIAGRAM

ABSOLUTE MAXIMUM RATINGS ($T_a=25^\circ\text{C}$)

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	$P_T(T_a=25^\circ\text{C})$	1000	mW
Operating Temperature Range	T_{opt}	-20 to +85	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

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	k Ω
Oscillation Frequency	f_{osc}	1		300	kHz
Operating Temperature	T_{opt}	-20		+70	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS ($V_{CC}=15\text{ V}$, $f=10\text{ kHz}$, $-20 \leq T_a \leq +70\text{ }^\circ\text{C}$, unless otherwise noted)

BLOCK	CHARACTERISTIC		SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITIONS
Reference Section	Output Voltage		V_{ref}	4.75	5	5.25	V	$I_{ref}=1\text{ mA}$, $T_a=25\text{ }^\circ\text{C}$
	Line Regulation		REG_{IN}		8	25	mV	$7\text{ V} \leq V_{CC} \leq 40\text{ V}$ $I_{ref}=1\text{ mA}$, $T_a=25\text{ }^\circ\text{C}$
	Load Regulation		REG_L		1	15	mV	$1\text{ mA} \leq I_{ref} \leq 10\text{ mA}$, $T_a=25\text{ }^\circ\text{C}$
	Temperature Coefficient		V_{ref}		0.01	0.03	%/ $^\circ\text{C}$	$-20\text{ }^\circ\text{C} = T_a \leq +85\text{ }^\circ\text{C}$ $I_{ref}=1\text{ mA}$
	(Note 2) Short Circuit Output Current		I_{short}		50		mA	$V_{ref}=0$, $T_a=25\text{ }^\circ\text{C}$
Oscillator Section	Frequency		f_{osc}		10		kHz	$C_T=0.01\text{ }\mu\text{F}$, $R_T=12\text{ k}\Omega$, $T_a=25\text{ }^\circ\text{C}$
	(Note 1) Standard Deviation of Frequency				10		%	$7\text{ V} \leq V_{CC} \leq 40\text{ V}$, C_T , R_T , const. $T_a=25\text{ }^\circ\text{C}$
	Frequency Change with Temperature				1	2	%	$0\text{ }^\circ\text{C} \leq T_a \leq 70\text{ }^\circ\text{C}$, $C_T=0.01\text{ }\mu\text{F}$ $R_T=12\text{ k}\Omega$
	Frequency Change with Voltage					1	%	$7\text{ V} \leq V_{CC} \leq 40\text{ V}$, $C_T=0.01\text{ }\mu\text{F}$ $T_a=25\text{ }^\circ\text{C}$, $R_T=12\text{ k}\Omega$
Dead-time Control Section	Input Bias Current				-2	-10	μA	$0 \leq V_I \leq 5.25\text{ V}$
	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	$V_{OAMP}=2.5\text{ V}$
	Input Offset Current		I_{IO}		25	250	nA	$V_{OAMP}=2.5\text{ V}$
	Input Bias Current				0.2	1	μA	$V_{OAMP}=2.5\text{ V}$
	Common Mode Input Voltage	Low	V_{ICM}	-0.3			V	$7\text{ V} \leq V_{CC} \leq 40\text{ V}$
		High		$V_{CC}-2$				
	Open-loop Voltage Amplification		A_v	60	80		dB	$V_{OAMP}=0.5\text{ V to } 3.5\text{ V}$, $T_a=25\text{ }^\circ\text{C}$
	Unity Gain Bandwidth			500	830		kHz	$T_a=25\text{ }^\circ\text{C}$
	Common Mode Rejection Ratio		CMR	65	80		dB	$V_{CC}=40\text{ V}$, $T_a=25\text{ }^\circ\text{C}$
	Output Sink Current			0.3	0.7		mA	$V_{OAMP}=0.7\text{ V}$
	Output Source Current			-2	-10		mA	$V_{OAMP}=3.5\text{ V}$

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

Calculation expression of frequency f_{osc} is as follows

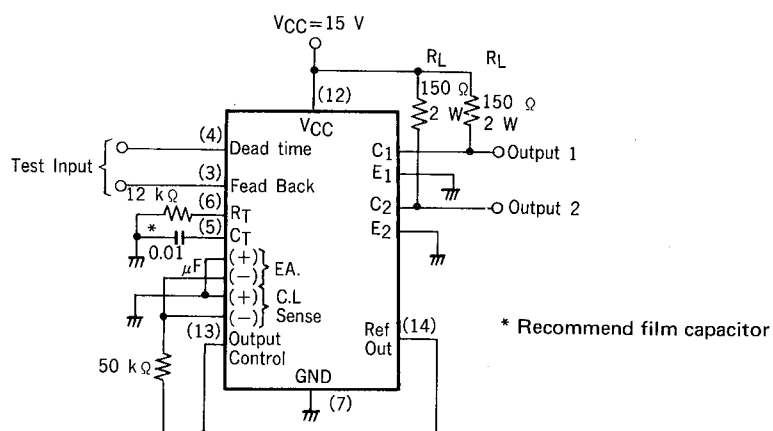
$$f_{osc} \approx \frac{1}{0.817 R_T \cdot C_T + 1.42 \cdot 10^{-6}} \text{ (Hz)} \quad [R_T] = \Omega, [C_T] = F$$

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

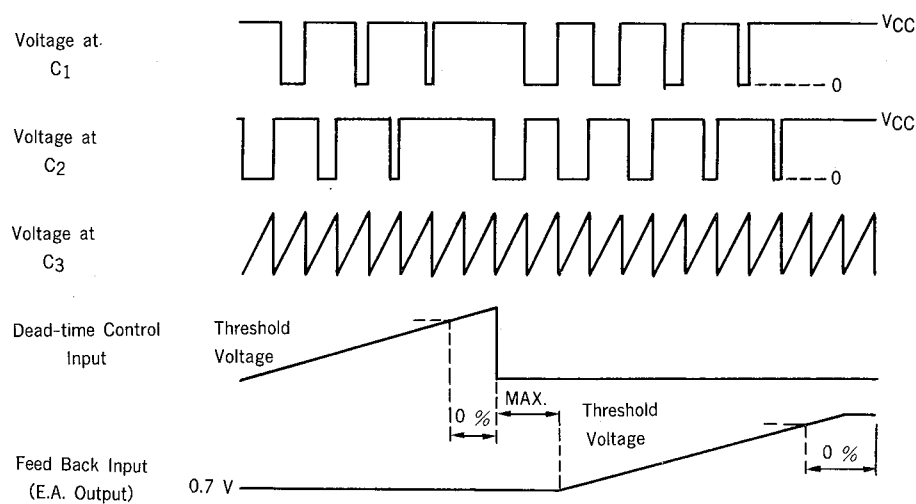
Note 2: Maximum duration of short circuit cond. is one second. (non repetitive)

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	$V_{(\text{pin } 3)}=0.7 \text{ V}$
Output Section	Collector Cutoff Current		I_{CER}			100	μA	$V_{\text{CE}}=40 \text{ V}, V_{\text{CC}}=40 \text{ V}$
	Emitter Cutoff Current					-100	μA	$V_{\text{CC}}=V_{\text{C}}=40 \text{ V}$
	Collector Saturation Voltage		$V_{\text{CE(sat)}}$		0.95	1.3	V	$I_{\text{C}}=200 \text{ mA}, V_{\text{E}}=0, \text{ Common Emitter}$
			$V_{\text{CE(ON)}}$		1.6	2.5	V	$I_{\text{E}}=200 \text{ mA}, V_{\text{C}}=15 \text{ V}$ Emitter follower
	Output Voltage Rise Time	common Emitter	t_{r}		100	200	ns	$V_{\text{CC}}=15 \text{ V}, R_{\text{L}}=150 \Omega$ $I_{\text{O}}=100 \text{ mA}$ $T_{\text{a}}=25^{\circ}\text{C}$
		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		$I_{\text{CC(S.B.)}}$		8	12.5	mA	$V_{\text{CC}}=15 \text{ V}$ all other inputs and outputs open
	Bias Current		$I_{\text{CC(BI.)}}$		10		mA	$V_{(\text{pin } 4)}=2 \text{ V}$, see Fig. 1

Fig. 1 Test Circuit



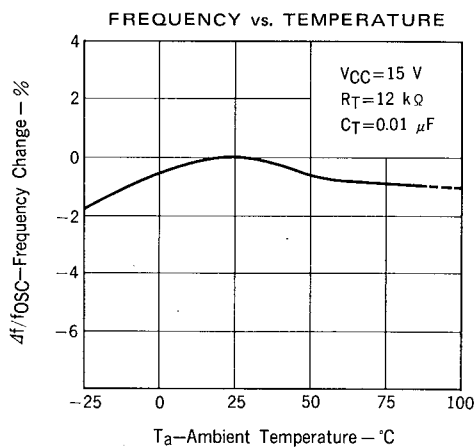
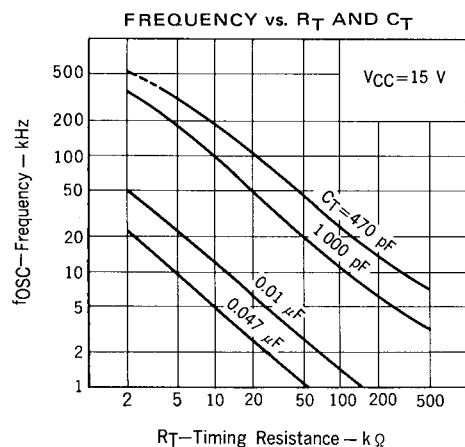
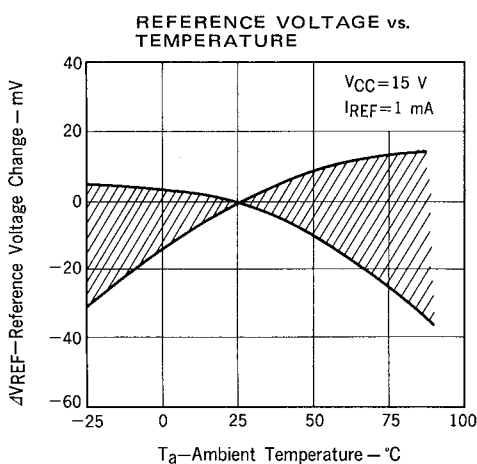
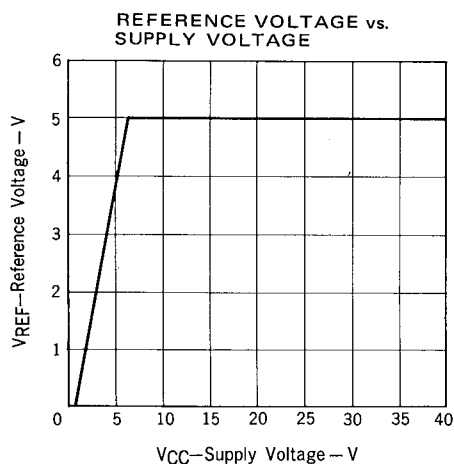
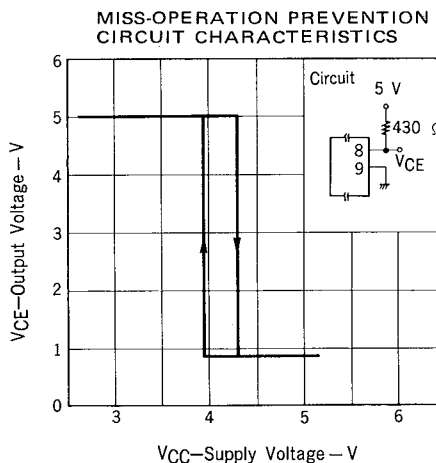
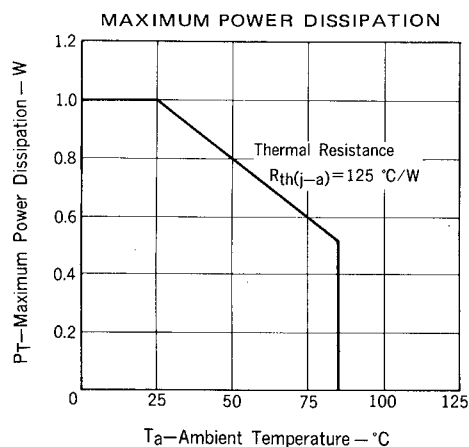
Voltage Waveform

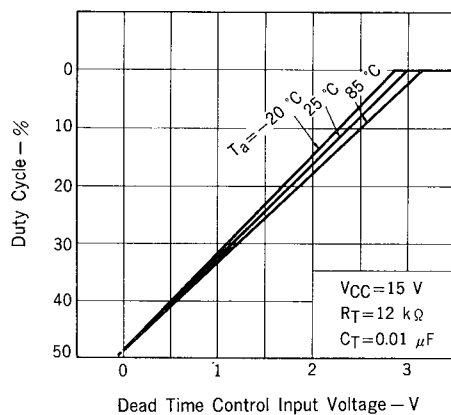
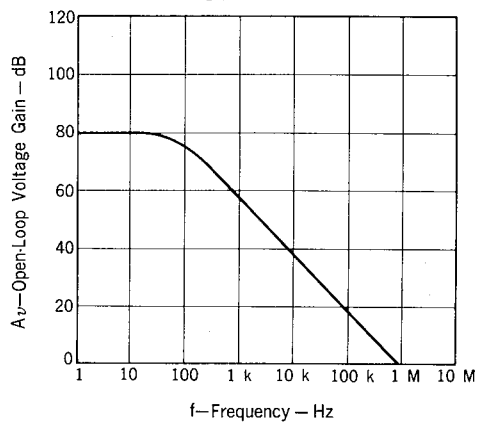
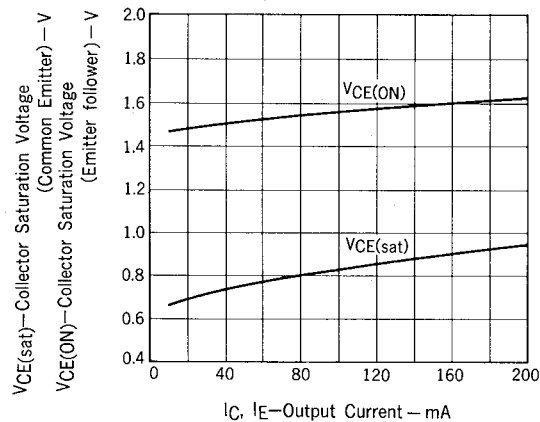
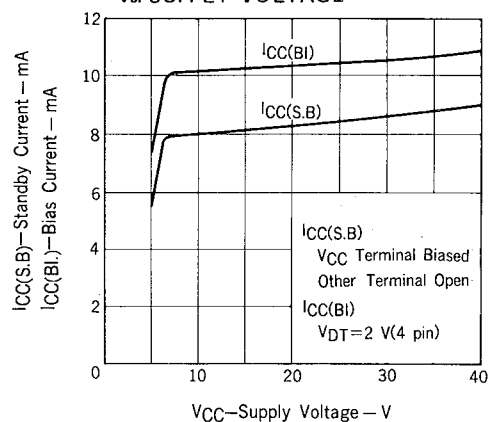


FUNCTION TABLE

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

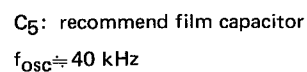
TYPICAL PERFORMANCE CHARACTERISTICS ($T_a = 25 \pm 2^\circ\text{C}$, $V_{IN} = 15\text{ V}$)



DUTY CYCLE vs. DEAD TIME
CONTROL INPUT VOLTAGEOPEN-LOOP VOLTAGE GAIN vs.
FREQUENCYCOLLECTOR SATURATION VOLTAGE
vs. OUTPUT CURRENTSTANDBY AND BIAS CURRENT
vs. SUPPLY VOLTAGE

BASIC APPLICATION CIRCUIT

Fig. 2 Circuit

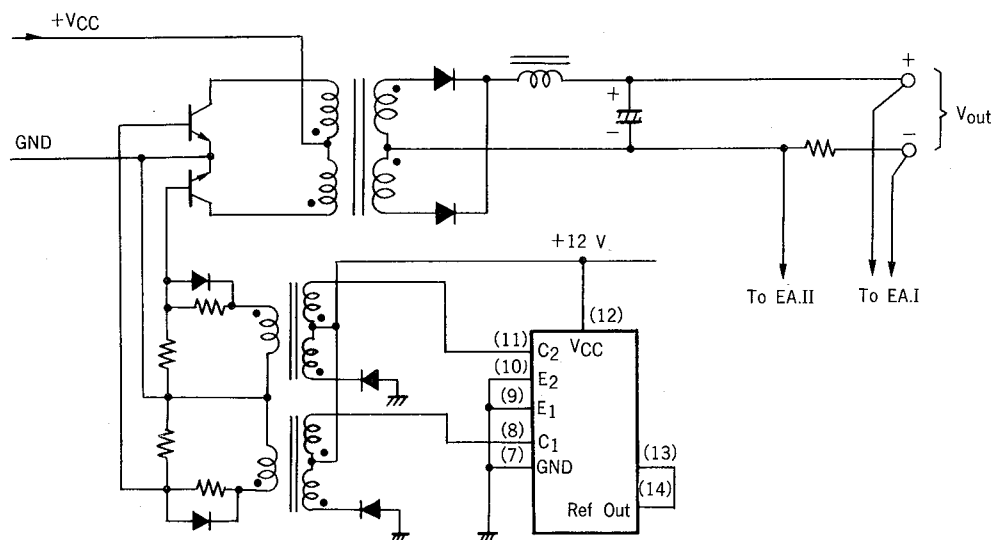


CONNECTION DIAGRAM

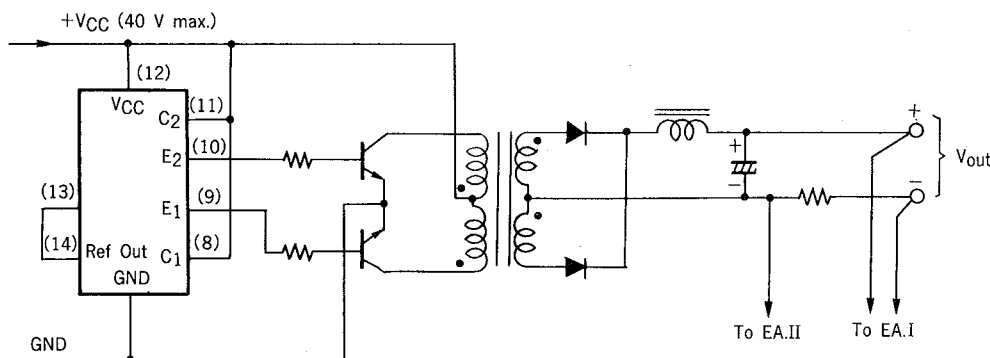
OUTPUT FUNCTION	OUTPUT CONTROL INPUT (13 pin)	OUTPUT MODE	OUTPUT VOLTAGE WAVEFORM
Push-Pull Operation	At Ref-Out (JP1 Wired)	Open Collector ($R_9, R_{10} 0 \Omega$)	C1  C2 
		Emitter Follower ($R_{11}, R_{12} 0 \Omega$)	E1  E2 
Single-Ended or Parallel Output	Grounded (JP2 Wired)	Open Collector ($R_9,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

2) Push-pull Type

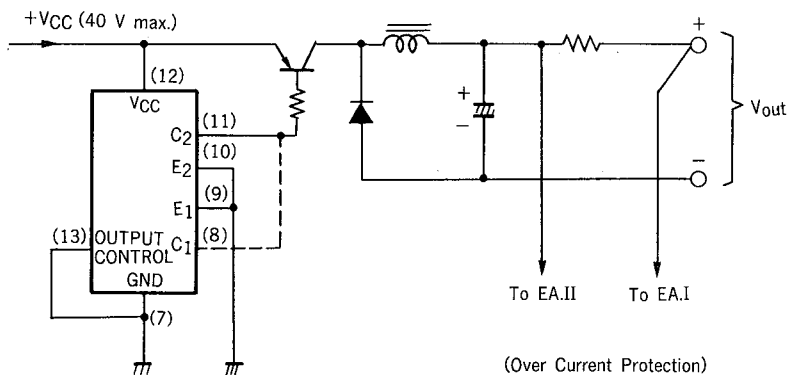
(Isolated)



(Non Isolated)



3) Stepdown Chopper

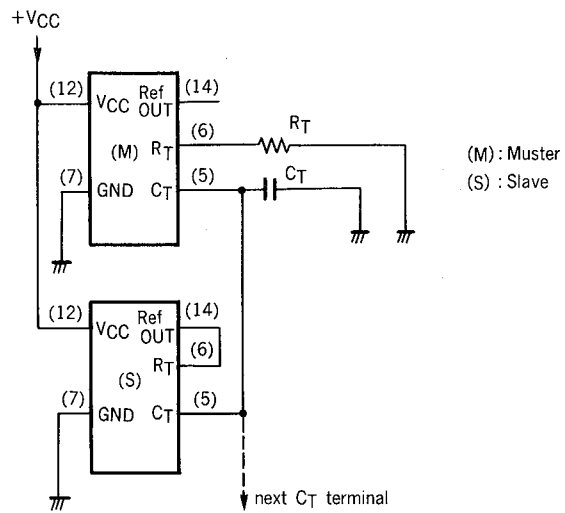


(Over Current Protection)

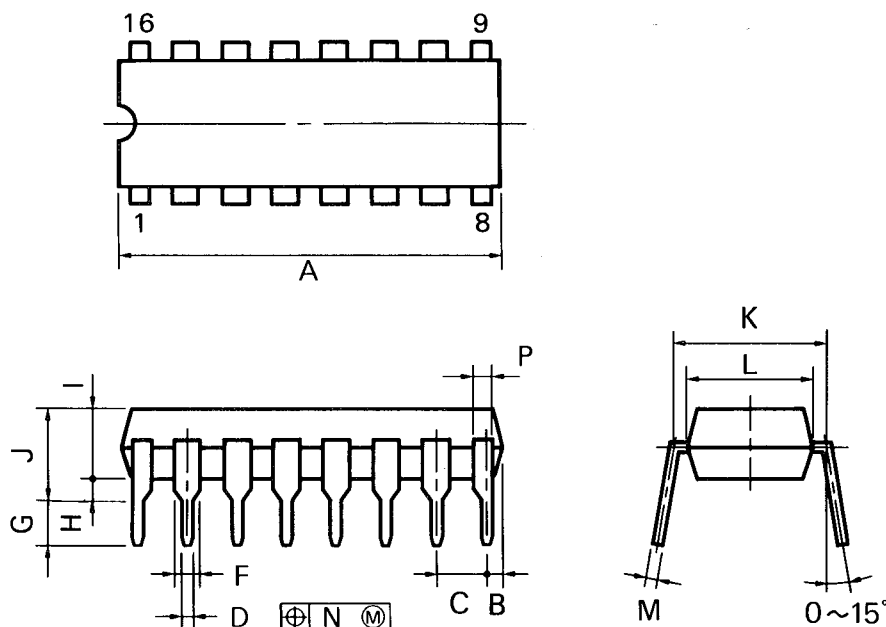
SYNCHRONIZED OPERATION

If synchronized operation is needed, master-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)

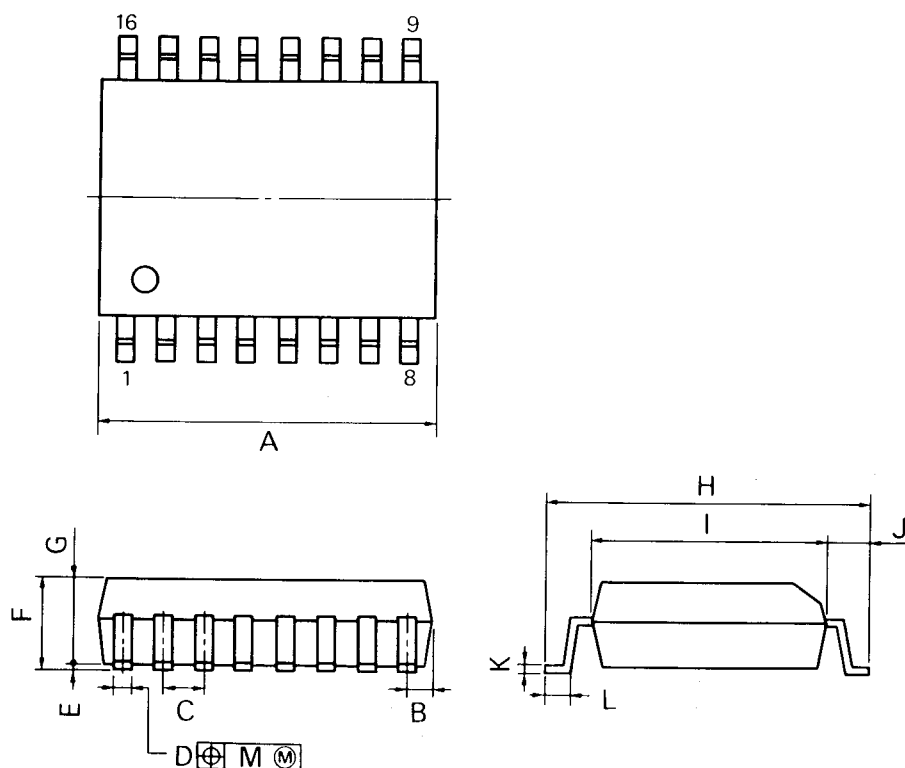


P16C-100-300B

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 ± 0.10	0.020 ± 0.004
F	1.1 MIN.	0.043 MIN.
G	3.5 ± 0.3	0.138 ± 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	0.010 ± 0.003
N	0.25	0.01
P	1.1 MIN.	0.043 MIN.

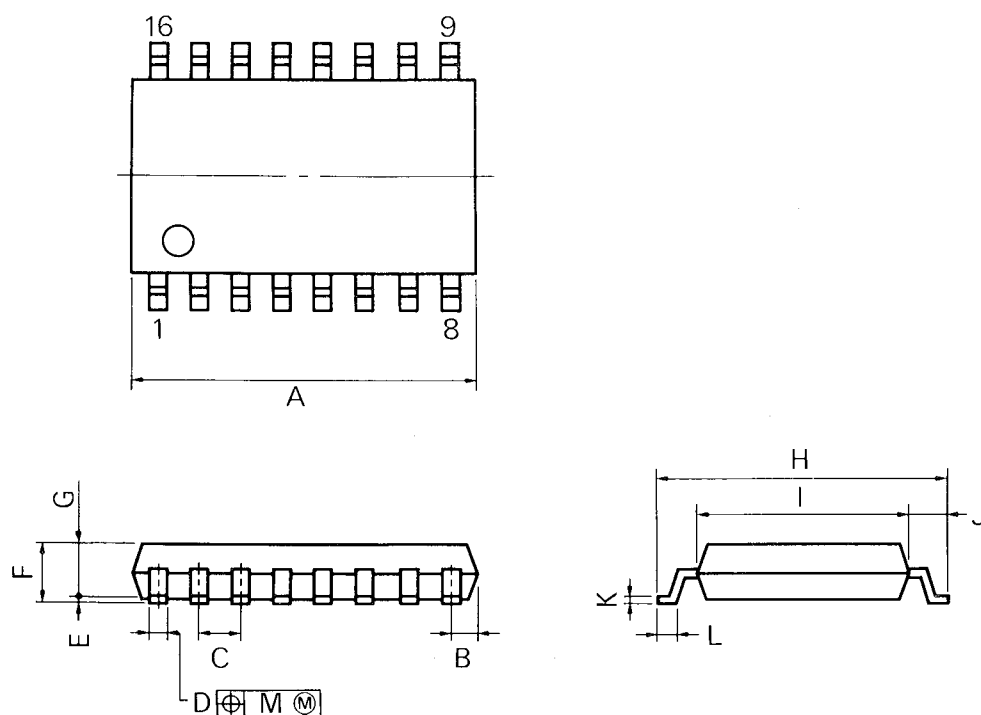
16PIN PLASTIC SOP (375 mil) (μ PC494G)

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	$0.1^{+0.2}_{-0.1}$	$0.004^{+0.008}_{-0.004}$
F	2.9 MAX.	0.115 MAX.
G	2.50	0.098
H	$10.3^{+0.3}$	$0.406^{+0.012}_{-0.013}$
I	7.2	0.283
J	1.6	0.063
K	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.002}$
L	$0.8^{+0.2}$	$0.031^{+0.009}_{-0.008}$
M	0.12	0.005

16PIN PLASTIC SOP (300 mil) (μ PC494GS)

NOTE

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

P16GM-50-300B-1

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} _{-0.005}
M	0.12	0.005

[MEMO]

No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Corporation. NEC Corporation assumes no responsibility for any errors which may appear in this document.

NEC Corporation does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from use of a device described herein or any other liability arising from use of such device. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Corporation or of others.