DATA SHEET

NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT
μPC494

SWITCHING REGULATOR CONTROL 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.

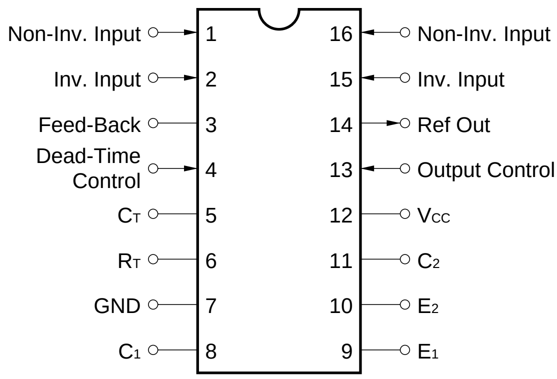
FEATURES

- 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 (7.62 mm (300))
μPC494G	16-pin plastic SOP (9.53 mm (375))
μPC494GS	16-pin plastic SOP (7.62 mm (300))

★ PIN CONFIGURATION (Top View)



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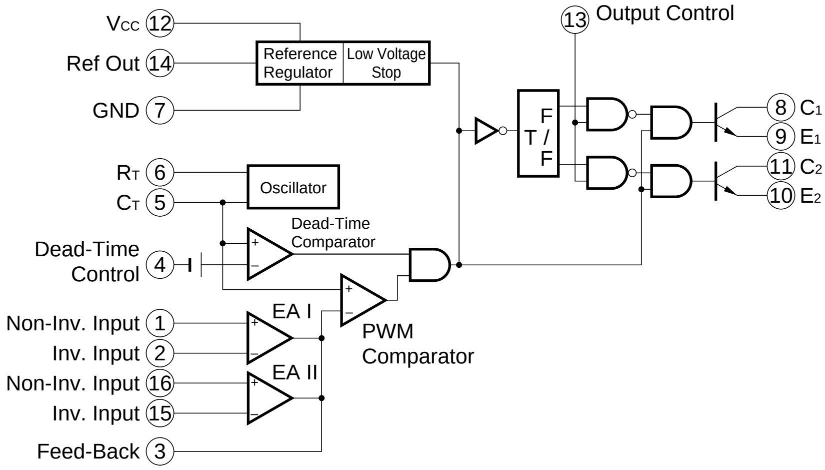
Printed in Japan

The mark ★ shows major revised points.

BLOCK DIAGRAM



★ ABSOLUTE MAXIMUM RATINGS (T_A = 25°C, unless otherwise noted)

Characteristics	Symbol	μPC494C	μPC494G	μPC494GS	Unit
Supply Voltage	V_{CC}	–0.3 to +41	–0.3 to +41	–0.3 to +41	V
Error Amplifier Input Voltage	V_{ICM}	–0.3 to V_{CC} + 0.3	–0.3 to V_{CC} + 0.3	–0.3 to V_{CC} + 0.3	V
Output Voltage	V_{CER}	–0.3 to +41	–0.3 to +41	–0.3 to +41	V
Output Current	I_C	250	250	250	mA
Total Power Dissipation	P_T	1000	780 Note	650 Note	mW
Operating Ambient Temperature	T_A	–20 to +85	–20 to +85	–20 to +85	°C
Storage Temperature	T_{stg}	–65 to +150	–65 to +150	–65 to +150	°C

Note With 25 cm^2 x 1.6 mm glass-epoxy substrate.

★ **Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.**

RECOMMENDED OPERATING CONDITIONS

Characteristics	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		10000	nF
Timing Resistance	R_T	1.8		500	kΩ
Oscillation Frequency	f_{OSC}	1		300	kHz
Operating Temperature	T_{opt}	–20		+70	°C

★ **Caution The recommended operating range may be exceeded without causing any problems provided that the absolute maximum ratings are not exceeded. However, if the device is operated in a way that exceeds the recommended operating conditions, the margin between the actual conditions of use and the absolute maximum ratings is small, and therefore thorough evaluation is necessary. The recommended operating conditions do not imply that the device can be used with all values at their maximum values.**

★ ELECTRICAL SPECIFICATIONS (V_{CC} = 15 V, f = 10 kHz, –20 ≤ T_A ≤ +70°C, unless otherwise noted)

(1/2)

Block	Characteristics	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Reference Section	Output Voltage	V_{REF}	I_{REF} = 1 mA, T_A = 25°C	4.75	5	5.25	V
	Line Regulation	REG_{IN}	7 V ≤ V_{CC} ≤ 40 V, I_{REF} = 1 mA, T_A = 25°C		8	25	mV
	Load Regulation	REG_L	1 mA ≤ I_{REF} ≤ 10 mA, T_A = 25°C		1	15	mV
	Temperature Coefficient	$\Delta V_{REF}/\Delta T$	–20°C ≤ T_A ≤ +85°C, I_{REF} = 1 mA		0.01	0.03	%/°C
	Short Circuit Output Current Note1	I_{SHORT}	V_{REF} = 0 V		50		mA
Oscillator Section	Frequency	f_{OSC}	C_T = 0.01 μF, R_T = 12 kΩ, T_A = 25°C		10		kHz
	Standard Deviation of Frequency Note2		7 V ≤ V_{CC} ≤ 40 V, T_A = 25°C, C_T, R_T, const.		10		%
	Frequency Change with Temperature		0°C ≤ T_A ≤ 70°C, C_T = 0.01 μF, R_T = 12 kΩ		1	2	%
	Frequency Change with Voltage		7 V ≤ V_{CC} ≤ 40 V, T_A = 25°C, C_T = 0.01 μF, R_T = 12 kΩ		1		%
Dead-Time Control Section	Input Bias Current		0 V ≤ V_I ≤ 5.25 V		–2	–10	μA
	Maximum Duty Cycle (Each Output)		V_I = 0 V	45	49		%
	Input Threshold Voltage 1	V_{TH1}	Output pulse 0% duty cycle		3	3.3	V
	Input Threshold Voltage 2	V_{TH2}	Output pulse maximum duty cycle	0			V
Error Amplifier Section	Input Offset Voltage	V_{IO}	V_{OAMP} = 2.5 V		2	10	mV
	Input Offset Current	I_{IO}	V_{OAMP} = 2.5 V		25	250	nA
	Input Bias Current		V_{OAMP} = 2.5 V		0.2	1	μA
	Common Mode Input Voltage — Low	V_{ICM}	7 V ≤ V_{CC} ≤ 40 V	–0.3			V
	Common Mode Input Voltage — High			V_{CC}–2			
	Open Loop Voltage Amplification	A_V	V_{OAMP} = 0.5 to 3.5 V, T_A = 25°C	60	80		dB
	Unity Gain Bandwidth		T_A = 25°C	500	830		kHz
	Common Mode Rejection Radio	CMR	V_{CC} = 40 V, T_A = 25°C	65	80		dB
	Output Sink Current		V_{OAMP} = 0.7 V	0.3	0.7		mA
	Output Source Current		V_{OAMP} = 3.5 V	–2	–10		mA
PWM Section	Input Threshold Voltage (3-pin)		Output pulse 0% duty cycle, see **Figure 1**.		4	4.5	V
	Input Sink Current		$V_{(pin\ 3)}$ = 0.7 V	0.3	0.7		mA

Remark The TYP. values are values at T_A = 25°C, except for the characteristics of temperature.

(2/2)

Block	Characteristics		Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Output Section	Collector Cut-off Current		I_{CER}	V_{CE} = 40 V, V_{CC} = 40 V, Common Emitter			100	μA
	Emitter Cut-off Current			V_{CC} = V_C = 40 V, V_E = 0 V, Emitter Follower			–100	μA
	Collector Saturation Voltage	Common Emitter	$V_{CE(sat)}$	I_C = 200 mA, V_E = 0 V		0.95	1.3	V
		Emitter Follower	$V_{CE(ON)}$	I_E = –200 mA, V_C = 15 V		1.6	2.5	V
	Output Voltage Rise Time	Common Emitter	t_{r1}	V_{CC} = 15 V, R_L = 150 Ω, $I_C \cong$ 100 mA, T_A = 25°C, see **Figure 1**.		100	200	ns
	Output Voltage Fall Time		t_{f1}			70	200	ns
	Output Voltage Rise Time	Emitter Follower	t_{r2}	V_C = 15 V, R_L = 150 Ω, $I_E \cong$ 100 mA, T_A = 25°C, see **Figure 1**.		100	200	ns
	Output Voltage Fall Time		t_{f2}			70	200	ns
Total Device	Standby Current		$I_{CC(S.B)}$	V_{CC} = 15 V, all other pins open.		8	12.5	mA
	Bias Current		$I_{CC(BI)}$	$V_{(pin\ 4)}$ = 2 V, see **Figure 1**.		10		mA

Remark The TYP. values are values at T_A = 25°C, except for the characteristics of temperature.

Notes 1. The short circuit output current flows for no more than 1 second. Repeat operation is possible if the internal heat accumulation is not within a harmful range.

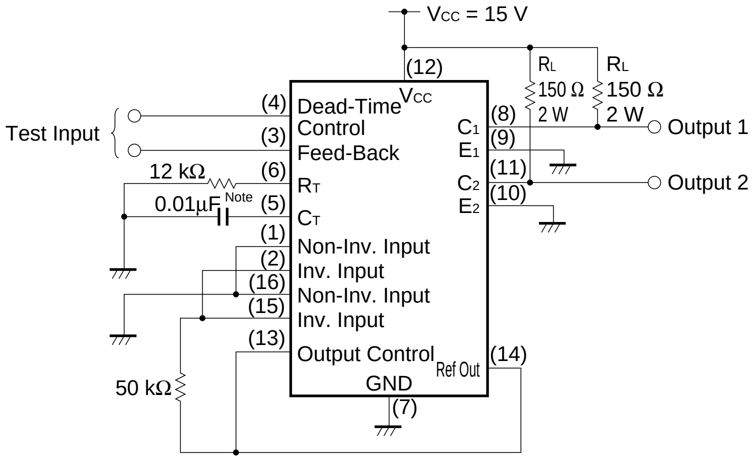
2. Standard deviation is a measure of the statistical distribution about the mean as derived from the formula ;

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

Calculation expression of frequency f_{OSC} is as follows ;

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

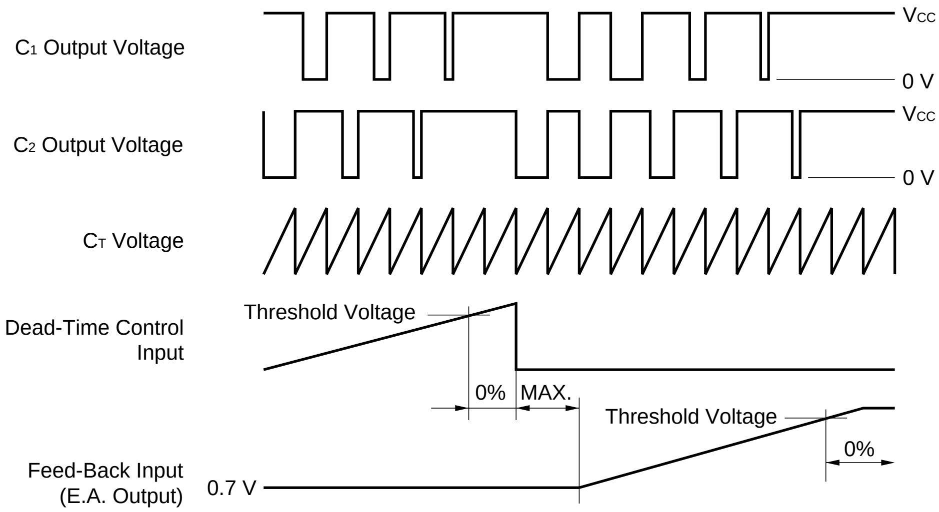
Figure1. Test Circuit



Note Recommend film capacitor.

★ **Caution When the emitter follower is output, connect C_1 and C_2 to V_{CC} and E_1 and E_2 to GND via R_L.**

Figure2. Voltage Waveform



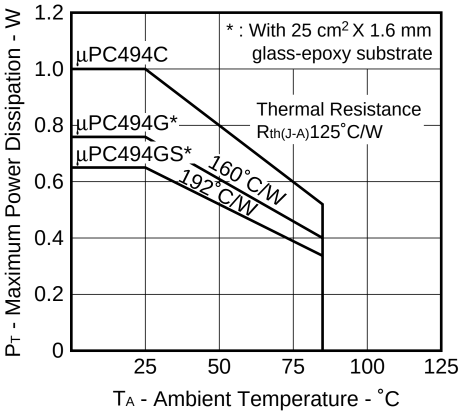
Connection of Output Control Pin (Pin No.13)

Output Control Input (Pin No.13)	Operation Mode
At Ref Out	Normal push-pull operation
Grounded	Single-ended or parallel output

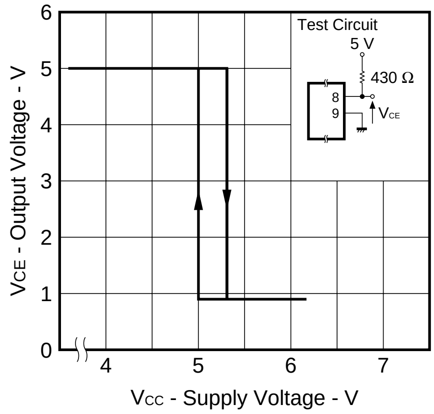
TYPICAL PERFORMANCE CHARACTERISTICS

★ **(Unless otherwise specified, T_A = 25°C, V_{CC} = 15 V, Reference)**

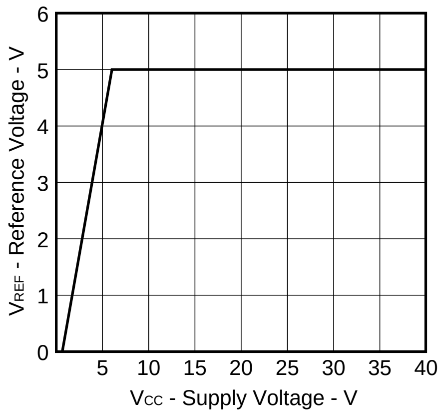
MAXIMUM POWER DISSIPATION



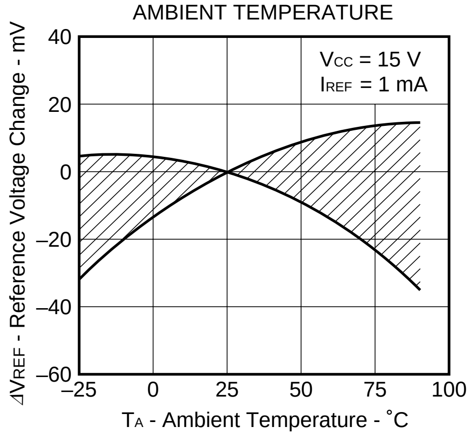
MISS-OPERATION PREVENTION CIRCUIT CHARACTERISTICS



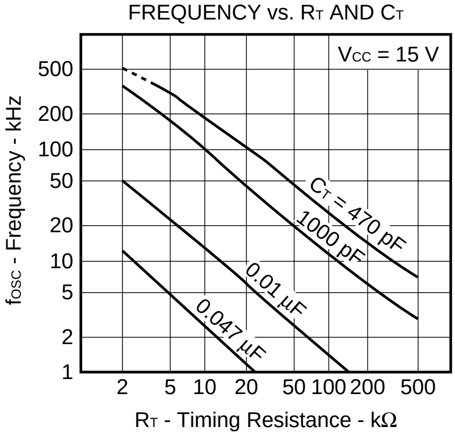
REFERENCE VOLTAGE vs. SUPPLY VOLTAGE



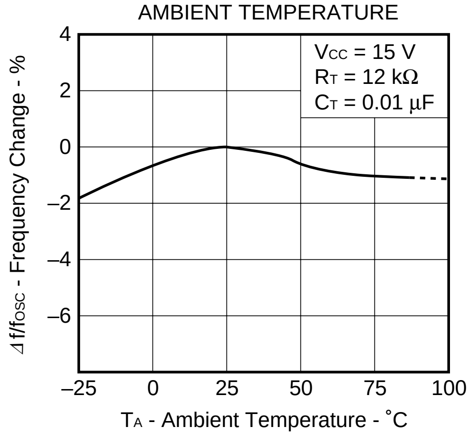
REFERENCE VOLTAGE vs. AMBIENT TEMPERATURE



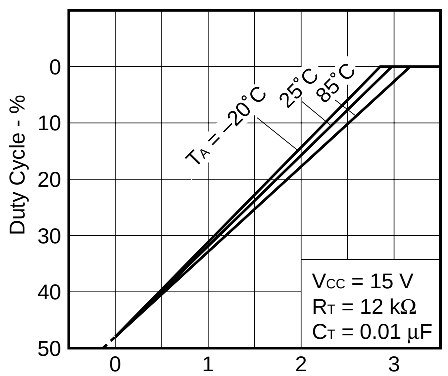
FREQUENCY vs. R_T AND C_T



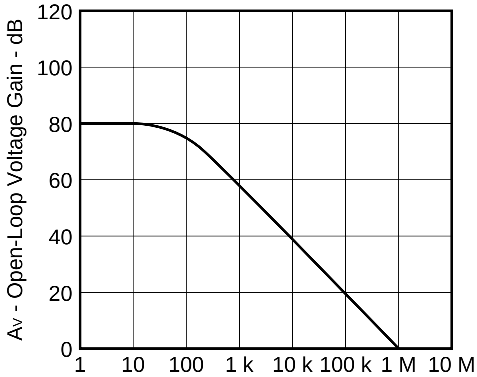
FREQUENCY vs. AMBIENT TEMPERATURE



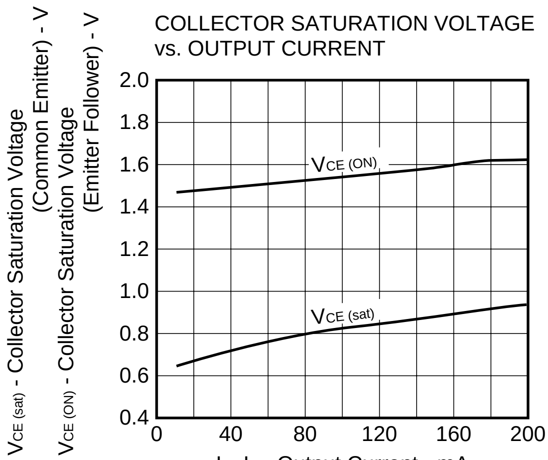
DUTY CYCLE vs. DEAD-TIME CONTROL INPUT VOLTAGE



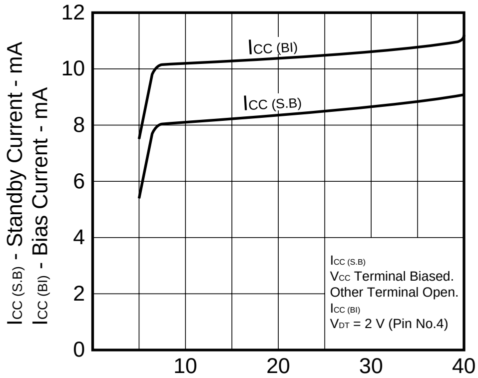
OPEN-LOOP VOLTAGE GAIN vs. FREQUENCY



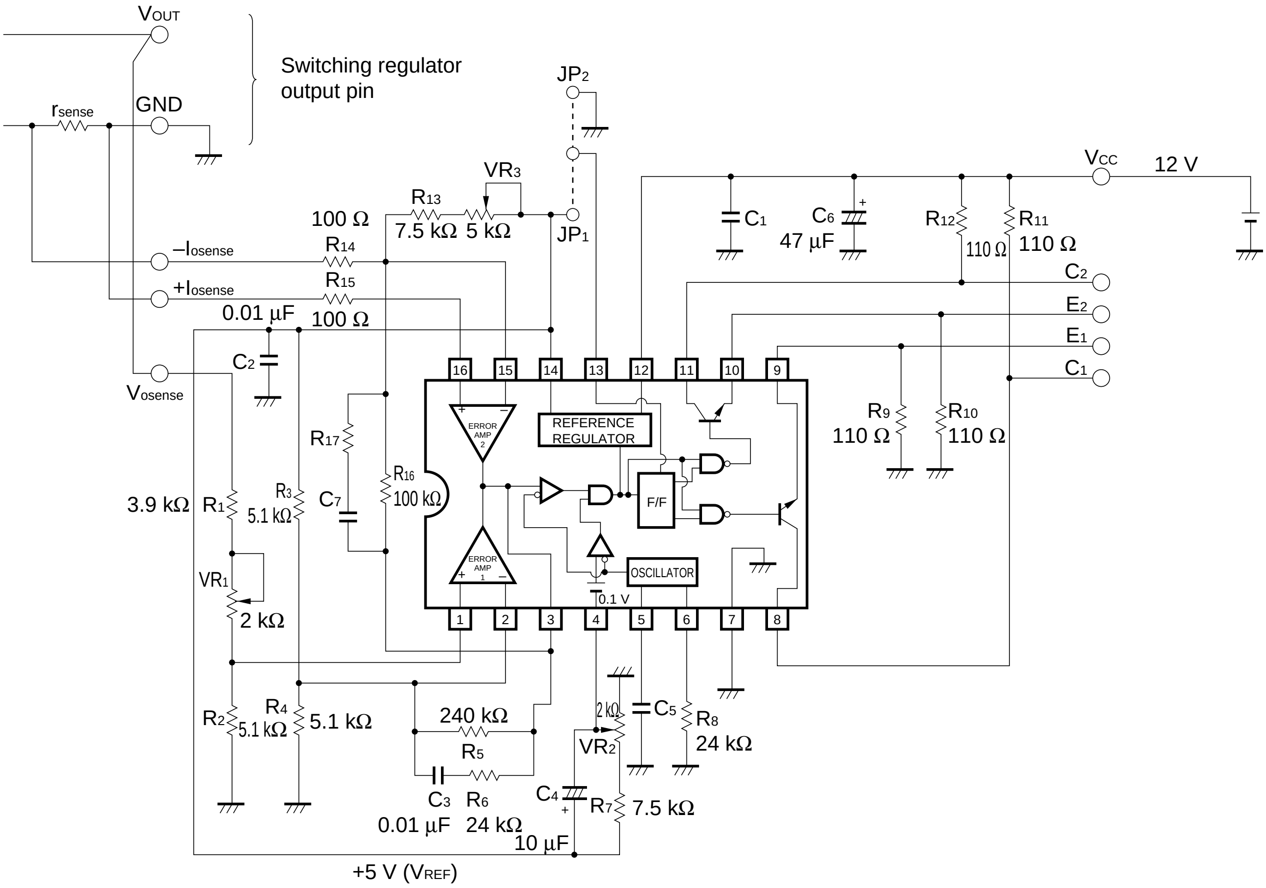
COLLECTOR SATURATION VOLTAGE vs. OUTPUT CURRENT



STANDBY AND BIAS CURRENT vs. SUPPLY VOLTAGE



BASIC APPLICATION CIRCUIT

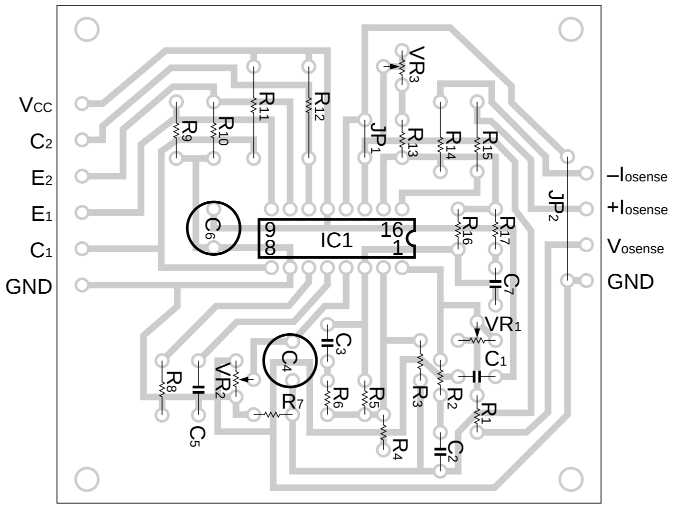


★ **Remark** $f_{OSC} \cong 40$ kHz, $C_5 = 1000$ pF (Recommend film capacitor)

CONNECTION DIAGRAM

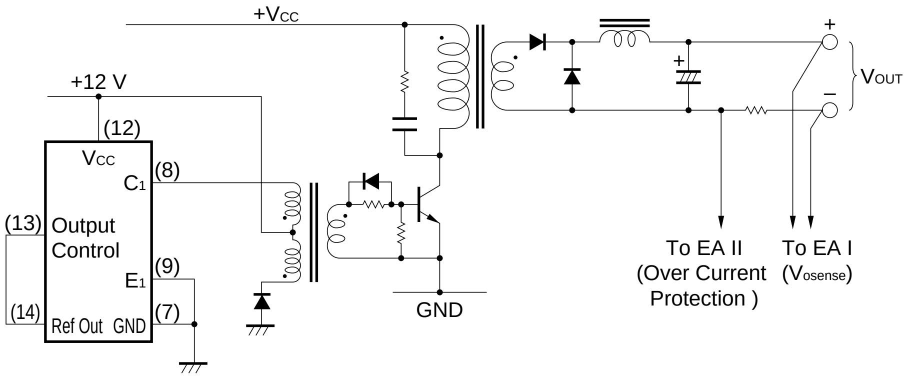
Operation Mode	Output Control Input (Pin No.13)	Output Mode	Output Voltage Waveform
Push-pull operation	At Ref-out (JP1 Wired)	Open collector (R_9, R_{10} 0Ω)	C_1, C_2
		Emitter follower (R_{11}, R_{12} 0Ω)	E_1, E_2
Single-ended or parallel output	Grounded (JP2 Wired)	Open collector (R_9, R_{10} 0Ω)	C_1, C_2
		Emitter follower (R_{11}, R_{12} 0Ω)	E_1, E_2

Printed Pattern (Example of μPC494C) (Pattern side, Actual size)



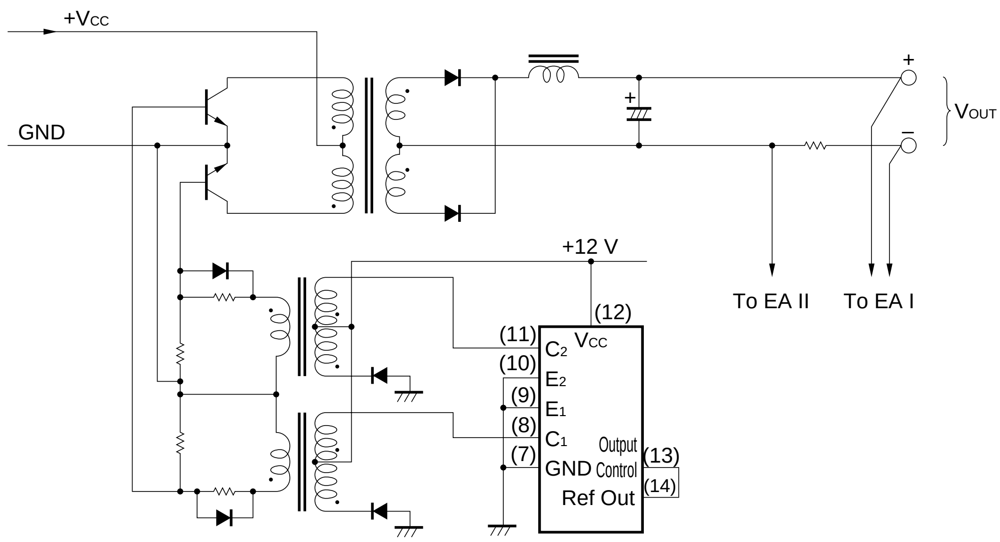
TYPICAL EXAMPLE OF APPLICATION CIRCUITS

1) Forward Type

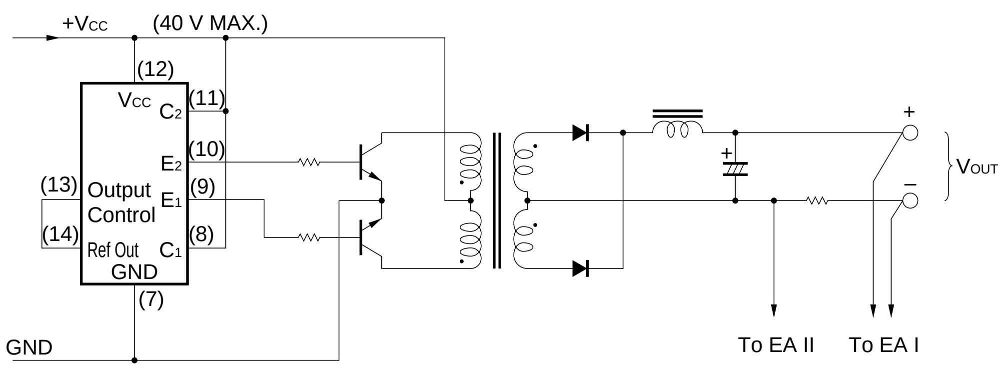


2) Push-pull Type

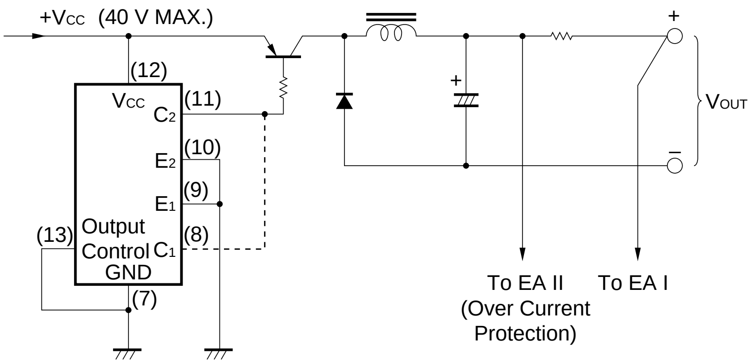
(Isolated)



(Non Isolated)



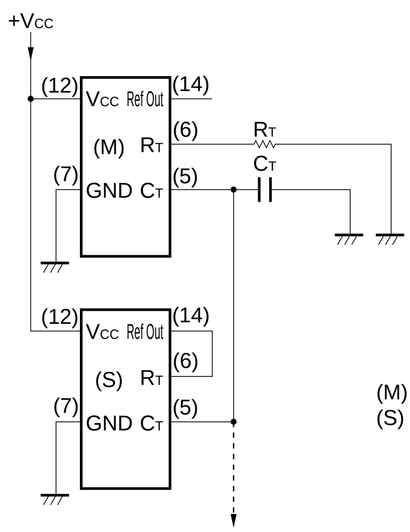
3) Step-down Chopper



Remark The dotted line indicates the connection in case of large current.

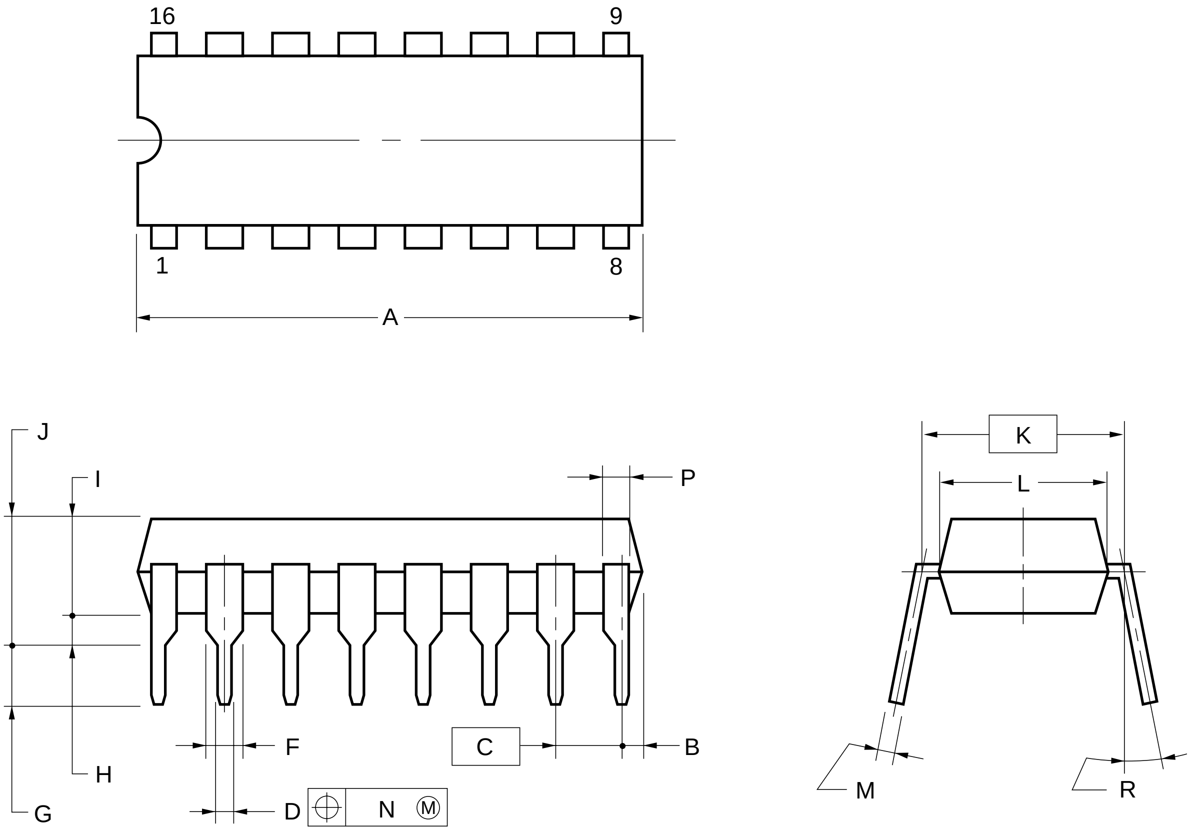
SYNCRONIZED OPERATION

If synchronized operation is needed, muster-slave circuit can be used. This circuit is shown below. Initially, R_T terminal of slave IC is connected to pin 14(Ref Out) and internal oscillator is stopped.



★ PACKAGE DRAWINGS (Unit : mm)

16-PIN PLASTIC DIP (7.62mm(300))



NOTES

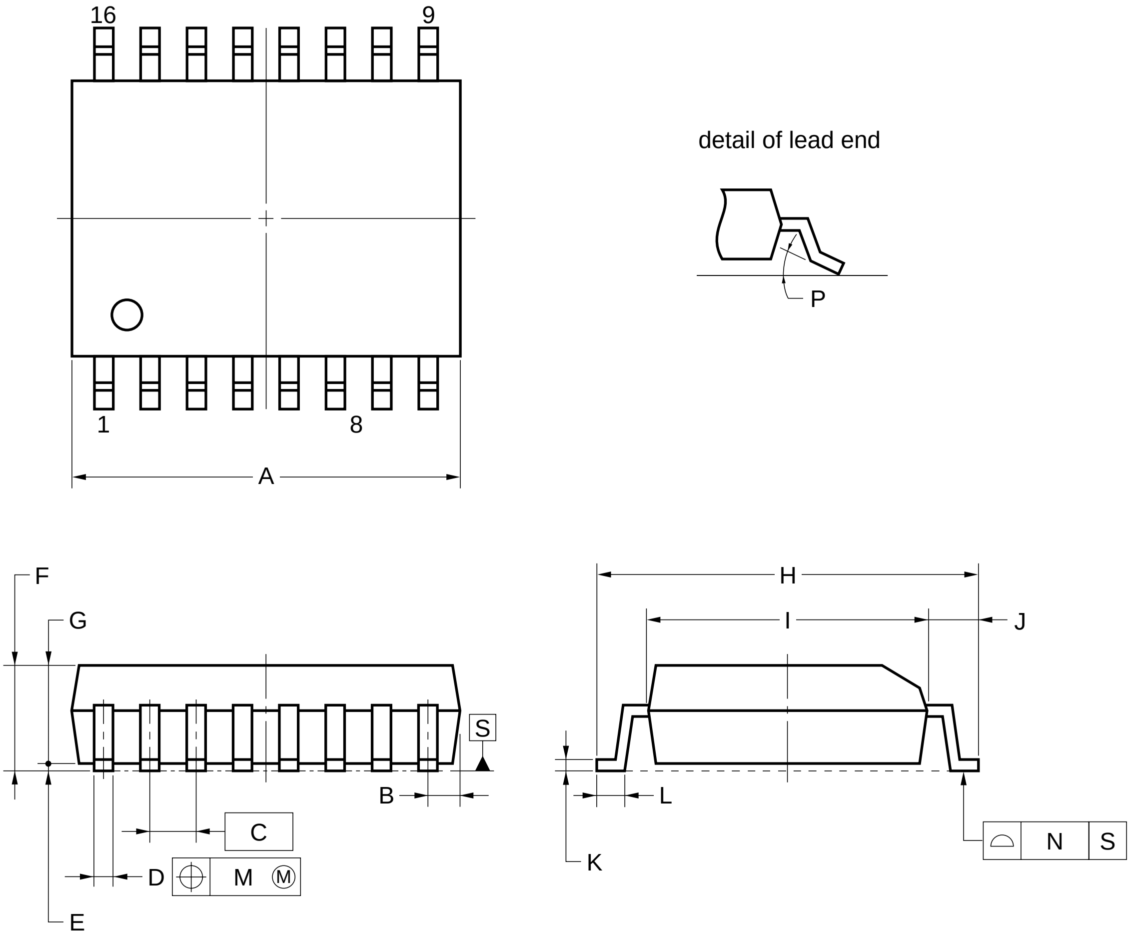
1. Each lead centerline is located within 0.25 mm of its true position (T.P.) at maximum material condition.

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

ITEM	MILLIMETERS
A	20.32 MAX.
B	1.27 MAX.
C	2.54 (T.P.)
D	0.50±0.10
F	1.1 MIN.
G	3.5±0.3
H	0.51 MIN.
I	4.31 MAX.
J	5.08 MAX.
K	7.62 (T.P.)
L	6.5
M	$0.25^{+0.10}_{-0.05}$
N	0.25
P	1.1 MIN.
R	0~15°

P16C-100-300B-2

16-PIN PLASTIC SOP (9.53 mm (375))



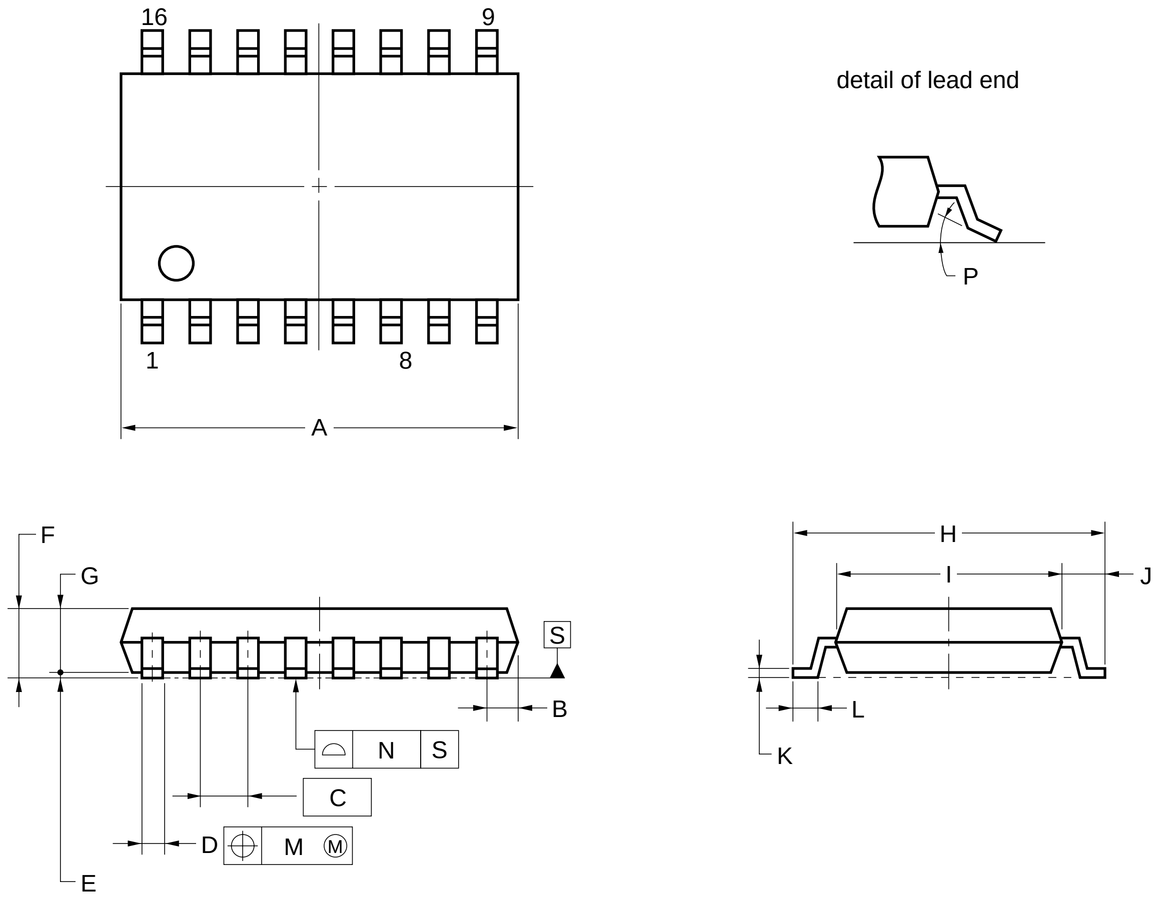
NOTE

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

ITEM	MILLIMETERS
A	10.0±0.2
B	0.78 MAX.
C	1.27 (T.P.)
D	$0.42^{+0.08}_{-0.07}$
E	0.125±0.075
F	2.77 MAX.
G	2.47±0.1
H	10.3±0.3
I	7.2
J	1.6
K	$0.17^{+0.08}_{-0.07}$
L	0.8±0.2
M	0.12
N	0.15
P	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$

P16GM-50-375B-6

16-PIN PLASTIC SOP (7.62 mm (300))



NOTE

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

ITEM	MILLIMETERS
A	10.2±0.2
B	0.78 MAX.
C	1.27 (T.P.)
D	$0.42^{+0.08}_{-0.07}$
E	0.1±0.1
F	1.65±0.15
G	1.55
H	7.7±0.3
I	5.6±0.2
J	1.1±0.2
K	$0.22^{+0.08}_{-0.07}$
L	0.6±0.2
M	0.12
N	0.10
P	$3°^{+7°}_{-3°}$

P16GM-50-300B-6

★ RECOMMENDED SOLDERING CONDITIONS

When soldering this product, it is highly recommended to observe the conditions as shown below. If other soldering processes are used, or if the soldering is performed under different conditions, please make sure to consult with our sales offices.

For more details, refer to our document "**SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL"(C10535E)**.

Type of Through-hole Device

μPC494C: 16-pin plastic DIP (7.62 mm (300))

Process	Conditions
Wave Soldering (only to leads)	Solder temperature: 260°C or below, Flow time: 10 seconds or less.
Partial Heating Method	Pin temperature: 300°C or below, Heat time: 3 seconds or less (per each lead).

Caution For through-hole device, the wave soldering process must be applied only to leads, and make sure that the package body does not get jet soldered.

Type of Surface Mount Device

μPC494G: 16-pin plastic SOP (9.53 mm (375))
μPC494GS: 16-pin plastic SOP (7.62 mm (300))

Process	Conditions	Symbol
Infrared Ray Reflow	Peak temperature: 230°C or below (Package surface temperature), Reflow time: 30 seconds or less (at 210°C or higher), Maximum number of reflow processes: 1 time.	IR30-00-1
Vapor Phase Soldering	Peak temperature: 215°C or below (Package surface temperature), Reflow time: 40 seconds or less (at 200°C or higher), Maximum number of reflow processes: 1 time.	VP15-00-1
Wave Soldering	Solder temperature: 260°C or below, Flow time: 10 seconds or less, Maximum number of flow processes: 1 time, Pre-heating temperature: 120°C or below (Package surface temperature).	WS60-00-1
Partial Heating Method	Pin temperature: 300°C or below, Heat time: 3 seconds or less (Per each side of the device).	–

Caution Apply only one kind of soldering condition to a device, except for "partial heating method", or the device will be damaged by heat stress.

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