

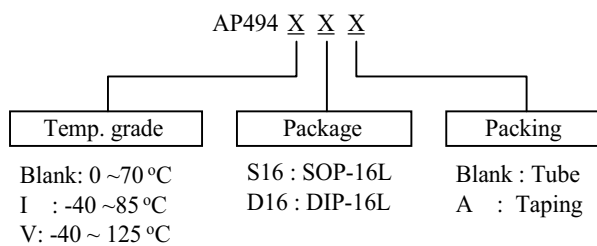
AP494

Voltage Mode PWM Controller

■ Features

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200-mA Sink or Source Current
- Output Control Selects Single-Ended or Push-Pull Operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Variable Dead Time Provides Control Over Total Range
- Internal Regulator Provides a Stable 5-V Reference Supply with 3% Tolerance
- Circuit Architecture allows Easy Synchronization

■ Ordering Information



■ Description

The AP494 incorporates on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control circuit. Designed primarily for power supply control, this device offers the systems engineer the flexibility to tailor the power supply control circuitry to a specific application.

The AP494 contains two error amplifiers, an on-chip adjustable oscillator, a dead-time control (DTC) comparator, a pulse-steering control flip-flop, a 5-V, 3%-precision regulator, and output-control circuits.

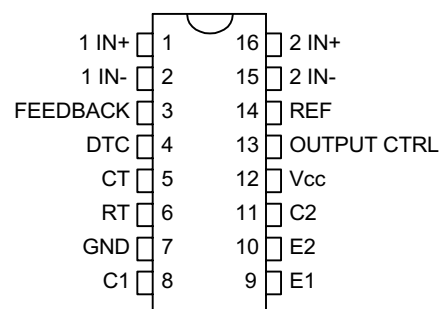
The error amplifiers exhibit a common-mode voltage range from $-0.3V$ to $V_{CC} - 2V$. The dead-time control comparator has a fixed offset that provides approximately 5% dead time. The on-chip oscillator may be bypassed by terminating RT to the reference output and providing a sawtooth input to CT, or it may drive the common circuits in synchronous multiple-rail power supplies.

The uncommitted output transistors provide either common-emitter or emitter-follower output capability. The AP494 provides for push-pull or single-ended output operation, which may be selected through the output-control function. The architecture of this device prohibits the possibility of either output being pulsed twice during push-pull operation.

The AP494 is characterized for operation from 0°C to 70°C.

■ Connection Diagram

(TOP VIEW)

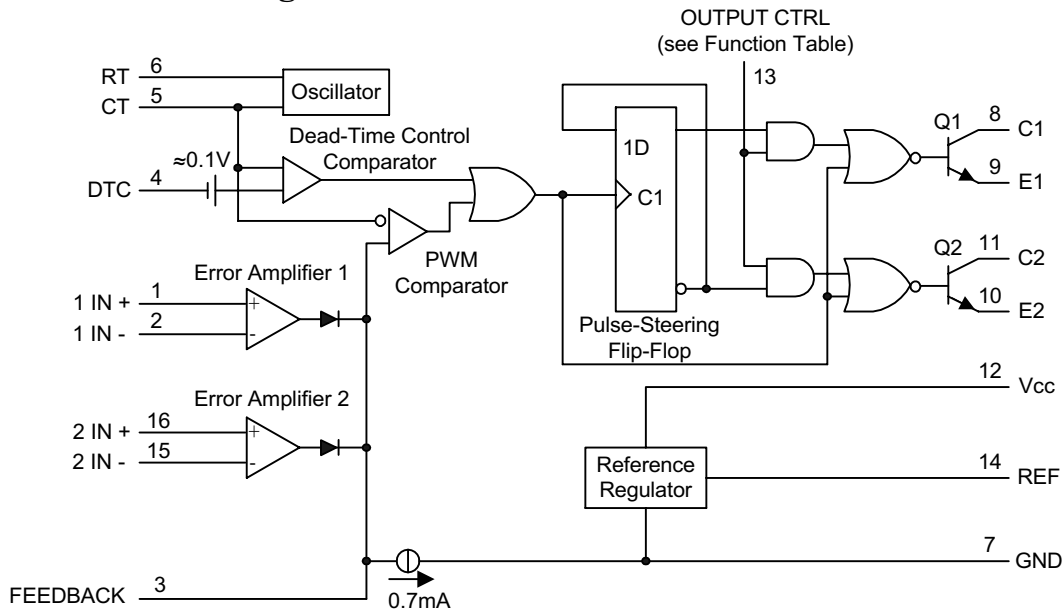


AP494

Voltage Mode PWM Controller



Functional Block Diagram



Absolute Maximum Ratings

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	40	V
Collector Output Voltage	V_{C1}, V_{C2}	40	V
Collector Output Current (Each transistor)	I_{C1}, I_{C2}	500	mA
Amplifier Input Voltage Range	V_{IR}	-0.3 to +40	V
Power Dissipation @ $T_A \leq 45^\circ\text{C}$	P_D	1000	mW
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	80	$^\circ\text{C}/\text{W}$
Operating Junction Temperature	T_J	125	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 to +125	$^\circ\text{C}$
Operating Ambient Temperature Range	T_A	0 to +70	$^\circ\text{C}$
Derating Ambient Temperature	T_A	45	$^\circ\text{C}$

Recommended Operating Conditions

Characteristics	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{CC}	7.0	15	40	V
Collector Output Voltage	V_{C1}, V_{C2}	-	30	40	V
Collector Output Current (Each transistor)	I_{C1}, I_{C2}	-	-	200	mA
Amplified Input Voltage	V_{in}	-0.3	-	$V_{CC}-2.0$	V
Current Into Feedback Terminal	I_{fb}	-	-	0.3	mA
Reference Output Current	I_{ref}	-	-	10	mA
Timing Resistor	R_T	1.8	30	500	$k\Omega$
Timing Capacitor	C_T	0.0047	0.001	10	μF
Oscillator Frequency	f_{OSC}	1.0	40	200	kHz

AP494



Voltage Mode PWM Controller

■ Electrical Characteristics

($V_{CC}=15V$, $C_T=0.01\mu F$, $R_T=12\text{ k}\Omega$, unless otherwise noted.) For typical values $T_A=25^\circ C$, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
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REFERENCE SECTION

Reference Voltage ($I_O=1.0\text{mA}$)	I_{ref}	4.85	5.0	5.15	V
Line Regulation ($V_{CC}=7.0\text{ V to }40\text{V}$)	Reg_{line}	-	2.0	25	mV
Load Regulation ($I_O=1.0\text{mA to }20\text{mA}$)	Reg_{load}	-	3.0	15	mA
Short Circuit Output Current ($I_{ref}=0\text{ V}$)	I_{SC}	4.5	60	75	mA

OUTPUT SECTION

Collector Off-State Current ($V_{CC}=40\text{V}$, $V_{CE}=40\text{V}$)	$I_{C(off)}$	-	2.0	100	μA
Emitter Off-State Current ($V_{CC}=40\text{V}$, $V_C=40\text{V}$, $V_E=0\text{V}$)	$I_{E(off)}$	-	-	-100	μA
Collector-Emitter Saturation Voltage (Note 1) Common-Emitter ($V_E=0\text{V}$, $I_C=200\text{mA}$)	$V_{sat(C)}$	-	1.1	1.5	V
Emitter-Follower ($V_C=15\text{V}$, $I_E=-200\text{mA}$)	$V_{sat(E)}$	-	1.5	2.5	
Output Control Pin Current Low State ($V_{OC}\leq 0.4\text{V}$)	I_{OCL}	-	10	-	μA
High State ($V_{OC}=V_{ref}$)	I_{OCH}	-	0.2	3.5	mA
Output Voltage Rise Time Common-Emitter (See Figure 4) Emitter-Follower (See Figure 5)	t_r	-	100	200	ns
Output Voltage Fall Time Common-Emitter (See Figure 4) Emitter-Follower (See Figure 5)	t_f	-	25	100	ns

NOTE: 1. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

ERROR AMPLIFIER SECTION

Input Offset Voltage ($V_{O(Pin\ 3)}=2.5\text{V}$)	V_{IO}	-	2.0	10	mV
Input Offset Current ($V_{O(Pin\ 3)}=2.5\text{V}$)	I_{IO}	-	5.0	250	nA
Input Bias Current ($V_{O(Pin\ 3)}=2.5\text{V}$)	V_{IB}	-	-0.1	-0.1	μA
Input Common Mode Voltage Range ($V_{CC}=40\text{V}$, $T_A=25^\circ C$)	I_{ICR}	-0.3 to $V_{CC}-2.0$			V
Open Loop Voltage Gain ($\Delta V_O=3.0\text{V}$, $V_O=0.5\text{V to }3.5\text{V}$, $R_L=2.0\text{ k}\Omega$)	A_{VOL}	70	95	-	dB
Unity-Gain Crossover Frequency ($V_O=0.5\text{V to }3.5\text{V}$, $R_L=2.0\text{ k}\Omega$)	f_c	-	350	-	kHz
Common Mode Rejection Ratio ($V_{CC}=40\text{V}$)	CMRR	64	90	-	dB
Output Sink Current ($V_{O(Pin\ 3)}=0.7\text{V}$)	I_{O-}	0.3	0.7	-	mA
Output Source Current ($V_{O(Pin\ 3)}=3.5\text{V}$)	I_{O+}	-10	-15	-	mA

PWM COMPARATOR SECTION (Test Circuit Figure 1)

Input Threshold Voltage (Zero Duty Cycle)	V_{TH}	-	2.5	4.5	V
Input Sink Current ($V_{(Pin\ 3)}=0.7\text{V}$)	I_L	0.3	0.7	-	mA

DEADTIME CONTROL SECTION (Test Circuit Figure 1)

Input Bias Current (Pin 4) ($V_{Pin4}=0\text{V to }5.25\text{V}$)	$I_{IB(DT)}$	-	-2.0	-10	μA
Maximum Duty Cycle, Each Output, Push-Pull Mode ($V_{Pin4}=0\text{V}$, $C_T=0.01\mu F$, $R_T=12\text{ k}\Omega$)	DC_{max}	45	48	50	%
Input Threshold Voltage (Pin4) (Zero Duty Cycle) (Maximum Duty Cycle)	V_{th}	- 0	2.8 -	3.3 -	V

AP494

Voltage Mode PWM Controller



OSCILLATOR SECTION

Frequency ($C_T=0.01\mu\text{F}, R_T=12\text{ k}\Omega$)	f_{OSC}	-	10	-	kHz
Standard Deviation of Frequency* ($C_T=0.001\mu\text{F}, R_T=30\text{ k}\Omega$)	σf_{OSC}	-	3.0	-	%
Frequency Change with Voltage ($V_{\text{CC}}=7.0\text{V to }40\text{V}, T_A=25^\circ\text{C}$)	$\Delta f_{\text{OSC}} (\Delta V)$	-	0.1	-	%
Frequency Change with Temperature ($\Delta T_A=T_{\text{low to }T_{\text{high}}}$) ($C_T=0.01\mu\text{F}, R_T=12\text{ k}\Omega$)	$\Delta f_{\text{OSC}} (\Delta T)$	-	-	12	%

TOTAL DEVICE

Standby Supply Current (Pin6 at V_{ref} , All other inputs and outputs open) ($V_{\text{CC}}=15\text{V}$) ($V_{\text{CC}}=40\text{V}$)	I_{CC}	-	5.5 7.0	10 15	mA
Average Supply Current ($C_T=0.01\mu\text{F}, R_T=12\text{ k}\Omega, V_{(\text{pin}4)}=2.0\text{V}$) ($V_{\text{CC}}=15\text{V}$) (See Figure 4)		-	7.0	-	mA

*Standard deviation is a measure of the statistical distribution about the mean as derived from the formula, σ

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

Figure 1. PARAMETER MEASUREMENT INFORMATION

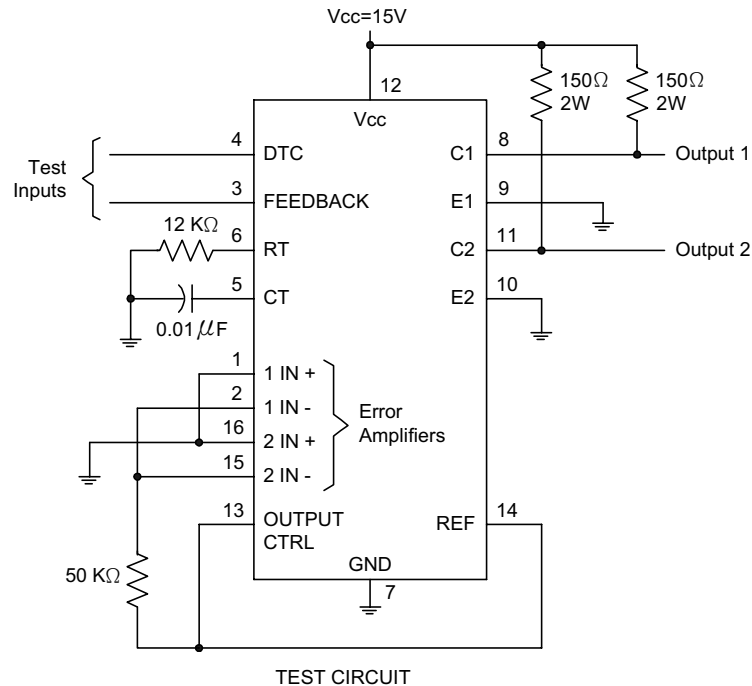


Figure 2. OPERATIONAL TEST CIRCUIT AND WAVEFORMS

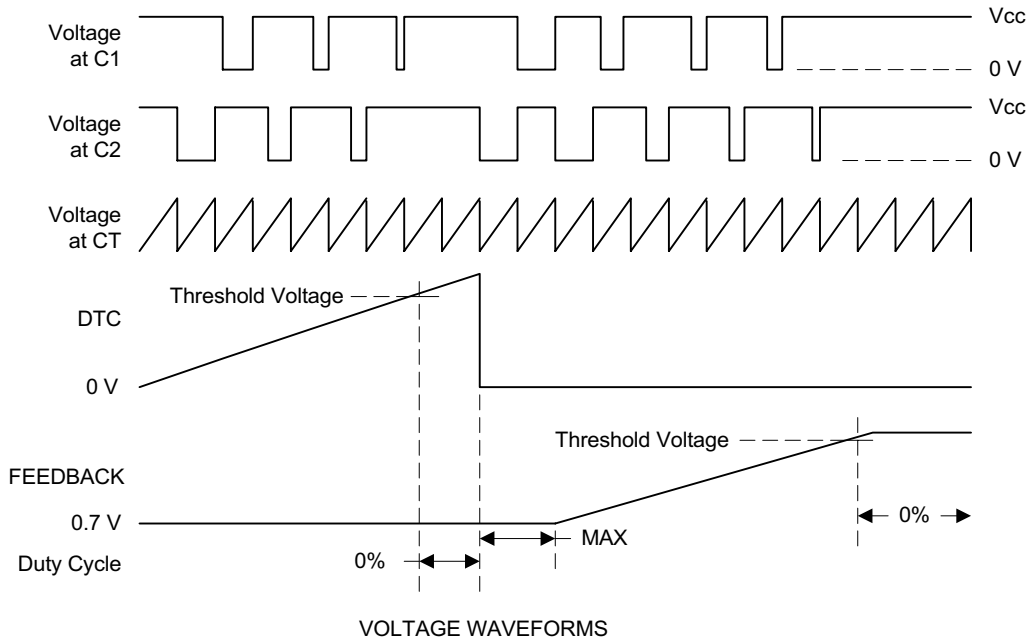


Figure 3. AMPLIFIER CHARACTERISTICS

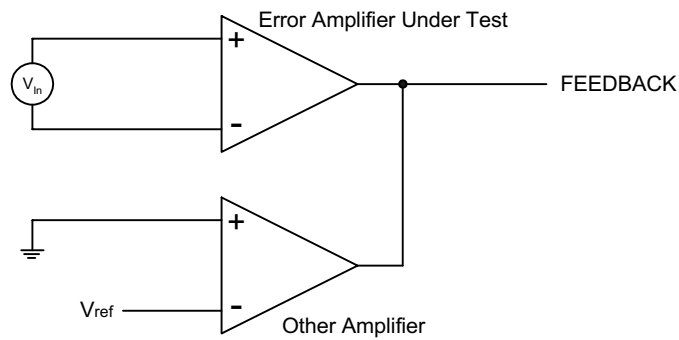
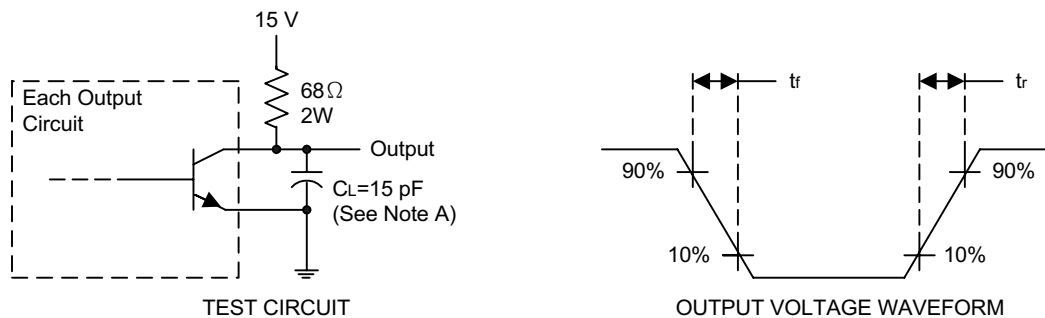
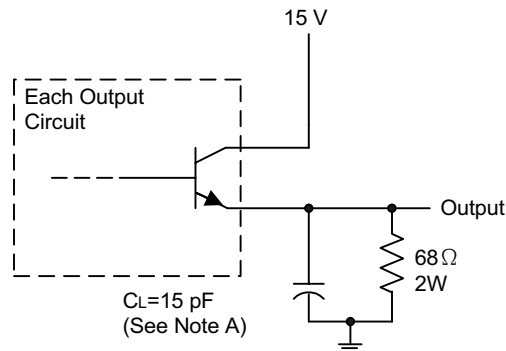


Figure 4. COMMON-EMITTER CONFIGURATION



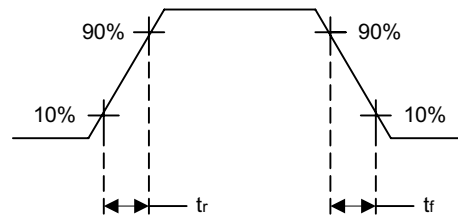
NOTE A. CL includes probe and jig capacitance.

Figure 5. EMITTER-FOLLOWER CONFIGURATION



TEST CIRCUIT

NOTE A. CL includes probe and jig capacitance.



OUTPUT VOLTAGE WAVEFORM

Figure 6.

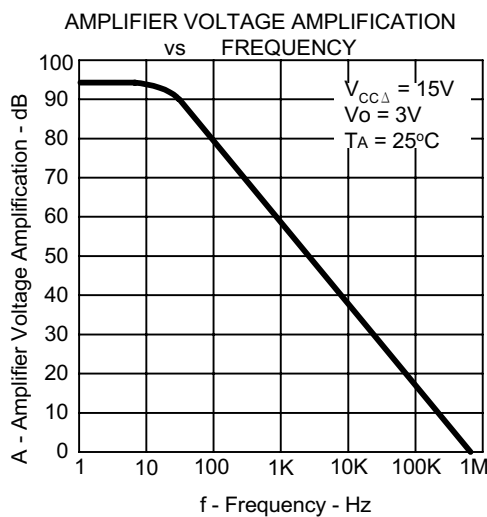


Figure 8.

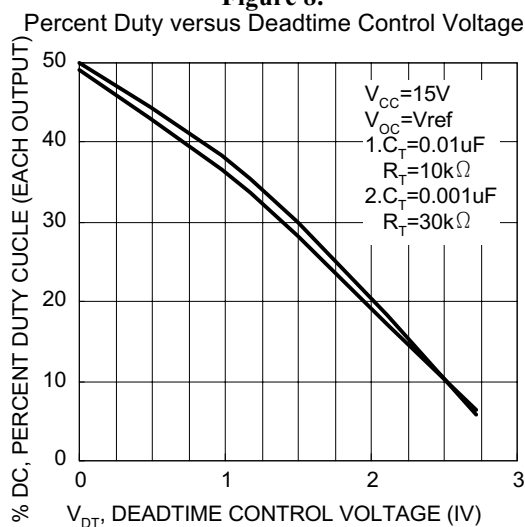


Figure 7.

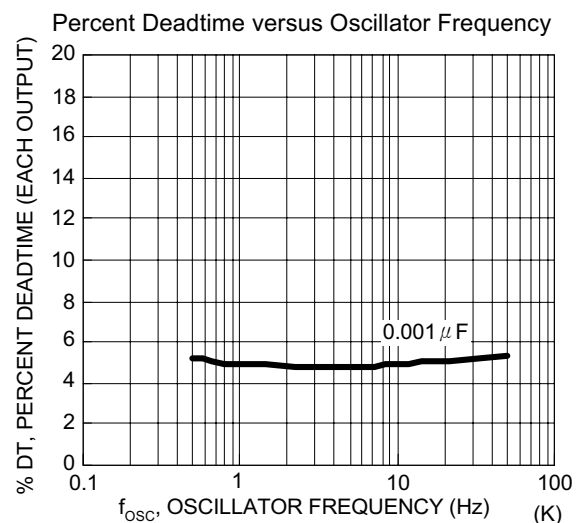


Figure 9.

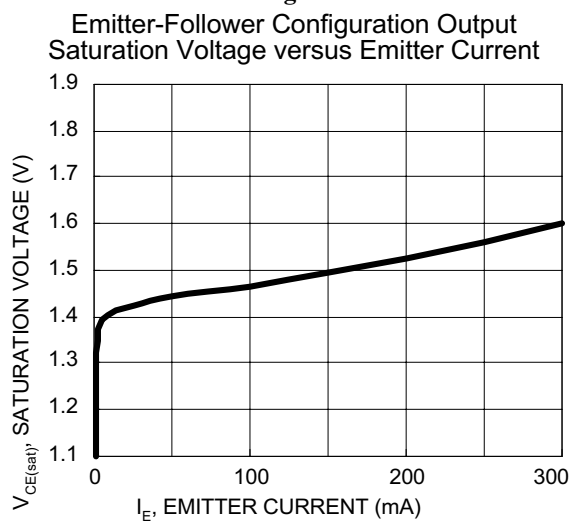


Figure 10.

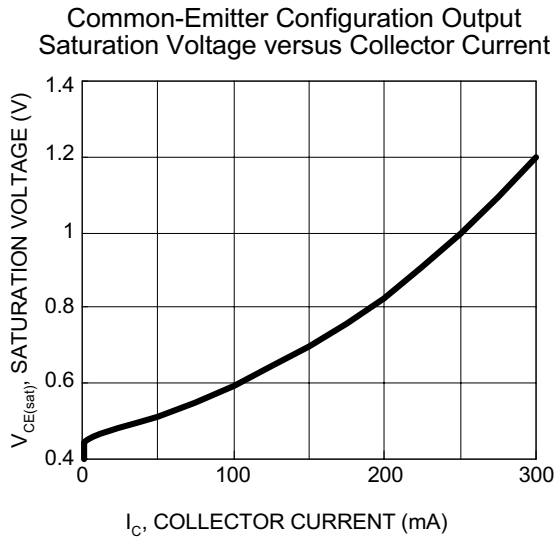


Figure 11.

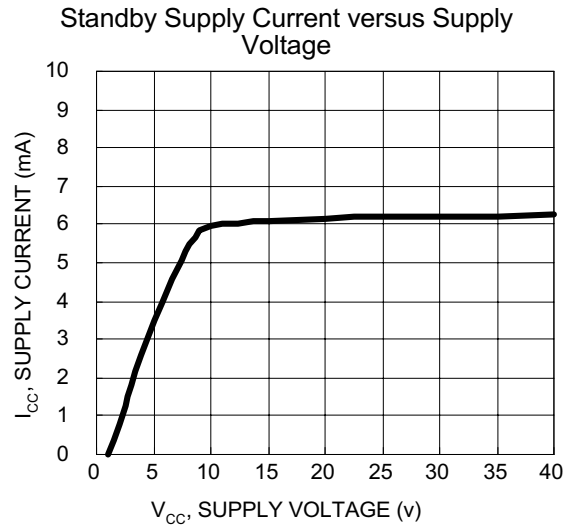
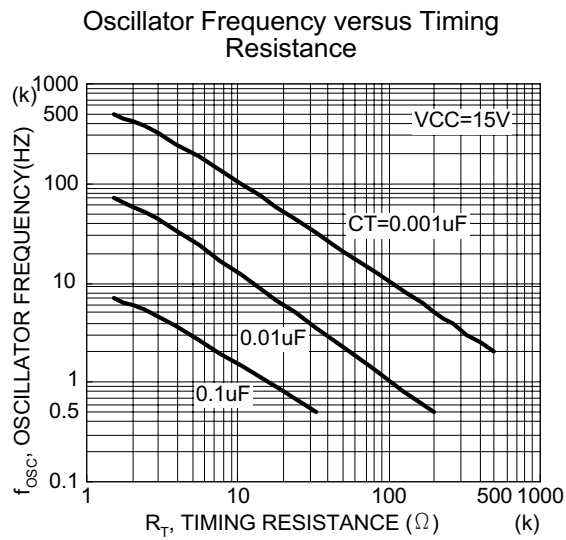


Figure 12.



AP494

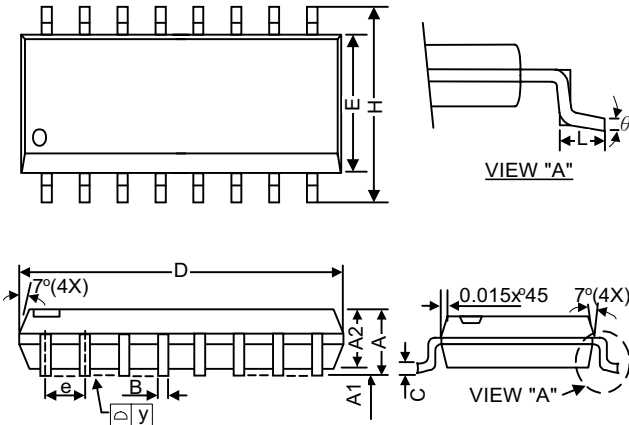
Voltage Mode PWM Controller



■ Package Dimension

(1) SOP-16L

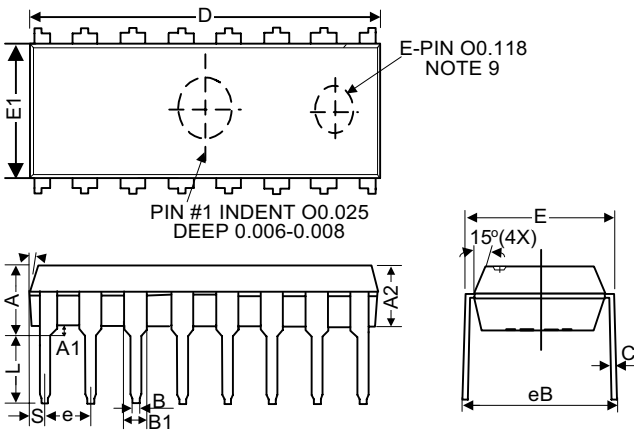
Package Dimension



Symbols	MILLIMETER			INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.60	1.75	0.055	0.063	0.069
A1	0.10	-	0.25	0.040	-	0.010
A2	1.30	1.45	1.50	0.051	0.057	0.059
B	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.007 5	0.008	0.009 8
D	9.80	9.91	10.01	0.386	0.390	0.394
E	3.80	3.91	4.00	0.150	0.154	0.157
e	-	1.27	-	-	0.050	-
H	5.79	5.99	6.20	0.228	0.236	0.244
L	0.38	0.71	1.27	0.015	0.028	0.050
Θ	0	-	8	0	-	8

(2) PDIP-16L

Package Dimension



Symbol	MILLIMETER		
	MIN	NOM	MAX
A	*	*	5.33
A1	0.38	*	*
A2	3.1	3.3	3.5
B	0.36	0.46	0.56
B1	1.4	1.52	1.65
B2	0.81	0.99	1.14
C	0.2	0.25	0.36
D	18.9	19.10	19.30
E	7.62	7.94	8.26
E1	6.15	6.35	6.55
e	*	2.54	*
L	2.92	3.3	3.81
eB	8.38	8.89	9.4
S	0.71	0.84	0.97