



Analog Technology, Inc.

AP1505

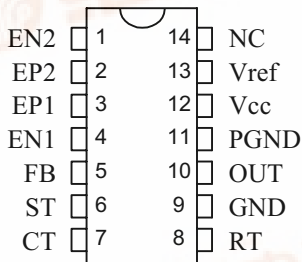
Single-end Voltage Mode PWM Controller

■ Features

- Complete PWM Power Control Circuitry
- Single-end Output
- A Stable $5V \pm 3\%$ Reference output
- Soft Start Function
- Adjustable Oscillator Frequency

■ Connection Diagram

(TOP VIEW)



■ General Description

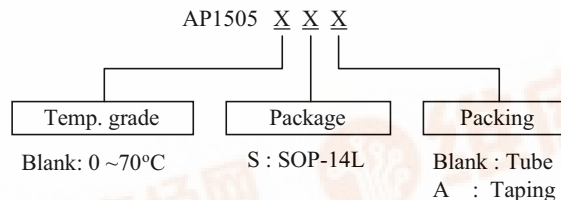
The AP1505 incorporates on a single monolithic chip all the functions required in the construction of a pulse-width-modulation (PWM) control circuit. Designed primarily for power supply control, this device offers the systems engineer the flexibility to tailor the power supply control circuitry to a specific application.

The AP1505 contains two error amplifiers, an on-chip adjustable oscillator, a dead-time comparator, a $5V \pm 3\%$ precision regulator and a single-end output transistor.

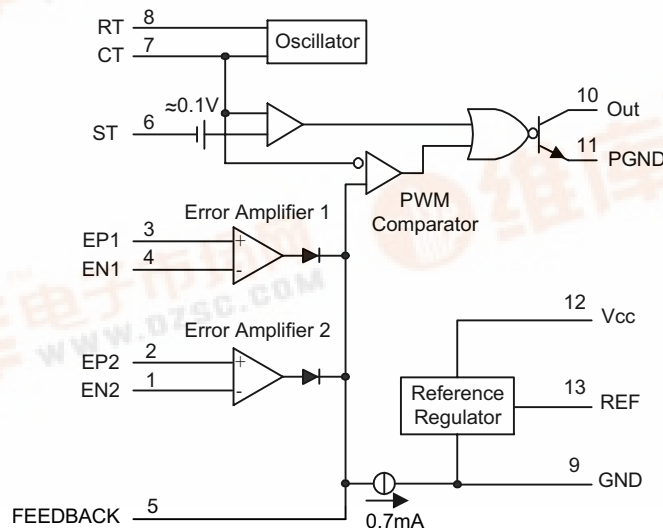
The error amplifiers exhibit a common-mode voltage range from $-0.3V$ to $V_{CC} - 2V$. The on-chip oscillator may be bypassed by terminating RT to the reference output and providing a sawtooth input to CT, or it may drive the common circuits in synchronous multiple-rail power supplies.

The uncommitted output transistors provide either common-emitter or emitter-follower output capability. The AP1505 provides for single-ended output operation and is characterized for operation from $0^{\circ}C$ to $70^{\circ}C$.

■ Ordering Information



■ Functional Block Diagram



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■ Absolute Maximum Ratings

Rating	Symbol	AP1505	Unit
Power Supply Voltage	V_{CC}	40	V
Collector Output Voltage	V_{C1}	40	V
Collector Output Current	I_{C1}	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}	-	30	40	V
Collector Output Current	I_{C1}	-	-	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	-	10	μF
Oscillator Frequency	f_{OSC}	1.0	40	200	kHz

■ Electrical Characteristics ($V_{CC}=15\text{V}$, $C_T=0.01\mu\text{F}$, $R_T=12\text{K}\Omega$, unless otherwise noted.)

For typical values $T_A=25^\circ\text{C}$, 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 40V)	Reg_{line}	-	2.0	25	mV
Load Regulation ($I_O=1.0\text{mA}$ to 20mA)	Reg_{load}	-	3.0	15	mV
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	V
Output Voltage Rise Time					
Common-Emitter (See Figure 3)	t_r	-	100	200	ns
Emitter-Follower (See Figure 4)		-	100	200	ns
Output Voltage Fall Time					
Common-Emitter (See Figure 3)	t_f	-	25	100	ns
Emitter-Follower (See Figure 4)		-	40	100	ns

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

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ERROR AMPLIFIER SECTION

Input Offset Voltage ($V_{O(Pin\ 5)}=2.5V$)	V_{IO}	-	2.0	10	mV
Input Offset Current ($V_{O(Pin\ 5)}=2.5V$)	I_{IO}	-	5.0	250	nA
Input Bias Current ($V_{O(Pin\ 5)}=2.5V$)	V_{IB}	-	-0.1	-0.1	μA
Input Common Mode Voltage Range ($V_{CC}=40V, T_A=25^\circ C$)	I_{ICR}	-0.3 to $V_{CC}-2.0$			V
Open Loop Voltage Gain ($\Delta V_O=3.0V, V_O=0.5V$ to $3.5V, R_L=2.0\ k\Omega$)	A_{VOL}	70	95	-	dB
Unity-Gain Crossover Frequency ($V_O=0.5V$ to $3.5V, R_L=2.0\ k\Omega$)	f_C	-	350	-	KHz
Common Mode Rejection Ratio ($V_{CC}=40V$)	CMRR	64	90	-	dB
Output Sink Current ($V_{O(Pin\ 5)}=0.7V$)	I_{O-}	0.3	0.7	-	mA
Output Source Current ($V_{O(Pin\ 5)}=3.5V$)	I_{O+}	-10	-15	-	mA

PWM COMPARATOR SECTION (Figure 1)

Input Threshold Voltage (Zero Duty Cycle)	V_{TH}	-	2.5	4.5	V
Input Sink Current ($V_{(Pin\ 5)}=0.7V$)	I_L	0.3	0.7	-	mA

DEADTIME CONTROL SECTION (Test Circuit Figure 1)

Input Bias Current (Pin 4)($V_{Pin4}=0V$ to $5.25V$)	$I_{IB(DT)}$	-	-2.0	-10	μA
Maximum Duty Cycle, Each Output, Push-Pull Mode ($V_{Pin4}=0V, C_T=0.01\ \mu F, R_T=12\ k\Omega$)	DC_{max}	-	95	100	%
Input Threshold Voltage (Pin6) (Zero Duty Cycle) (Maximum Duty Cycle)	V_{th}	- 0	2.8 -	3.3 -	V

OSCILLATOR SECTION

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

TOTAL DEVICE

Standby Supply Current(Pin6 at V_{ref} , All other inputs and outputs open) ($V_{CC}=15V$) ($V_{CC}=40V$)	I_{CC}	- -	5.5 7.0	10 15	mA
Average Supply Current ($C_T=0.01\ \mu F, R_T=12\ k\Omega, V_{(Pin4)}=2.0V$) ($V_{CC}=15V$) (See Figure 4)		-	7.0	-	mA

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

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

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Figure 1. Parameter Measurement Information

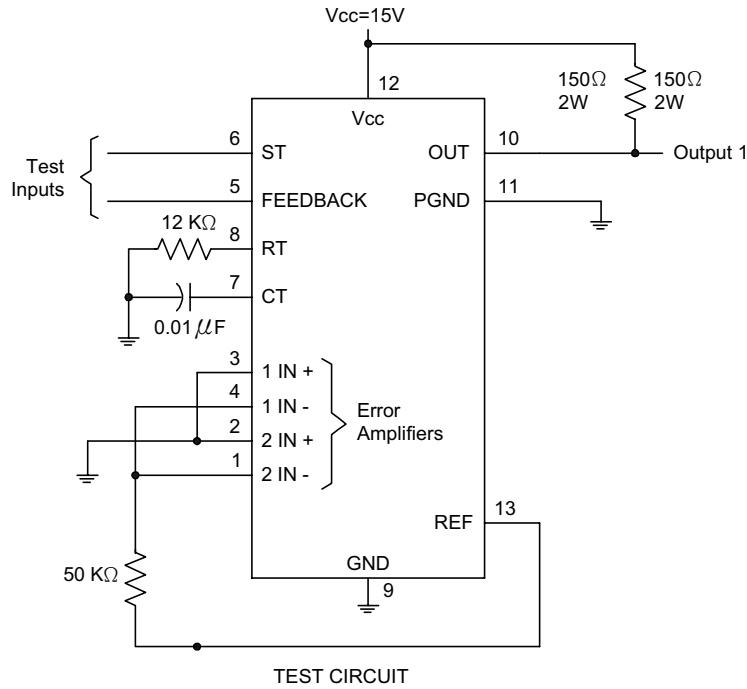


Figure 2. Amplifier Characteristics

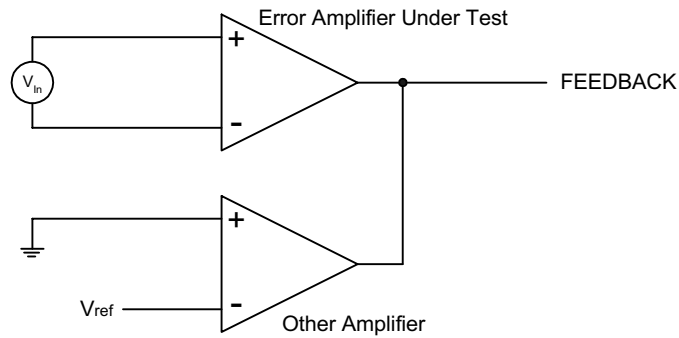
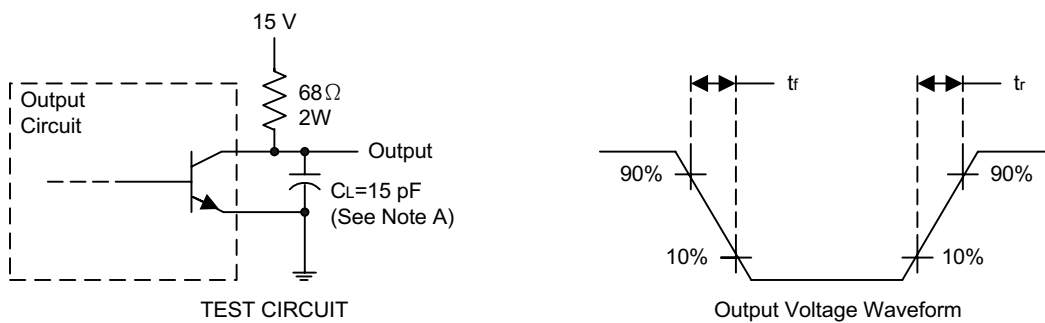


Figure 3. Common-Emitter Configuration



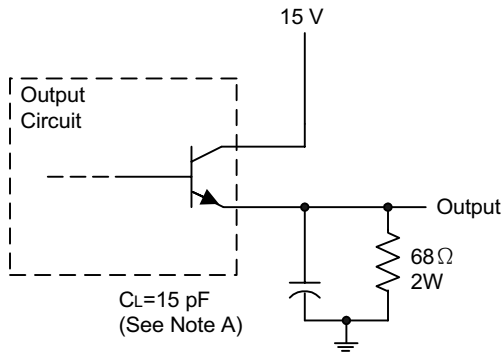
NOTE A. CL includes probe and jig capacitance.

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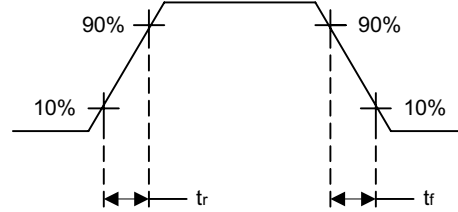


Figure 4. Emitter-Follower Configuration



TEST CIRCUIT

NOTE A. CL includes probe and jig capacitance.



Output Voltage Waveform

Figure 5.

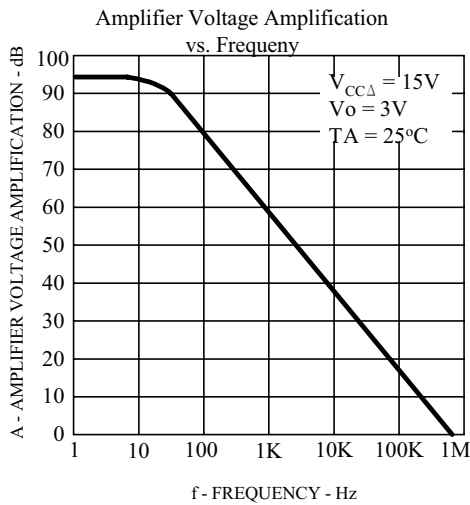


Figure 6.

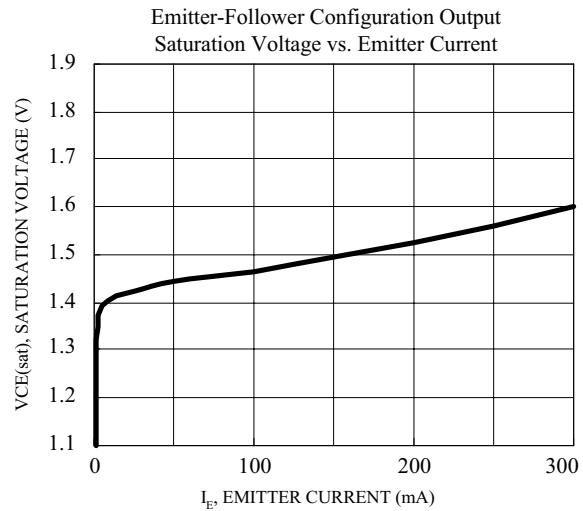


Figure 7.

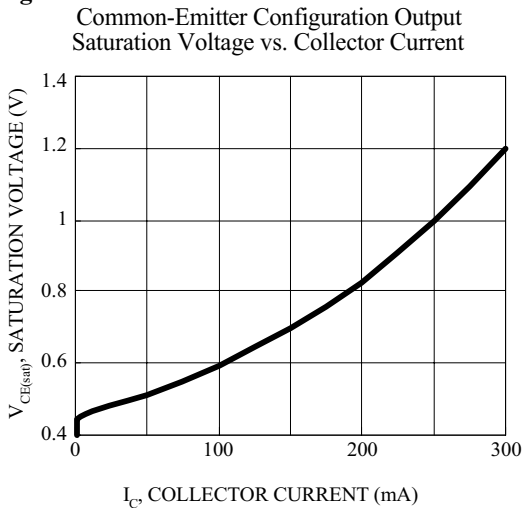
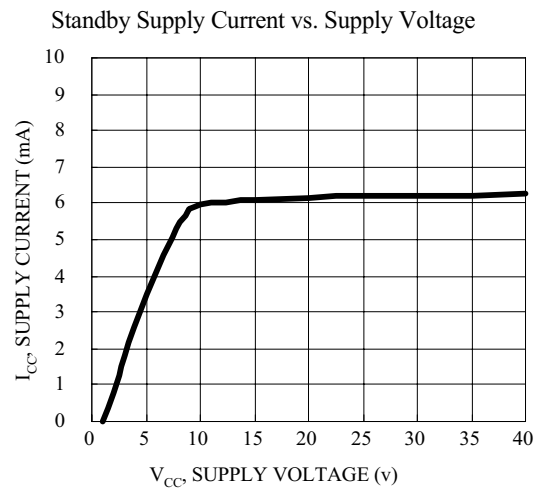


Figure 8.

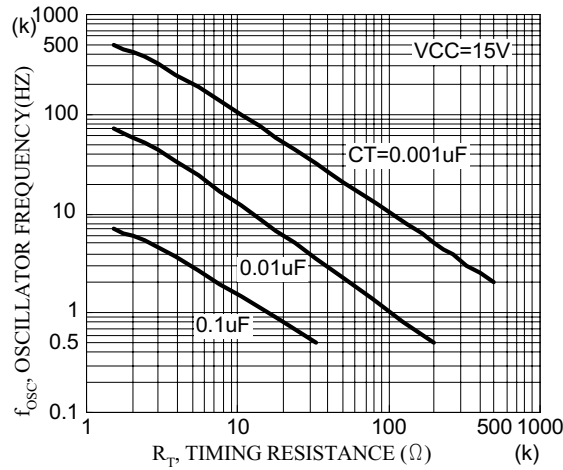


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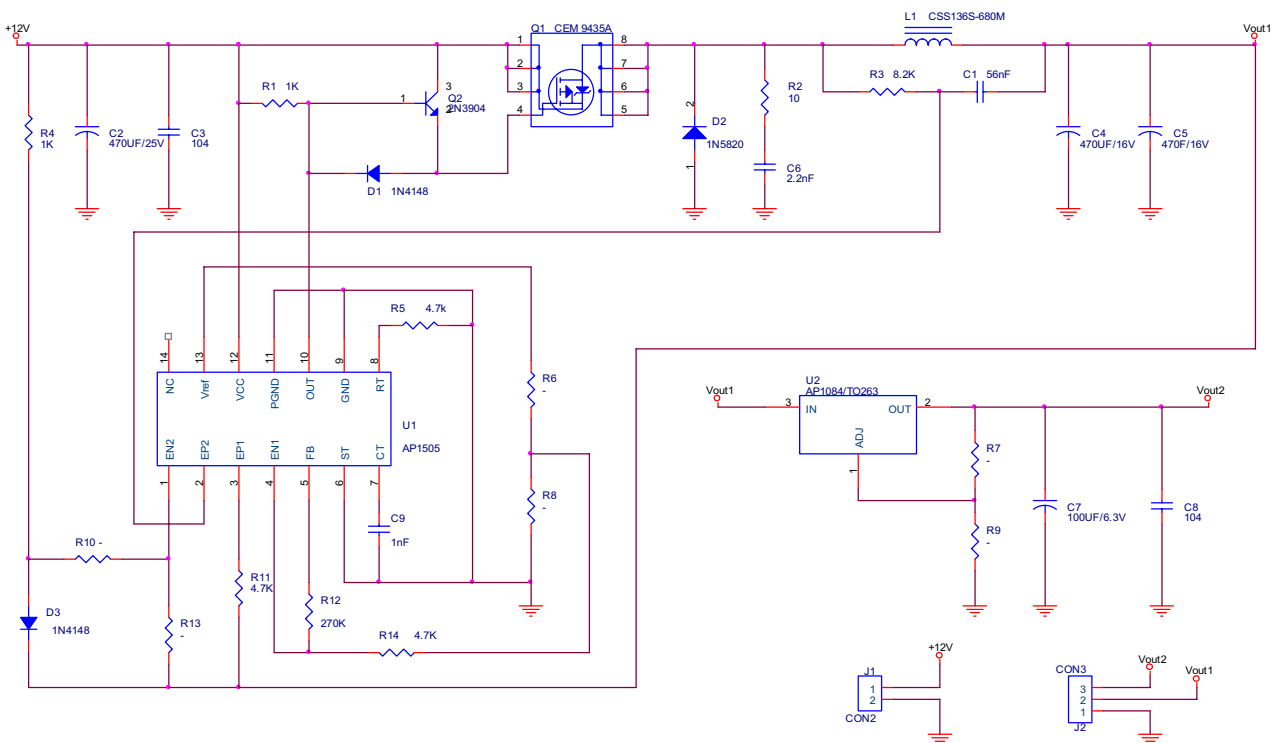
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Figure 9. Oscillator Frequency vs. Timing Resistance



Application Circuit



CASE1:

Vout1=5V/1A R6=Short, R8=Open

Vout2=3.3V/1A R7=120, R9=200

$$I_{out}(\text{limit}) = 0.7 / \text{DCR}(L1) * [R13 / (R10 + R13)]$$

CASE2:

Vout1=3.3V/1A

Vout2=1.8V/1A

R6=2K, R8=3.9K

R7=120, R9=56

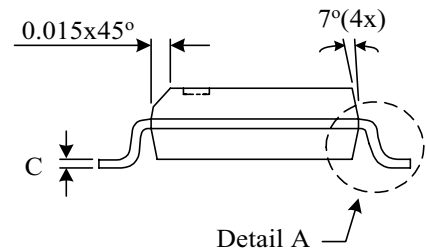
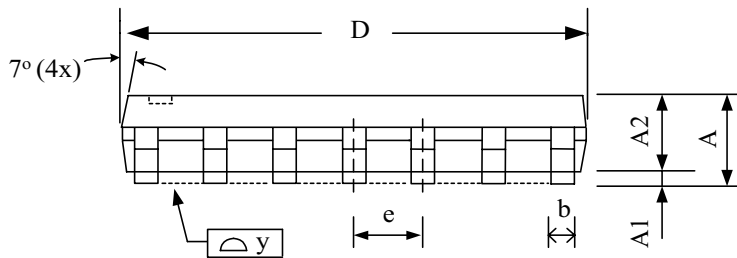
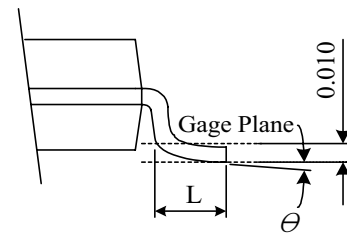
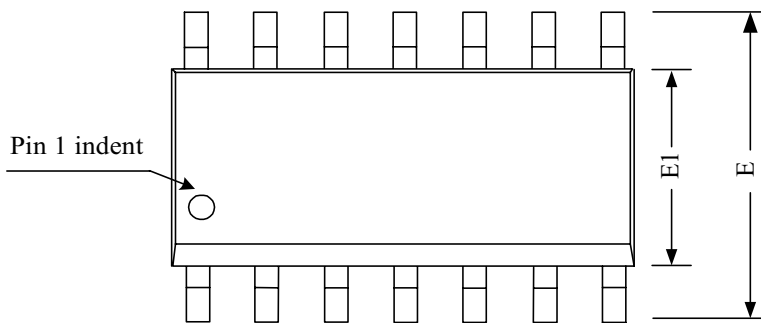
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■ Package Dimension

(1) Package type : SOP-14



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.47	1.60	1.73	0.058	0.063	0.068
A1	0.10	—	0.25	0.004	—	0.010
A2	—	1.45	—	—	0.057	—
b	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.0098
D	8.53	8.64	8.74	0.336	0.340	0.344
E	5.79	5.99	6.20	0.228	0.236	0.244
E1	3.81	3.91	3.99	0.150	0.154	0.157
e	—	1.27	—	—	0.050	—
L	0.38	0.71	1.27	0.015	0.028	0.050
Y	—	—	0.076	—	—	0.003
θ	0°	—	8°	0°	—	8°