

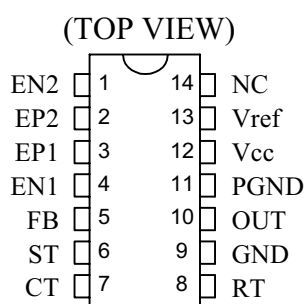
AP1505

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



■ General Description

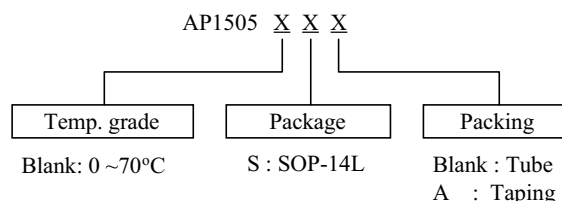
The AP1505 incorporates on a single monolithic chip all the functions required in the construction of a pulse-width-modulation (PWM) control circuit. Designed primarily for power supply control, this device offers the systems engineer the flexibility to tailor the power supply control circuitry to a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

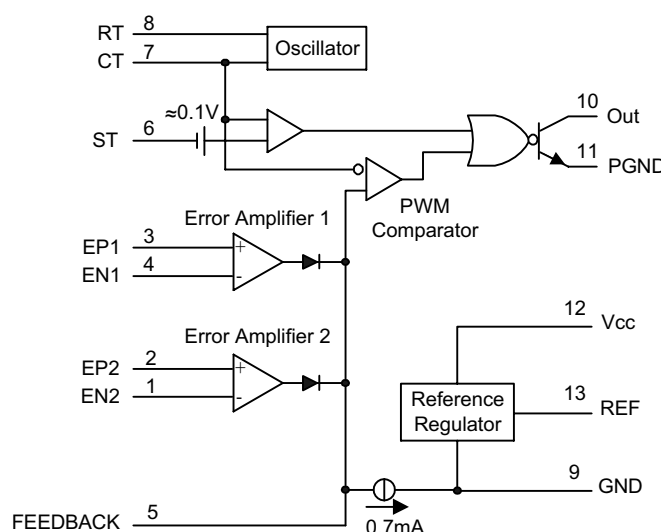
The error amplifiers exhibit a common-mode voltage range from $-0.3V$ to $V_{CC} - 2V$. The on-chip oscillator may be bypassed by terminating RT to the reference output and providing a sawtooth input to CT, or it may drive the common circuits in synchronous multiple-rail power supplies.

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	$^\circ\text{C/W}$
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	
Output Voltage Rise Time					
Common-Emitter (See Figure 3)	t_r	-	100	200	ns
Emitter-Follower (See Figure 4)		-	100	200	
Output Voltage Fall Time					
Common-Emitter (See Figure 3)	t_f	-	25	100	ns
Emitter-Follower (See Figure 4)		-	40	100	

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,

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

Figure1. Parameter Measurement Information

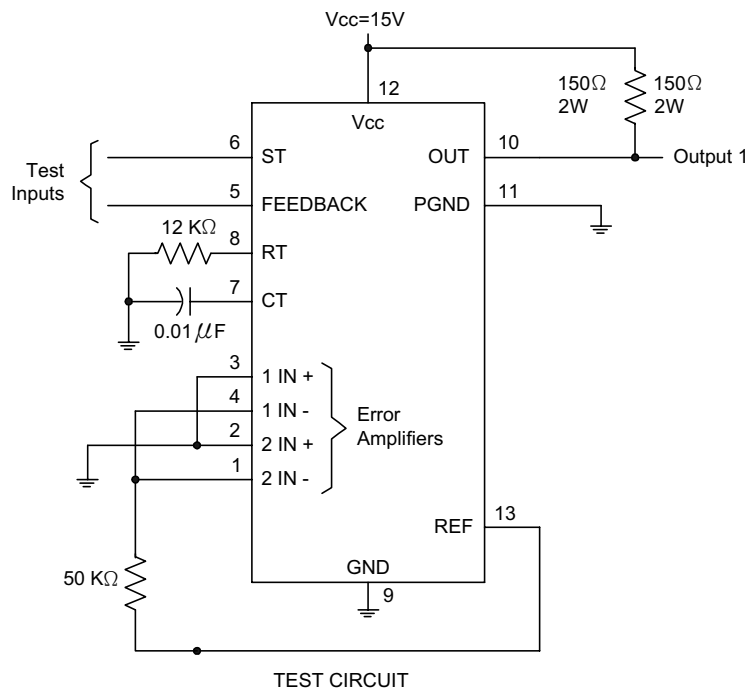


Figure 2. Amplifier Characteristics

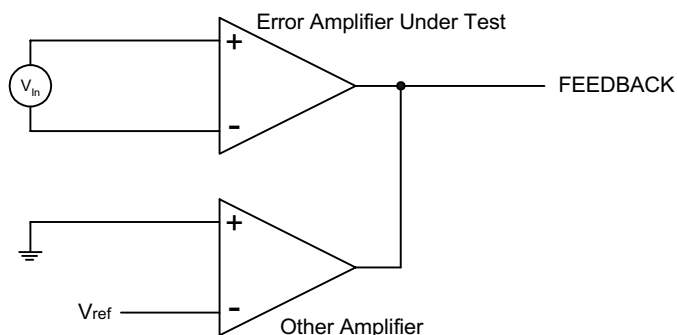
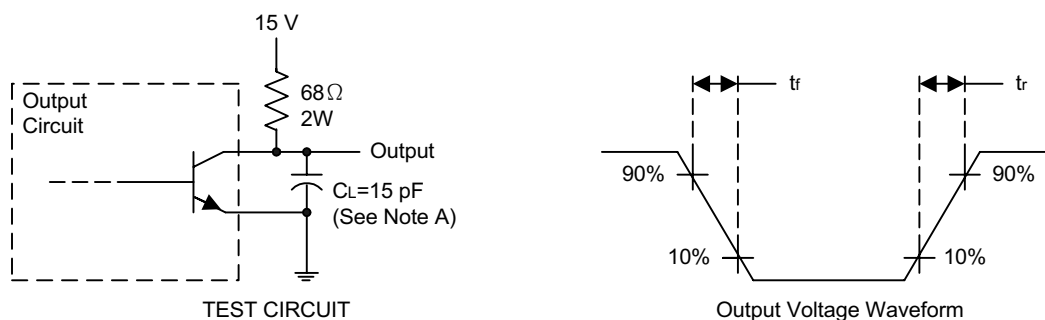
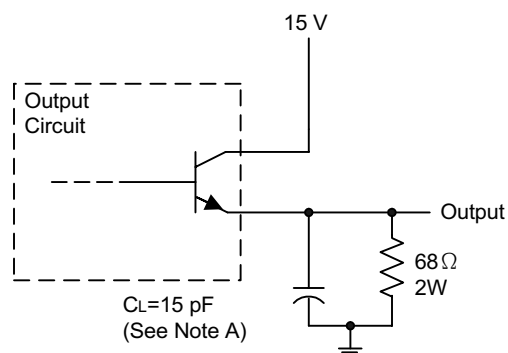


Figure 3. Common-Emitter Configuration



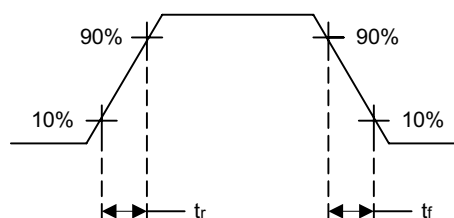
NOTE A. C_L includes probe and jig capacitance.

Figure 4. Emitter-Follower Configuration



TEST CIRCUIT

NOTE A. CL includes probe and jig capacitance.



Output Voltage Waveform

Figure 5.

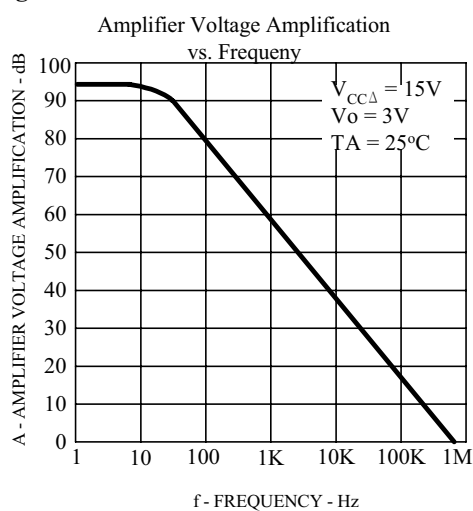


Figure 6.

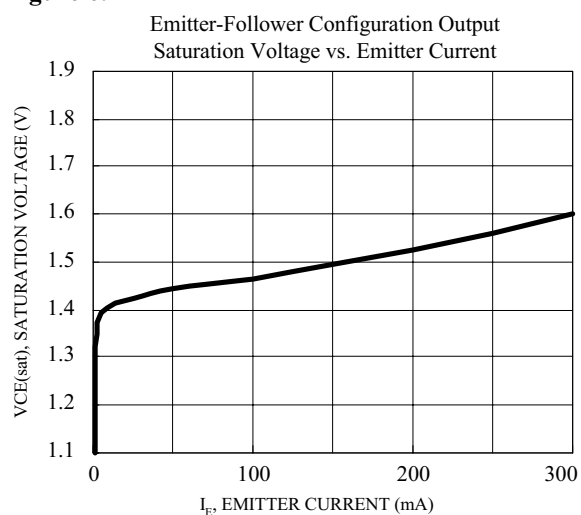


Figure 7.

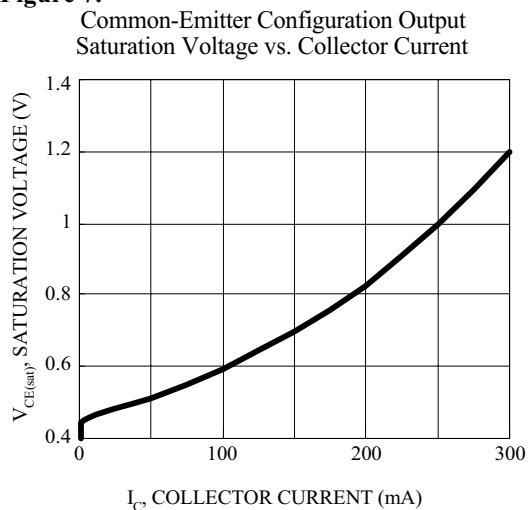


Figure 8.

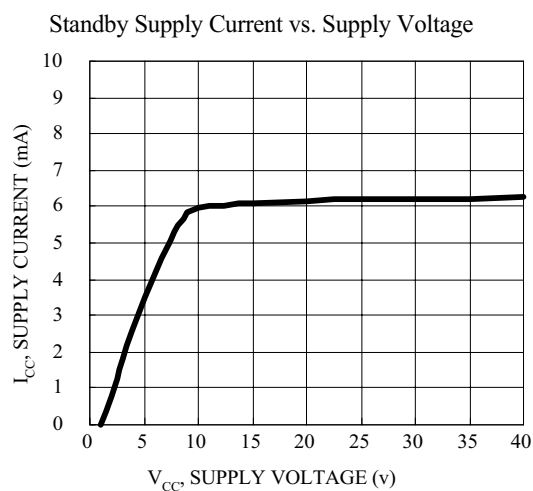
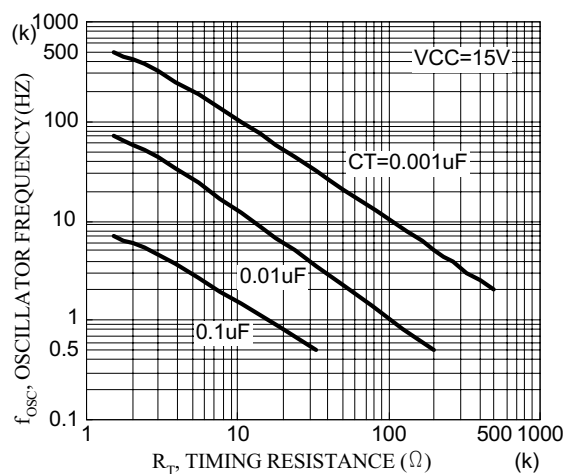
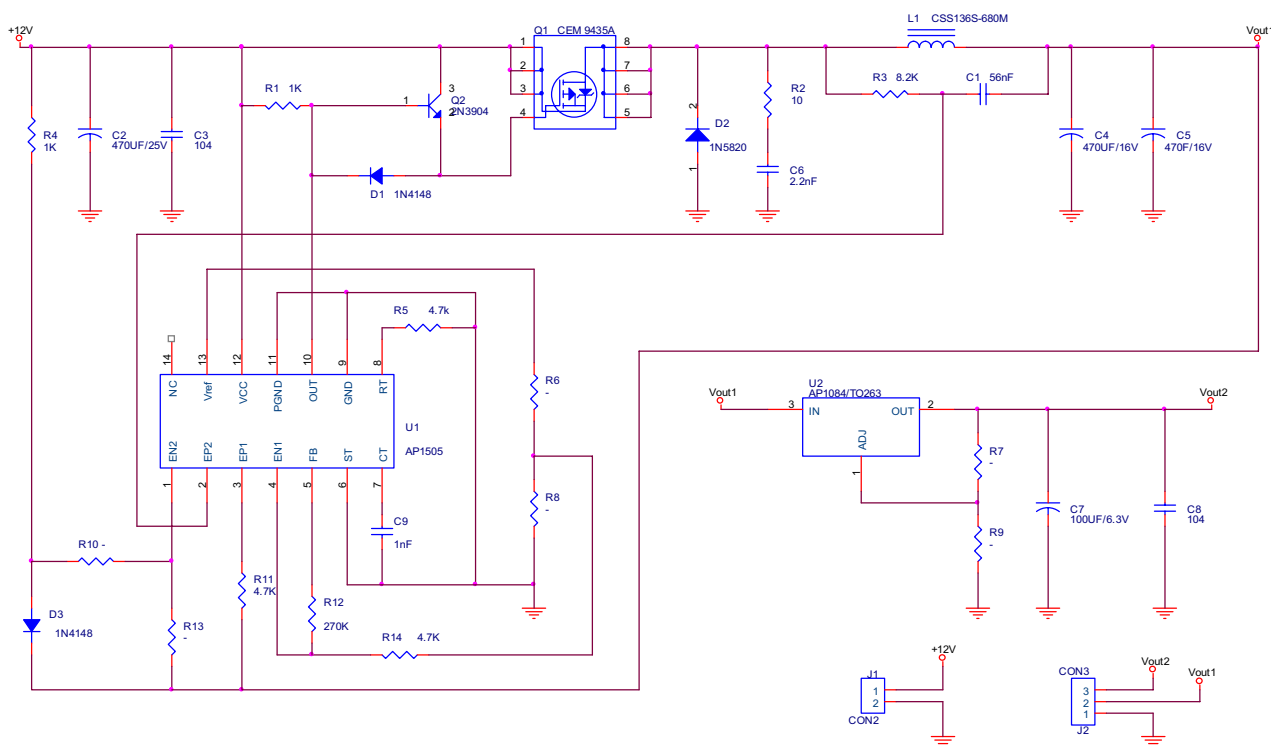


Figure 9.

Oscillator Frequency vs. Timing Resistance



Application Circuit



CASE1:

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

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

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

CASE2:

Vout1=3.3V/1A

Vout2=1.8V/1A

R6=2K, R8=3.9K

R7=120, R9=56

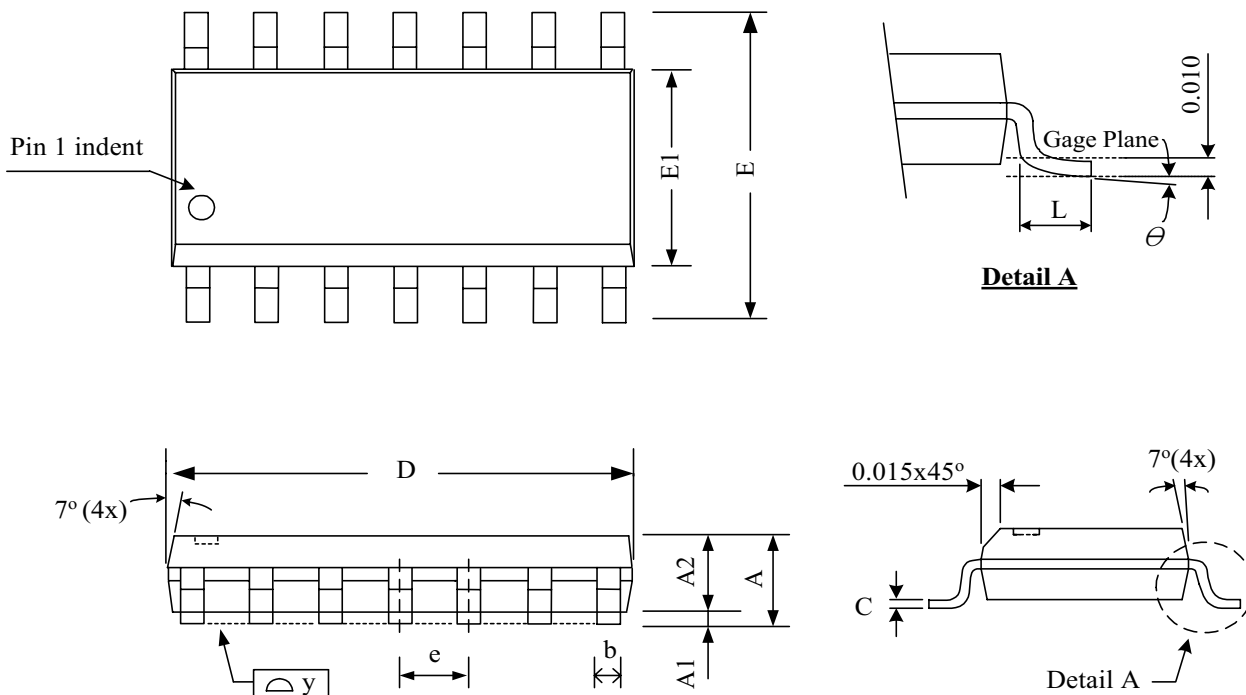
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ATC

■ 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°