

Monolithic Dual Channel PWM Controller

■ Features

- Dual PWM control circuitry
- Operating voltage can be up to 50V
- Adjustable Dead Time Control (DTC)
- Under Voltage Lockout (UVLO) protection
- Short Circuit Protection (SCP)
- Variable oscillator frequency..... 500KHz Max
- 2.5V voltage reference output
- 16-pin PDIP, TSSOP and SOP packages

■ Applications

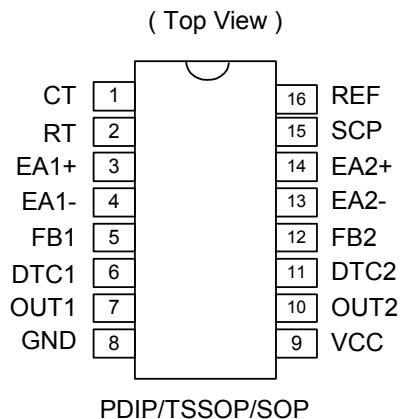
- Backlight inverter
- DC/DC converts in computers, etc.

■ General Description

The AP2001 integrates Pulse-width-Modulation (PWM) control circuit into a single chip, mainly designs for power-supply regulator. All the functions included an on-chip 2.5V reference output, two error amplifiers, an adjustable oscillator, two dead-time comparators, UVLO, SCP, DTC circuitry, and dual common-emitter (CE) output transistor circuit.

Recommend the output CE transistors as pre-driver for Driving externally. The DTC can provide from 0% to 100%. Switching frequency can be adjustable by trimming RT and CT. During low VCC situation, the UVLO makes sure that the outputs are off until the internal circuit is operational normally.

■ Pin Assignments

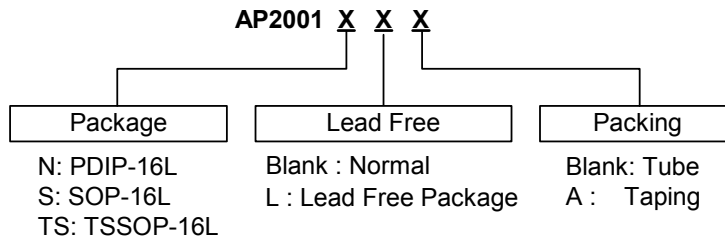


■ Pin Descriptions

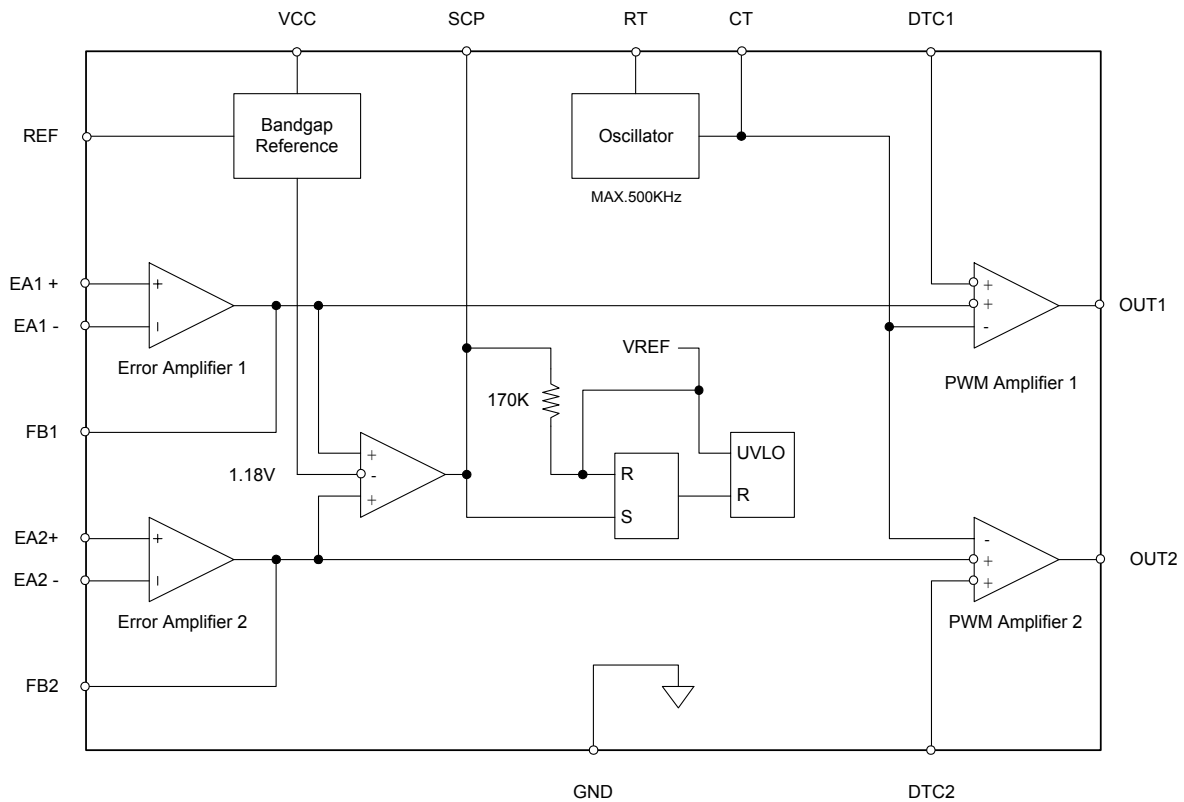
Name	Description
CT	Timing Capacitor
RT	Timing Resistor
EA+	Error Amplifier Input(+)
EA -	Error Amplifier Input(-)
FB	Feedback Loop Compensation
DTC	Dead Time Control
OUT	Pre-driver Output
GND	Ground
VCC	Supply Voltage
SCP	Short Circuit Protection
REF	Voltage Reference

Monolithic Dual Channel PWM Controller

■ Ordering Information



■ Block Diagram



**■ Absolute Maximum Ratings**

Symbol	Parameter	Rating	Unit
V _{CC}	Supply Voltage	40	V
V _I	Amplifier Input Voltage	20	V
V _O	Collector Output Voltage	40	V
I _O	Collector Output Current	21	mA
T _{OP}	Operating Temperature Range	-20 to +85	°C
T _{ST}	Storage Temperature Range	-65 to +150	°C
T _{LEAD}	Lead Temperature 1.6 mm (1/16 inch) from Case for 10 Seconds	260	°C

■ Recommended Operating Conditions

Symbol	Parameter	Min.	Max.	Unit
V _{CC}	Supply Voltage	3.6	40	V
V _I	Amplifier Input Voltage	1.05	1.45	V
V _O	Collector Output Voltage		40	V
I _O	Collector Output Current		20	mA
I _{FB}	Current into Feedback Terminal		45	μA
R _F	Feedback Resistor	100		kΩ
C _T	Timing Capacitor	150	15000	pF
R _T	Timing Resistor	5.1	100	kΩ
F _{OSC}	Oscillator Frequency	1	500	KHz
T _{OP}	Operating Free-air Temperature	-20	85	°C

Monolithic Dual Channel PWM Controller
■ Electrical Characteristics ($T_A=25^\circ\text{C}$, $V_{CC}=6\text{V}$, $f=200\text{ KHz}$)

Reference (REF)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_O	Output Voltage (pin 16)	$I_O = 1\text{mA}$	2.4	2.5	2.6	V
	Output Voltage Change with Temperature	$T_A = -20^\circ\text{C} \sim 25^\circ\text{C}$		-0.1	± 1	%
		$T_A = 25^\circ\text{C} \sim 85^\circ\text{C}$			-0.2	± 1
V_{DLI}	Input Stability	$V_{CC}=3.6\text{V} \sim 40\text{V}$		2	12.5	mV
V_{DLO}	Output Stability	$I_O=0.1\text{mA} \sim 1\text{mA}$		1	7.5	mV
I_O	Short-circuit Output Current	$V_O=0$	3	10	30	mA

Under voltage lockout (UVLO)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{UT}	Upper Threshold Voltage (V_{CC})	$I_{O(REF)} = 0.1\text{mA}$ $T_A = 25^\circ\text{C}$		2.65		V
V_{LWT}	Lower Threshold Voltage (V_{CC})				2.45	V
V_{HT}	Hysteresis (V_{CC})		80	200		mV

Short-circuit protection (SCP) control

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{IT}	Input Threshold Voltage	$T_A = 25^\circ\text{C}$	0.65	0.7	0.75	V
V_{STB}	Standby Voltage	No pull up	140	185	230	mV
V_{LT}	Latched Input Voltage	No pull up		60	120	mV
I_{SCP}	Input (Source) Current	$V_I = 0.7\text{V}$, $T_A = 25^\circ\text{C}$	-10	-15	-20	μA
V_{CT}	Comparator Threshold Voltage (FB)			1.18		V

Oscillator (OSC)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
F_{OSC}	Frequency	$C_T = 330\text{ pF}$, $R_T = 10\text{ K}\Omega$		200		KHz
ΔF_{OSC}	Standard Deviation of Frequency	$C_T = 330\text{ pF}$, $R_T = 10\text{ K}\Omega$		10		%
	Frequency Change with Voltage	$V_{CC}=3.6\text{V} \sim 40\text{V}$		1		
	Frequency Change with Temperature	$T_A = -20^\circ\text{C} \sim 25^\circ\text{C}$			-0.4	
$T_A = 25^\circ\text{C} \sim 85^\circ\text{C}$				-0.2	± 2	

Dead-time control (DTC)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{BDT}	Input Bias Current				1	μA
I_{DT}	Latch Mode (Source) Current	$T_A = 25^\circ\text{C}$	-80	-145		
V_{DT}	Latched Input Voltage	$I_O = 40\mu\text{A}$	2.3			V
V_{T0}	Input Threshold Voltage at $f = 10\text{ KHz}$	Zero duty cycle		2.05	2.25	
V_{T100}		Maximum duty cycle	1.2	1.45		

■ Electrical Characteristics (Continued)
Error-amplifier

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input Offset Voltage	V_O (FB)=1.25V			±6	mV
I_{IO}	Input Offset Current	V_O (FB)=1.25V			±100	nA
I_{IB}	Input Bias Current	V_O (FB)=1.25V		160	500	nA
V_{CM}	Common-mode Input Voltage Range	V_{CC} =3.6V ~ 40V	1.05 to 1.45			V
AV	Open-loop Voltage Amplification	R_F =200 KΩ	70	80		dB
GBW	Unity-gain Bandwidth			1.5		MHz
CMRR	Common-mode Rejection Ratio		60	80		dB
V_{OH}	Max. Output Voltage		V_{ref} -0.1			V
V_{OL}	Min. Output Voltage				1	V
I_{OI}	Output (Sink) Current (FB)	$V_{ID} = -0.1V, V_O = 1.25V$	0.5	1.6		mA
I_{OO}	Output (Source) Current (FB)	$V_{ID} = 0.1V, V_O = 1.25V$	-45	-70		μA

Output section

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{LEAK}	Leakage Current	$V_O = 40V$			10	μA
V_{SAT}	Output Saturation Voltage	$I_O = 10$ mA		1.2	2	V
I_{SC}	Short-circuit Output Current	$V_O = 6V$		90		mA

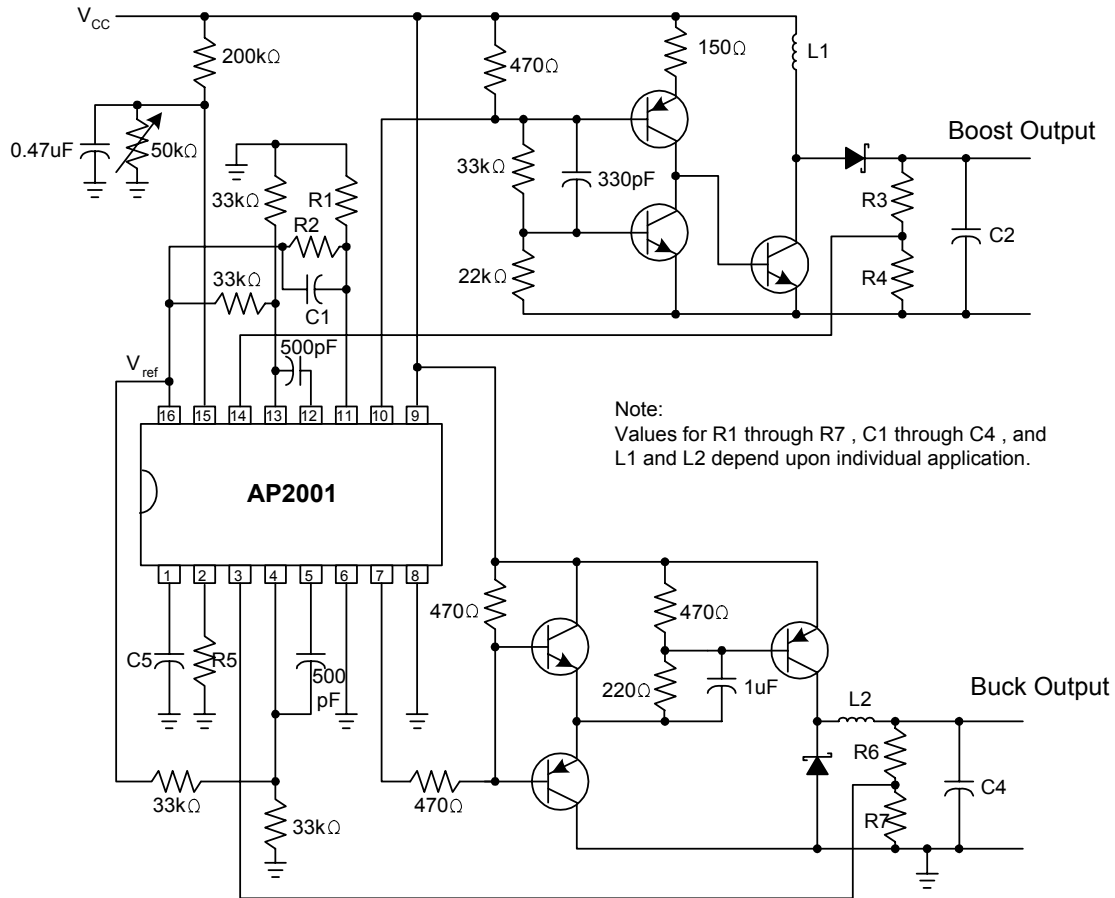
PWM comparator

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{T0}	Input Threshold Voltage at f = 10 KHz (FB)	Zero duty cycle		2.05	2.25	V
V_{T100}		Maximum duty cycle	1.2	1.45		V

Total device

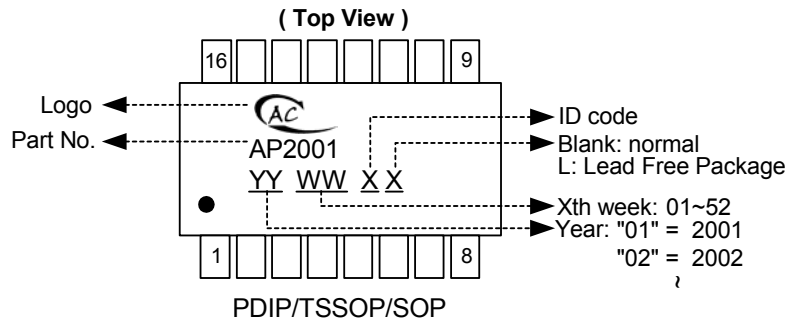
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{CCS}	Standby Supply Current	Off-state		2.5	3.0	mA
I_{CCA}	Average Supply Current	$R_T = 10$ KΩ		2.8	3.5	mA

■ Typical Application Circuit



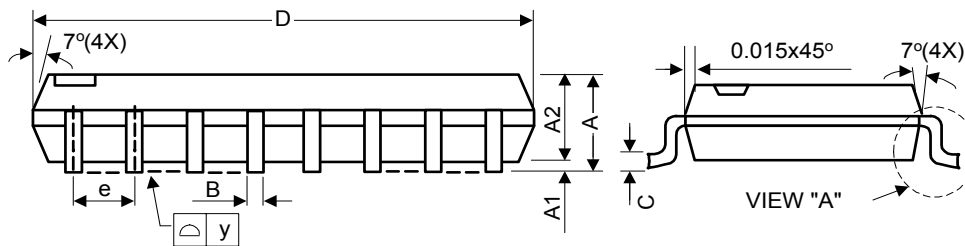
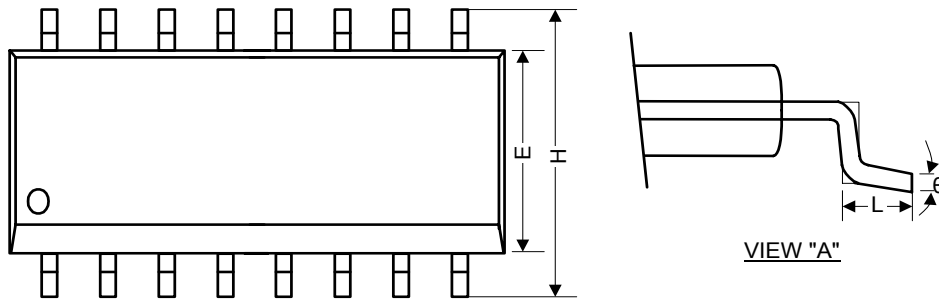
Dual output DC/DC converter

■ Marking Information



■ Package Information

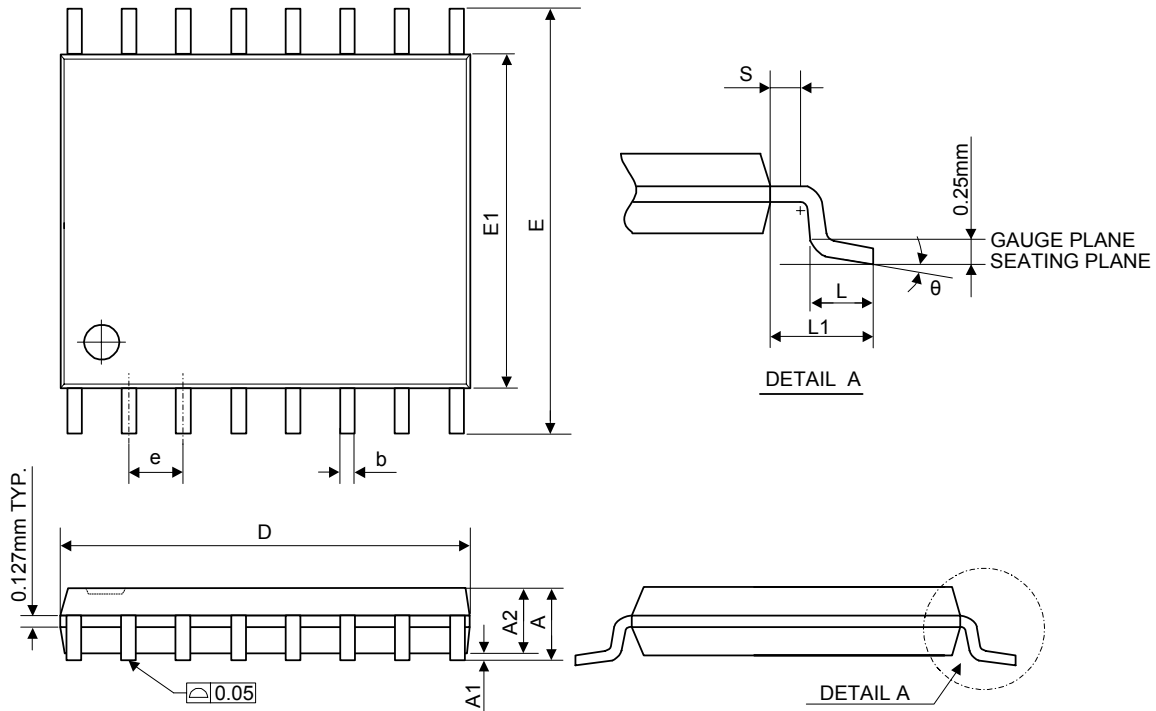
(1) Package Type: SOP-16L



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	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	0.0075	0.008	0.0098
D	9.80	9.90	10.00	0.386	0.390	0.394
E	3.80	3.90	4.00	0.150	0.154	0.157
e	-	1.27	-	-	0.050	-
H	5.80	6.00	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

■ Package Information (Continued)

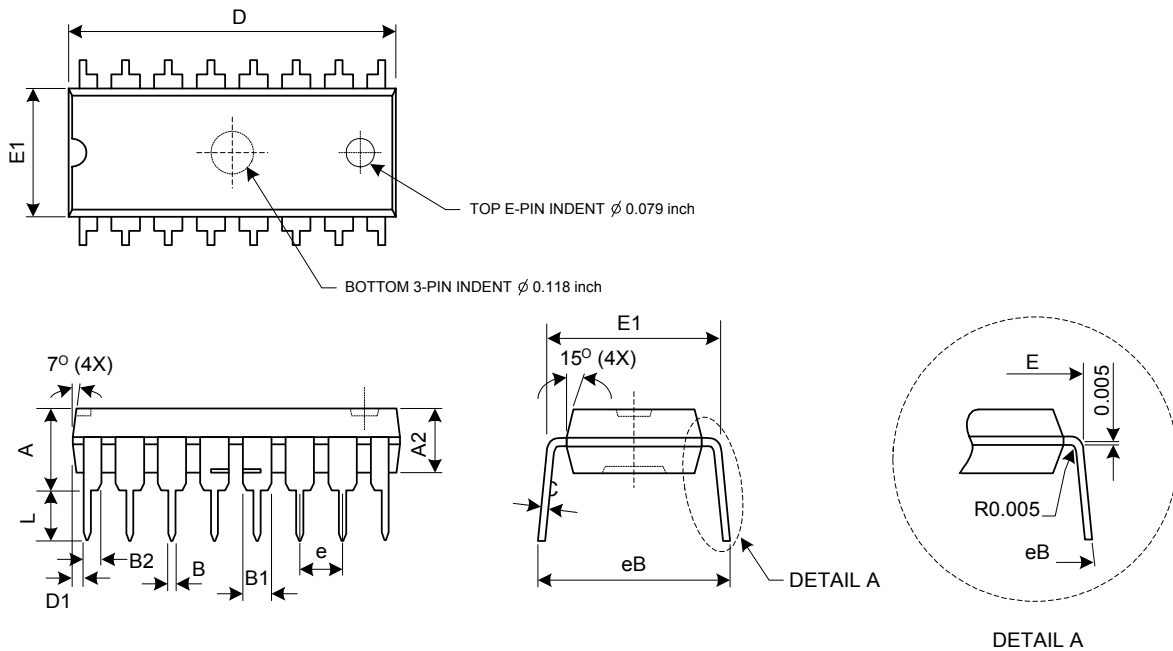
(2) Package Type: TSSOP-16L



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.20	-	-	0.047
A1	0.00	-	0.15	0.000	-	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19	-	0.30	0.007	-	0.012
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.40 BSC.			0.252 BSC.		
E1	4.30	4.40	4.50	0.169	0.173	0.177
e	0.65 BSC.			0.026 BSC.		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00 REF.			0.039 REF.		
S	0.20	-	-	0.008	-	-
θ	0°	-	8°	0°	-	8°

■ Package Information (Continued)

(3) Package Type: PDIP-16L



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	4.57	-	-	0.180
A1	0.38	-	-	0.015	-	-
A2	3.15	3.33	3.50	0.124	0.131	0.138
B	0.36	0.46	0.56	0.014	0.018	0.022
B1	1.14	1.27	1.52	0.045	0.050	0.060
B2	0.81	0.99	1.17	0.032	0.039	0.046
C	0.20	0.25	0.33	0.008	0.010	0.013
D	18.90	19.10	19.30	0.744	0.752	0.760
D1	0.56	0.69	0.76	0.022	0.027	0.030
E	7.62	-	8.26	0.3000	-	0.325
E1	6.15	6.35	6.55	0.242	0.250	0.258
e	-	2.54	-	-	0.100	-
L	2.92	-	3.81	0.115	-	0.150
eB	8.38	-	9.40	0.330	-	0.370