

## 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 and SOP packages

### ■ Applications

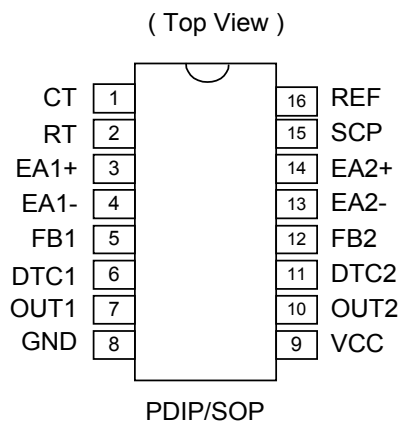
- Backlight inverter
- DC/DC converts in computers, etc.

### ■ 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

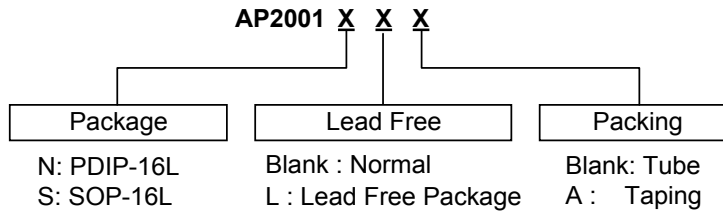


### ■ Pin Descriptions

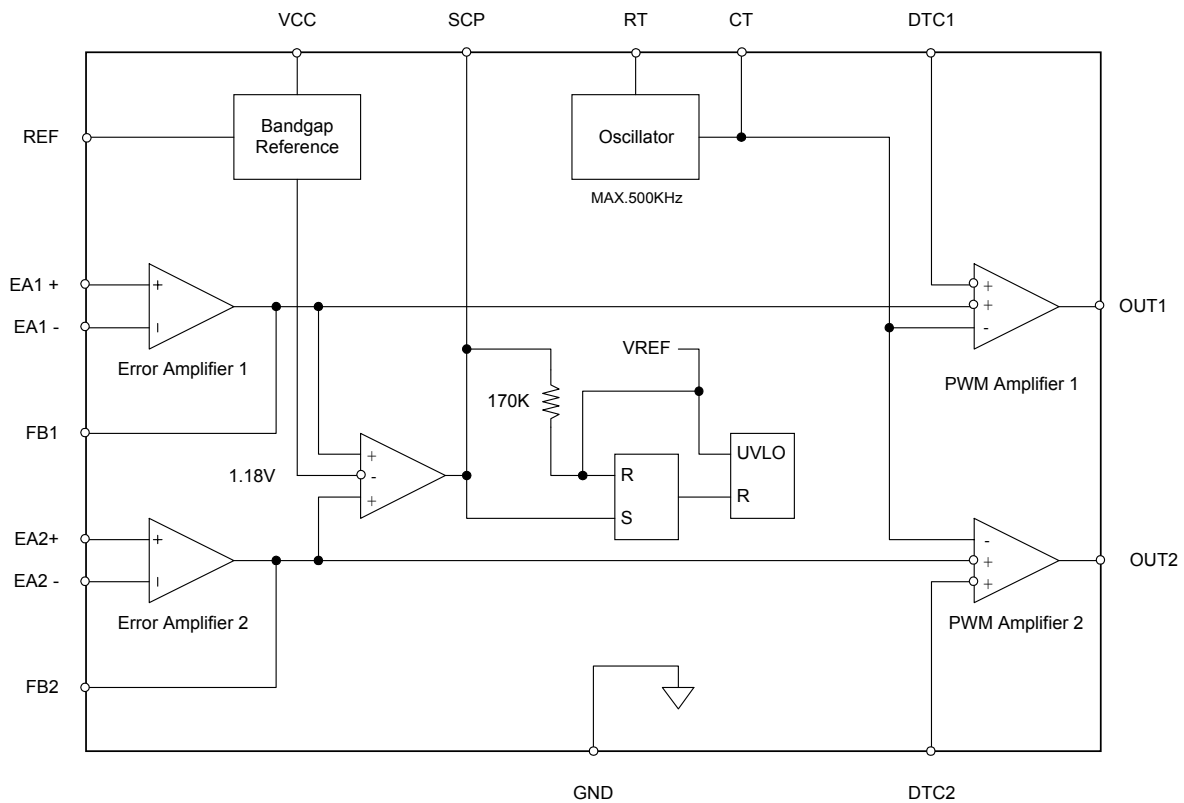
Name	Description
CT	Timing Capacitor
RT	Timing Resistor
EA+	Error Amplifier Input(+)
EA -	Error Amplifier Input(-)
FB	Feedback Loop Compensation
DTC	Dead Time Control
OUT	Pre-driver Output
GND	Ground
VCC	Supply Voltage
SCP	Short Circuit Protection
REF	Voltage Reference

## 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	$T_A = -20^\circ\text{C} \sim 25^\circ\text{C}$ $T_A = 25^\circ\text{C} \sim 85^\circ\text{C}$		-0.1 -0.2	$\pm 1$ $\pm 1$	%
$V_{DLI}$	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	$\mu\text{A}$
$V_{CT}$	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
$\Delta F_{OSC}$	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	$T_A = -20^\circ\text{C} \sim 25^\circ\text{C}$ $T_A = 25^\circ\text{C} \sim 85^\circ\text{C}$		-0.4 -0.2	$\pm 2$ $\pm 2$	

**Dead-time control (DTC)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$I_{BDT}$	Input bias current				1	$\mu\text{A}$
$I_{DT}$	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		

**Monolithic Dual Channel PWM Controller**
**■ 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

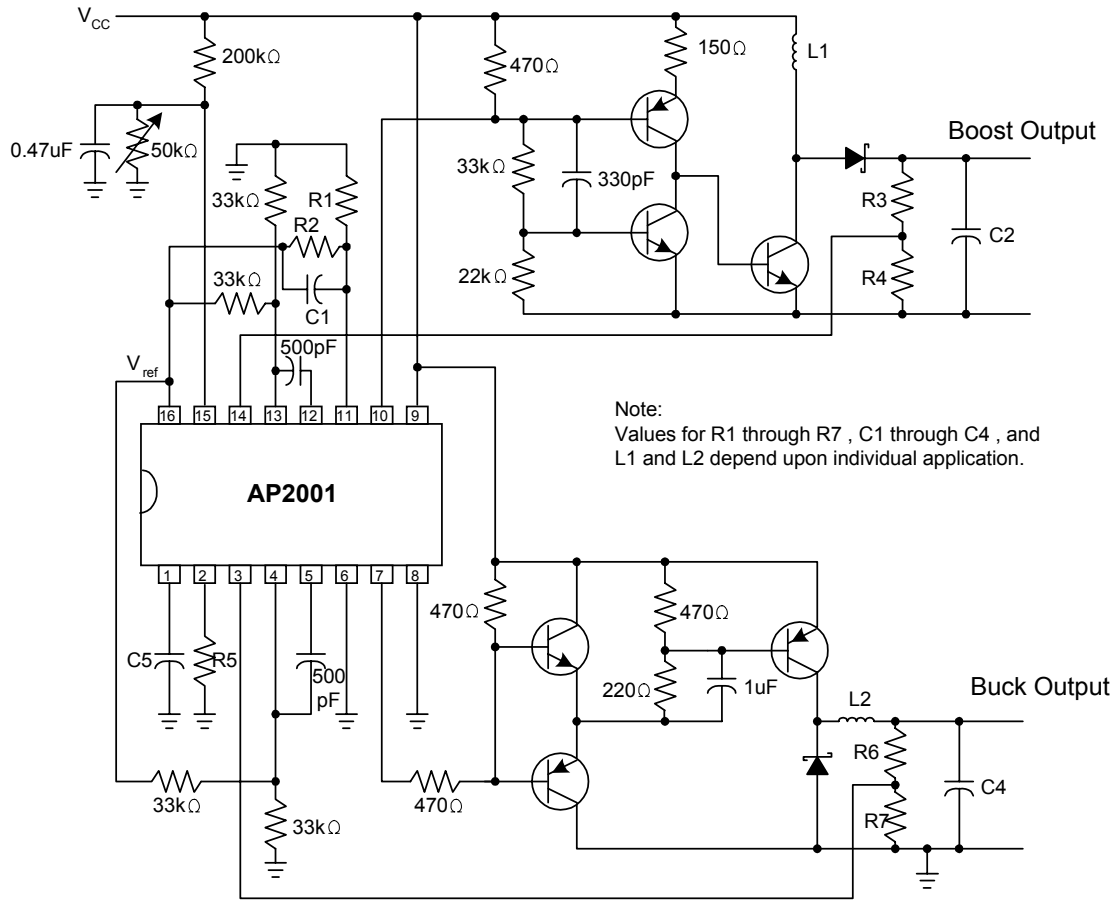
**PWM comparator**

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**

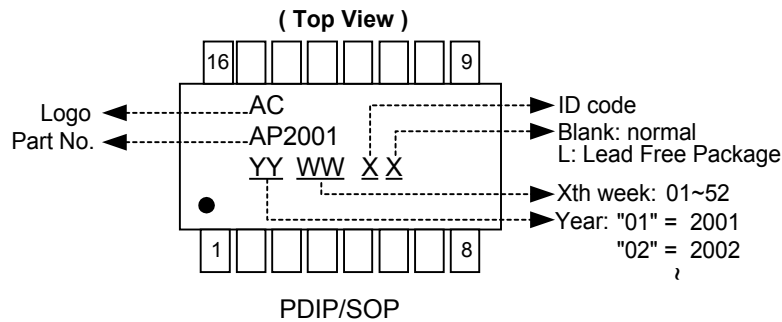
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$I_{CCS}$	Standby supply current	Off-state		2.5	3.0	mA
$I_{CCA}$	Average supply current	$R_T = 10$ kΩ		2.8	3.5	mA

### ■ Typical Application Circuit



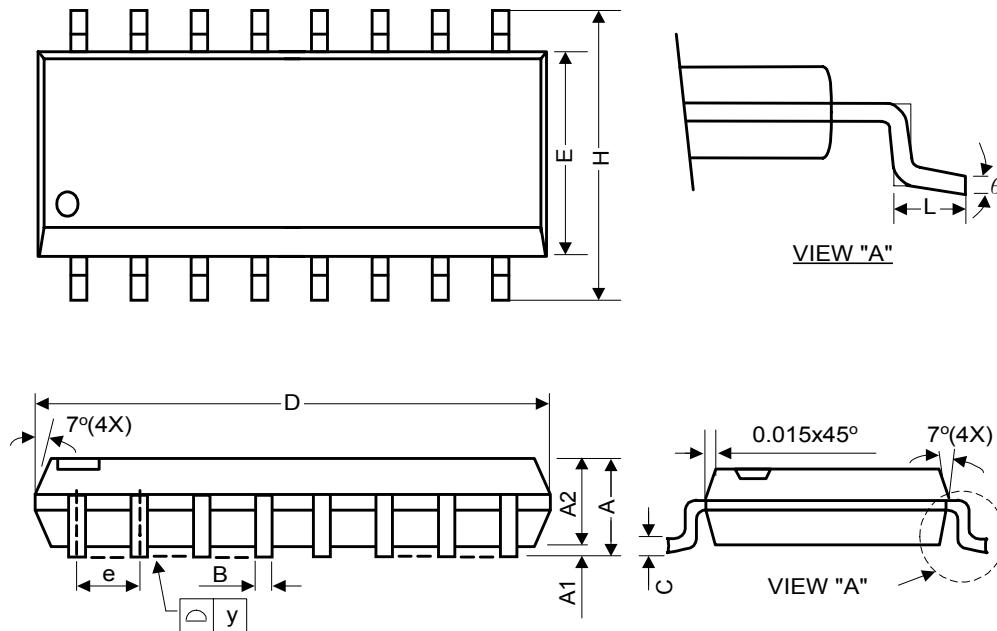
Dual output DC/DC converter

### ■ Marking Information



### ■ Package Information

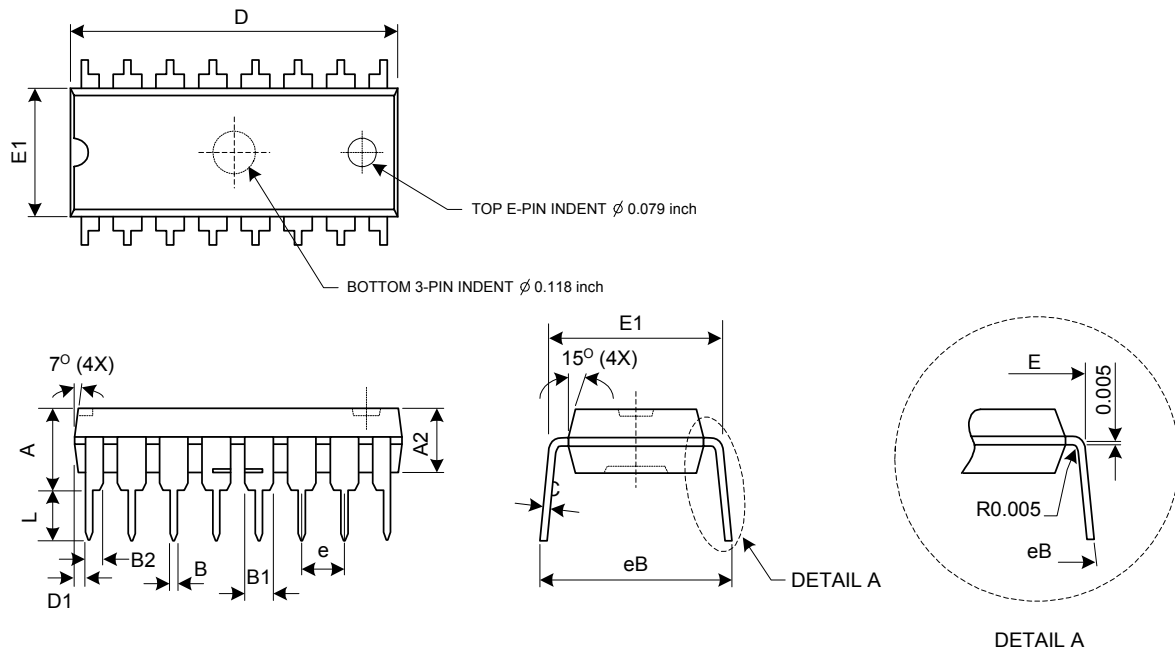
(1) Package Type: SOP-16L



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: 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