

## Features

- Dual PWM control circuitry
- Operating voltage can be up to 40V
- Adjustable Dead Time Control (DTC)
- Under Voltage Lockout (UVLO) protection
- Short Circuit Protection (SCP)
- Variable oscillator frequency: 500KHz Max
- 2.5V voltage reference output
- SOP-16L package
- Lead Free Finish/RoHS Compliant for Lead Free products (Note 1)

## General Description

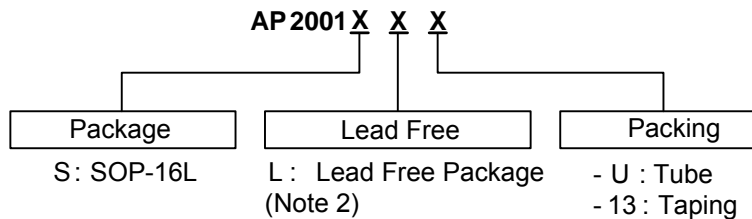
The AP2001 integrates Pulse-width-Modulation (PWM) control circuit into a single chip, mainly designed for power-supply regulator. All the functions included are an on-chip 2.5V reference output, two error amplifiers, an adjustable oscillator, two dead-time comparators, UVLO, SCP, DTC circuitry, and 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  $V_{CC}$  situation, the UVLO makes sure that the outputs are off until the internal circuit is operating normally.


## Applications

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

## Ordering Information

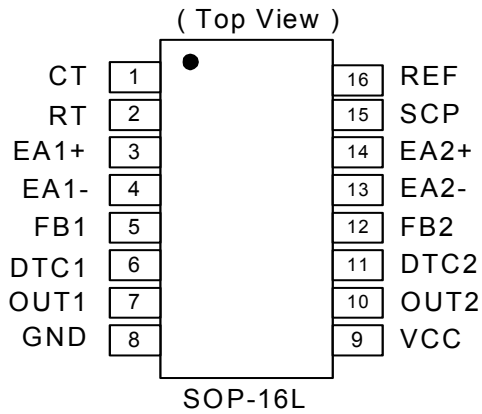


Note: 1. RoHS revision 13.2.2003. Glass and High Temperature Solder Exemptions Applied, see *EU Directive Annex Notes 5 and 7*.

Device	Package Code	Packaging (Note 2)	Tube		13" Tape and Reel	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
 AP2001S	S	SOP-16L	50	-U	2500/Tape & Reel	-13

Note: 2. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

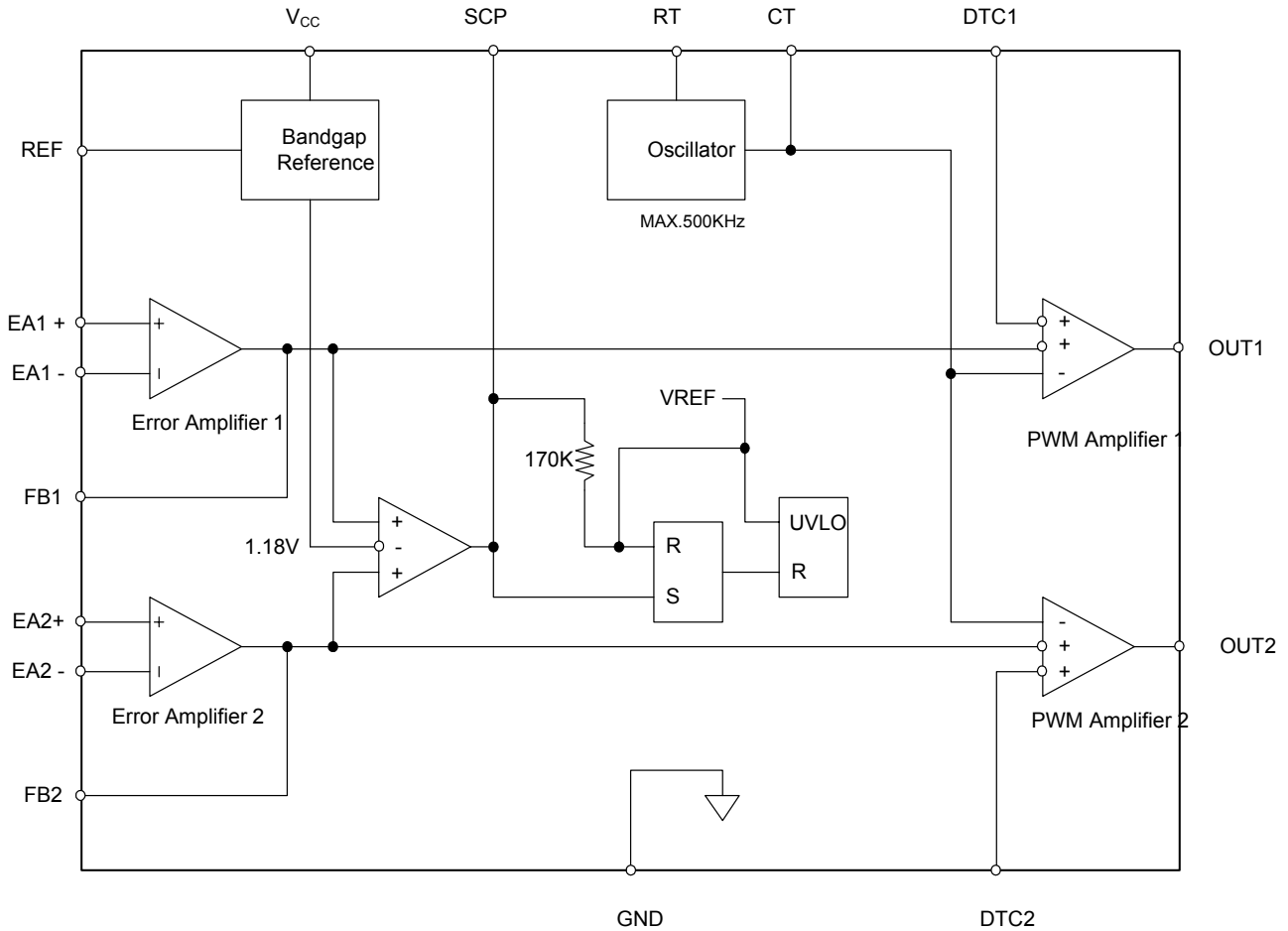
## Pin Assignments



## 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

**Block Diagram**



**Absolute Maximum Ratings**

Symbol	Parameter	Rating	Unit
V <sub>CC</sub>	Supply Voltage	40	V
V <sub>I</sub>	Amplifier Input Voltage	20	V
V <sub>O</sub>	Collector Output Voltage	40	V
I <sub>O</sub>	Collector Output Current	21	mA
T <sub>OP</sub>	Operating Temperature Range	-20 to +85	°C
T <sub>ST</sub>	Storage Temperature Range	-65 to +150	°C
T <sub>LEAD</sub>	Lead Temperature 1.6 mm (1/16 inch) from Case for 5 Seconds	245	°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	$\mu$ A
$R_F$	Feedback Resistor	100		k $\Omega$
$C_T$	Timing Capacitor	150	15000	pF
$R_T$	Timing Resistor	5.1	100	k $\Omega$
$F_{OSC}$	Oscillator Frequency	1	500	KHz
$T_{OP}$	Operating Free-air Temperature	-20	85	$^{\circ}$ C

**Electrical Characteristics** ( $T_A = 25^{\circ}$ C,  $V_{CC} = 6$ V,  $f = 200$  KHz)

**Reference (REF)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_O$	Output Voltage (pin 16)	$I_O = 1$ mA	2.4	2.5	2.6	V
	Output Voltage Change with Temperature	$T_A = -20^{\circ}$ C ~ $25^{\circ}$ C $T_A = 25^{\circ}$ C ~ $85^{\circ}$ C		-0.1 -0.2	$\pm 1$ $\pm 1$	% %
$V_{DLI}$	Input Stability	$V_{CC} = 3.6$ V ~ 40V		2	12.5	mV
$V_{DLO}$	Output Stability	$I_O = 0.1$ mA ~ 1mA		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 ( $V_{CC}$ )	$I_{O(REF)} = 0.1$ mA $T_A = 25^{\circ}$ C		2.65		V
$V_{LWT}$	Lower Threshold Voltage ( $V_{CC}$ )			2.45		V
$V_{HT}$	Hysteresis ( $V_{CC}$ )		80	200		mV

**Electrical Characteristics (Continued)**
**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		

**Error-amplifier**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{IO}$	Input Offset Voltage	$V_O (\text{FB}) = 1.25\text{V}$			$\pm 6$	mV
$I_{IO}$	Input Offset Current	$V_O (\text{FB}) = 1.25\text{V}$			$\pm 100$	nA
$I_{IB}$	Input Bias Current	$V_O (\text{FB}) = 1.25\text{V}$		160	500	nA
$V_{CM}$	Common-mode Input Voltage Range	$V_{CC} = 3.6\text{V} \sim 40\text{V}$	1.05 to 1.45			V
$A_V$	Open-loop Voltage Amplification	$R_F = 200\text{ K}\Omega$	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)	$V_{ID} = -0.1\text{V}, V_O = 1.25\text{V}$	0.5	1.6		mA
$I_{OO}$	Output (Source) Current (FB)	$V_{ID} = 0.1\text{V}, V_O = 1.25\text{V}$	-45	-70		$\mu\text{A}$

**Electrical Characteristics ( Continued )**

**Output section**

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

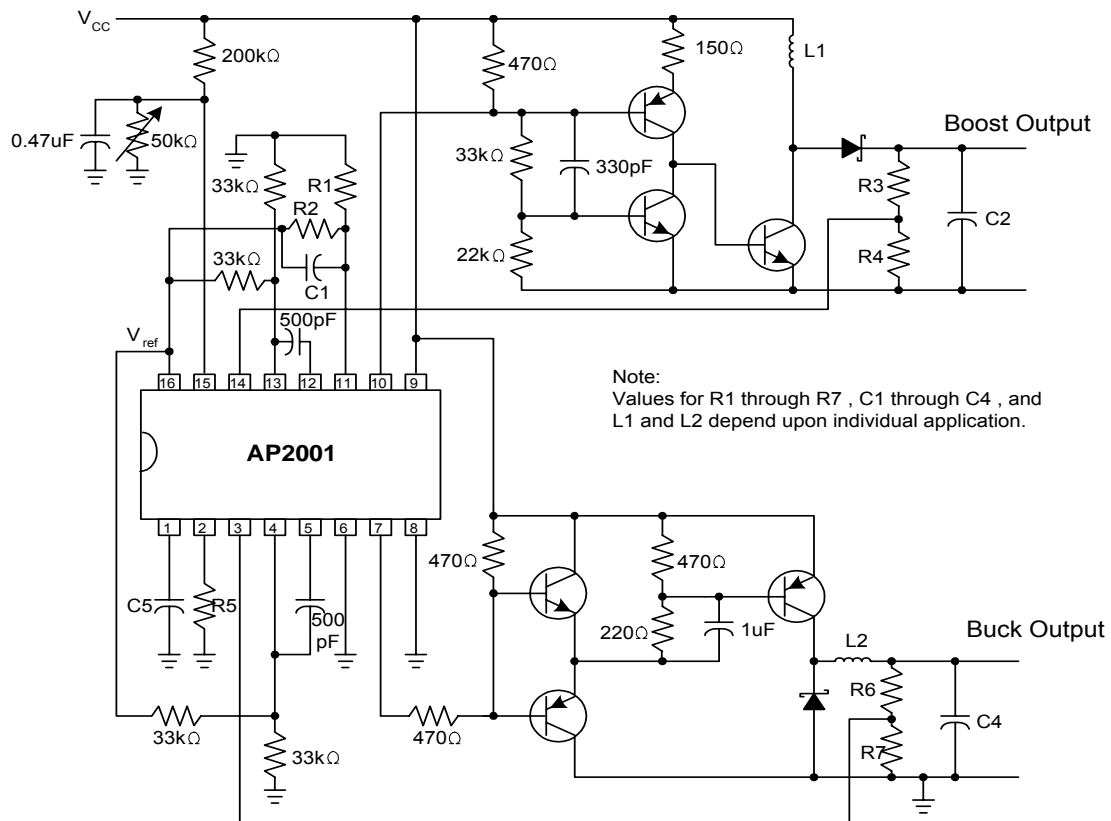
**PWM comparator**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{T0}$	Input Threshold Voltage at $f = 10\text{ KHz (FB)}$	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	$R_T = 10\text{ K}\Omega$		2.8	3.5	mA

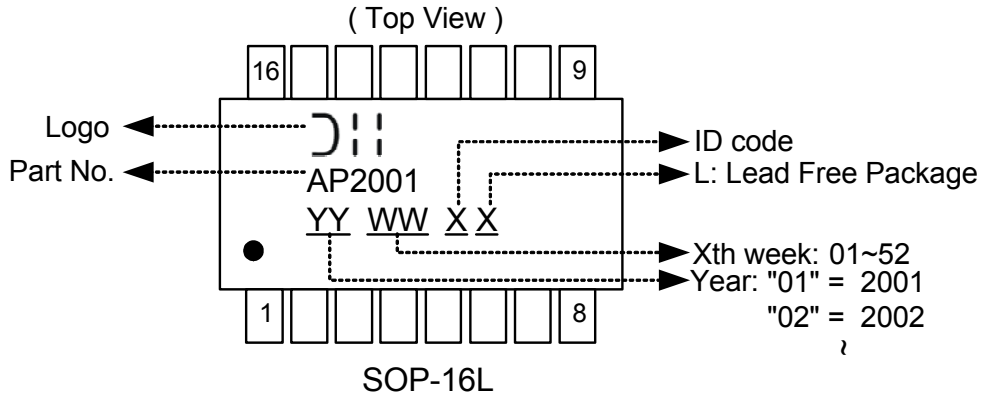
**Typical Application Circuit**



**Dual output DC/DC converter**

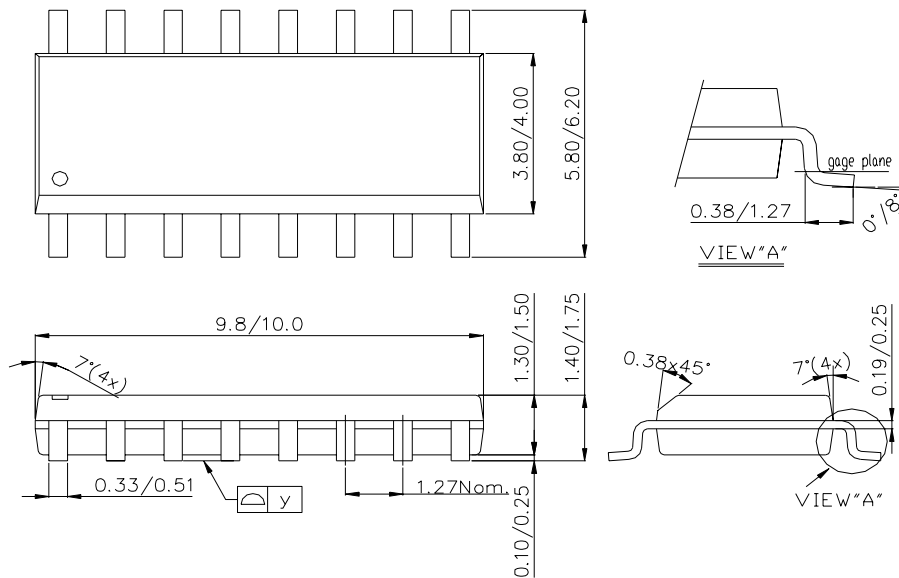
**Marking Information**

(1) SOP-16L



**Package Information**

**(1) Package Type: SOP-16L**



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