AP1605

PWM/PFM Dual-mode Step-Down Switching Regulator

■ Features

- Low current consumption:
  In operation: 100µA max.
  Power off: 2µA max.
- Input voltage: 2.5V to 7V.
  Adjustable version ($\pm$2.5%)
- PWM/PFM dual Mode
- Oscillation frequency: 300KHz (Typ.)
- With a power-off function.
- Built-in internal SW P-channel MOS
- SOP-8L/TSSOP-8L Package.

■ Applications

- On-board power supplies of battery devices for portable telephones, electronic notebooks, PDA, and other hand-held sets.
- Power supplies for audio equipment, including portable CD players and headphone stereo equipment.
- Fixed voltage power supply for cameras, video equipment and communications equipment.
- Power supplies for microcomputers.
- Conversion from four Ni-H or Ni-Cd cells or two lithium-ion cells to 3.3V/3V.
- Conversion of AC adapter input to 5V/3V.
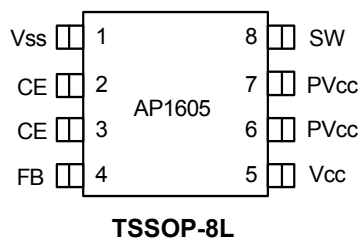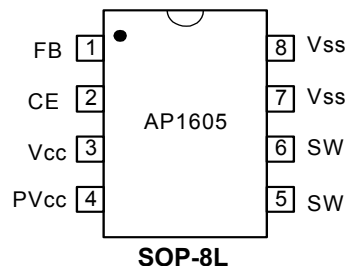
■ General Description

AP1605 consists of CMOS step-down switching regulator with PWM/PFM dual mode control. These devices include a reference voltage source, oscillation circuit, error amplifier, internal PMOS and etc.

AP1605 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM/PFM control circuit is able to very the duty ratio linearly 0%~0.25% (PFM) and 25%~100% (PWM).
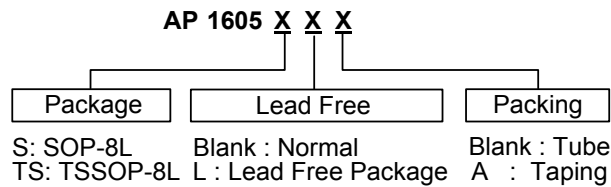
With the addition of an internal P-channel Power MOS, a coil, capacitors, and a diode connected externally, these ICs can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP–8L mini-package, providing such outstanding features as low current consumption. Since this converter can accommodate an input voltage of up to 7V, it is also ideal when operating via an AC adapter.
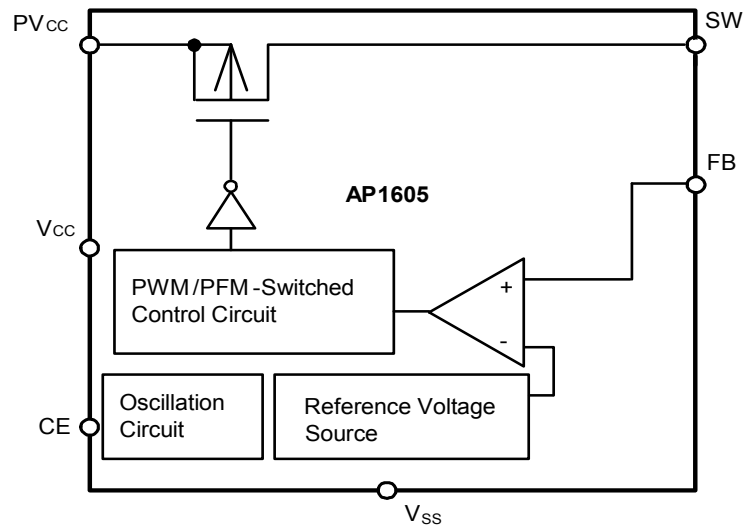
■ Pin Assignments

SOP-8L

TSSOP-8L

■ Pin Descriptions

Pin Name	Pin No.		Description
	SOP	TSSOP	
FB	1	4	Feedback pin

CE	2	2、3	Chip Enable:
			  H: Enable
			  L: Disable

Vcc	3	5	IC signal power supply pin, add a 10Ω resistor to PVcc and a 0.1µF capacitor to GND.
PVcc	4	6、7	IC power supply pin
SW	5、6	8	Switch Pin. Connect external inductor/diode here. Minimize trace area at this pin to reduce EMI.
Vss	7、8	1	GND Pin

■ Ordering Information

AP 1605 X X X

Package	Lead Free	Packing

S: SOP-8L   Blank : Normal   Blank : Tube
TS: TSSOP-8L   L : Lead Free Package   A : Taping

■ Block Diagram

■ Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
V_{CC} [*1]	V_{CC} Pin Voltage		V_{SS} - 0.3 to V_{SS} + 8	V
PV_{CC}	PV_{CC} Pin Voltage		V_{SS} - 0.3 to V_{SS} + 8	V
FB	FB Pin Voltage		V_{SS} - 0.3 to V_{SS} + 8	V
V_{CE}	ON/OFF Pin Voltage		V_{SS} - 0.3 to V_{SS} + 8	V
V_{SW}	Switch Pin Voltage		V_{SS} - 0.3 to V_{IN} + 0.3	V
P_D	Power Dissipation	SOP-8L	1200	mW
		TSSOP-8L	700	
T_{OPR}	Operating Temperature Range		-20 to +85	^{o}C
T_{STG}	Storage Temperature Range		-20 to +125	^{o}C

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.
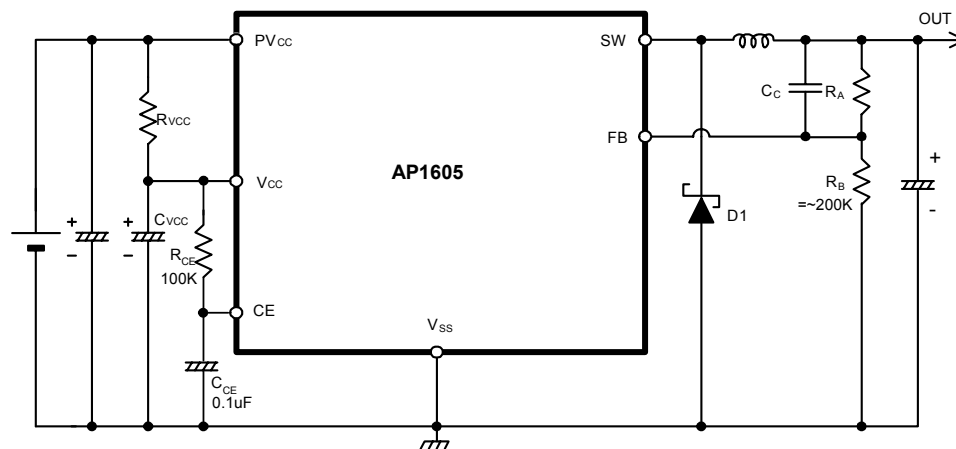
PWM/PFM Dual-mode Step-Down Switching Regulator

■ Electrical Characteristics (V_{IN} = 5V, T_a=25°C, unless otherwise specified)

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	AP1605 Series		2.5	--	7	V
V_{REF}	Internal Reference Voltage			1.1625	1.2	1.2375	V
V_{UVLO}	UVLO Voltage	Voltage required to maintain V_{OUT}		--	--	2.2	V
MAXDTY	Maximum Duty Ratio			100	--	--	%
PFMDTY	PFM Duty Ratio			15	25	35	%
I_{SW}	Switch Current	Duty = 50%	SOP-8L	3	--	--	A
			TSSOP-8L	1.5	--	--	
I_{SS}	Current Consumption POWER$_{ON}$	V_{OUT}=2.5V		--	35	100	µA
I_{SSS}	Current Consumption During Power Off	$V_{ON/OFF}$ =0V		--	--	2	µA
ΔV_{OUT1}	Line Regulation	2.5V~7V @ I_{OUT}=0.1A		--	0.2	0.5	%
ΔV_{OUT2}	Load Regulation	0.1A~3A(SOP-8L), 0.1A~1.5A(TSSOP-8L)		--	1	1.5	%
F_{OSC}	Oscillation Frequency			220	300	380	KHz
V_{CEH}	CE Pin "High" Voltage	Evaluate oscillation at SW pin		0.65	--	--	*Vcc
V_{CEL}	CE Pin "Low" Voltage	Evaluate oscillation stop at SW pin		--	--	0.2	
I_{SH}	Power-Off Pin Input	--		-0.1	--	0.1	µA
I_{SL}	Leakage Current	--		-0.1	--	0.1	µA
EFFI	Efficiency	V_{IN} = 5V, V_{OUT} = 2.5V I_{OUT} = 1A		--	93	--	%

■ Typical Application Circuit

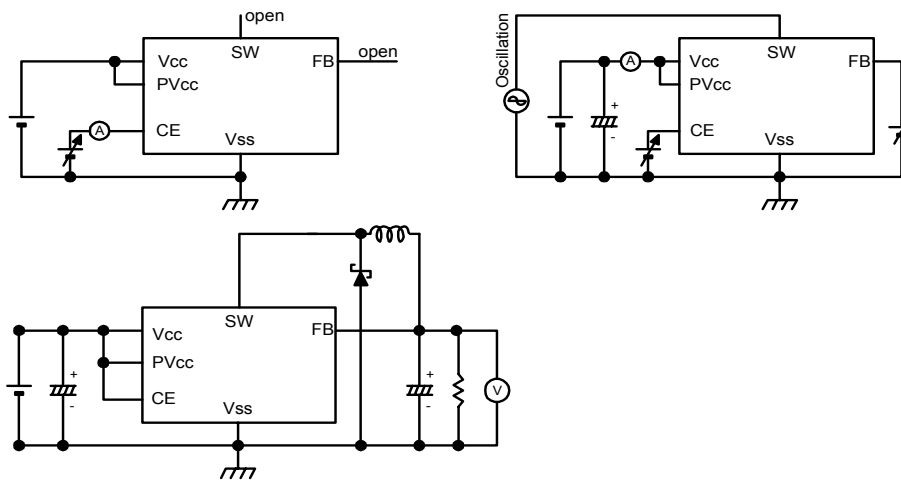（1） Normal Application

$$Vo = Vref \times (1+\frac{R_A}{R_B})$$

■ **Typical Application Circuit (Continued)**

（2） Application with Short Circuit Protection

$$Vo = Vref \times (1 + \frac{R_A}{R_B})$$
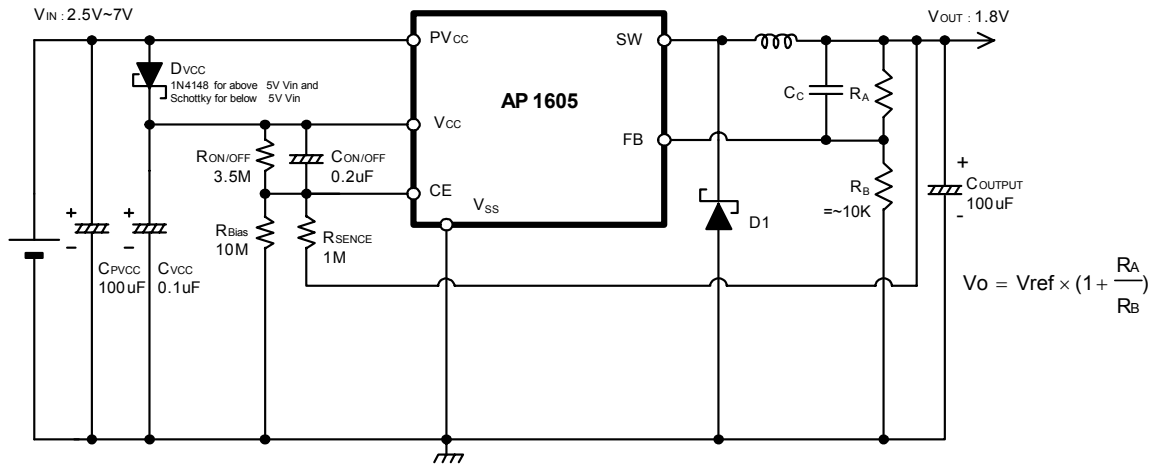
■ **Test Circuit**

■ **Function Description**

PWM/PFM Control (AP1605 Series)

The AP1605 consists of DC/DC converters that employ a PWM/PFM auto-switch system.

In converters of the AP1605, the PFM mode varies in a range of duty cycle from 0% to 25%, and the PWM mode varies in a range of duty cycle from 25% to 100% according to the load current, and yet ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant. Therefore, these converters provide a low-ripple power over broad ranges of input voltage and load current.
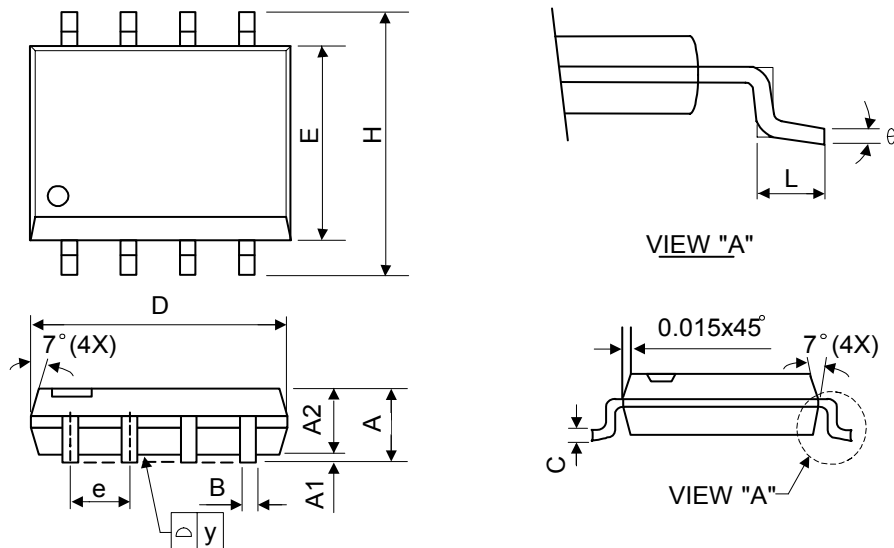
PWM/PFM Dual-mode Step-Down Switching Regulator

■ Marking Information

(Top View)

SOP-8L/TSSOP-8L
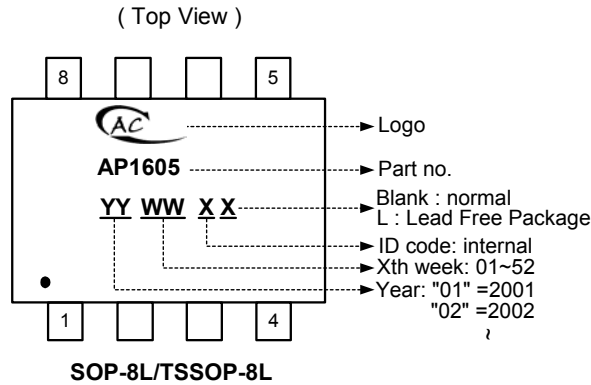
■ Package Information

Package Type: SOP-8L

VIEW "A"

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	–	0.100
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	0.010
D	4.80	5.05	5.30	0.189	0.199	0.209
E	3.70	3.90	4.10	0.146	0.154	0.162
e	–	1.27	–	–	0.050	–
H	5.79	5.99	6.20	0.228	0.236	0.244
L	0.38	0.71	1.27	0.015	0.028	0.050
y	–	–	0.10	–	–	0.004
θ	0°	–	8°	0°	–	8°

■ Package Information (Continued)

Package Type: TSSOP-8L
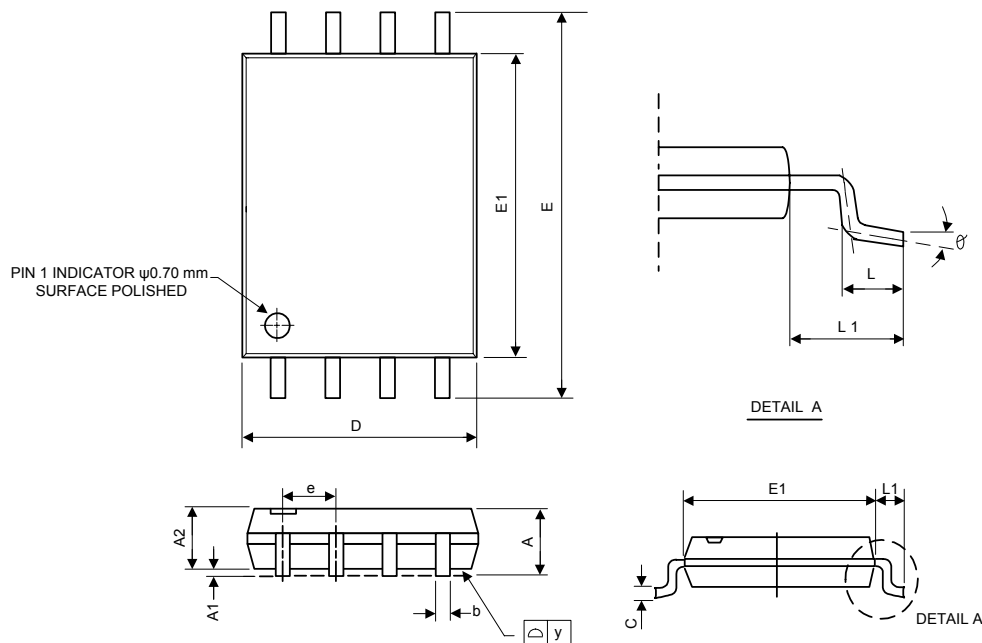
Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.05	1.10	1.20	0.041	0.043	0.047
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	-	1.00	1.05	-	0.039	0.041
b	0.20	0.25	0.28	0.008	0.01	0.011
C	-	0.13	-	-	0.005	-
D	2.90	3.05	3.10	0.114	0.12	0.122
E	6.20	6.40	6.60	0.244	0.252	0.26
E1	4.30	4.40	4.50	0.169	0.173	0.177
e	-	0.65	-	-	0.026	-
L	0.50	0.60	0.70	0.02	0.024	0.028
L1	0.90	1.00	1.10	0.035	0.039	0.043
y	-	-	0.10	-	-	0.004
θ	0°	4°	8°	0°	4°	8°