

## PWM/PFM Dual-mode Step-Down Switching Regulator

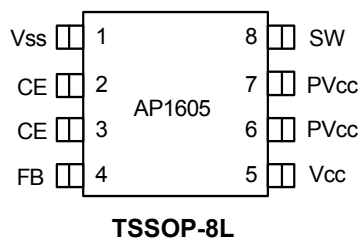
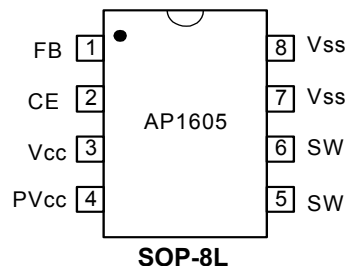
### ■ Features

- Low current consumption:  
In operation: 100 $\mu$ A max.  
Power off: 2 $\mu$ A 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.

### ■ Pin Assignments



### ■ 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 vary the duty ratio linearly 0%~0.25% (PFM) and 25%~100% (PWM).

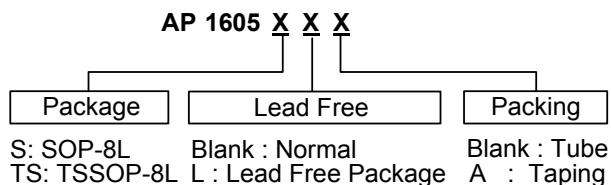
With the addition of an internal P-channel Power MOS, a coil, capacitors, and a diode connected externally, these ICs can function as step-down switching regulators. They serve as ideal power supply units for portable devices when coupled with the SOP-8L mini-package, providing such outstanding features 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 Descriptions

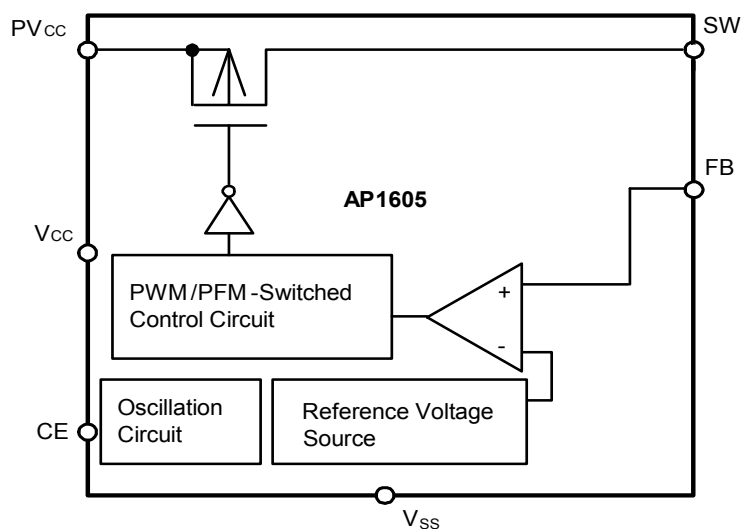
Pin Name	Pin No.		Description
	SOP	TSSOP	
FB	1	4	Feedback pin
CE	2	2 · 3	Chip Enable: H: Enable L: Disable
Vcc	3	5	IC signal power supply pin, add a 10 $\Omega$ resistor to PVcc and a 0.1 $\mu$ F capacitor to GND.
PVcc	4	6 · 7	IC power supply pin
SW	5 · 6	8	Switch Pin. Connect external inductor/diode here. Minimize trace area at this pin to reduce EMI.
Vss	7 · 8	1	GND Pin

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### ■ Ordering Information



### ■ 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
		TSSOP-8L	700
$T_{OPR}$	Operating Temperature Range	-20 to +85	°C
$T_{STG}$	Storage Temperature Range	-20 to +125	°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.

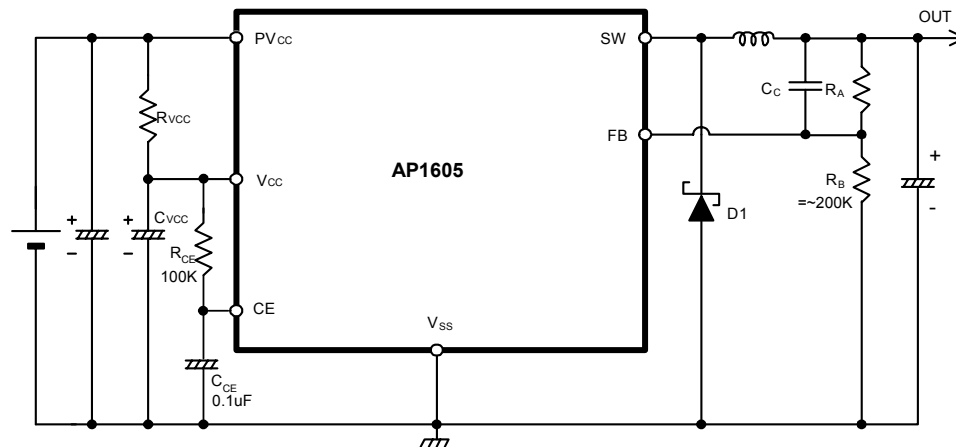
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### ■ Electrical Characteristics ( $V_{IN} = 5V$ , $T_a = 25^\circ C$ , unless otherwise specified)

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	$\mu A$	
$I_{SSS}$	Current Consumption During Power Off	$V_{ON/OFF} = 0V$	--	--	2	$\mu A$	
$\Delta V_{OUT1}$	Line Regulation	$2.5V \sim 7V @ I_{OUT} = 0.1A$	--	0.2	0.5	%	
$\Delta V_{OUT2}$	Load Regulation	$0.1A \sim 3A$ (SOP-8L), $0.1A \sim 1.5A$ (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 Leakage Current	--	-0.1	--	0.1	$\mu A$	
$I_{SL}$	Leakage Current	--	-0.1	--	0.1	$\mu A$	
EFFI	Efficiency	$V_{IN} = 5V$ , $V_{OUT} = 2.5V$ $I_{OUT} = 1A$	--	93	--	%	

### ■ Typical Application Circuit

#### (1) Normal Application

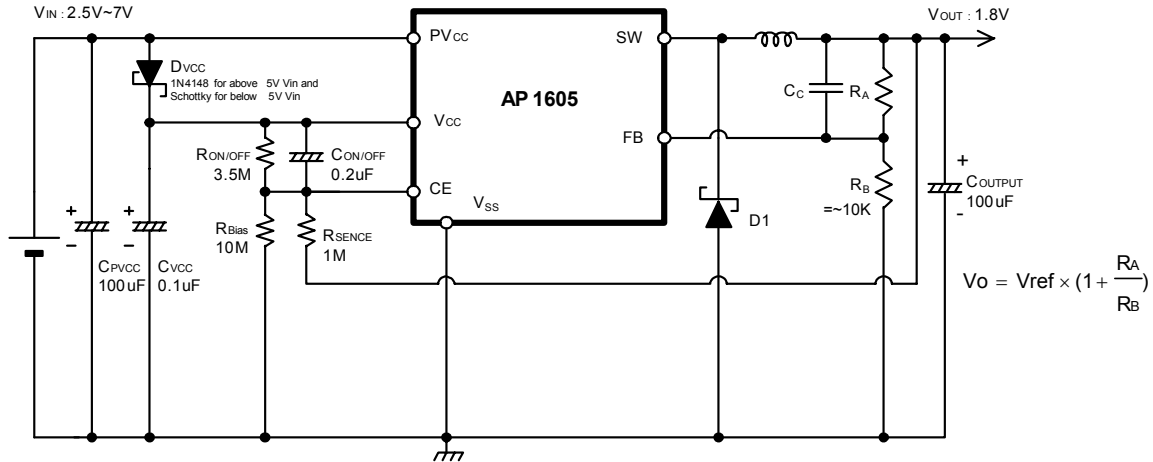


$$V_o = V_{ref} \times \left(1 + \frac{R_A}{R_B}\right)$$

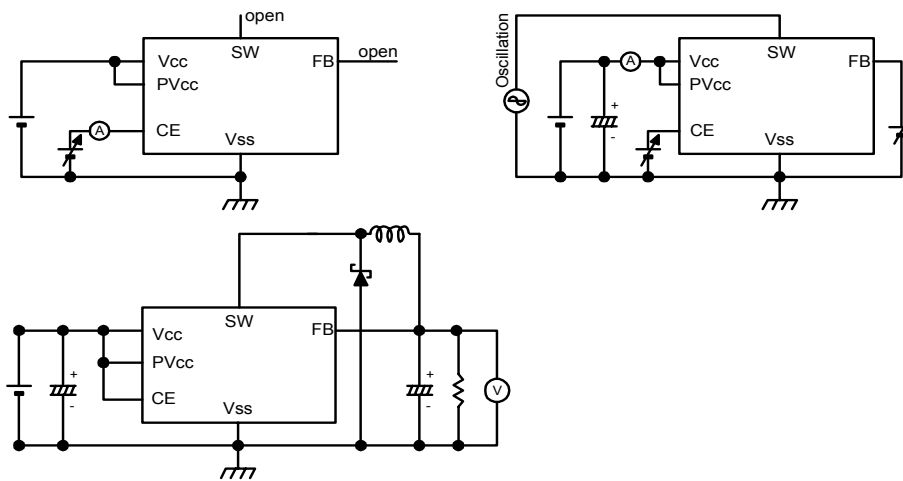
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### ■ Typical Application Circuit (Continued)

(2) Application with Short Circuit Protection



### ■ Test Circuit



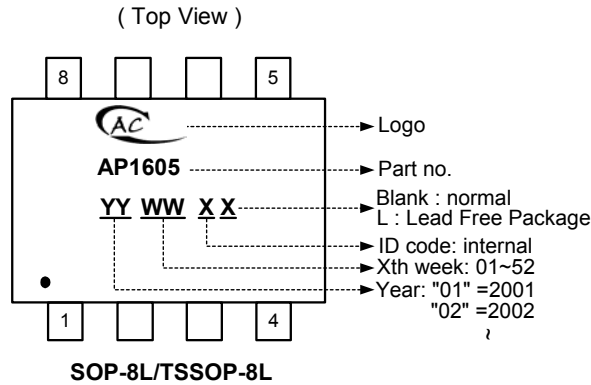
### ■ Function Description

#### 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.

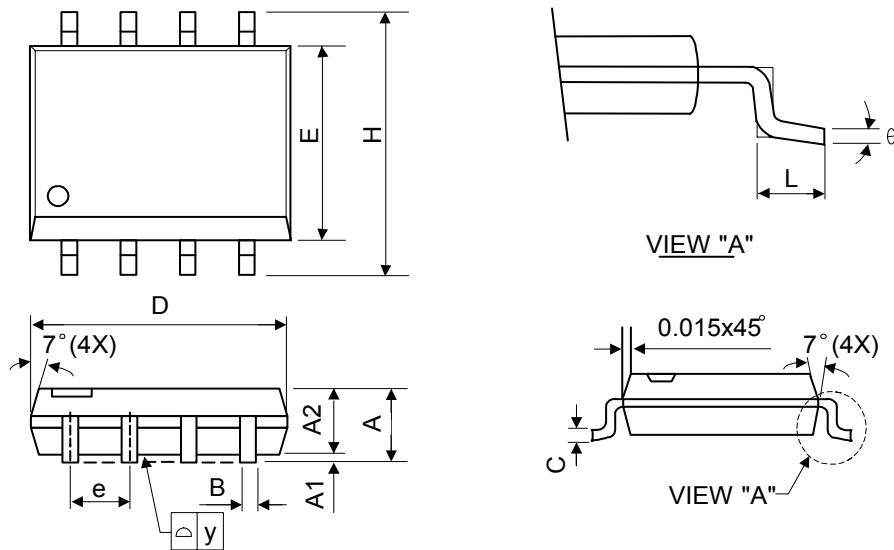
## PWM/PFM Dual-mode Step-Down Switching Regulator

### ■ Marking Information



### ■ Package Information

Package Type: SOP-8L

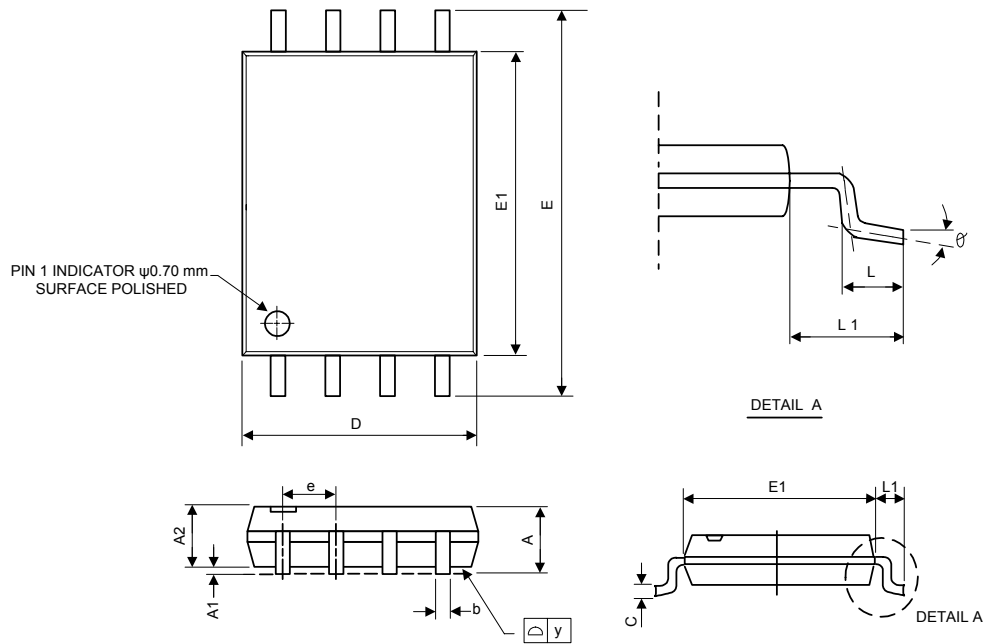


Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.40	1.60	1.75	0.055	0.063	0.069
A1	0.10	-	0.25	0.040	-	0.100
A2	1.30	1.45	1.50	0.051	0.057	0.059
B	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.010
D	4.80	5.05	5.30	0.189	0.199	0.209
E	3.70	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
$\theta$	0°	-	8°	0°	-	8°

## PWM/PFM Dual-mode Step-Down Switching Regulator

### ■ 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°