AP1201

Single-Channel Power Distribution Switch (Preliminary)

■ Features

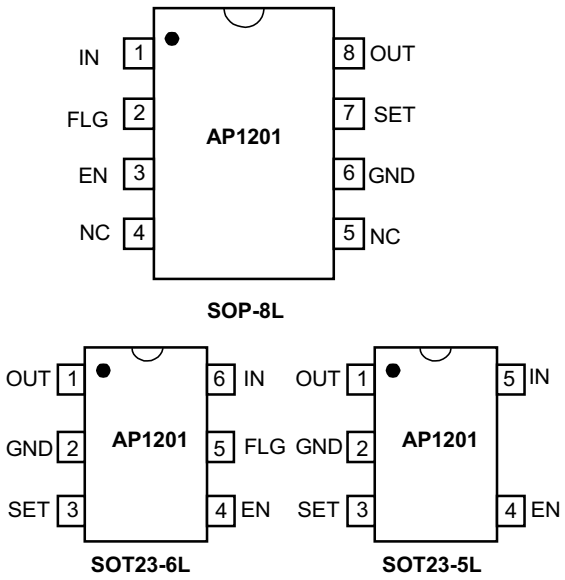
- 110mΩ typical on-resistance
- 2.7V to 5.5V input voltage
- Adjustable current-limit 0.3A to 1.5A
- Fault flag
- 1 μA typical off-state supply current
- 80 μA typical on-state supply current
- Output can be forced higher than input (off-state)
- Thermal shutdown
- 2.4V typical under voltage lockout (UVLO)
- Slow turn-on (soft-start) and fast turn-off
- Enable Active-High or active-Low
- SOT23-5L, SOT23-6L and SOP-8L packages
- UL Recognized Component

■ Applications

- USB Power Switch
- Battery-charger circuits
- Hot plug-in power supplies

■ Pin Assignments

(Top View)



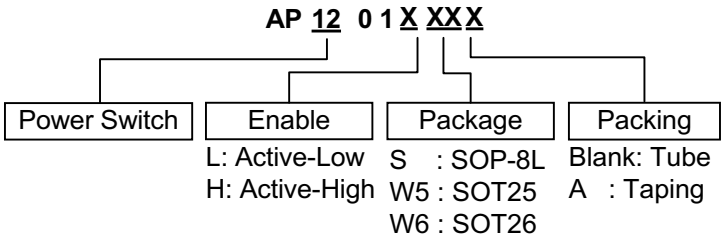
■ General Description

The AP1201 series are integrated high-side power switch with enable, flag functions and adjustable current-limit 0.3A to 1.5A, optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. The AP1201 series support the following USB requirements: each switch channel supplies up to 500mA as required by USB downstream devices; the switch's low on-resistance meets USB voltage drop requirements; fault current is limited to typically 800mA, well below the UL 25VA safety requirements; and a flag output is available to indicate fault conditions to the local USB controller. Soft start eliminates the momentary voltage drop on the upstream port that may occur when the switch is enabled in bus-powered applications.
Additional features include thermal shutdown to prevent catastrophic switch failure from high-current loads, under voltage lockout (UVLO) to ensure that the device remains off unless there is a valid input voltage present, and 3.3V and 5V logic compatible enable inputs.

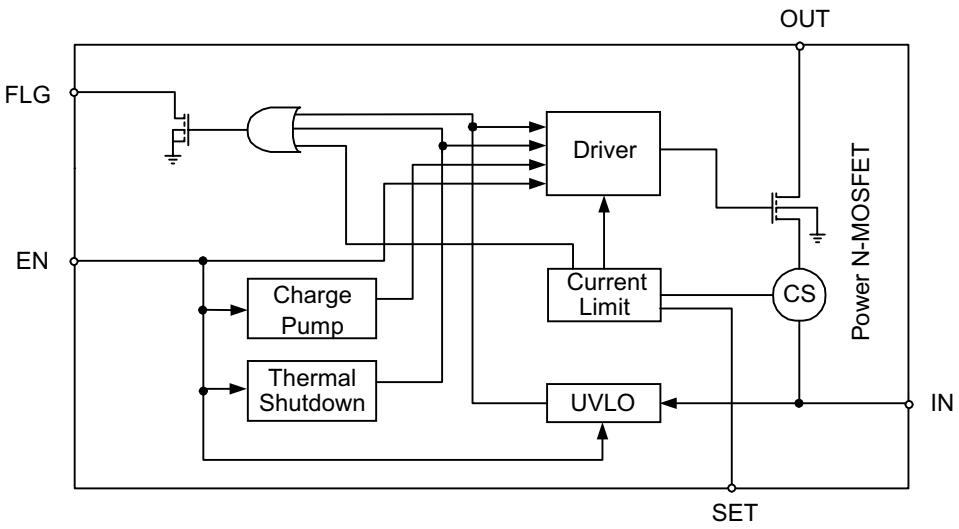
■ Pin Descriptions

Name	Descriptions
EN	Enable: Logic-compatible enable input. (H: active high, L: active low). Do not float.
FLG	Fault Flag: Active-low, open-drain output. Indicates over current, UVLO, and thermal shutdown.
GND	Ground: Supply return.
IN	Supply Input: Output MOSFET drain. Also supplies IC's internal circuitry. Connect to positive supply.
OUT	Switch Output: Output MOSFET source. Typically connect to switched side of load.
SET	Current limit set input. A resistor pull_high to set current-limit value.

■ Ordering Information



■ Block Diagram



■ Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Rating	Unit
V_{IN}	Supply Voltage	+7	V
V_{FLG}	Fault Flag Voltage	+7	V
I_{MAX}	Maximum Continuous Current	1.5	A
V_{OUT}	Output Voltage	+7	V
V_{EN}	Control Input	–0.3 to +15	V
T_S	Storage Temperature	-65 to +150	^oC
T_{LEAD}	Lead Temperature	260	^oC
V_{ESD}	ESD Rating ,Note 3	4	KV

■ Operating Ratings (Note 2)

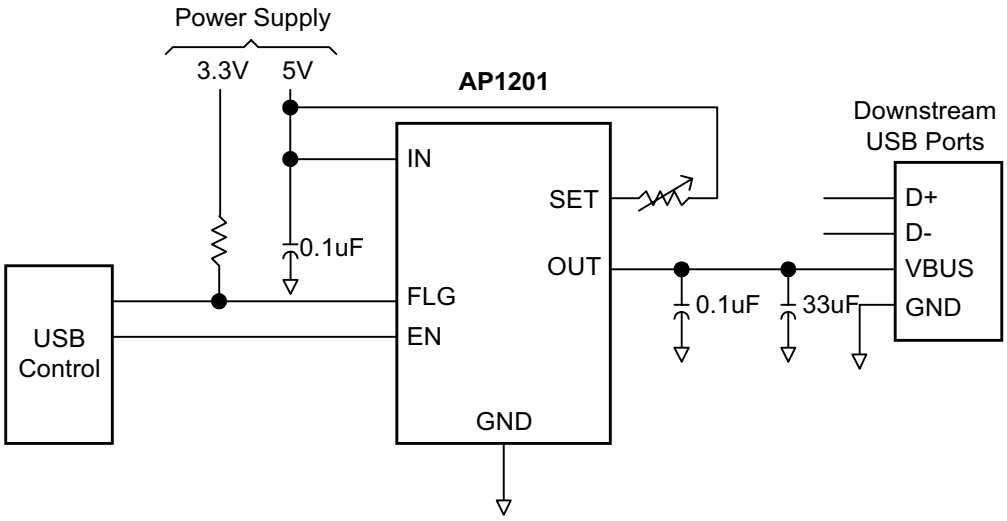
Symbol	Parameter	Rating	Unit
V_{IN}	Supply Voltage	+2.7 to +5.5	V
T_A	Ambient Operating Temperature	-40 to +85	°C
Θ_{JA}	SOIC	120	°C/W
Θ_{JA}	SOT25,SOT26	150	°C/W

■ Electrical Characteristics (Under Operating Conditions) V_{in}=+5V;T_A=25°C; unless noted.

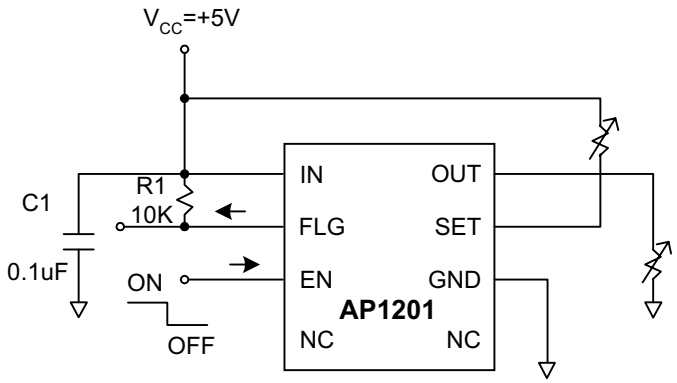
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current	switch off, OUT = open (Note 4)		0.5	5	μA
		switch on, OUT = open (Note 4)		80	110	μA
V_{IT}	Enable Input Threshold	low-to-high transition(Note 4)		1.7	2.4	V
		high-to-low transition(Note 4)	0.8	1.5		V
I_{EN}	Enable Input Current	V_{EN} =0V to 5.5V	-1	± 0.01	1	μA
C_{EN}	Enable Input Capacitance			1		pF
$R_{DS(ON)}$	Switch Resistance	V_{IN} =5V, I_{OUT} =500mA		110	140	mΩ
		V_{IN} =3.3V, I_{OUT} =500mA		100	130	mΩ
T_{OND}	Output Turn-On Delay	R_L =10Ω		30		μs
T_r	Output Turn-On Rise Time	R_L =10Ω		1		ms
T_{OFFD}	Output Turnoff Delay	R_L =10Ω		1	20	μs
T_f	Output Turnoff Fall Time	R_L =10Ω		1	20	μs
I_{LEAK}	Output Leakage Current				10	μA
I_{OUT}	Continuous Load Current		0.3		1.5	A
I_{LIM}	Current-Limit Threshold	Ramped load applied to Output, R_{SET}=360Ω (Note 5)	0.85	1.1	1.35	A
	Short-circuit Current-Limit	V_{OUT}=0V, R_{SET}=360Ω (Note 5)	0.75	1	1.25	A
	Minimum Current-Limit	R_{SET}=floating		0.3		A
T_{TS}	Over-temperature Shutdown Threshold	T_J increasing		140		°C
		T_J decreasing		130		°C
R_{FO}	Error Flag Output Resistance	V_{IN} = 5V, I_L = 10mA		10	25	Ω
		V_{IN} = 3.3V, I_L = 10mA		15	40	Ω
I_{FOH}	Error Flag Off Current	V_{FLAG} = 5V		0.01	1	μA
UVLO	UVLO Threshold	V_{IN} = increasing		2.5		V
		V_{IN} = decreasing		2.3		V

Note 1. Exceeding the absolute maximum rating may damage the device.
Note 2. The device is not guaranteed to function outside its operating rating.
Note 3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.
Note 4. Off is $V_{EN} \leqq 0.8V$and on is $V_{EN} \geqq 2.4V$ for the AP1201-H. Off is $V_{EN} \geqq 2.4V$ and on is $V_{EN} \leqq 0.8V$ for the AP1201-L. The enable input has approximately 200mV of hysteresis. See control threshold charts.
Note 5. See Function Description: Current-Limit.

■ Typical Application Circuit



■ Test Circuit



■ Function Description

Error Flag
An open-drained output of an N-channel MOSFET, the FLG output is pulled low to signal the following fault conditions: input under-voltage, output current limit, and thermal shutdown.

Current Limit
The current limit is set externally. It protects the output MOSFET switches from damage due to undesirable short circuit conditions or excess inrush current often encountered during hot plug-in. The low limit of the current limit threshold of the AP1201 allows a minimum current of 0.3A through the MOSFET switches. A current limit condition will signal the error flag. A resistor from SET to VIN to set the current-Limit value.

$I_{LIM(MAX)}$ ~ 1.25X $I_{LIM(TYP)}$
$I_{LIM(MIN)}$ ~ 0.75X $I_{LIM(TYP)}$

R_{SET}(Ω)	Current-Limit Typ. (mA)	Current-Limit Threshold Typ. (mA)
Floating	300	330
2600	400	440
1280	500	550
850	600	660
635	700	770
510	800	880
420	900	990
360	1000	1100
315	1100	1210
280	1200	1320
250	1300	1430
228	1400	1540
210	1500	1650

Thermal Shutdown
When the chip temperature exceeds 140ºC for any reason, the thermal shutdown function turns off MOSFET switch and signal the error flag. A hysteresis of 10ºC prevents the MOSFETs from turning back on until the chip temperature drops to below 130ºC.

Supply Filtering
A 0.1µF to 1µF bypass capacitor from IN to GND, located near the device, is strongly recommended to control supply transients. Without a bypass capacitor, an output short may cause sufficient ringing on the input (from supply lead inductance) to damage internal control circuitry.

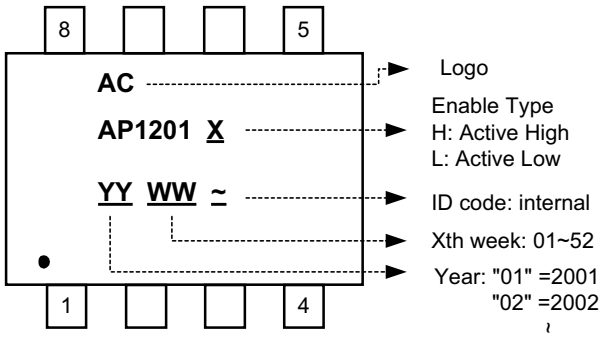
Transient Droop Requirements
USB support dynamic attachment (hot plug-in) of peripherals. A current surge is caused by the input capacitance of downstream device. Ferrite beads are recommended in series with all power and ground connector pins. Ferrite beads reduce EMI and limit the inrush current during hot-attachment by filtering high-frequency signals.

Short Circuit Transient
Bulk capacitance provides the short-term transient current needed during a hot-attachment event. With a 33µF, 16V tantalum or 100µF, 10V electrolytic capacitor mounted close to downstream connector per port should provide transient drop protection.

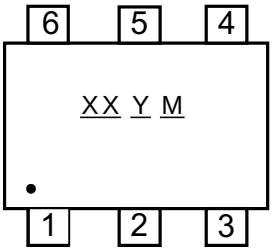
Printed Circuit Layout
The power circuitry of USB printed circuit boards requires a customized layout to maximize thermal dissipation and to minimize voltage drop and EMI.

■ Marking Information

(Top View)

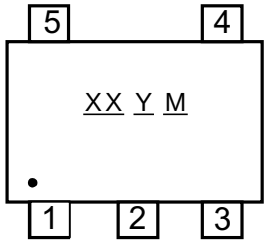


SOP-8L



SOT26-6L

XX : Identification code
(See Appendix)
Y : Year: 0-9
M : Month: A~L



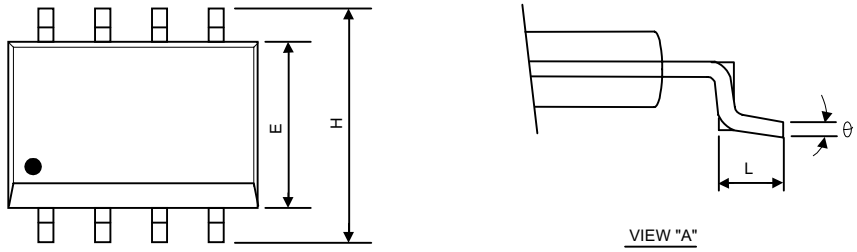
SOT25-5L

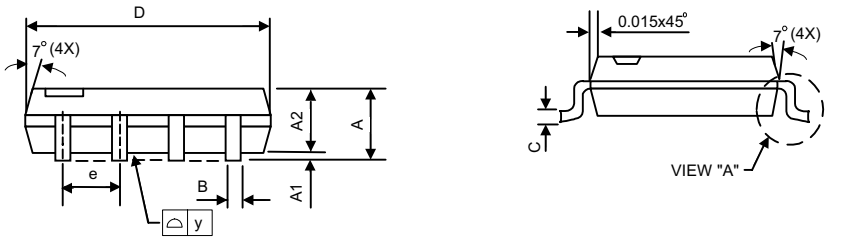
Appendix

Part Number	Package	Identification Code
AP1201L	SOT26	FL
AP1201H	SOT26	FH
AP1201L	SOT25	F1
AP1201H	SOT25	F2

■ Package Information

(1) Package Type: SOP-8L

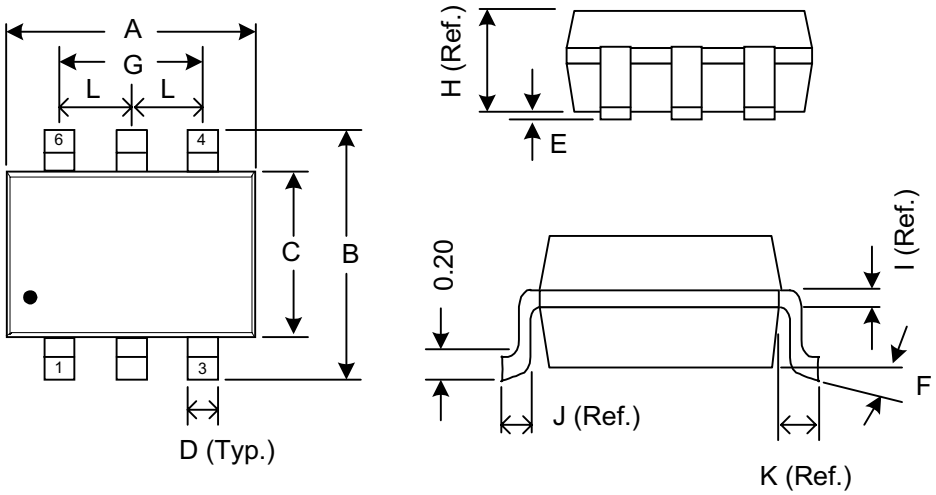




Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.40	1.60	1.75	0.055	0.063	0.069
A1	0.10	–	0.25	0.040	–	0.100
A2	1.30	1.45	1.50	0.051	0.057	0.059
B	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.010
D	4.80	4.85	5.05	0.189	0.191	0.199
E	3.80	3.91	4.00	0.150	0.154	0.157
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^O	–	8^O	0^O	–	8^O

■ Package Information (Continued)

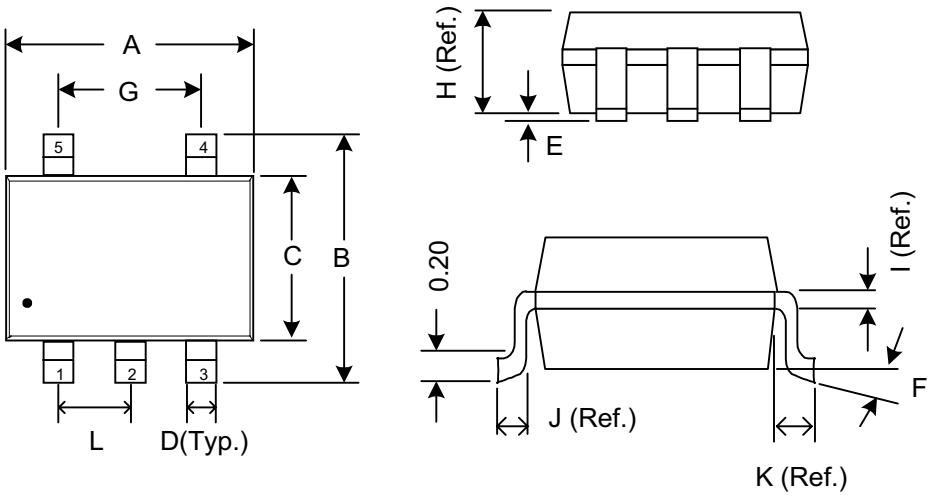
(2) Package Type: SOT23-6L



Symbol	Dimensions In Millimeters	
	Min.	Max.
A	2.70	3.10
B	2.60	3.00
C	1.40	1.80
D	0.30	0.55
E	0	0.10
F	0^{o}	10^{o}
G	1.90 Ref.	
H	1.20 Ref.	
I	0.12 Ref.	
J	0.37 Ref.	
K	0.60 Ref.	
L	0.95 Ref.	

■ Package Information (Continued)

(3) Package Type: SOT23-5L



Symbol	Dimensions In Millimeters	
	Min.	Max.
A	2.70	3.10
B	2.60	3.00
C	1.40	1.80
D	0.30	0.55
E	0	0.10
F	0^{o}	10^{o}
G	1.90 Ref.	
H	1.20 Ref.	
I	0.12 Ref.	
J	0.37 Ref.	
K	0.60 Ref.	
L	0.95 Ref.	