



# 1A Ultra Low Dropout Linear Regulator

## Features

- Ultra Low Dropout of 0.2V (typ.) at 1A Output Current
- Low ESR Output Capacitor (Multi-layer Chip Capacitors (MLCC)) Applicable
- Reference Voltage of 0.8V
- Fast Transient Response
- Adjustable Output Voltage by External Resistors
- Power-On-Reset Monitoring on Both VCNTL and VIN Pins
- Internal Soft-Start
- Under-Voltage Protection
- Current-Limit and Thermal Shutdown Protection
- Power-OK Output with a Delay Time
- RoHS-compliant ESO-8, SOT-26 and DFN 2x2

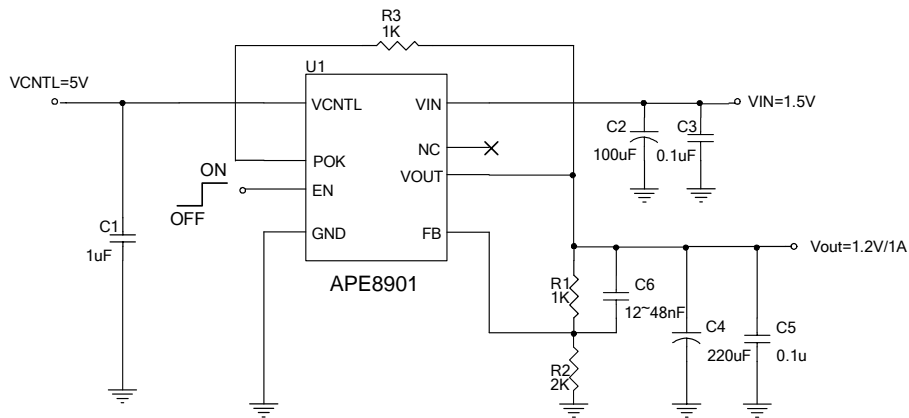
## Description

The APE8901 is a 1A ultra low dropout linear regulator, specifically designed to provide reliable supply voltages for front-side-bus termination on motherboards and NB applications. The IC needs two supply voltages, a control voltage for the circuitry and a main supply voltage for power conversion, to reduce power dissipation and provide extremely low dropout. The APE8901 integrates many functions. A Power-On-Reset (POR) circuit monitors both supply voltages to prevent incorrect operation. Thermal shutdown and current limit functions protect the device against thermal and current over-loads. A POK indicates the output status with a time delay which is set internally, and can control another converter for power sequencing. The APE8901 can be enabled by another power system. Pulling and holding the EN pin below 0.3V shuts off the output.

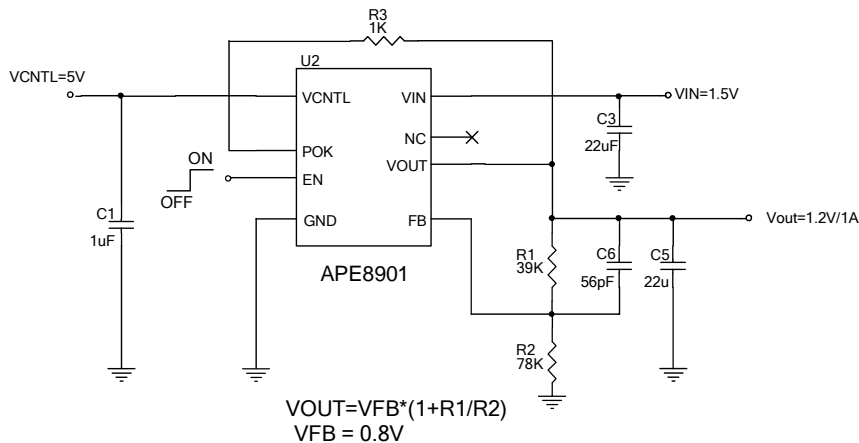
The APE8901 is available in ESO-8, SOT-26 and DFN 2x2 packages. The ESO-8 features the small size of an SO-8 with an exposed pad to reduce the thermal impedance, and is suitable for 2-3W applications.

## Typical Application

1. Using an Output Capacitor with ESR  $\geq 20m\Omega$



2. Using an MLCC as the Output Capacitor





**Absolute Maximum Ratings** (at T<sub>A</sub> = 25°C)

VCNTL Supply Voltage (V <sub>CNTL</sub> )	-----	-0.3V to 7V
VIN Supply Voltage (V <sub>IN</sub> )	-----	-0.3V to 6V
EN & FB Pin Voltage (V <sub>EN</sub> , V <sub>FB</sub> )	-----	-0.3V to VCNTL+0.3V
Power Good Voltage (V <sub>POK</sub> )	-----	-0.3V to 7V
Power Dissipation (P <sub>D</sub> )	ESOP-8 -----	3W
	SOT-26 -----	0.4W
	DFN 2x2 -----	0.8W
Storage Temperature Range (T <sub>ST</sub> )	-----	-65°C To 150°C
Junction Temperature Range (T <sub>J</sub> )	-----	-40°C To 125°C
Operating Temperature Range (T <sub>OP</sub> )	-----	-40°C To 85°C
Thermal Resistance, Junction-Ambient (R <sub>thja</sub> )		
	ESOP-8 -----	40°C/W
	SOT-26 -----	250°C/W
	DFN 2x2 -----	125°C/W
Thermal Resistance, Junction-Case (R <sub>thjc</sub> )		
	ESOP-8 -----	15°C/W
	SOT-26 -----	180°C/W
	DFN 2x2 -----	20°C/W

Note. R<sub>thja</sub> is measured with a PCB copper area (must be connected to the exposed pad) of approximately 1.5 in<sup>2</sup> (Multi-layer) for the ESOP-8 and DFN-8L packages.

**Recommended Operating Conditions**

V <sub>CNTL</sub> Supply Voltage (V <sub>CNTL</sub> )	-----	3V to 6V
VIN Supply Voltage (V <sub>IN</sub> )	-----	1V to 5.5V
Output Voltage (V <sub>OUT</sub> )	----- (V <sub>CNTL</sub> -V <sub>OUT</sub> > 1.9V)-----	0.8V to 2.8V
Output Current (I <sub>OUT</sub> )	-----	0 to 1A

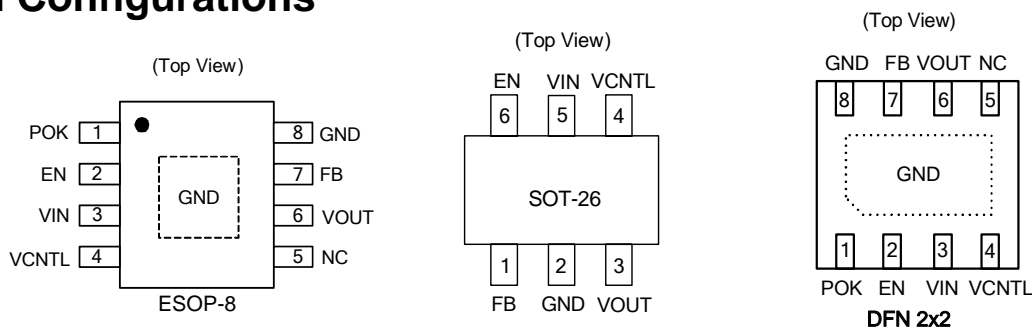
**Ordering Information**

**APE8901X-HF-3TR**

Package type:

- MP : RoHS-compliant halogen-free ESO-8
- Y : RoHS-compliant halogen-free SOT-26
- GN2 : RoHS-compliant halogen-free DFN 2x2

**Pin Configurations**



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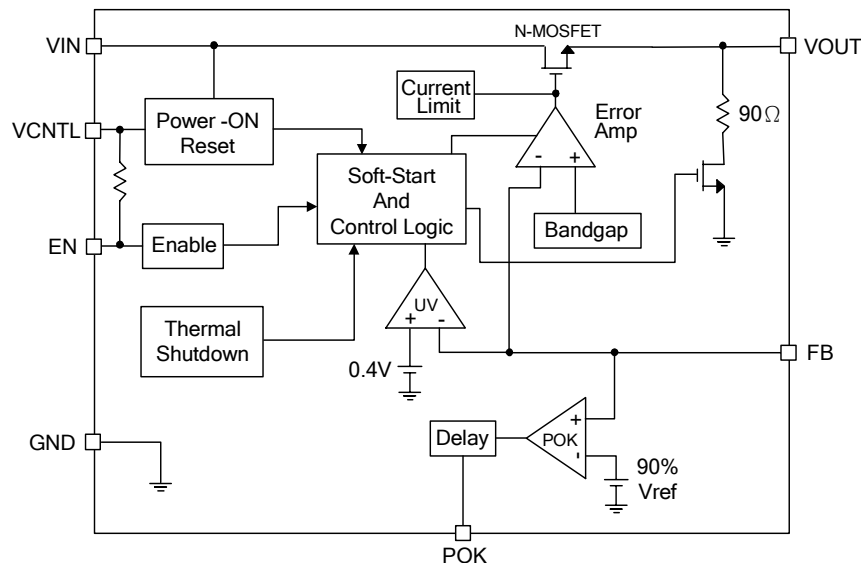


## Electrical Specifications

( $V_{CNTL} = 5V$ ,  $V_{IN} = 1.5V$ ,  $V_{OUT} = 1.2V$ ,  $T_A = 25^\circ C$  unless otherwise specified)

Parameter	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS	
VCNTL POR Threshold	$V_{CNTL}$		2.5	2.7	2.9	V	
VCNTL POR Hysteresis	$V_{CNTL(hys)}$		-	0.4	-	V	
VIN POR Threshold	$V_{IN}$		0.8	0.9	1	V	
VIN POR Hysteresis	$V_{IN(hys)}$		-	0.5	-	V	
VCNTL Nominal Supply Current	$I_{CNTL}$	EN = $V_{CNTL}$	0.4	1	2	mA	
VCNTL Shutdown Current	$I_{SD}$	EN = 0V	-	10	30	uA	
Feedback Voltage	$V_{FB}$	$V_{CNTL} = 3 \sim 6.0V$	0.784	0.8	0.816	V	
Load Regulation		$I_{OUT} = 0A \sim 1A$	-	0.06	0.25	%	
Dropout Voltage	$V_{DROP}$	$V_{OUT} < 2.0V, I_{OUT} = 1A$	-	200	250	mV	
		$2.0V < V_{OUT} < 2.8V, I_{OUT} = 1A$	-	250	300		
VOUT Pull Low Resistance		EN = 0V	-	90	120	$\Omega$	
Soft Start Time	$T_{SS}$		-	2	-	mS	
EN Pin Logic High Threshold Voltage	$V_{ENH}$	Enable	1.2	-	-	V	
	$V_{ENL}$	Disable	-	-	0.4		
EN Hysteresis			-	50	-	mV	
EN Pin Pull-Up Current	$I_{EN}$	EN = GND	-	10	-	uA	
Current Limit	$I_{LIM}$	125 $^\circ C$	1.2	-	-	A	
Ripple Rejection	$\frac{V_{IN}}{V_{CNTL}}$	PSRR	F = 120Hz, $I_{OUT} = 100mA$	-	70	-	dB
				-	65	-	
Under-Voltage Threshold		VFB Falling	-	0.4	-	V	
POK Threshold Voltage for Power OK	$V_{POK}$	VFB Rising	89%	92%	95%	VFB	
POK Threshold Voltage for Power Not OK	$V_{PNOK}$	VFB Falling	78%	81%	84%	VFB	
POK Low Voltage		POK sinks 5mA	-	0.25	0.4	V	
POK Delay Time	$T_{DELAY}$		0.8	2	10	mS	
Thermal Shutdown Temp	TSD		-	150	-	$^\circ C$	
Thermal Shutdown Hysteresis			-	40	-	$^\circ C$	

## Block Diagram





## Pin Descriptions/Functions

PIN SYMBOL	PIN DESCRIPTION
FB	Feedback Pin
EN	Internal Pull High. EN=High or Floating → Enable EN=Low → Shutdown Mode
VIN	Input voltage.
POK	Power OK Output Pin
VCNTL	CNTL Pin Input Voltage
NC	No connect
VOUT	Output Voltage
GND	GND Pin.

**FB** Connecting this pin to an external resistor divider supplies the feedback voltage to the regulator. The output voltage set by the resistor divider is determined by:

$$V_{OUT} = 0.8 \cdot \left( 1 + \frac{R1}{R2} \right) \quad (V)$$

where R1 is connected from VOUT to FB with Kelvin sensing and R2 is connected from FB to GND. A bypass capacitor may be connected with R1 in parallel to improve load transient response. The recommended R2 and R1 are in the range of 1k~100kΩ.

**VIN** Main supply input pins for power conversion. The voltage at this pin is also monitored for Power-On Reset purposes.

**VCNTL** Power input pin of the control circuitry. Connecting this pin to a +5V (recommended) supply voltage provides the bias for the control circuitry. The voltage at this pin is also monitored for Power-On Reset purposes.

**POK** Power-OK signal output pin. This pin is an open-drain output used to indicate status of the output voltage by sensing the FB voltage. This pin is pulled low when the rising FB voltage is not above the VPOK threshold or the falling FB voltage is below the VPOK threshold, indicating the output is not OK.

**EN** Enable control pin. Pulling and holding this pin below 0.4V shuts down the output. When re-enabled, the IC undergoes a new soft-start cycle. If this pin is left open, it has an internal pull-up to VCNTL voltage, enabling the regulator.

**VOUT** Output of the regulator. Please connect Pin 6 using wide tracks. It is necessary to connect an output capacitor to this pin for closed-loop compensation and to improve transient response.



## **FUNCTION DESCRIPTION**

### **Power-On-Reset**

A Power-On-Reset (POR) circuit monitors both input voltages at VCNTL and VIN pins to prevent incorrect logic controls. The POR function initiates a soft-start process after the two supply voltages exceed their rising POR threshold voltages during powering on. The POR function also pulls low the POK pin regardless of the output voltage when the VCNTL voltage falls below its falling POR threshold.

### **Internal Soft-Start**

An internal soft-start function controls the slew rate of the output voltage to limit the current surge at start-up. The typical soft-start interval is about 2mS.

### **Output Voltage Regulation**

An error amplifier working with a temperature compensated 0.8V reference and an output NMOSFET regulates the output to the preset voltage. The error amplifier is designed with high bandwidth and DC gain, providing very fast transient response and less load regulation. It compares the reference with the feedback voltage and amplifies the difference to drive the output NMOSFET which provides load current from VIN to VOUT.

### **Current-Limit**

The APE8901 monitors the current via the output NMOSFET and limits the maximum current to protect both the load and the APE8901 from damage during overload or short circuit conditions.

### **Under-Voltage Protection (UVP)**

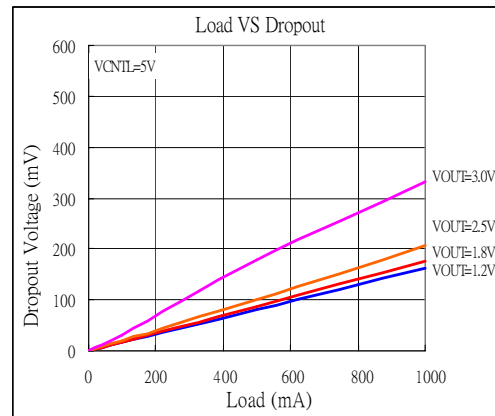
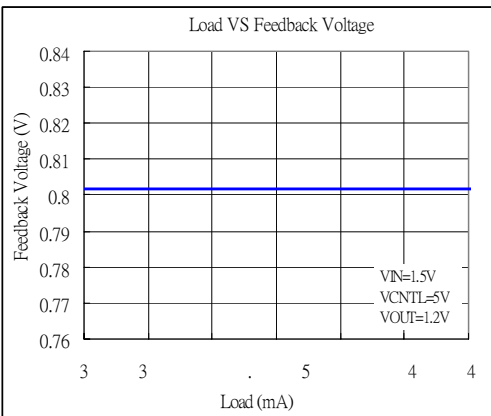
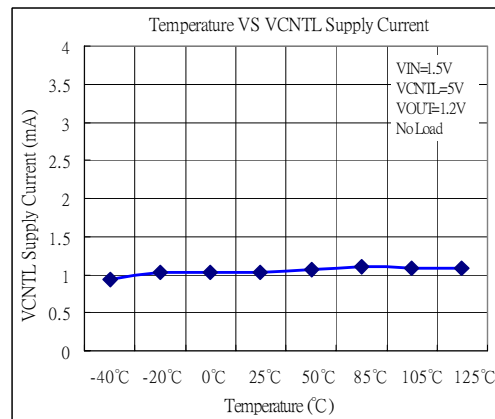
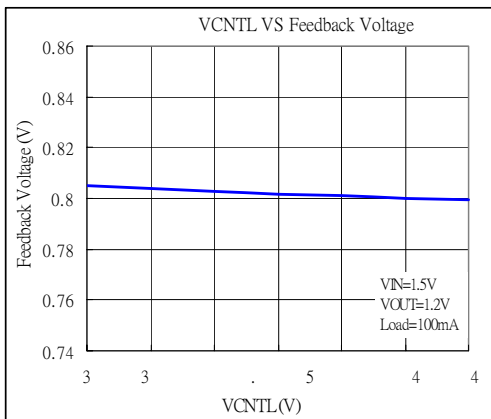
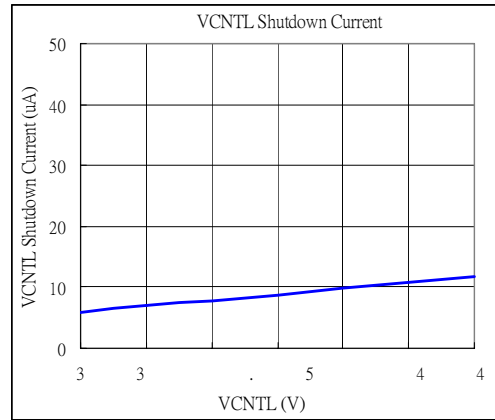
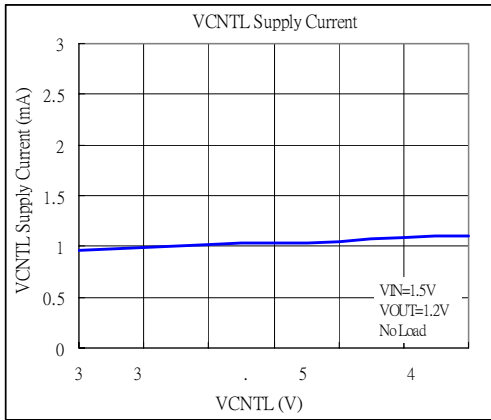
The APE8901 monitors the voltage on FB pin after the soft-start process has finished. Therefore the UVP is disabled during soft-start. When the voltage on FB pin falls below the under-voltage threshold, the UVP circuit shuts off the output immediately. After a while, the APE8901 starts a new soft-start cycle to regulate output.

### **Thermal Shutdown**

A thermal shutdown circuit limits the junction temperature of the APE8901. When the junction temperature exceeds +150°C, a thermal sensor turns off the output NMOSFET, allowing the device to cool down. The regulator regulates the output again by initiating a new soft-start cycle after the junction temperature cools by 40°C, resulting in a pulsed output during continuous thermal overload conditions.

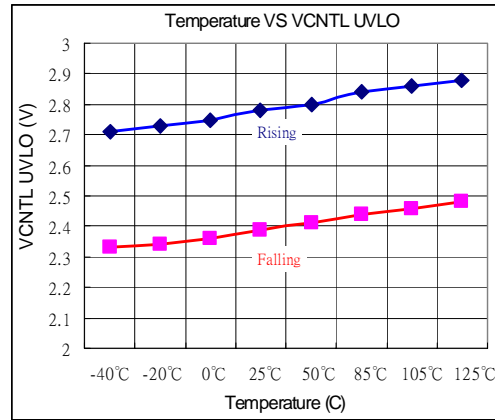
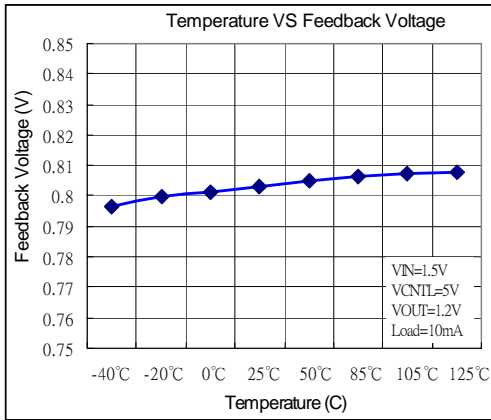


Electrical Characteristics (cont.)

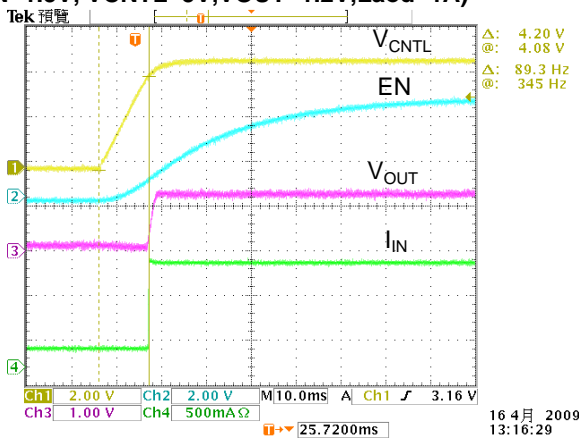




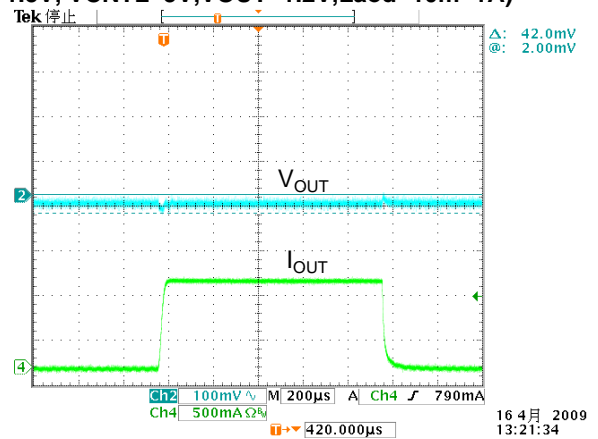
Electrical Characteristics (cont.)



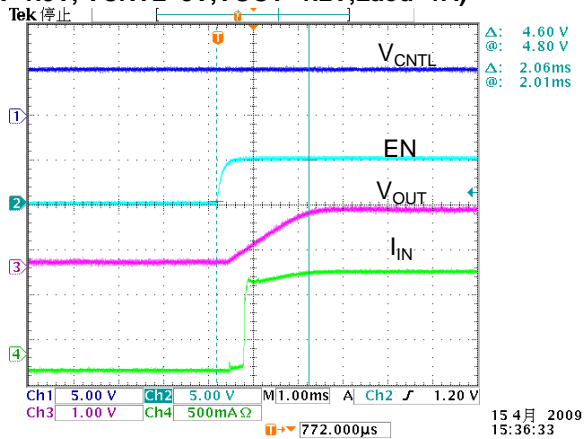
Power -ON  
( $V_{IN}=1.5V, V_{CNTL}=5V, V_{OUT}=1.2V, I_{LOAD}=1A$ )



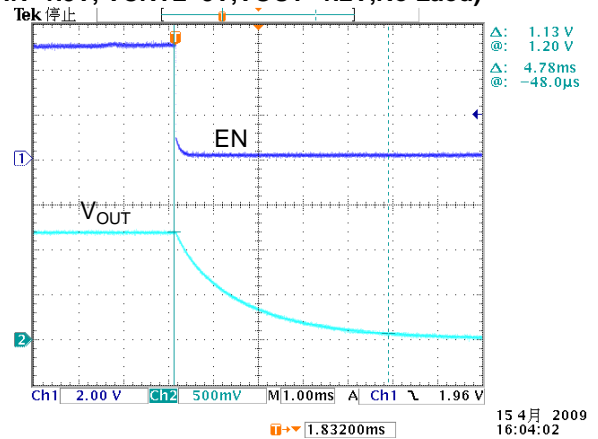
Load Transient  
( $V_{IN}=1.5V, V_{CNTL}=5V, V_{OUT}=1.2V, I_{LOAD}=10m\sim 1A$ )



Enable -ON  
( $V_{IN}=1.5V, V_{CNTL}=5V, V_{OUT}=1.2V, I_{LOAD}=1A$ )

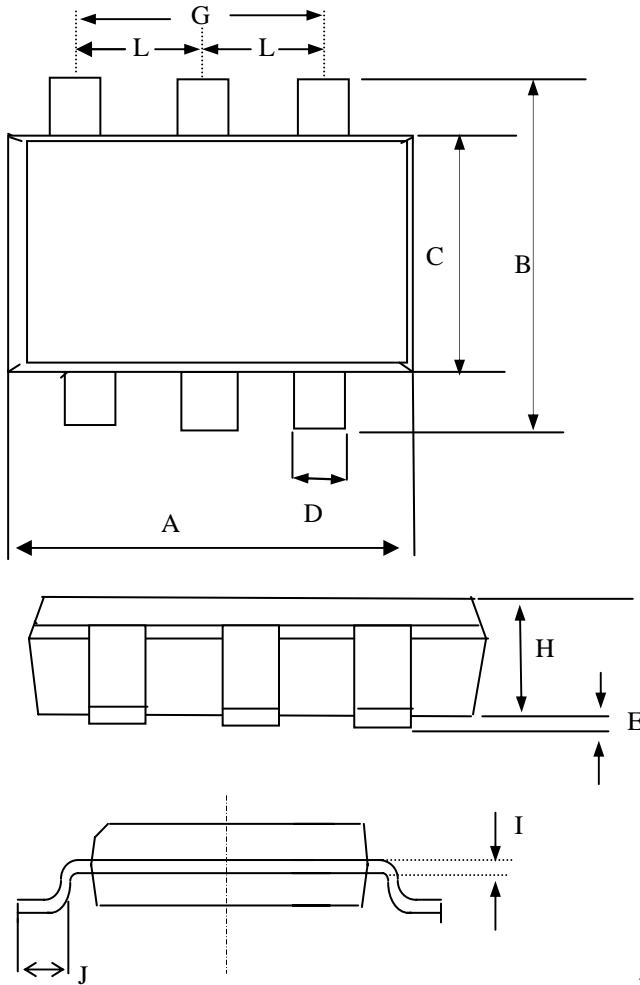


Enable -OFF  
( $V_{IN}=1.5V, V_{CNTL}=5V, V_{OUT}=1.2V, No\ Load$ )





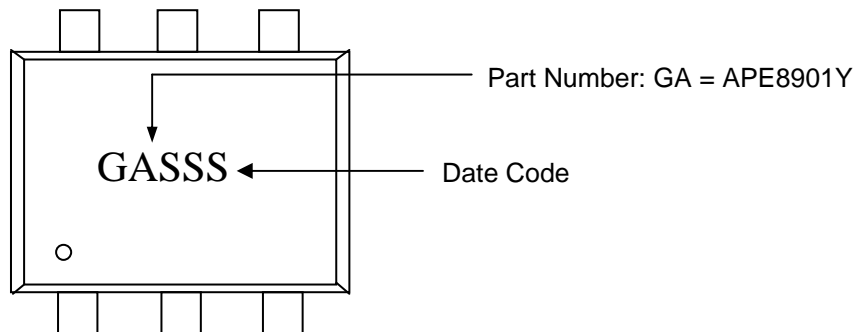
Package Dimensions: SOT-26



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	2.70	2.90	3.10
B	2.60	2.80	3.00
C	1.40	1.60	1.80
D	0.30	0.43	0.55
E	0.00	0.05	0.10
H	1.20REF		
G	1.90REF		
I	0.12REF		
J	0.37REF		
L	0.95REF		

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

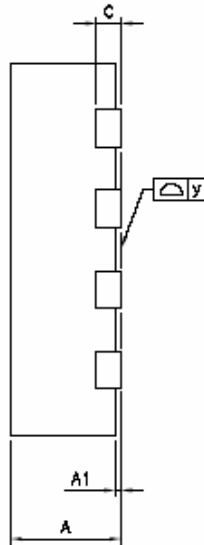
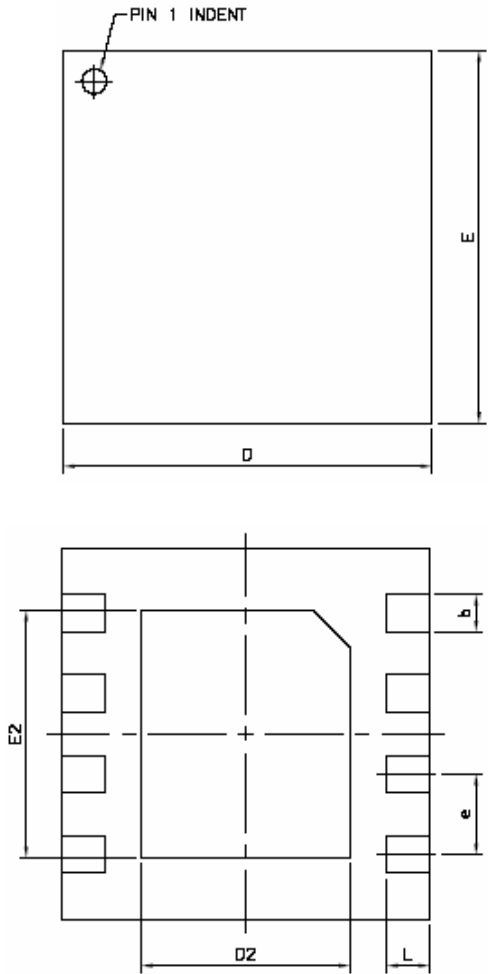
Marking Information







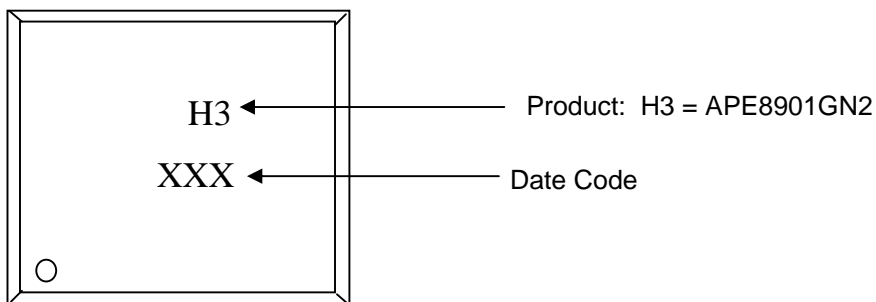
**Package Dimensions: DFN 2x2**



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	0.77	0.90	1.03
A1	0.00	0.015	0.03
b	0.18	0.23	0.28
C	0.203 REF		
D	1.95	2.00	2.05
D2	0.55	0.60	0.65
E	1.95	2.00	2.05
E2	1.15	1.20	1.25
e	—	0.50	—
L	0.3	0.35	0.4
y	0	—	0.03

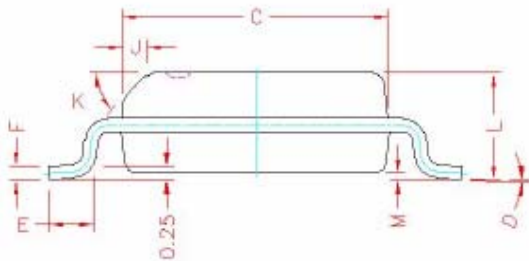
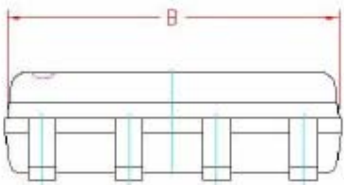
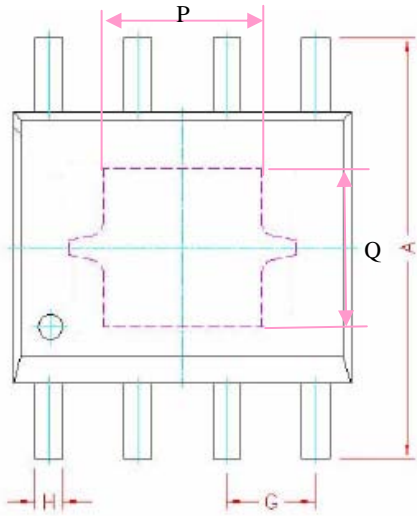
1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

**Marking Information**





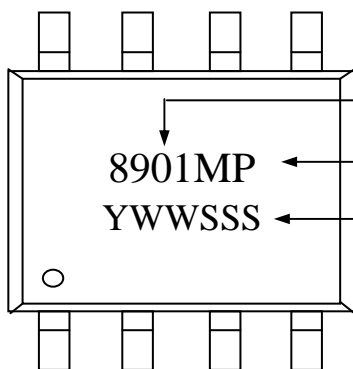
**Package Dimensions: ESO-8**



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	5.80	6.00	6.20
B	4.80	4.90	5.00
C	3.80	3.90	4.00
D	0°	4°	8°
E	0.40	0.65	0.90
F	0.19	0.22	0.25
M	0.00	0.08	0.15
H	0.35	0.42	0.49
L	1.35	1.55	1.75
J	0.375 REF.		
K	45°		
G	1.27 TYP.		
P	2.15	2.25	2.35
Q	2.15	2.25	2.35

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

**Marking Information**



Product: APE8901

Package Code: MP = RoHS-compliant halogen-free ESO-8

Date Code (YWWSSS)

Y: Last digit of the year

WW: Work week

SSS: Lot code sequence