



## FEATURES

- Ultra Low Dropout 0.23V(typical) @ 2A Output Current for 1.2V Output Voltage
- Low ESR Output Capacitor (Multi-layer Chip Capacitors (MLCC)) Applicable
- EN Pull-low for APE8903BMP-A  
EN Pull-high for APE8903BMP-B
- 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
- SO-8 with Exposed Pad Pb-Free Package.
- Halogen Free Product

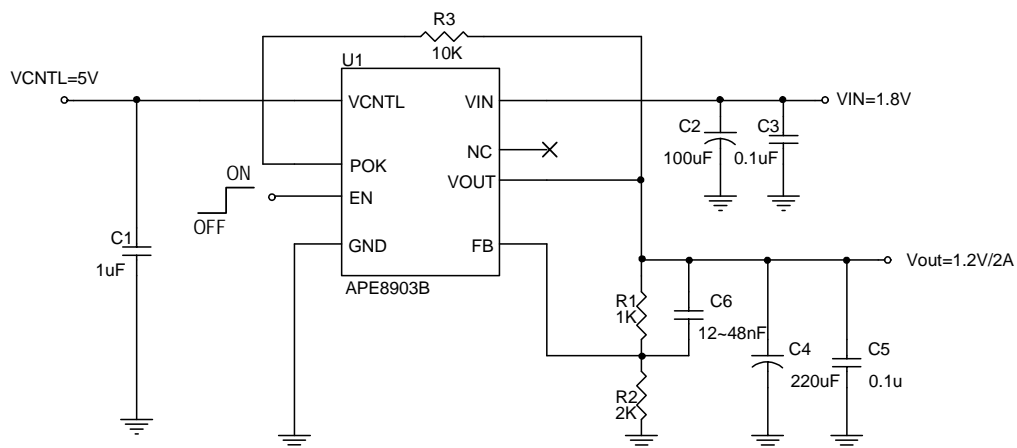
## DESCRIPTION

The APE8903B series is a 3A ultra low dropout linear regulator. This product is specifically designed to provide well supply voltage 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 APE8903B series integrates many functions. A Power-On-Reset (POR) circuit monitors both supply voltages to prevent wrong operations. A thermal shutdown and current limit functions protect the device against thermal and current over-loads. A POK indicates the output status with time delay which is set internally. It can control other converter for power sequence. The APE8903B series can be enabled by other power system. Pulling and holding the EN pin below 0.4V shuts off the output.

The APE8903B series is available in ESOP-8 package which features small size as SO-8 and an Exposed Pad to reduce the junction-to-case resistance, being applicable in 2~3W applications.

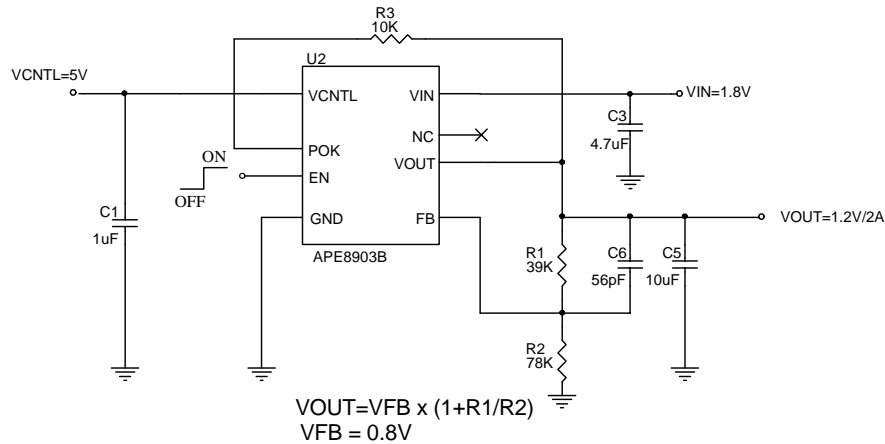
## TYPICAL APPLICATION

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



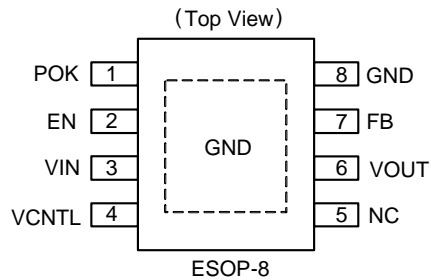
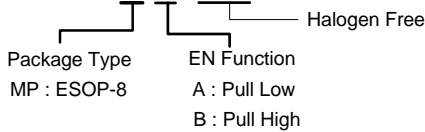
**TYPICAL APPLICATION**

**2. Using an MLCC as the Output Capacitor**



**PACKAGE/ORDERING INFORMATION**

**APE8903BX-X - HF**



**ABSOLUTE MAXIMUM RATINGS (Note1)**

|  |       |                          |
|--|-------|--------------------------|
| CNTL Supply Voltage ( $V_{CNTL}$ )                                       | ----- | -0.3V To 6.5V            |
| Input Supply Voltage ( $V_{IN}$ )  | ----- | -0.3V To 6.5V            |
| EN & FB Pin Voltage ( $V_{EN}/V_{FB}$ )                                  | ----- | -0.3V To $V_{CNTL}+0.3V$ |
| Power Good Voltage ( $V_{POK}$ )   | ----- | -0.3V To 6.5V            |
| Power Dissipation ( $P_D$ )  | ----- | 2.5W                     |
| Storage Temperature Range ( $T_{ST}$ )                                   | ----- | -65°C To 150°C           |
| Junction Temperature Range ( $T_J$ )                                     | ----- | -40°C To 150°C           |
| Thermal Resistance Junction to Ambient ( $R_{th_{ja}}$ ) <sup>Note</sup> | ----- | 40°C/W                   |
| Thermal Resistance Junction to Case ( $R_{th_{jc}}$ )                    | ----- | 15°C/W                   |

Note.  $R_{th_{ja}}$  is measured with the PCB copper area (need connect to Expose-Pad) of approximately 1.5 in<sup>2</sup> (Multi-layer)

**RECOMMENDED OPERATING CONDITIONS**

|   |       |                |
|---|-------|----------------|
| Operating Junction Temperature Range ( $T_{OJ}$ ) | ----- | -40°C To 125°C |
| Operating Ambient Temperature Range ( $T_{OA}$ )  | ----- | -40°C To 85°C  |
| VCNTL Supply Voltage ( $V_{CNTL}$ )               | ----- | 3V To 6V       |
| Input Supply Voltage ( $V_{IN}$ )                 | ----- | 1.1V To 5.5V   |
| Output Voltage ( $V_{OUT}$ )@ $V_{CNTL}=5V$       | ----- | 0.8V To 2.8V   |
| Output Current ( $I_{OUT}$ )                      | ----- | 0A To 3A       |



**ELECTRICAL SPECIFICATIONS**

$V_{CNTL}=5V$ ,  $V_{IN}=1.8V$ ,  $V_{OUT}=1.2V$ ,  $T_A=25^{\circ}C$  unless otherwise specified

| Parameter                              | SYM             | TEST CONDITION   | MIN                      | TYP  | MAX   | UNITS       |    |
|--|-----------------|--|--------------------------|------|-------|-------------|----|
| $V_{CNTL}$ POR Threshold               | $V_{CNTL}$      |  | 2.5                      | 2.7  | 2.9   | V           |    |
| $V_{CNTL}$ POR Hysteresis              | $V_{CNTL(hys)}$ |  | -                        | 0.4  | -     | V           |    |
| $V_{IN}$ POR Threshold                 | $V_{IN}$        |  | 0.8                      | 0.9  | 1     | V           |    |
| $V_{IN}$ POR Hysteresis                | $V_{IN(hys)}$   |  | -                        | 0.5  | -     | V           |    |
| $V_{CNTL}$ Nominal Supply Current      | $I_{CNTL}$      | EN= $V_{CNTL}$   | 0.4                      | 1    | 1.5   | mA          |    |
| $V_{CNTL}$ Shutdown Current            | $I_{SD}$        | EN=0V  | APE8903BMP-A             | -    | -     | 1           | uA |
|  |                 |  | APE8903BMP-B             | -    | 10    | 30          |    |
| Feedback Voltage                       | $V_{FB}$        | $V_{CNTL}=3 \sim 6V$ , $I_{OUT}=10mA$ ,<br>$V_{IN}=V_{OUT}+0.5\sim 5.5V$ | 0.784                    | 0.8  | 0.816 | V           |    |
| Load Regulation                        |                 | $I_{OUT}=0A \sim 2A$   | -                        | 0.2  | 1     | %           |    |
| On Resistance                          | $R_{DS(ON)}$    | $I_{OUT}=100mA$ , $V_{CNTL}=V_{EN}=5.0V$ ,<br>$V_{OUT}=1.2V$             | -                        | 115  | 150   | m $\Omega$  |    |
| Dropout Voltage                        | $V_{DROP}$      | $I_{OUT}=2A$ , $V_{CNTL}=5V$ , $V_{OUT}=1.2V$                            | -                        | 0.23 | 0.3   | V           |    |
| $V_{OUT}$ Pull Low Resistance          |                 | EN=0V  | -                        | 90   | -     | $\Omega$    |    |
| Soft Start Time                        | $T_{SS}$        |  | -                        | 2    | -     | ms          |    |
| EN Pin Logic High Threshold Voltage    | $V_{ENH}$       | Enable   | 1.2                      | -    | -     | V           |    |
|  | $V_{ENL}$       | Disable  | -                        | -    | 0.6   |             |    |
| EN Hysteresis                          |                 |  | -                        | 40   | -     | mV          |    |
| EN Pin Pull-Up Current                 | $I_{EN}$        | EN=5V, APE8903BMP-A  | -                        | 10   | 20    | uA          |    |
|  |                 | EN=GND, APE8903BMP-B   | -                        | 10   | 20    |             |    |
| Current Limit                          | $I_{LIM}$       | $V_{CNTL}=5V$ , $V_{IN}=V_{OUT}+1V$                                      | 3.1                      | -    | -     | A           |    |
| Ripple Rejection                       | $V_{IN}$        | PSRR   | F=120Hz, $I_{OUT}=100mA$ | -    | 65    | -           | dB |
|  | $V_{CNTL}$      |  |                          | -    | 65    | -           |    |
| Inrush current                         |                 | $V_{CNTL}=5V$ , $C_{OUT}=10\mu F$ ,<br>EN startup, $I_{OUT}=2A$          | -                        | 0.5  | -     | A           |    |
| 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             |  | -                        | 160  | -     | $^{\circ}C$ |    |
| Thermal Shutdown Hysteresis            |                 |  | -                        | 40   | -     | $^{\circ}C$ |    |

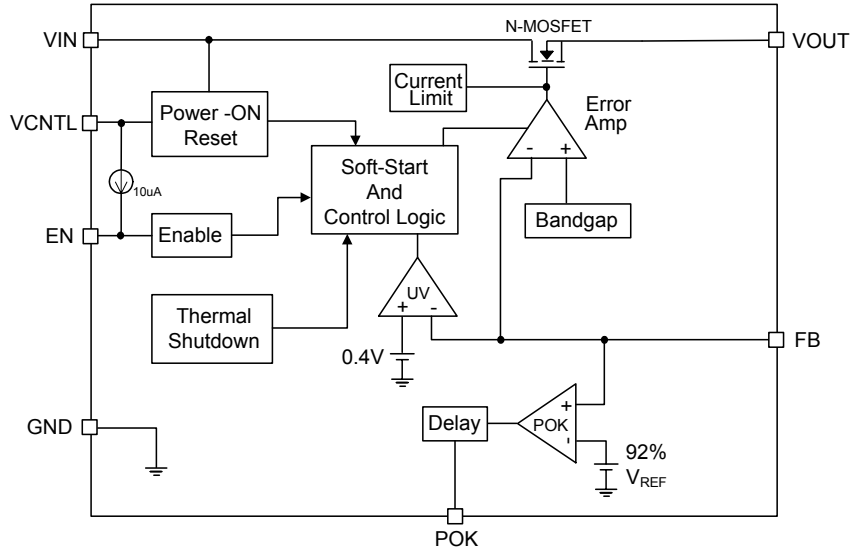


**PIN DESCRIPTIONS**

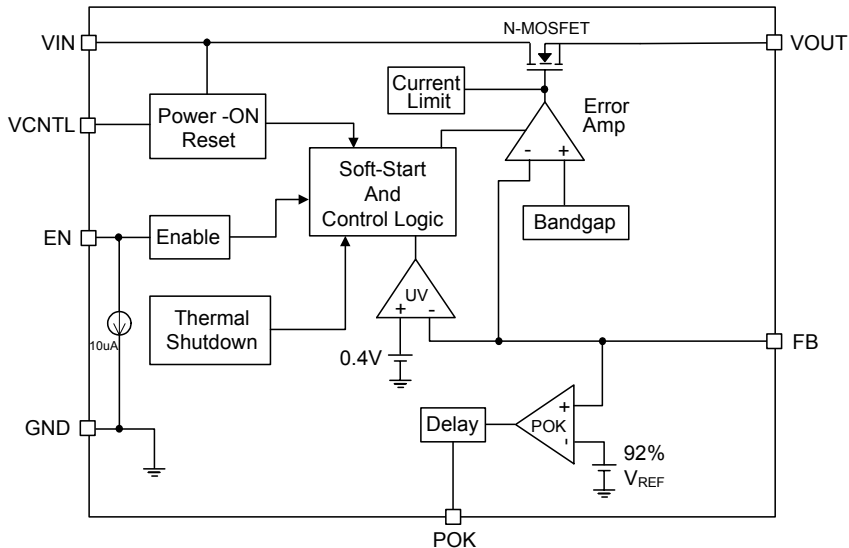
| PIN SYMBOL | PIN DESCRIPTION  |
|------------|--|
| POK        | Power OK Output Pin  |
| EN         | Internal Pull High (APE8903BMP-B) or Pull Low (APE8903BMP-A)<br>EN=High or Floating → Enable<br>EN=Low → Shutdown Mode |
| VIN        | Input Voltage.   |
| VCNTL      | CNTL Pin Input Voltage   |
| NC         | No Connect   |
| VOUT       | Output Voltage   |
| FB         | Feedback Pin   |
| GND        | GND Pin  |

**BLOCK DIAGRAM**

**APE8903BMP-A**



**APE8903BMP-B**



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**PIN DESCRIPTION****FB**

Connecting this pin to an external resistor divider receives the feedback voltage of 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 R2 range in 1K~4.7K  $\Omega$  for AL output capacitor and 30K~100K  $\Omega$  for MLCC output capacitor are recommended.

**VIN**

Main supply input pins for power conversions. The voltage at this pin is monitored for Power-On Reset purpose.

**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 monitored for Power-On Reset purpose.

**POK**

Power-OK signal output pin. This pin is an open-drain output used to indicate status of output voltage by sensing 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. For APE8903BMP-B, this pin is internal pulled up to VCNTL voltage, enabling the regulator. For APE8903BMP-A, this pin is internal pulled down to GND voltage, shutdown the regulator. The pull-high or pull-low current is 10uA (typ.)

**VOUT**

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

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**FUNCTION DESCRIPTION****Power-On-Reset**

A Power-On-Reset (POR) circuit monitors both input voltages at VCNTL and VIN pins to prevent wrong 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 the output voltage when the VCNTL voltage falls below its falling POR threshold.

**Internal Soft-Start**

An internal soft-start function controls rise 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 NMOS regulates output to the preset voltage. The error amplifier designed with high bandwidth and DC gain provides very fast transient response and less load regulation. It compares the reference with the feedback voltage and amplifies the difference to drive the output NMOS which provides load current from VIN to VOUT.

**Current-Limit**

The APE8903B monitors the current via the output NMOS and limits the maximum current to prevent load and APE8903B from damages during overload or short circuit conditions.



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## **FUNCTION DESCRIPTION**

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

The APE8903B monitors the voltage on FB pin after soft-start process is finished. Therefore the UVP is disabling 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 APE8903B starts a new soft-start to regulate output.

### **Thermal Shutdown**

A thermal shutdown circuit limits the junction temperature of APE8903B. When the junction temperature exceeds +160°C, a thermal sensor turns off the output NMOS, allowing the device to cool down. The regulator regulates the output again through initiation of a new soft-start cycle after the junction temperature cools by 40°C, resulting in a pulsed output during continuous thermal overload conditions. The thermal shutdown designed.

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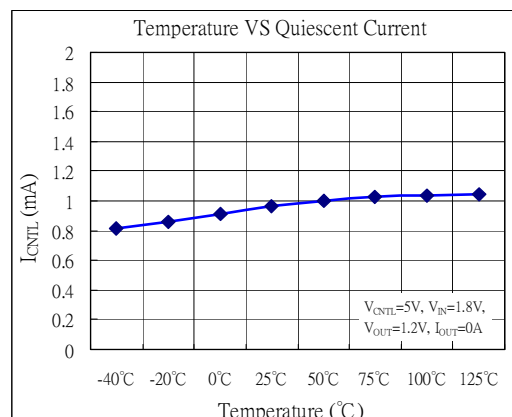
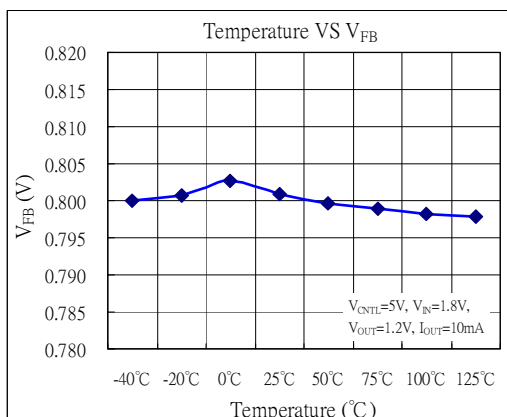
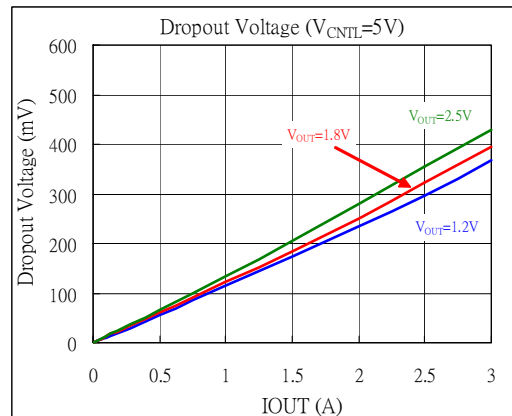
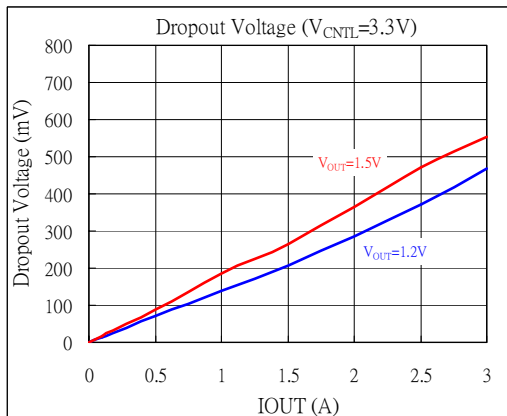
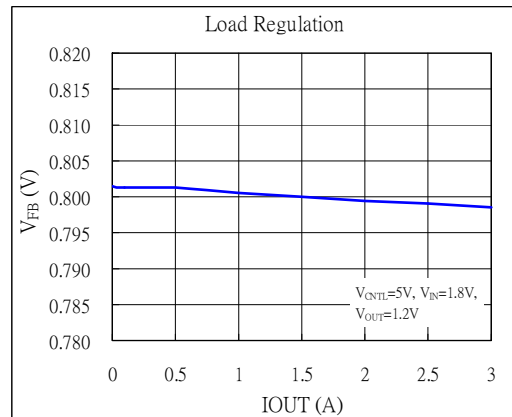
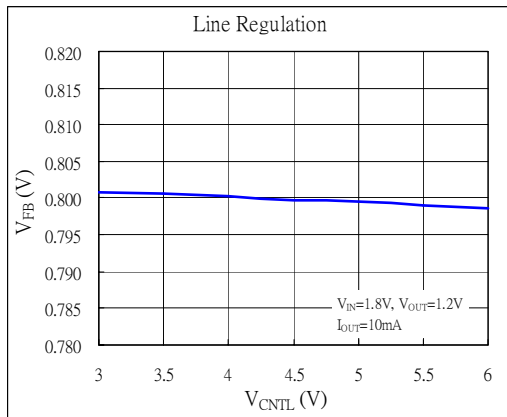
## **APPLICATION INFORMATION**

### **Capacitor Selection**

Normally, use a MLCC capacitor on the input and output of the APE8903B. Larger input capacitor values provide better supply-noise rejection and transient response. A higher-value output capacitor may be necessary if large, fast transients are anticipated and the device is located several inches from the power source. The X5R and X7R type in MLCC is recommended. For aluminum electrolytic capacitor application, 100uF in input capacitor and 220uF in output capacitor ( $30\text{m}\Omega < \text{ESR} < 200\text{m}\Omega$ ) are recommended. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR.

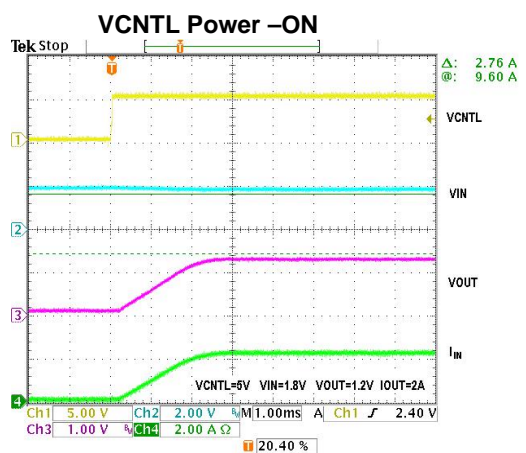
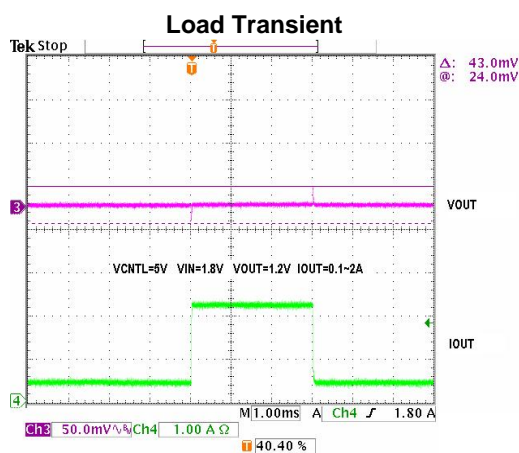
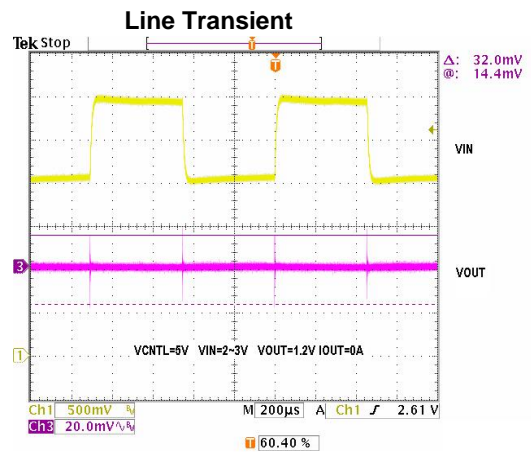
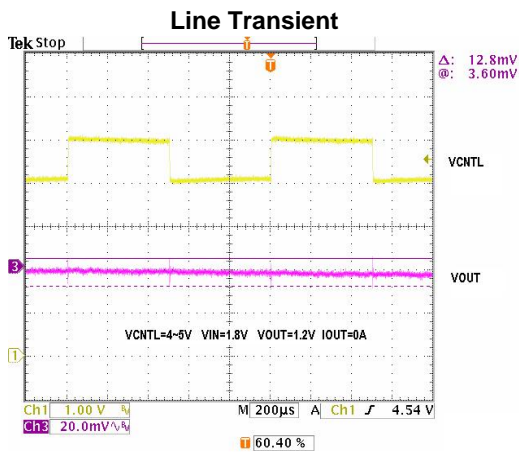
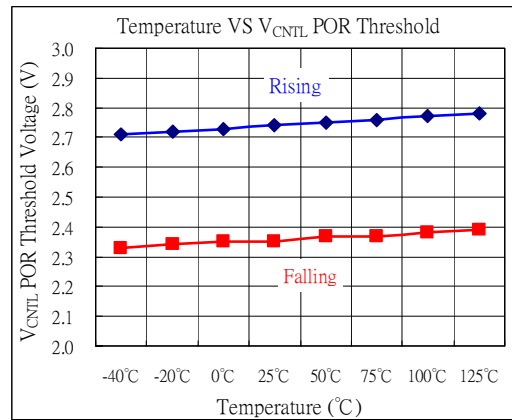
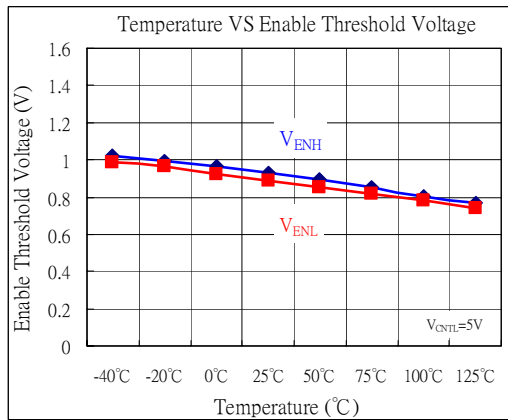


TYPICAL PERFORMANCE CHARACTERISTICS





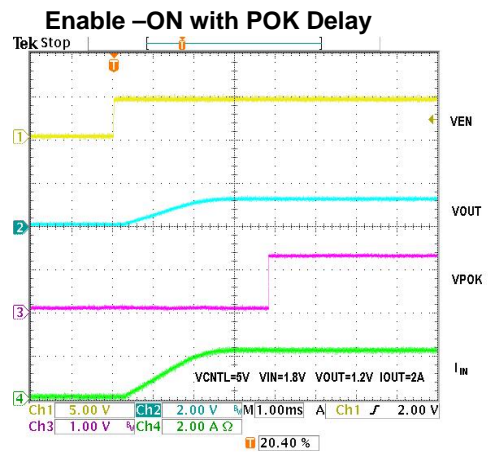
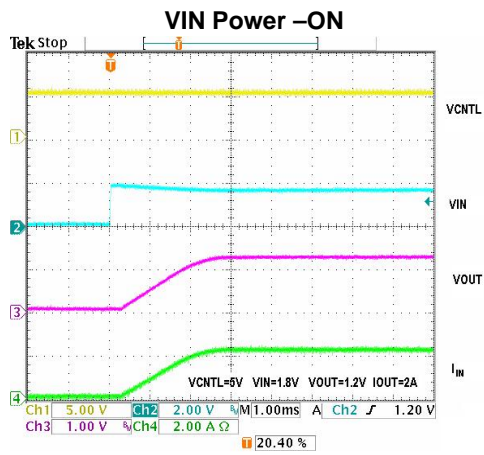
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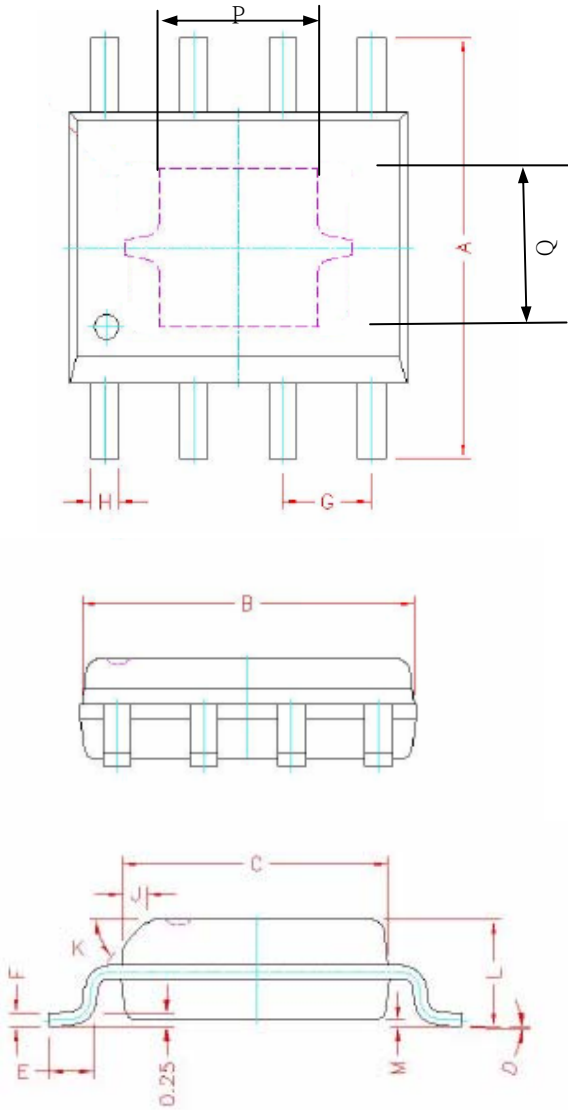


TYPICAL PERFORMANCE CHARACTERISTICS





## Package Outline : ESOP-8

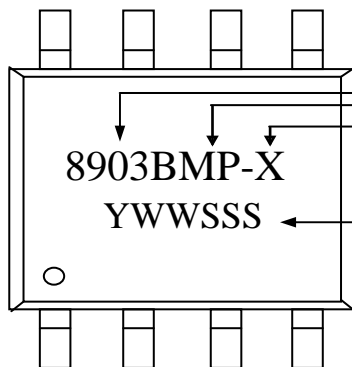


| SYMBOLS | Millimeters |      |      |
|---------|-------------|------|------|
|         | MIN         | NOM  | MAX  |
| A       | 5.80        | 6.00 | 6.20 |
| B       | 4.80        | 4.90 | 5.00 |
| C       | 3.80        | 3.90 | 4.00 |
| D       | 0°          | 4°   | 8°   |
| E       | 0.40        | 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 Dimension Are In Millimeters.

2.Dimension Does Not Include Mold Protrusions.

## Part Marking Information & Packing : ESOP-8



Part Number  
Package Cod  
EN Function

Date Code (YWWSSS)

Y : Last Digit Of The Year

WW : Week

SSS : Sequence