3A Ultra-low Dropout Regulator

Features

- **Ultra-low Dropout of 0.23V (typical) at 3A Output Current**
- **Low ESR Output Capacitor (compatible with Multi-layer Chip Capacitors (MLCC))**
- **Reference Voltage of 0.8V**
- **Fast Transient Response**
- **Adjustable Output Voltage using 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 ESOP-8 Package, with Exposed Pad - halogen-free (HF) option available**

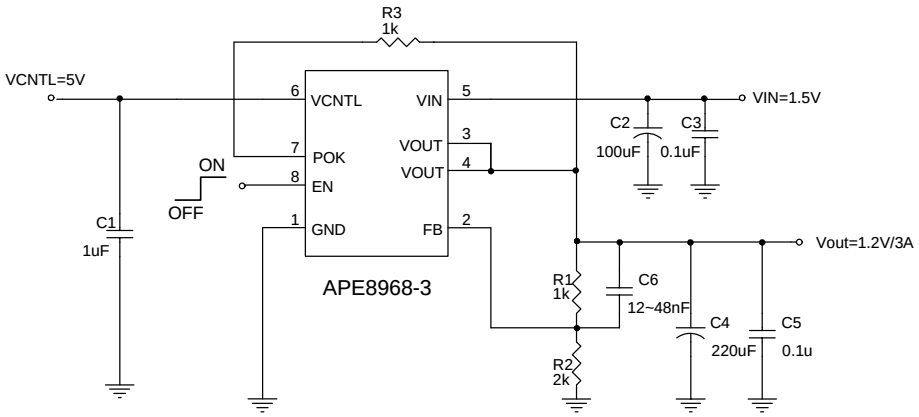
Description

The APE8968-3 is a 3A ultra low dropout linear regulator. This product is specifically designed to provide a 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 APE8968-3 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. It can control another converter for power sequencing. The APE8968 can be also be enabled by other power system. Pulling and holding the EN pin below 0.4V shuts off the output.

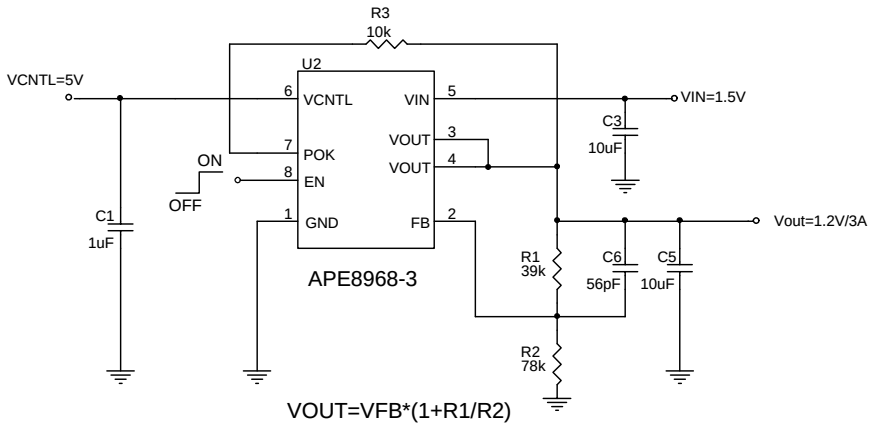
The APE8968-3 is available in an ESOP-8 package which features the small size of SO-8 with an exposed pad to reduce the junction-to-case thermal resistance, making it suitable for 2~3W applications.

Typical Application Circuit

1. Using an Output Capacitor with ESR ≥20mΩ



2. Using an MLCC as the Output Capacitor



VOUT=VFB*(1+R1/R2)
VFB = 0.8V

Absolute Maximum Ratings (at T_A=25°C)

VCNTL Supply Voltage(V_{CNTL})	-0.3V to 7V
VIN Supply Voltage(V_{IN})	-0.3V to 6V
EN and FB Pin Voltage($V_{I/O}$)	-0.3V to V_{CNTL}+0.3V
Power Dissipation(P_D)	3W
Power Good Voltage(V_{POK})	-0.3V to 7V
Storage Temperature Range(T_{ST})	-65°C to +150°C
Junction Temperature Range(T_J)	-40°C To 125°C
Operating Temperature Range (T_{OP})	-40°C to +85°C
Thermal Resistance from Junction to Case(Rth_{JC})	15°C/W
Thermal Resistance from Junction to Ambient(Rth_{JA})	40°C/W

Note: Rth_{JA} is measured with the PCB copper area (connected to the exposed pad) of approximately 1.5 in2 (Multi-layer)

Recommended Operating Conditions

VCNTL Supply Voltage(V_{CNTL})	3V to 5.5V
VIN Supply Voltage(V_{IN})	1.2V to 3.65V
Output Voltage(V_{OUT})	0.8V to V_{IN}-V_{DROP} (V_{CNTL} - V_{OUT} > 1.9V)
Output Current(I_{OUT})	0 to 3A

Ordering Information

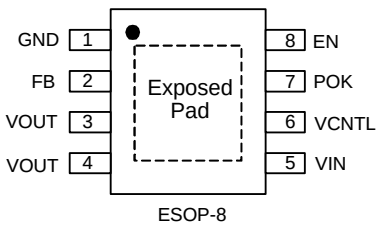
APE8968MP-3TR
APE8968MP-HF-3TR

Package Type
MP : RoHS-compliant ESOP-8
MP-HF : RoHS-compliant halogen-free ESOP-8

Packing TR : Products in ESOP-8 are shipped on tape and reel. The device is rated MSL3 for moisture sensitivity, and the reel is packed in a moisture barrier bag.

Pin Configuration

(Top View)



ESOP-8

Exposed pad is not connected internally.

THIS PRODUCT IS SENSITIVE TO ELECTROSTATIC DISCHARGE, PLEASE HANDLE WITH CAUTION.

USE OF THIS PRODUCT AS A CRITICAL COMPONENT IN LIFE SUPPORT OR OTHER SIMILAR SYSTEMS IS NOT AUTHORIZED.

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Pin Functional Description

FB

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

$$VOUT = 0.8 \times (1 + R1/R2)$$

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 in parallel with R1 to improve load transient response. The recommended R2 and R1 are in the range of 1K~100kΩ.

VIN

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

VCNTL

Power input pin of the control circuitry. Connecting this pin to a (recommended) +5V 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 the 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 left open, this pin is internally pulled up to the VCNTL voltage, enabling the regulator.

VOUT

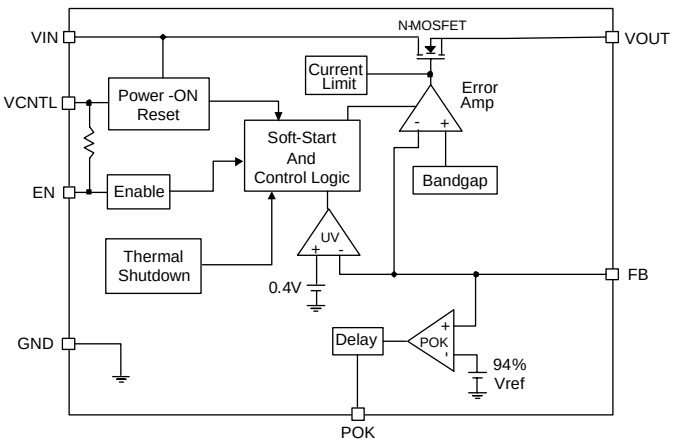
Output of the regulator. Please connect Pin 3 and Pin 4 using wide tracks. It is essential to connect an output capacitor to this pin for closed-loop compensation and to improve the transient response.

Electrical Characteristics

(V_{CNTL} = 5V, V_{IN} = 1.5V, V_{OUT} = 1.2V, T_A=25°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}	-	1	1.8	mA
VCNTL Shuntdown Current	I_{SD}	EN= 0V	-	15	30	uA
Feedback Voltage	V_{FB}	V_{CNTL}=3.0 ~ 5.5V, I_{OUT}=10mA	0.784	0.8	0.816	V
Load Regulation		I_{OUT}=0A ~ 3A	-	0.2	0.5	%
Dropout Voltage	V_{DROP}	1.2V＜V_{OUT}＜1.8V	-	0.23	0.28	V
		1.8V≦V_{OUT}＜2.5V	-	0.24	0.29	
		2.5V≦V_{OUT}≦2.8V	-	0.28	0.38	
VOUT Pull Low Resistance		EN=0V	-	65	-	Ω
Soft Start Time	T_{SS}		-	2	4	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}	V_{CNTL}=3~5.5V	4.3	-	-	A
		T_J= -40 ~ 125°C				
Ripple Rejection VIN	PSRR	F=120Hz, I_{OUT}=100mA	-	65	-	dB
Ripple Rejection VCNTL			-	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	79%	82%	85%	VFB
POK Low Voltage		POK sinks 5mA	-	0.25	0.4	V
POK Delay Time	T_{DELAY}		0.8	2	4	ms
Thermal Shutdown Temp	TSD		-	150	-	°C
Thermal Shutdown Hysteresis			-	50	-	

Block Diagram



Function Descriptions

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.

Current Limit

The APE8968-3 monitors the current via the output NMOSFET and limits the maximum current to prevent damage to the load and the APE8968-3 during overload or short circuit conditions.

Output Voltage Regulation

An error amplifier working with a temperature compensated 0.8V reference and an output NMOSFET regulates 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.

Under Voltage Protection (UVP)

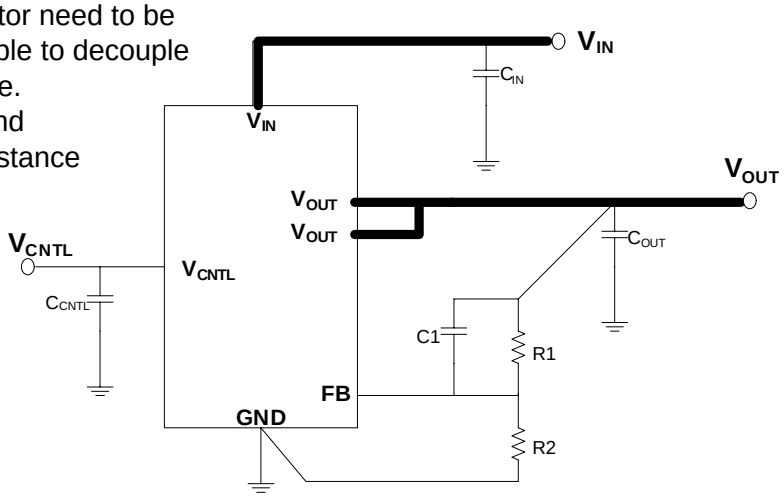
The APE8968-3 monitors the voltage on the FB pin after the soft-start process is finished. Therefore the UVP is disabed during soft-start. When the voltage on FB pin falls below the under-voltage threshold, the UVP circuit shuts off the output immediately. After a while, the APE8968-3 starts a new soft-start to regulate output.

Thermal Shutdown

A thermal shutdown circuit limits the junction temperature of the APE8968-3. 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 through the initiation of a new soft-start cycle after the junction temperature cools by 50°C, resulting in pulsed output during continuous thermal overload conditions.

PCB Layout Consideration

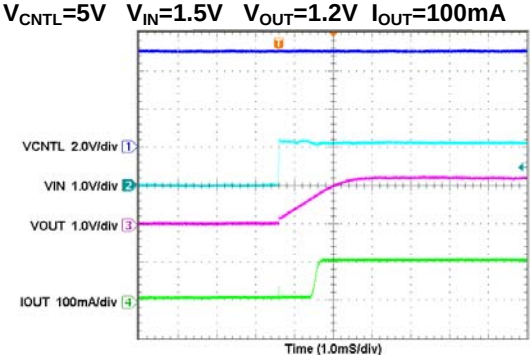
It is necessary to solder the exposed pad to either Vin or the Gnd plane as a heat sink and ensure it has enough pcb copper area to radiate the heat. Input capacitor, output capacitor, voltage divider and bypass capacitor need to be placed as close to the IC as possible to decouple the high frequency ripple and noise. The traces should be kept short and wide to minimize the parasitic resistance and inductance, and the whole application circuit should be as close to the load as possible for excellent load transient response.



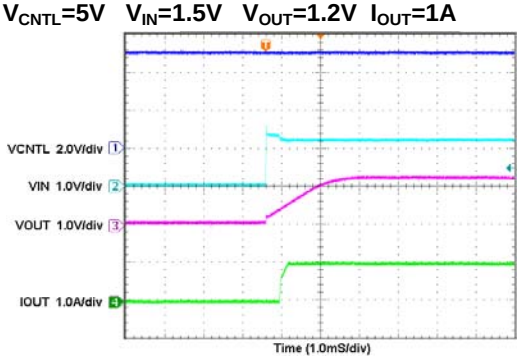
Typical Performance Characteristics

START UP WAVEFORM -1 VCNTL READY

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=100mA

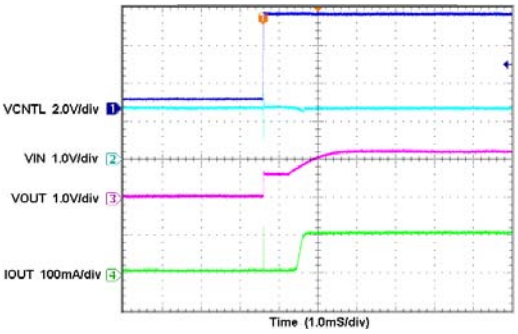


V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=1A

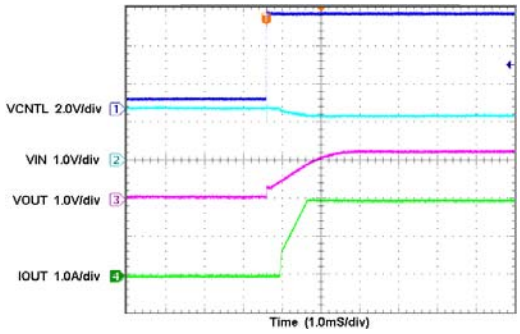


START UP WAVEFORM -2 VIN READY

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=100mA

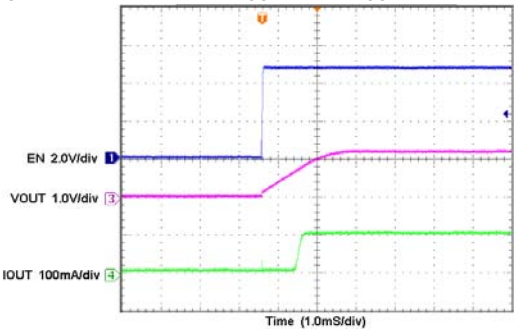


V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=2A

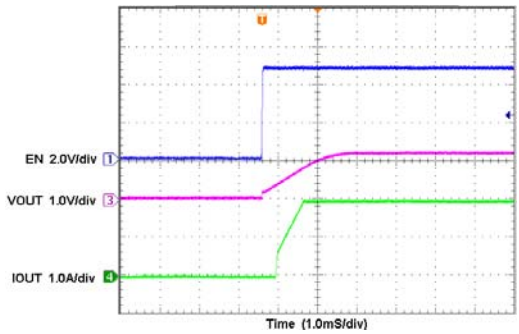


EN OFF → ON

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=100mA



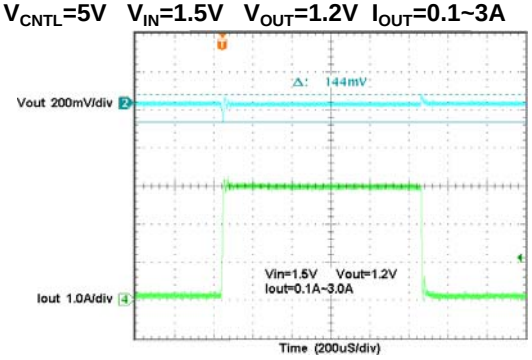
V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=2A



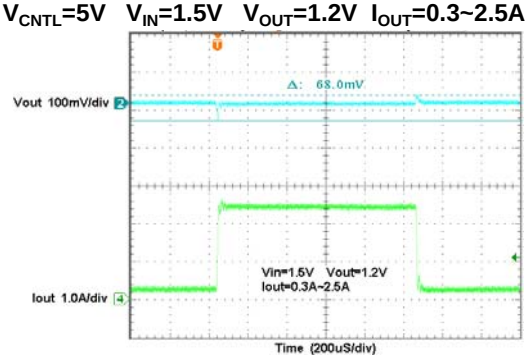
TYPICAL PERFORMANCE CHARACTERISTICS

LOAD TRANSIENT

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=0.1~3A

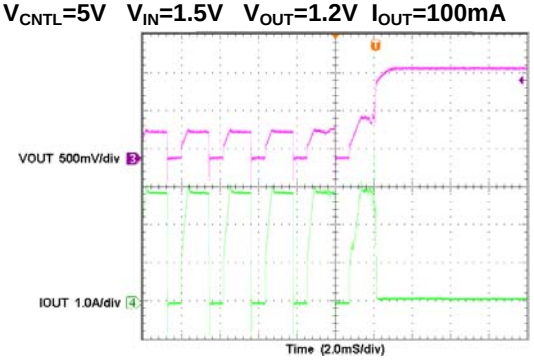


V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=0.3~2.5A

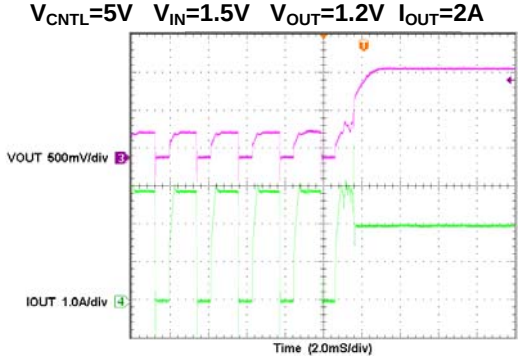


SHORT CIRCUIT RELEASE

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=100mA

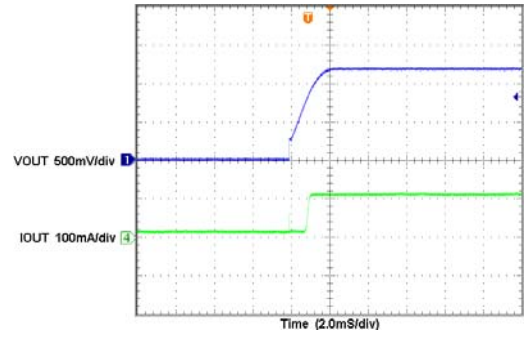


V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=2A

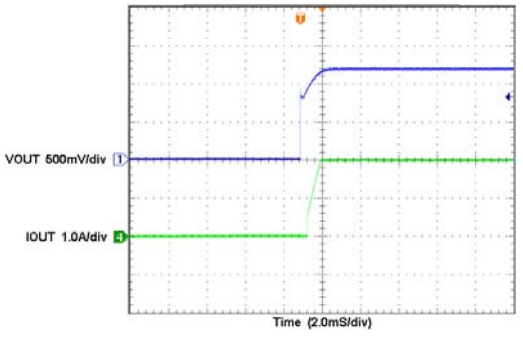


THERMAL SHUT DOWN RELEASE

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=100mA



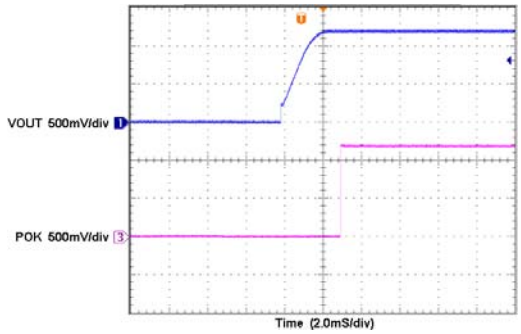
V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=2A



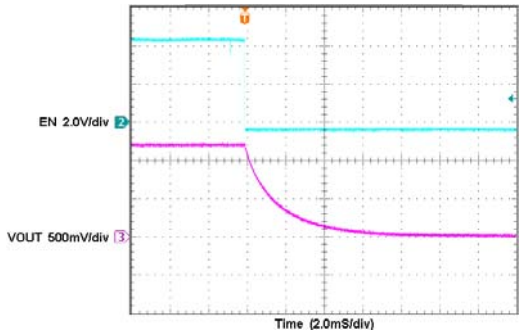
TYPICAL PERFORMANCE CHARACTERISTICS

POK VS. DISABLE

V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=100mA

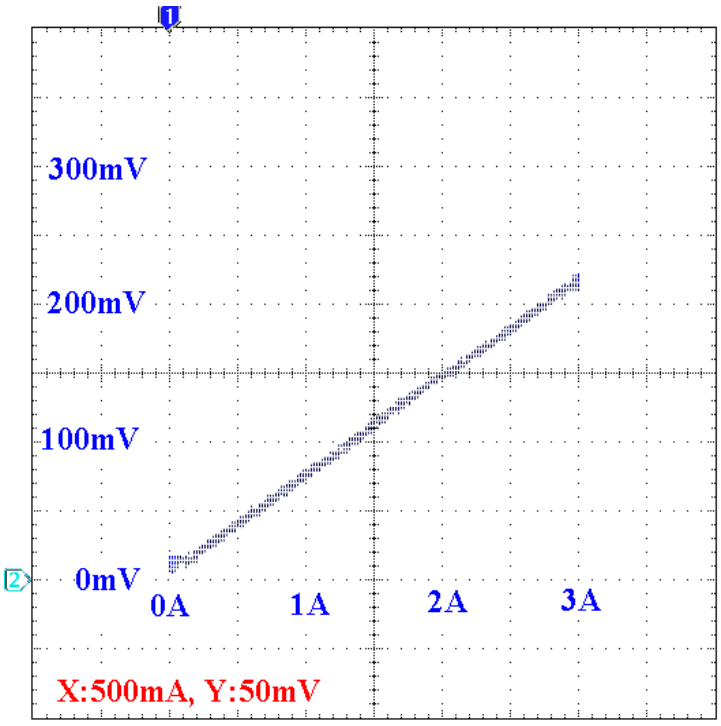


V_{CNTL}=5V V_{IN}=1.5V V_{OUT}=1.2V I_{OUT}=0A

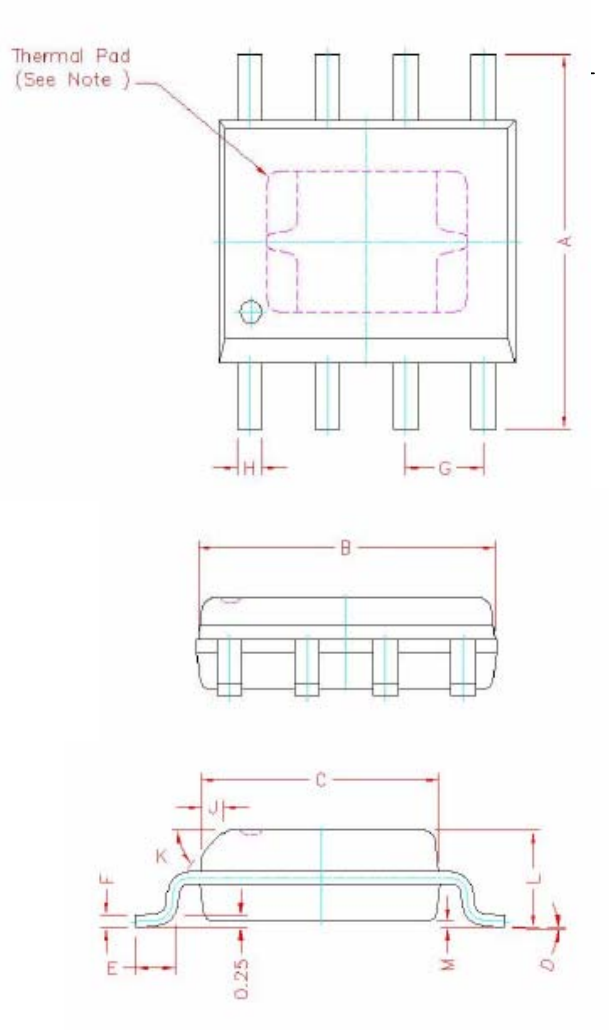


DROPOUT VOLTAGE VS. OUTPUT CURRENT

VCNTL=5V, I_{OUT} = 0mA to 3A



Package Dimensions: ESOP-8



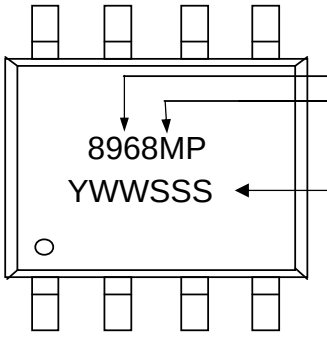
	Millimeters		
SYMBOLS	MIN	NOM	MAX
A	5.80	6.00	6.20
B	4.80	4.90	5.00
C	3.80	3.90	4.00
D	0°	4°	8°
E	0.40	0.65	0.90
F	0.19	0.22	0.25
M	0.00	0.08	0.15
H	0.35	0.42	0.49
L	1.35	1.55	1.75
J	0.375 REF.		
K	45°		
G	1.27 TYP.		

NOTES:

(L/F 90*90) Thermal Pad Dimensions □2.25 ±0.1

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

Marking Information



Product : APE8968

Package code : MP = RoHS-compliant ESOP-8

Date/lot code (YWWSSS)

Y: Last digit of the year

W: Work week

SSS: Lot code sequence

NOTE: For the standard RoHS part, APE8968MP-3, the last character in the lot code is a number.
For the halogen-free option, APE8968MP-HF-3, the last character is a letter.