



### 300mA Low Drop-out Linear Regulator

#### Features

- Low Dropout Voltage of 250mV at 300mA
- Guaranteed 300mA Output Current
- Very Low Quiescent Current of about 30 $\mu$ A
- Output Voltage Accuracy of  $\pm 2\%$  for 1.2V~3.3V
- Needs only 1 $\mu$ F Capacitor for Stability
- Thermal Shutdown Protection
- Current Limit Protection
- Output Voltage Fast Discharge
- Low-ESR Ceramic Capacitor for Output Stability
- SC-70-4, SC-70-5, SOT-23 and SOT-23-5 packages
- RoHS-compliant and Halogen-free
- High PSRR

#### Applications

- DVD/CD-ROM/, CD/RW drives
- Wireless Devices
- LCD Modules
- Battery Power Systems
- Card Readers
- XDSL Routers

#### Description

The APE8865-HF-3 series are low dropout, positive linear regulators with very low quiescent current, and can supply 300mA of output current with a low drop-out voltage of about 250mV.

The APE8865-HF-3 regulator is able to operate with output capacitors as small as 1 $\mu$ F for stability. As well as current limit protection, the APE8865-HF-3 also offers an on-chip thermal shutdown feature providing protection against overload or conditions where the junction temperature exceeds the specified thermal shutdown temperature.

The APE8865-3 is available with fixed output voltages from 1.2V to 3.3V in 100mV increments.

The APE8865-HF-3 series are available in low-profile, space-saving SC-70-4, SC-70-5, SOT-23 and SOT-23-5 packages.

#### Typical Application Circuit

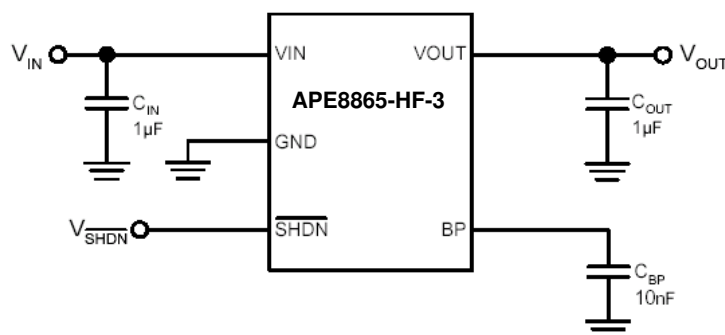


Figure 1. Typical Application Circuit of APE8865-HF-3

Note : If ceramics are used as input or output capacitors, it is recommended that, in order to prevent oscillation, X7R or X5R dielectric capacitors with a minimum value of 1 $\mu$ F are used.

#### Ordering Information

APE8865xx-yy-HF-3TR

Package Type:

N : RoHS-compliant halogen-free SOT-23  
NL : RoHS-compliant halogen-free SOT-23  
NR : RoHS-compliant halogen-free SOT-23  
Y5 : RoHS-compliant halogen-free SOT-23-5  
U4 : RoHS-compliant halogen-free SC-70-4  
U5 : RoHS-compliant halogen-free SC-70-5

Fixed Output Voltage Options

yy = 12 : 1.2V

15 : 1.5V

in 100mV increments through

33 : 3.3V

Packing TR : Products are shipped on tape and reel, 3000pcs/reel.

The device is rated MSL3 for moisture sensitivity, and the reel is packed in a moisture barrier bag.



### Absolute Maximum Ratings (at $T_A=25^{\circ}\text{C}$ )

Input Voltage ( $V_{IN}$ )	6V
SHDN Voltage ( $V_{SHDN}$ )	GND - 0.3V to $V_{IN} + 0.3\text{V}$
Power Dissipation (SOT-23, SOT-23-5)	0.4W
(SC-70-4)	0.23W
(SC-70-5)	0.23W
Storage Temperature Range	$-65^{\circ}\text{C}$ to $+150^{\circ}\text{C}$
Maximum Junction Temperature	$150^{\circ}\text{C}$
Maximum Thermal Resistance, Junction-ambient:	
SOT-23, SOT-23-5	$250^{\circ}\text{C/W}$
SC-70-4/5	$600^{\circ}\text{C/W}$

### Recommended Operating Conditions

Input Voltage ( $V_{IN}$ )	2.8 to 5.5V
Operating Junction Temperature Range ( $T_J$ )	$-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$
Ambient Temperature ( $T_A$ )	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$

### Electrical Specifications

( $V_{IN}=V_{OUT}+1\text{V}$  or  $V_{IN}=2.8\text{V}$  whichever is greater,  $C_{IN}=1\mu\text{F}$ ,  $C_{OUT}=1\mu\text{F}$ ,  $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

Parameter	SYM	TEST CONDITION	MIN	TYP	MAX	UNITS
Output Voltage Accuracy	$\Delta V_{OUT}$	$I_O = 1\text{mA}$	-2	-	2	%
Current Limit	$I_{LIMIT}$	$R_{Load}=1\Omega$	300	-	-	mA
Quiescent Current	$I_Q$	$I_O = 0\text{mA}$	-	30	55	$\mu\text{A}$
Dropout Voltage (Note 1)	$V_{DROP}$	$I_O=300\text{mA}$ $1.2\text{V} < V_{OUT} < 2.0\text{V}$	-	1000	-	mV
		$2.0\text{V} < V_{OUT} < 2.8\text{V}$	-	350	-	
		$2.8\text{V} < V_{OUT} < 3.3\text{V}$	-	250	-	
Line Regulation	$\Delta V_{LINE}$	$I_O=1\text{mA}$ , $V_{IN}=V_{OUT}+1\text{V}$ to 5V	-	1	5	mV
Load Regulation (Note 2)	$\Delta V_{LOAD}$	$I_O=0\text{mA}$ to 300mA	-	6	20	mV
Ripple Rejection	PSRR	$I_O=1\text{mA}$ , $C_{OUT}=1\mu\text{F}$ , $f_{RIPPLE} = 100\text{Hz}$	-	-73	-	dB
		$f_{RIPPLE} = 10\text{kHz}$	-	-50	-	
Temperature Coefficient	TC	$I_{OUT} = 1\text{mA}$ , $V_{IN} = 5\text{V}$	-	50	-	ppm/ $^{\circ}\text{C}$
Thermal Shutdown Temperature	TSD		-	160	-	$^{\circ}\text{C}$
Thermal Shutdown Hysteresis	$\Delta\text{TSD}$		-	25	-	$^{\circ}\text{C}$
Shutdown Pin Current	$I_{SHDN}$		-	-	0.1	$\mu\text{A}$
Shutdown Pin Voltage (ON)	$V_{SHDN(ON)}$		1.4	-	-	V
Shutdown Pin Voltage (OFF)	$V_{SHDN(OFF)}$		-	-	0.4	V
Shutdown Exit Delay Time	$\Delta T$	$C_{BP}=0.1\mu\text{F}$ , $C_{OUT}=1\mu\text{F}$ , $I_{OUT}=30\text{mA}$	-	150	-	$\mu\text{s}$

Note 1 : The dropout voltage is defined as  $V_{IN}-V_{OUT}$ , which is measured when  $V_{OUT}$  drops about 100mV.

Note 2 : Regulation is measured at a constant junction temperature by using 30ms current pulse and load regulation in the load range from 0mA to 300mA.

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

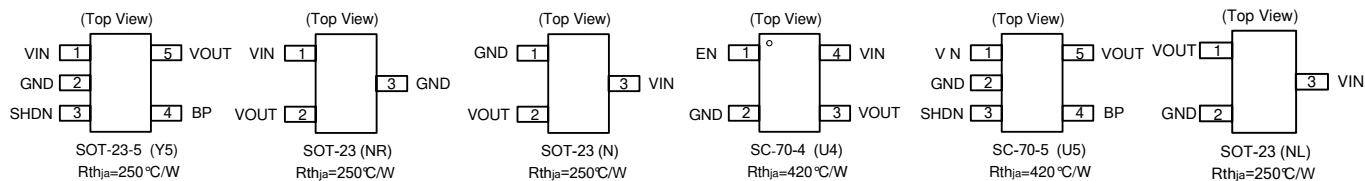
USE OF THIS PRODUCT AS A CRITICAL COMPONENT IN LIFE SUPPORT OR OTHER SIMILAR SYSTEMS IS NOT AUTHORIZED.

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APEC RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN.



## Pin Configuration



## Pin Descriptions

PIN SYMBOL	PIN DESCRIPTION
VIN	Power is supplied to the device through this pin and requires an input filter capacitor. In general, an input capacitor in the range of 1 $\mu$ F to 10 $\mu$ F is sufficient.
VOUT	The output supplies power to loads. The output capacitor is required to provide a stable output voltage. The APE8865-HF-3 is stable with an output capacitor of 1 $\mu$ F or greater. A larger output capacitor will be required for applications with large transient loads to limit peak voltage transients, and can also reduce output noise, improve stability and PSRR.
GND	Common ground pin
BP	Reference-noise bypass (the bypass capacitor should be at least 1nF )
SHDN	Chip-enable (active-high)

## Block Diagram

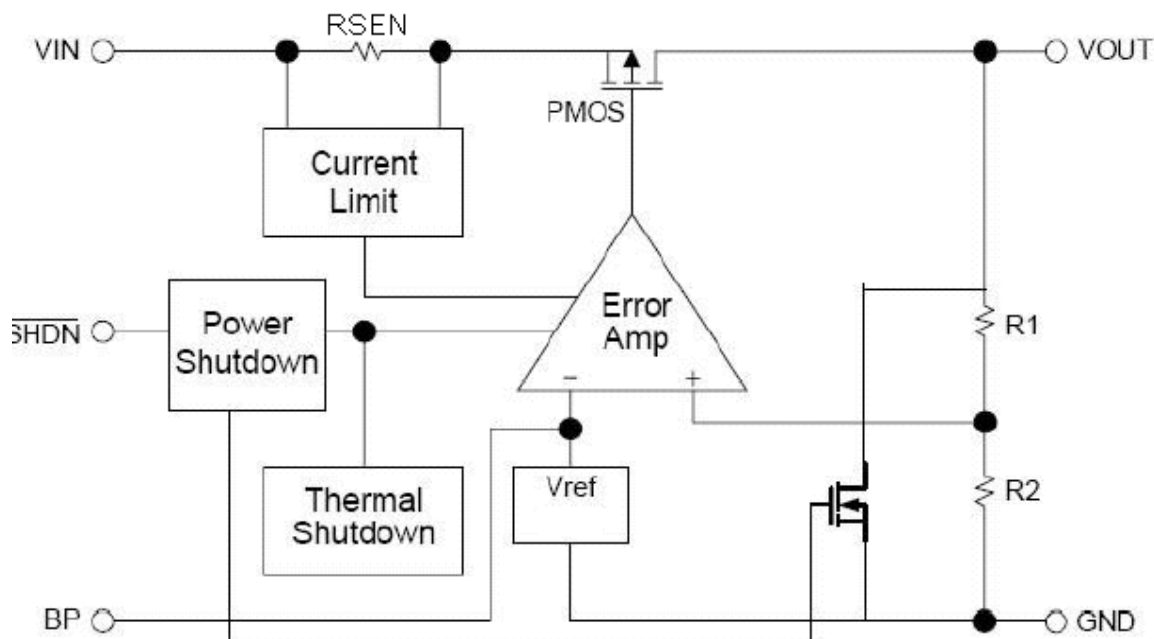


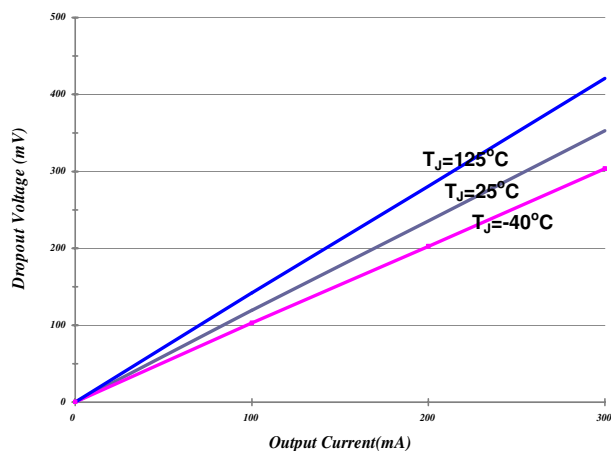
Figure 2. Block diagram of APE8865-3 with auto-discharge



## Typical Performance Characteristics

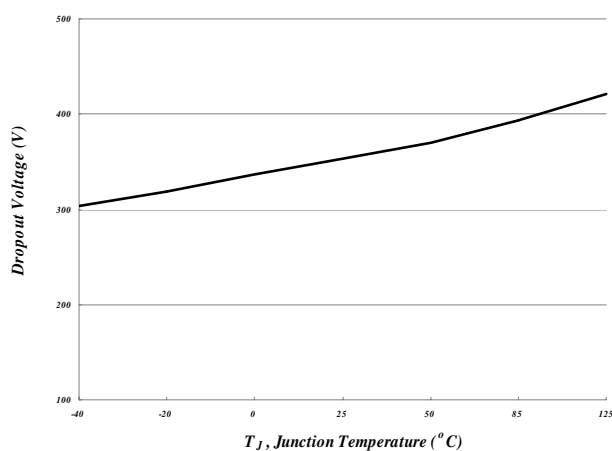
**Fig. 1 Dropout Voltage vs. Output Current**

VIN=4.3V, VOUT=3.3V, IOUT=1~300mA



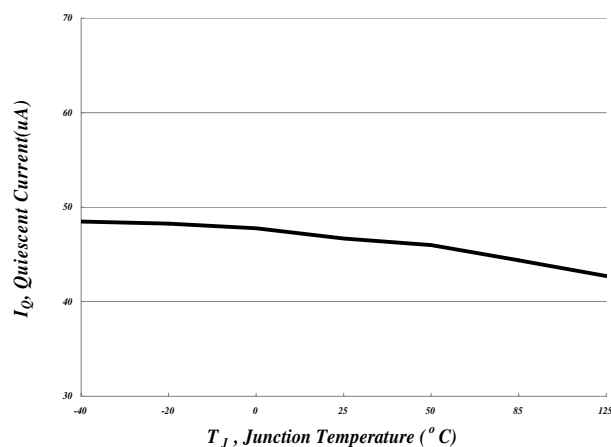
**Fig.2 Dropout Voltage vs. Temperature**

VIN=4.3V, VOUT=3.3V, IOUT=1~300mA



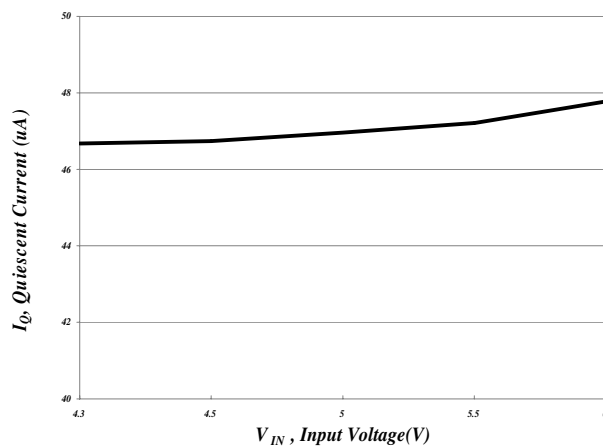
**Fig.3 Quiescent Current vs. Temperature**

VIN=4.3 ~ 6V, VOUT=3.3V



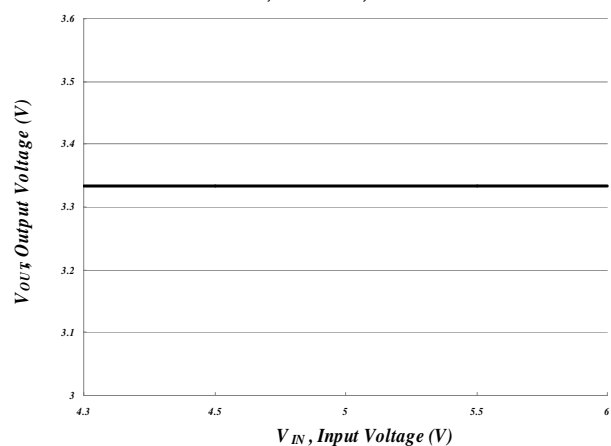
**Fig.4 Quiescent Current vs Input Voltage**

VIN=4.3 ~ 6V, VOUT=3.3V



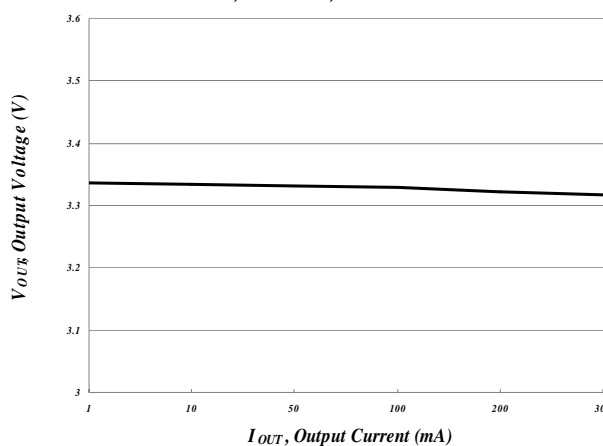
**Fig.5 Line Regulation**

VIN=4.3 ~ 6V, VOUT=3.3V, IOUT=1mA



**Fig.6 Load Regulation**

VIN=4.3V, VOUT=3.3V, IOUT=1 ~ 300mA





### Typical Performance Characteristics (cont.)

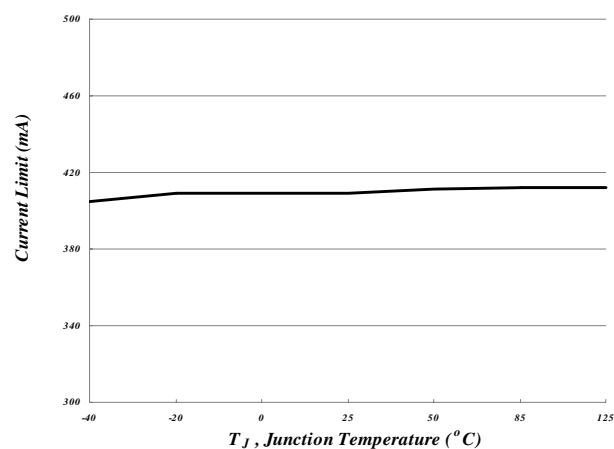
**Fig.7 Load Transient**

VIN=4.3V, VOUT=1.8V, ELOAD=10~300mA



**Fig.8 Current Limit vs. Temperature**

VIN=4.3V, VOUT=3.3V, ELOAD= Short GND



**Fig.9 Power ON**

VIN=4.3V, VOUT=3.3V, ROUT=11Ω



**Fig.10 Power OFF**

VIN=4.3V, VOUT=3.3V, ROUT=11Ω



**Fig.11 Enable ON**

VIN=4.3V, VOUT=3.3V, ROUT=11Ω



**Fig. 12 Enable OFF**

VIN=4.3V, VOUT=3.3V, ROUT=11Ω





### Application Description

The APE8865-3 series are low dropout linear regulators that can provide 300mA output current with a drop-out voltage of about 300mV. Also, current limit and on-chip thermal shutdown features provide protection against any combination of overload or junction temperature that exceeds the shutdown temperature.

#### 1. Output and Input Capacitor

The APE8865-3 regulator is designed to be stable with a wide range of output capacitors. The ESR of the output capacitor affects stability. Larger values of the output capacitor decrease the peak deviations and provide improved transient response for larger current changes.

The various capacitor types (aluminum, ceramic, tantalum) have different characteristics such as temperature and voltage coefficients. All ceramic capacitors are manufactured with a variety of dielectrics, each with different behavior across temperature and applications. Common dielectrics used are X5R, X7R and Y5V. It is recommended to use 1 $\mu$ F X5R or X7R dielectric ceramic capacitors with 30m $\Omega$  to 50m $\Omega$  ESR range between device outputs to ground for transient stability.

The APE8865-3 is designed to be stable with low ESR ceramic capacitors, and higher values of capacitors and ESR can improve output stability.

So the ESR of the output capacitor is very important because it generates a zero to provide phase lead for loop stability.

There are no requirements for the ESR on the input capacitor, but its voltage and temperature coefficient have to be considered for the device application environment.

#### 2. Protection Features

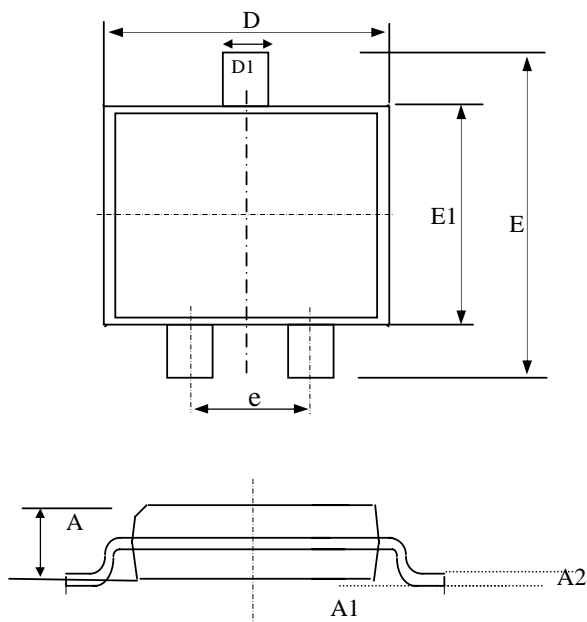
In order to prevent overloading or a thermal condition from damaging the device, the APE8865-3 regulator has internal thermal and current-limiting functions designed to protect the device. It will rapidly shut off the internal P-channel MOSFET pass element during overloading or an over-temperature condition.

#### 3. Thermal Consideration

The power handling capability of the device is limited by the maximum operation junction temperature (125°C). The power dissipated by the device can be estimated by  $PD = I_{OUT} \times (V_{IN} - V_{OUT})$ . This power dissipation must be lower than the maximum power dissipation listed in the "Absolute Maximum Ratings" section.



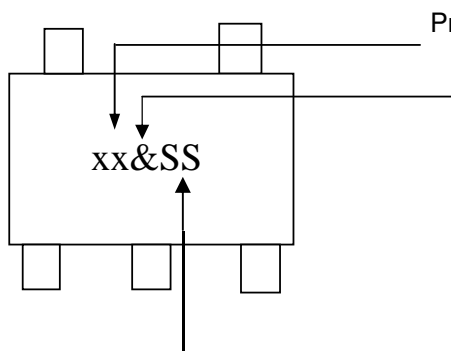
Package Dimensions: SOT-23



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.15	1.30
A1	0.00	--	0.10
A2	0.10	0.15	0.25
D1	0.30	0.40	0.50
e	1.70	2.00	2.30
D	2.70	2.90	3.10
E	2.40	2.65	3.00
E1	1.40	1.50	1.60

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

Marking Information



Product: RL = APE8865N-HF-3, RI = APE8865NR-HF-3  
rl = APE8865NL-HF-3

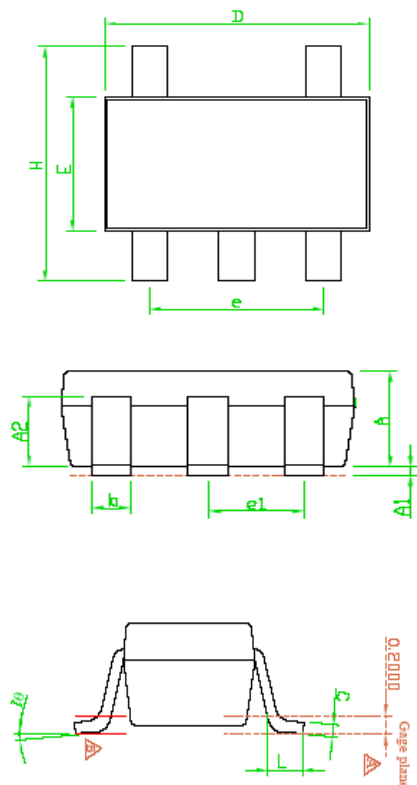
Fixed output voltage - see table below:

V <sub>OUT</sub>	Identification Code	V <sub>OUT</sub>	Identification Code
1.2V	2	2.4V	T
1.5V	5	2.5V	F
1.6V	S	2.6V	f
1.7V	X	2.7V	D
1.8V	A	2.8V	E
1.9V	a	2.9V	h
2.0V	e	3.0V	H
2.1V	B	3.1V	x
2.2V	C	3.2V	U
2.3V	v	3.3V	I

SS = Date/lot code  
For details on translating this  
code to YYWW, please  
contact APEC USA



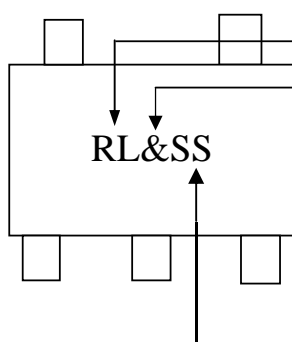
Package Dimensions: SOT-23-5



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A1	0.00	---	0.10
A2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.50	1.60	1.80
e	---	1.90(TYP)	---
H	2.60	2.80	3.00
L	0.37	---	---
$\theta 1$	1°	5°	9°
e2	---	0.95(TYP)	---

- Note 1: Dimensions exclude mold flash protrusions or gate burrs.  
Note 2: Tolerance  $\pm 0.1000$  mm (4mil) unless otherwise specified.  
Note 3: Coplanarity : 0.1000 mm  
Note 4: Dimension L is measured in gage plane.

Marking Information



SS = Date/lot code  
For details on translating this  
code to YYWW, please  
contact APEC USA

Product: RL = APE8865

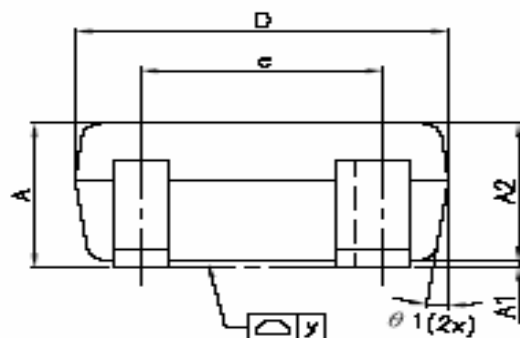
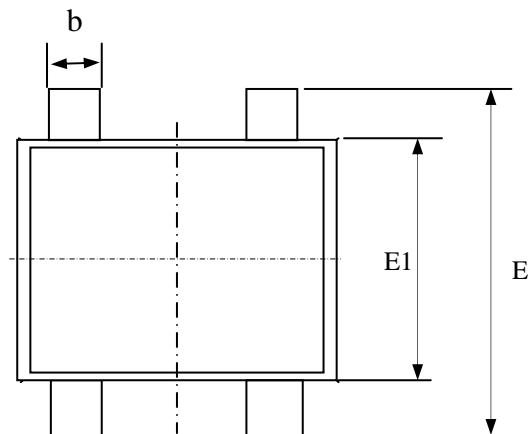
Fixed output voltage - see table below:

V <sub>OUT</sub>	Identification Code	V <sub>OUT</sub>	Identification Code
1.2V	2	2.4V	T
1.5V	5	2.5V	F
1.6V	S	2.6V	f
1.7V	X	2.7V	D
1.8V	A	2.8V	E
1.9V	a	2.9V	h
2.0V	e	3.0V	H
2.1V	B	3.1V	x
2.2V	C	3.2V	U
2.3V	v	3.3V	I

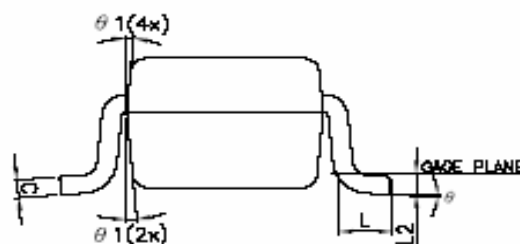




Package Dimensions: SC-70-4

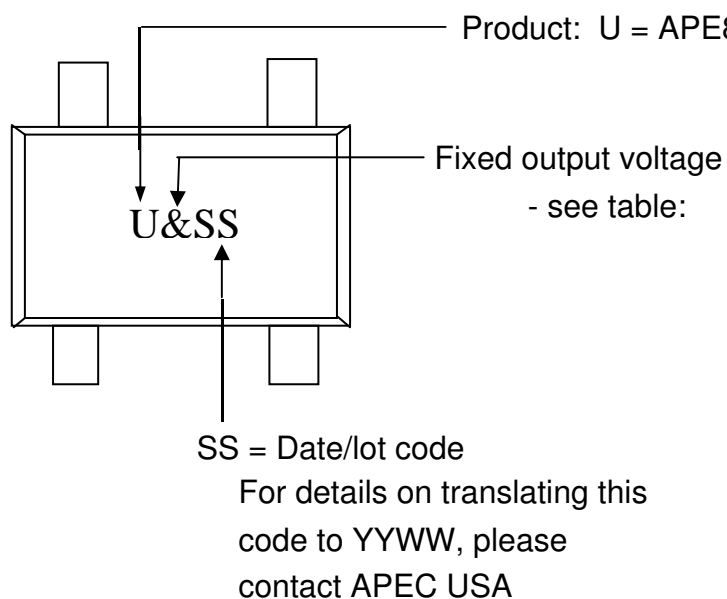


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	0.80	—	1.10
A1	0.00	—	0.10
A2	0.70	0.90	1.00
b	0.25	0.30	0.40
C	0.10	—	0.26
D	1.80	2.00	2.20
E1	1.15	1.25	1.35
E	1.80	2.10	2.40
e	—	1.30	—
L	0.15	0.30	0.45
L2	—	0.15	—
y	—	—	0.10
$\theta$	0°	—	8°
$\theta 1$	4°	—	12°



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

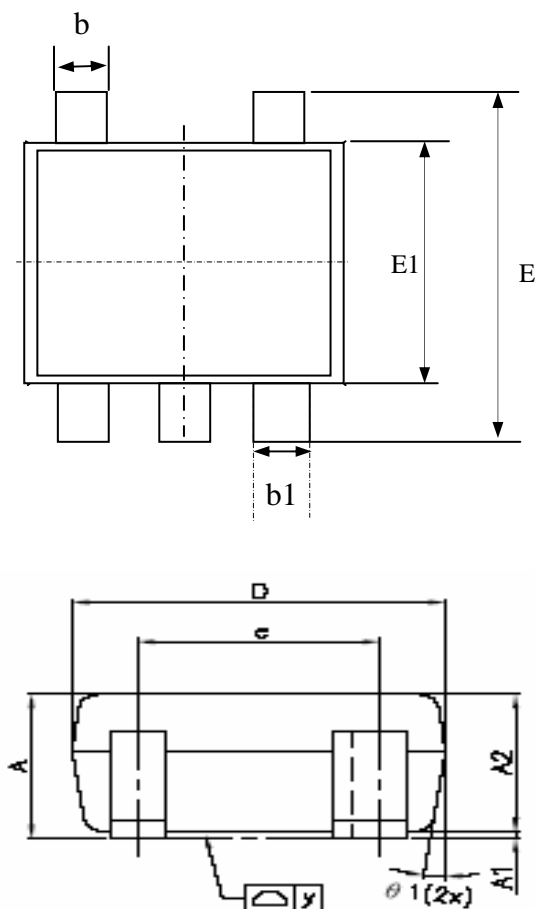
Marking Information



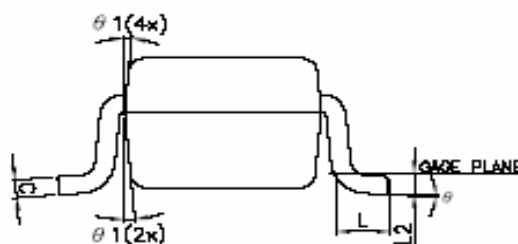
V <sub>OUT</sub>	Identification Code	V <sub>OUT</sub>	Identification Code
1.2V	B	2.4V	T
1.5V	C	2.5V	F
1.6V	S	2.6V	f
1.7V	X	2.7V	w
1.8V	D	2.8V	G
1.9V	a	2.9V	h
2.0V	e	3.0V	H
2.1V	b	3.1V	x
2.2V	O	3.2V	U
2.3V	v	3.3V	I



Package Dimensions: SC70-5

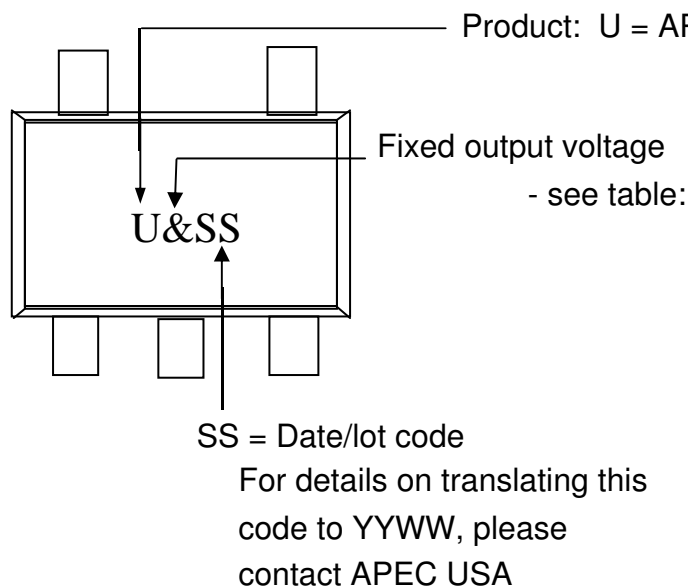


SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	0.80	—	1.10
A1	0.00	—	0.10
A2	0.70	0.90	1.00
b	0.25	0.30	0.40
b1	—	0.38	—
C	0.10	—	0.26
D	1.80	2.00	2.20
E1	1.15	1.25	1.35
E	1.80	2.10	2.40
e	—	1.30	—
L	0.15	0.30	0.45
L2	—	0.15	—
y	—	—	0.10
θ	0°	—	8°
θ1	4°	—	12°



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

Marking Information



V <sub>OUT</sub>	Identification Code	V <sub>OUT</sub>	Identification Code
1.2V	B	2.4V	T
1.5V	C	2.5V	F
1.6V	S	2.6V	f
1.7V	X	2.7V	w
1.8V	D	2.8V	G
1.9V	a	2.9V	h
2.0V	e	3.0V	H
2.1V	b	3.1V	x
2.2V	O	3.2V	U
2.3V	v	3.3V	I