1.5A HIGH OUTPUT CURRENT LDO REGULATOR

FEATURES

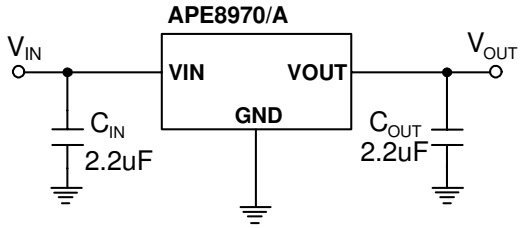
- **Input Voltage：2.6V to 5.5V**
- **Dropout Voltage is 450mV at 1.5A Output Current @ V_{OUT} = 3.30V**
- **Guaranteed 1.5A Output Current**
- **Low Quiescent Current is 50μA (Typ.)**
- **Fixed Output Voltage is form 1.2 V to 5V by 0.1V Steps.**
- **Fast Transient Response**
- **Current Limit and Thermal Shutdown Protection**
- **Short Circuit Current Fold-back**
- **Available in the 3-Pin Pb-Free SOT-223, TO-263, TO-252, SOT-89 and SO-8 Packages**

DESCRIPTIOON

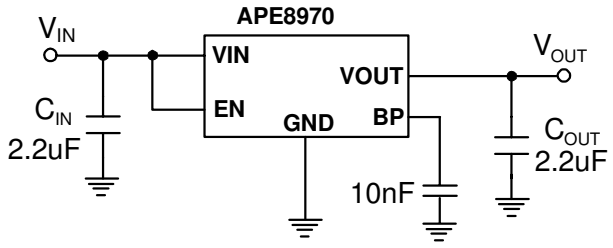
The APE8970/A is a low noise, high output current, low quiescent current and low dropout linear regulator. The Device includes pass element, error amplifier, band-gap, current-limit and thermal shutdown circuitry. The output current is up to 1.5A. The characteristics of low dropout voltage and less quiescent current make it good for some critical current application, for example, some battery powered devices. The typical quiescent current is approximately 50 μ A. Due to internal flexible design; result in extensively fixed output voltage versions form 1.2V to 5V per 0.1V steps. Built-in current-limit, Short current protection and thermal-shutdown functions prevent any fault condition from IC damage.

TYPICAL APPLICATION

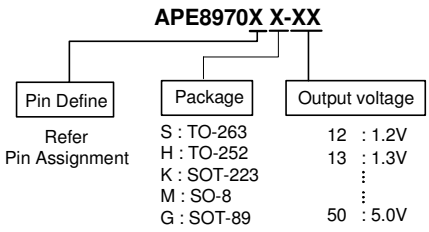
1. For SOT-223/TO-252/TO-263/SOT-89 packages



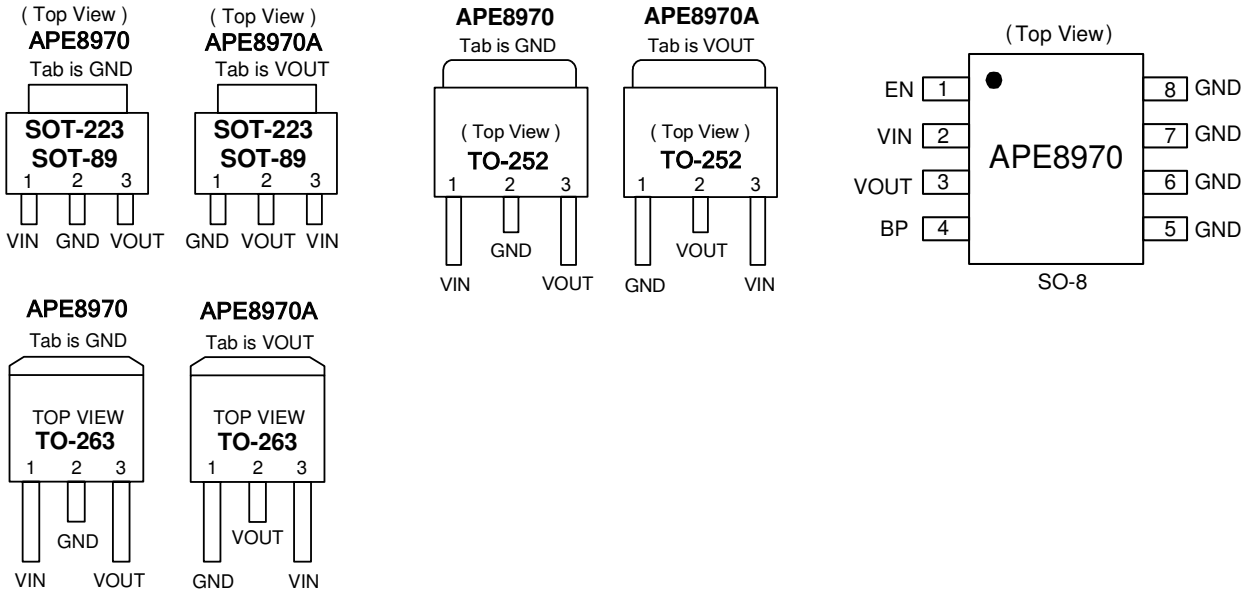
2. For SO-8 package



ORDERING INFORMATION



PACKAGE INFORMATION



ABSOLUTE MAXIMUM RATINGS (at T_A=25°C)

VIN Pin Voltage (V_{IN}) ---------- GND - 0.3V to GND + 6.5V
OUTPUT Pin Voltage (V_{OUT}) ---------- GND - 0.3V to VIN + 0.3V
EN and BP Pin Voltage (V_{EN}/V_{BP}) ---------- GND - 0.3V to VIN + 0.3V
Power Dissipation (P_D)
SOT-223------- 1.3W
TO-252--------- 2.2W
TO-263--------- 4W
SO-8---------- 1.4W
SOT-89-------- 0.6W
Storage Temperature Range (T_{ST}) ---------- -40 to +150℃
Operating Temperature Range (T_{OP}) ---------- -40 to +85℃
Junction Temperature Range (T_J) ---------- -40 to +125℃
Thermal Resistance from Junction to Ambient (R_{thja})
SOT-223------- 75℃/W
TO-252--------- 45℃/W
TO-263--------- 25℃/W
SO-8---------- 70℃/W
SOT-89-------- 160℃/W
Thermal Resistance from Junction to Case (R_{thjc})
SOT-223------- 15°C/W
TO-252--------- 10°C/W
TO-263--------- 3.5°C/W
SO-8---------- 25°C/W
SOT-89-------- 100℃/W

Note1 : R_{thJA} is measured with the PCB copper area of approximately 1 in^2(Multi-layer). That need connect to tap pin.

ELECTRICAL SPECIFICATIONS (T_A=25°C, unless otherwise specified)

Parameter	SYM	TEST CONDITION		MIN	TYP	MAX	UNITS
Input Voltage	V_{IN}	I_{OUT}=30mA		2.6	-	5.5	V
Output Voltage Accuracy **(Note1)**	ΔV_{OUT}	$V_{IN}=V_{OUT}$+0.1V to 5.5V		-2	-	2	%
		$V_{OUT}\geqq$2.5V, I_{OUT}=1mA					
		V_{IN}=2.6V to 5.5V		-3	-	3	
		2.5V$>V_{OUT}\geqq$1.20V, I_{OUT}=1mA					
Quiescent Current	I_Q	I_{OUT} =0mA, V_{IN}=5V		-	50	80	μA
Shutdown Current	I_{SD}	I_{OUT} =0mA, V_{EN}=0V		-	-	2	μA
Dropout Voltage	V_{DROP}	I_{OUT}=1.5A	V_{OUT}=1.20V	-	1.3	1.7	V
			V_{OUT}=1.50V	-	1	1.4	
			V_{OUT}=1.80V	-	0.7	1.1	
			V_{OUT}=2.50V	-	0.55	0.75	
			V_{OUT}=3.30V	-	0.45	0.65	
Current Limit **(Note 2)**	I_{LIMIT}			1.6	2	-	A
Short Circuit Current	I_{SHORT}	Output Voltage < 0.25*V_{OUT}		-	600	-	mA
Load Regulation **(Note 3)**	ΔVLOAD	I_{OUT} =10m~1.5A	2.0V$>V_{OUT}$	-	10	20	mV
			2.0V$\leqq V_{OUT}$	-	0.5	1	%
Ripple Rejection	PSRR	C_{IN}=2.2uF, C_O=2.2uF, I_{OUT} =10mA	F=120Hz	-	65	-	dB
			F=1KHz	-	60	-	
Enable Input Threshold (SO-8 only)	V_{ENH}	Regulator Enable		2	-	-	V
	V_{ENL}	Regulator Shutdown		-	-	0.6	
Enable Pin Current (SO-8 only)	I_{ENH}	$V_{EN}=V_{IN}$		-	0.003	0.1	μA
	I_{ENL}	V_{EN}=0V		-	1	1.5	
Temperature Shutdown	T_S			-	150	-	ºC
Temperature Shutdown Hysterisis	T_{SH}			-	30	-	ºC

Note1: Minimum VIN voltage is defined by output adds a dropout voltage.

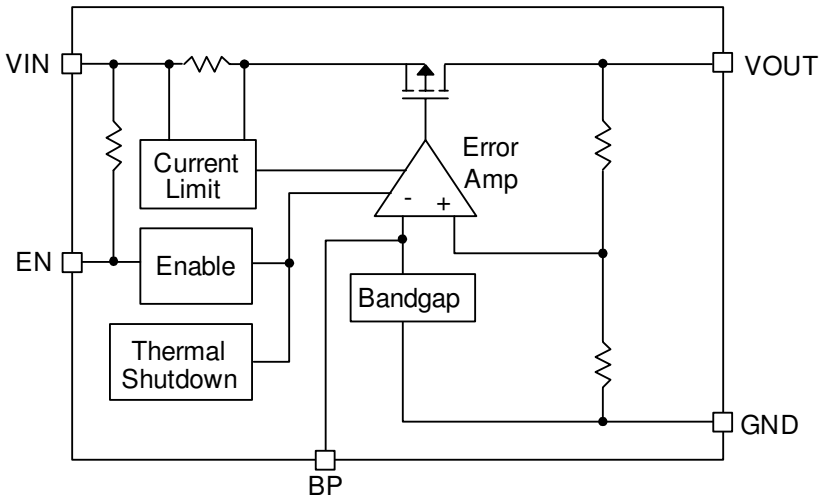
Note2: Current limit is measured at constant junction temperature by using pulsed testing with a low ON time.

Note3: Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.

PIN DESCRIPTIONS

PIN SYMBOL	PIN DESCRIPTION
EN	Active-Low Shutdown Input. A logic low reduces the supply current to less than 2μA. Connect to VIN or Floating for normal operation. (SO-8 only)
VOUT	Output Voltage
VIN	Input Voltage
BP	Band-gap (SO-8 only)
GND	Ground

BLOCK DIAGRAM



FUNCTION DESCRIPTIONS

A minimum of 2.2µF capacitor must be connected from V_{OUT} to ground to insure stability. Typically a large storage capacitor is connected from V_{IN} to ground to ensure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be dropout voltage higher than V_{OUT} in order for the device to regulate properly.

APPLICATION INFORMATION

Like any low-dropout regulator, the APE8970/A requires input and output decoupling capacitors. The device is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance. Please note that linear regulators with a low dropout voltage have high internal loop gains which require care in guarding against oscillation caused by insufficient decoupling capacitance.

Capacitor Selection

Normally, use a 2.2µF capacitor on the input and a 2.2µF capacitor on the output of the APE8970/A. Larger input capacitor values and lower ESR (X5R, X7R) provide better supply-noise rejection and transient response. A higher- value output capacitor (4.7µF) may be necessary if large, fast transients are anticipated and the device is located several inches from the power source.

Input-Output (Dropout) Voltage

A regulator's minimum input-to-output voltage differential (dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. Because the device uses a PMOS, its dropout voltage is a function of drain-to source on-resistance, $R_{DS(ON)}$, multiplied by the load current:

$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

Current Limit and Short-Circuit Protection

The APE8970/A used a current sense-resistor to monitor the output current. A portion of the PMOS output transistor's current is mirrored to a resistor such that the voltage across this resistor is proportional to the output current. Once the output current exceeds limit threshold, APE8970/A would be protected with a limited output current. Further more, when the output is short to ground, the output current would be folded-back to a less limit.

Thermal Considerations

The APE8970/A series can deliver a current of up to 1.5A over the full operating junction temperature range. However, the maximum output current must be dated at higher ambient temperature to ensure the junction temperature does not exceed 125 °C. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

$$P_D = (V_{IN} - V_{OUT})\ I_{OUT}$$

The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

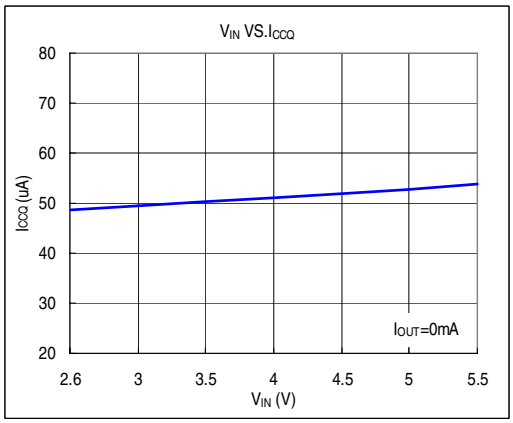
$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / R_{thJA}$$

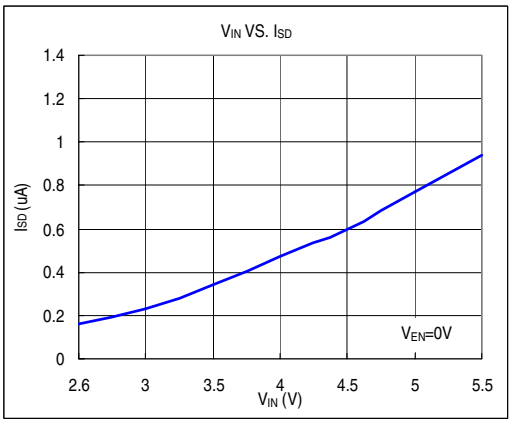
Where $T_{J(MAX)}$ is the maximum junction temperature of the die (125 °C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (R_{thJA}) for SOT-223 package at recommended minimum footprint is 75°C/W (please refer Maximum rating table) that is connected 1 in^2 PCB copper area to tap pin.

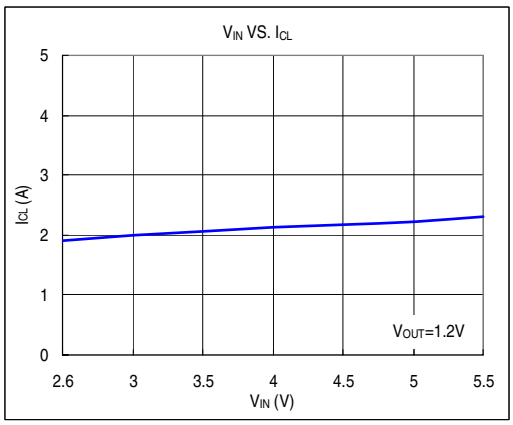
PCB Layout

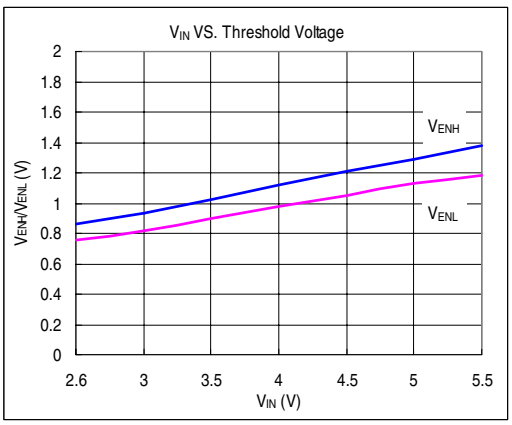
An input capacitance of $\simeq$ 2.2µF is required between the APE8970/A input pin and ground (the amount of the capacitance may be increased without limit), this capacitor must be located a distance of not more than 1cm from the input and return to a clean analog ground. Input capacitor can filter out the input voltage spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire. Otherwise, the actual voltage at the VIN pin may exceed the absolute maximum rating. The output capacitor also must be located a distance of not more than 1cm from output to a clean analog ground. Because it can filter out the output spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire.

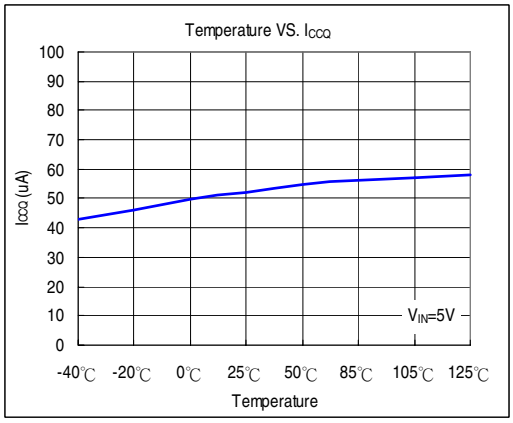
TYPICAL PERFORMANCE CHARACTERISTICS

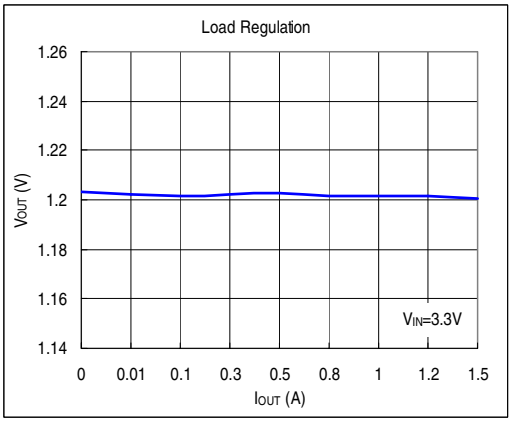




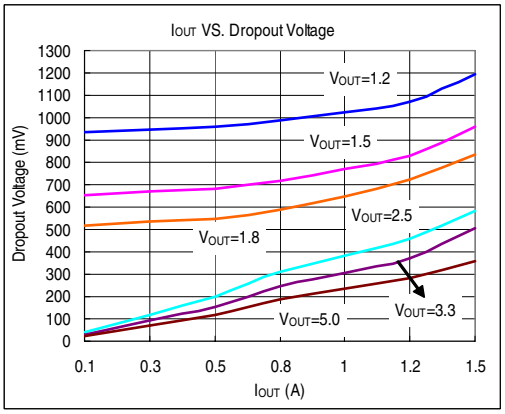




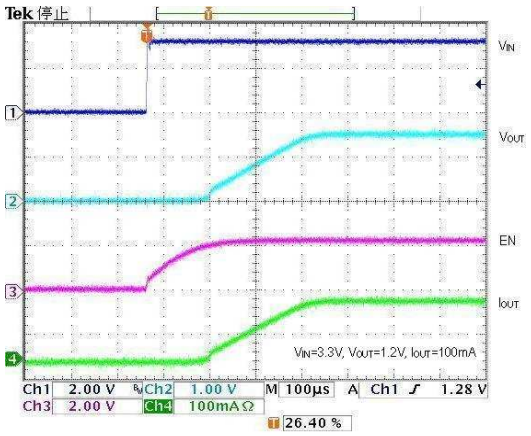




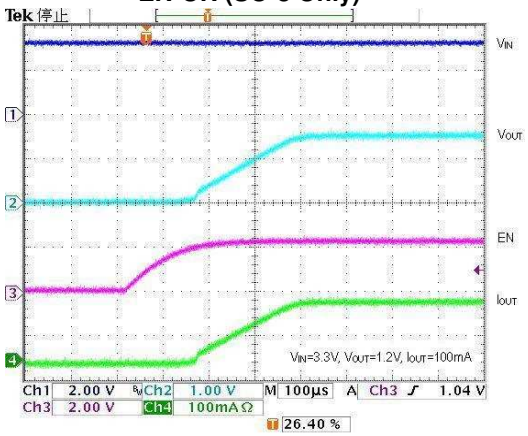
TYPICAL PERFORMANCE CHARACTERISTICS



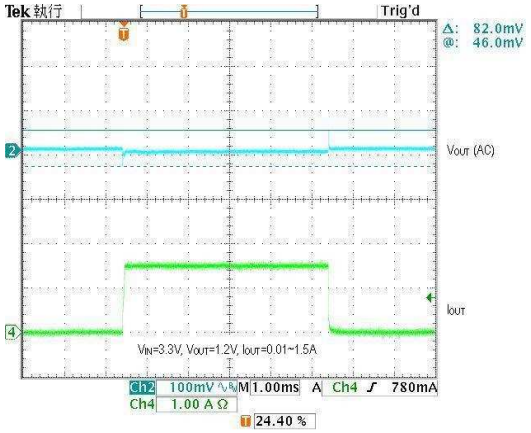
Power-ON



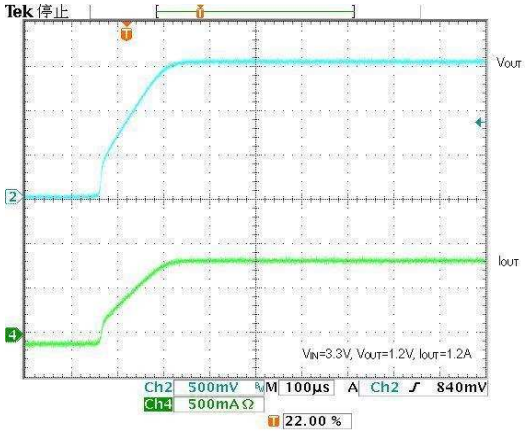
EN-ON (SO-8 Only)



Load Transient

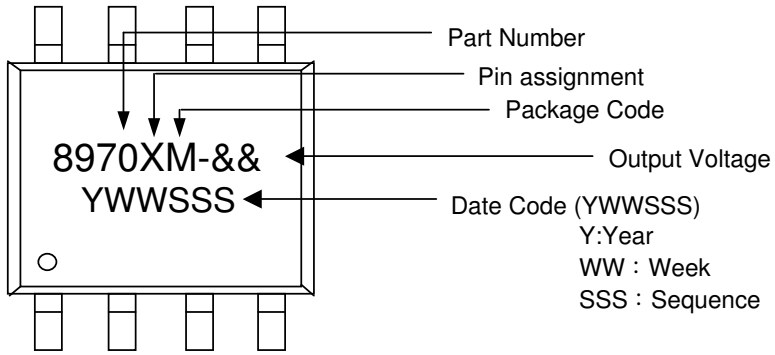


Thermal Shutdown Release

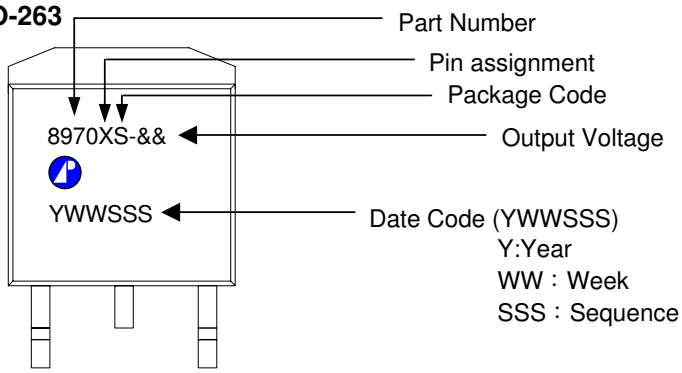


MARKING INFORMATION

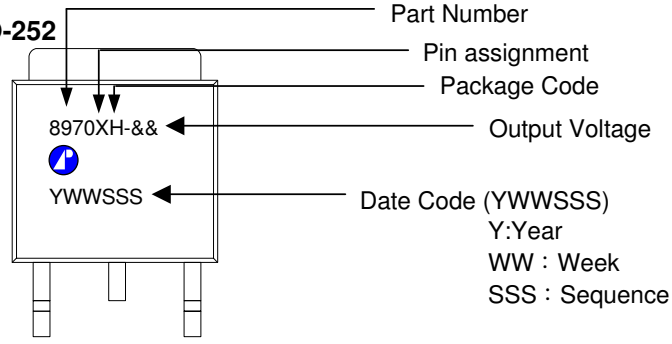
SO-8



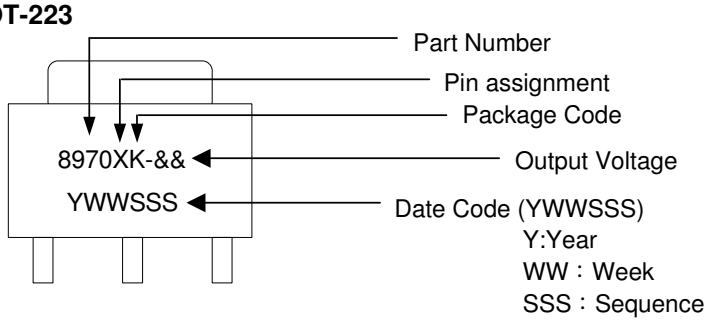
TO-263



TO-252

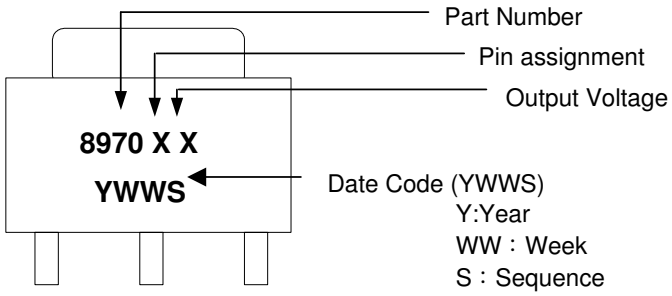


SOT-223



MARKING INFORMATION

SOT-89



V_{OUT}	Identification Code	V_{OUT}	Identification Code	V_{OUT}	Identification Code
1.2V	B	2.5V	F	3.8V	l
1.3V	n	2.6V	f	3.9V	e
1.4V	t	2.7V	w	4.0V	L
1.5V	C	2.8V	G	4.1V	V
1.6V	S	2.9V	h	4.2V	r
1.7V	X	3.0V	H	4.3V	R
1.8V	D	3.1V	x	4.4V	W
1.9V	a	3.2V	U	4.5V	M
2.0V	E	3.3V	I	4.6V	u
2.1V	b	3.4V	j	4.7V	y
2.2V	O	3.5V	N	4.8V	Z
2.3V	v	3.6V	K	4.9V	z
2.4V	T	3.7V	Y	5.0V	J