Ultra-Low Quiescent Current Voltage Detector

Features

- **Ultra-Low Quiescent Current 1.0 μA (Typ.)**
- **High Accuracy of Detection Voltage ±2%**
- **Hysteresis Width 5% V_{DET} (Typ.)**
- **Detection Voltage 1.6V to 6.0V (0.1V Step)**
- **Operating Voltage Range 1.5V to 6.0V**
- **N-ch Open Drain and CMOS Output**
- **SOT-23, SC-82 and SC-70 Packages**
- **RoHS Compliant and 100% Lead (Pb)-Free and Green (Halogen Free with Commercial Standard)**

General Description

The AP8821 series are highly accurate, ultra-low current consumption voltage detectors, developed by CMOS process. Two output forms N-channel open-drain and CMOS output are available. The device is ideal for battery powered portable devices which require low current consumption.

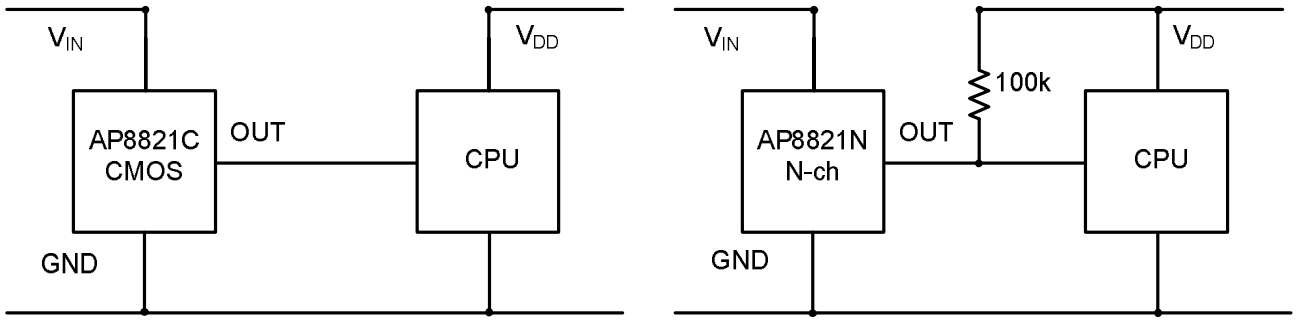
The AP8821 consists of a comparator, a voltage reference unit, a resistor divider, an output driver, and a hysteresis circuit. The detection voltage is fixed internally with ±2.0% accuracy by advanced trimming technology.

The devices are available in SOT-23,SC-82 and SC-70 packages.

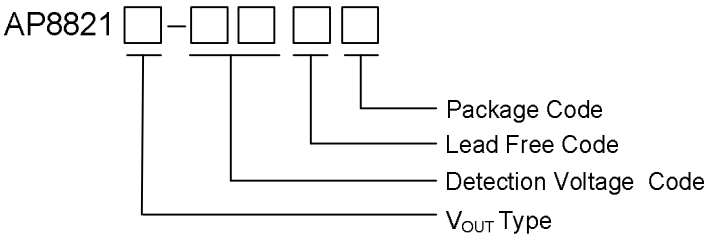
Applications

- Microprocessor Reset Circuitry
- Memory Battery Back-up Circuits
- Power-on Reset Circuits
- Power Failure Detection
- System Battery Life and Charge Voltage Monitors

Typical Application Circuit



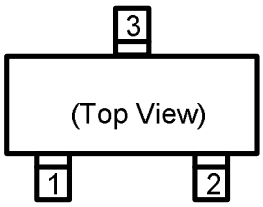
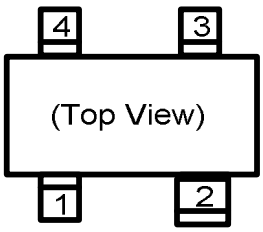
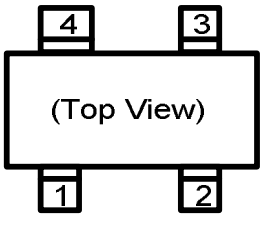
Ordering Information

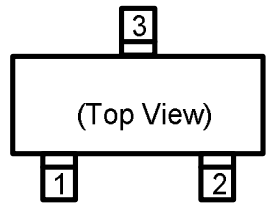


Vout Type：
N：N-ch open drain
C：CMOS
Detection Voltage Code：
Ex：**16**=1.6V、**17**=1.7V、**18**=1.8V…
Lead Free Code：
P：Commercial Standard, Lead (Pb) Free And Phosphorous (P) Free Package
G：Green (Halogen Free with Commercial Standard)
Package Code：
C：SOT-23 **I**：SC-82*
S：SC-82* **T**：SC-70

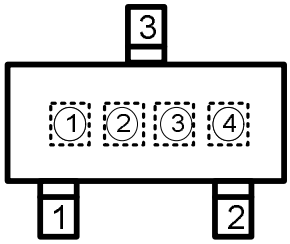
Note：
* The difference between “I” & “S” type, please refer ”Pin Description”.

Pin Description

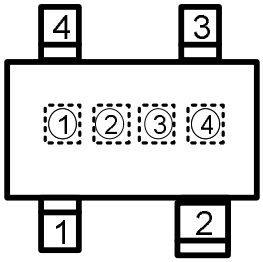
Part NO.	Part NO.	Pin	Symbol	Pin Description
 SOT-23	AP8821C/N-XXXC	1	V_{OUT}	Regulator Output Pin.
		2	GND	Ground Pin.
		3	V_{IN}	Regulator Input Pin.
 SC-82	AP8821C/N-XXXI	1	V_{OUT}	Regulator Output Pin.
		2	V_{IN}	Regulator Input Pin.
		3	NC	No Connect
		4	GND	Ground Pin.
 SC-82	AP8821C/N-XXXS	1	V_{OUT}	Regulator Output Pin.
		2	V_{IN}	Regulator Input Pin.
		3	NC	No Connect
		4	GND	Ground Pin.

 SC-70	AP8821C/N-XXXT	1	GND	Ground Pin.
		2	V_{OUT}	Regulator Output Pin.
		3	V_{IN}	Regulator Input Pin.

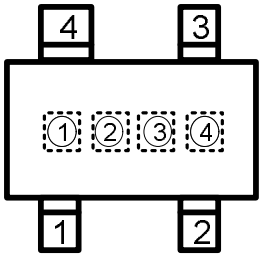
Package Marking Information



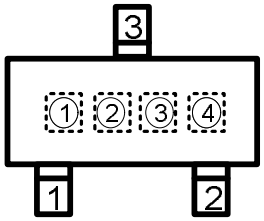
SOT-23
(Top View)



SC-82 (I)
(Top View)



SC-82 (S)
(Top View)



SC-70
(Top View)

① **Represents Products Series**

Mark	Product	Configuration	Voltage(V)
A	AP8821	CMOS	0.X
B	AP8821	CMOS	1.X
C	AP8821	CMOS	2.X
D	AP8821	CMOS	3.X
E	AP8821	CMOS	4.X
F	AP8821	CMOS	5.X
G	AP8821	CMOS	6.X
H	AP8821	N-ch	0.X
J	AP8821	N-ch	1.X
K	AP8821	N-ch	2.X
L	AP8821	N-ch	3.X
M	AP8821	N-ch	4.X
N	AP8821	N-ch	5.X
P	AP8821	N-ch	6.X

② Represents decimal number of detect voltage			
Mark	**Voltage(V)**	**Mark**	**Voltage(V)**
0	X.0	5	X.5
1	X.1	6	X.6
2	X.2	7	X.7
3	X.3	8	X.8
4	X.4	9	X.9

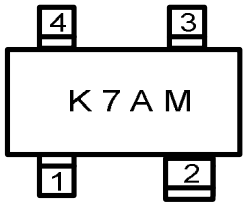
③、④**Represents Production Date Code**

Note：

* There are two under-lines on 4th & 5th digit for Green package.

* There are no under-lines on 4th & 5th digit for Pb-Free package.

Example：



SC-82 (I)
(Top View)

Part No.: AP8821N-27PI
Date Code: 2007
24th week

Absolute Maximum Ratings

Parameter		Symbol	Ratings	Units
Input Voltage V_{IN} to GND		V_{IN}	6.0	V
Output Voltage, CMOS		V_{OUT}	GND~V_{IN}+0.3V	V
Output Voltage, N-ch			GND~6V	
Output Current		I_{OUT}	50	mA
Junction Temperature		T_J	+155	°C
Power Dissipation	SOT-23	P_D	310	mW
	SC-82		250	
	SC-70		250	
Operating Ambient Temperature		T_{OPR}	-40 ~ +85	°C
Storage Temperature		T_{STG}	-55 ~ +150	°C
Lead Temperature (soldering, 10sec)			+260	°C

Note：

* The power dissipation values are based on the condition that junction temperature T_J and ambient temperature T_A difference is 100°C.

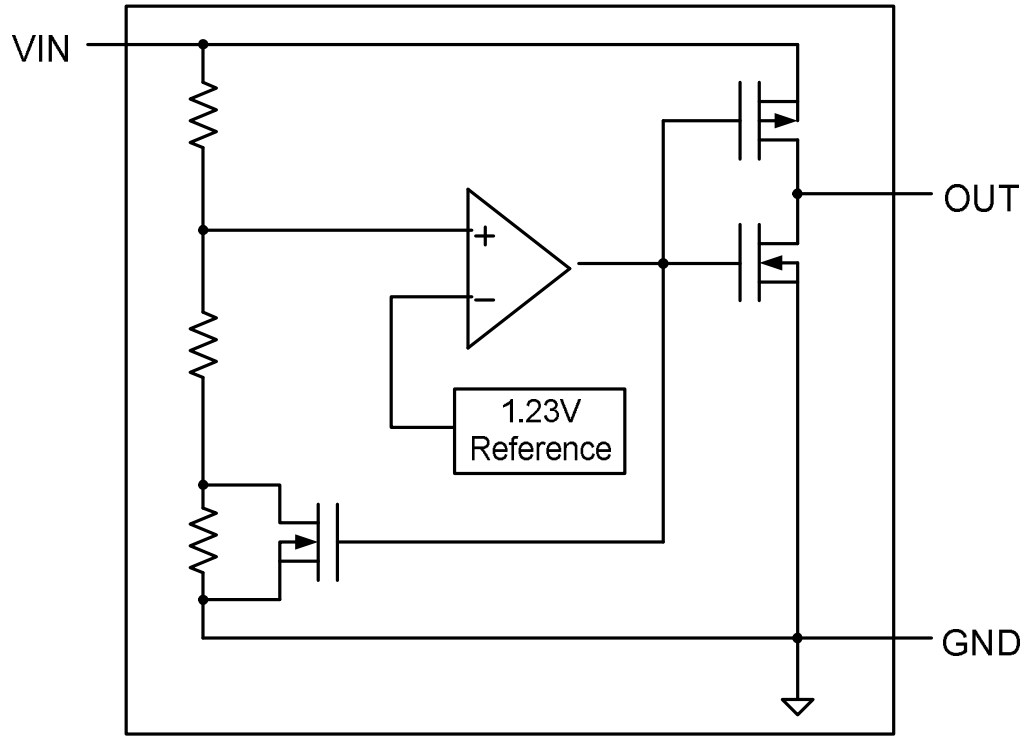
* Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum -rated conditions for extended periods may affect device reliability.

Electrical Characteristics

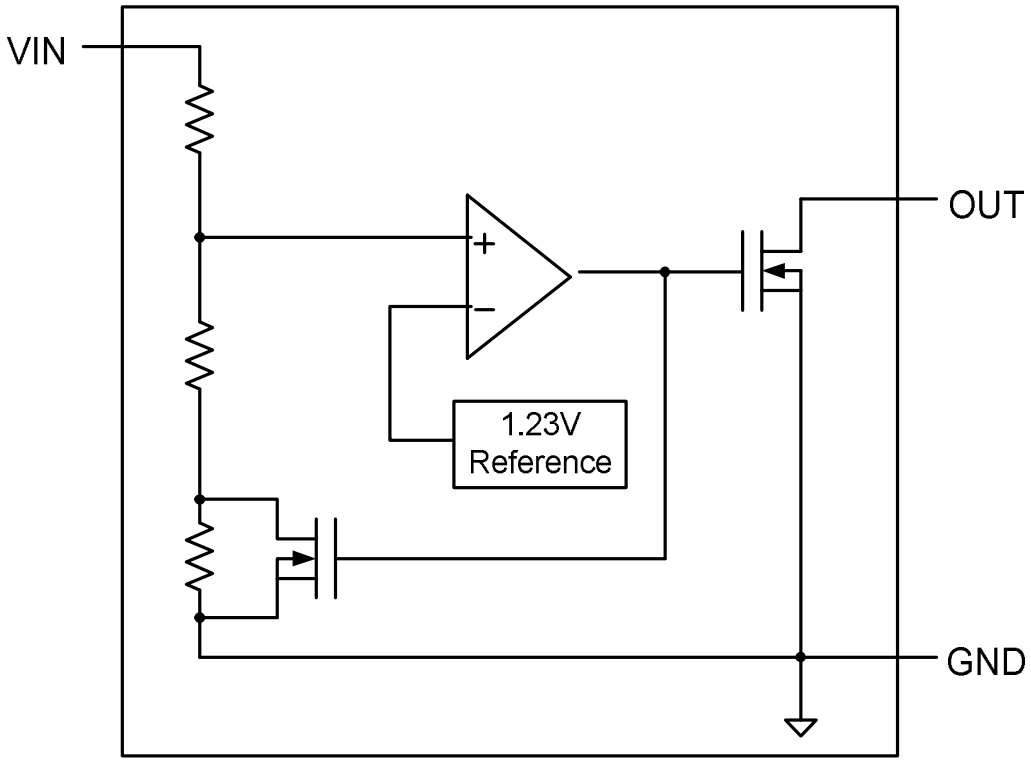
(T_A=25℃, unless otherwise noted.)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
V_{IN}	Operating Voltage			1.5		6.0	V
V_{DET}	Detection Voltage			V_{DET}* 0.98	V_{DET}	V_{DET}* 1.02	V
V_{HYS}	Hysteresis Width			V_{DET}* 0.03	V_{DET}* 0.05	V_{DET}* 0.08	V
I_Q	Quiescent Current	V_{IN}=5V			1.0	3.0	μA
I_{OUT}	Output Current	N-ch Output	V_{IN}=2V	3	7		mA
			V_{IN}=3V	5	10		
			V_{IN}=5V	7	13		
I_{LEAK}	Leakage Current	N-ch, V_{IN}=V_{OUT}=5V				0.1	μA
T_C	Temperature Coefficient	-40°C<T_A< +85°C			100	350	ppm/°C
	Response Time					200	μS

Function Block Diagram



CMOS Output

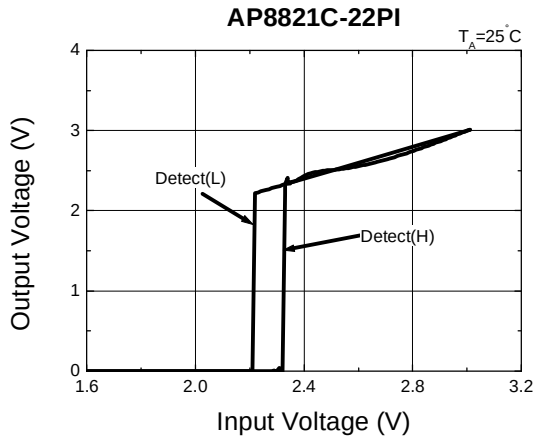


N-channel Open Drain Output

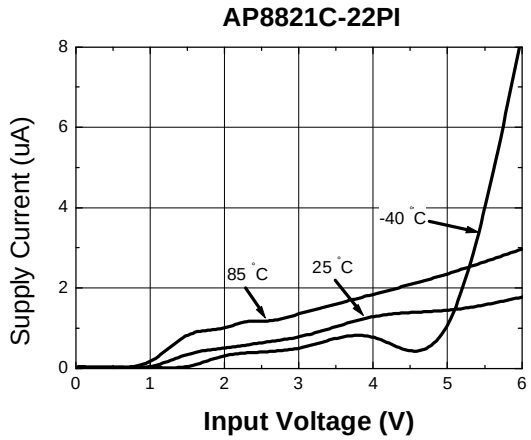
Typical Operating Characteristics

(AP8821C-22PI tested, T_A=+25℃, unless otherwise noted.)

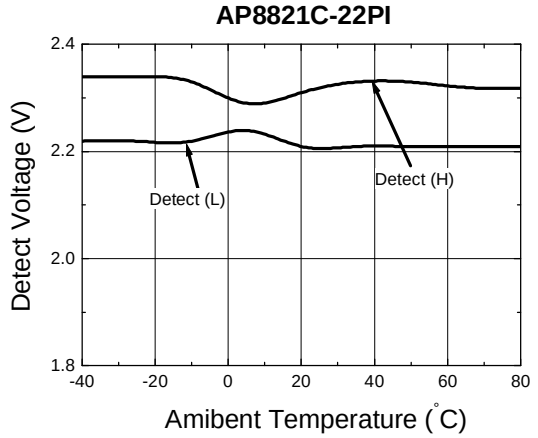
(1) Output Voltage v.s Input Voltage



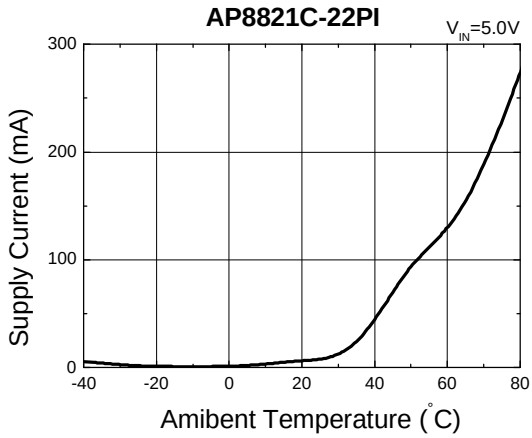
(2) Supply Current v.s Input Voltage



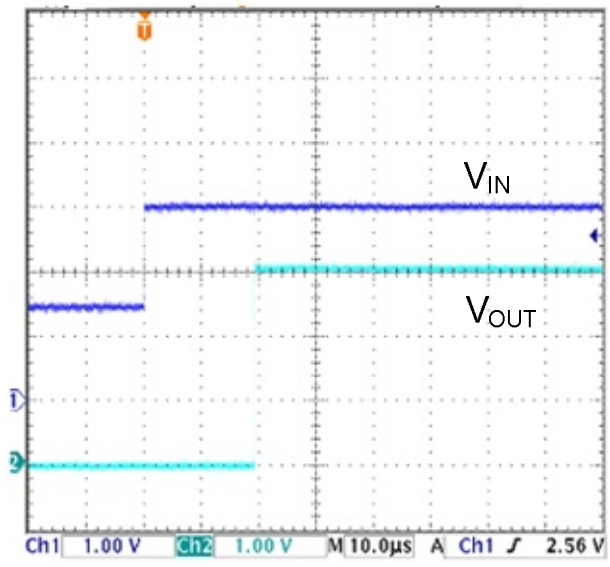
(3) Detect Voltage v.s Amibent Temperature



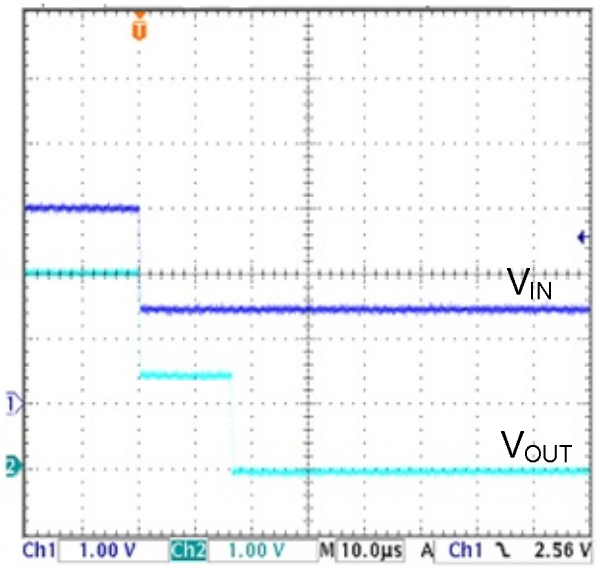
(4) Supply Current v.s Amibent Temperature



(5) Start-up Voltage Waveform



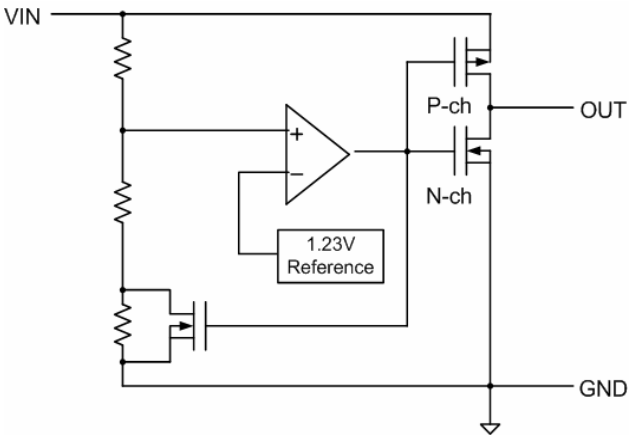
(6) Shutdown Voltage Waveform

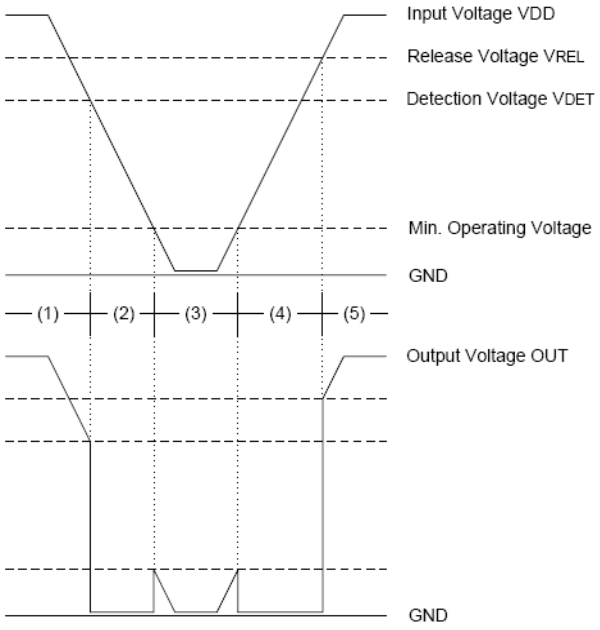


Detail Description

Basic Operation

For AP8821C CMOS Active low output:





(1) When the input voltage V_{IN} is higher than the release voltage V_{REL} (V_{REL} = V_{DET} + V_{HYS}), the N-ch MOS is OFF and P-ch MOS is ON to provide V_{IN} at the output. Since NMOS is OFF, the comparator input voltage is

$$V_{IN} \times (R2+R3) / (R1+R2+R3)$$

When the V_{IN} goes below the V_{REL}, V_{IN} keeps at the output since V_{IN} remains above the detection voltage V_{DET}. The difference between V_{REL} and V_{DET} is the hysteresis range.

(2) When the V_{IN} goes below the V_{DET}, the N-ch MOS is ON and P-ch MOS is OFF to provide GND level at the output. At this time NMOS is ON, the comparator input voltage is

$$V_{IN} \times R2 / (R1+R2)$$

(3) When the V_{IN} falls below the minimum operating voltage, the output becomes undefined changed to V_{IN} if the output is pulled up to V_{IN}.

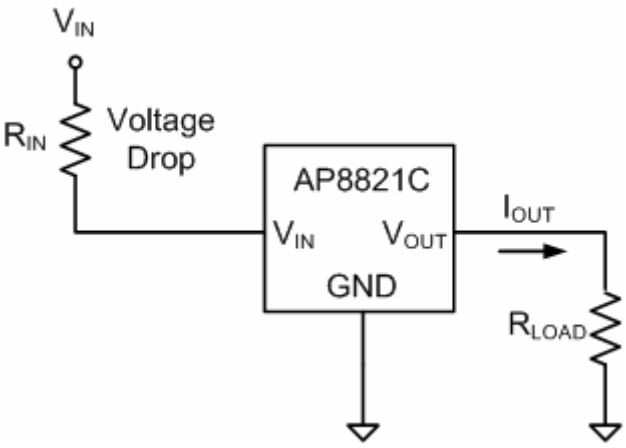
(4) When the V_{IN} rises above the minimum operating voltage, the GND level appears at the output. The GND level keeps at the output even when V_{IN} goes above the detection voltage V_{DET}, as long as it doesn't exceed the release voltage V_{REL}.

(5) When the V_{IN} rises above the release voltage V_{REL}, the N-ch MOS is OFF and P-ch MOS is ON to provide V_{IN} at the output.

Oscillation Notice

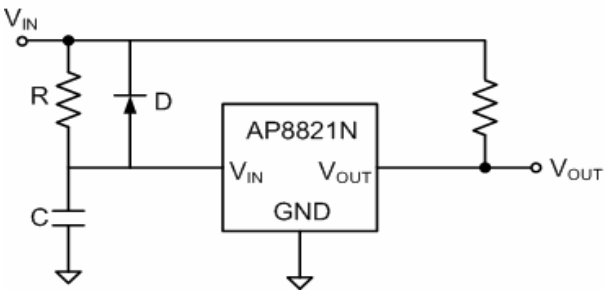
When a resistor is connected between the input voltage and the input pin V_{IN} with CMOS output configuration, oscillation may occur due to voltage drop at R_{IN}. The voltage drop is

$$V_{DROP} = R_{IN} \times I_{OUT}$$

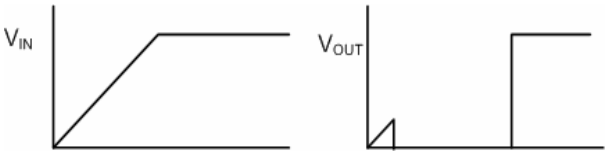


When the V_{IN} input voltage rises above the release voltage, the detector output voltage increases and the load current I_{OUT} will flow at R_{LOAD}. A voltage drop is produced at R_{IN}. The voltage drop will also lead to a fall in the input voltage at V_{IN} pin. When the V_{IN} input voltage falls below the detection voltage, output voltage falls to GND and the output current will cease.
Then the voltage drop at R_{IN} will disappear, and the V_{IN} input voltage will rise to commence release operation. Oscillation may occur with this release detection-release repetition. It's recommended not to use the CMOS configuration when a resistor R_{IN} is connected between V_{IN} input pin and the power source. Please use N-channel open drain configuration when R_{IN} is required.

Power-on Reset Circuit

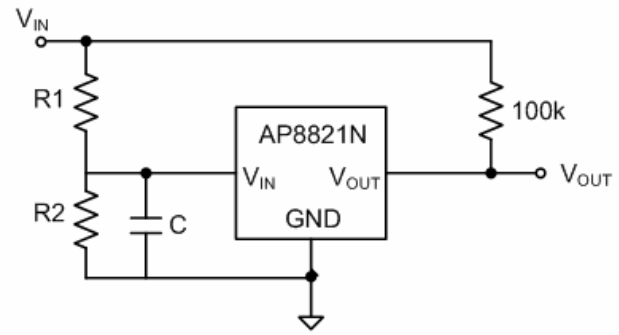


A power-on reset circuit example using AP8821N is shown in the figure. Resistor R should be 75 kΩ or less to avoid oscillation. Diode D instantaneously discharges the charge stored in the capacitor C at the power falling. Diode D can be removed when the delay of the falling time is not important.



Change of Detection Voltage

For AP8821N N-channel open drain output configuration, the detection voltage can be changed with resistance dividers as shown in the figure.



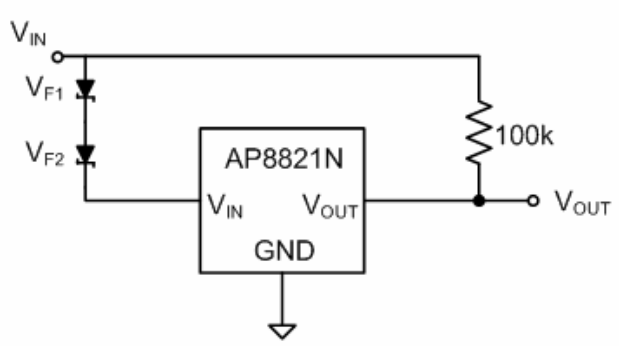
Detection voltage is changed to

$$V_{DET} \times (R1+R2) / R2$$

Hysteresis width is also changed to

$$V_{HYS} \times (R1+R2) / R2$$

Resistor R1 should be 75 kΩ or less to avoid oscillation. The detection voltage can also be changed with diodes as shown in the figure.

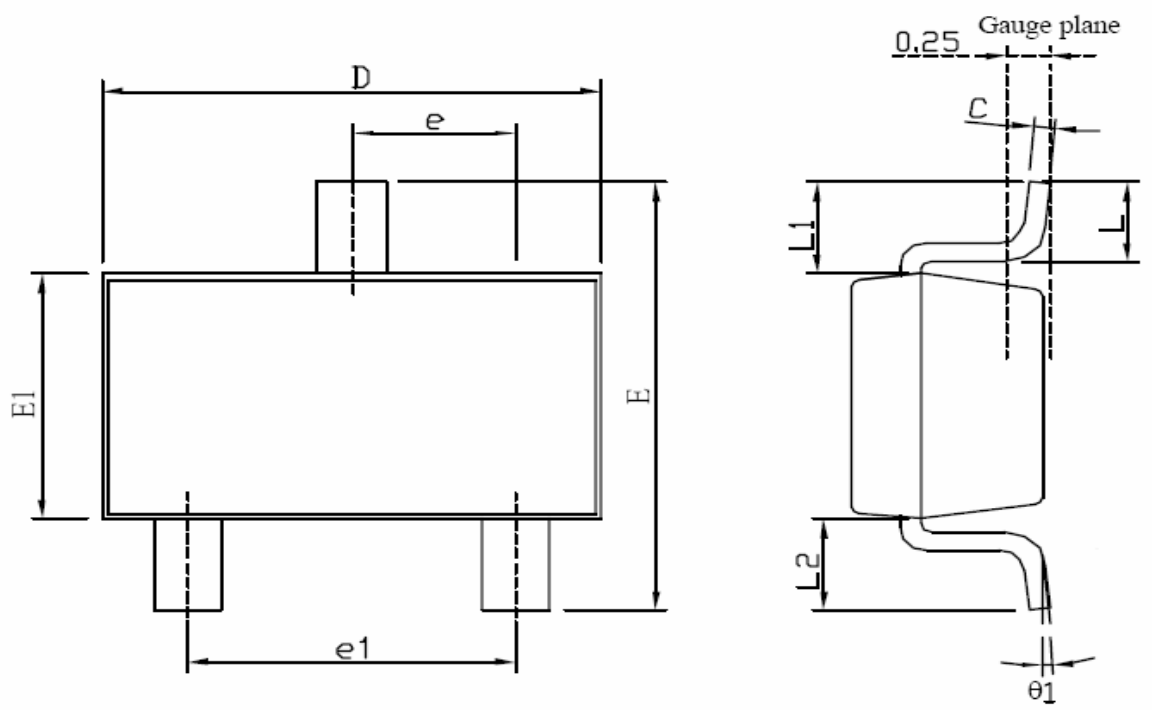


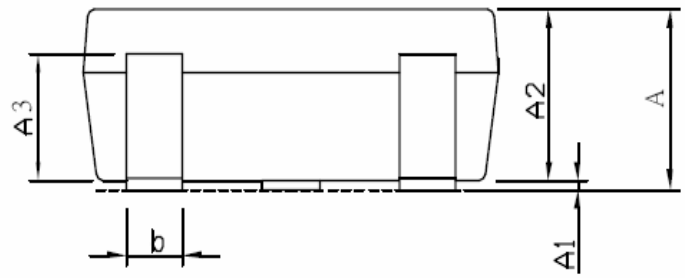
Detection voltage becomes

$$V_{F1} + V_{F2} + V_{DET}$$

Package Outline

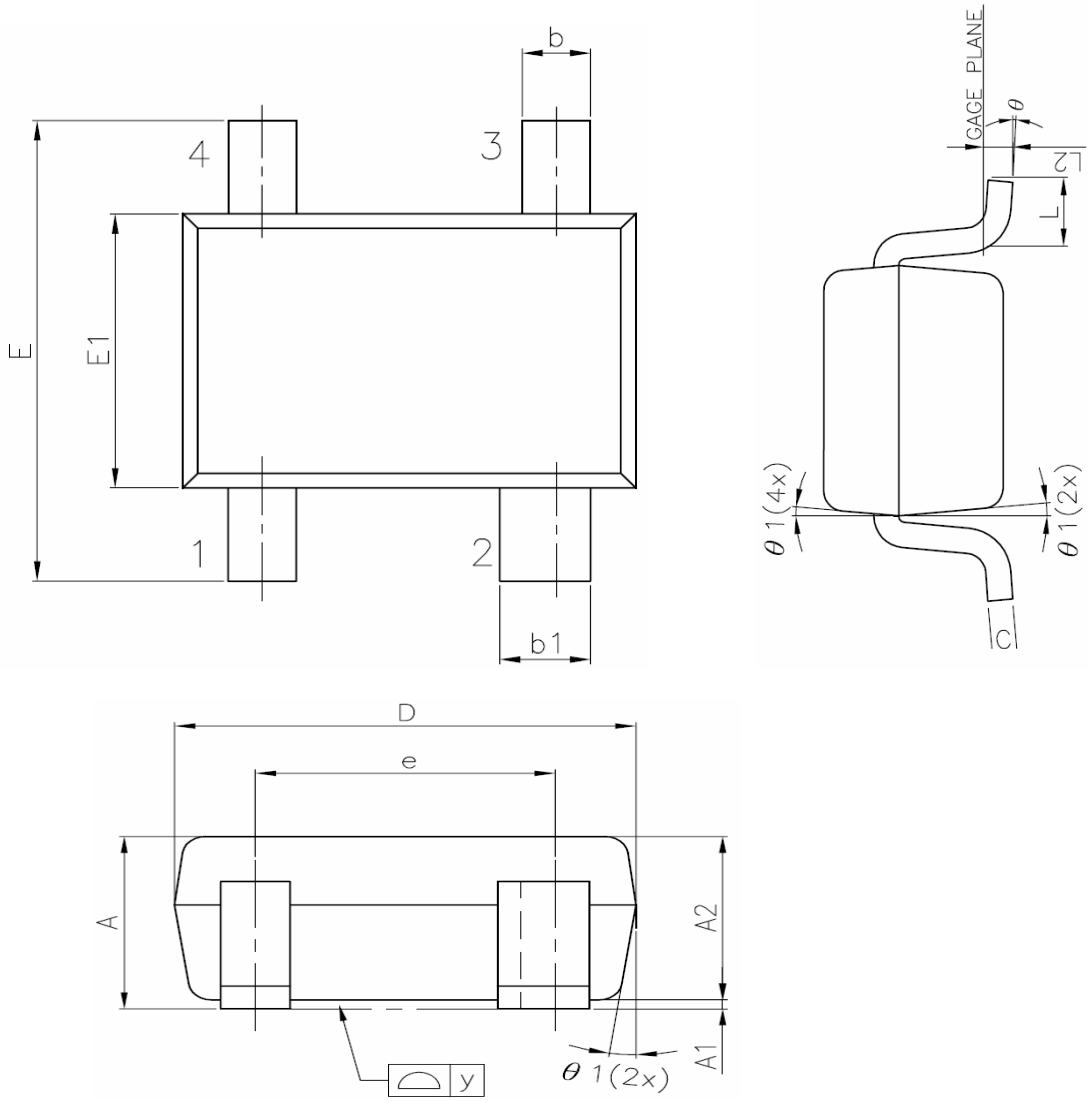
A) SOT-23





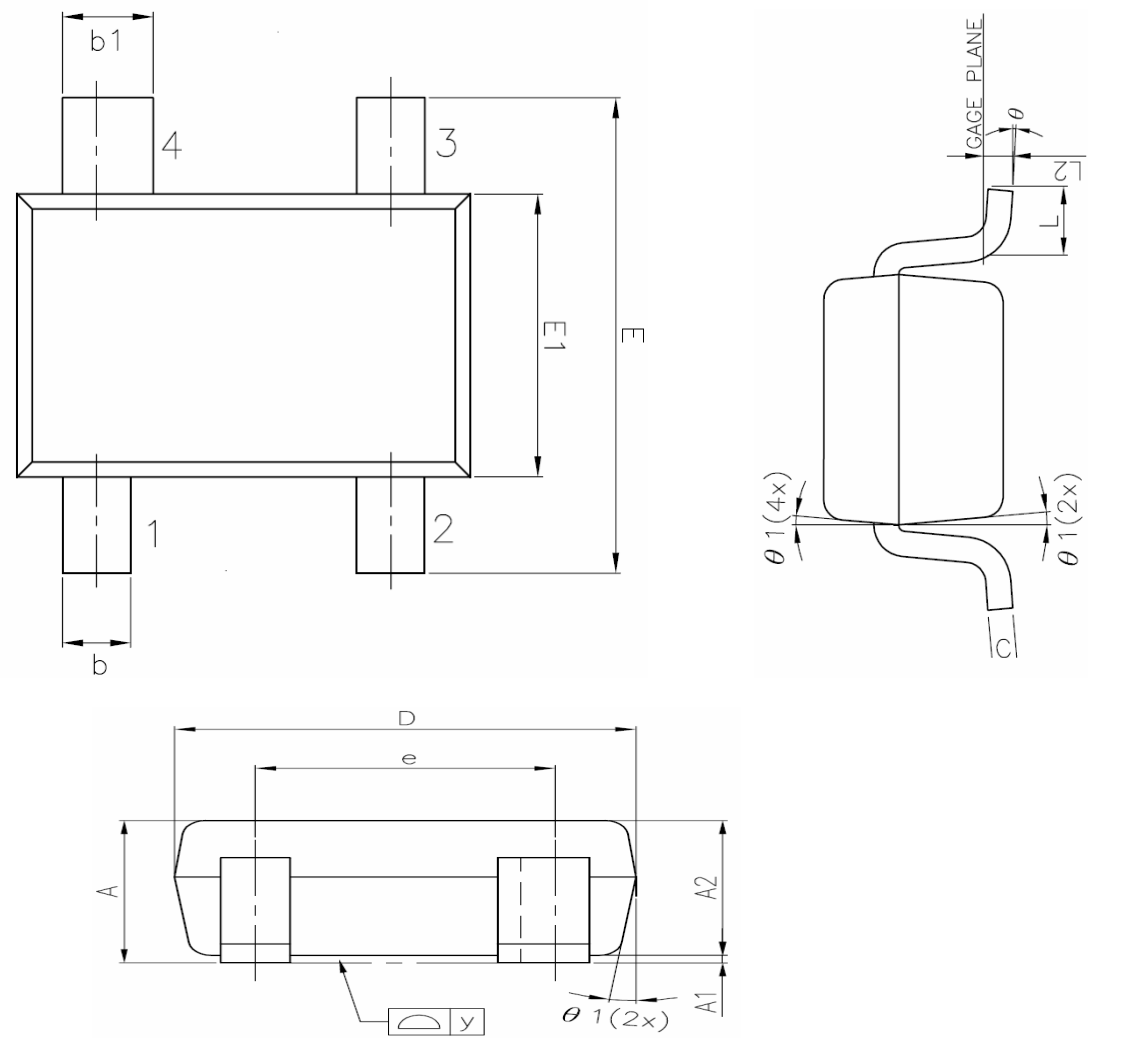
Symbols	Dimensions in Millmeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	0.05	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	---	0.95(Typ)	---
e1	---	1.90(Typ)	---
θ1	1°	5°	9°
L	0.37	---	---
L1	---	0.6REF	---
L1-L2	---	---	0.12

B) SC-82 (I Type)



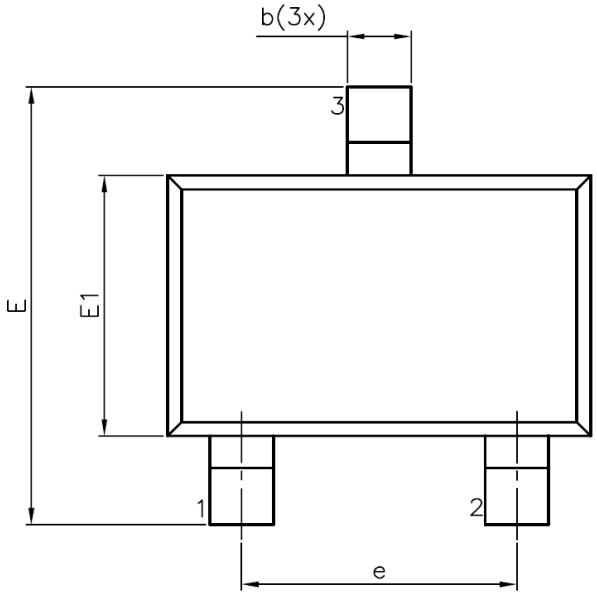
Symbols	Dimension in millimeters			Dimension in inches		
	Min	Nom	Max	Min	Nom	Max
A	0.80	---	1.10	0.031	---	0.043
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.90	1.00	0.027	0.035	0.039
b	0.25	0.30	0.40	0.010	0.012	0.016
b1	0.35	0.40	0.50	0.014	0.016	0.020
C	0.10	---	0.26	0.004	---	0.010
D	1.80	2.00	2.20	0.071	0.079	0.087
E1	1.15	1.25	1.35	0.045	0.049	0.053
E	1.80	2.10	2.40	0.071	0.083	0.094
e	---	1.30	---	---	0.051	---
L	0.26	0.36	0.46	0.010	0.014	0.018
L2	---	0.15	---	---	0.006	---
y	---	---	0.10	---	---	0.004
θ	0°	---	8°	0°	---	8°
θ1	4°	---	12°	4°	---	12°

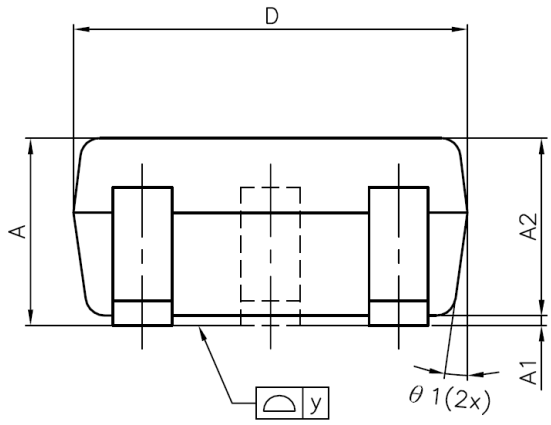
C) SC-82 (S Type)

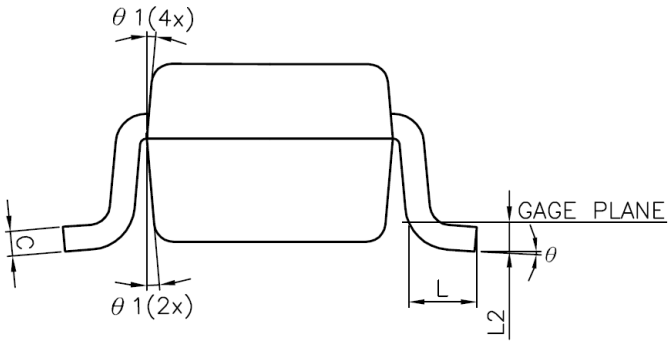


Symbols	Dimension in millimeters			Dimension in inches		
	Min	Nom	Max	Min	Nom	Max
A	0.80	---	1.10	0.031	---	0.043
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.90	1.00	0.027	0.035	0.039
b	0.25	0.30	0.40	0.010	0.012	0.016
b1	0.35	0.40	0.50	0.014	0.016	0.020
C	0.10	---	0.26	0.004	---	0.010
D	1.80	2.00	2.20	0.071	0.079	0.087
E1	1.15	1.25	1.35	0.045	0.049	0.053
E	1.80	2.10	2.40	0.071	0.083	0.094
e	---	1.30	---	---	0.051	---
L	0.26	0.36	0.46	0.010	0.014	0.018
L2	---	0.15	---	---	0.006	---
y	---	---	0.10	---	---	0.004
θ	0°	---	8°	0°	---	8°
θ1	4°	---	12°	4°	---	12°

D) SC-70

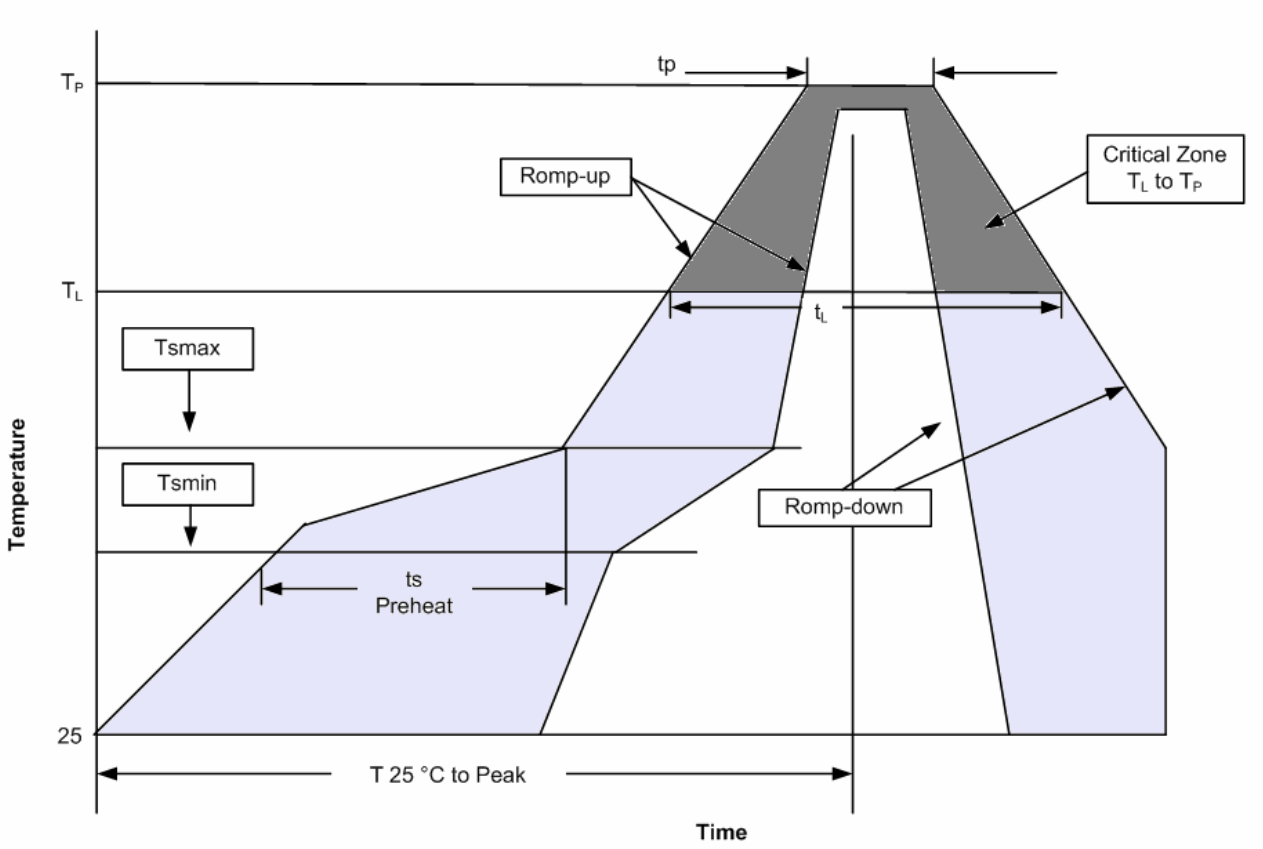






Symbols	Dimensions in millmeters			Dimensions in millmeters		
	Min	Nom	Max	Min	Nom	Max
A	0.80	---	1.10	0.031	---	0.043
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.90	1.00	0.028	0.035	0.039
b	0.25	---	0.40	0.010	---	0.016
C	0.08	---	0.22	0.003	---	0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e	---	1.30	---	---	0.051	---
L	0.26	0.36	0.46	0.010	0.014	0.018
L2	---	0.15	---	---	0.006	---
y	---	---	0.10	---	---	0.004
θ	0°	4°	8°	0°	4°	8°
θ1	4°	---	12°	4°	---	12°

Reflow Condition (IR/Convection or VPR Reflow)



Classification Reflow Profiles

Profile Feature	Pb-Free / Green Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (min to max) (ts)	150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	217°C 60-150 seconds
Peak/Classification Temperature (Tp)	See table 1
Time within 5°C of actual Peak Temperature (tp)	20-40 seconds
Ramp-down Rate	6°C/second max
Time 25°C to Peak Temperature	8 minutes max

Notes：
1) All temperatures refer to topside of the package.
2) Measured on the body surface.

Table 2. Pb-free / Green Process – Package Classification Reflow Temperatures

Package Thickness	Volume mm³ <350	Volume mm³ 350~2000	Volume mm³ ≧2000
<2.5 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6-2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≧2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*

Notes：

* Tolerance: The device manufacturer/supplier shall assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.
MSL level.