September 2002

National Semiconductor

LM809/LM810
3-Pin Microprocessor Reset Circuits

General Description

The LM809/810 microprocessor supervisory circuits can be used to monitor the power supplies in microprocessor and digital systems. They provide a reset to the microprocessor during power-up, power-down and brown-out conditions.

The function of the LM809/810 is to monitor the V_{CC} supply voltage, and assert a reset signal whenever this voltage declines below the factory-programmed reset threshold. The reset signal remains asserted for 240ms after V_{CC} rises above the threshold. The LM809 has an active-low $\overline{\text{RESET}}$ output, while the LM810 has an active-high RESET output.

Seven standard reset voltage options are available, suitable for monitoring 5V, 3.3V, and 3V supply voltages.

With a low supply current of only 15µA, the LM809/810 are ideal for use in portable equipment. The LM809/LM810 are available in the 3-pin SOT23 package and in the 6-Lead LLP package.

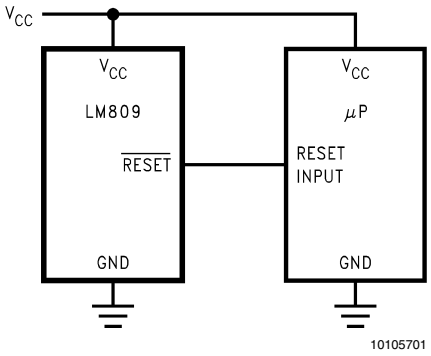
Features

- Precise monitoring of 3V, 3.3V, and 5V supply voltages
- Superior upgrade to MAX809/810
- Fully specified over temperature
- 140ms min. Power-On Reset pulse width, 240ms typical
  - Active-low $\overline{\text{RESET}}$ Output (LM809)
  - Active-high RESET Output (LM810)
- Guaranteed RESET Output valid for $V_{CC} \geq 1V$
- Low Supply Current, 15µA typ.
- Power supply transient immunity

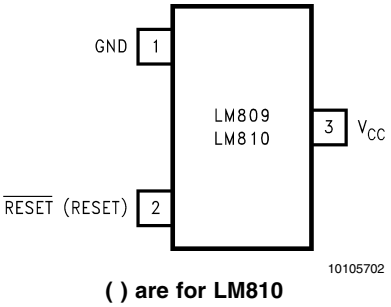
Applications

- Microprocessor Systems
- Computers
- Controllers
- Intelligent Instruments
- Portable/Battery-Powered Equipment
- Automotive

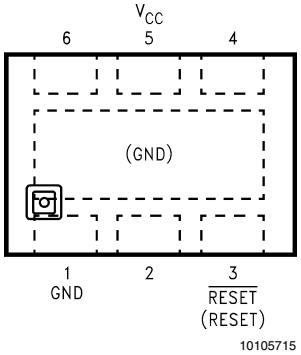
Typical Application Circuit



Connection Diagrams



( ) are for LM810



Top View
See NS package Number LDB06A
( ) are for LM810

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Ordering Information

Reset Threshold (V)	LM809 Supplied as 1000 units, tape & reel	LM809 Supplied as 3000 units, tape & reel	Package Top Mark	Package Type	NSC Package
4.63	LM809M3-4.63	LM809M3X-4.63	S8B	SOT23-3	M03B
4.38	LM809M3-4.38	LM809M3X-4.38	S7B		
4.00	LM809M3-4.00	LM809M3X-4.00	S6B		
3.08	LM809M3-3.08	LM809M3X-3.08	S5B		
2.93	LM809M3-2.93	LM809M3X-2.93	S4B		
2.63	LM809M3-2.63	LM809M3X-2.63	S3B		
2.45	LM809M3-2.45	LM809M3X-2.45	SFB		

Reset Threshold (V)	LM810 Supplied as 1000 units, tape & reel	LM810 Supplied as 3000 units, tape & reel	Package Top Mark	Package Type	NSC Package
4.63	LM810M3-4.63	LM810M3X-4.63	SEB	SOT23-3	M03B
4.38	LM810M3-4.38	LM810M3X-4.38	SDB		
4.00	LM810M3-4.00	LM810M3X-4.00	SCB		
3.08	LM810M3-3.08	LM810M3X-3.08	SBB		
2.93	LM810M3-2.93	LM810M3X-2.93	SAB		
2.63	LM810M3-2.63	LM810M3X-2.63	S9B		

Reset Threshold (V)	LM809 Supplied as 1000 units, tape & reel	LM809 Supplied as 4500 units, tape & reel	Package Top Mark	Package Type	NSC Package
2.63	LM809LD-2.63	LM809LDX-2.63	S13	LLP-6	LDB06A

Custom voltages and improved accuracies are available, subject to minimum orders. Contact your local National Semiconductor Sales Office for information.

Pin Descriptions

PIN		NAME	FUNCTION
(LLP)	SOT-23		
1	1	GND	Ground reference
3	2	$\overline{\text{RESET}}$ (LM809)	Active-low output. $\overline{\text{RESET}}$ remains low while V_{CC} is below the reset threshold, and for 240ms after V_{CC} rises above the reset threshold.
		RESET (LM810)	Active-high output. RESET remains high while V_{CC} is below the reset threshold, and for 240ms after V_{CC} rises above the reset threshold.
5	3	V_{CC}	Supply Voltage (+5V, +3.3V, or +3.0V)

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

V_{CC}	−0.3V to 6.0V
RESET, $\overline{\text{RESET}}$	−0.3V to (V_{CC}+ 0.3V)
Input Current, V_{CC} Pin	20mA
Output Current, RESET, $\overline{\text{RESET}}$ Pin	20mA
Rate of Rise, V_{CC}	100V/µs
ESD Rating (Note 2)	2kV
Continuous Power Dissipation (Note 4)	320mW
θ_{JA}:	
LLP-6	152˚C/W
SOT23-3	326˚C/W
Ambient Temperature Range	−40˚C to +105˚C
Maximum Junction Temperature	125˚C
Storage Temperature Range	−65˚C to +160˚C
Lead Temperature (soldering, 10sec)	+300˚C

Electrical Characteristics

V_{CC} = full range, T_A = −40˚C to +105˚C, unless otherwise noted. Typical values are at T_A = +25˚C, V_{CC} = 5V for 4.63/4.38/4.00 versions, V_{CC} = 3.3V for 3.08/2.93 versions, and V_{CC} = 3V for 2.63/2.45 version (Note 3).

Symbol	Parameter	Conditions		Min	Typ	Max	Units
	V_{CC} Range	T_A = 0˚C to +70˚C		1.0		5.5	V
		T_A = −40˚C to +105˚C		1.2		5.5	
I_{CC}	Supply Current	T_A = −40˚C to +85˚C	V_{CC}<5.5V, LM8_ _ -4.63/4.38/4.00		18	60	µA
			V_{CC}<3.6V, LM8_ _ -3.08/2.93/2.63/2.45		15	50	
		T_A = +85˚C to +105˚C	V_{CC}<5.5V, LM8_ _ -4.63/4.38/4.00			100	
			V_{CC}<3.6V, LM8_ _ -3.08/2.93/2.63/2.45			100	
V_{TH}	Reset Threshold (Note 5)	LM8_ _ -4.63	T_A = +25˚C	4.56	4.63	4.70	V
			T_A = −40˚C to +85˚C	4.50		4.75	
			T_A = +85˚C to +105˚C	4.40		4.86	
		LM8_ _ -4.38	T_A = +25˚C	4.31	4.38	4.45	
			T_A = −40˚C to +85˚C	4.25		4.50	
			T_A = +85˚C to +105˚C	4.16		4.56	
		LM8_ _ -4.00	T_A = +25˚C	3.93	4.00	4.06	
			T_A = −40˚C to +85˚C	3.89		4.10	
			T_A = +85˚C to +105˚C	3.80		4.20	
		LM8_ _ -3.08	T_A = +25˚C	3.04	3.08	3.11	
			T_A = −40˚C to +85˚C	3.00		3.15	
			T_A = +85˚C to +105˚C	2.92		3.23	
		LM8_ _ -2.93	T_A = +25˚C	2.89	2.93	2.96	
			T_A = −40˚C to +85˚C	2.85		3.00	
			T_A = +85˚C to +105˚C	2.78		3.08	
		LM8_ _ -2.63	T_A = +25˚C	2.59	2.63	2.66	
			T_A = −40˚C to +85˚C	2.55		2.70	
			T_A = +85˚C to +105˚C	2.50		2.76	
		LM8_ _ -2.45	T_A = +25˚C	2.41	2.45	2.49	
			T_A = −40˚C to +85˚C	2.38		2.52	
			T_A = +85˚C to +105˚C	2.33		2.57	
	Reset Threshold Temperature Coefficient				30		ppm/˚C
	V_{CC} to Reset Delay (Note 5)	V_{CC} = V_{TH} to (V_{TH} − 100mV)			20		µs
	Reset Active Timeout Period	T_A = −40˚C to +85˚C		140	240	560	ms
		T_A = +85˚C to +105˚C		100		840	

Electrical Characteristics (Continued)

V_{CC} = full range, T_A = −40˚C to +105˚C, unless otherwise noted. Typical values are at T_A = +25˚C, V_{CC} = 5V for 4.63/4.38/4.00 versions, V_{CC} = 3.3V for 3.08/2.93 versions, and V_{CC} = 3V for 2.63/2.45 version (Note 3).

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{OL}	$\overline{\text{RESET}}$ Output Voltage Low (LM809)	$V_{CC} = V_{TH}$ min, I_{SINK} = 1.2mA, LM809-2.45/2.63/2.93/3.08			0.3	V
		$V_{CC} = V_{TH}$ min, I_{SINK} = 3.2mA, LM809-4.63/4.38/4.00			0.4	
		V_{CC} > 1.0V, I_{SINK} = 50µA			0.3	
V_{OH}	$\overline{\text{RESET}}$ Output Voltage High (LM809)	$V_{CC} > V_{TH}$ max, I_{SOURCE} = 500µA, LM809-2.45/2.63/2.93/3.08	$0.8V_{CC}$			V
		$V_{CC} > V_{TH}$ max, I_{SOURCE} = 800µA, LM809-4.63/4.38/4.00	V_{CC}−1.5			
V_{OL}	RESET Output Voltage Low (LM810)	$V_{CC} = V_{TH}$ max, I_{SINK} = 1.2mA, LM810-2.63/2.93/3.08			0.3	V
		$V_{CC} = V_{TH}$ max, I_{SINK} = 3.2mA, LM810-4.63/4.38/4.00			0.4	
V_{OH}	RESET Output Voltage High (LM810)	1.8V < $V_{CC} < V_{TH}$ min, I_{SOURCE} = 150µA	$0.8V_{CC}$			V

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are conditions under which the device operates correctly. Operating ratings do not imply guaranteed performance limits. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics.

Note 2: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin.

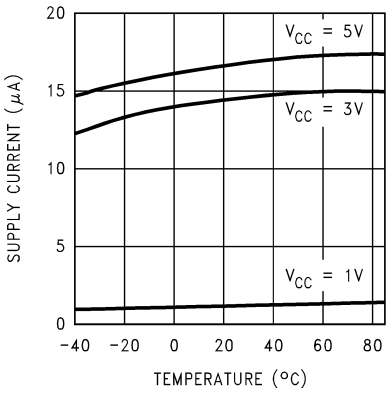
Note 3: Production testing done at T_A = +25˚C, over temperature limits guaranteed by design only.

Note 4: At elevated temperatures, devices must be derated based on package thermal resistance. The device in the SOT23-3 package must be derated at 4mW/˚C at ambient temperatures above 70˚C. The device has internal thermal protection.

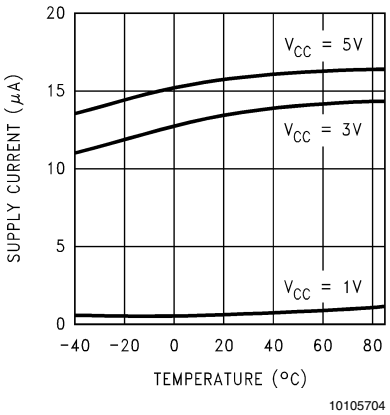
Note 5: $\overline{\text{RESET}}$ Output for LM809, RESET output for LM810.

Typical Performance Characteristics

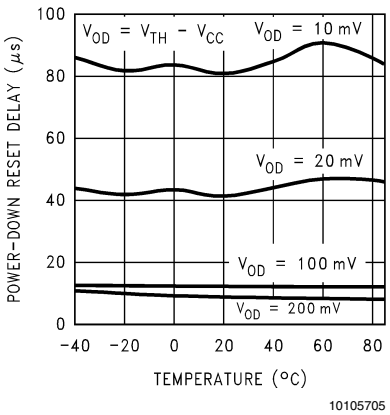
Supply Current vs Temperature (No Load, LM8_ _-2.63/2.93/3.08)



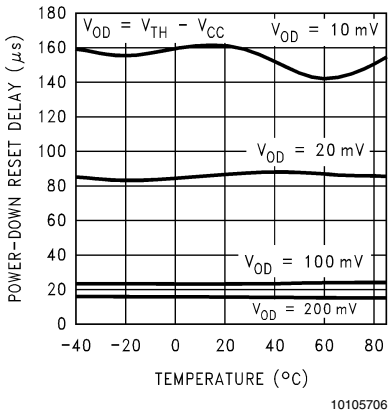
Supply Current vs Temperature (No Load, LM8_ _-4.63/4.38)



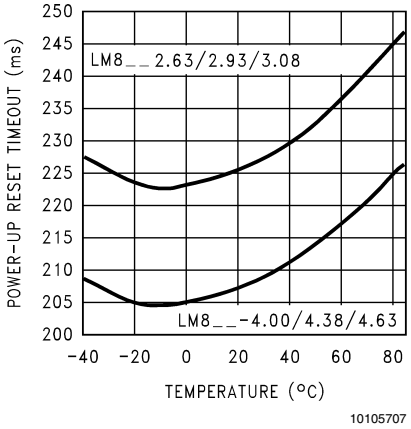
Power-Down Reset Delay vs Temp (LM8_ _-2.63/2.93/3.08)



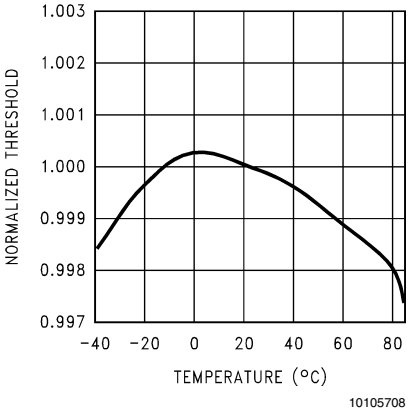
Power-Down Reset Delay vs Temperature (LM8_ _-4.63/4.38)



Power-Up Reset Timeout vs Temperature



Normalized Reset Threshold vs Temperature



Applications Information

Benefits of Precision Reset Thresholds

A microprocessor supply supervisor must provide a reset output within a predictable range of the supply voltage. A common threshold range is between 5% and 10% below the nominal supply voltage. The 4.63V and 3.08V options of the LM809/810 use highly accurate circuitry to ensure that the reset threshold occurs only within this range (for 5V and 3.3V supplies). The other voltage options have the same tight tolerance to ensure a reset signal for other narrow monitor ranges. See *Table 1* for examples of how the standard reset thresholds apply to 3V, 3.3V, and 5V nominal supply voltages.

TABLE 1. Reset Thresholds Related to Common Supply Voltages

Reset Threshold	3.0V	3.3V	5.0V
4.63 ± 3%			90 - 95%
4.38 ± 3%			85 - 90%
4.00 ± 3%			78 - 82%
3.08 ± 3%		90 - 95%	
2.93 ± 3%		86 - 90%	
2.63 ± 3%	85 - 90%	77 - 81%	
2.45 ± 3%	79 - 84%	72 - 76%	

Ensuring a Valid Reset Output Down to V_{CC} = 0V

When V_{CC} falls below 1V, the LM809 $\overline{\text{RESET}}$ output no longer sinks current. A high-impedance CMOS logic input connected to $\overline{\text{RESET}}$ can therefore drift to undetermined voltages. To prevent this situation, a 100kΩ resistor should be connected from the $\overline{\text{RESET}}$ output to ground, as shown in *Figure 1*.

A 100kΩ pull-up resistor to V_{CC} is also recommended for the LM810, if RESET is required to remain valid for V_{CC} < 1V.

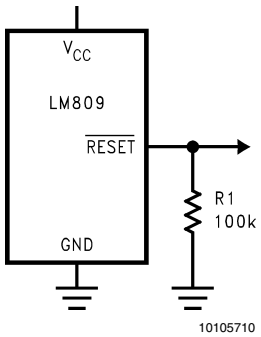


FIGURE 1. $\overline{\text{RESET}}$ Valid to V_{CC} = Ground Circuit

Negative-Going V_{CC} Transients

The LM809/810 are relatively immune to short negative-going transients or glitches on V_{CC}. *Figure 2* shows the maximum pulse width a negative-going V_{CC} transient can have without causing a reset pulse. In general, as the magnitude of the transient increases, going further below the threshold, the maximum allowable pulse width decreases. Typically, for the 4.63V and 4.38V version of the LM809/810, a V_{CC} transient that goes 100mV below the reset threshold and lasts 20µs or less will not cause a reset pulse. A 0.1 µF bypass capacitor mounted as close as possible to the V_{CC} pin will provide additional transient rejection.

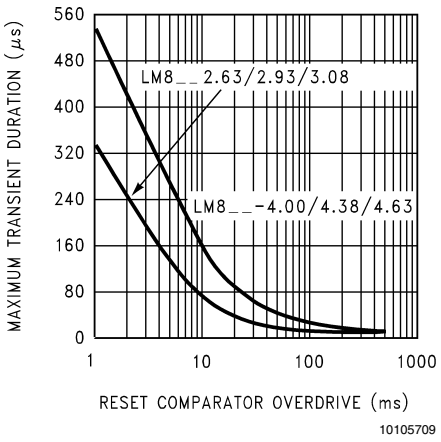


FIGURE 2. Maximum Transient Duration without Causing a Reset Pulse vs. Reset Comparator Overdrive

Interfacing to µPs with Bidirectional Reset Pins

Microprocessors with bidirectional reset pins, such as the Motorola 68HC11 series, can be connected to the LM809 $\overline{\text{RESET}}$ output. To ensure a correct output on the LM809 even when the microprocessor reset pin is in the opposite state, connect a 4.7kΩ resistor between the LM809 $\overline{\text{RESET}}$ output and the µP reset pin, as shown in *Figure 3*. Buffer the LM809 $\overline{\text{RESET}}$ output to other system components.

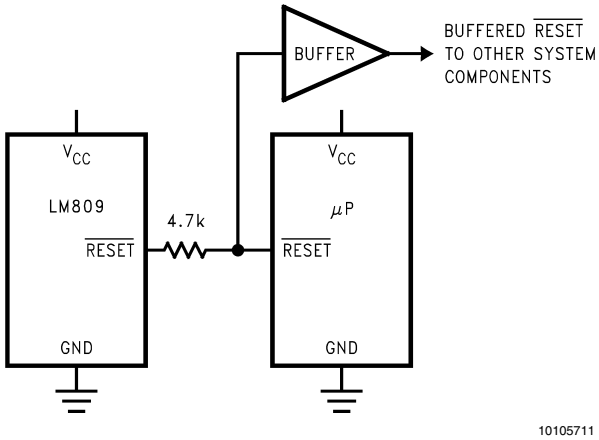
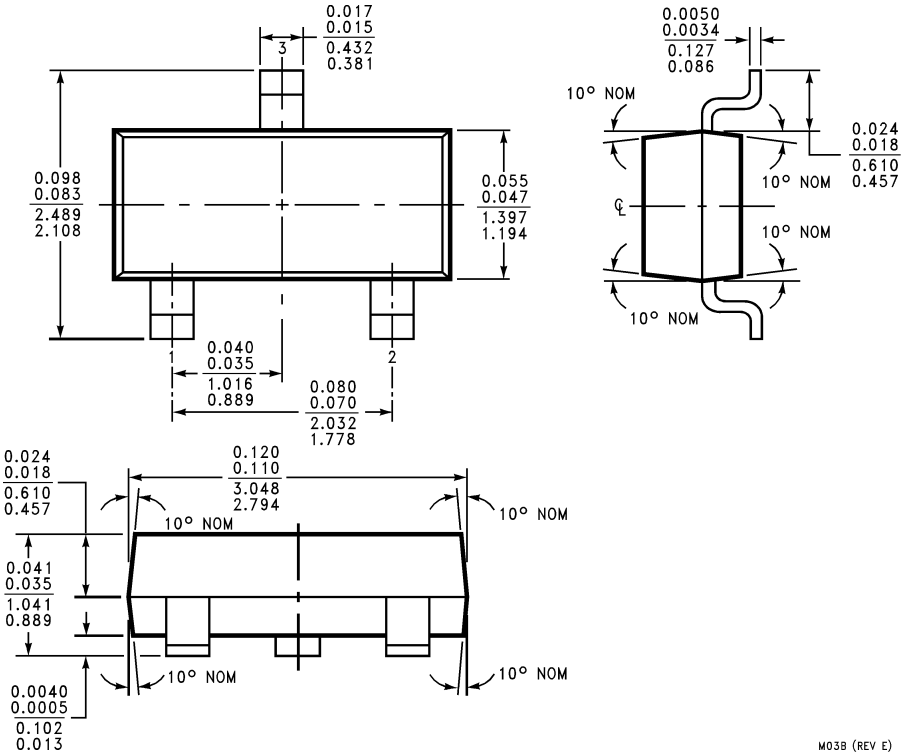


FIGURE 3. Interfacing to Microprocessors with Bidirectional Reset I/O

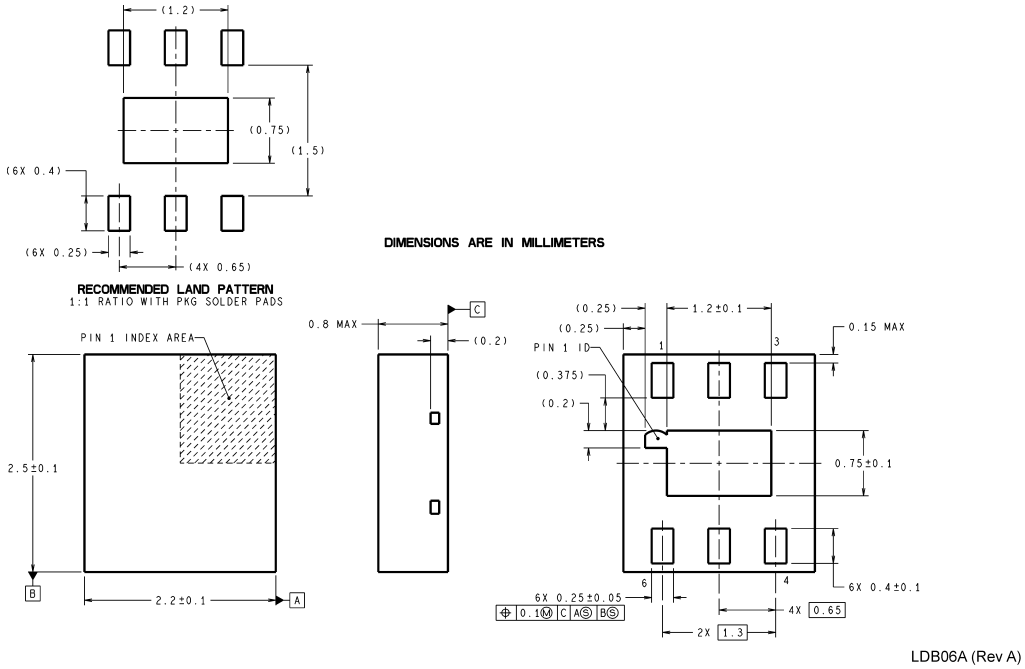
LLP Mounting

The LLP package requires special mounting techniques which are detailed in National Semiconductor Application Note AN-1187. Referring to the section PCB Design Recommendations, it should be noted that the pad style which should be used with the LLP package is the NSMD (non-solder mask defined) type.

Physical Dimensions inches (millimeters) unless otherwise noted



3-Lead SOT23-3
For Ordering, refer to Ordering Information table
NS Package Number M03B



6-Lead LLP (NLDBB006)
For Ordering, refer to Ordering Information table
NS Package Number LDB06A

Notes

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