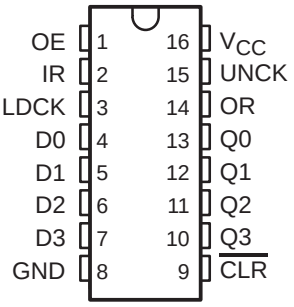
- **Independent Synchronous Inputs and Outputs**
- **16 Words by 4 Bits**
- **Data Rates From 0 to 10 MHz**
- **Fall-Through Time . . . 50 ns Typ**
- **Data Terminals Arranged for Printed-Circuit-Board Layout**
- **Expandable Using External Gating**
- **Packaged in Standard Plastic 300-mil DIPs**

N PACKAGE
(TOP VIEW)



description

This 64-bit memory is a low-power Schottky memory array organized as 16 words by 4 bits. It can be expanded in multiples of 15m + 1 words or 4n bits, or both (where n is the number of packages in the vertical array and m is the number of packages in the horizontal array), however some external gating is required (see Figure 1). For longer words using the SN74LS228, the IR signals of the first-rank packages and OR signals of the last-rank packages must be ANDed for proper synchronization.

A first-in, first-out (FIFO) memory is a storage device that allows data to be written into and read from its array at independent data rates. These FIFOs are designed to process data at rates from 0 to 10 MHz in a bit-parallel format, word by word.

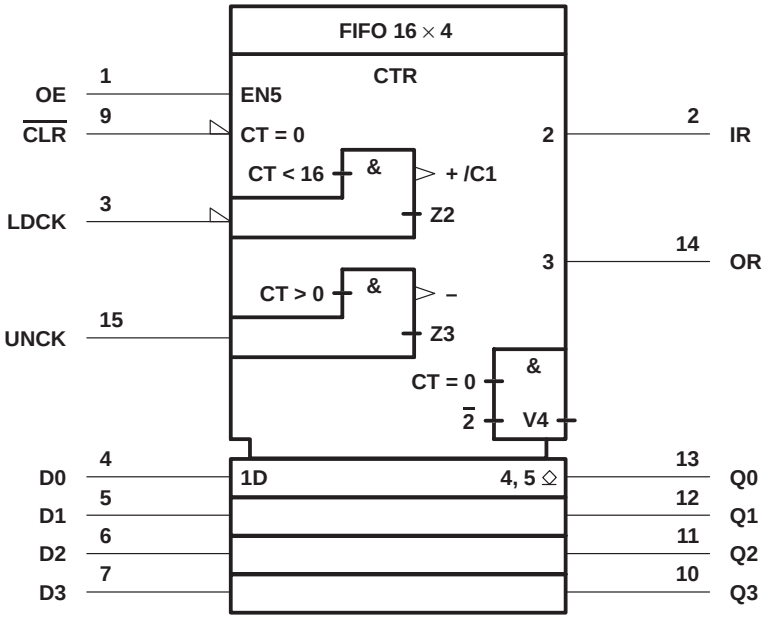
Data is written into memory on a low-to-high transition at the load-clock (LDCK) input and is read out on a low-to-high transition at the unload-clock (UNCK) input. The memory is full when the number of words clocked in exceeds by 16 the number of words clocked out. When the memory is full, LDCK signals have no effect on the data residing in memory. When the memory is empty, UNCK signals have no effect.

Status of the FIFO memory is monitored by the input-ready (IR) and output-ready (OR) flags that indicate not-full and not-empty conditions. IR is high only when the memory is not full and the LDCK is low. OR is high only when the memory is not empty and UNCK is high.

A low level on the clear ($\overline{\text{CLR}}$) input resets the internal stack-control pointers and also sets IR high and OR low to indicate that old data remaining at the data outputs is invalid. Data outputs are noninverting with respect to the data inputs and are at high impedance when the output-enable (OE) input is low. OE does not affect the IR and OR outputs.

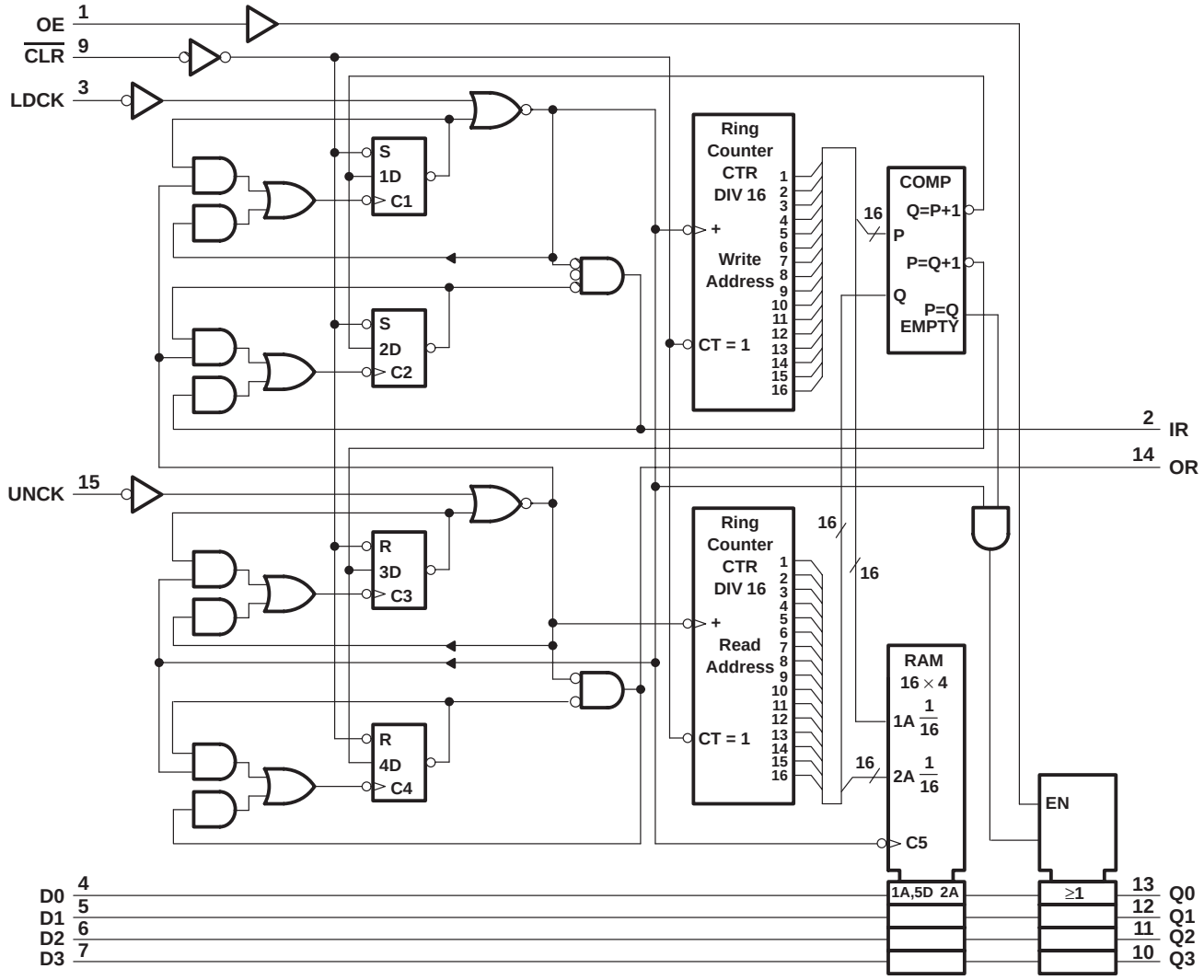
The SN74LS228 is characterized for operation from 0°C to 70°C.

logic symbol†



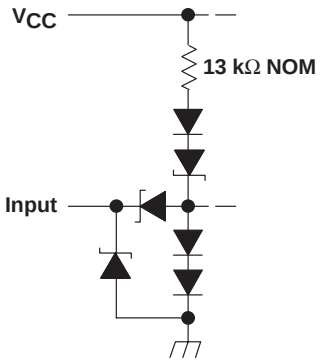
† This symbol is in accordance with ANSI/IEEE Standard 91-1984 and IEC Publication 617-12. This symbol is functionally accurate but does not show the details of implementation; for these, see the logic diagram. The symbol represents the memory as if it were controlled by a single counter whose content is the number of words stored at the time. Output data is invalid when the counter content (CT) is 0.

logic diagram (positive logic)

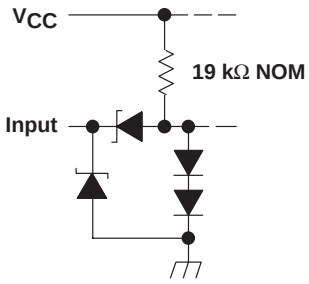


schematics of inputs and outputs

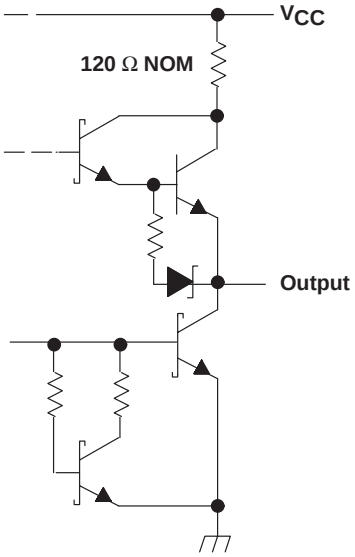
EQUIVALENT OF $\overline{\text{CLR}}$ AND ORE INPUTS



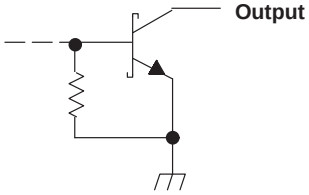
EQUIVALENT OF OTHER INPUTS



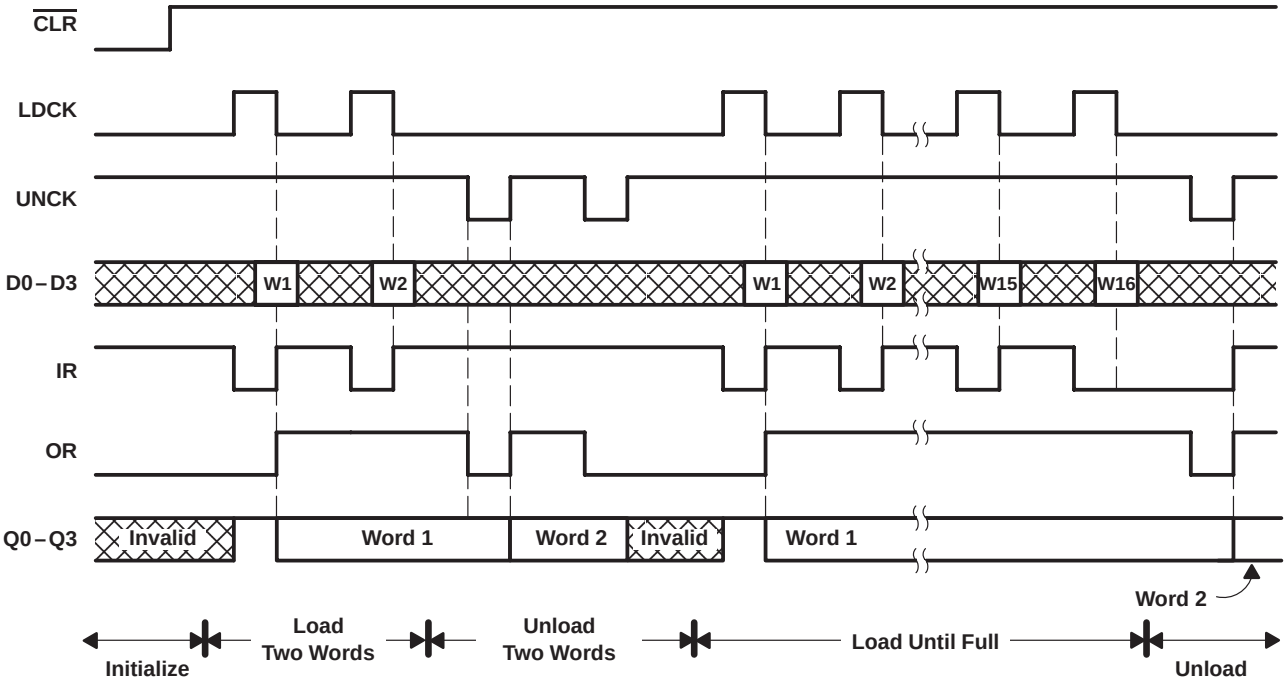
TYPICAL OF IR AND OR OUTPUTS



TYPICAL OF Q OUTPUTS



timing diagram



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage, V_I . . . . . 7 V
Off-state output voltage, V_O . . . . . 5.5 V
Operating free-air temperature range . . . . . 0°C to 70°
Storage temperature range . . . . . –65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional 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.

NOTE 1: All voltage values are with respect to GND.

recommended operating conditions (see Note 2)

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.75	5	5.25	V
V_{IH}	High-level input voltage		2			V
V_{IL}	Low-level input voltage				0.8	V
V_{OH}	High-level output voltage	Q outputs			5.5	V
I_{OH}	High-level output current	IR, OR			–0.4	mA
I_{OL}	Low-level output current	Q outputs			24	mA
		IR, OR			8	
t_w	Pulse duration	LDCK high	60			ns
		LDCK low	15			
		UNCK low	30			
		UNCK high	30			
		$\overline{CLR}$ low	20			
t_{su}	Setup time	Data to LDCK↓	50			ns
		LDCK↓ before UNCK↓	50			
		UNCK↑ before LDCK↑	50			
t_h	Hold time	Data from LDCK↓	0			ns
T_A	Operating free-air temperature		0		70	°C

NOTE 2: To ensure proper operation of this high-speed FIFO device, it is necessary to provide a clean signal to the LDCK and UNCK clock inputs. Any excessive noise or glitching on the clock inputs that violates the V_{IL}, V_{IH}, or minimum pulse duration limits can cause a false clock or improper operation of the internal read and write pointers.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IK}		V_{CC} = 4.75 V,	I_I = –18 mA			–1.5	V
I_{OH}	Q outputs	V_{CC} = 4.75 V,	V_{OH} = 5.5 V			0.1	mA
V_{OH}	IR, OR	V_{CC} = 4.75 V,	I_{OH} = –0.4 mA	2.7	3.4		V
V_{OL}	Q outputs	V_{CC} = 4.75 V	I_{OL} = 12 mA		0.25	0.4	V
			I_{OL} = 24 mA		0.35	0.5	
	IR, OR	V_{CC} = 4.75 V	I_{OL} = 4 mA		0.25	0.4	
			I_{OL} = 8 mA		0.35	0.5	
I_{OZH}	Q outputs	V_{CC} = 5.25 V,	V_O = 2.7 V			20	µA
I_{OZL}	Q outputs	V_{CC} = 5.25 V,	V_O = 0.4 V			–20	µA
I_I		V_{CC} = 5.25 V,	V_I = 7 V			0.1	mA
I_{IH}		V_{CC} = 5.25 V,	V_I = 2.7 V			20	µA
I_{IL}		V_{CC} = 5.25 V,	V_I = 0.4 V			–0.4	mA
I_{OS}‡	IR, OR	V_{CC} = 5.25 V		–20		–100	mA
I_{CC}		V_{CC} = 5.25 V	Outputs high		84	135	mA
			Outputs low		87	155	
			Outputs disabled		89	155	

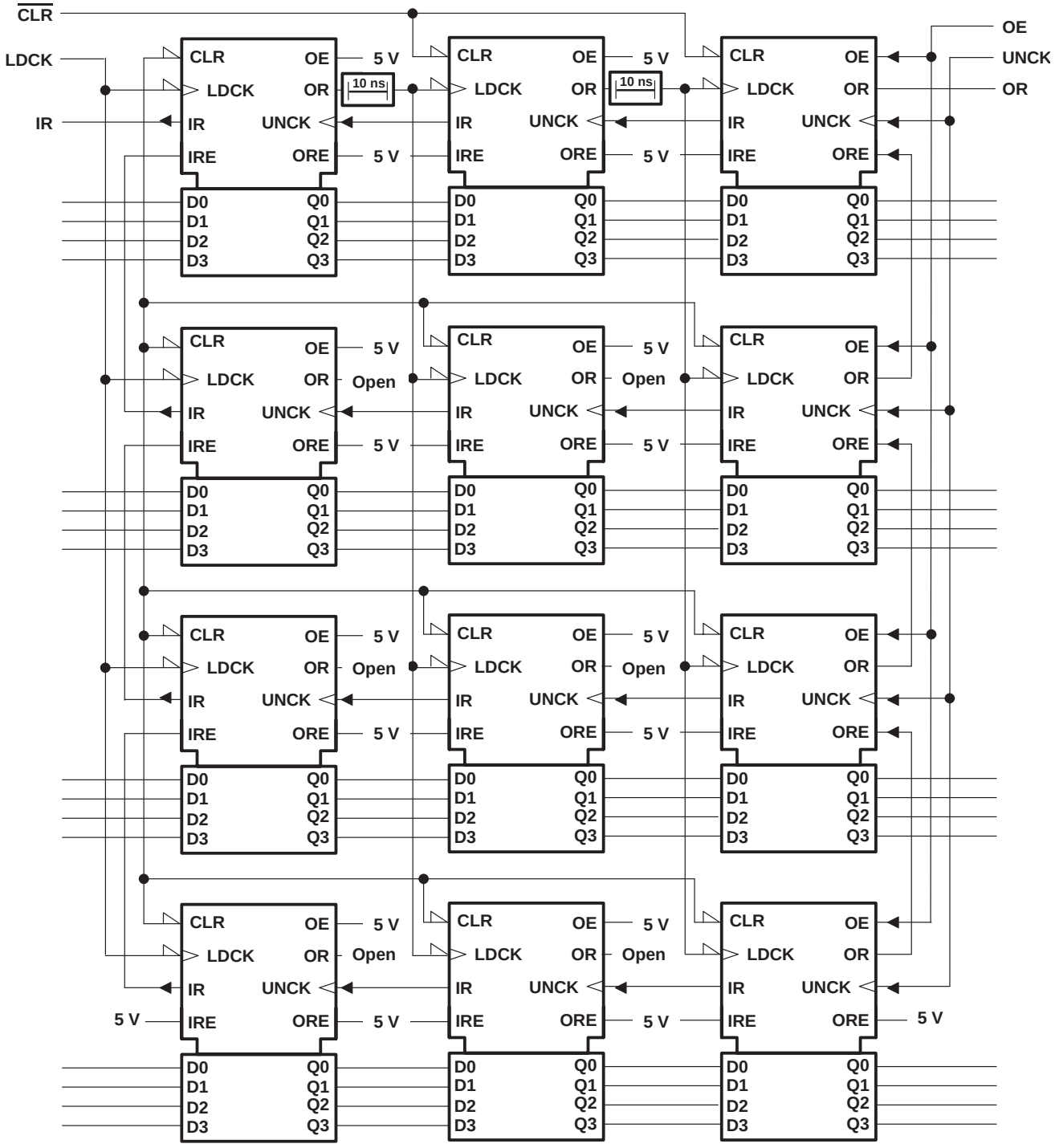
† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see Note 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	TYP	MAX	UNIT
t_{PLH}	IRE↑	IR	R_L = 2 kΩ, C_L = 15 pF	N/A	N/A	ns
t_{PHL}	IRE↓			N/A	N/A	
t_{PLH}	ORE↑	OR		N/A	N/A	ns
t_{PHL}	ORE↓			N/A	N/A	
t_{PLH}	LDCK↓	IR		25	40	ns
t_{PHL}	LDCK↑			36	50	
t_{PLH}	LDCK↓	OR		48	70	ns
t_{PLH}	UNCK↑	OR		29	45	ns
t_{PHL}	UNCK↓			28	45	
t_{PLH}	UNCK↑	IR		49	70	ns
t_{PLH}	CLR↓	IR		36	55	ns
t_{PHL}		OR		25	40	
t_{PHL}	LDCK↓	Q	R_L = 667 Ω, C_L = 45 pF	34	50	ns
t_{PLH}	UNCK↑	Q		54	80	ns
t_{PHL}				45	70	
t_{PLH}	OE↓	Q		21	30	ns
t_{PHL}	OE↑			20	35	

NOTE 3: Load circuit and voltage waveforms are shown in Section 1 of the 1988 *TTL Logic Data Book*, literature #SDLD001A.

APPLICATION INFORMATION



10 ns ≡ Noninverting delay ≥ 10 ns (e.g., two stages of ’LS04), two places.

Figure 1. 48-Word by 16-Bit Expansion Using ’LS227

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
SN74LS228N	OBSOLETE	PDIP	N	16		TBD	Call TI	Call TI

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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