

## STROBED FIRST-IN, FIRST-OUT MEMORY

SCAS209A – APRIL 1992 – REVISED SEPTEMBER 1995

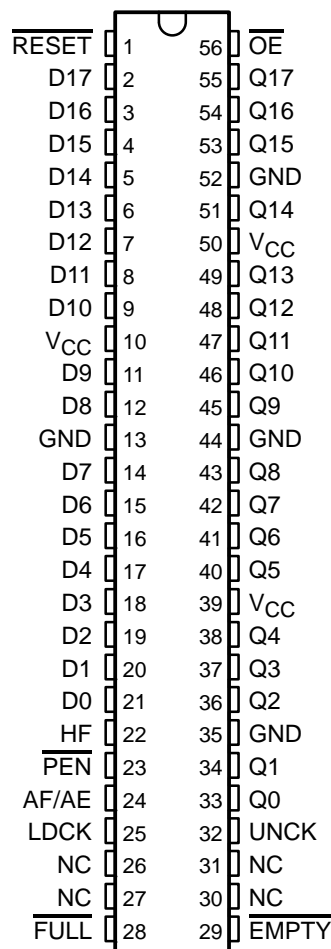
- Member of the Texas Instruments Widebus™ Family
- Load Clock and Unload Clock Can Be Asynchronous or Coincident
- 64 Words by 18 Bits
- Low-Power Advanced CMOS Technology
- Full, Empty, and Half-Full Flags
- Programmable Almost-Full/Almost-Empty Flag
- Fast Access Times of 15 ns With a 50-pF Load and All Data Outputs Switching Simultaneously
- Data Rates From 0 to 50 MHz
- 3-State Outputs
- Pin Compatible With SN74ACT7804 and SN74ACT7806
- Packaged in Shrink Small-Outline 300-mil (DL) Package Using 25-mil Center-to-Center Spacing

## description

A FIFO memory is a storage device that allows data to be written into and read from its array at independent data rates. The SN74ACT7814 is a 64-word by 18-bit FIFO for high speed and fast access times. It processes data at rates up to 50 MHz and access times of 15 ns in a bit-parallel format.

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 the number of words clocked out by 64. 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 full ( $\overline{\text{FULL}}$ ), empty ( $\overline{\text{EMPTY}}$ ), half-full (HF), and almost-full/almost-empty (AF/AE) flags. The  $\overline{\text{FULL}}$  output is low when the memory is full and high when the memory is not full. The  $\overline{\text{EMPTY}}$  output is low when the memory is empty and high when it is not empty. The HF output is high when the FIFO contains 32 or more words and is low when it contains 31 or less words. The AF/AE status flag is a programmable flag. The first one or two low-to-high transitions of LDCK after reset are used to program the almost-empty offset value (X) and the almost-full offset value (Y) if program enable ( $\overline{\text{PEN}}$ ) is low. The AF/AE flag is high when the FIFO contains X or less words or (64 – Y) or more words. The AF/AE flag is low when the FIFO contains between (X + 1) and (63 – Y) words.

DL PACKAGE  
(TOP VIEW)

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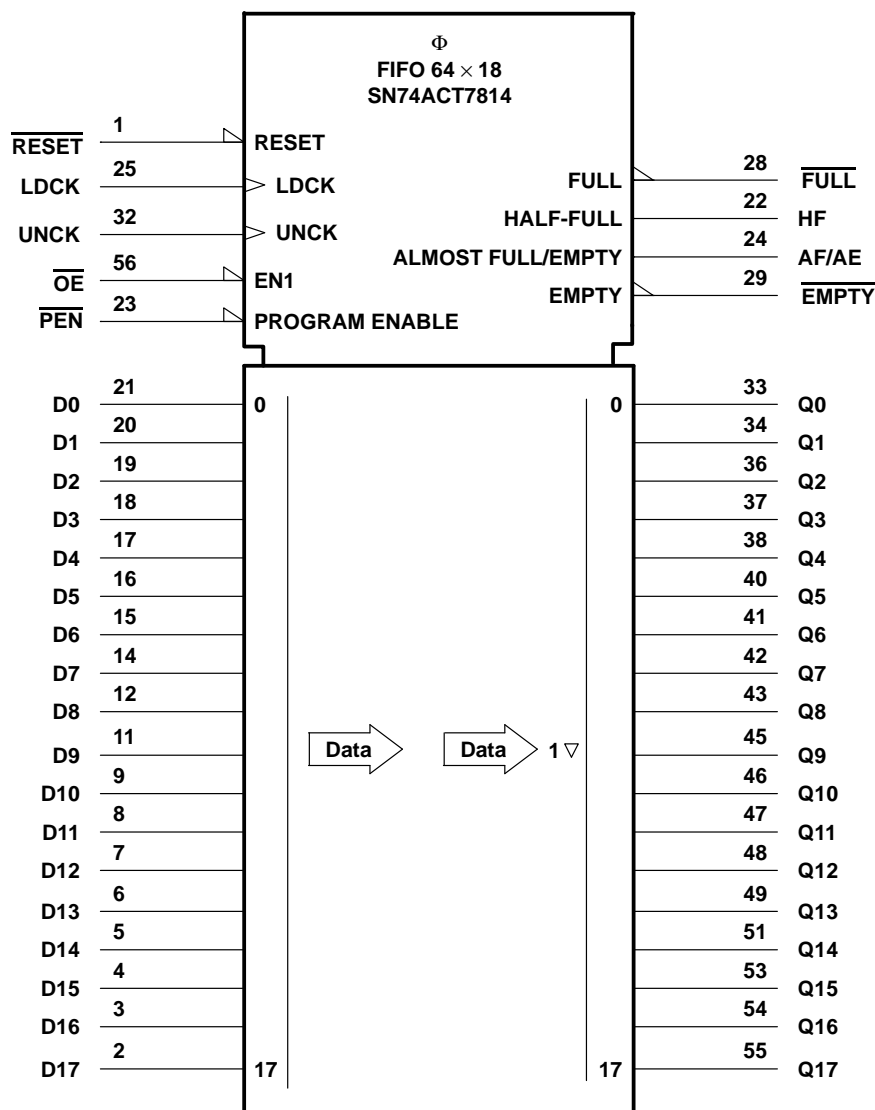
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## description (continued)

A low level on the reset ( $\overline{\text{RESET}}$ ) input resets the internal stack pointers and sets  $\overline{\text{FULL}}$  high, HF low, and  $\overline{\text{EMPTY}}$  low. The Q outputs are not reset to any specific logic level. The FIFO must be reset upon power up. The first word loaded into empty memory causes  $\overline{\text{EMPTY}}$  to go high and the data to appear on the Q outputs. It is important to note that the first word does not have to be unloaded. The data outputs are noninverting with respect to the data inputs and are in the high-impedance state when the output-enable ( $\overline{\text{OE}}$ ) input is high.

The SN74ACT7814 is characterized for operation from 0°C to 70°C.

## logic symbol†

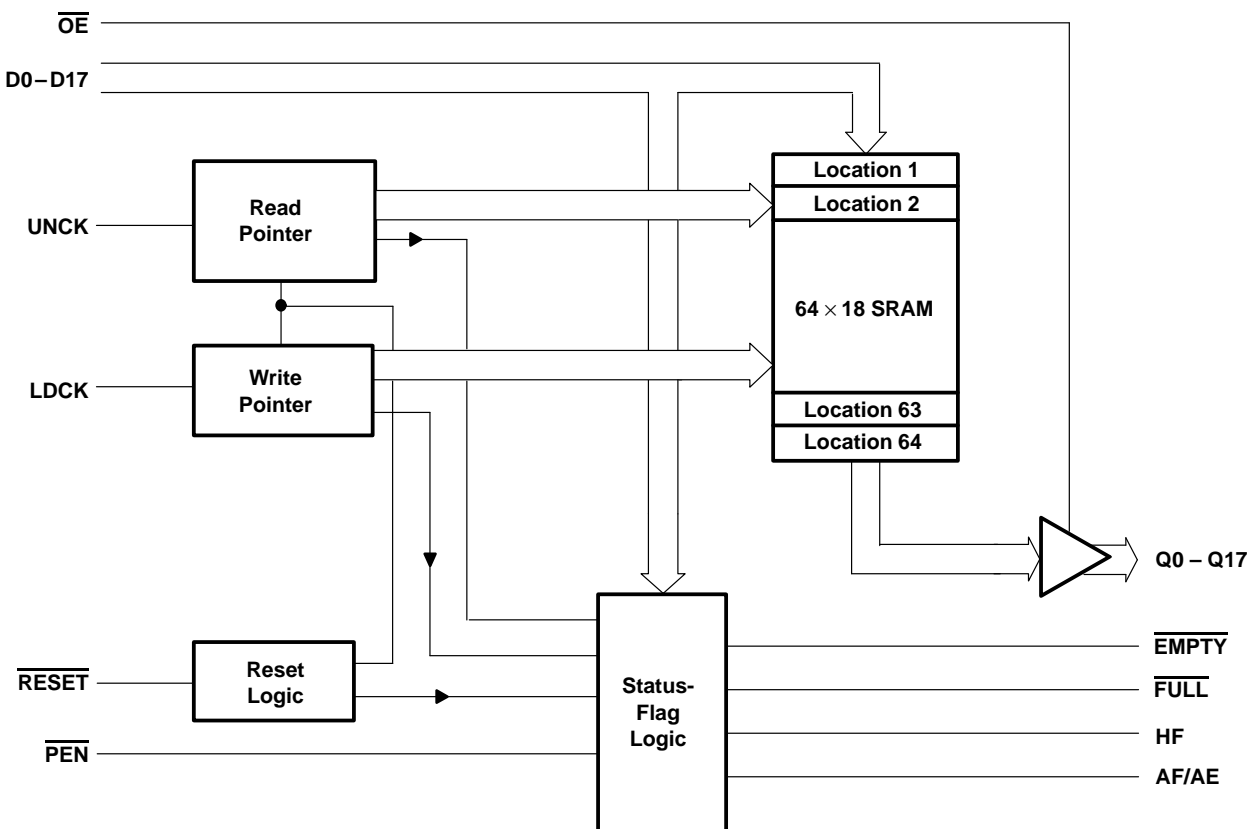


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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## functional block diagram



## Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
AF/AE	24	O	Almost-full/almost-empty flag. Depth-offset values can be programmed for AF/AE, or the default value of 8 can be used for both the almost-empty offset (X) and the almost-full offset (Y). AF/AE is high when memory contains X or less words or (64 – Y) or more words. AF/AE is high after reset.
D0–D17	2–9, 11–12, 14–21	I	18-bit data input port
$\overline{\text{EMPTY}}$	29	O	Empty flag. $\overline{\text{EMPTY}}$ is high when the FIFO memory is not empty; $\overline{\text{EMPTY}}$ is low when the FIFO memory is empty or upon assertion of $\overline{\text{RESET}}$ .
$\overline{\text{FULL}}$	28	O	Full flag. $\overline{\text{FULL}}$ is high when the FIFO memory is not full or upon assertion of $\overline{\text{RESET}}$ ; $\overline{\text{FULL}}$ is low when the FIFO memory is full.
HF	22	O	Half-full flag. HF is high when the FIFO memory contains 32 or more words. HF is low after reset.
LDCK	25	I	Load clock. Data is written to the FIFO on the rising edge of LDCK when $\overline{\text{FULL}}$ is high.
$\overline{\text{OE}}$	56	I	Output enable. When $\overline{\text{OE}}$ is high, the data outputs are in the high-impedance state.
$\overline{\text{PEN}}$	23	I	Program enable. After reset and before the first word is written to the FIFO, the binary value on D0–D4 is latched as an AF/AE offset value when $\overline{\text{PEN}}$ is low and WRTCLK is high.
Q0–Q17	33–34, 36–38, 40–43, 45–49, 51, 53–55	O	18-bit data output port
$\overline{\text{RESET}}$	1	I	Reset. A low level on $\overline{\text{RESET}}$ resets the FIFO and drives $\overline{\text{FULL}}$ high and HF and $\overline{\text{EMPTY}}$ low.
UNCK	32	I	Unload clock. Data is read from the FIFO on the rising edge of UNCK when $\overline{\text{EMPTY}}$ is high.

## offset values for AF/AE

The almost-full/almost-empty flag has two programmable limits: the almost-empty offset value (X) and the almost-full offset value (Y). They can be programmed after the FIFO is reset and before the first word is written to memory. The AF/AE flag is high when the FIFO contains X or less words or (64 – Y) or more words.

To program the offset values, program enable ( $\overline{\text{PEN}}$ ) can be brought low after reset only when LDCK is low. On the following low-to-high transition of LDCK, the binary value on D0–D4 is stored as the almost-empty offset value (X) and the almost-full offset value (Y). Holding  $\overline{\text{PEN}}$  low for another low-to-high transition of LDCK reprograms Y to the binary value on D0–D4 at the time of the second LDCK low-to-high transition. Writes to the FIFO memory are disabled while the offsets are programmed. A maximum value of 31 can be programmed for either X or Y (see Figure 1). To use the default values of X = Y = 8,  $\overline{\text{PEN}}$  must be held high.

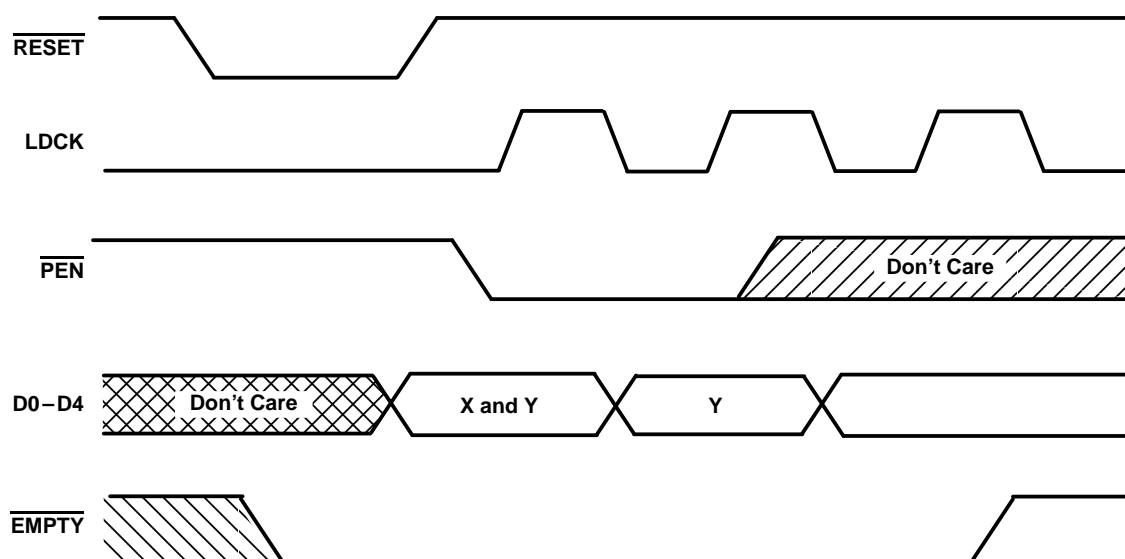


Figure 1. Programming X and Y Separately

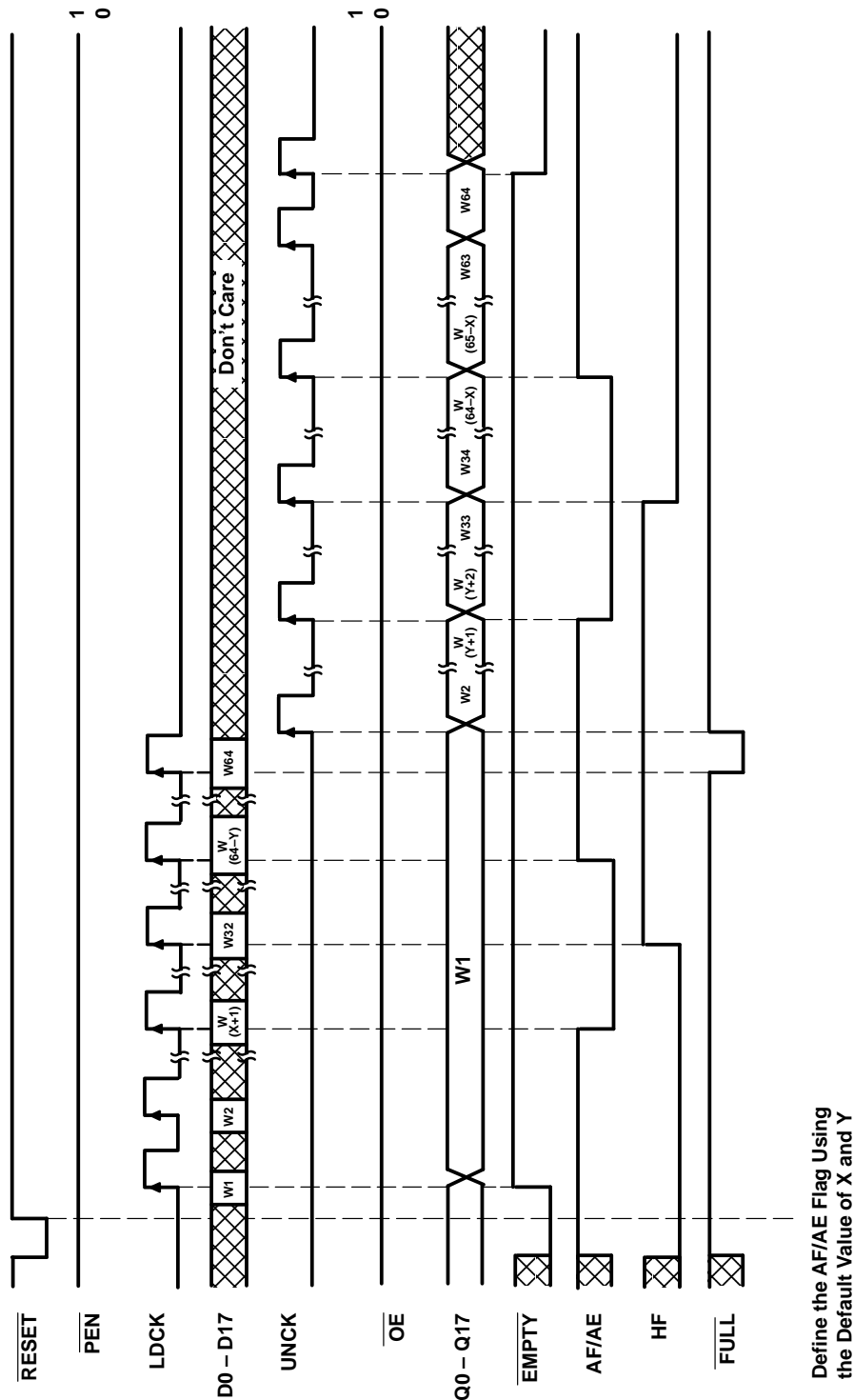


Figure 2. Write, Read, and Flag Timing Reference

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

Supply voltage range, $V_{CC}$	–0.5 V to 7 V
Input voltage, $V_I$	7 V
Voltage applied to a disabled 3-state output	5.5 V
Operating free-air temperature range, $T_A$	0°C to 70°C
Storage temperature range, $T_{stg}$	–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.

**recommended operating conditions**

			'ACT7814-20		'ACT7814-25		'ACT7814-40		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>CC</sub>	Supply voltage		4.5	5.5	4.5	5.5	4.5	5.5	V
V <sub>IH</sub>	High-level input voltage		2		2		2		V
V <sub>IL</sub>	Low-level input voltage		0.8		0.8		0.8		V
I <sub>OH</sub>	High-level output current	Q outputs, Flags	−8		−8		−8		mA
I <sub>OL</sub>	Low-level output current	Q outputs	16		16		16		mA
		Flags	8		8		8		
f <sub>clock</sub>	Clock frequency		50		40		25		MHz
t <sub>w</sub>	Pulse duration	LDCK high or low	7		8		12		ns
		UNCK high or low	7		8		12		
		PEN low	7		8		12		
		RESET low	10		10		12		
t <sub>su</sub>	Setup time	D0–D17 before LDCK↑	5		5		5		ns
		PEN before LDCK↑	5		5		5		
		LDCK inactive before RESET high	5		6		6		
t <sub>h</sub>	Hold time	D0–D17 after LDCK↑	0		0		0		ns
		LDCK inactive after RESET high	5		6		6		
		PEN low after LDCK↑	3		3		3		
		PEN high after LDCK↓	0		0		0		
T <sub>A</sub>	Operating free-air temperature		0	70	0	70	0	70	°C

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

PARAMETER	TEST CONDITIONS		MIN	TYP‡	MAX	UNIT
$V_{OH}$	$V_{CC} = 4.5\text{ V}$ ,	$I_{OH} = -8\text{ mA}$	2.4			V
$V_{OL}$	Flags	$V_{CC} = 4.5\text{ V}$ ,			0.5	V
	Q outputs	$V_{CC} = 4.5\text{ V}$ ,			0.5	
$I_I$	$V_{CC} = 5.5\text{ V}$ ,	$V_I = V_{CC}$ or 0			±5	μA
$I_{OZ}$	$V_{CC} = 5.5\text{ V}$ ,	$V_O = V_{CC}$ or 0			±5	μA
$I_{CC}$	$V_I = V_{CC} - 0.2\text{ V}$ or 0				400	μA
$\Delta I_{CC}^{\S}$	$V_{CC} = 5.5\text{ V}$ ,	One input at 3.4 V, Other inputs at $V_{CC}$ or GND			1	mA
$C_i$	$V_I = 0$ ,	$f = 1\text{ MHz}$		4		pF
$C_o$	$V_O = 0$ ,	$f = 1\text{ MHz}$		8		pF

‡ All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

§ This is the supply current for each input that is at one of the specified TTL voltage levels rather 0 V or  $V_{CC}$ .

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switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50$  pF (unless otherwise noted) (see Figures 5 and 6)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	'ACT7814-20			'ACT7814-25		'ACT7814-40		UNIT
			MIN	TYP†	MAX	MIN	MAX	MIN	MAX	
$f_{max}$	LDCK or UNCK		50			40		25		MHz
$t_{pd}$	LDCK↑	Any Q	9		20	9	22	9	24	ns
	UNCK↑		6	11.5	15	6	18	6	20	
	UNCK↑‡			10.5						
$t_{PLH}$	LDCK↑	EMPTY	6		15	6	17	6	19	ns
$t_{PHL}$	UNCK↑		6		15	6	17	6	19	
	RESET low		4		16	4	18	4	20	
$t_{PHL}$	LDCK↑	FULL	6		15	6	17	6	19	ns
$t_{PLH}$	UNCK↑		6		15	6	17	6	19	
	RESET low		4		18	4	20	4	22	
$t_{pd}$	LDCK↑	AF/AE	7		18	7	20	7	22	ns
	UNCK↑		7		18	7	20	7	22	
$t_{PLH}$	RESET low		2		10	2	12	2	14	
$t_{PLH}$	LDCK↑	HF	5		18	5	20	5	22	ns
$t_{PHL}$	UNCK↑		7		18	7	20	7	22	
	RESET low		3		12	3	14	3	16	
$t_{en}$	OE	Any Q	2		9	2	10	2	11	ns
$t_{dis}$			2		10	2	11	2	12	

† All typical values are at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$ .

‡ This parameter is measured at  $C_L = 30$  pF (see Figure 3).

operating characteristics,  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$ 

PARAMETER			TEST CONDITIONS	TYP	UNIT
$C_{pd}$	Power dissipation capacitance per FIFO channel	Outputs enabled	$C_L = 50$ pF, $f = 5$ MHz	53	pF

TYPICAL CHARACTERISTICS

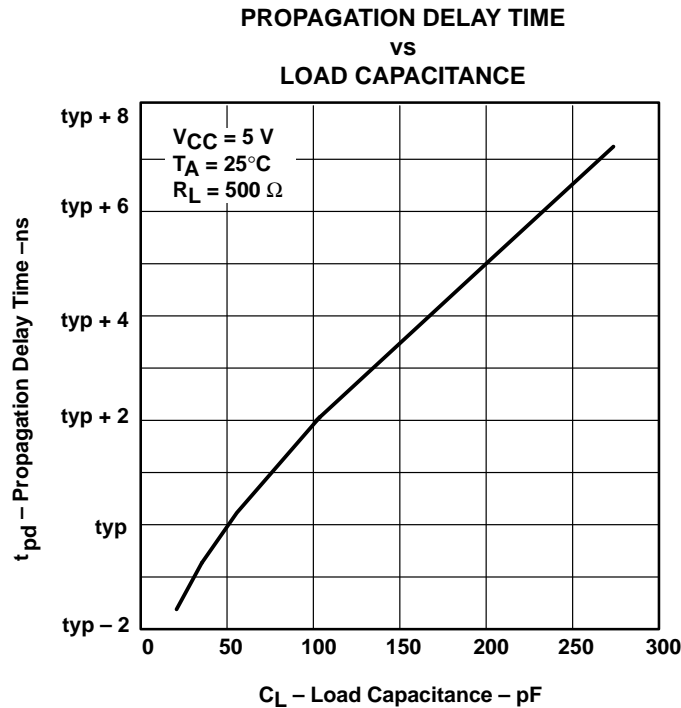


Figure 3

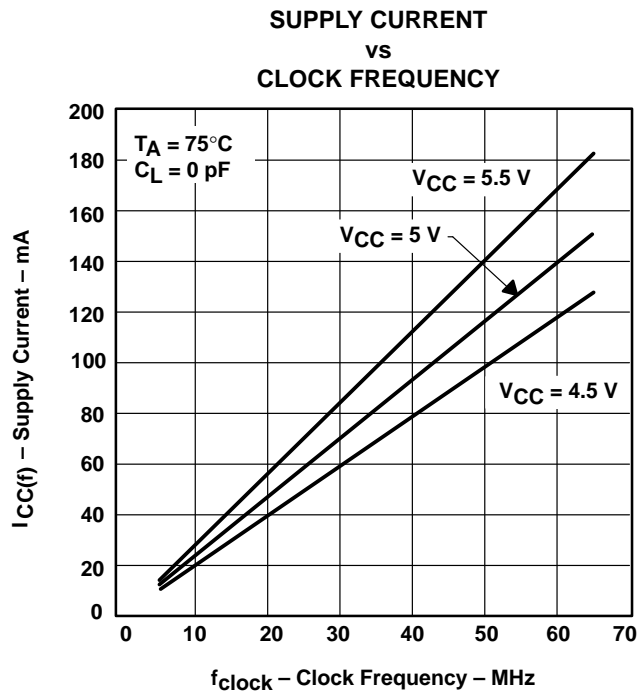


Figure 4



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## TYPICAL CHARACTERISTICS

### calculating power dissipation

With  $I_{CC(f)}$  taken from Figure 4, the maximum power dissipation ( $P_T$ ) based on all data outputs changing states on each read can be calculated by:

$$P_T = V_{CC} \times [I_{CC(f)} + (N \times \Delta I_{CC} \times dc)] + \Sigma(C_L \times V_{CC}^2 \times f_o)$$

A more accurate power calculation based on device use and average number of data outputs switching can be found by:

$$P_T = V_{CC} \times [I_{CC} + (N \times \Delta I_{CC} \times dc)] + \Sigma(C_{pd} \times V_{CC}^2 \times f_i) + \Sigma(C_L \times V_{CC}^2 \times f_o)$$

where:

$I_{CC}$	=	power-down $I_{CC}$ maximum
$N$	=	number of inputs driven by a TTL device
$\Delta I_{CC}$	=	increase in supply current
$dc$	=	duty cycle of inputs at a TTL high level of 3.4 V
$C_{pd}$	=	power dissipation capacitance
$C_L$	=	output capacitive load
$f_i$	=	data input frequency
$f_o$	=	data output frequency

## APPLICATION INFORMATION

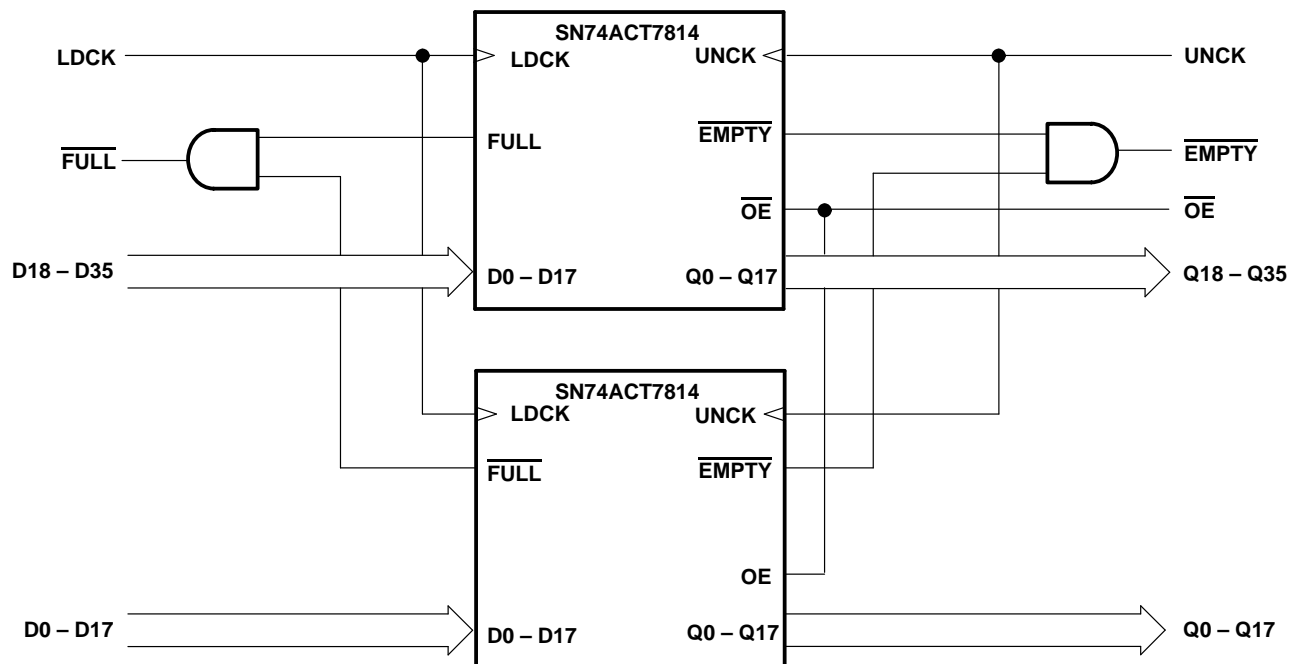
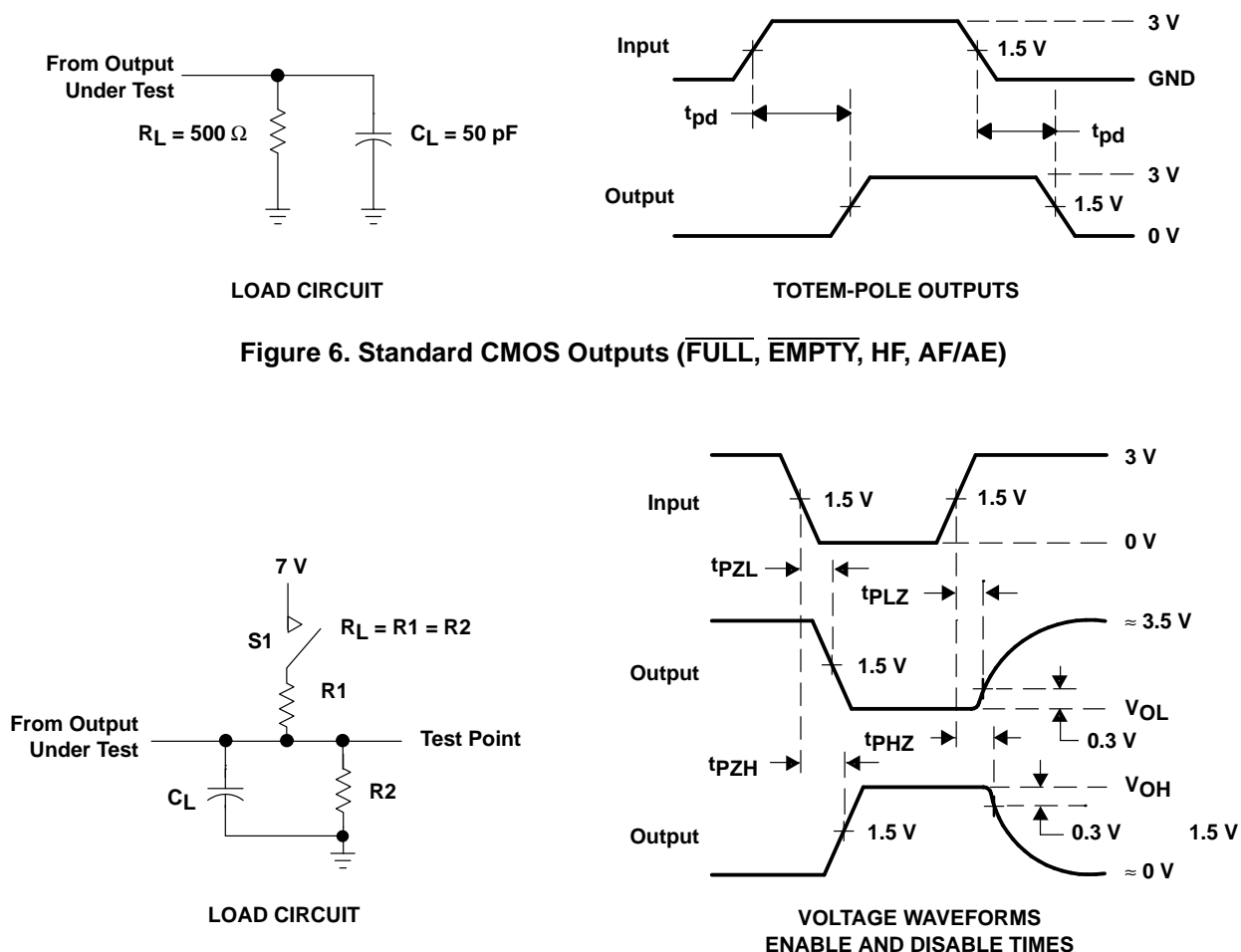


Figure 5. Word-Width Expansion: 64 Words by 36 Bits

## PARAMETER MEASUREMENT INFORMATION

Figure 6. Standard CMOS Outputs (FULL, EMPTY, HF, AF/AE)

PARAMETER		R1, R2	$C_L^\dagger$	S1
$t_{en}$	$t_{PZH}$	500 $\Omega$	50 pF	Open
	$t_{PZL}$			Closed
$t_{dis}$	$t_{PHZ}$	500 $\Omega$	50 pF	Open
	$t_{PLZ}$			Closed
$t_{pd}$		500 $\Omega$	50 pF	Open

$^\dagger$  Includes probe and test-fixture capacitance

Figure 7. 3-State Outputs (Any Q)

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