

**CYPRESS**

64/256/512/1K/2K/4K x18 Low-Voltage Synchronous FIFOs

Features

- 3.3V operation for low power consumption and easy integration into low-voltage systems
- High-speed, low-power, first-in first-out (FIFO) memories
- 64 x 18 (CY7C4425V)
- 256 x 18 (CY7C4205V)
- 512 x 18 (CY7C4215V)
- 1K x 18 (CY7C4225V)
- 2K x 18 (CY7C4235V)
- 4K x 18 (CY7C4245V)
- 0.65 μ CMOS
- High-speed 67-MHz operation (15-ns read/write cycle times)
- Low power
 - $I_{CC} = 30$ mA
- 5V tolerant inputs ($V_{IH\ MAX} = 5V$)
- Fully asynchronous and simultaneous read and write operation
- Empty, Full, Half Full, and programmable Almost Empty and Almost Full status flags
- TTL compatible
- Retransmit function
- Output Enable (\overline{OE}) pin
- Independent read and write enable pins
- Supports free-running 50% duty cycle clock inputs
- Width Expansion Capability
- Depth Expansion Capability
- 64-pin 14x14 TQFP and 64-pin 10x10 STQFP

Functional Description

The CY7C42X5V are high-speed, low-power, first-in first-out (FIFO) memories with clocked read and write interfaces. All are 18 bits wide. The CY7C42X5V can be cascaded to increase FIFO depth. Programmable features include Almost Full/Automatic Empty flags. These FIFOs provide solutions for a wide variety of data buffering needs, including high-speed data acquisition, multiprocessor interfaces, and communications buffering.

These FIFOs have 18-bit input and output ports that are controlled by separate clock and enable signals. The input port is controlled by a Free-Running Clock (WCLK) and a Write Enable pin (WEN).

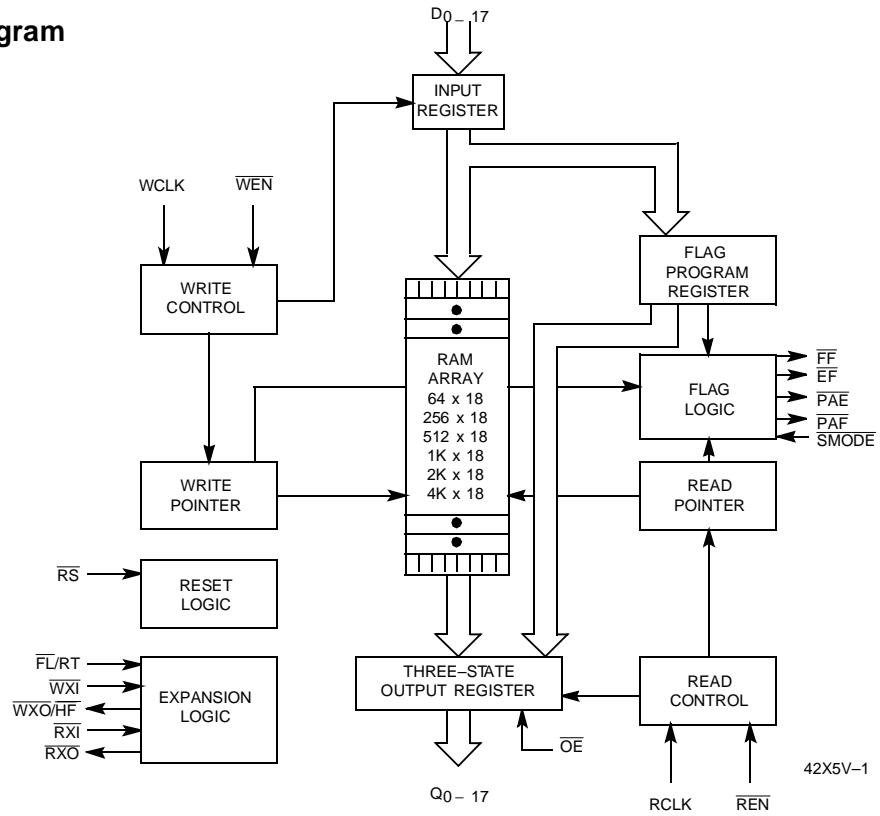
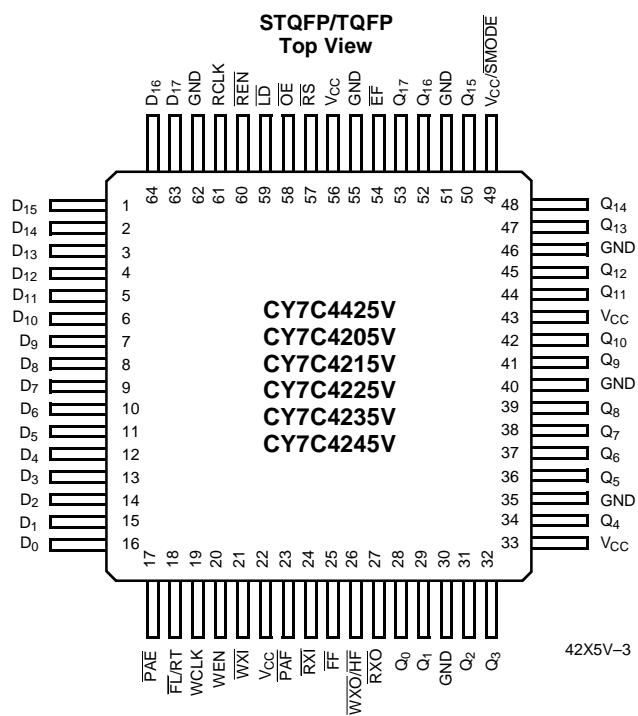
When \overline{WEN} is asserted, data is written into the FIFO on the rising edge of the WCLK signal. While \overline{WEN} is held active, data is continually written into the FIFO on each cycle. The output port is controlled in a similar manner by a Free-Running Read Clock (RCLK) and a Read Enable pin (REN). In addition, the CY7C42X5V have an Output Enable pin (OE). The read and write clocks may be tied together for single-clock operation or the two clocks may be run independently for asynchronous read/write applications. Clock frequencies up to 66 MHz are achievable.

Retransmit and Synchronous Almost Full/Automatic Empty flag features are available on these devices.

Depth expansion is possible using the Cascade Input (\overline{WXI} , \overline{RXI}), Cascade Output (\overline{WXO} , \overline{RXO}), and First Load (\overline{FL}) pins. The \overline{WXO} and \overline{RXO} pins are connected to the \overline{WXI} and \overline{RXI} pins of the next device, and the \overline{WXO} and \overline{RXO} pins of the last device should be connected to the \overline{WXI} and \overline{RXI} pins of the first device. The \overline{FL} pin of the first device is tied to V_{SS} and the \overline{FL} pin of all the remaining devices should be tied to V_{CC} .

The CY7C42X5V provides five status pins. These pins are decoded to determine one of five states: Empty, Almost Empty, Half Full, Almost Full, and Full (see Table 2). The Half Full flag shares the \overline{WXO} pin. This flag is valid in the stand-alone and width-expansion configurations. In the depth expansion, this pin provides the expansion out (\overline{WXO}) information that is used to signal the next FIFO when it will be activated.

The Empty and Full flags are synchronous, i.e., they change state relative to either the Read Clock (RCLK) or the write clock (WCLK). When entering or exiting the Empty states, the flag is updated exclusively by the RCLK. The flag denoting Full states is updated exclusively by WCLK. The synchronous flag architecture guarantees that the flags will remain valid from one clock cycle to the next. As mentioned previously, the Almost Empty/Automatic Full flags become synchronous if the V_{CC}/\overline{SMODE} is tied to V_{SS} . All configurations are fabricated using an advanced 0.65 μ P-Well CMOS technology. Input ESD protection is greater than 2001V, and latch-up is prevented by the use of guard rings.

Logic Block Diagram

Pin Configuration




**CY7C4425V/4205V/4215V
CY7C4225V/4235V/4245V**

Selection Guide

| | CY7C42X5V-15 | CY7C42X5V-25 | CY7C42X5V-35 |
|------------------------------------|---------------------|---------------------|---------------------|
| Maximum Frequency (MHz) | 66.7 | 40 | 28.6 |
| Maximum Access Time (ns) | 11 | 15 | 20 |
| Minimum Cycle Time (ns) | 15 | 25 | 35 |
| Minimum Data or Enable Set-Up (ns) | 4 | 6 | 7 |
| Minimum Data or Enable Hold (ns) | 1 | 1 | 2 |
| Maximum Flag Delay (ns) | 11 | 15 | 20 |
| Operating Current (mA) | Commercial | 30 | 30 |

| | CY7C4425V | CY7C4205V | CY7C4215V | CY7C4225V | CY7C4235V | CY7C4245V |
|----------|---|---|---|---|---|---|
| Density | 64 x 18 | 256 x 18 | 512 x 18 | 1K x 18 | 2K x 18 | 4K x 18 |
| Packages | 64-pin 14x14 TQFP 64-pin 10x10 STQFP |

Pin Definitions

| Signal Name | Description | I/O | Function |
|-------------------|------------------------------------|-----|--|
| D ₀₋₁₇ | Data Inputs | I | Data inputs for an 18-bit bus. |
| Q ₀₋₁₇ | Data Outputs | O | Data outputs for an 18-bit bus. |
| WEN | Write Enable | I | Enables the WCLK input. |
| REN | Read Enable | I | Enables the RCLK input. |
| WCLK | Write Clock | I | The rising edge clocks data into the FIFO when WEN is LOW and the FIFO is not Full. When LD is asserted, WCLK writes data into the programmable flag-offset register. |
| RCLK | Read Clock | I | The rising edge clocks data out of the FIFO when REN is LOW and the FIFO is not Empty. When LD is asserted, RCLK reads data out of the programmable flag-offset register. |
| WXO/HF | Write Expansion Out/Half Full Flag | O | Dual-Mode Pin: Single device or width expansion - Half Full status flag. Cascaded - Write Expansion Out signal, connected to WXI of next device. |
| EF | Empty Flag | O | When EF is LOW, the FIFO is empty. EF is synchronized to RCLK. |
| FF | Full Flag | O | When FF is LOW, the FIFO is full. FF is synchronized to WCLK. |
| PAE | Programmable Almost Empty | O | When PAE is LOW, the FIFO is almost empty based on the almost empty offset value programmed into the FIFO. PAE is asynchronous when V _{CC} /SMODE is tied to V _{CC} ; it is synchronized to RCLK when V _{CC} /SMODE is tied to V _{SS} . |
| PAF | Programmable Almost Full | O | When PAF is LOW, the FIFO is almost full based on the almost full offset value programmed into the FIFO. PAF is asynchronous when V _{CC} /SMODE is tied to V _{CC} ; it is synchronized to WCLK when V _{CC} /SMODE is tied to V _{SS} . |
| LD | Load | I | When LD is LOW, D ₀₋₁₇ (O ₀₋₁₇) are written (read) into (from) the programmable-flag-offset register. |
| FL/RT | First Load/Retransmit | I | Dual-Mode Pin: Cascaded - The first device in the daisy chain will have FL tied to V _{SS} ; all other devices will have FL tied to V _{CC} . In standard mode of width expansion, FL is tied to V _{SS} on all devices. Not Cascaded - Tied to V _{SS} . Retransmit function is also available in standalone mode by strobing RT. |
| WXI | Write Expansion Input | I | Cascaded - Connected to WXO of previous device. Not Cascaded - Tied to V _{SS} . |



**CY7C4425V/4205V/4215V
CY7C4225V/4235V/4245V**

Pin Definitions (continued)

| Signal Name | Description | I/O | Function |
|------------------------|--|-----|--|
| RXI | Read Expansion Input | I | Cascaded - Connected to RXO of previous device. Not Cascaded - Tied to V _{SS} . |
| RXO | Read Expansion Output | O | Cascaded - Connected to RXI of next device. |
| RS | Reset | I | Resets device to empty condition. A reset is required before an initial read or write operation after power-up. |
| OE | Output Enable | I | When OE is LOW, the FIFO's data outputs drive the bus to which they are connected. If OE is HIGH, the FIFO's outputs are in High Z (high-impedance) state. |
| V _{CC} /SMODE | Synchronous Almost Empty/ Almost Full Flags | I | Dual-Mode Pin Asynchronous Almost Empty/Almost Full flags - tied to V _{CC} . Synchronous Almost Empty/Almost Full flags - tied to V _{SS} . (Almost Empty synchronized to RCLK, Almost Full synchronized to WCLK.) |

Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)

Storage Temperature -65°C to +150°C

Ambient Temperature with

Power Applied -55°C to +125°C

Supply Voltage to Ground Potential -0.5V to +5.0V

DC Voltage Applied to Outputs
in High Z State -0.5V to V_{CC}+0.5V

DC Input Voltage -0.5V to +5V

Output Current into Outputs (LOW) 20 mA

Static Discharge Voltage >2001V
(per MIL-STD-883, Method 3015)

Latch-Up Current >200 mA

Operating Range

| Range | Ambient Temperature | V _{CC} |
|-------|---------------------|-----------------|
| | Commercial | 0°C to +70°C |
| | | 3.3V ± 300 mV |

Electrical Characteristics Over the Operating Range

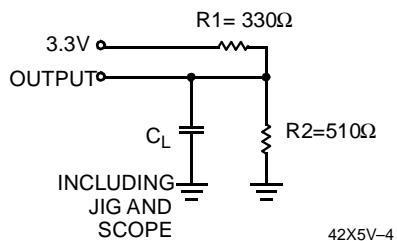
| Parameter | Description | Test Conditions | 7C42X5V-15 | | 7C42X5V-25 | | 7C42X5V-35 | | Unit |
|--------------------------------------|-------------------------------|--|------------|------|------------|------|------------|------|------|
| | | | Min. | Max. | Min. | Max. | Min. | Max. | |
| V _{OH} | Output HIGH Voltage | V _{CC} = Min., I _{OH} = -2.0 mA | 2.4 | | 2.4 | | 2.4 | | V |
| V _{OL} | Output LOW Voltage | V _{CC} = Min., I _{OL} = 8.0 mA | | 0.4 | | 0.4 | | 0.4 | V |
| V _{IH} | Input HIGH Voltage | Low = 2.0V High = V _{CC} + 0.5V | 2.0 | 5.0 | 2.0 | 5.0 | 2.0 | 5.0 | V |
| V _{IL} ^[1] | Input LOW Voltage | Low = -3.0V High = 0.8 V | -0.5 | 0.8 | -0.5 | 0.8 | -0.5 | 0.8 | V |
| I _{IX} | Input Leakage Current | V _{CC} = Max. | -10 | 10 | -10 | 10 | -10 | 10 | µA |
| I _{OZL} I _{OZH} | Output OFF, High Z Current | OE ≥ V _{IH} , V _{SS} < V _O < V _{CC} | -10 | +10 | -10 | +10 | -10 | +10 | µA |
| I _{CC} ^[2] | Operating Current | V _{CC} = Max., I _{OUT} = 0 mA | | 30 | | 30 | | 30 | mA |
| I _{SB} ^[3] | Standby Current | V _{CC} = Max., I _{OUT} = 0 mA | | 6 | | 6 | | 6 | mA |

Notes:

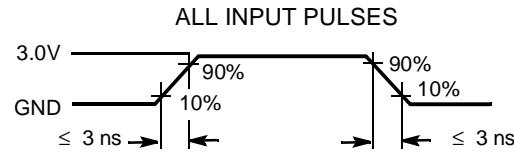
1. The V_{IH} and V_{IL} specifications apply for all inputs except WX_I, RX_I. The WX_I, RX_I pin is not a TTL input. It is connected to either RXO, WXO of the previous device or V_{SS}.
2. Input signals switch from 0V to 3V with a rise/fall time less than 3 ns, clocks and clock enables switch at 20 MHz, while the data inputs switch at 10 MHz. Outputs are unloaded.
3. All inputs = V_{CC} - 0.2V, except WCLK and RCLK, which are switching at 20 MHz.

Capacitance^[4]

| Parameter | Description | Test Conditions | Max. | Unit |
|-----------|--------------------|--|------|------|
| C_{IN} | Input Capacitance | $T_A = 25^\circ C$, $f = 1$ MHz, $V_{CC} = 5.0V$ | 5 | pF |
| C_{OUT} | Output Capacitance | | 7 | pF |

AC Test Loads and Waveforms^[5, 6]


42X5V-4



42X5V-5

Equivalent to: THÉVENIN EQUIVALENT
 $R_{th}=200\Omega$
 $OUTPUT \sim V_{th}=2.0V$

Switching Characteristics Over the Operating Range

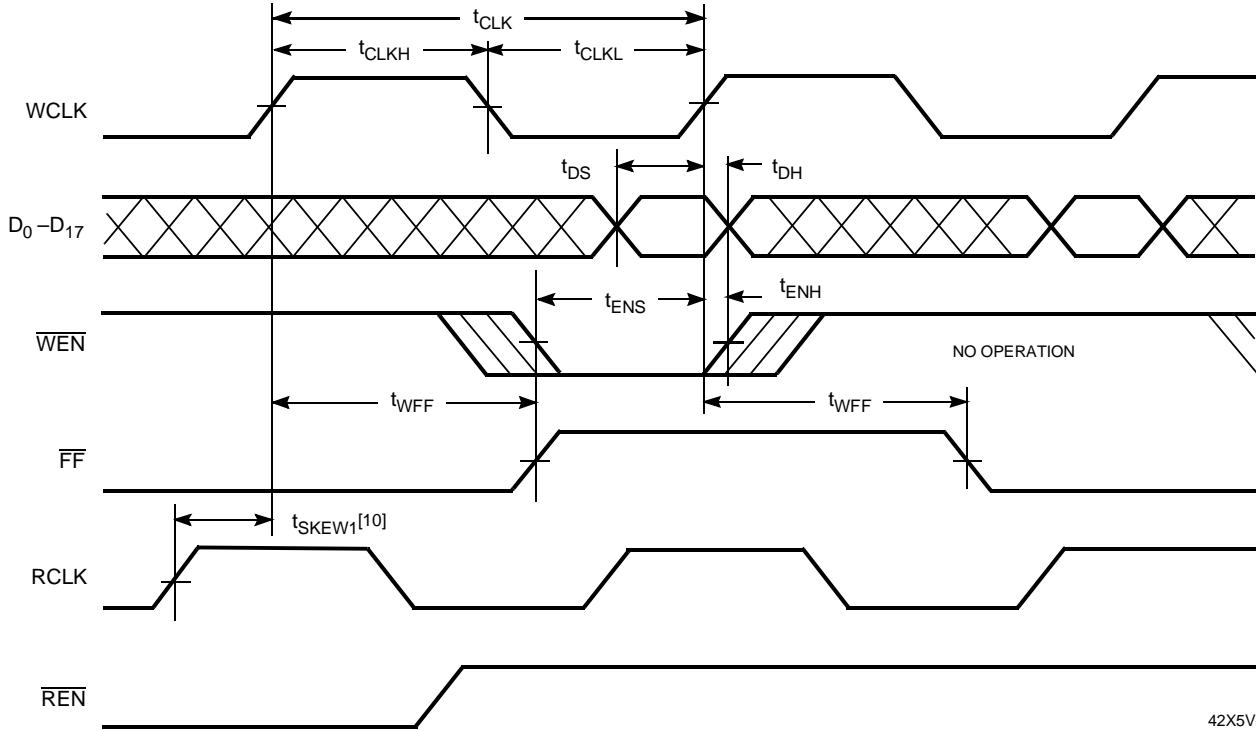
| Parameter | Description | 7C42X5V-15 | | 7C42X5V-25 | | 7C42X5V-35 | | Unit |
|----------------|--|------------|------|------------|------|------------|------|----------|
| | | Min. | Max. | Min. | Max. | Min. | Max. | |
| t_S | Clock Cycle Frequency | | | 66.7 | | 40 | | 28.6 MHz |
| t_A | Data Access Time | 2 | 11 | 2 | 15 | 2 | 20 | ns |
| t_{CLK} | Clock Cycle Time | 15 | | 25 | | 35 | | ns |
| t_{CLKH} | Clock HIGH Time | 6 | | 10 | | 14 | | ns |
| t_{CLKL} | Clock LOW Time | 6 | | 10 | | 14 | | ns |
| t_{DS} | Data Set-Up Time | 4 | | 6 | | 7 | | ns |
| t_{DH} | Data Hold Time | 1 | | 2 | | 2 | | ns |
| t_{ENS} | Enable Set-Up Time | 4 | | 6 | | 7 | | ns |
| t_{ENH} | Enable Hold Time | 1 | | 2 | | 2 | | ns |
| t_{RS} | Reset Pulse Width ^[7] | 15 | | 25 | | 35 | | ns |
| t_{RSR} | Reset Recovery Time | 10 | | 15 | | 20 | | ns |
| t_{RSF} | Reset to Flag and Output Time | | 18 | | 25 | | 35 | ns |
| t_{PRT} | Retransmit Pulse Width | 15 | | 25 | | 35 | | ns |
| t_{RTR} | Retransmit Recovery Time | 15 | | 25 | | 35 | | ns |
| t_{OLZ} | Output Enable to Output in Low Z ^[8] | 0 | | 0 | | 0 | | ns |
| t_{OE} | Output Enable to Output Valid | 3 | 8 | 3 | 12 | 3 | 15 | ns |
| t_{OHZ} | Output Enable to Output in High Z ^[8] | 3 | 8 | 3 | 12 | 3 | 15 | ns |
| t_{WFF} | Write Clock to Full Flag | | 11 | | 15 | | 20 | ns |
| t_{REF} | Read Clock to Empty Flag | | 11 | | 15 | | 20 | ns |
| $t_{PAFsynch}$ | Clock to Programmable Almost-Full Flag ^[9] (Asynchronous mode, $V_{CC}/SMODE$ tied to V_{CC}) | | 18 | | 22 | | 25 | ns |

Notes:

4. Tested initially and after any design or process changes that may affect these parameters
5. $C_L = 30$ pF for all AC parameters except for t_{OHZ}
6. $C_L = 5$ pF for t_{OHZ} .
7. Pulse widths less than minimum values are not allowed.
8. Values guaranteed by design, not currently tested.
9. $t_{PAFsynch}$, $t_{PAEsynch}$, after program register write will not be valid until 5 ns + $t_{PAF(E)}$.

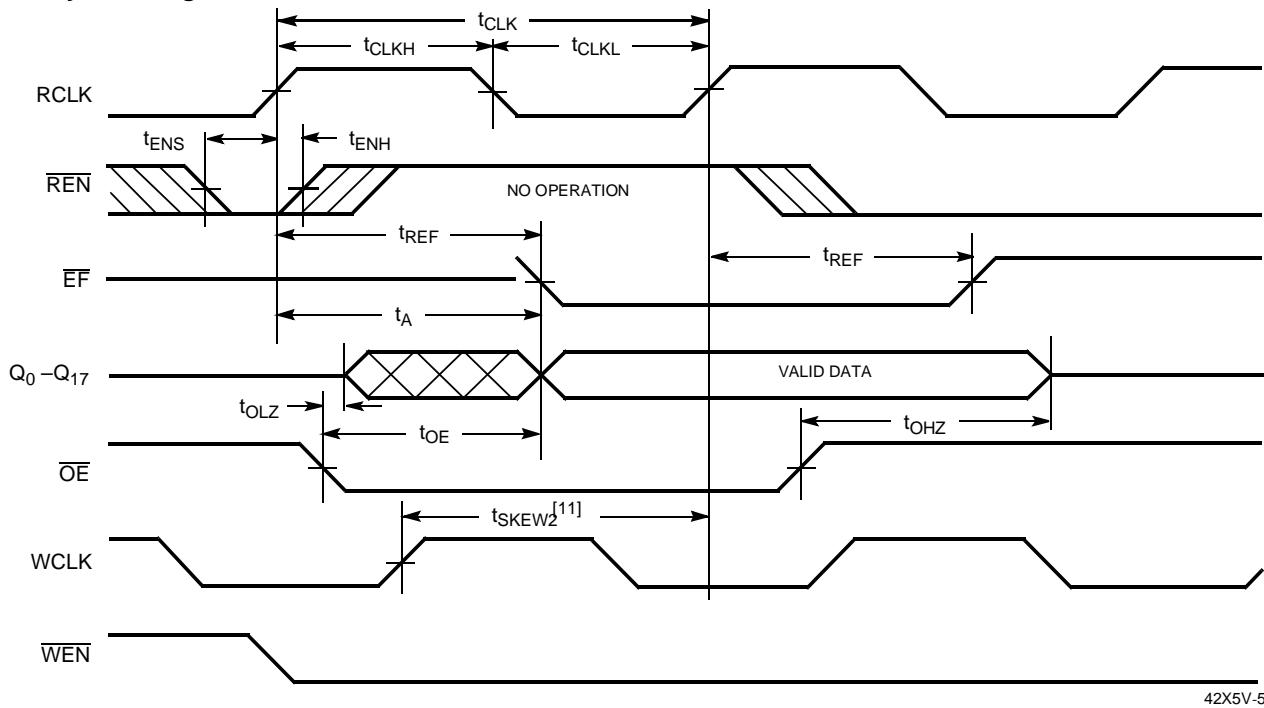
Switching Characteristics Over the Operating Range (continued)

| Parameter | Description | 7C42X5V-15 | | 7C42X5V-25 | | 7C42X5V-35 | | Unit |
|-----------------|--|------------|------|------------|------|------------|------|------|
| | | Min. | Max. | Min. | Max. | Min. | Max. | |
| $t_{PAFsynch}$ | Clock to Programmable Almost-Full Flag (Synchronous mode, $V_{CC}/SMODE$ tied to V_{SS}) | | 11 | | 15 | | 20 | ns |
| $t_{PAEasynch}$ | Clock to Programmable Almost-Empty Flag ^[9] (Asynchronous mode, $V_{CC}/SMODE$ tied to V_{CC}) | | 18 | | 22 | | 25 | ns |
| $t_{PAEsynch}$ | Clock to Programmable Almost-Full Flag (Synchronous mode, $V_{CC}/SMODE$ tied to V_{SS}) | | 11 | | 15 | | 20 | ns |
| t_{HF} | Clock to Half-Full Flag | | 16 | | 20 | | 25 | ns |
| t_{XO} | Clock to Expansion Out | | 10 | | 15 | | 20 | ns |
| t_{XI} | Expansion in Pulse Width | 6.5 | | 10 | | 14 | | ns |
| t_{XIS} | Expansion in Set-Up Time | 5 | | 10 | | 15 | | ns |
| t_{SKEW1} | Skew Time between Read Clock and Write Clock for Full Flag | 6 | | 10 | | 12 | | ns |
| t_{SKEW2} | Skew Time between Read Clock and Write Clock for Empty Flag | 6 | | 10 | | 12 | | ns |
| t_{SKEW3} | Skew Time between Read Clock and Write Clock for Programmable Almost Empty and Programmable Almost Full Flags. | 15 | | 18 | | 20 | | ns |

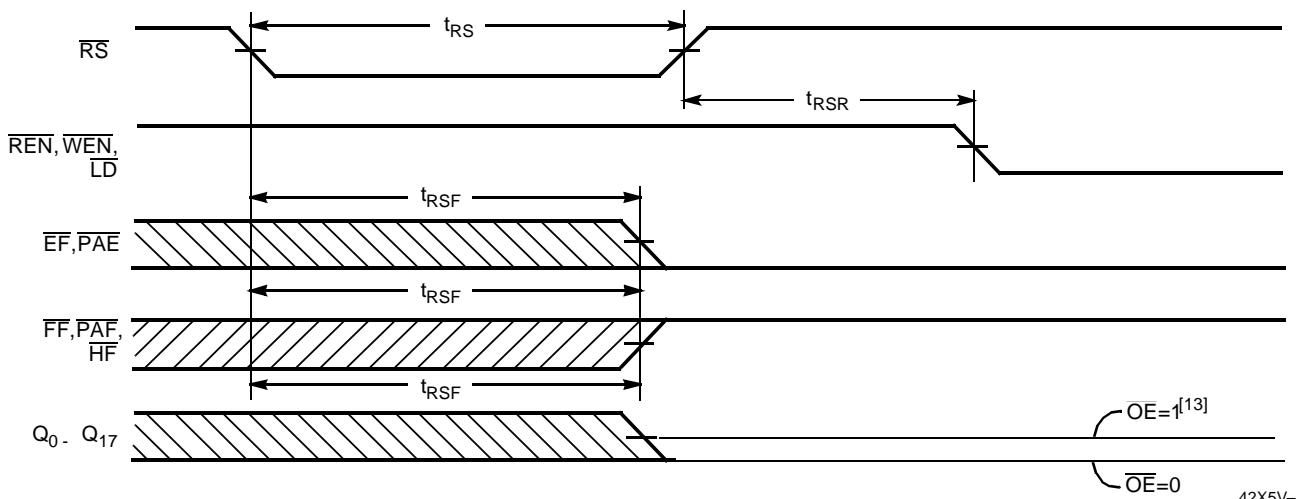
Switching Waveforms
Write Cycle Timing

Note:

10. t_{SKEW1} is the minimum time between a rising RCLK edge and a rising WCLK edge to guarantee that \overline{FF} will go HIGH during the current clock cycle. If the time between the rising edge of RCLK and the rising edge of WCLK is less than t_{SKEW1} , then \overline{FF} may not change state until the next WCLK edge.

Switching Waveforms (continued)

Read Cycle Timing


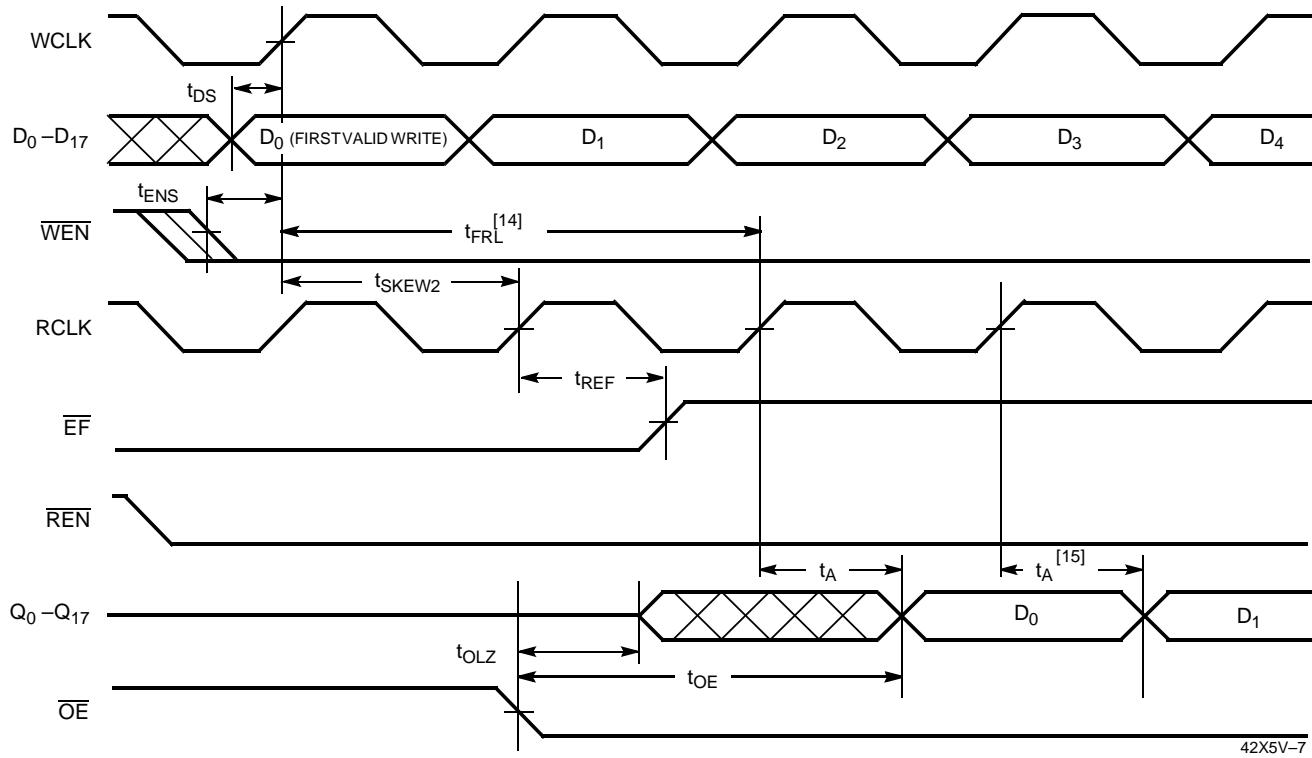
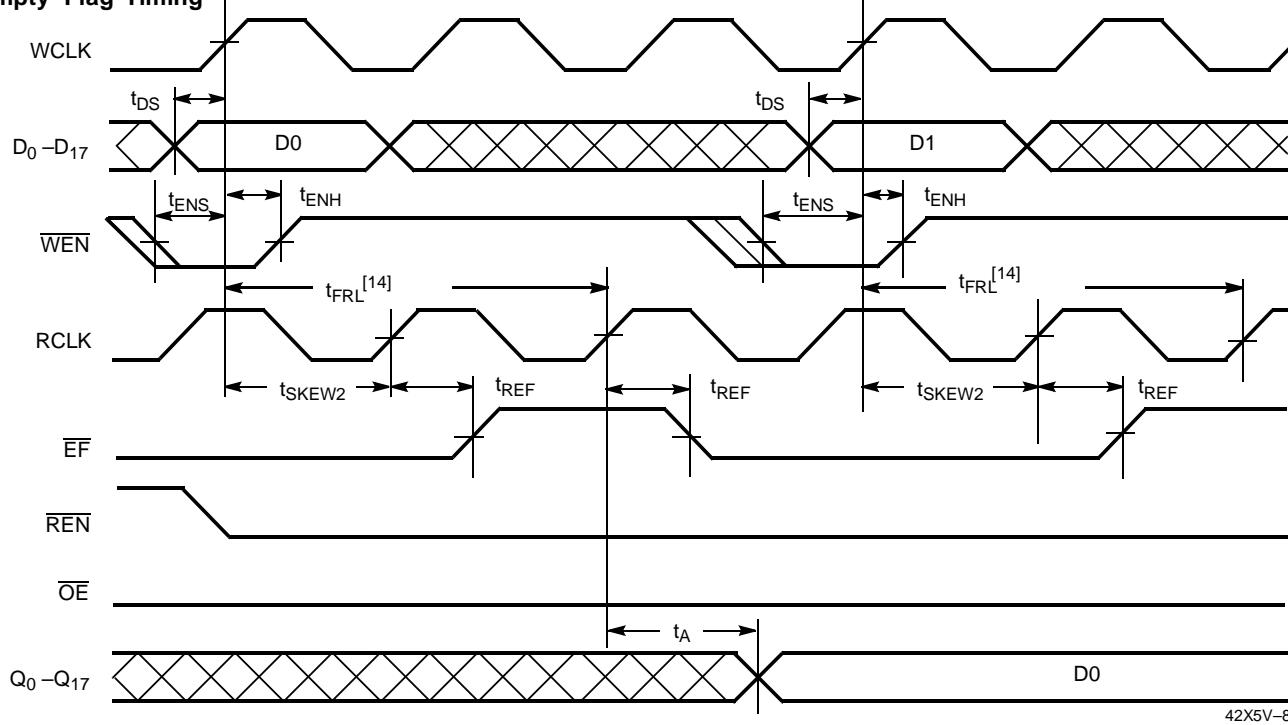
42X5V-5

Reset Timing^[12]


42X5V-6

Notes:

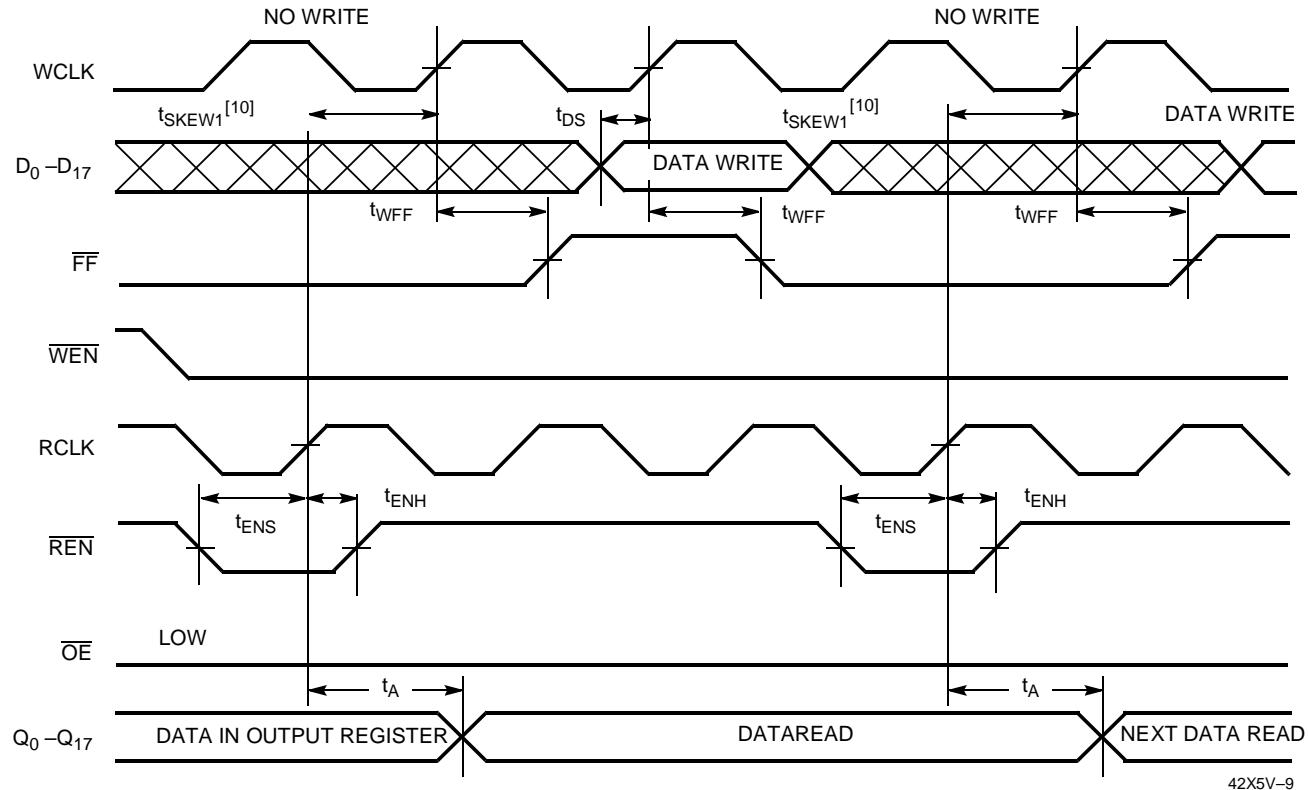
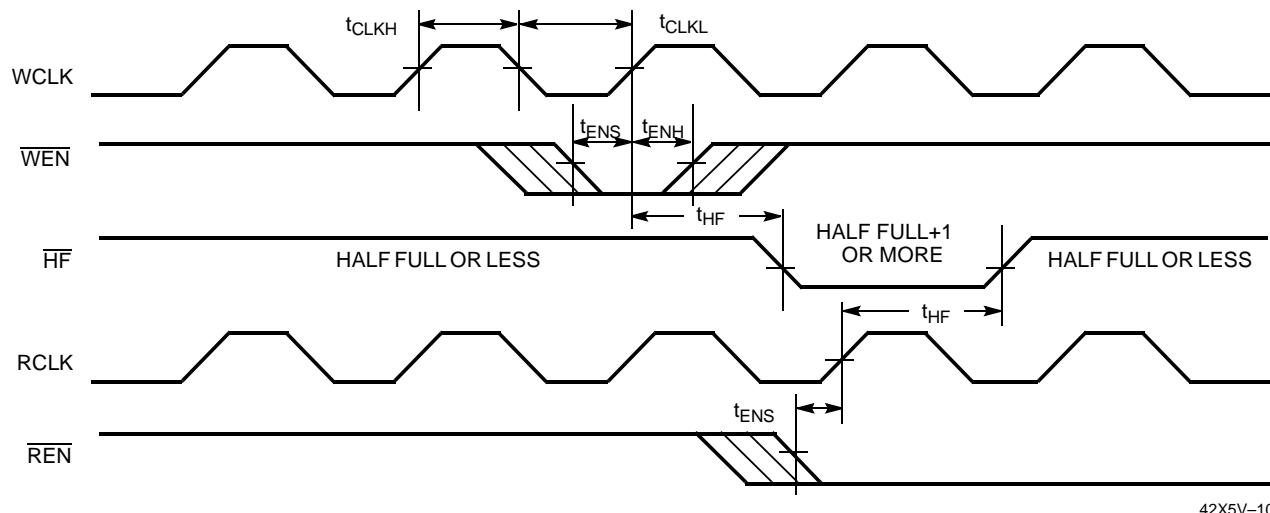
11. t_{SKEW2} is the minimum time between a rising WCLK edge and a rising RCLK edge to guarantee that \overline{EF} will go HIGH during the current clock cycle. If the time between the rising edge of WCLK and the rising edge of RCLK is less than t_{SKEW2} , then \overline{EF} may not change state until the next RCLK edge.
12. The clocks (RCLK, WCLK) can be free-running during reset.
13. After reset, the outputs will be LOW if $\overline{OE} = 0$ and three-state if $\overline{OE} = 1$.

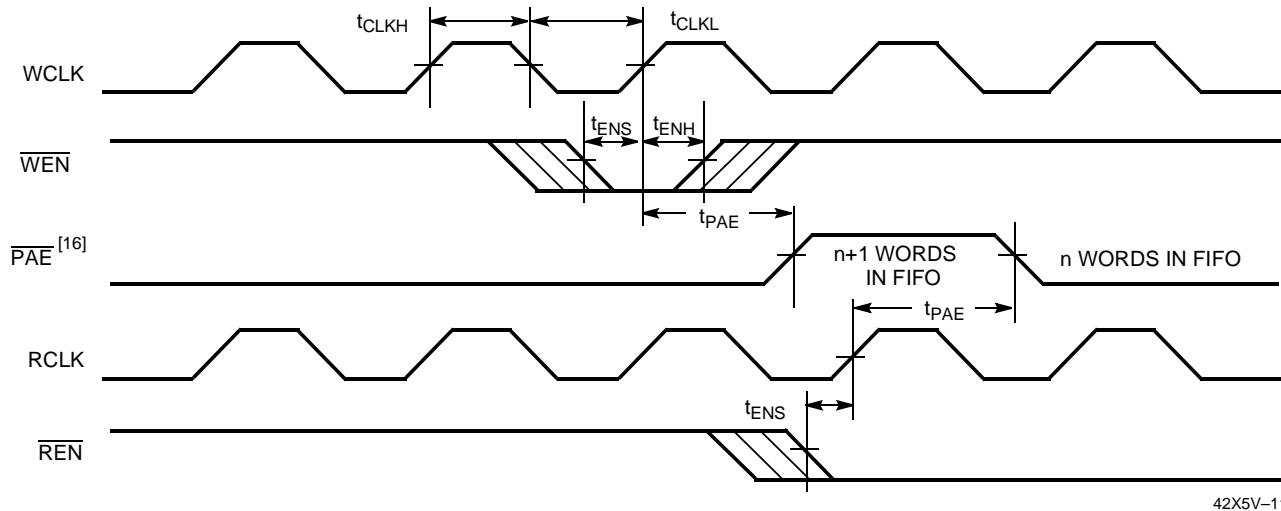
Switching Waveforms (continued)
First Data Word Latency after Reset with Simultaneous Read and Write

Empty Flag Timing

Notes:

14. When $t_{SKEW2} \geq$ minimum specification, t_{FRL} (maximum) = $t_{CLK} + t_{SKEW2}$. When $t_{SKEW2} <$ minimum specification, t_{FRL} (maximum) = either $2*t_{CLK} + t_{SKEW2}$ or $t_{CLK} + t_{SKEW2}$. The Latency Timing applies only at the Empty Boundary (EF = LOW).

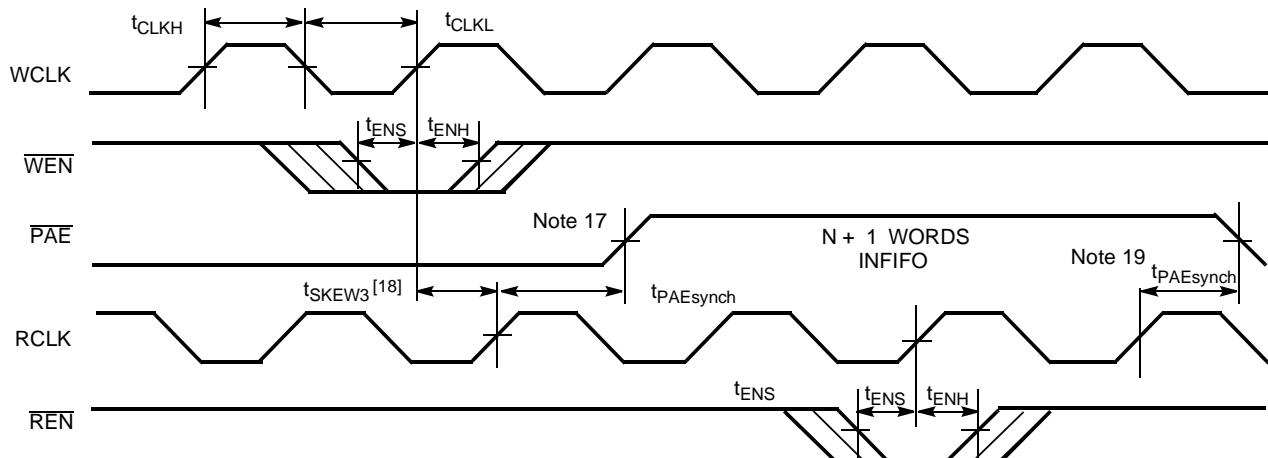
15. The first word is available the cycle after EF goes HIGH, always.

Switching Waveforms (continued)

Full Flag Timing

Half-Full Flag Timing


Switching Waveforms (continued)
Programmable Almost Empty Flag Timing


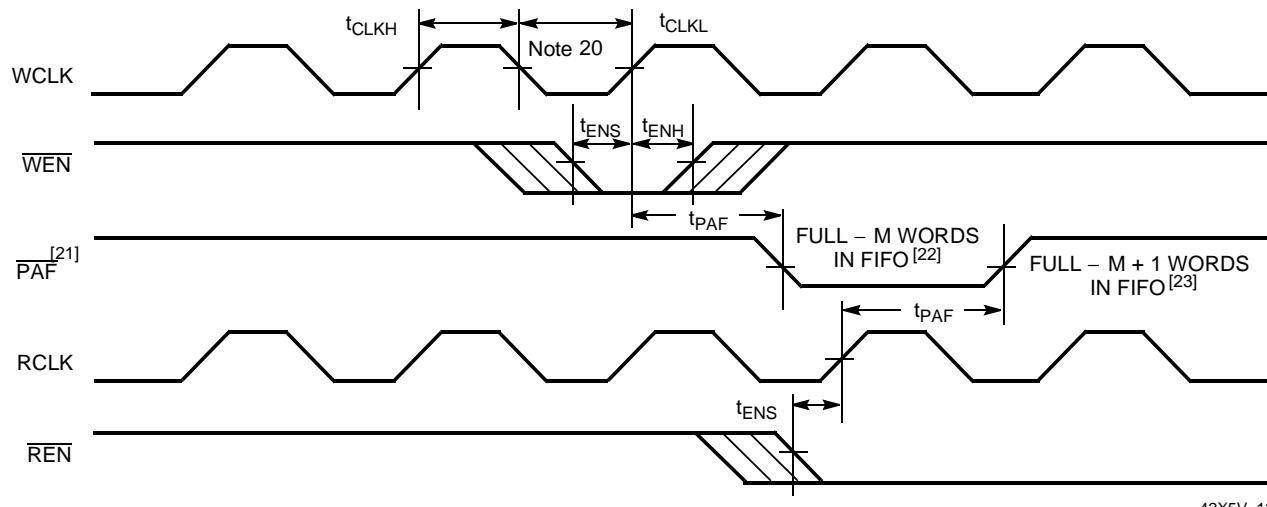
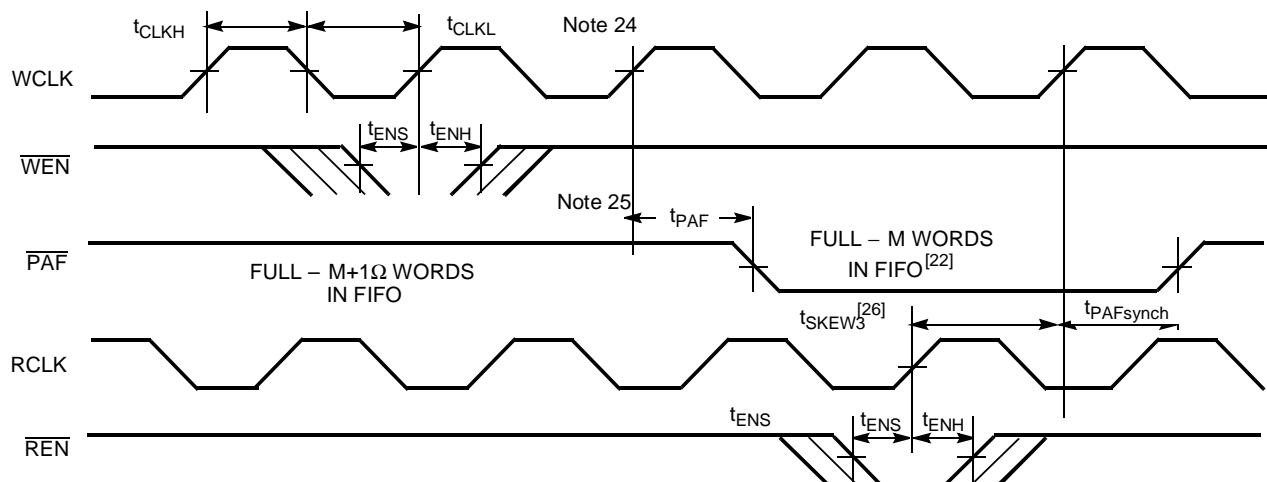
42X5V-11

Programmable Almost Empty Flag Timing (applies only in $\overline{\text{SMODE}}$ (SMODE is LOW))


42X5V-12

Notes:

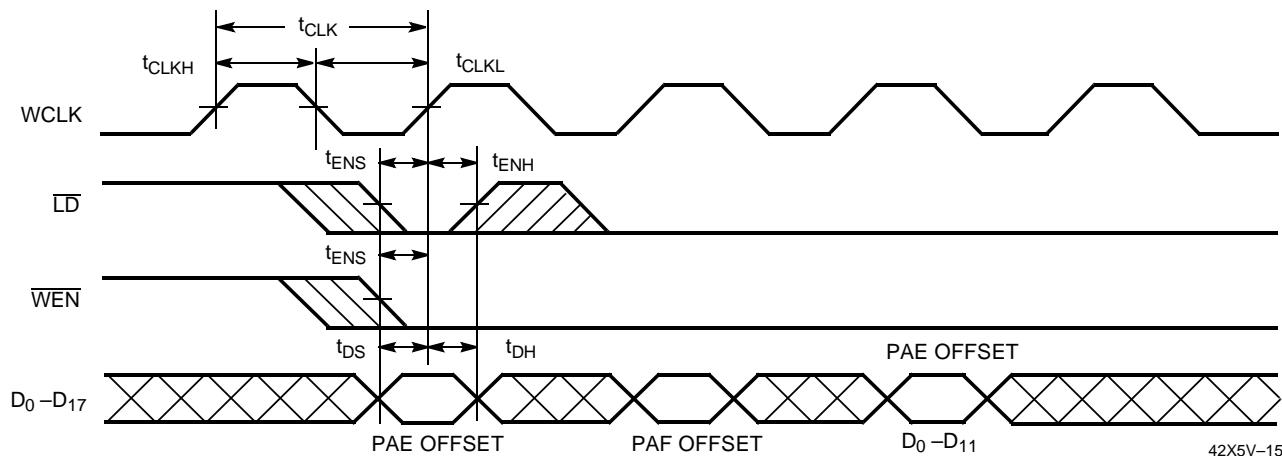
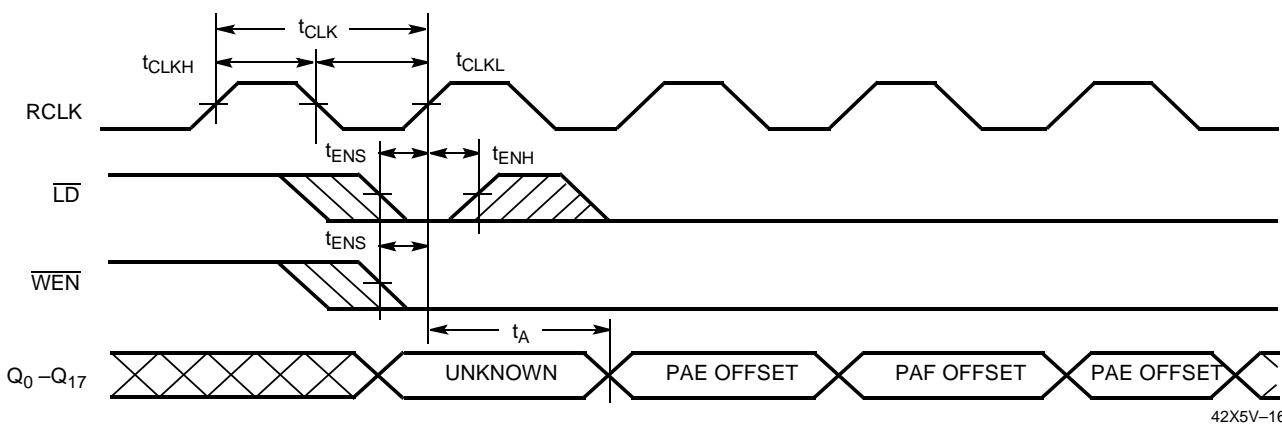
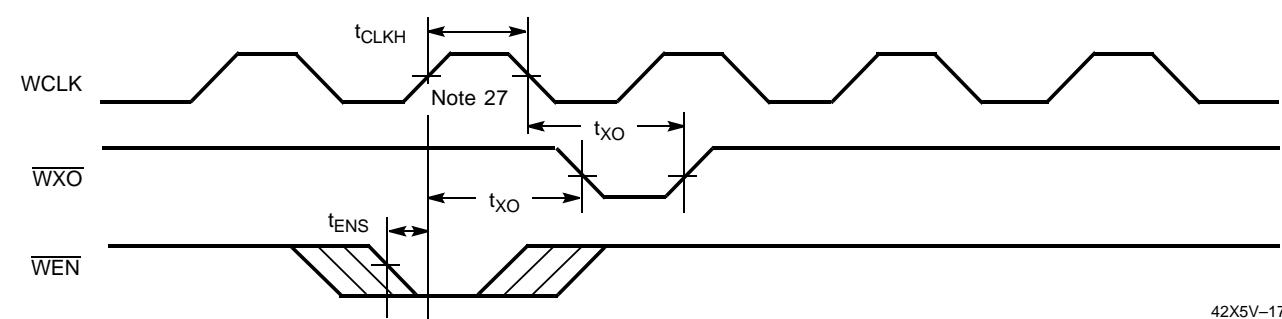
16. PAE offset $-n$. Number of data words into FIFO already = n .
17. PAE offset $-n$.
18. $t_{\text{SKEW}3}$ is the minimum time between a rising WCLK and a rising RCLK edge for PAE to change state during that clock cycle. If the time between the edge of WCLK and the rising RCLK is less than $t_{\text{SKEW}3}$, then PAE may not change state until the next RCLK.
19. If a read is performed on this rising edge of the read clock, there will be Empty + $(n-1)$ words in the FIFO when PAE goes LOW.

Switching Waveforms (continued)
Programmable Almost Full Flag Timing

Programmable Almost Full Flag Timing (applies only in $\overline{\text{SMODE}}$ (SMODE in LOW))


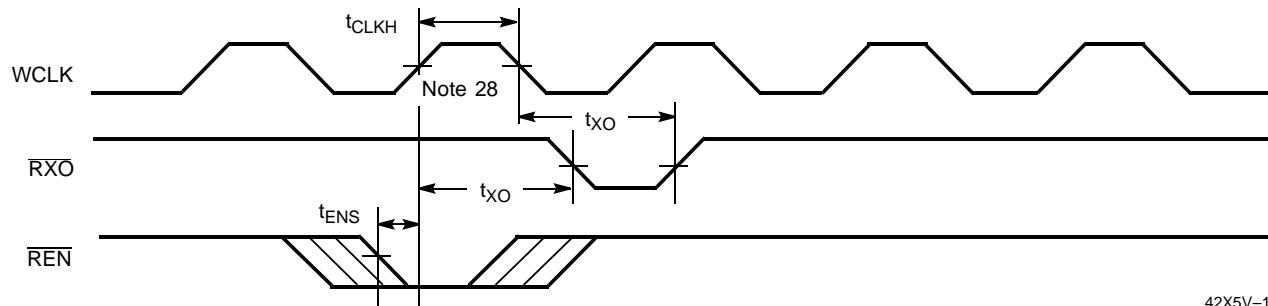
42X5V-14

Notes:

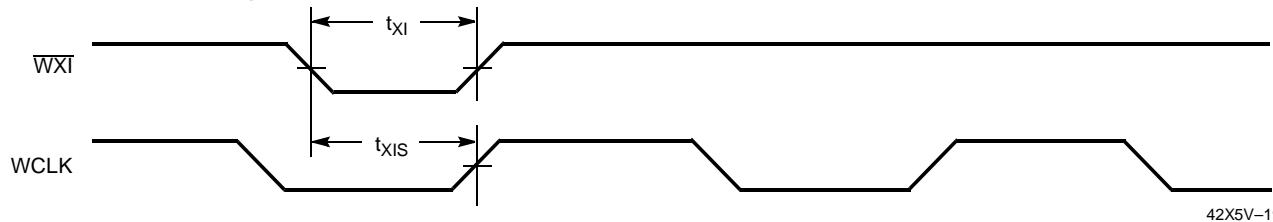
20. PAF offset = m. Number of data words written into FIFO already = $64 - m + 1$ for the CY7C4425V, $256 - m + 1$ for the CY7C4205V, $512 - m + 1$ for the CY7C4215V. $1024 - m + 1$ for the CY7C4225V, $2048 - m + 1$ for the CY7C4235V, and $4096 - m + 1$ for the CY7C4245V.
21. PAF is offset = m.
22. $64 - m$ words in CY7C4425V, $256 - m$ words in CY7C4205V, $512 - m$ words in CY7C4215V. $1024 - m$ words in CY7C4225V, $2048 - m$ words in CY7C4235V, and $4096 - m$ words in CY7C4245V.
23. $64 - m + 1$ words in CY7C4425V, $256 - m + 1$ words in CY7C4205V, $512 - m + 1$ words in CY7C4215V, $1024 - m + 1$ CY7C4225V, $2048 - m + 1$ in CY7C4235V, and $4096 - m + 1$ words in CY7C4245V.
24. If a write is performed on this rising edge of the write clock, there will be Full - (m-1) words of the FIFO when $\overline{\text{PAF}}$ goes LOW.
25. PAF offset = m.
26. t_{SKEW3} is the minimum time between a rising RCLK and a rising WCLK edge for PAF to change state during that clock cycle. If the time between the edge of RCLK and the rising edge of WCLK is less than t_{SKEW3} , then PAF may not change state until the next WCLK rising edge.

Switching Waveforms (continued)
Write Programmable Registers

Read Programmable Registers

Write Expansion Out Timing

Note:

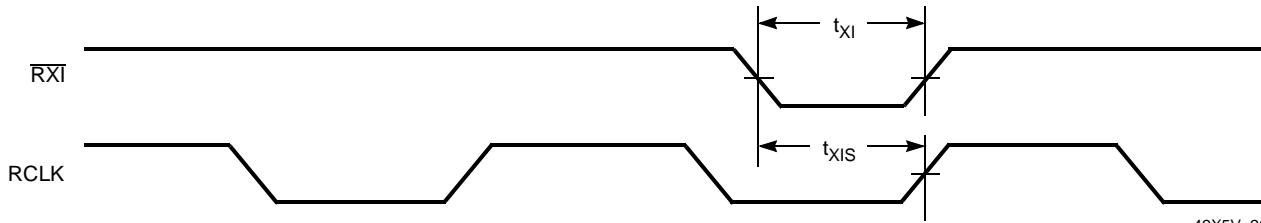
27. Write to Last Physical Location.

Switching Waveforms (continued)
Read Expansion Out Timing


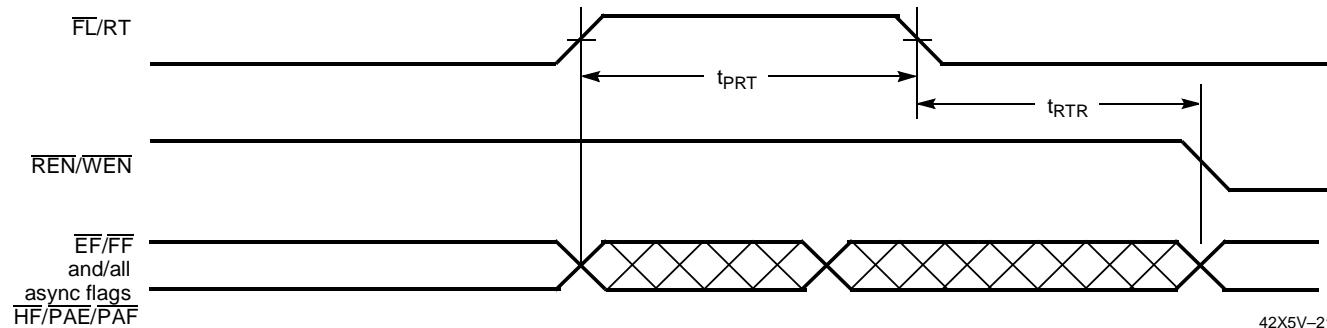
42X5V-18

Write Expansion In Timing


42X5V-19

Read Expansion In Timing


42X5V-20

Retransmit Timing^[29, 30, 31]


42X5V-21

Notes:

28. Read from Last Physical Location.
29. Clocks are free running in this case.
30. The flags may change state during Retransmit as a result of the offset of the read and write pointers, but flags will be valid at tRTR.
31. For the synchronous PAE and PAF flags (SMODE), an appropriate clock cycle is necessary after tRTR to update these flags.

Architecture

The CY7C42X5V consists of an array of 64 to 4K words of 18 bits each (implemented by a dual-port array of SRAM cells), a read pointer, a write pointer, control signals (RCLK, WCLK, REN, WEN, RS), and flags (EF, PAE, HF, PAF, FF). The CY7C42X5V also includes the control signals WX1, RX1, WX0, RX0 for depth expansion.

Resetting the FIFO

Upon power-up, the FIFO must be reset with a Reset (RS) cycle. This causes the FIFO to enter the Empty condition signified by EF being LOW. All data outputs go LOW after the falling edge of RS only if OE is asserted. In order for the FIFO to reset to its default state, a falling edge must occur on RS and the user must not read or write while RS is LOW.

FIFO Operation

When the WEN signal is active (LOW), data present on the D₀₋₁₇ pins is written into the FIFO on each rising edge of the WCLK signal. Similarly, when the REN signal is active LOW, data in the FIFO memory will be presented on the Q₀₋₁₇ outputs. New data will be presented on each rising edge of RCLK while REN is active LOW and OE is LOW. REN must set up t_{ENS} before RCLK for it to be a valid read function. WEN must occur t_{ENS} before WCLK for it to be a valid write function.

An Output Enable (OE) pin is provided to three-state the Q₀₋₁₇ outputs when OE is deasserted. When OE is enabled (LOW), data in the output register will be available to the Q₀₋₁₇ outputs after t_{OE}. If devices are cascaded, the OE function will only output data on the FIFO that is read enabled.

The FIFO contains overflow circuitry to disallow additional writes when the FIFO is full, and underflow circuitry to disallow additional reads when the FIFO is empty. An empty FIFO maintains the data of the last valid read on its Q₀₋₁₇ outputs even after additional reads occur.

Programming

The CY7C42X5V devices contain two 12-bit offset registers. Data present on D₀₋₁₁ during a program write will determine the distance from Empty (Full) that the Almost Empty (Almost Full) flags become active. If the user elects not to program the FIFO's flags, the default offset values are used (see Table 2). When the Load LD pin is set LOW and WEN is set LOW, data on the inputs D₀₋₁₁ is written into the Empty offset register on the first LOW-to-HIGH transition of the write clock (WCLK). When the LD pin and WEN are held LOW then data is written into the Full offset register on the second LOW-to-HIGH transition of the Write Clock (WCLK). The third transition of the Write Clock (WCLK) again writes to the Empty offset register (see Table 1). Writing all offset registers does not have to occur at one time. One or two offset registers can be written and then, by bringing the LD pin HIGH, the FIFO is returned to normal read/write operation. When the LD pin is set LOW, and WEN is LOW, the next offset register in sequence is written.

The contents of the offset registers can be read on the output lines when the LD pin is set LOW and REN is set LOW; then, data can be read on the LOW-to-HIGH transition of the Read Clock (RCLK).

Table 1. Write Offset Register

| LD | WEN | WCLK ^[32] | Selection |
|----|-----|---|---|
| 0 | 0 |  | Writing to offset registers: Empty Offset Full Offset |
| 0 | 1 |  | No Operation |
| 1 | 0 |  | Write Into FIFO |
| 1 | 1 |  | No Operation |

Note:

32. The same selection sequence applies to reading from the registers. REN is enabled and read is performed on the LOW-to-HIGH transition of RCLK.

Flag Operation

The CY7C42X5V devices provide five flag pins to indicate the condition of the FIFO contents. Empty and Full are synchronous. PAE and PAF are synchronous if V_{CC}/SMODE is tied to V_{SS}.

Full Flag

The Full Flag (FF) will go LOW when device is Full. Write operations are inhibited whenever FF is LOW regardless of the state of WEN. FF is synchronized to WCLK, i.e., it is exclusively updated by each rising edge of WCLK.

Empty Flag

The Empty Flag (EF) will go LOW when the device is empty. Read operations are inhibited whenever EF is LOW, regardless of the state of REN. EF is synchronized to RCLK, i.e., it is exclusively updated by each rising edge of RCLK.

Programmable Almost Empty/Automatic Full Flag

The CY7C42X5V features programmable Almost Empty and Almost Full Flags. Each flag can be programmed (described in the Programming section) a specific distance from the corresponding boundary flags (Empty or Full). When the FIFO contains the number of words or fewer for which the flags have been programmed, the PAF or PAE will be asserted, signifying that the FIFO is either Almost Full or Almost Empty. See Table 2 for a description of programmable flags.

When the SMODE pin is tied LOW, the PAF flag signal transition is caused by the rising edge of the write clock and the PAE flag transition is caused by the rising edge of the read clock.

Retransmit

The retransmit feature is beneficial when transferring packets of data. It enables the receipt of data to be acknowledged by the receiver and retransmitted if necessary.

The Retransmit (RT) input is active in the standalone and width expansion modes. The retransmit feature is intended for use when a number of writes equal to or less than the depth of the FIFO have occurred since the last RS cycle. A HIGH pulse on RT resets the internal read pointer to the first physical location of the FIFO. WCLK and RCLK may be free running but must be disabled during and tRTR after the retransmit pulse. With every valid read cycle after retransmit, previously accessed

data is read and the read pointer is incremented until it is equal to the write pointer. Flags are governed by the relative locations of the read and write pointers and are updated during a

retransmit cycle. Data written to the FIFO after activation of RT are transmitted also.

The full depth of the FIFO can be repeatedly retransmitted.

Table 2. Flag Truth Table

| Number of Words in FIFO | | | FF | PAF | HF | PAE | EF |
|------------------------------|--------------------------------|--------------------------------|----|-----|----|-----|----|
| 7C4425V - 64 x 18 | 7C4205V - 256 x 18 | 7C4215V - 512 x 18 | | | | | |
| 0 | 0 | 0 | H | H | H | L | L |
| 1 to n ^[33] | 1 to n ^[33] | 1 to n ^[33] | H | H | H | L | H |
| (n+1) to 32 | (n+1) to 128 | (n+1) to 256 | H | H | H | H | H |
| 33 to (64-(m+1)) | 129 to (256-(m+1)) | 257 to (512-(m+1)) | H | H | L | H | H |
| (64-m) ^[34] to 63 | (256-m) ^[34] to 255 | (512-m) ^[34] to 511 | H | L | L | H | H |
| 64 | 256 | 512 | L | L | L | H | H |

| Number of Words in FIFO | | | FF | PAF | HF | PAE | EF |
|----------------------------------|----------------------------------|----------------------------------|----|-----|----|-----|----|
| 7C4225V - 1K x 18 | 7C4235V - 2K x 18 | 7C4245V - 4K x 18 | | | | | |
| 0 | 0 | 0 | H | H | H | L | L |
| 1 to n ^[33] | 1 to n ^[33] | 1 to n ^[33] | H | H | H | L | H |
| (n+1) to 512 | (n+1) to 1024 | (n+1) to 2048 | H | H | H | H | H |
| 513 to (1024 -(m+1)) | 1025 to (2048 -(m+1)) | 2049 to (4096 -(m+1)) | H | H | L | H | H |
| (1024-m) ^[34] to 1023 | (2048-m) ^[34] to 2047 | (4096-m) ^[34] to 4095 | H | L | L | H | H |
| 1024 | 2048 | 4096 | L | L | L | H | H |

Notes:

33. n = Empty Offset (Default Values: CY7C4425V n = 7, CY7C4205V n = 31, CY7C4215V n = 63, CY7C4225V/7C4235V/7C4245V n = 127).
34. m = Full Offset (Default Values: CY7C4425V n = 7, CY7C4205V n = 31, CY7C4215V n = 63, CY7C4225V/7C4235V/7C4245V n = 127).

Width Expansion Configuration

The CY7C42X5V can be expanded in width to provide word widths greater than 18 in increments of 18. During width expansion mode all control line inputs are common and all flags

are available. Empty (Full) flags should be created by ANDing the Empty (Full) flags of every FIFO. This technique will avoid ready data from the FIFO that is "staggered" by one clock cycle due to the variations in skew between RCLK and WCLK. *Figure 2* demonstrates a 36-word width by using two CY7C42X5V.

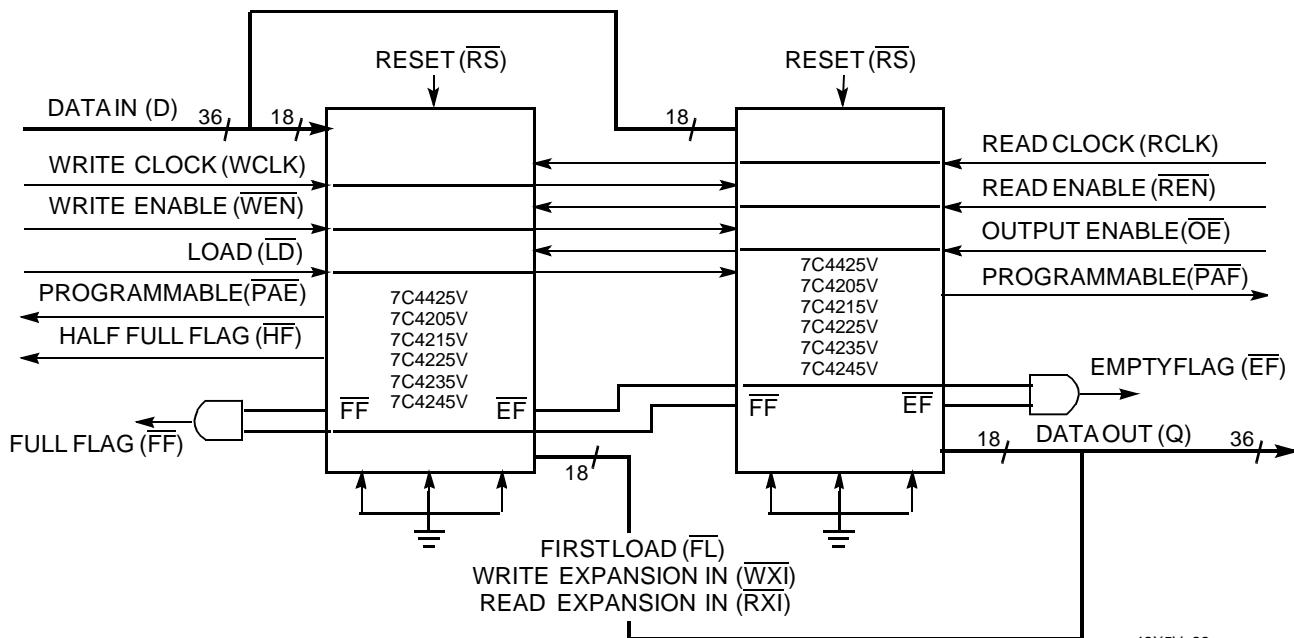


Figure 1. Block Diagram of Low-Voltage Synchronous FIFO Memories Used in a Width Expansion Configuration

Depth Expansion Configuration (with Programmable Flags)

The CY7C42X5V can easily be adapted to applications requiring more than 64/256/512/1024/2048/4096 words of buffering. Figure 2 shows Depth Expansion using three CY7C42X5Vs. Maximum depth is limited only by signal loading. Follow these steps:

1. The first device must be designated by grounding the First Load (FL) control input.
2. All other devices must have \overline{FL} in the HIGH state.

3. The Write Expansion Out (\overline{WXO}) pin of each device must be tied to the Write Expansion In (\overline{WXI}) pin of the next device.
4. The Read Expansion Out (\overline{RXO}) pin of each device must be tied to the Read Expansion In (\overline{RXI}) pin of the next device.
5. All Load (\overline{LD}) pins are tied together.
6. The Half-Full Flag (\overline{HF}) is not available in the Depth Expansion Configuration.
7. \overline{EF} , \overline{FF} , \overline{PAE} , and \overline{PAF} are created with composite flags by ORing together these respective flags for monitoring. The composite \overline{PAE} and \overline{PAF} flags are not precise.

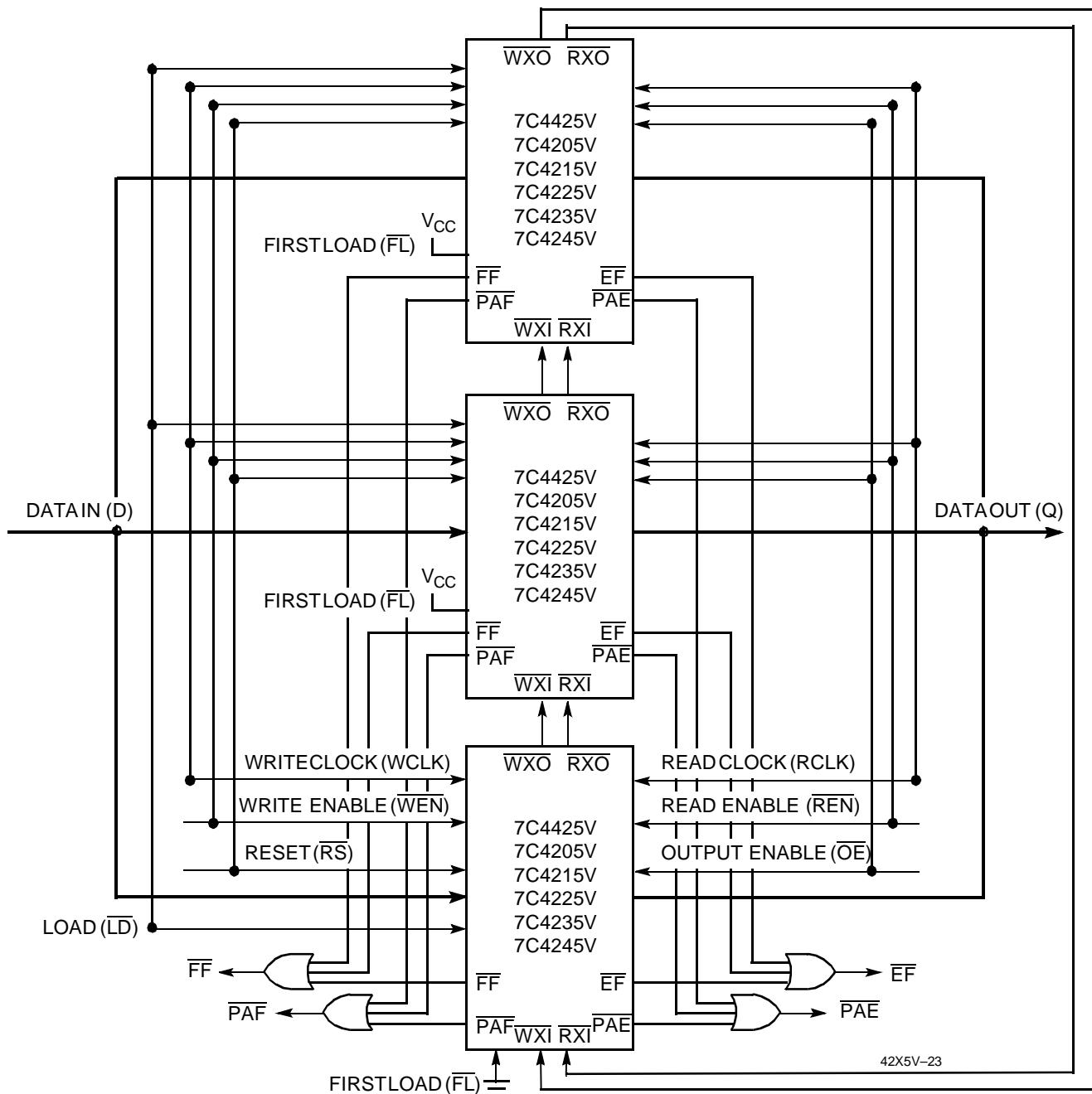


Figure 2. Block Diagram of Low-Voltage Synchronous FIFO Memory with Programmable Flags used in Depth Expansion Configuration



**CY7C4425V/4205V/4215V
CY7C4225V/4235V/4245V**

Ordering Information

64 x 18 Low-Voltage Synchronous FIFO

| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|-----------------|--------------|----------------------------------|-----------------|
| 15 | CY7C4425V-15ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 25 | CY7C4425V-25ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 35 | CY7C4425V-35ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |

256 x 18 Low-Voltage Synchronous FIFO

| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|-----------------|--------------|----------------------------------|-----------------|
| 15 | CY7C4205V-15ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| | CY7C4205V-15AC | A65 | 64-Lead 14x14 Thin Quad Flatpack | |
| 25 | CY7C4205V-25ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 35 | CY7C4205V-35ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |

512 x 18 Low-Voltage Synchronous FIFO

| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|-----------------|--------------|----------------------------------|-----------------|
| 15 | CY7C4215V-15ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 25 | CY7C4215V-25ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 35 | CY7C4215V-35ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |

1K x 18 Low-Voltage Synchronous FIFO

| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|-----------------|--------------|----------------------------------|-----------------|
| 15 | CY7C4225V-15ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| | CY7C4225V-15AC | A65 | 64-Lead 14x14 Thin Quad Flatpack | |
| 25 | CY7C4225V-25ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 35 | CY7C4225V-35ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |

2K x 18 Low-Voltage Synchronous FIFO

| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|-----------------|--------------|----------------------------------|-----------------|
| 15 | CY7C4235V-15ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 25 | CY7C4235V-25ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 35 | CY7C4235V-35ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |

4K x 18 Low-Voltage Synchronous FIFO

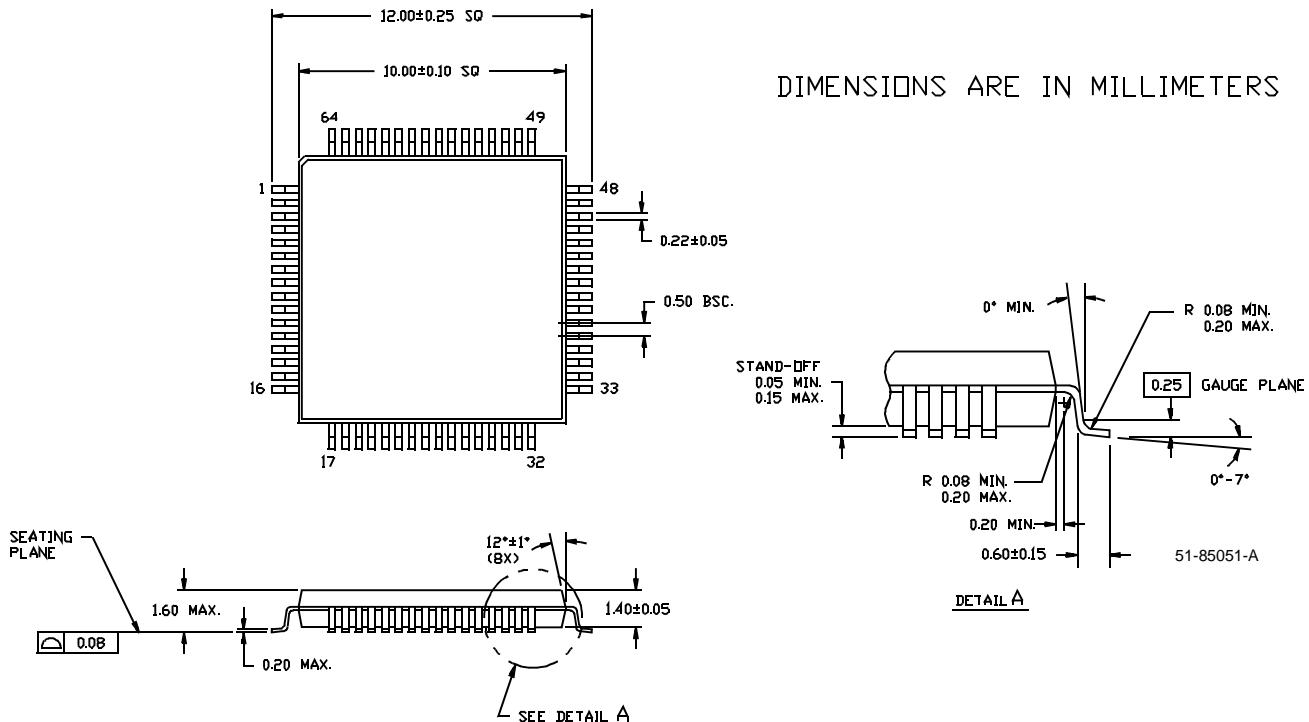
| Speed (ns) | Ordering Code | Package Name | Package Type | Operating Range |
|------------|-----------------|--------------|----------------------------------|-----------------|
| 15 | CY7C4245V-15ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 25 | CY7C4245V-25ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |
| 35 | CY7C4245V-35ASC | A64 | 64-Lead 10x10 Thin Quad Flatpack | Commercial |



**CY7C4425V/4205V/4215V
CY7C4225V/4235V/4245V**

Package Diagrams

64-Pin Thin Plastic Quad Flat Pack (10 x 10 x 1.4 mm) A64



64-Lead Thin Plastic Quad Flat Pack (14 x 14 x 1.4 mm) A65

