PRELIMINARY

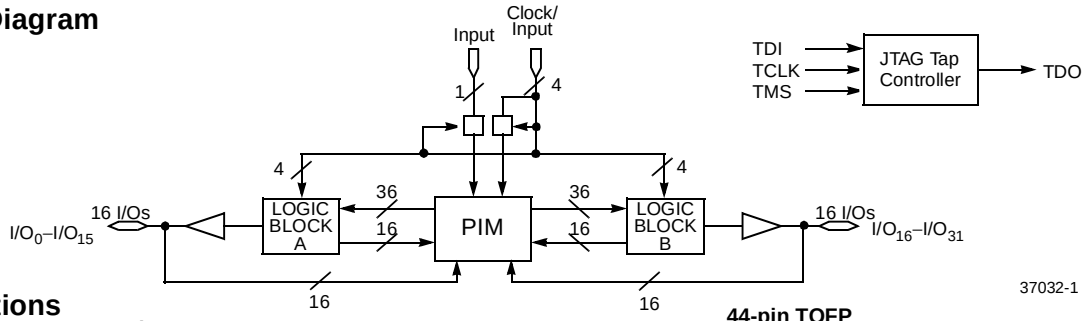
CY37032

UltraLogic™ 32-Macrocell ISR™ CPLD

Features

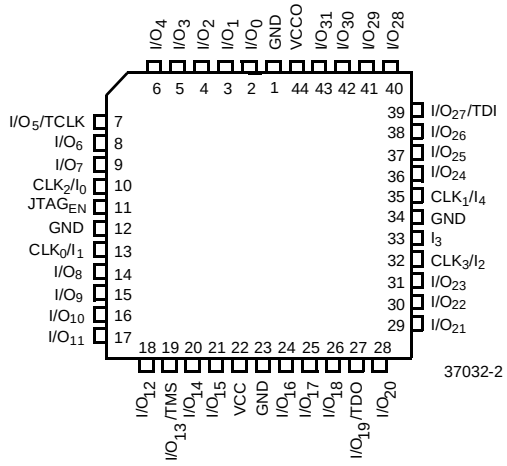
- 32 macrocells in two logic blocks
- In-System Reprogrammable™ (ISR™)
  - JTAG-compliant on-board programming
  - Design changes don't cause pinout changes
  - Design changes don't cause timing changes
- Up to 32 I/Os
  - plus 5 dedicated inputs including 4 clock inputs
- High speed
  - f_{MAX} = 222 MHz
  - t_{PD} = 5.0 ns
  - t_S = 3 ns
  - t_{CO} = 4 ns
- Product-term clocking
- IEEE 1149.1 JTAG boundary scan
- Programmable slew rate control on individual I/Os
- Low power option on individual logic block basis
- 5V and 3.3V I/O capability
- User-Programmable Bus Hold capabilities on all I/Os
- Simple Timing Model
- PCI compliant
- Available in 44-pin TQFP and 44-pin PLCC
- Pinout compatible with the CY37032V, CY37064/ CY37064V, CY7C371i

Logic Block Diagram

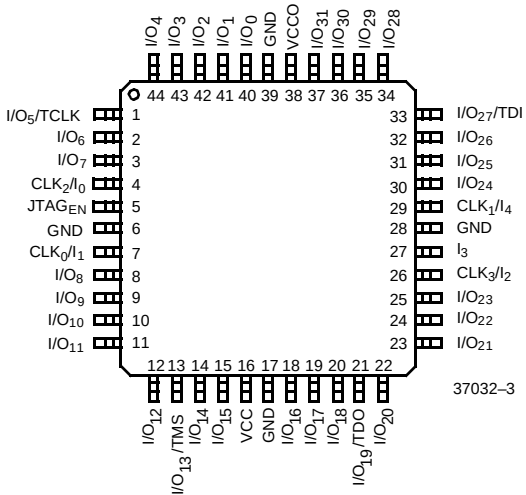


Pin Configurations

44-pin PLCC
Top View



44-pin TQFP
Top View



Selection Guide

	CY37032-222	CY37032-200	CY37032-167	CY37032-125
Maximum Propagation Delay, t_{PD} (ns)	5.0	6.0	6.5	10
Minimum Set-Up, t_S (ns)	3.0	4	4	5.5
Maximum Clock to Output, t_{CO} (ns)	4.0	4	4	6.5
Typical Supply Current, I_{CC} (mA) in Low Power Mode	15	15	15	15

Shaded areas contain advance information.

Functional Description

The CY37032 is an In-System Reprogrammable (ISR) Complex Programmable Logic Device (CPLD) and is part of the Ultra37000™ family of high-density, high-speed CPLDs. Like all members of the Ultra37000 family, the CY37032 is designed to bring the ease of use and high performance of the 22V10 to high-density PLDs.

The CY37032 is rich in I/O resources. Each macrocell in the device features an associated I/O pin, resulting in 32 I/O pins on the CY37032.

For a more detailed description of the architecture and features of the CY37032 see the Ultra37000 family data sheet.

Fully Routable with 100% Logic Utilization

The CY37032 is designed with a robust routing architecture which allows utilization of the entire device with a fixed pinout. This makes Ultra37000 optimal for implementing on board design changes using ISR without changing pinouts.

Simple Timing Model

The CY37032 features a very simple timing model with predictable delays. Unlike other high-density CPLD architectures, there are no hidden speed delays such as fanout effects, interconnect delays, or expander delays. The timing model allows for design changes with ISR without causing changes to system performance.

Low Power Operation

Each Logic Block of the CY37032 can be configured as either High-Speed (default) or Low-Power. In the Low-Power mode, the logic block consumes approximately 50% less power and slows down by t_{LP}.

Output Slew Rate Control

Each output can be configured with either a fast edge rate (default) for high performance, or a slow edge rate for added noise reduction. In the fast edge rate mode, outputs switch at 3V/ns max. and in the slow edge rate mode, outputs switch at 1V/ns max. There is a nominal delay for I/Os using the slow edge rate mode.

3.3V or 5V I/O operation

The CY37032 operates with a 5V supply, and can support 5V or 3.3V I/O levels. V_{CCO} connections provide the capability of interfacing to either a 5V or 3.3V bus. By connecting the V_{CCO} pins to 5V the user insures 5V TTL levels on the outputs. If V_{CCO} is connected to 3.3V the output levels meet 3.3V JEDEC standard CMOS levels and are 5V tolerant. A nominal timing delay is incurred on output buffers when V_{CCO} is set to 3.3V. This device requires 5V ISR programming.

In System Reprogramming

The CY37032 can be programmed in system using IEEE 1149.1 compliant JTAG programming protocol. The CY37032 can also be programmed on a number of traditional parallel programmers including Cypress's *Impulse3*™ programmer and industry standard third-party programmers. For an overview of ISR programming, refer to the Ultra37000 Family data sheet and for UltraISR cable and software specifications, refer to InSRkit: ISR Programming data sheet (CY3600i).

User-Programmable Bus Hold

All outputs of the CY37032 can either be configured into bus hold mode or left floating. When in bus hold mode, the undriven outputs retain their last value with a weak latch. This feature allows the designer the flexibility of either eliminating or including external pull-up/pull-down resistors. Enabling this feature affects all I/Os simultaneously.

Design Tools

Development software for the CY37032 is available from Cypress's *Warp*™ or third-party bolt-in software packages as well as a number of third-party development packages. Please refer to the *Warp* or third-party tool support data sheets for further information.

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 +7.0V

DC Voltage Applied to Outputs in High Z State.....–0.5V to +7.0V

DC Input Voltage .....–0.5V to +7.0V

DC Program Voltage..... 4.5 to 5.5V

Current into Outputs ..... 16 mA

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

Latch-Up Current..... >200 mA

Operating Range[1]

Range	Ambient Temperature[1]	Junction Temperature	Output Condition	V_{CC}	V_{CCO}
Commercial	0°C to +70°C	0°C to +90°C	5.0V	5V ± 0.25V	5V ± 0.25V
			3.3V	5V ± 0.25V	3.3V ± 0.3V
Industrial	–40°C to +85°C	–40°C to +125°C	5.0V	5V ± 0.50V	5V ± 0.50V
			3.3V	5V ± 0.50V	3.3V ± 0.3V

Note:

1. Normal Programming Conditions apply across Ambient Temperature Range for specified programming methods. For more information on programming the Ultra37000 family devices see the Ultra37000 family data sheet.

Electrical Characteristics Over the Operating Range

Parameter	Description	Test Conditions		Min.	Typ.	Max.	Unit
V_{OH}	Output HIGH Voltage	V_{CC} = Min.	I_{OH} = –3.2 mA (Com'l/Ind)[2]	2.4			V
V_{OHZ}	Output HIGH Voltage with Output Disabled[6]	V_{CC} = Max.	I_{OH} = 0 µA (Com'l/Ind)[3]			4.0	V
			I_{OH} = –50 µA (Com'l/Ind)[3]			3.6	V
V_{OL}	Output LOW Voltage	V_{CC} = Min.	I_{OL} = 16 mA (Com'l/Ind)[2]			0.5	V
V_{IH}	Input HIGH Voltage	Guaranteed Input Logical HIGH voltage for all inputs[4]		2.0		V_{CCmax}	V
V_{IL}	Input LOW Voltage	Guaranteed Input Logical LOW voltage for all inputs[4]		–0.5		0.8	V
I_{IX}	Input Load Current	V_I = GND OR V_{CC}		–10		10	µA
I_{OZ}	Output Leakage Current	V_O = GND or V_{CC}, Output Disabled		–50		50	µA
		V_{CC} = Max., V_O = 3.3V, Output Disabled[3]		0	–70	–125	µA
I_{OS}	Output Short Circuit Current[5, 6]	V_{CC} = Max., V_{OUT} = 0.5V		–30		–160	mA
I_{BHL}	Input Bus Hold LOW Sustaining Current	V_{CC} = Min., V_{IL} = 0.8V		+75			µA
I_{BHH}	Input Bus Hold HIGH Sustaining Current	V_{CC} = Min., V_{IH} = 2.0V		–75			µA
I_{BHLO}	Input Bus Hold LOW Overdrive Current	V_{CC} = Max.				+500	µA
I_{BHHO}	Input Bus Hold HIGH Overdrive Current	V_{CC} = Max.				-500	µA

Inductance[6]

Parameter	Description	Test Conditions	44-lead TQFP	44-lead PLCC	Unit
L	Maximum Pin Inductance	V_{IN} = 5.0V at f = 1 MHz	2	5	nH

Capacitance[6]

Parameter	Description	Test Conditions	Max.	Unit
$C_{I/O}$	Input/Output Capacitance	V_{IN} = 5.0V at f = 1 MHz at T_A = 25°C	8	pF
C_{CLK}	Clock Signal Capacitance	V_{IN} = 5.0V at f = 1 MHz at T_A = 25°C	12	pF

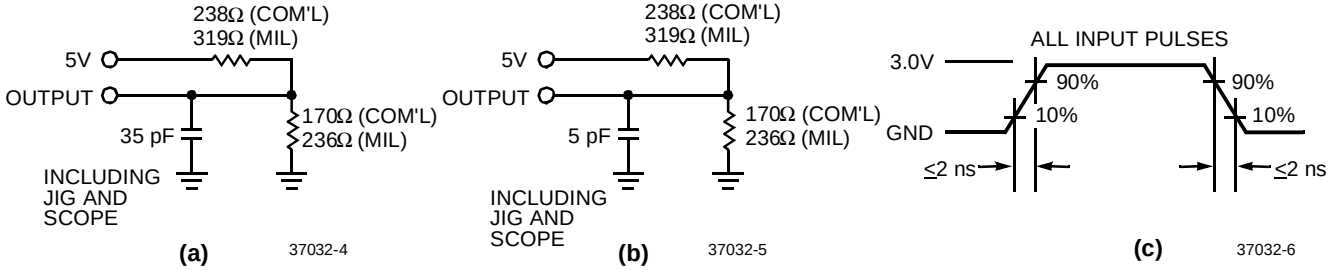
Endurance Characteristics[6]

Parameter	Description	Test Conditions	Min.	Typ.	Unit
N	Minimum Reprogramming Cycles	Normal Programming Conditions[1]	1,000	10,000	Cycles

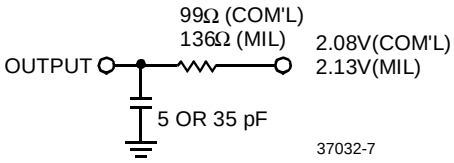
Notes:

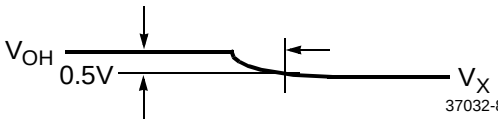
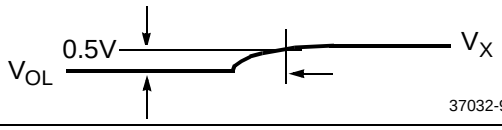
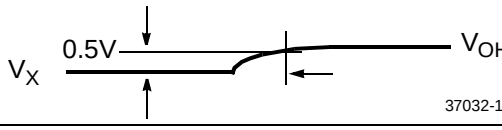
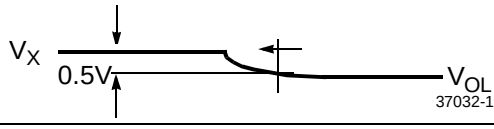
2. I_{OH} = –2 mA, I_{OL} = 2 mA for TDO.
3. When the I/O is output disabled, the bus-hold circuit can weakly pull the I/O to a maximum of 4.0V if no leakage current is allowed. This voltage is lowered significantly by a small leakage current. Note that all I/Os are output disabled during ISR programming. Refer to the application note "Understanding Bus Hold" for additional information.
4. These are absolute values with respect to device ground. All overshoots due to system or tester noise are included.
5. Not more than one output should be tested at a time. Duration of the short circuit should not exceed 1 second. V_{OUT} = 0.5V has been chosen to avoid test problems caused by tester ground degradation.
6. Tested initially and after any design or process changes that may affect these parameters.

AC Test Loads and Waveforms



Equivalent to: THÉVENIN EQUIVALENT



Parameter[7]	V_X	Output Waveform—Measurement Level
$t_{ER(-)}$	1.5V	
$t_{ER(+)}$	2.6V	
$t_{EA(+)}$	1.5V	
$t_{EA(-)}$	V_{the}	

(d) Test Waveforms

Note:

7. t_{ER} measured with 5-pF AC Test Load and t_{EA} measured with 35-pF AC Test Load.

Switching Characteristics Over the Operating Range[8]

Parameter	Description	37032-222		37032-200		37032-167		37032-125		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Combinatorial Mode Parameters										
t_{PD}[9,10,11]	Input to Combinatorial Output		5		6		6.5		10	ns
t_{PDL}[9,10,11]	Input to Output Through Transparent Input or Output Latch		8		8.5		10		13	ns
t_{PDLL}[9,10,11]	Input to Output Through Transparent Input and Output Latches		10		10.5		12		15	ns
t_{EA}[9,10,11]	Input to Output Enable		8		9		10		14	ns
t_{ER}[9]	Input to Output Disable		8		9		10		14	ns
Input Register Parameters										
t_{WL}	Clock or Latch Enable Input LOW Time[6]	2		2.5		2.5		3		ns
t_{WH}	Clock or Latch Enable Input HIGH Time[6]	2		2.5		2.5		3		ns
t_{IS}	Input Register or Latch Set-Up Time	2		2		2		2		ns
t_{IH}	Input Register or Latch Hold Time	2		2		2		2		ns
t_{ICO}[9,10,11]	Input Register Clock or Latch Enable to Combinatorial Output		10		11		11		12.5	ns
t_{ICOL}[9,10,11]	Input Register Clock or Latch Enable to Output Through Transparent Output Latch		11		12		12		16	ns
Synchronous Clocking Parameters										
t_{CO}[10,11]	Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable to Output		4.0		4		4		6.5	ns
t_S[9]	Set-Up Time from Input to Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable	3.0		4		4		5.5		ns
t_H	Register or Latch Data Hold Time	0		0		0		0		ns
t_{CO2}[9,10,11]	Output Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable to Combinatorial Output Delay (Through Logic Array)		9		9.5		10		14	ns
t_{SCS}[9]	Output Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable to Output Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable (Through Logic Array)	4.5		5		6		8		ns
t_{SL}[9]	Set-Up Time from Input Through Transparent Latch to Output Register Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable	7		7.5		7.5		10		ns
t_{HL}	Hold Time for Input Through Transparent Latch from Output Register Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) or Latch Enable	0		0		0		0		ns
Product Term Clocking Parameters										
t_{COPT}[9,10,11]	Product Term Clock or Latch Enable (PTCLK) to Output		6		7		7.5		11	ns

Shaded areas contain advance information

Notes:

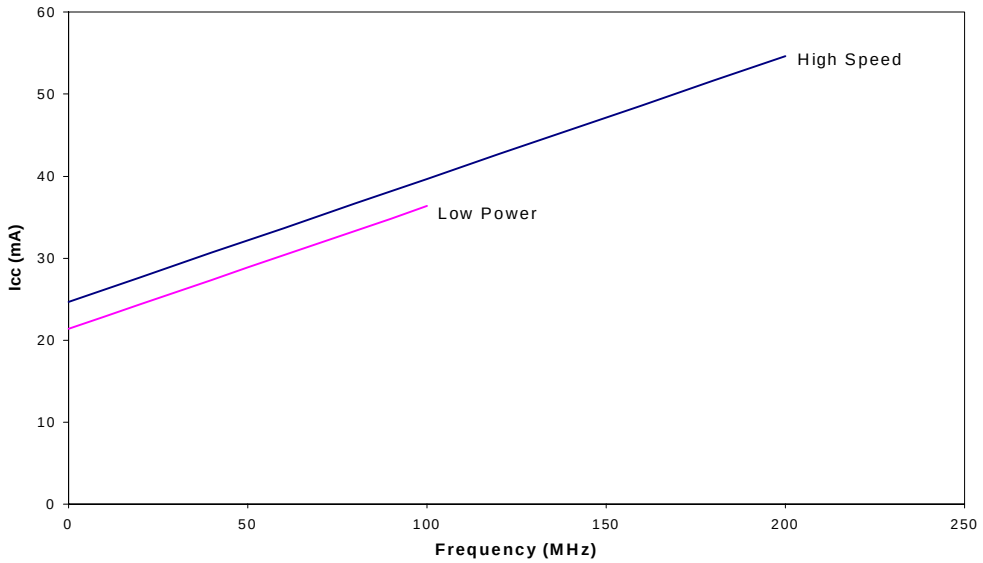
8. All AC parameters are measured with 16 outputs switching and 35-pF AC Test Load.
9. Logic Blocks operating in low power mode, add t_{LP} to this spec.
10. Outputs using Slow Output Slew Rate, add t_{SLEW} to this spec.
11. When V_{CCO}= 3.3V, add $t_{3.3IO}$ to this spec.

Switching Characteristics Over the Operating Range[8] (continued)

Parameter	Description	37032-222		37032-200		37032-167		37032-125		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
t_{SPT}	Set-Up Time from Input to Product Term Clock or Latch Enable (PTCLK)	2		2.5		2.5		3		ns
t_{HPT}	Register or Latch Data Hold Time	2		2.5		2.5		3		ns
t_{CO2PT}[9,10,11]	Product Term Clock or Latch Enable (PT-CLK) to Output Delay (Through Logic Array)		11		12		14		19	ns
Pipelined Mode Parameters										
t_{ICS}[9]	Input Register Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3) to Output Register Synchronous Clock (CLK_0, CLK_1, CLK_2, or CLK_3)	4.5		5.0		6		8		ns
Operating Frequency Parameters										
f_{MAX1}	Maximum Frequency with Internal Feedback (Lesser of $1/t_{SCS}$, $1/(t_S + t_H)$, or $1/t_{CO}$)[6]	222		200		167		125		MHz
f_{MAX2}	Maximum Frequency Data Path in Output Registered/Latched Mode (Lesser of $1/(t_{WL} + t_{WH})$, $1/(t_S + t_H)$, or $1/t_{CO}$)	250		200		200		158		MHz
f_{MAX3}	Maximum Frequency with External Feedback (Lesser of $1/(t_{CO} + t_S)$ or $1/(t_{WL} + t_{WH})$)	125		125		125		83		MHz
f_{MAX4}	Maximum Frequency in Pipelined Mode (Lesser of $1/(t_{CO} + t_{IS})$, $1/t_{ICS}$, $1/(t_{WL} + t_{WH})$, $1/(t_{IS} + t_{IH})$, or $1/t_{SCS}$)	154		154		154		125		MHz
Reset/Preset Parameters										
t_{RW}	Asynchronous Reset Width[6]	7		8		8		10		ns
t_{RR}[9]	Asynchronous Reset Recovery Time[6]	9		10		10		12		ns
t_{RO}[9, 10, 11]	Asynchronous Reset to Output		11		12		13		15	ns
t_{PW}	Asynchronous Preset Width[6]	7		8		8		10		ns
t_{PR}[9]	Asynchronous Preset Recovery Time[6]	9		10		10		12		ns
t_{PO}[9, 10, 11]	Asynchronous Preset to Output		11		12		13		15	ns
User Option Parameters										
t_{LP}	Low Power Adder		4		4		4		4	ns
t_{SLEW}	Slow Output Slew Rate Adder		2		2		2		2	ns
$t_{3.3IO}$	3.3V I/O Mode Timing Adder		0.1		0.1		0.1		0.1	ns
JTAG Timing Parameters										
$t_{S\ JTAG}$	Set-Up Time from TDI and TMS to TCK	0		0		0		0		ns
$t_{H\ JTAG}$	Hold Time on TDI and TMS	20		20		20		20		ns
$t_{CO\ JTAG}$	Falling Edge of TCK to TDO		20		20		20		20	ns
f_{JTAG}	Maximum JTAG Tap Controller Frequency		20		20		20		20	MHz

Shaded areas contain advance information

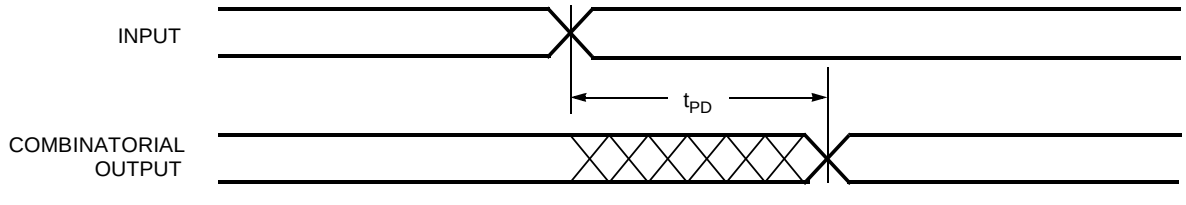
Typical I_{CC} Characteristics



The typical pattern is a 16-bit up counter, per logic block, with outputs disabled.
V_{CC} = 5.0V, T_A = Room Temperature

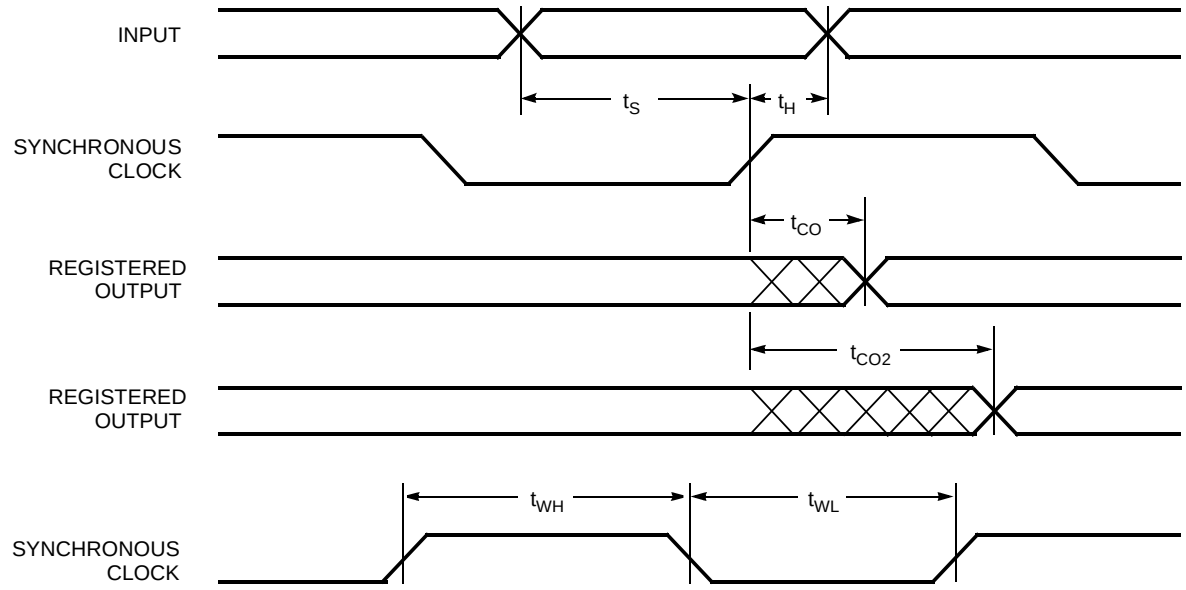
Switching Waveforms

Combinatorial Output



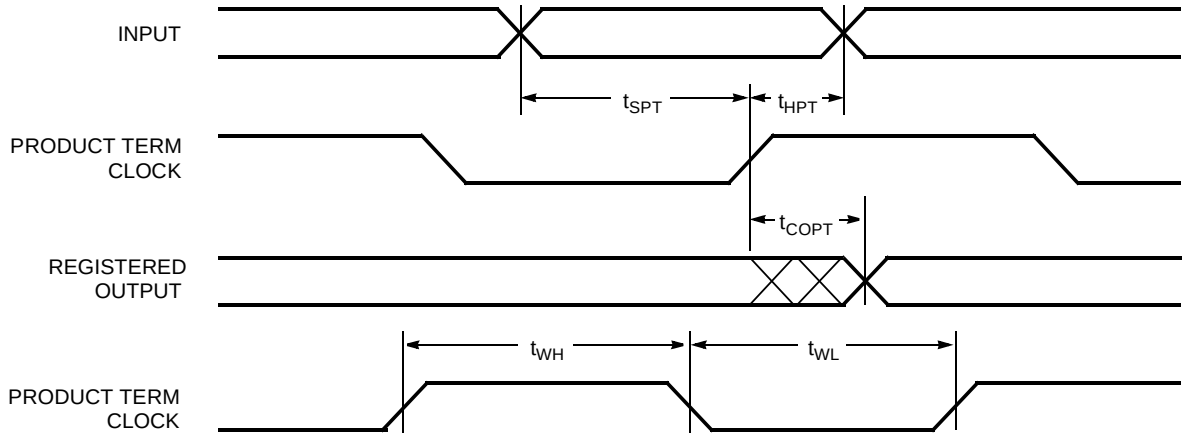
37032-12

Registered Output with Synchronous Clocking



37032-13

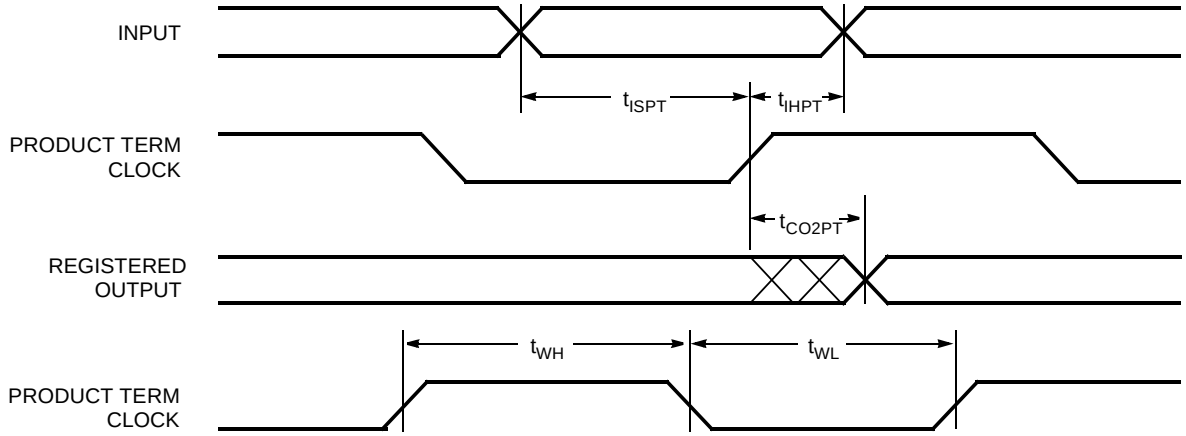
Registered Output with Product Term Clocking Input Going Through the Array



37032-14

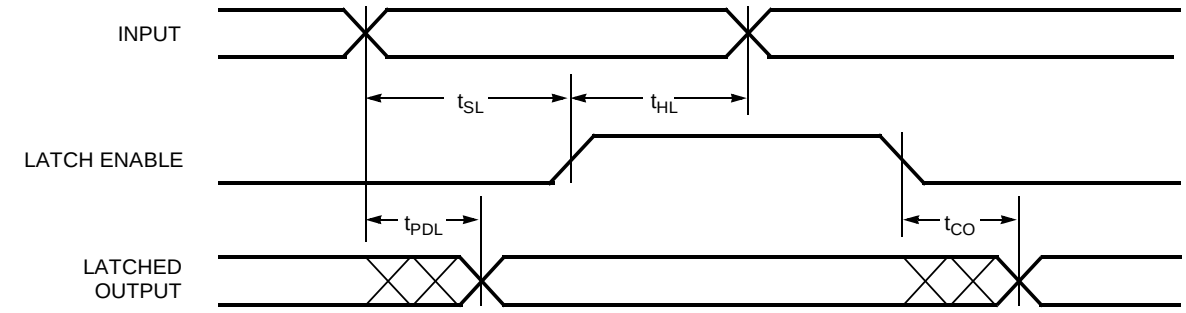
Switching Waveforms (continued)

Registered Output with Product Term Clocking Input Coming From Adjacent Buried Register



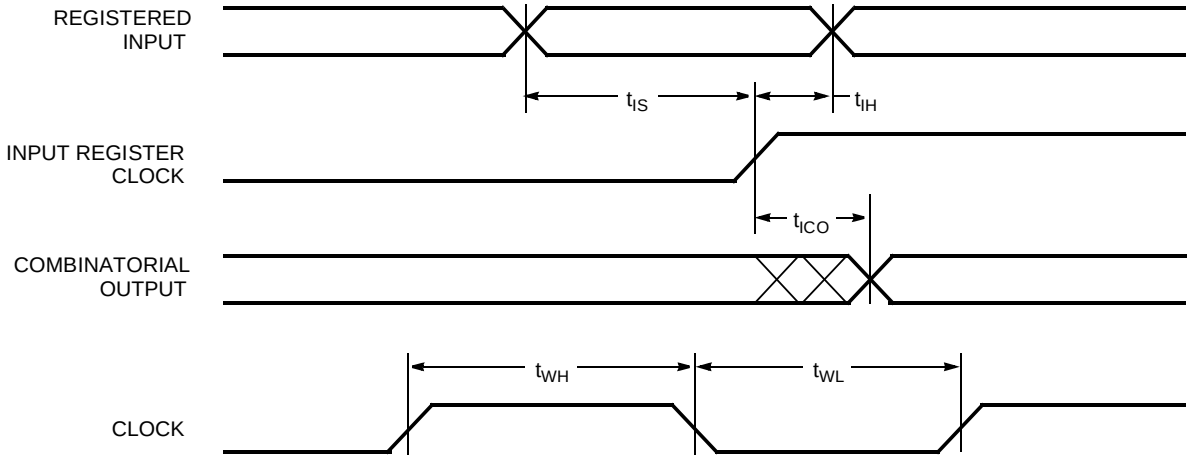
37032-15

Latched Output



37032-16

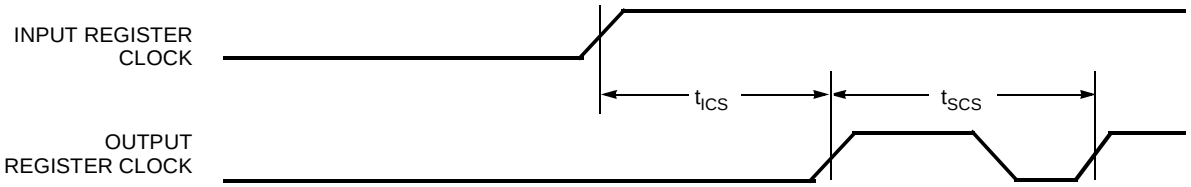
Registered Input



37032-17

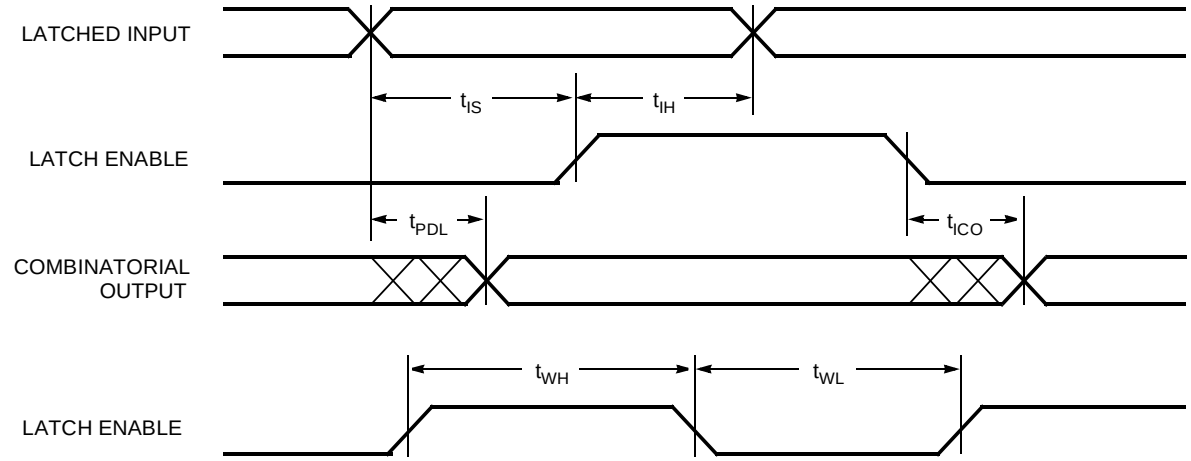
Switching Waveforms (continued)

Clock to Clock



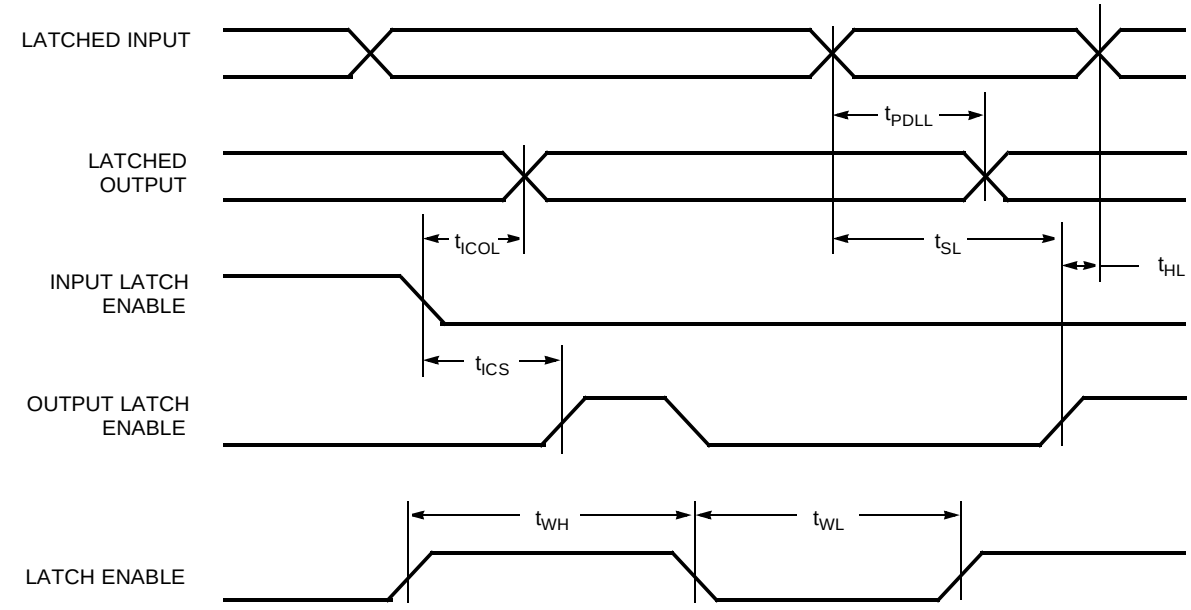
37032-18

Latched Input



37032-19

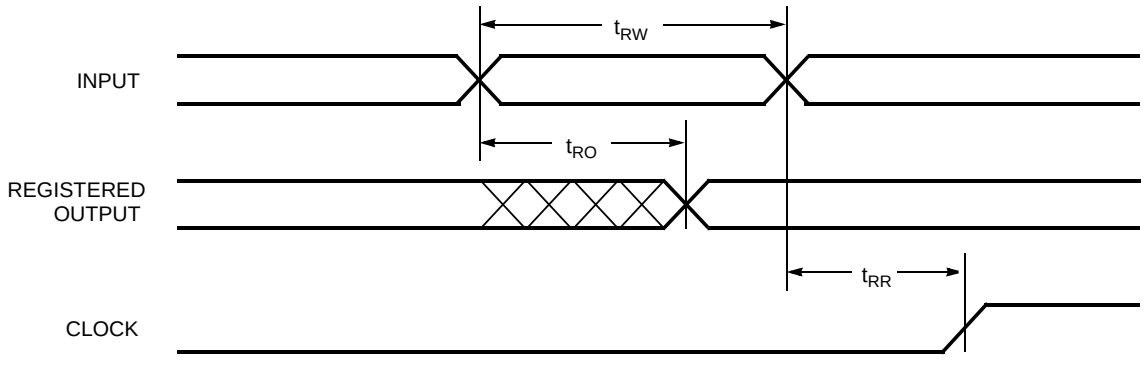
Latched Input and Output



37032-20

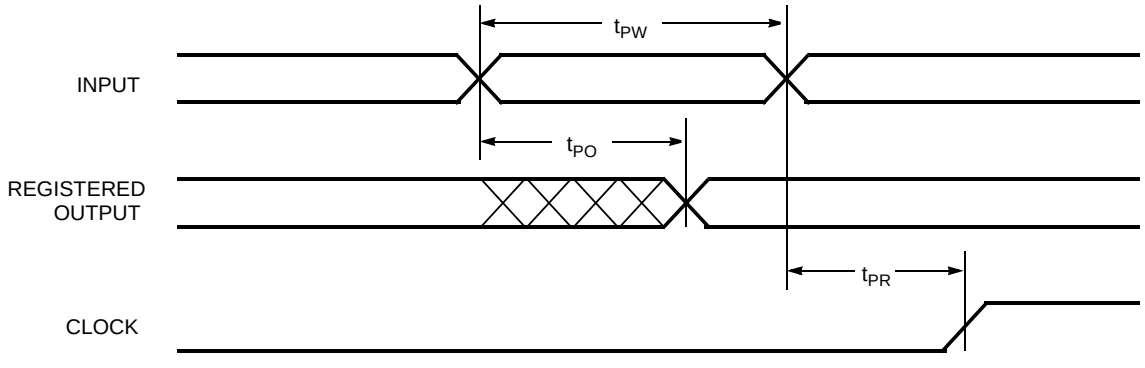
Switching Waveforms (continued)

Asynchronous Reset



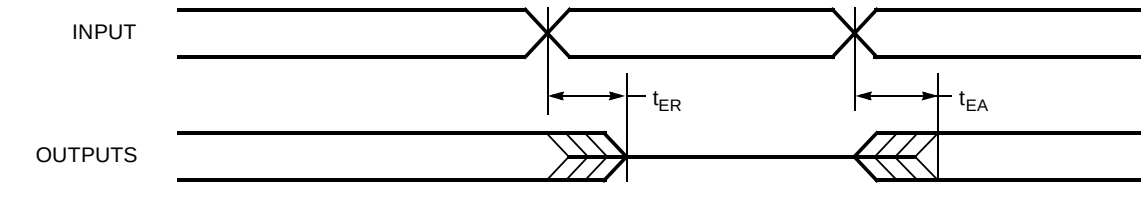
37032-21

Asynchronous Preset



37032-22

Output Enable/Disable



37032–23

Ordering Information

Speed (MHz)	Ordering Code	Package Name	Package Type	Operating Range
222	CY37032P44-222AC	A44	44-Pin Thin Quad Flatpack	Commercial
	CY37032P44-222JC	J67	44-Pin Plastic Leaded Chip Carrier	
200	CY37032P44-200AC	A44	44-Pin Thin Quad Flatpack	Commercial
	CY37032P44-200JC	J67	44-Pin Plastic Leaded Chip Carrier	
167	CY37032P44-167AC	A44	44-Pin Thin Quad Flatpack	Commercial
	CY37032P44-167JC	J67	44-Pin Plastic Leaded Chip Carrier	
	CY37032P44-167AI	A44	44-Pin Thin Quad Flatpack	Industrial
	CY37032P44-167JI	J67	44-Pin Plastic Leaded Chip Carrier	
125	CY37032P44-125AC	A44	44-Pin Thin Quad Flatpack	Commercial
	CY37032P44-125JC	J67	44-Pin Plastic Leaded Chip Carrier	
	CY37032P44-125AI	A44	44-Pin Thin Quad Flatpack	Industrial
	CY37032P44-125JI	J67	44-Pin Plastic Leaded Chip Carrier	

Shaded areas contain advance information

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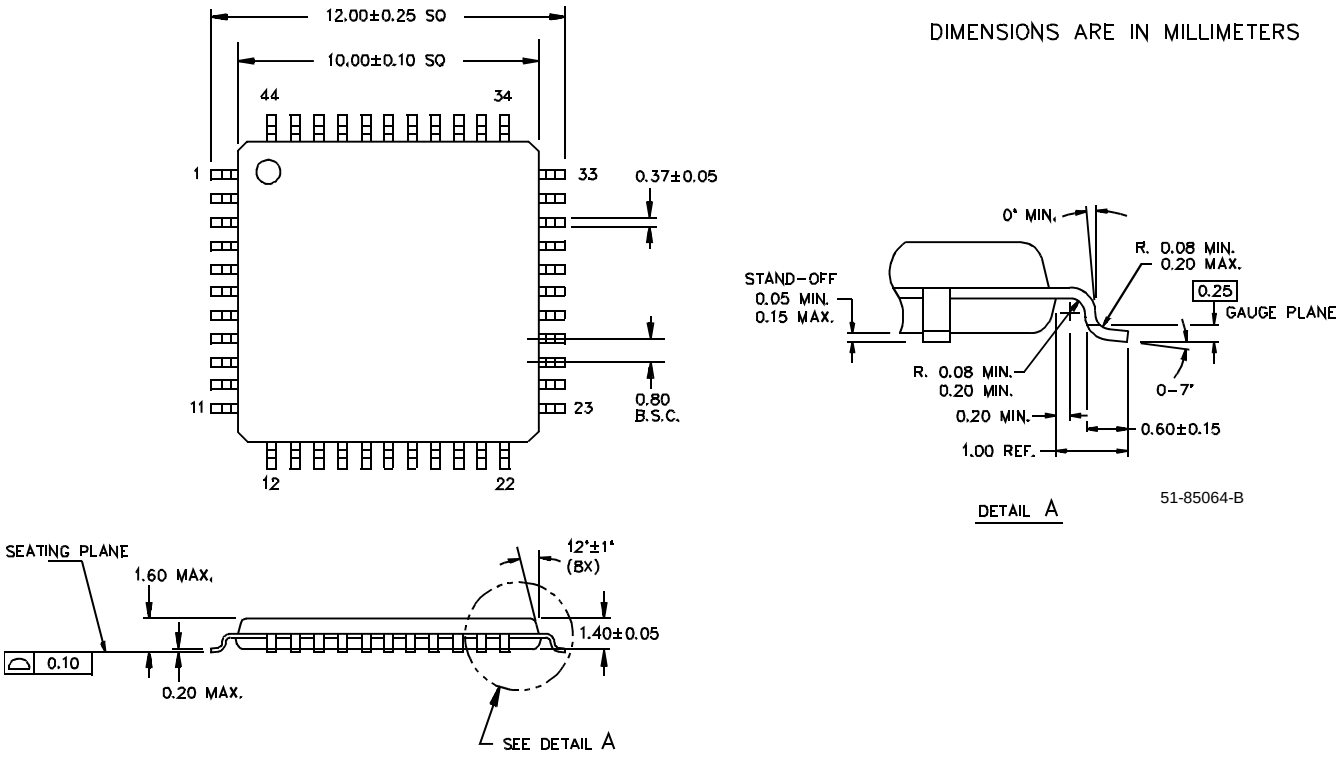
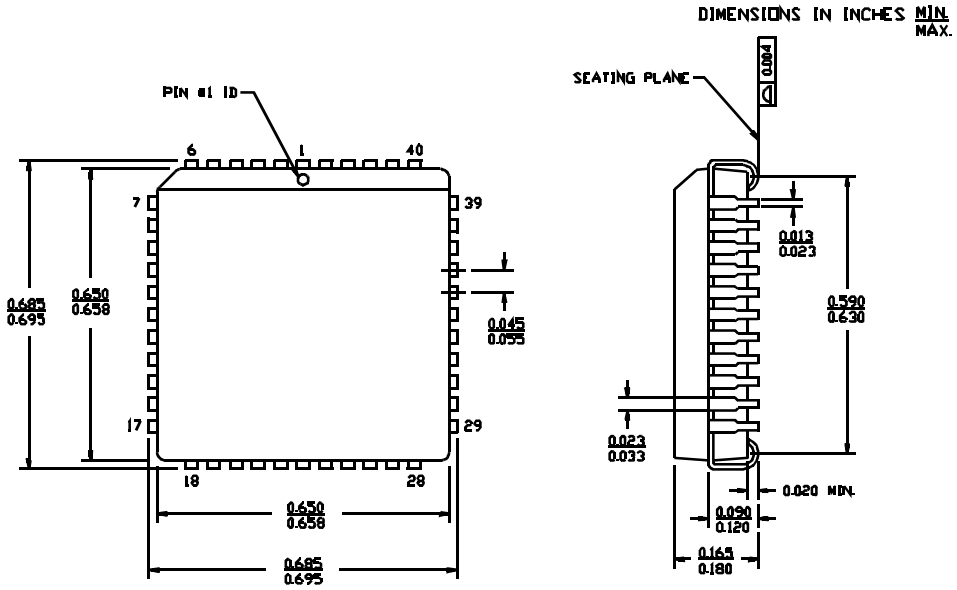
Package Diagrams

44-Lead Thin Plastic Quad Flat Pack A44



Package Diagrams (continued)

44-Lead Plastic Leaded Chip Carrier J67



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