



CYPRESS SEMICONDUCTOR

T-46-23-10

CY7C164
CY7C166

16,384 x 4 Static R/W RAM

Features

- Automatic power-down when deselected
- Output Enable (\overline{OE}) feature (7C166)
- CMOS for optimum speed/power
- High speed
— $t_{AA} = 10$ ns
- Low active power
— 880 mW
- Low standby power
— 220 mW
- TTL-compatible inputs and outputs
- Capable of withstanding greater than 2001V electrostatic discharge

Functional Description

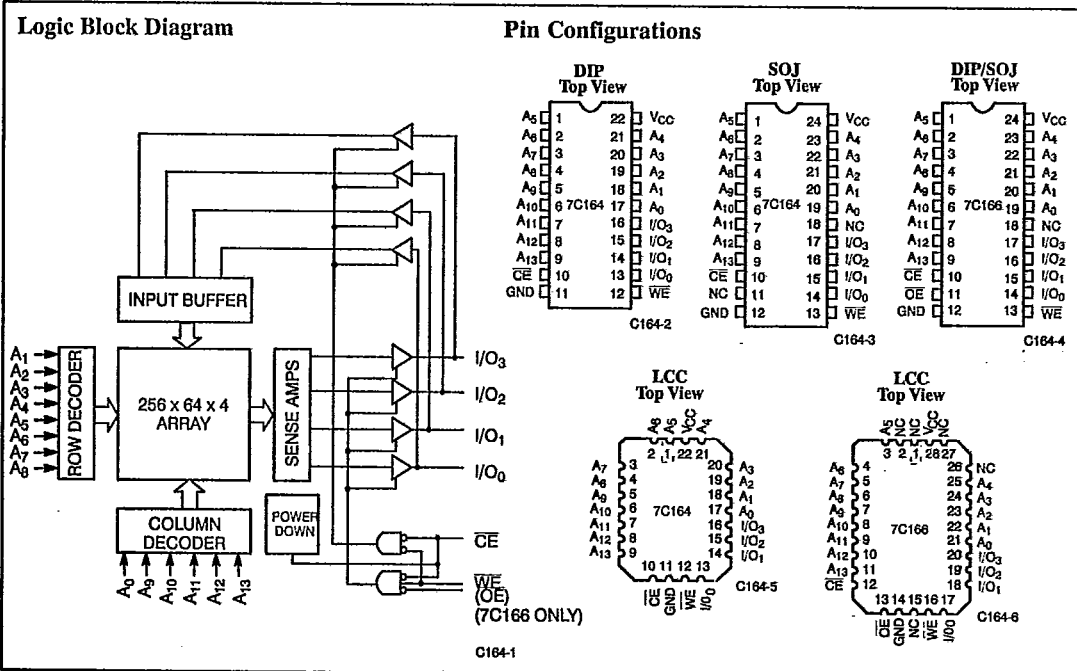
The CY7C164 and CY7C166 are high-performance CMOS static RAMs organized as 16,384 by 4 bits. Easy memory expansion is provided by an active LOW chip enable (CE) and three-state drivers. The CY7C166 has an active low output enable (\overline{OE}) feature. Both devices have an automatic power-down feature, reducing the power consumption by 65% when deselected.

Writing to the device is accomplished when the chip enable (CE) and write enable (\overline{WE}) inputs are both LOW (and the output enable (\overline{OE}) is LOW for the 7C166).

Data on the four input/output pins (I/O_0 through I/O_3) is written into the memory location specified on the address pins (A_0 through A_{13}).

Reading the device is accomplished by taking chip enable (CE) LOW (and \overline{OE} LOW for 7C166), while write enable (\overline{WE}) remains HIGH. Under these conditions the contents of the memory location specified on the address pins will appear on the four data I/O pins.

The I/O pins stay in high-impedance state when chip enable (CE) is HIGH, or write enable (\overline{OE}) is HIGH for 7C166). A die coat is used to insure alpha immunity.





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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 - 3.0V to +7.0V

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	5V ± 10%



Electrical Characteristics Over the Operating Range

Parameters	Description	Test Conditions	7C164-10 7C166-10		7C164-12 7C166-12		7C164-15 7C166-15		Units
			Min.	Max.	Min.	Max.	Min.	Max.	
V _{OH}	Output HIGH Voltage	V _{CC} = Min., I _{OH} = -4.0 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		2.2	V _{CC}	2.2	V _{CC}	2.2	V _{CC}	V
V _{IL}	Input LOW Voltage ^[2]		-3.0	0.8	-3.0	0.8	-3.0	0.8	V
I _{IX}	Input Load Current	GND ≤ V _I ≤ V _{CC}	-10	+10	-10	+10	-10	+10	µA
I _{OZ}	Output Leakage Current	GND ≤ V _O ≤ V _{CC} , Output Disabled	-10	+10	-10	+10	-10	+10	µA
I _{OS}	Output Short Circuit Current ^[3]	V _{CC} = Max., V _{OUT} = GND		-350		-350		-350	mA
I _{CC}	V _{CC} Operating Supply Current	V _{CC} = Max., I _{OUT} = 0 mA		160		160		115	mA
I _{SB1}	Automatic \overline{CE} Power-Down Current ^[4]	Max. V _{CC} , $\overline{CE} \geq V_{IH}$, Min. Duty Cycle = 100%		40		40		40	mA
I _{SB2}	Automatic \overline{CE} Power-Down Current ^[4]	Max. V _{CC} , $\overline{CE} \geq V_{CC} - 0.3V$, V _{IN} ≥ V _{CC} - 0.3V or V _{IN} ≤ 0.3V		20		20		20	mA

Shaded area contains advanced information.



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Electrical Characteristics Over the Operating Range (continued)

Parameters	Description	Test Conditions	7C164-20 7C166-20		7C164-25, 35 7C166-25, 35		7C164-45 7C166-45		Units
			Min.	Max.	Min.	Max.	Min.	Max.	
V _{OH}	Output HIGH Voltage	V _{CC} = Min., I _{OH} = -4.0 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		2.2	V _{CC}	2.2	V _{CC}	2.2	V _{CC}	V
V _{IL}	Input LOW Voltage ^[3]		-3.0	0.8	-3.0	0.8	-3.0	0.8	V
I _{IX}	Input Load Current	GND ≤ V _I ≤ V _{CC}	-10	+10	-10	+10	-10	+10	μA
I _{OZ}	Output Leakage Current	GND ≤ V _O ≤ V _{CC} , Output Disabled	-10	+10	-10	+10	-10	+10	μA
I _{OS}	Output Short Circuit Current ^[3]	V _{CC} = Max., V _{OUT} = GND		-350		-350		-350	mA
I _{CC}	V _{CC} Operating Supply Current	V _{CC} = Max., I _{OUT} = 0 mA		80		70		50	mA
I _{SB1}	Automatic \overline{CE} Power-Down Current ^[4]	Max. V _{CC} , $\overline{CE} \geq V_{IH}$, Min. Duty Cycle = 100%		40		20		20	mA
I _{SB1}	Automatic \overline{CE} Power-Down Current ^[4]	Max. V _{CC} , $\overline{CE} \geq V_{CC} - 0.3V$, V _{IN} ≥ V _{CC} - 0.3V or V _{IN} ≤ 0.3V		20		20		20	mA

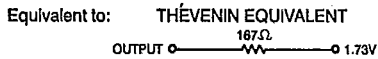
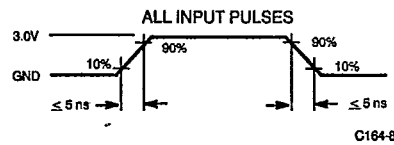
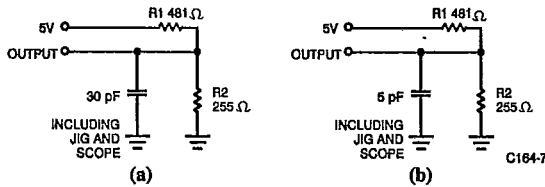
Capacitance^[5]

Parameters	Description	Test Conditions	Max.	Units
C _{IN}	Input Capacitance	T _A = 25°C, f = 1 MHz, V _{CC} = 5.0V	10	pF
C _{OUT}	Output Capacitance		10	pF

Notes:

- V_{IL} min. = -3.0V for pulse durations less than 30 ns.
- Not more than 1 output should be shorted at one time. Duration of the short circuit should not exceed 30 seconds.
- A pull-up resistor to V_{CC} on the \overline{CE} input is required to keep the device deselected during V_{CC} power-up, otherwise I_{SB} will exceed values given.
- Tested initially and after any design or process changes that may affect these parameters.

AC Test Loads and Waveforms





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Switching Characteristics Over the Operating Range^[6]

Parameters	Description	7C164-10 7C166-10		7C164-12 7C166-12		7C164-15 7C166-15		7C164-20 7C166-20		Units
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
READ CYCLE										
t _{RC}	Read Cycle Time	10		12		15		20		ns
t _{AA}	Address to Data Valid		10		12		15		20	ns
t _{OHA}	Output Hold from Address Change	3		3		3		5		ns
t _{ACE}	\overline{CE} LOW to Data Valid		10		12		15		20	ns
t _{DOE}	\overline{OE} LOW to Data Valid	7C166	5		6		10		10	ns
t _{LZOE}	\overline{OE} LOW to Low Z	7C166	0	0		3		3		ns
t _{HZOE}	\overline{OE} HIGH to High Z	7C166	5		7		8		8	ns
t _{LZCE}	\overline{CE} LOW to Low Z ^[7]		2		3		3		5	ns
t _{HZCE}	\overline{CE} HIGH to High Z ^[7, 8]		5		7		8		8	ns
t _{PU}	\overline{CE} LOW to Power-Up	0		0		0		0		ns
t _{PD}	\overline{CE} HIGH to Power-Down		10		12		15		20	ns
WRITE CYCLE^[9]										
t _{WC}	Write Cycle Time	10		12		15		20		ns
t _{SCE}	\overline{CE} LOW to Write End	8		8		12		15		ns
t _{AW}	Address Set-Up to Write End	8		9		12		15		ns
t _{HA}	Address Hold from Write End	0		0		0		0		ns
t _{SA}	Address Set-Up to Write Start	0		0		0		0		ns
t _{PWE}	\overline{WE} Pulse Width	8		8		12		15		ns
t _{SD}	Data Set-Up to Write End	5		6		10		10		ns
t _{HD}	Data Hold from Write End	0		0		0		0		ns
t _{LZWE}	\overline{WE} HIGH to Low Z ^[7]	2		3		5		5		ns
t _{HZWE}	\overline{WE} LOW to High Z ^[7, 8]		6		6		7		7	ns

Shaded area contains advanced information.



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CY7C164
CY7C166Switching Characteristics Over the Operating Range^[6]

Parameters	Description	7C164-25 7C166-25		7C164-35 7C166-35		7C164-45 7C166-45		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
READ CYCLE								
t _{RC}	Read Cycle Time	25		35		45		ns
t _{AA}	Address to Data Valid		25		35		45	ns
t _{OHA}	Output Hold from Address Change	5		5		5		ns
t _{ACE}	\overline{CE} LOW to Data Valid		25		35		45	ns
t _{DOE}	\overline{OE} LOW to Data Valid	7C166	12		15		20	ns
t _{LZOE}	\overline{OE} LOW to Low Z	7C166	3		3		3	ns
t _{HZOE}	\overline{OE} HIGH to High Z	7C166	10		12		15	ns
t _{LZCE}	\overline{CE} LOW to Low Z ^[7]		5		5		5	ns
t _{HZCE}	\overline{CE} HIGH to High Z ^[7,8]		10		15		15	ns
t _{PU}	\overline{CE} LOW to Power-Up		0		0		0	ns
t _{PD}	\overline{CE} HIGH to Power-Down		20		20		25	ns
WRITE CYCLE^[9]								
t _{WC}	Write Cycle Time	20		25		40		ns
t _{SCE}	\overline{CE} LOW to Write End	20		25		30		ns
t _{AW}	Address Set-Up to Write End	20		25		30		ns
t _{HA}	Address Hold from Write End	0		0		0		ns
t _{SA}	Address Set-Up to Write Start	0		0		0		ns
t _{PWE}	\overline{WE} Pulse Width	15		20		20		ns
t _{SD}	Data Set-Up to Write End	10		15		15		ns
t _{HD}	Data Hold from Write End	0		0		0		ns
t _{LZWE}	\overline{WE} HIGH to Low Z ^[7]		5		5		5	ns
t _{HZWE}	\overline{WE} LOW to High Z ^[7,8]		7		10		15	ns

Notes:

- Test conditions assume signal transition time of 5 ns or less, timing reference levels of 1.5V, input pulse levels of 0 to 3.0V, and output loading of the specified I_{OL}/I_{OH} and 30-pF load capacitance.
- At any given temperature and voltage condition, t_{HZCE} is less than t_{LZCE} for any given device. These parameters are guaranteed and not 100% tested.
- t_{HZCE} and t_{HZWE} are specified with C_L = 5 pF as in part (b) in AC Test Loads. Transition is measured ±500 mV from steady state voltage.
- The internal write time of the memory is defined by the overlap of \overline{CE} LOW and \overline{WE} LOW. Both signals must be LOW to initiate a write and either signal can terminate a write by going HIGH. The data input set-up and hold timing should be referenced to the rising edge of the signal that terminates the write.

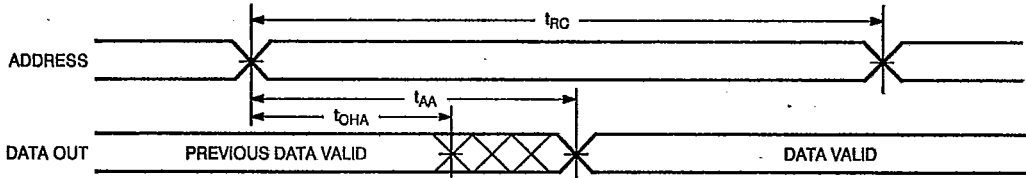


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CY7C166

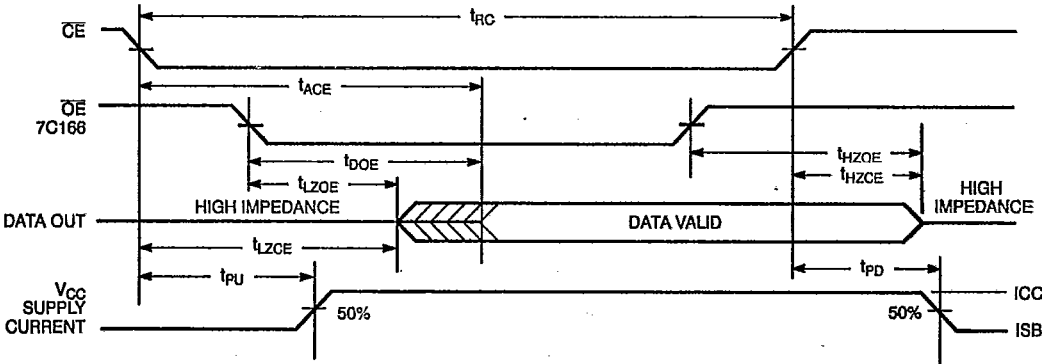
Switching Waveforms

Read Cycle No. 1^[10, 11]



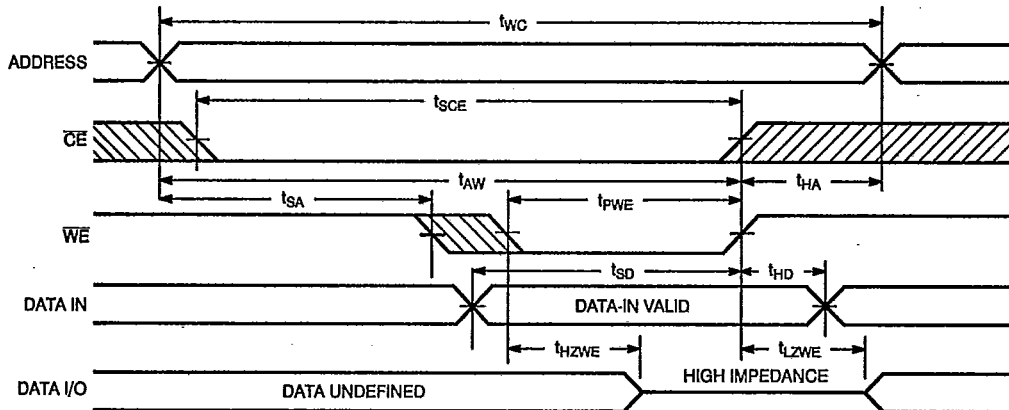
C164-9

Read Cycle No. 2^[10, 12]



C164-10

Write Cycle No. 1 (\overline{WE} Controlled)^[9, 13]



C164-11

Notes:

- 10. \overline{WE} is HIGH for read cycle.
- 11. Device is continuously selected, $\overline{CE} = V_{IL}$. (7C166: $\overline{OE} = V_{IL}$ also).
- 12. Address valid prior to or coincident with \overline{CE} transition LOW.
- 13. 7C166 only: Data I/O will be high impedance if $\overline{OE} = V_{IH}$.
- 14. If \overline{CE} goes HIGH simultaneously with \overline{WE} HIGH, the output remains in a high-impedance state.

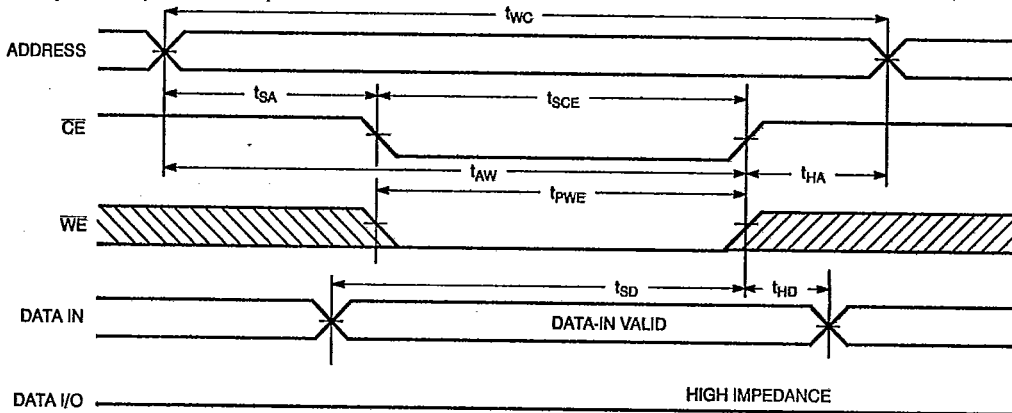




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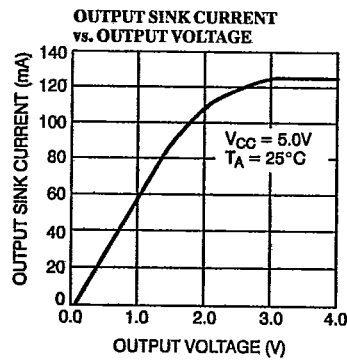
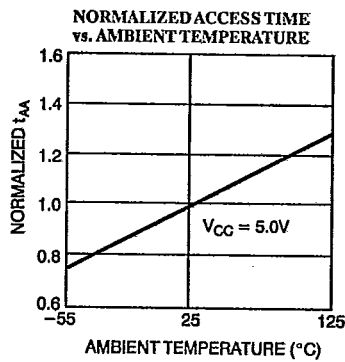
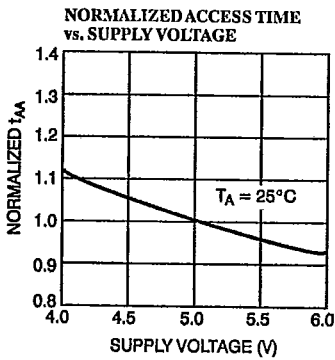
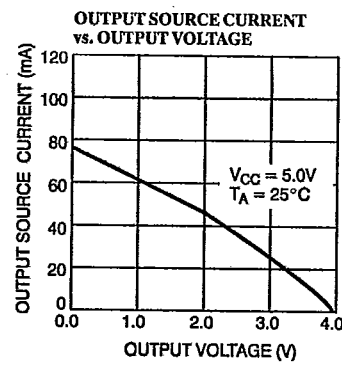
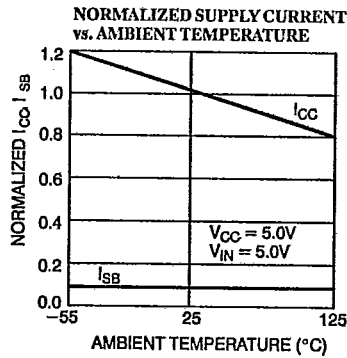
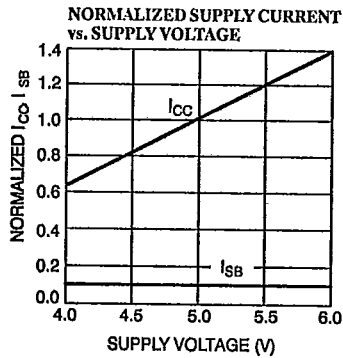
Switching Waveforms (continued)

Write Cycle No. 2 (CE Controlled)^[9,13,14]



C164-12

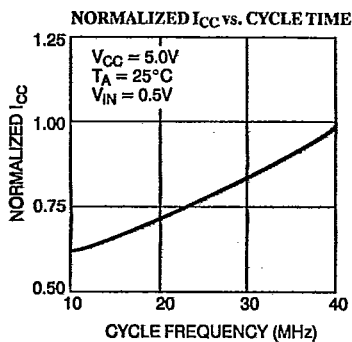
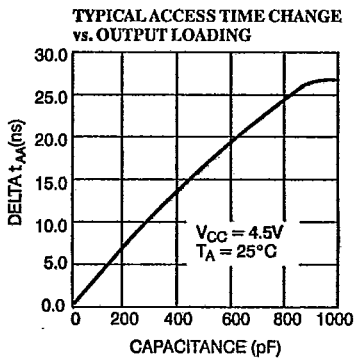
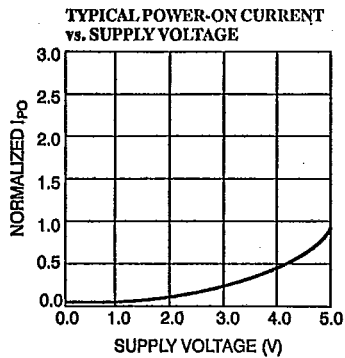
Typical DC and AC Characteristics





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Typical DC and AC Characteristics (continued)



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CY7C164 Truth Table

CE	WE	Inputs/Outputs	Mode
H	X	High Z	Deselect/Power-Down
L	H	Data Out	Read
L	L	Data In	Write

CY7C166 Truth Table

CE	WE	OE	Inputs/Outputs	Mode
H	X	X	High Z	Deselect/Power-Down
L	H	L	Data Out	Read
L	L	H	Data In	Write
L	H	H	High Z	Write

Address Designators

Address Name	Address Function	CY7C164 Pin Number	CY7C166 Pin Number
A5	X3	1	1
A6	X4	2	2
A7	X5	3	3
A8	X6	4	4
A9	X7	5	5
A10	Y5	6	6
A11	Y4	7	7
A12	Y0	8	8
A13	Y1	9	9
A0	Y2	17	19
A1	Y3	18	20
A2	X0	19	21
A3	X1	20	22
A4	X2	21	23

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Ordering Information

Speed (ns)	Ordering Code	Package Type	Operating Range
10	CY7C164-10DC	D10	Commercial
	CY7C164-10LC	L52	
	CY7C164-10PC	P9	
	CY7C164-10VC	V13	
12	CY7C164-12DC	D10	Commercial
	CY7C164-12LC	L52	
	CY7C164-12PC	P9	
	CY7C164-12VC	V13	
15	CY7C164-15DC	D10	Commercial
	CY7C164-15LC	L52	
	CY7C164-15PC	P9	
	CY7C164-15VC	V13	
20	CY7C164-20DC	D10	Commercial
	CY7C164-20LC	L52	
	CY7C164-20PC	P9	
	CY7C164-20VC	V13	
25	CY7C164-25DC	D10	Commercial
	CY7C164-25LC	L52	
	CY7C164-25PC	P9	
	CY7C164-25VC	V13	
35	CY7C164-35DC	D10	Commercial
	CY7C164-35LC	L52	
	CY7C164-35PC	P9	
	CY7C164-35VC	V13	
45	CY7C164-45DC	D10	Commercial
	CY7C164-45LC	L52	
	CY7C164-45PC	P9	
	CY7C164-45VC	V13	

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Speed (ns)	Ordering Code	Package Type	Operating Range
10	CY7C166-10DC	D14	Commercial
	CY7C166-10LC	L54	
	CY7C166-10PC	P13	
	CY7C166-10VC	V13	
12	CY7C166-12DC	D14	Commercial
	CY7C166-12LC	L54	
	CY7C166-12PC	P13	
	CY7C166-12VC	V13	
15	CY7C166-15DC	D14	Commercial
	CY7C166-15LC	L54	
	CY7C166-15PC	P13	
	CY7C166-15VC	V13	
20	CY7C166-20DC	D14	Commercial
	CY7C166-20LC	L54	
	CY7C166-20PC	P13	
	CY7C166-20VC	V13	
25	CY7C166-25DC	D14	Commercial
	CY7C166-25LC	L54	
	CY7C166-25PC	P13	
	CY7C166-25VC	V13	
35	CY7C166-35DC	D14	Commercial
	CY7C166-35LC	L54	
	CY7C166-35PC	P13	
	CY7C166-35VC	V13	
45	CY7C166-45DC	D14	Commercial
	CY7C166-45LC	L54	
	CY7C166-45PC	P13	
	CY7C166-45VC	V13	

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