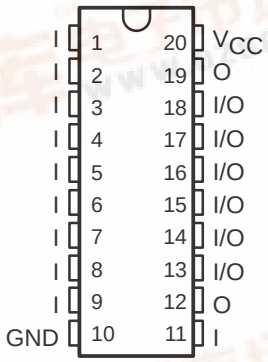
TIBPAL16L8-15C, TIBPAL16R4-15C, TIBPAL16R6-15C, TIBPAL16R8-15C
TIBPAL16L8-20M, TIBPAL16R4-20M, TIBPAL16R6-20M, TIBPAL16R8-20M
HIGH-PERFORMANCE *IMPACT* ™ *PAL*® CIRCUITS

SRPS019A – FEBRUARY 1984 – REVISED APRIL 2000

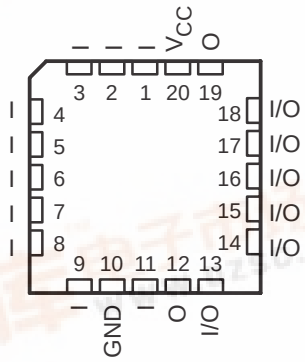
- **High-Performance Operation:**
  Propagation Delay
  C Suffix . . . 15 ns Max
  M Suffix . . . 20 ns Max
- **Functionally Equivalent, but Faster Than PAL16L8A, PAL16R4A, PAL16R6A, and PAL16R8A**
- **Power-Up Clear on Registered Devices (All Register Outputs Are Set High, but Voltage Levels at the Output Pins Go Low)**
- **Package Options Include Both Plastic and Ceramic Chip Carriers in Addition to Plastic and Ceramic DIPs**
- **Dependable Texas Instruments Quality and Reliability**

DEVICE	I INPUTS	3-STATE O OUTPUTS	REGISTERED Q OUTPUTS	I/O PORTS
PAL16L8	10	2	0	6
PAL16R4	8	0	4 (3-state buffers)	4
PAL16R6	8	0	6 (3-state buffers)	2
PAL16R8	8	0	8 (3-state buffers)	0

TIBPAL16L8'
C SUFFIX . . . J OR N PACKAGE
M SUFFIX . . . J OR W PACKAGE
(TOP VIEW)



TIBPAL16L8'
C SUFFIX . . . FN PACKAGE
M SUFFIX . . . FK PACKAGE
(TOP VIEW)

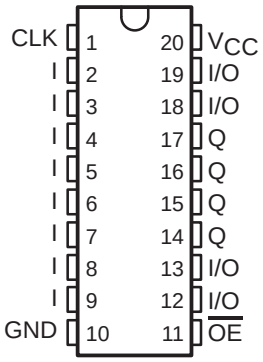


description

These programmable array logic devices feature high speed and functional equivalency when compared with currently available devices. These IMPACT™ circuits combine the latest Advanced Low-Power Schottky technology with proven titanium-tungsten fuses to provide reliable, high-performance substitutes for conventional TTL logic. Their easy programmability allows for quick design of custom functions and typically results in a more compact circuit board. In addition, chip carriers are available for further reduction in board space.

The TIBPAL16' C series is characterized from 0°C to 75°C. The TIBPAL16' M series is characterized for operation over the full military temperature range of –55°C to 125°C.

TIBPAL16R4'
C SUFFIX . . . J OR N PACKAGE
M SUFFIX . . . J OR W PACKAGE
(TOP VIEW)



TIBPAL16R4'
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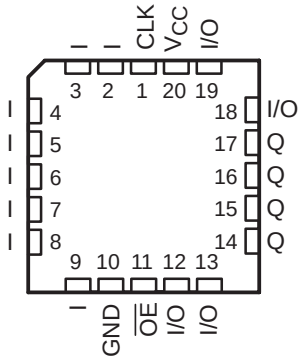
M SUFFIX . . . FK PACKAGE
(TOP VIEW)



TIBPAL16R6'
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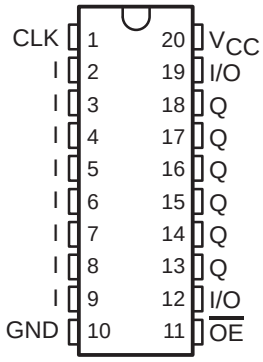
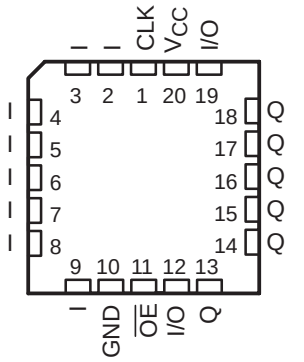
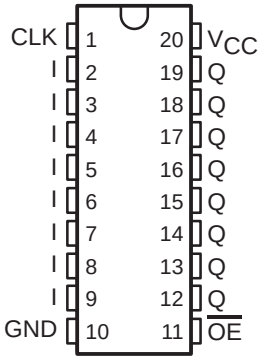
M SUFFIX . . . J OR W PACKAGE
(TOP VIEW)



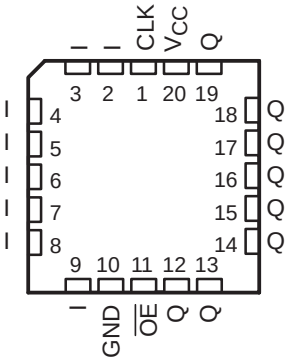
TIBPAL16R6'
C SUFFIX . . . FN PACKAGE
M SUFFIX . . . FK PACKAGE
(TOP VIEW)



TIBPAL16R8'
C SUFFIX . . . J OR N PACKAGE
M SUFFIX . . . J OR W PACKAGE
(TOP VIEW)

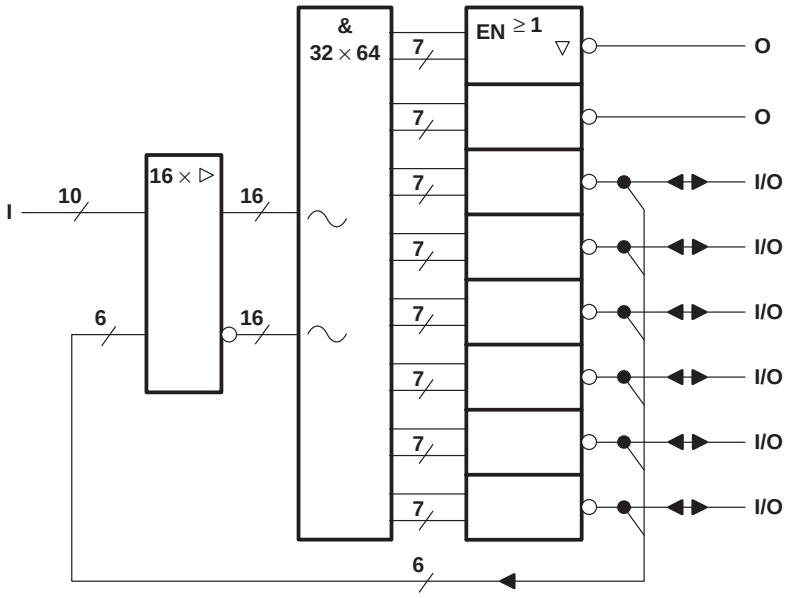


TIBPAL16R8'
C SUFFIX . . . FN PACKAGE
M SUFFIX . . . FK PACKAGE
(TOP VIEW)

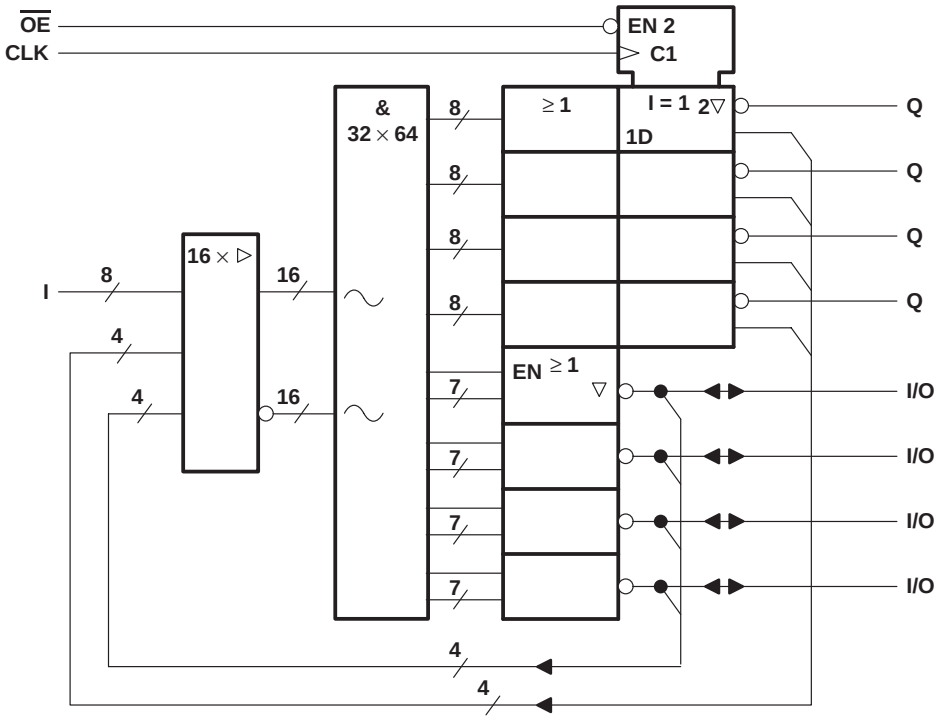


functional block diagrams (positive logic)

TIBPAL16L8'



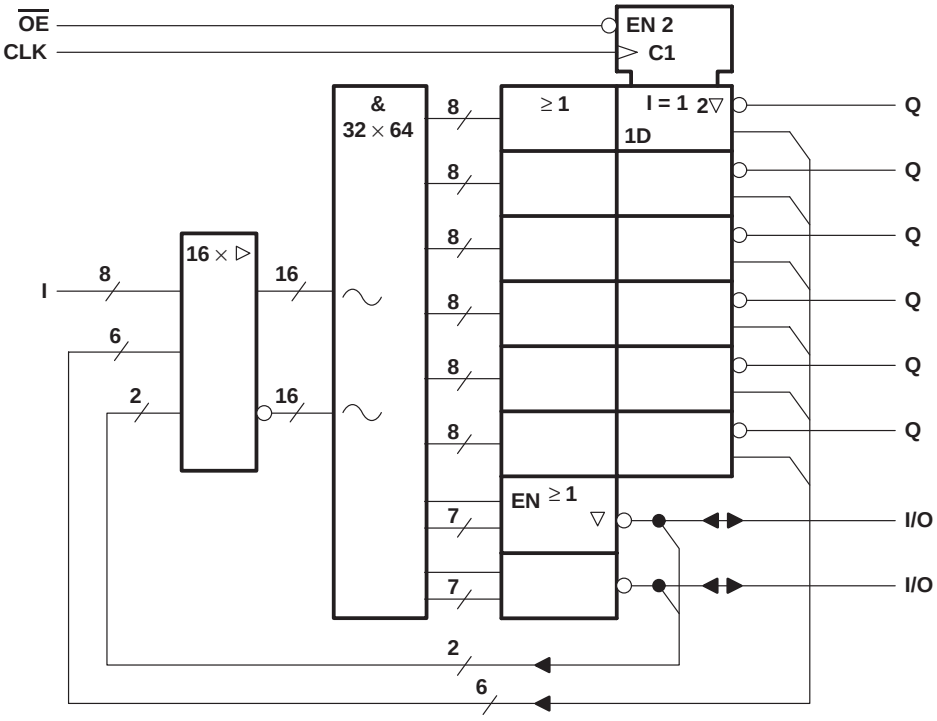
TIBPAL16R4'



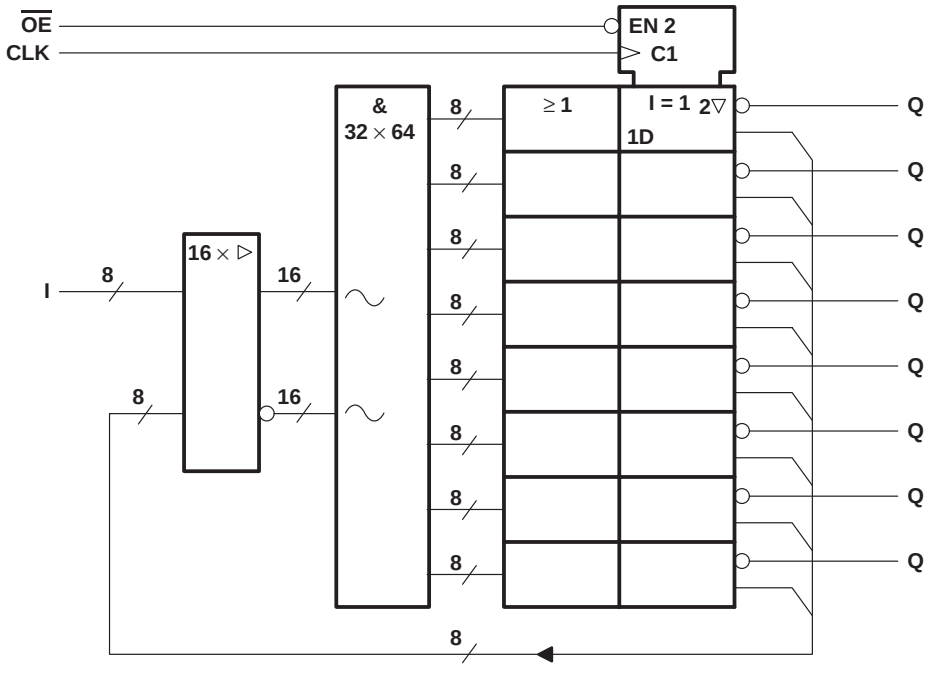
denotes fused inputs

functional block diagrams (positive logic)

TIBPAL16R6'

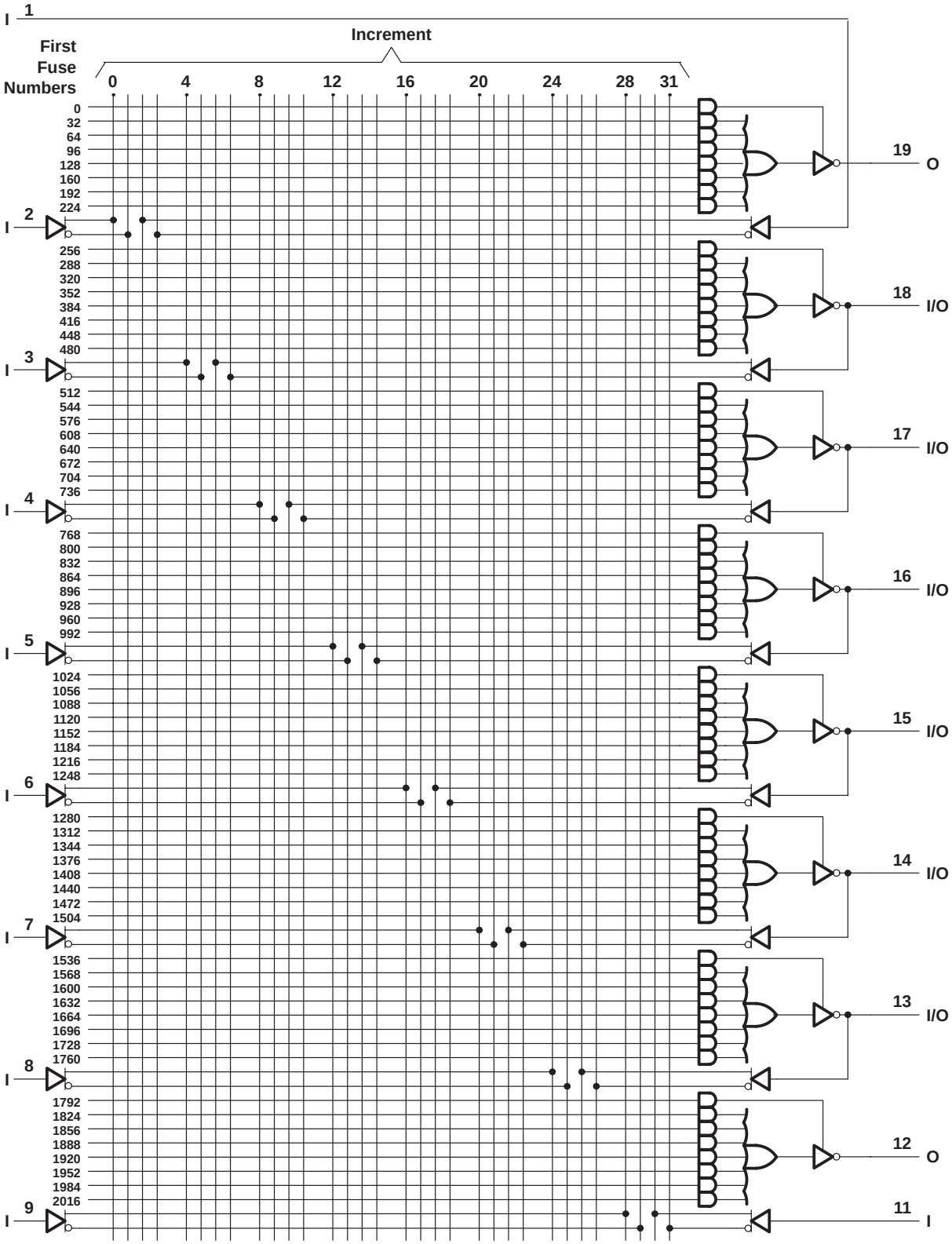


TIBPAL16R8'



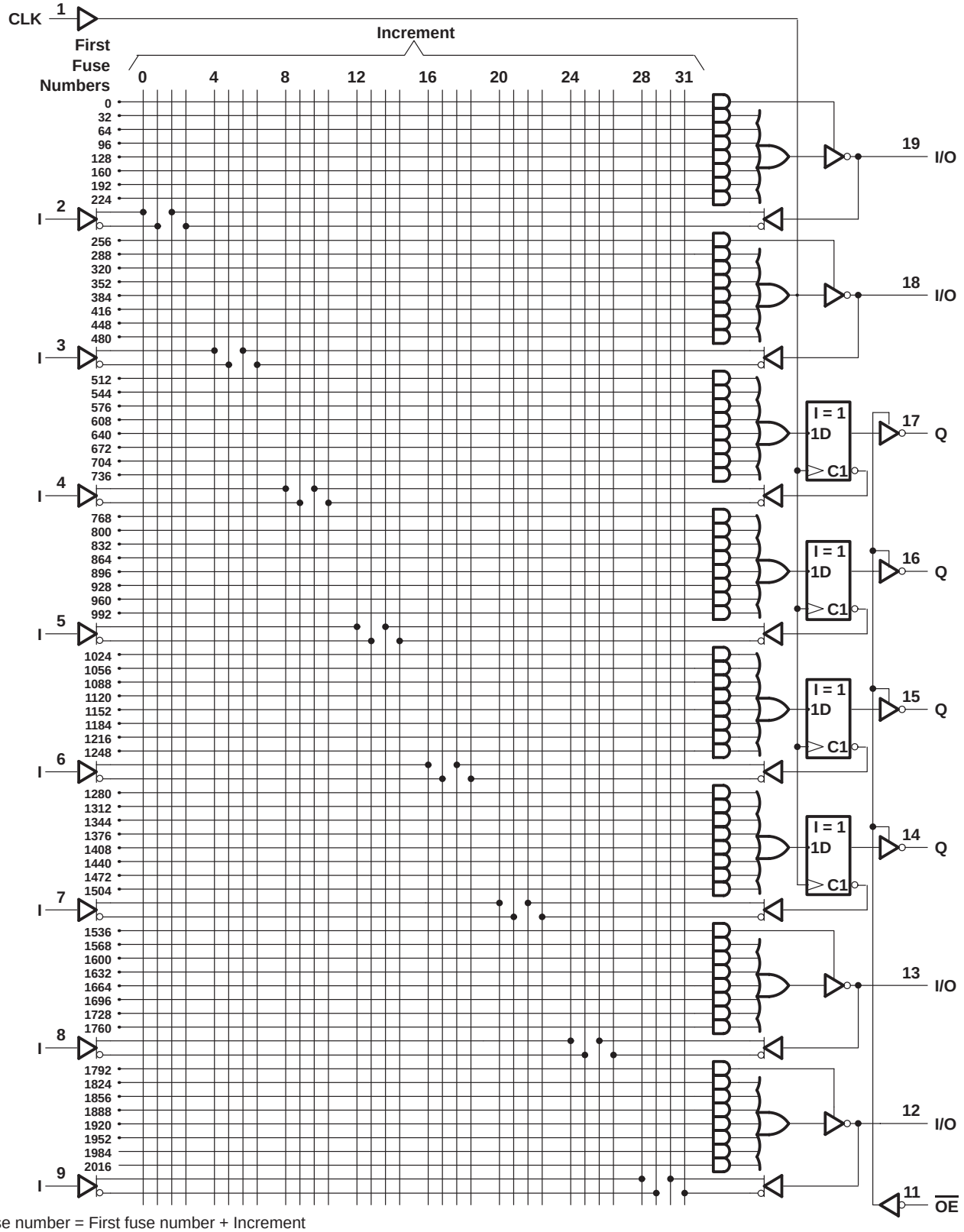
~ denotes fused inputs

logic diagram (positive logic)



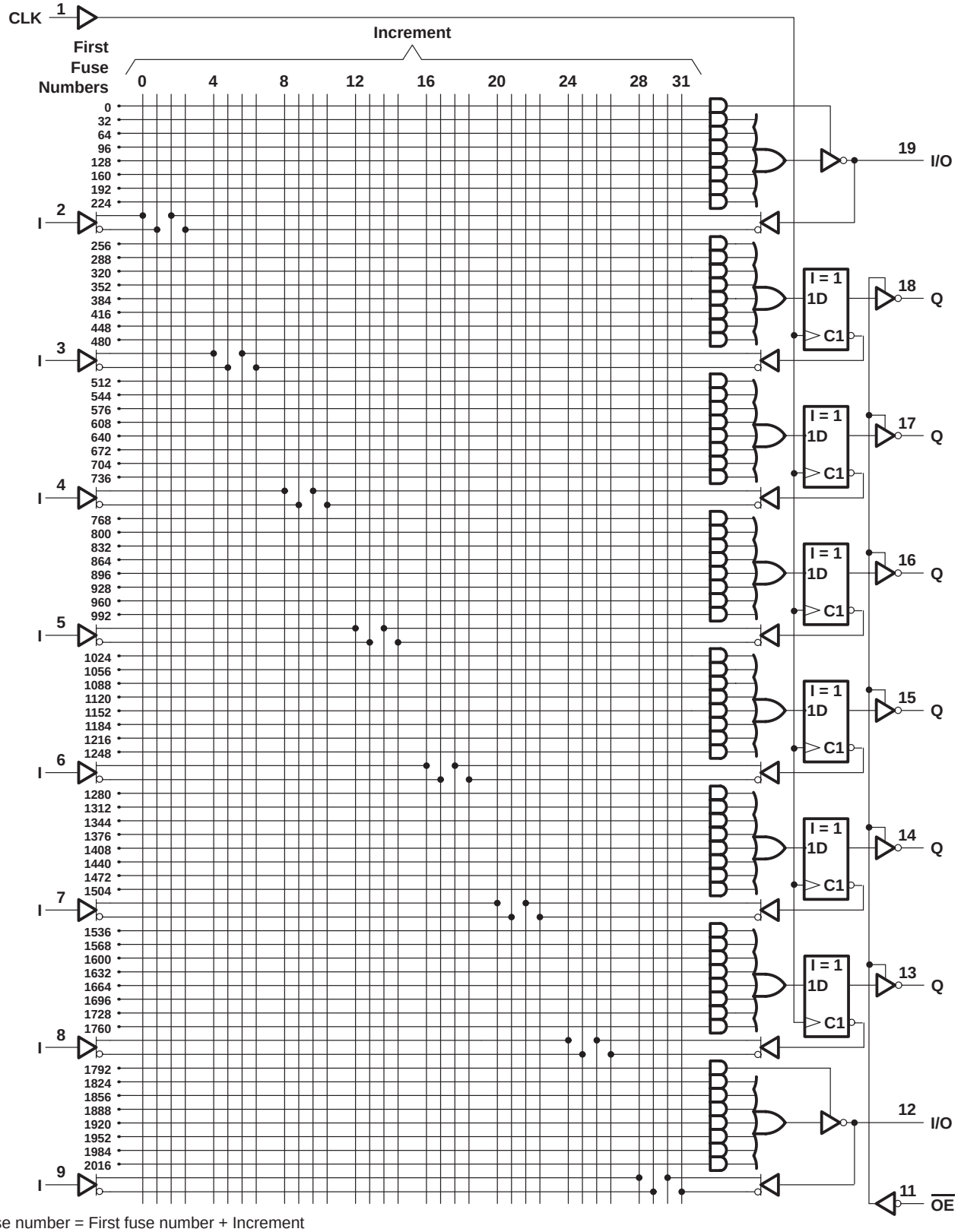
Fuse number = First fuse number + Increment

logic diagram (positive logic)



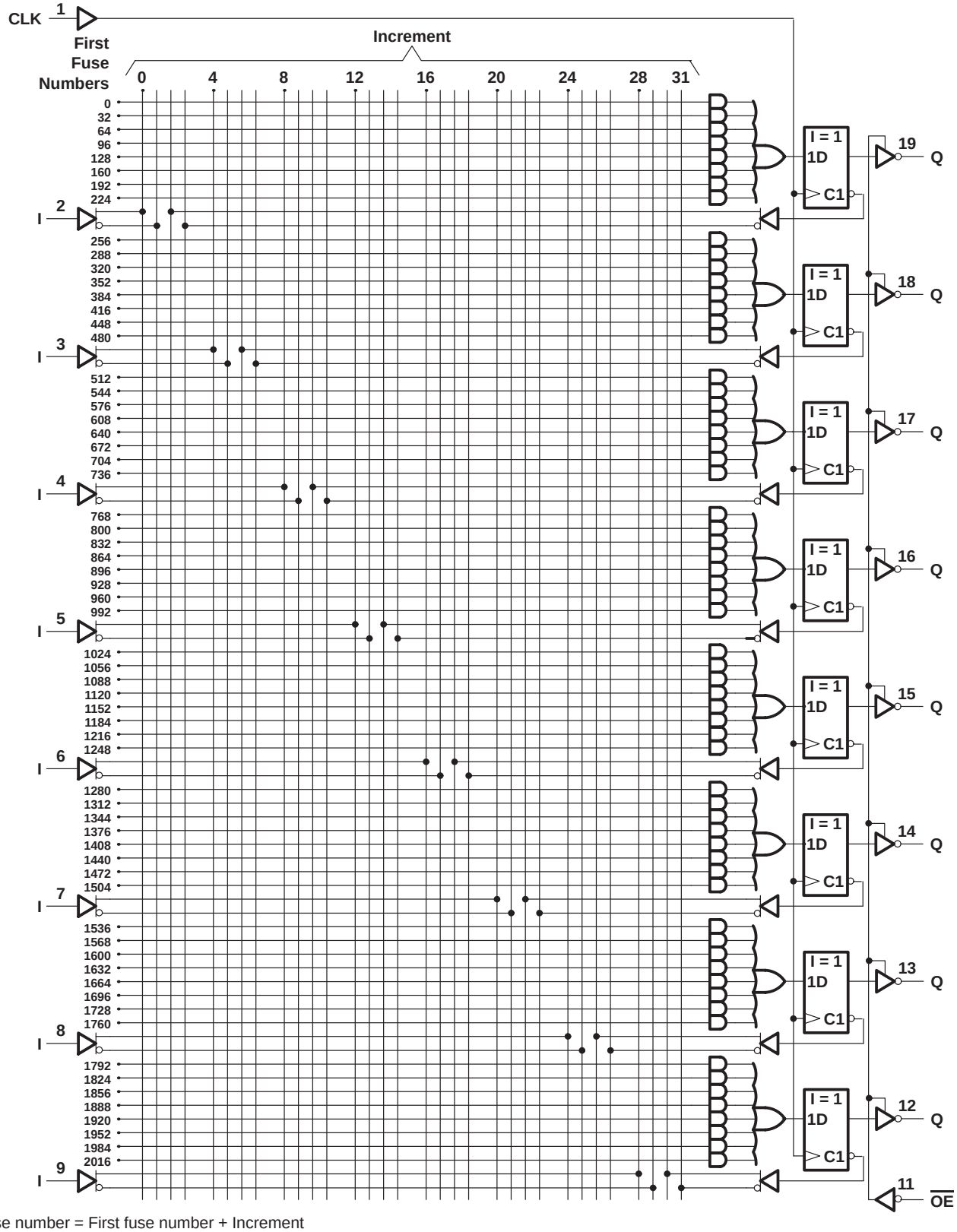
Fuse number = First fuse number + Increment

logic diagram (positive logic)



Fuse number = First fuse number + Increment

logic diagram (positive logic)



Fuse number = First fuse number + Increment

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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage (see Note 1) . . . . . 5.5 V
Voltage applied to disabled output (see Note 1) . . . . . 5.5 V
Operating free-air temperature range . . . . . 0°C to 75°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C

NOTE 1: These ratings apply, except for programming pins, during a programming cycle.

recommended operating conditions

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.75	5	5.25	V
V_{IH}	High-level input voltage		2		5.5	V
V_{IL}	Low-level input voltage				0.8	V
I_{OH}	High-level output current				–3.2	mA
I_{OL}	Low-level output current				24	mA
f_{clock}	Clock frequency		0		50	MHz
t_w	Pulse duration, clock (see Note 2)	High	8			ns
		Low	9			
t_{su}	Setup time, input or feedback before clock↑		15			ns
t_h	Hold time, input or feedback after clock↑		0			ns
T_A	Operating free-air temperature		0	25	75	°C

NOTE 2: The total clock period of clock high and clock low must not exceed clock frequency, f_{clock}. The minimum pulse durations specified are for clock high or low only, but not for both simultaneously.

electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS			MIN	TYP†	MAX	UNIT
V_{IK}		V_{CC} = 4.75 V,	I_I = –18 mA				–1.5	V
V_{OH}		V_{CC} = 4.75 V,	I_{OH} = –3.2 mA		2.4	3.3		V
V_{OL}		V_{CC} = 4.75 V,	I_{OL} = 24 mA			0.35	0.5	V
I_{OZH}	Outputs	V_{CC} = 5.25 V,	V_O = 2.7 V				20	µA
	I/O ports						100	
I_{OZL}	Outputs	V_{CC} = 5.25 V,	V_O = 0.4 V				–20	µA
	I/O ports						–250	
I_I		V_{CC} = 5.25 V,	V_I = 5.5 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				–0.2	mA
I_O‡		V_{CC} = 5.25 V,	V_O = 2.25 V		–30		–125	mA
I_{CC}		V_{CC} = 5.25 V,	V_I = 0,	Outputs open		140	180	mA

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ The output conditions have been chosen to produce a current that closely approximates one-half of the short-circuit output current, I_{OS}.

switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
f_{max}			R1 = 500 Ω, R2 = 500 Ω, See Figure 3	50			MHz
t_{pd}	I, I/O	O, I/O			10	15	ns
t_{pd}	CLK↑	Q			8	12	ns
t_{en}	OE↓	Q			8	12	ns
t_{dis}	OE↑	Q			7	10	ns
t_{en}	I, I/O	O, I/O			10	15	ns
t_{dis}	I, I/O	O, I/O			10	15	ns

† All typical values are at V_{CC} = 5 V, T_A = 25°C.

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

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage (see Note 1) . . . . . 5.5 V
Voltage applied to disabled output (see Note 1) . . . . . 5.5 V
Operating free-air temperature range . . . . . –55°C to 125°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C

NOTE 1: These ratings apply, except for programming pins, during a programming cycle.

recommended operating conditions

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage		2		5.5	V
V_{IL}	Low-level input voltage				0.8	V
I_{OH}	High-level output current				–2	mA
I_{OL}	Low-level output current				12	mA
f_{clock}	Clock frequency		0		41.6	MHz
t_w	Pulse duration, clock (see Note 2)	High	10			ns
		Low	11			
t_{su}	Setup time, input or feedback before clock↑		20			ns
t_h	Hold time, input or feedback after clock↑		0			ns
T_A	Operating free-air temperature		–55	25	125	°C

NOTE 2: The total clock period of clock high and clock low must not exceed clock frequency, f_{clock}. The minimum pulse durations specified are for clock high or low only, but not for both simultaneously.

electrical characteristics over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS			MIN	TYP†	MAX	UNIT
V_{IK}		V_{CC} = 4.5 V,	I_I = –18 mA				–1.5	V
V_{OH}		V_{CC} = 4.5 V,	I_{OH} = –2 mA		2.4	3.2		V
V_{OL}		V_{CC} = 4.5 V,	I_{OL} = 12 mA			0.25	0.4	V
I_{OZH}	Outputs	V_{CC} = 5.5 V,	V_O = 2.7 V				20	µA
	I/O ports						100	
I_{OZL}	Outputs	V_{CC} = 5.5 V,	V_O = 0.4 V				–20	µA
	I/O ports						–250	
I_I	Pin 1, 11	V_{CC} = 5.5 V,	V_I = 5.5 V				0.2	mA
	All others						0.1	
I_{IH}	Pin 1, 11	V_{CC} = 5.5 V,	V_I = 2.7 V				50	µA
	I/O ports						100	
	All others						20	
I_{IL}	I/O ports	V_{CC} = 5.5 V,	V_I = 0.4 V				–0.25	mA
	All others						–0.2	
I_{OS}‡		V_{CC} = 5.5 V,	V_O = 0.5 V		–30		–250	mA
I_{CC}		V_{CC} = 5.5 V,	V_I = 0,	Outputs open		140	190	mA

† 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 the duration of the short circuit should not exceed one second. Set V_O at 0.5 V to avoid test-equipment degradation.

switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
f_{max}			R1 = 390 Ω, R2 = 750 Ω, See Figure 4	41.6			MHz
t_{pd}	I, I/O	O, I/O			10	20	ns
t_{pd}	CLK↑	Q			8	15	ns
t_{en}	OE↓	Q			8	15	ns
t_{dis}	OE↑	Q			7	15	ns
t_{en}	I, I/O	O, I/O			10	20	ns
t_{dis}	I, I/O	O, I/O			10	20	ns

† All typical values are at V_{CC} = 5 V, T_A = 25°C.

programming information

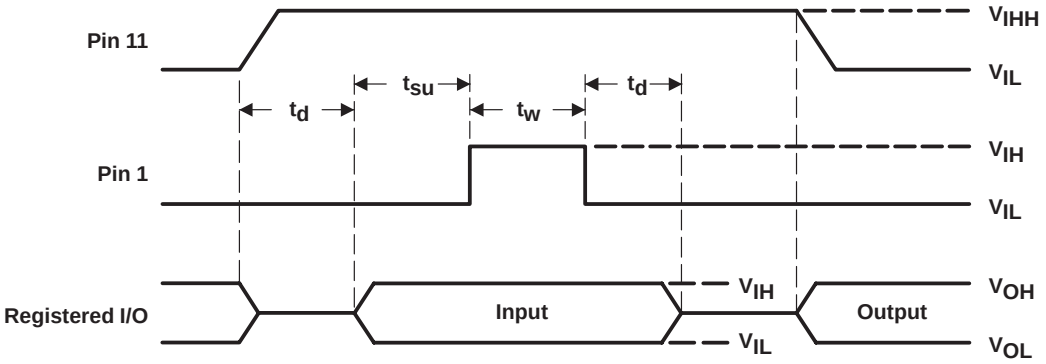
Texas Instruments programmable logic devices can be programmed using widely available software and inexpensive device programmers.

Complete programming specifications, algorithms, and the latest information on hardware, software, and firmware are available upon request. Information on programmers capable of programming Texas Instruments programmable logic also is available, upon request, from the nearest TI field sales office or local authorized TI distributor, by calling Texas Instruments at +1 (972) 644–5580, or by visiting the TI Semiconductor Home Page at www.ti.com/sc.

preload procedure for registered outputs (see Figure 1 and Note 3)

The output registers can be preloaded to any desired state during device testing. This permits any state to be tested without having to step through the entire state-machine sequence. Each register is preloaded individually by following the steps given below.

Step 1. With V_{CC} at 5 V and Pin 1 at V_{IL}, raise Pin 11 to V_{IHH}.
Step 2. Apply either V_{IL} or V_{IH} to the output corresponding to the register to be preloaded.
Step 3. Pulse Pin 1, clocking in preload data.
Step 4. Remove output voltage, then lower Pin 11 to V_{IL}. Preload can be verified by observing the voltage level at the output pin.

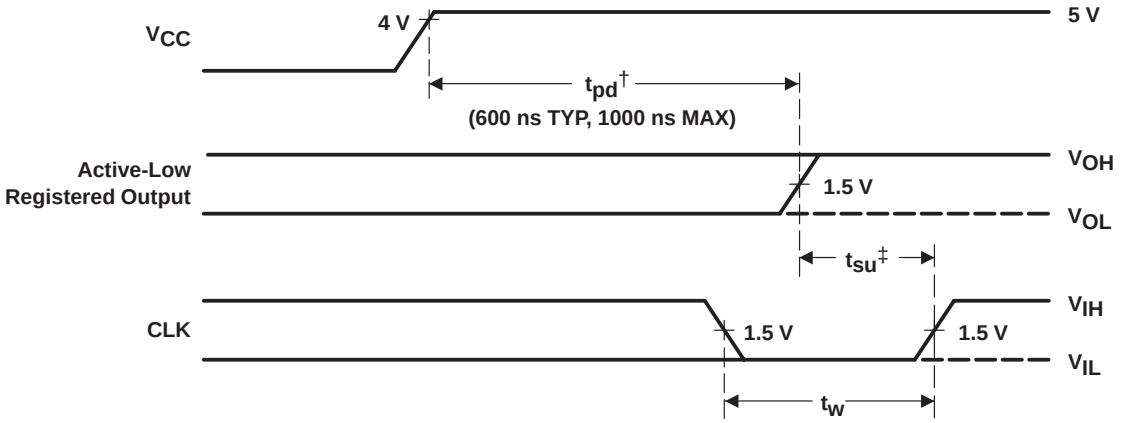


NOTE 3: $t_d = t_{su} = t_h = 100$ ns to 1000 ns $V_{IHH} = 10.25$ V to 10.75 V

Figure 1. Preload Waveforms

power-up reset (see Figure 2)

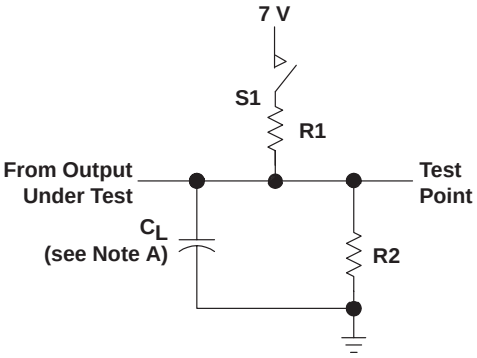
Following power up, all registers are set high. This feature provides extra flexibility to the system designer and is especially valuable in simplifying state-machine initialization. To ensure a valid power-up reset, it is important that the rise of V_{CC} be monotonic. Following power-up reset, a low-to-high clock transition must not occur until all applicable input and feedback setup times are met.



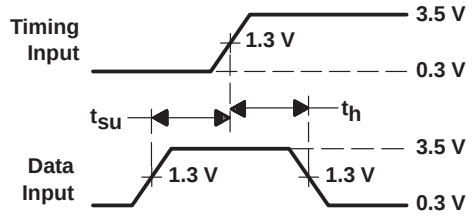
† This is the power-up reset time and applies to registered outputs only. The values shown are from characterization data.
‡ This is the setup time for input or feedback.

Figure 2. Power-Up Reset Waveforms

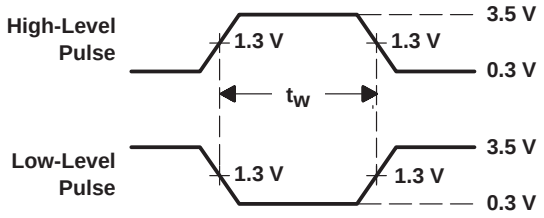
PARAMETER MEASUREMENT INFORMATION



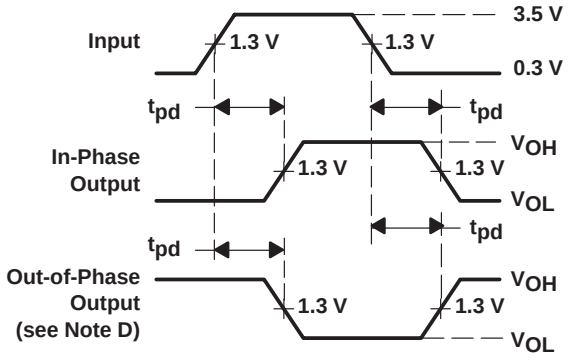
LOAD CIRCUIT FOR 3-STATE OUTPUTS



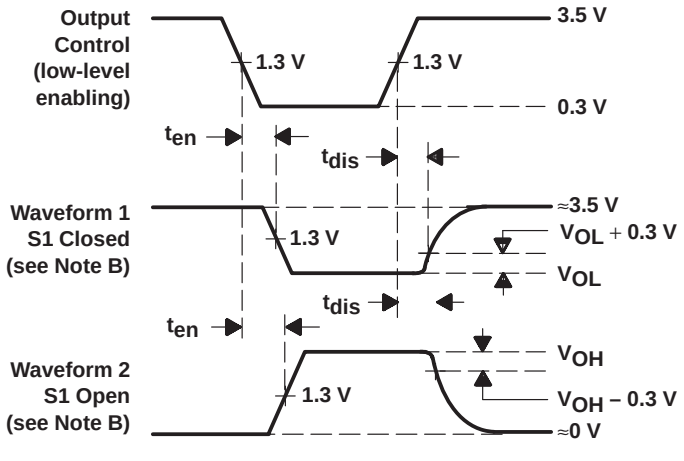
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

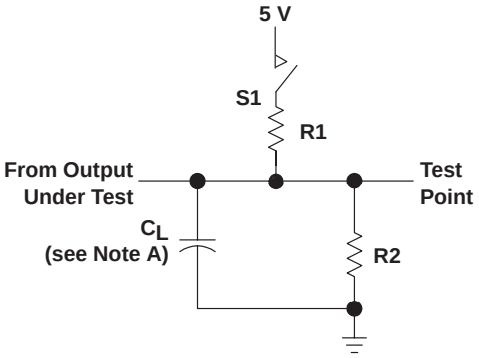


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

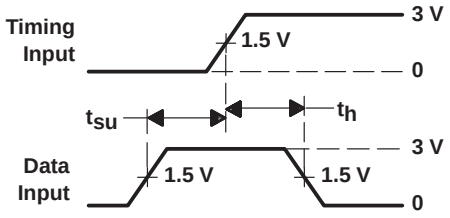
NOTES: A. C_L includes probe and jig capacitance and is 50 pF for t_{pd} and t_{en}, 5 pF for t_{dis}.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. All input pulses have the following characteristics: PRR ≤ 1 MHz, $t_r = t_f \leq 2$ ns, duty cycle = 50%
D. When measuring propagation delay times of 3-state outputs from low to high, switch S1 is closed. When measuring propagation delay times of 3-state outputs from high to low, switch S1 is open.
E. Equivalent loads may be used for testing.

Figure 3. Load Circuit and Voltage Waveforms

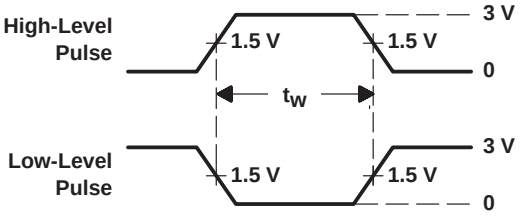
PARAMETER MEASUREMENT INFORMATION



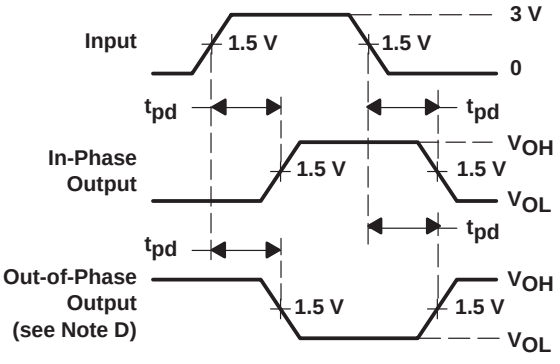
LOAD CIRCUIT FOR 3-STATE OUTPUTS



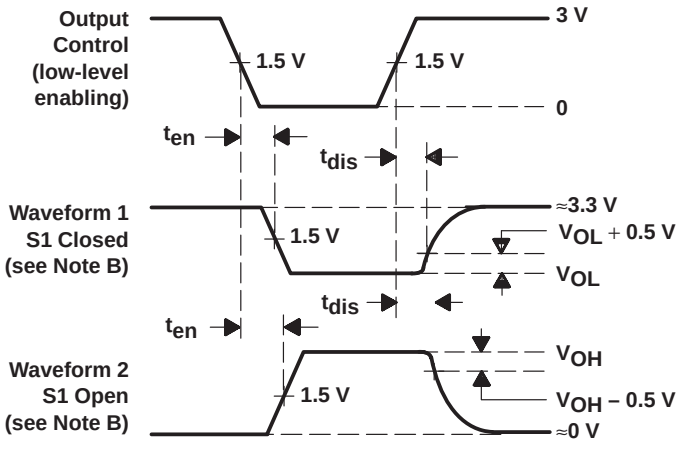
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATIONS



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

NOTES: A. C_L includes probe and jig capacitance and is 50 pF for t_{pd} and t_{en}, 5 pF for t_{dis}.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. All input pulses have the following characteristics: PRR ≤ 10 MHz, $t_r = t_f \leq 2$ ns, duty cycle = 50%
D. When measuring propagation delay times of 3-state outputs, switch S1 is closed.
E. Equivalent loads may be used for testing.

Figure 4. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
5962-85155012A	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
5962-8515501RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
5962-8515501SA	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
5962-85155022A	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
5962-8515502RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
5962-8515502SA	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
5962-85155032A	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
5962-8515503RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
5962-8515503SA	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
5962-85155042A	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
5962-8515504RA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
5962-8515504SA	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
JM38510/50601BRA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
JM38510/50602BRA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
JM38510/50603BRA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
JM38510/50604BRA	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16L8-15CFN	ACTIVE	PLCC	FN	20	46	None	Call TI	Level-1-220-UNLIM
TIBPAL16L8-15CN	ACTIVE	PDIP	N	20	20	None	Call TI	Level-NC-NC-NC
TIBPAL16L8-20MFKB	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16L8-20MJ	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16L8-20MJB	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16L8-20MWB	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R4-15CFN	ACTIVE	PLCC	FN	20	46	None	Call TI	Level-1-220-UNLIM
TIBPAL16R4-15CN	ACTIVE	PDIP	N	20	20	None	Call TI	Level-NC-NC-NC
TIBPAL16R4-20MFKB	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R4-20MJ	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R4-20MJB	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R4-20MWB	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R6-15CFN	ACTIVE	PLCC	FN	20	46	None	Call TI	Level-1-220-UNLIM
TIBPAL16R6-15CN	ACTIVE	PDIP	N	20	20	None	Call TI	Level-NC-NC-NC
TIBPAL16R6-20MFKB	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R6-20MJ	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R6-20MJB	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R6-20MWB	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R8-15CFN	ACTIVE	PLCC	FN	20	46	None	Call TI	Level-1-220-UNLIM
TIBPAL16R8-15CN	ACTIVE	PDIP	N	20	20	None	Call TI	Level-NC-NC-NC
TIBPAL16R8-20MFKB	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R8-20MJ	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R8-20MJB	ACTIVE	CDIP	J	20	1	None	Call TI	Level-NC-NC-NC
TIBPAL16R8-20MWB	ACTIVE	CFP	W	20	1	None	Call TI	Level-NC-NC-NC

(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 - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
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" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

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

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