

TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C
TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M
HIGH-PERFORMANCE IMPACT™ PAL® CIRCUITS

SRPS021A – D2920, JUNE 1986 – REVISED DECEMBER 2010

- **High-Performance: f_{max} (w/o feedback)**
TIBPAL20R' -15C Series . . . 45 MHz
TIBPAL20R' -20M Series . . . 41.6 MHz
- **High-Performance . . . 45 MHz Min**
- **Reduced I_{CC} of 180 mA Max**
- **Functionally Equivalent, but Faster Than**
PAL20L8, PAL20R4, PAL20R6, PAL20R8
- **Power-Up Clear on Registered Devices (All**
Register Outputs are Set Low, but Voltage
Levels at the Output Pins Go High)
- **Preload Capability on Output Registers**
Simplifies Testing
- **Package Options Include Both Plastic and**
Ceramic Chip Carriers in Addition to Plastic
and Ceramic DIPs

DEVICE	I INPUTS	3-STATE O OUTPUTS	REGISTERED Q OUTPUTS	I/O PORT S
PAL20L8	14	2	0	6
PAL20R4	12	0	4 (3-state buffers)	4
PAL20R6	12	0	6 (3-state buffers)	2
PAL20R8	12	0	8 (3-state buffers)	0

description

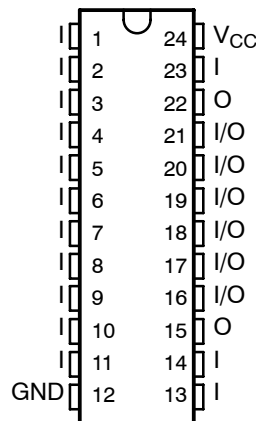
These programmable array logic devices feature high speed and functional equivalency when compared with currently available devices. These IMPACT™ circuits combine the latest Advanced Low-Power Schottky technology with proven titanium-tungsten fuses to provide reliable, high-performance substitutes for 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.

Extra circuitry has been provided to allow loading of each register asynchronously to either a high or low state. This feature simplifies testing because the registers can be set to an initial state prior to executing the test sequence.

The TIBPAL20' C series is characterized from 0°C to 75°C. The TIBPAL20' M series is characterized for operation over the full military temperature range of -55°C to 125°C.

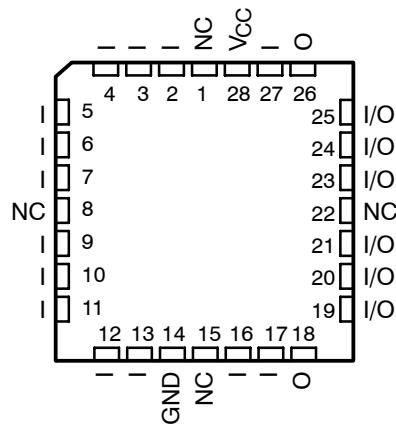
TIBPAL20L8'
C SUFFIX . . . JT OR NT PACKAGE
M SUFFIX . . . JT OR W PACKAGE

(TOP VIEW)



TIBPAL20L8'
C SUFFIX . . . FN PACKAGE
M SUFFIX . . . FK PACKAGE

(TOP VIEW)



NC – No internal connection
 Pin assignments in operating mode

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



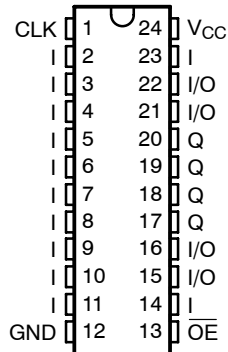
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TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C
TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M
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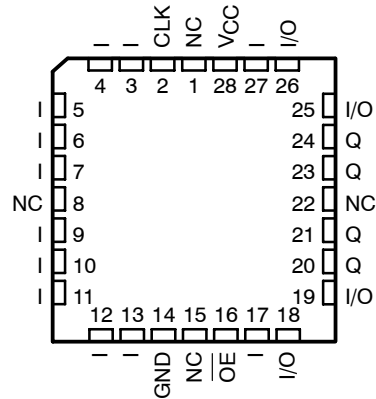
TIBPAL20R4'
C SUFFIX . . . JT OR NT PACKAGE
M SUFFIX . . . JT OR W PACKAGE

(TOP VIEW)



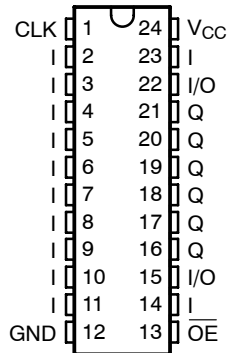
TIBPAL20R4'
C SUFFIX . . . FN PACKAGE
M SUFFIX . . . FK PACKAGE

(TOP VIEW)



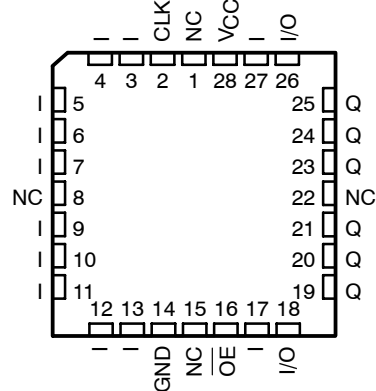
TIBPAL20R6'
C SUFFIX . . . JT OR NT PACKAGE
M SUFFIX . . . JT OR W PACKAGE

(TOP VIEW)



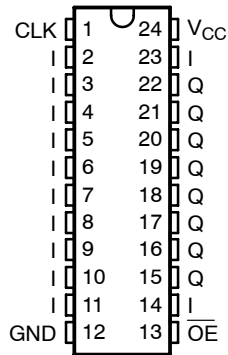
TIBPAL20R6'
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M SUFFIX . . . FK PACKAGE

(TOP VIEW)



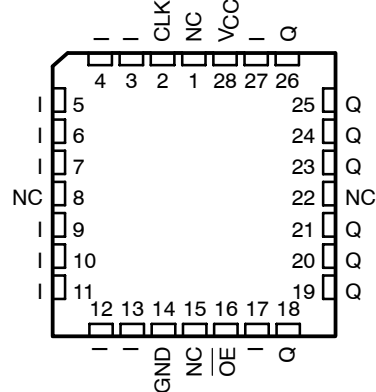
TIBPAL20R8'
C SUFFIX . . . JT OR NT PACKAGE
M SUFFIX . . . JT OR W PACKAGE

(TOP VIEW)



TIBPAL20R8'
C SUFFIX . . . FN PACKAGE
M SUFFIX . . . FK PACKAGE

(TOP VIEW)



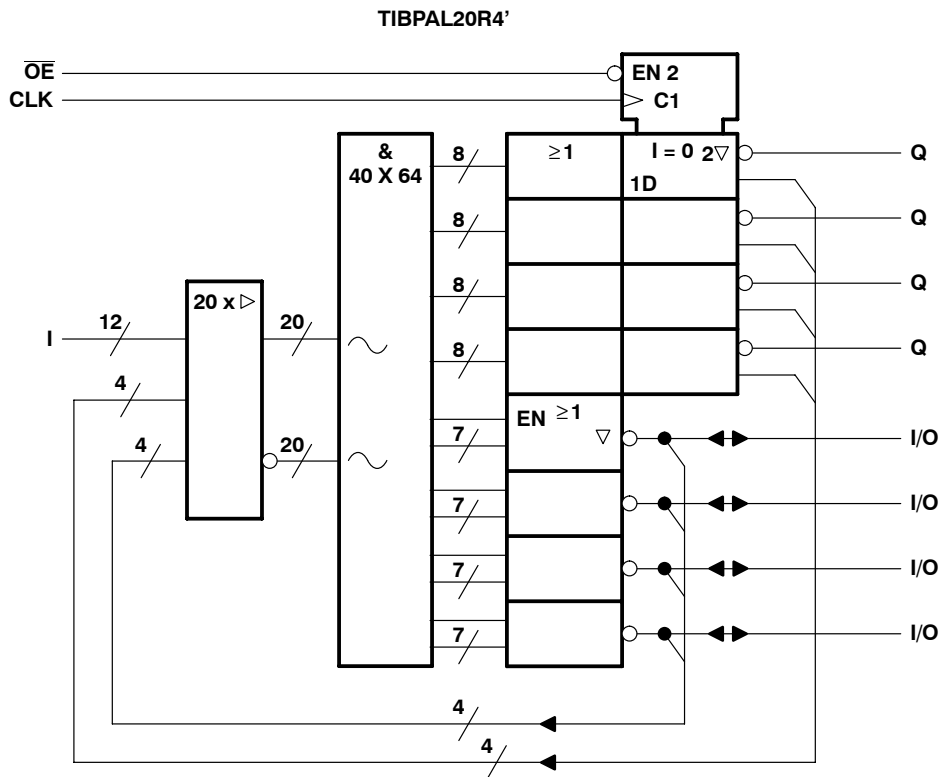
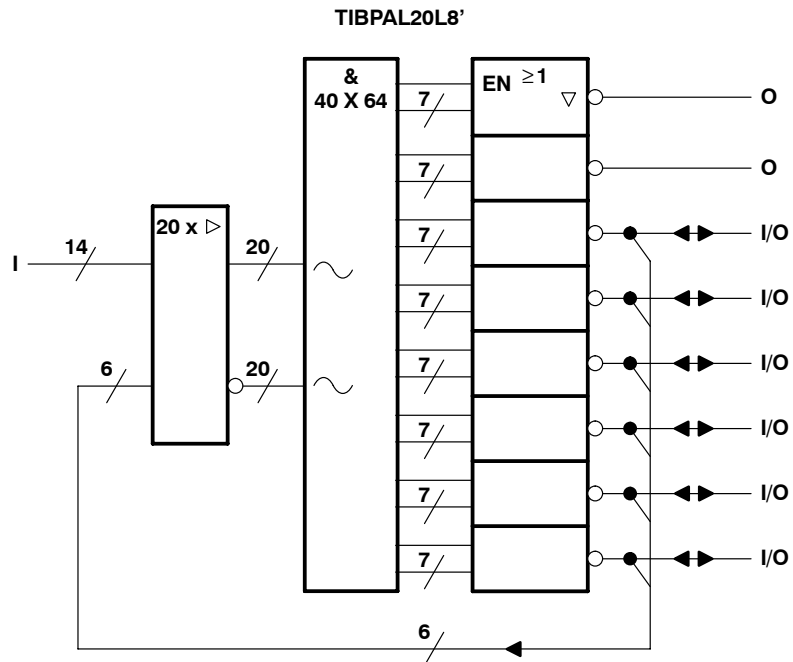
Pin assignments in operating mode

NC – No internal connection



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functional block diagrams (positive logic)



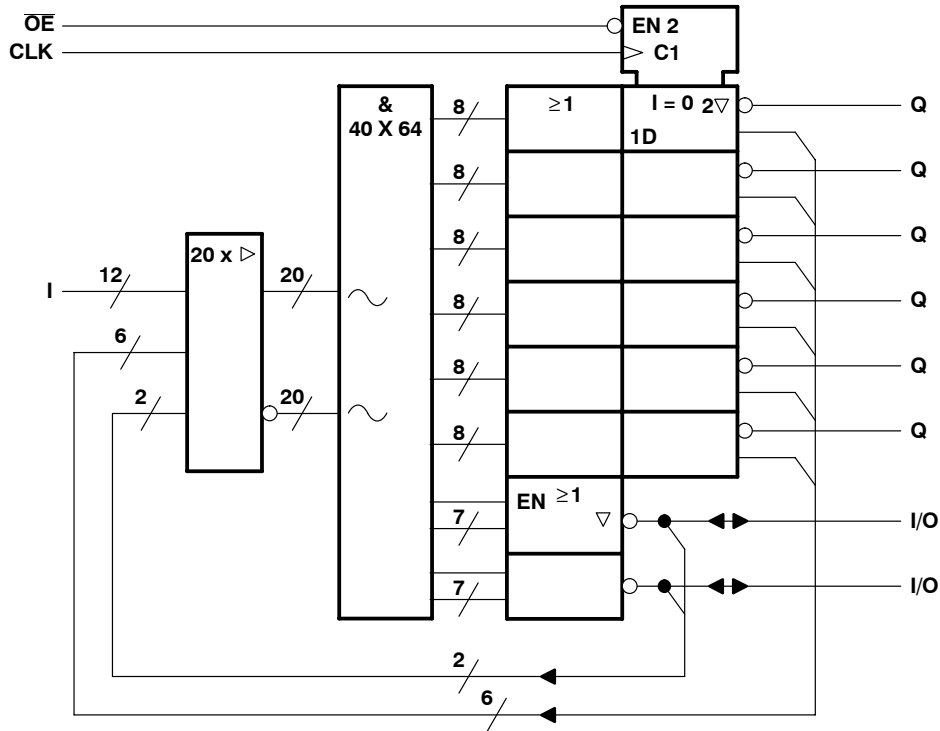
~ denotes fused inputs

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TIBPAL20R6-20M, TIBPAL20R8-20M
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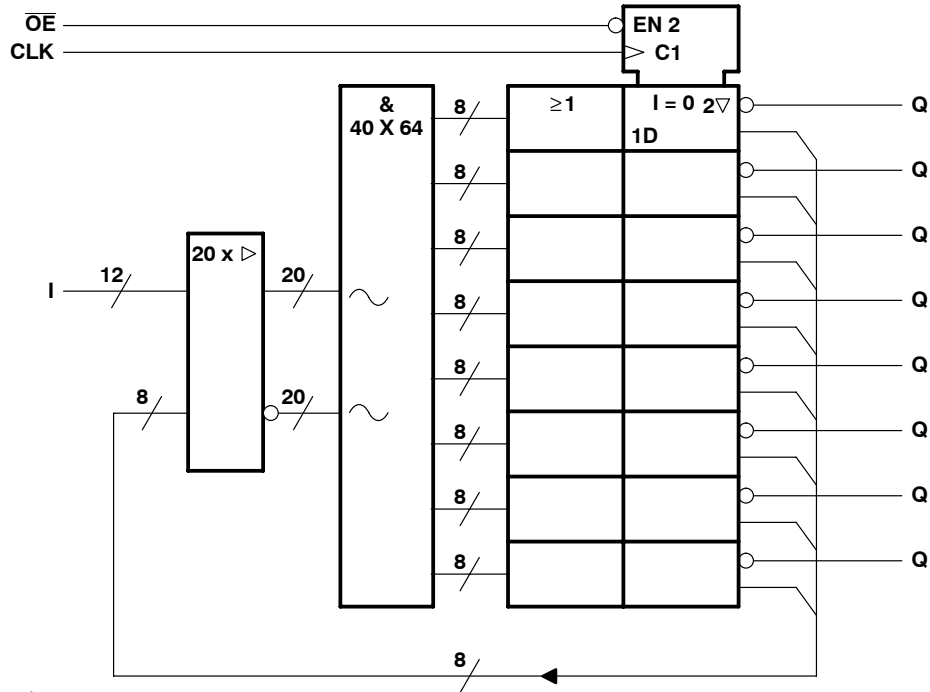
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functional block diagrams (positive logic)

TIBPAL20R6'



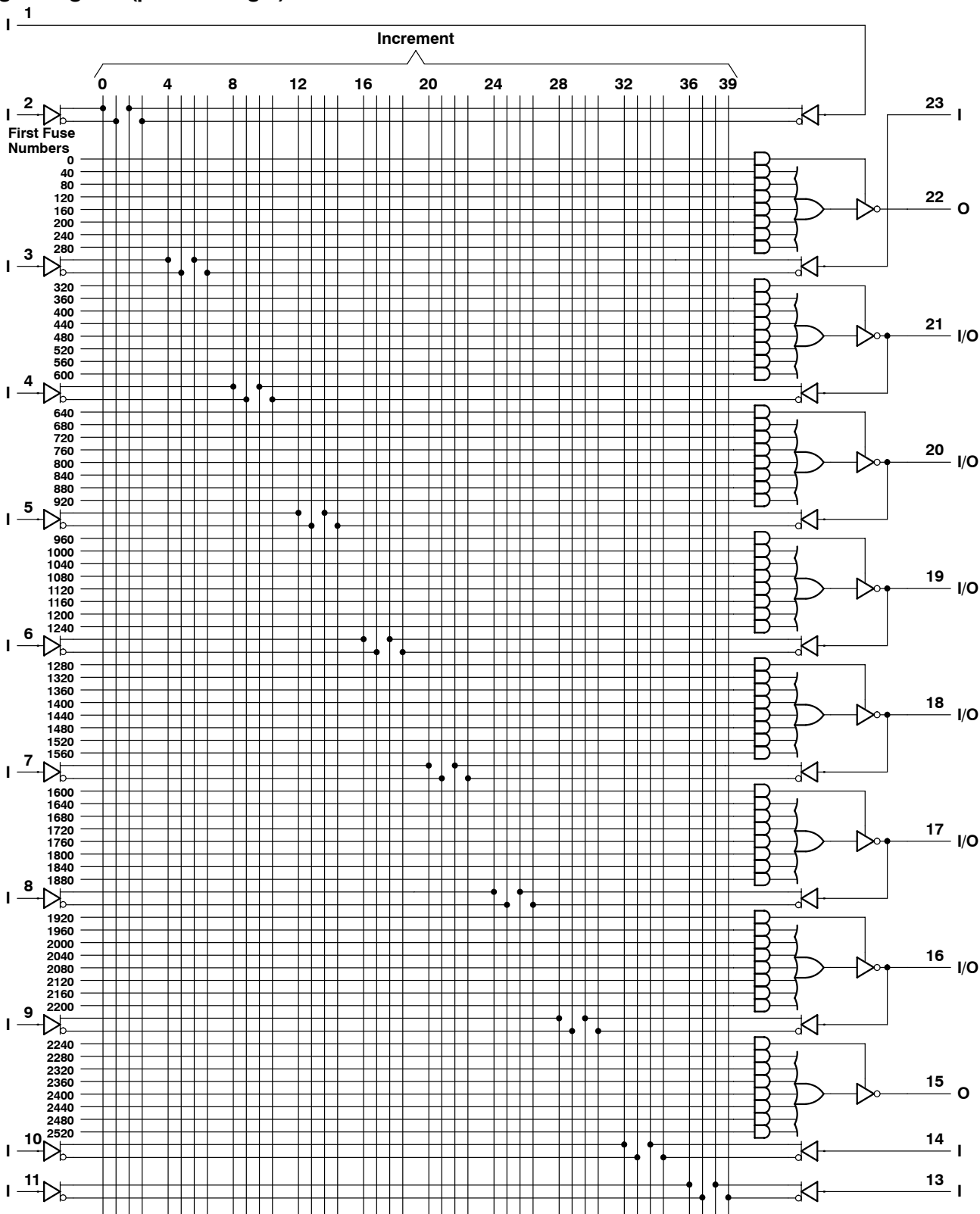
TIBPAL20R8'



~ denotes fused inputs



logic diagram (positive logic)



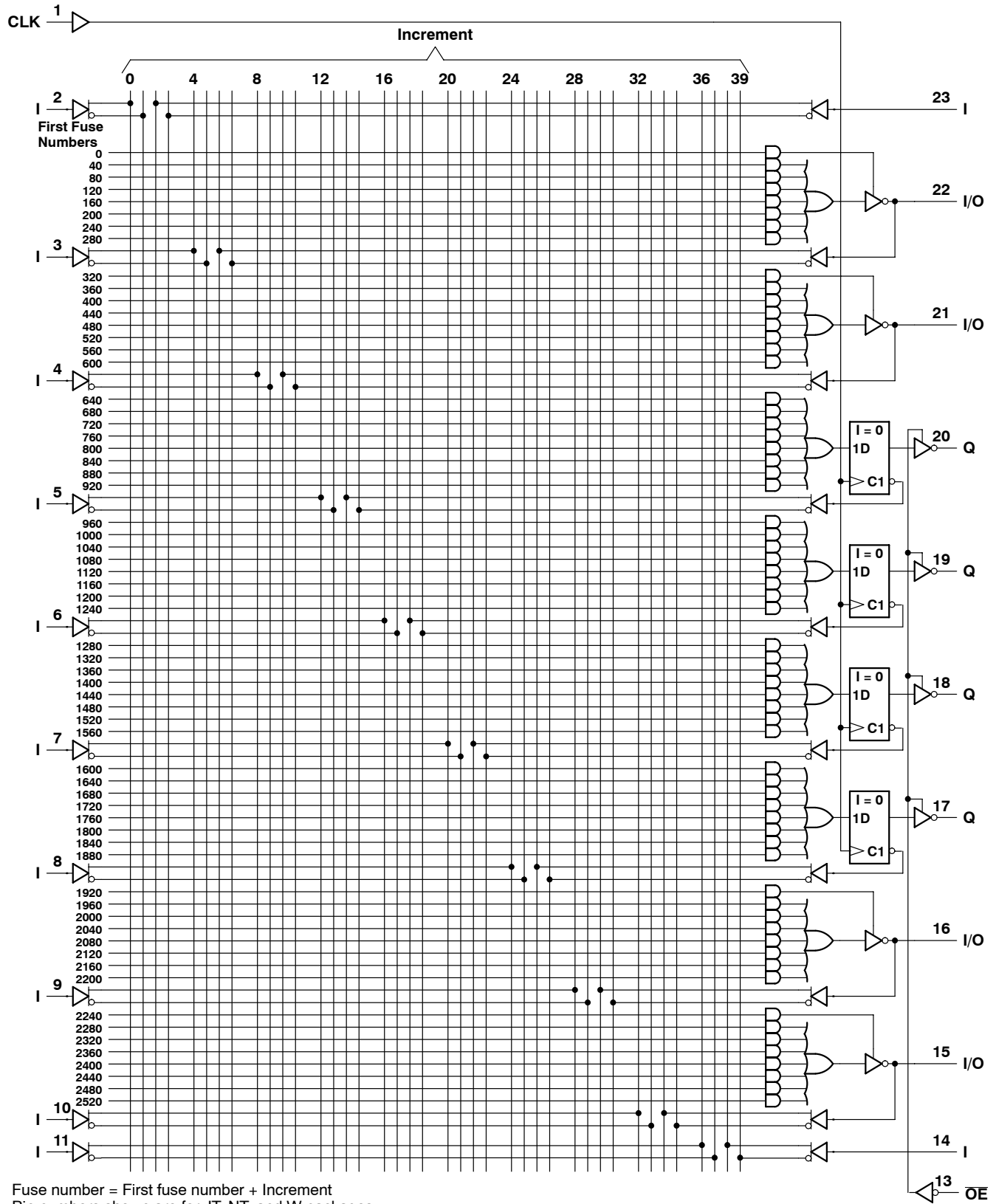
Fuse number = First fuse number + Increment
 Pin numbers shown are for JT, NT, and W packages.



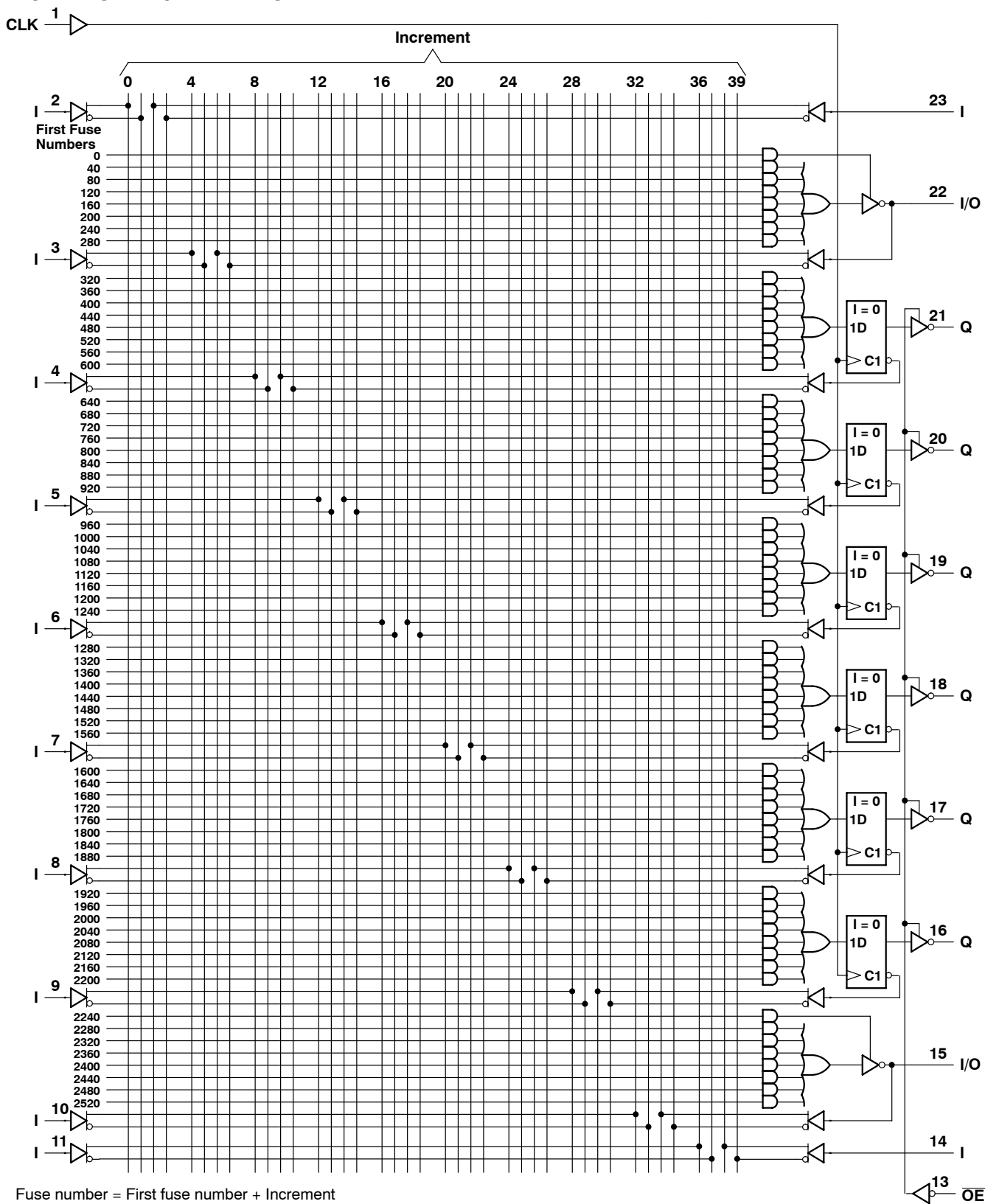
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TIBPAL20R4-20M
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logic diagram (positive logic)



logic diagram (positive logic)

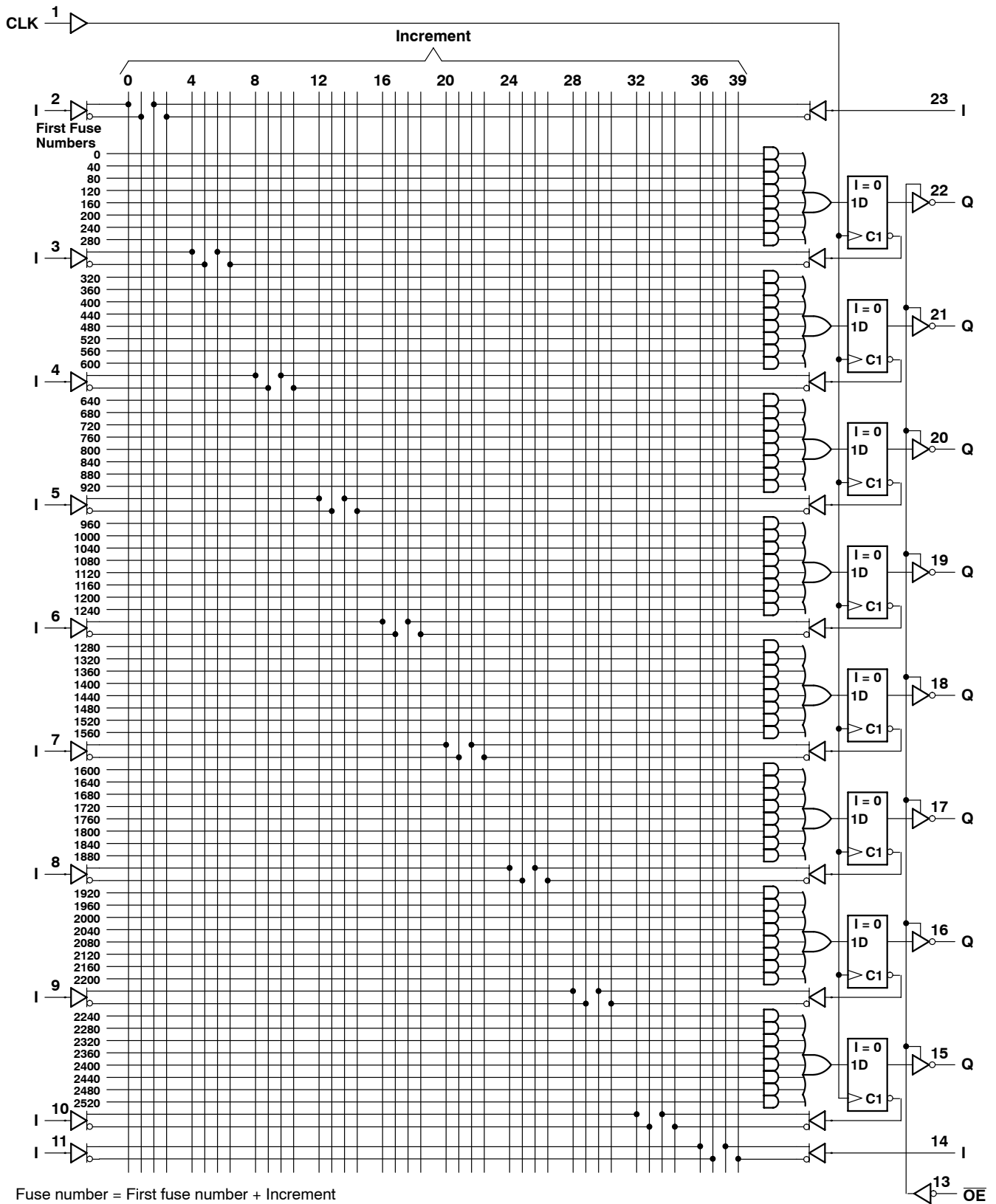


Fuse number = First fuse number + Increment
 Pin numbers shown are for JT, NT, and W packages.

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TIBPAL20R8-20M
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logic diagram (positive logic)



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TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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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	–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}^\dagger	Clock frequency	0		45	MHz
t_w^\dagger	Pulse duration, clock	High		10	ns
		Low		12	
t_{su}^\dagger	Setup time, input or feedback before clock \uparrow	15			ns
t_h^\dagger	Hold time, input or feedback after clock \uparrow	0			ns
T_A	Operating free-air temperature	0	25	75	°C

$^\dagger f_{clock}$, t_w , t_{su} , and t_h do not apply for TIBPAL20L8'.



TIBPAL20L8-15C, TIBPAL20R4-15C, TIBPAL20R6-15C, TIBPAL20R8-15C HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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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		-0.8	-1.5	V
V _{OH}		V _{CC} = 4.75 V,	I _{OH} = -3.2 mA	2.4			V
V _{OL}		V _{CC} = 4.75 V,	I _{OL} = 24 mA		0.3	0.5	V
I _{OZH}	O, Q outputs	V _{CC} = 5.25 V,	V _O = 2.7 V			20	μA
	I/O ports					100	
I _{OZL}	O, Q 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			25	μA
I _{IL} ‡		V _{CC} = 5.25 V,	V _I = 0.4 V			-0.25	mA
I _{OS} §		V _{CC} = 5.25 V,	V _O = 0.5 V	-30	-70	-130	mA
I _{CC}		V _{CC} = 5.25 V, Outputs open,	V _I = 0, \overline{OE} at V _{IH}		120	180	mA

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITION	MIN	TYP†	MAX	UNIT
f _{max} ¶	With feedback		R1 = 200 Ω, R2 = 390 Ω, See Figure 3	37	40		MHz
	Without feedback			45	50		
t _{pd}	I, I/O	O, I/O			12	15	ns
t _{pd}	CLK↑	Q			8	12	ns
t _{en}	\overline{OE}	Q			10	15	ns
t _{dis}	\overline{OE} ↑	Q			8	12	ns
t _{en}	I, I/O	O, I/O			12	18	ns
t _{dis}	I, I/O	O, I/O			12	15	ns

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

‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.

§ Not more than one output should be shorted at a time, and the duration of the short-circuit should not exceed one second.

$$¶ f_{\max}(\text{with feedback}) = \frac{1}{t_{\text{su}} + t_{\text{pd}}(\text{CLK to Q})}, \quad f_{\max}(\text{without feedback}) = \frac{1}{t_{\text{w high}} + t_{\text{w low}}}$$

f_{max} does not apply for TIBPAL20L8.



TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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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	–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}^\dagger	Clock frequency	0		41.6	MHz
t_w^\dagger	Pulse duration, clock	High		12	ns
		Low		12	
t_{su}^\dagger	Setup time, input or feedback before clock \uparrow	20			ns
t_h^\dagger	Hold time, input or feedback after clock \uparrow	0			ns
T_A	Operating free-air temperature	–55	25	125	°C

$^\dagger f_{clock}$, t_w , t_{su} , and t_h do not apply for TIBPAL20L8'.



TIBPAL20L8-20M, TIBPAL20R4-20M, TIBPAL20R6-20M, TIBPAL20R8-20M HIGH-PERFORMANCE *IMPACT*™ *PAL*® CIRCUITS

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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		-0.8	-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		0.3	0.5	V
I _{OZH}		V _{CC} = 5.5 V,	V _O = 2.7 V			100	μA
I _{OZL} ‡	O, Q outputs	V _{CC} = 5.5 V,	V _O = 0.4 V			-20	μA
	I/O ports					-250	
I _I		V _{CC} = 5.5 V,	V _I = 5.5 V			1	mA
I _{IH} ‡	I/O ports	V _{CC} = 5.5 V,	V _I = 2.7 V			100	μA
	All others					25	
I _{IL} ‡		V _{CC} = 5.5 V,	V _I = 0.4 V			-0.25	mA
I _{OS} §		V _{CC} = 5.5 V,	V _O = 0.5 V	-30	-70	-250	mA
I _{CC}		V _{CC} = 5.5 V, Outputs open,	V _I = 0, OE = V _{IH}		120	180	mA

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITION	MIN	TYP†	MAX	UNIT
f _{max} ¶	With feedback		R1 = 390 Ω, R2 = 750 Ω, See Figure 3	28.5	40		MHz
	Without feedback			41.6	50		
t _{pd}	I, I/O	O, I/O			12	20	ns
t _{pd}	CLK↑	Q			8	15	ns
t _{en}	OE	Q			10	20	ns
t _{dis}	OE↑	Q			8	20	ns
t _{en}	I, I/O	O, I/O			12	25	ns
t _{dis}	I, I/O	O, I/O		12	20	ns	

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

‡ For I/O ports, the parameters I_{IH} and I_{IL} include the off-state output current.

§ 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 ground degradation.

$$¶ f_{\text{max}}(\text{with feedback}) = \frac{1}{t_{\text{su}} + t_{\text{pd}}(\text{CLK to Q})}, \quad f_{\text{max}}(\text{without feedback}) = \frac{1}{t_{\text{w high}} + t_{\text{w low}}}$$

f_{max} does not apply for TIBPAL20L8.



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 is also available, upon request, from the nearest TI field sales office, local authorized TI distributor, or by calling Texas Instruments at (214) 997-5666.

preload procedure for registered outputs (see Figure 1 and Notes 2 and 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 volts and Pin 1 at V_{IL} , raise Pin 13 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 13 to V_{IL} . Preload can be verified by observing the voltage level at the output pin.

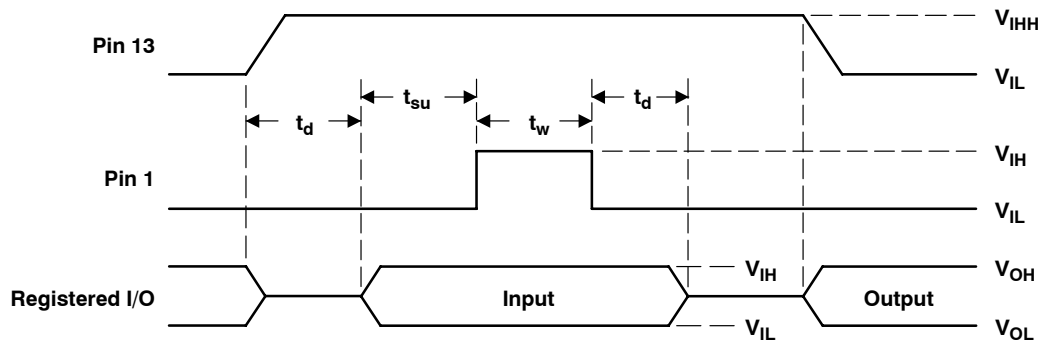


Figure 1. Preload Waveforms

NOTES: 2. Pin numbers shown are for JT, NT, and W packages only. If chip carrier socket adapter is not used, pin numbers must be changed accordingly.

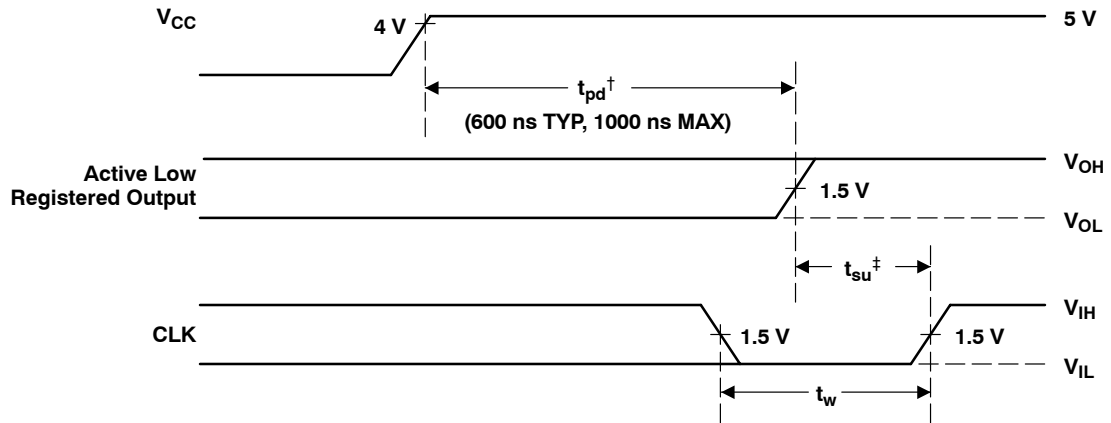
3. $t_d = t_{su} = t_h = 100$ ns to 1000 ns $V_{IHH} = 10.25$ V to 10.75 v

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power-up reset (see Figure 2)

Following power up, all registers are reset to zero. 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.

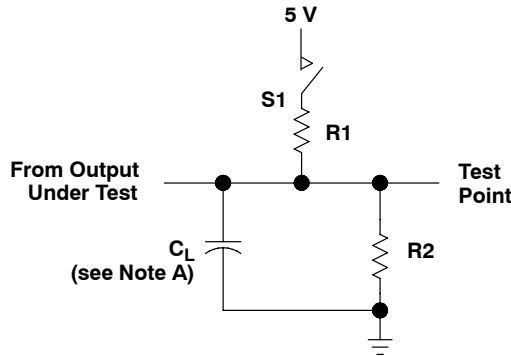


[†] This is the power-up reset time and applies to registered outputs only. The values shown are from characterization data.

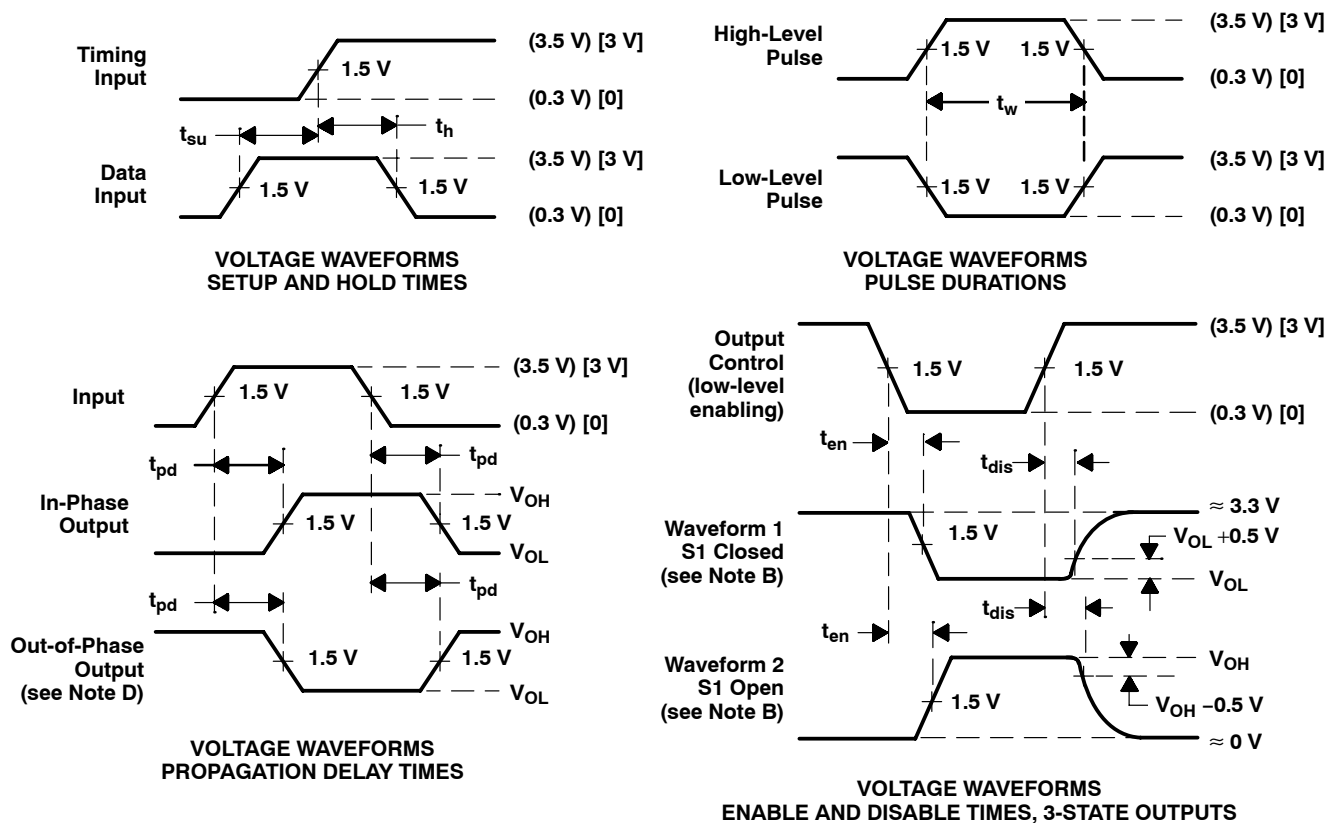
[‡] This is the setup time for input or feedback.

Figure 2. Power-Up Reset Waveforms

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT FOR 3-STATE OUTPUTS



- 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: For C suffix, use the voltage levels indicated in parentheses (). $PRR \leq 1$ MHz, $t_r = t_f \leq 2$ ns, duty cycle = 50%. For M suffix, use the voltage levels indicated in brackets []. $PRR \leq 10$ MHz, t_r and $t_f \leq 2$ 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 3. Load Circuit and Voltage Waveforms

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TI Die Processors

Chip Supply (407) 298-7100
 Elmo Semiconductor (818) 768-7400
 Minco Technology Labs (512) 834-2022



D0892

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-87671013A	ACTIVE	LCCC	FD	28	42	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962- 87671013A TIBPAL20 L8-20MFDB	Samples
5962-87671043A	ACTIVE	LCCC	FD	28	42	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962- 87671043A TIBPAL20 R4-20MFDB	Samples
5962-8767104LA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8767104LA TIBPAL20R4-20M JTB	Samples
8412901XA	ACTIVE	LCCC	FK	28	42	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	8412901XA TIBPAL20 L8-20MFKB	Samples
8412902LA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	8412902LA TIBPAL20R8-20M JTB	Samples
8412904LA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	8412904LA TIBPAL20R4-20M JTB	Samples
JM38510/50501BLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JM38510/ 50501BLA	Samples
JM38510/50502BLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JM38510/ 50502BLA	Samples
JM38510/50504BLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JM38510/ 50504BLA	Samples
M38510/50501BLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JM38510/ 50501BLA	Samples
M38510/50502BLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JM38510/ 50502BLA	Samples
M38510/50504BLA	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JM38510/ 50504BLA	Samples
TIBPAL20R4-20MJT	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	TIBPAL20R4-20M JT	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TIBPAL20R4-20MJTB	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8767104LA TIBPAL20R4-20M JTB	Samples
TIBPAL20R8-20MJTB	ACTIVE	CDIP	JT	24	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8767102LA TIBPAL20R8-20M JTB	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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JT (R-GDIP-T**)

CERAMIC DUAL-IN-LINE

24 LEADS SHOWN



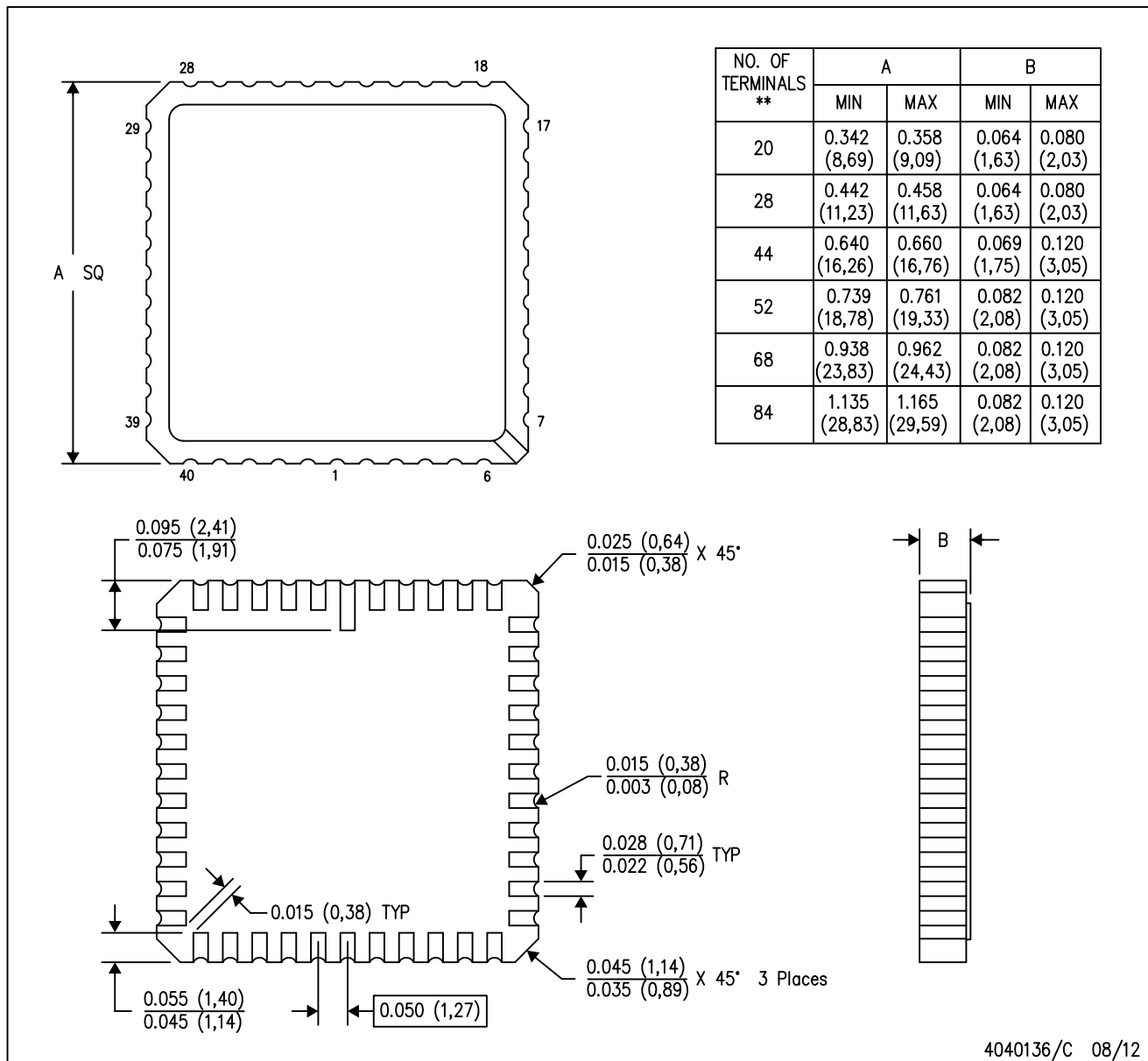
- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification.
 E. Falls within MIL STD 1835 GDIP3-T24, GDIP4-T28, and JEDEC MO-058 AA, MO-058 AB

MECHANICAL DATA

FD (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

44 TERMINAL SHOWN



- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a metal lid.
 - The terminals will be gold plated.
 - Falls within JEDEC MS-004.

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a metal lid.
 - Falls within JEDEC MS-004

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