PAL devices 16L8, 16R8, 16R6, 16R4

PLUS16R8D/-7 SERIES

FEATURES

- Ultra high-speed
  - t_{PD} = 7.5ns and f_{MAX} = 74MHz for the PLUS16R8-7 Series
  - t_{PD} = 10ns and f_{MAX} = 60 MHz for the PLUS16R8D Series
- 100% functionally and pin-for-pin compatible with industry standard 20-pin PAL® ICs
- Power-up reset function to enhance state machine design and testability
- Design support provided via SNAP and other CAD tools for Series 20 PAL devices
- Field-programmable on industry standard programmers
- Security fuse
- Individual 3-State control of all outputs

DESCRIPTION

The Philips Semiconductors PLUS16XX family consists of ultra high-speed 7.5ns and 10ns versions of Series 20 PAL devices.

The PLUS16XX family is 100% functional and pin-compatible with the 16L8, 16R8, 16R6, and 16R4 Series devices.

The sum of products (AND-OR) architecture is comprised of 64 programmable AND gates and 8 fixed OR gates. Multiple bidirectional pins provide variable input/output pin ratios. Individual 3-State control of all outputs and registers with feedback (R8, R6, R4) is also provided. Proprietary designs can be protected by programming the security fuse.

The PLUS16R8, R6, and R4 have D-type flip-flops which are loaded on the Low-to-High transition of the clock input.

In order to facilitate state machine design and testing, a power-up reset function has been incorporated into these devices to reset all internal registers to Active-Low after a specific period of time.

The Philips Semiconductors State-of-the-Art oxide isolation Bipolar fabrication process is employed to achieve high-performance operation.

The PLUS16XX family of devices are field programmable, enabling the user to quickly generate custom patterns using standard programming equipment. See the programmer chart for qualified programmers.

The SNAP software package from Philips Semiconductors supports easy design entry for the PLUS16XX series as well as other PLD devices from Philips Semiconductors. The PLUS16XX series are also supported by other standard CAD tools for PAL-type devices.

Order codes are listed in the Ordering Information table.

DEVICE NUMBER	DEDICATED INPUTS	COMBINATORIAL OUTPUTS	REGISTERED OUTPUTS
PLUS16L8	10	8 (6 I/O)	0
PLUS16R8	8	0	8
PLUS16R6	8	2 I/O	6
PLUS16R4	8	4 I/O	4

ORDERING INFORMATION

DESCRIPTION	ORDER CODE	DRAWING NUMBER
20-Pin Plastic Dual-In-Line 300mil-wide	PLUS16R8DN PLUS16R6DN PLUS16R4DN PLUS16L8DN PLUS16R8–7N PLUS16R6–7N PLUS16R4–7N PLUS16L8–7N	0408B
20-Pin Plastic Leaded Chip Carrier (PLCC)	PLUS16R8DA PLUS16R6DA PLUS16R4DA PLUS16L8DA PLUS16R8–7A PLUS16R6–7A PLUS16R4–7A PLUS16L8–7A	0400E

NOTE:
The PLUS16XX series of devices are also processed to military requirements for operation over the military temperature range. For specifications and ordering information, consult the Philips Semiconductors Military Data Book.

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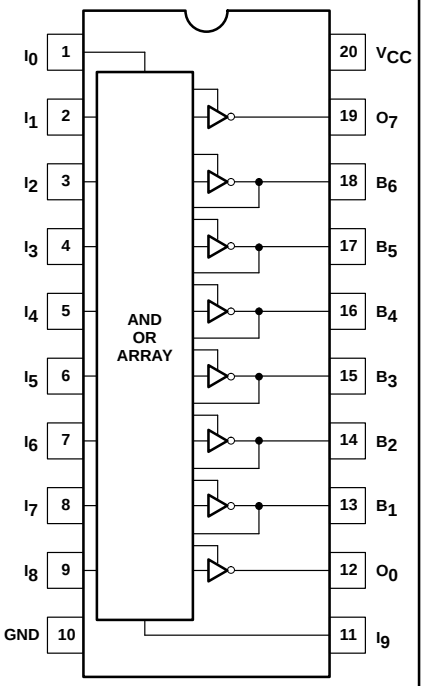
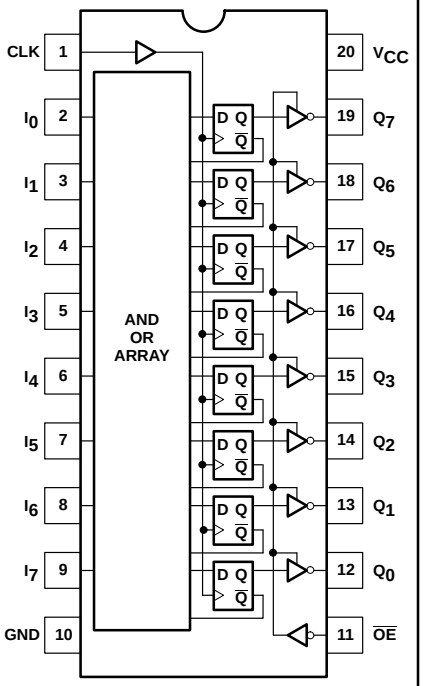
PIN CONFIGURATIONS

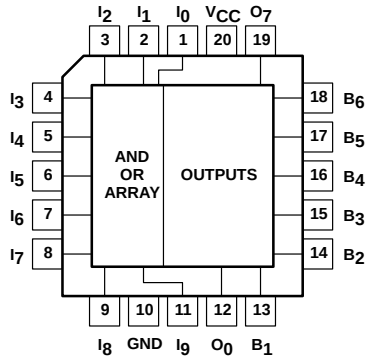
PLUS16L8



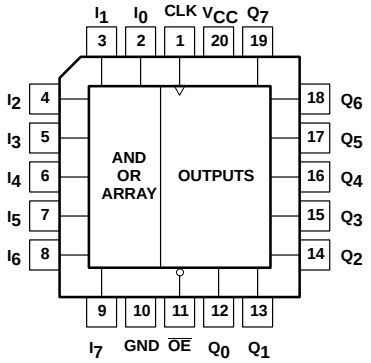
PLUS16R8



PLUS16L8



PLUS16R8

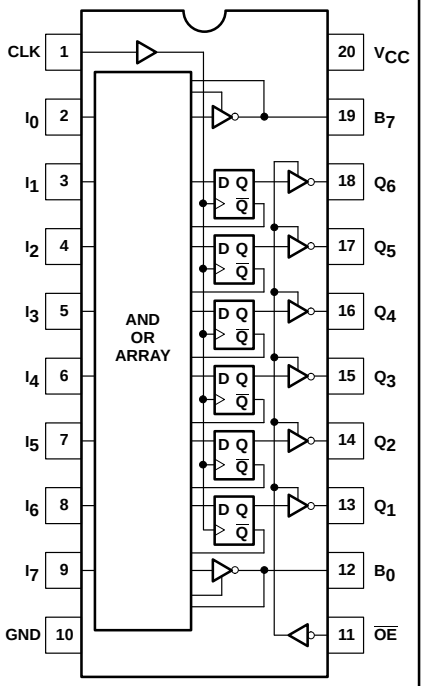


SYMBOL	DESCRIPTION
I	Dedicated Input
O	Dedicated combinatorial Output
Q	Registered output
B	Bidirectional (input/output)
CLK	Clock input
$\overline{OE}$	Output Enable
V_{CC}	Supply Voltage
GND	Ground

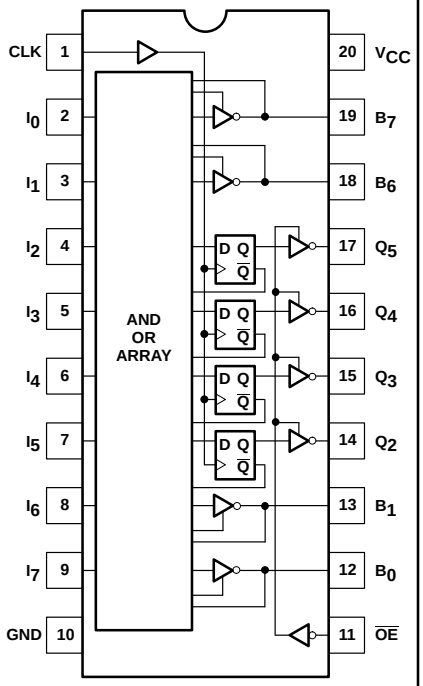
SYMBOL	DESCRIPTION
I	Dedicated Input
O	Dedicated combinatorial Output
Q	Registered output
B	Bidirectional (input/output)
CLK	Clock input
$\overline{OE}$	Output Enable
V_{CC}	Supply Voltage
GND	Ground

PIN CONFIGURATIONS

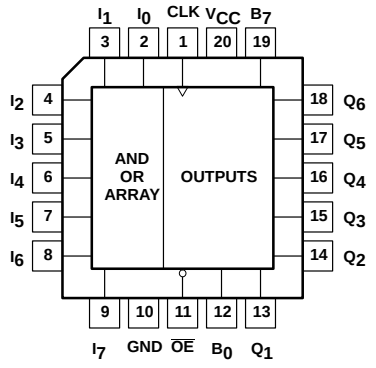
PLUS16R6



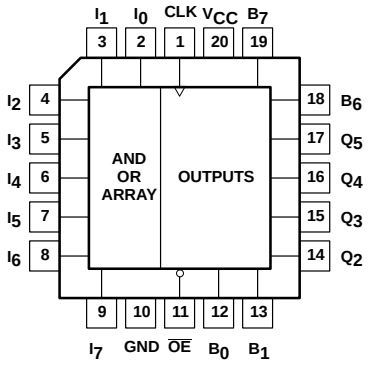
PLUS16R4



PLUS16R6



PLUS16R4

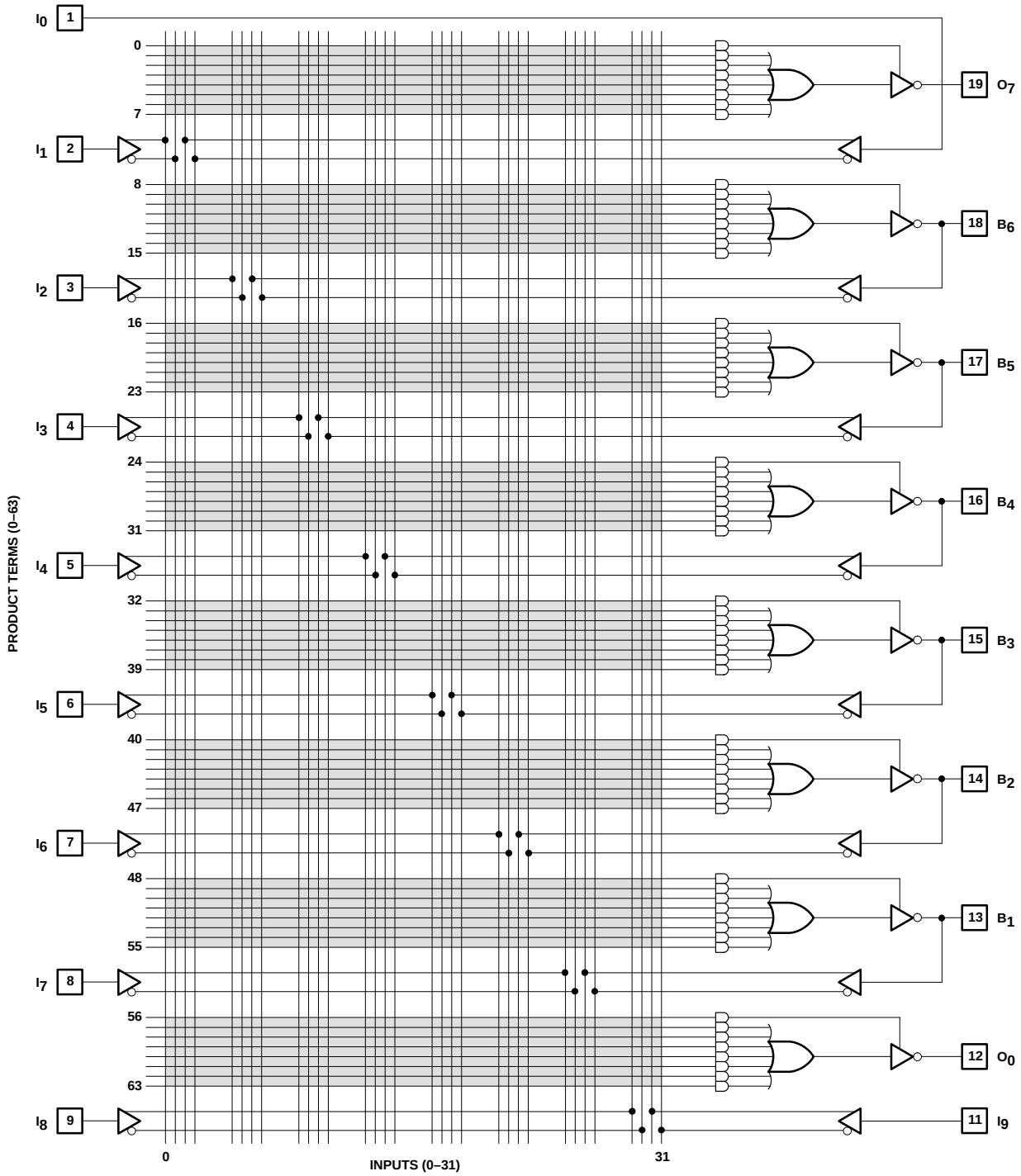


SYMBOL	DESCRIPTION
I	Dedicated Input
O	Dedicated combinatorial Output
Q	Registered output
B	Bidirectional (input/output)
CLK	Clock input
$\overline{OE}$	Output Enable
V_{CC}	Supply Voltage
GND	Ground

SYMBOL	DESCRIPTION
I	Dedicated Input
O	Dedicated combinatorial Output
Q	Registered output
B	Bidirectional (input/output)
CLK	Clock input
$\overline{OE}$	Output Enable
V_{CC}	Supply Voltage
GND	Ground

LOGIC DIAGRAM

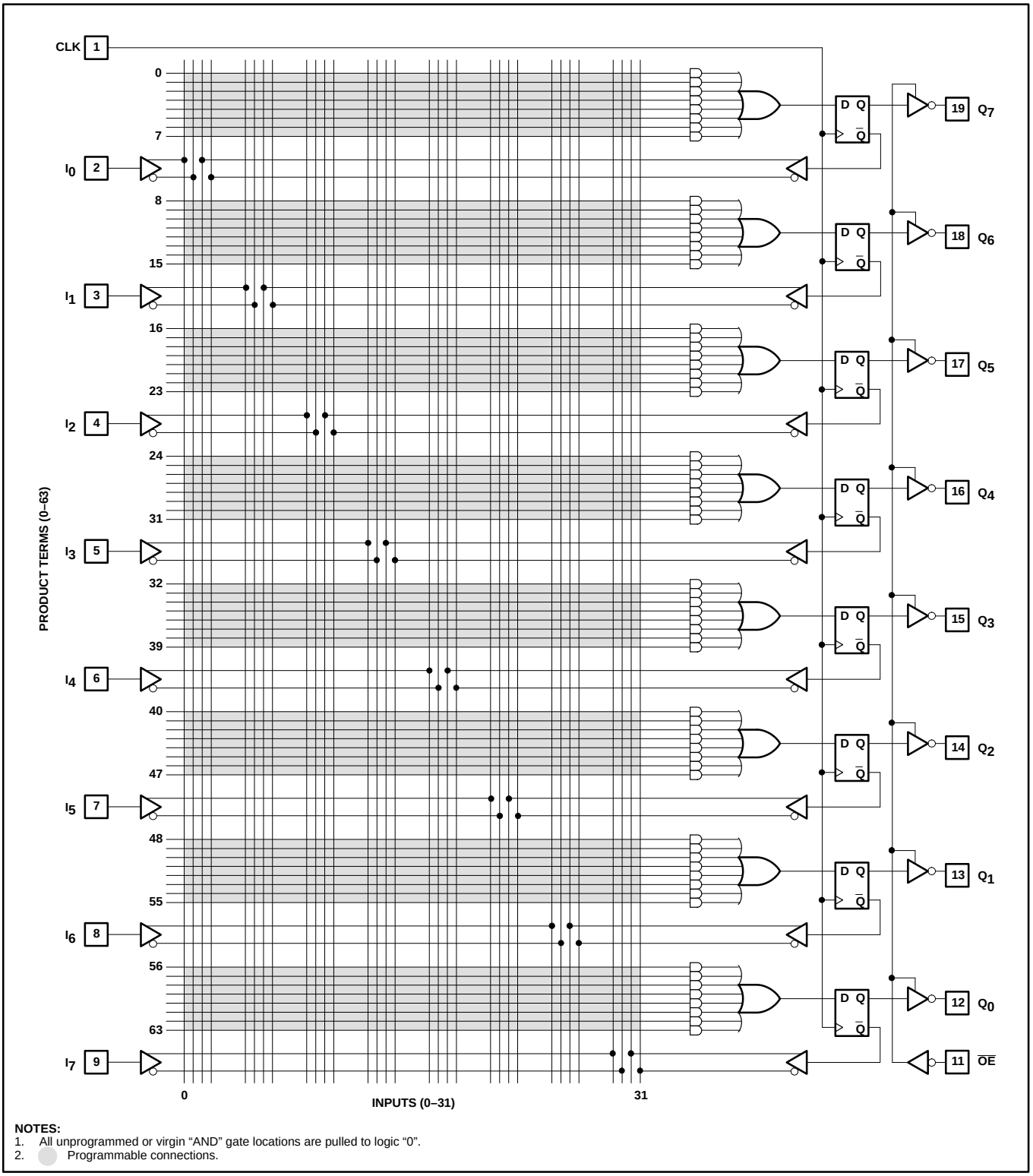
PLUS16L8



NOTES:
1. All unprogrammed or virgin “AND” gate locations are pulled to logic “0”.
2. Programmable connections.

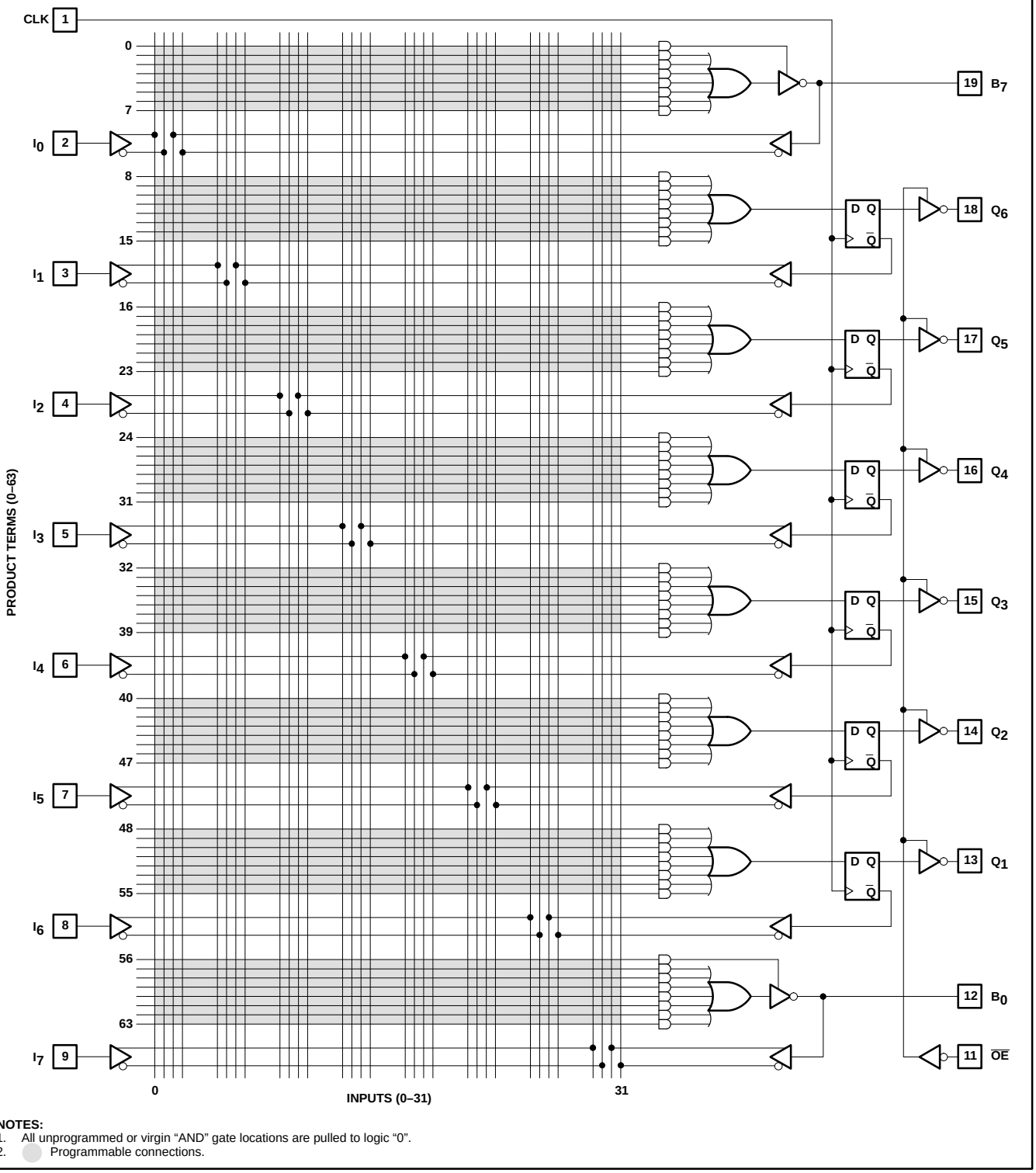
LOGIC DIAGRAM

PLUS16R8



NOTES:
1. All unprogrammed or virgin “AND” gate locations are pulled to logic “0”.
2. Programmable connections.

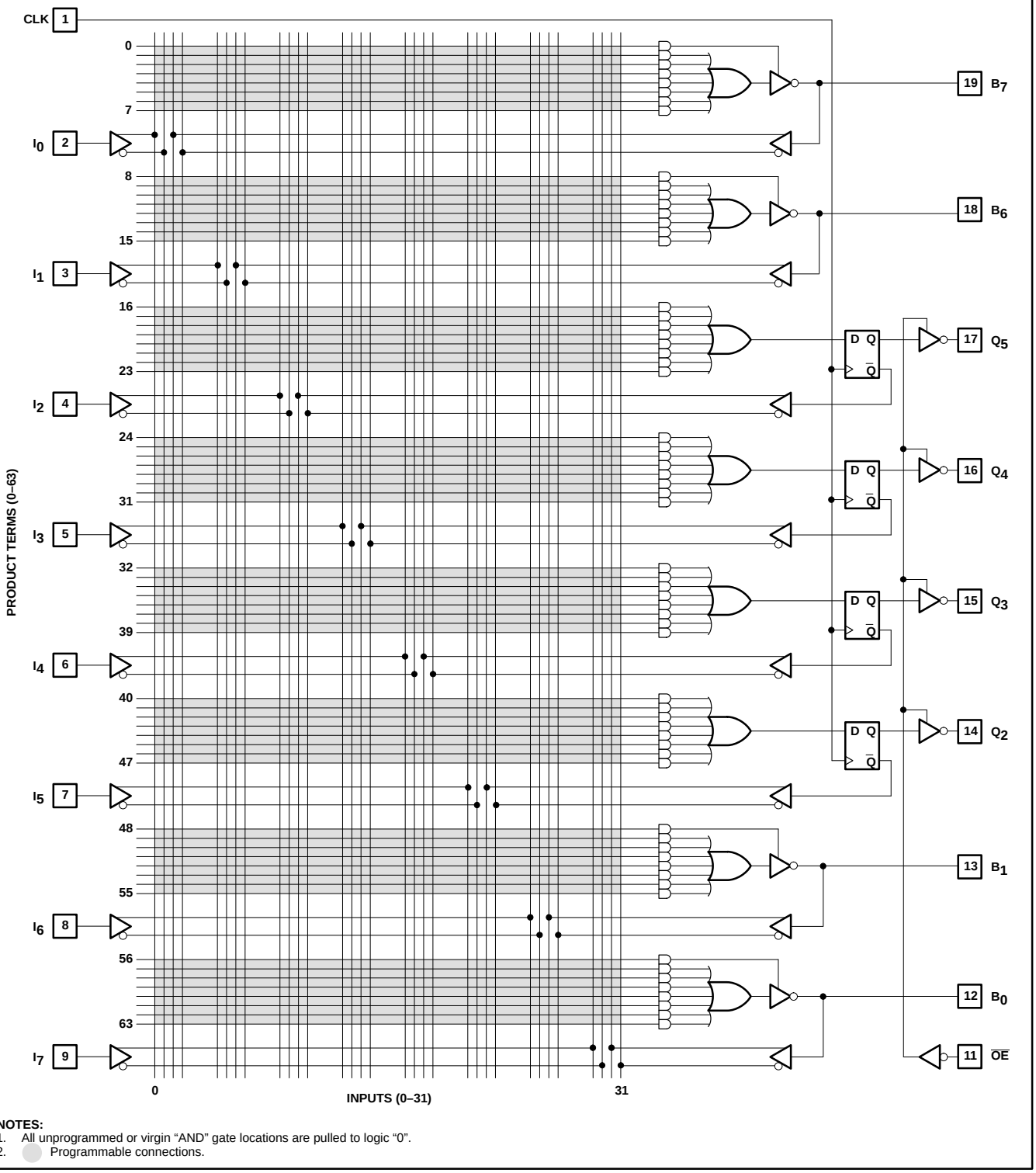
LOGIC DIAGRAM PLUS16R6



NOTES:
1. All unprogrammed or virgin “AND” gate locations are pulled to logic “0”.
2. Programmable connections.

LOGIC DIAGRAM

PLUS16R4



NOTES:
1. All unprogrammed or virgin "AND" gate locations are pulled to logic "0".
2. Programmable connections.

FUNCTIONAL DESCRIPTIONS

The PLUS16XX series utilizes the familiar sum-of-products implementation consisting of a programmable AND array and a fixed OR array. These devices are capable of replacing an equivalent of four or more SSI/MSI integrated circuits to reduce package count and board area occupancy, consequently improving reliability and design cycle over Standard Cell or gate array options. By programming the security fuse, proprietary designs can be protected from duplication.

The PLUS16XX series consists of four PAL-type devices. Depending on the particular device type, there are a variable number of combinatorial and registered outputs available to the designer. The PLUS16L8 is a combinatorial part with 8 user configurable outputs (6 bidirectional), while the other three devices, PLUS16R8, PLUS16R6, PLUS16R4, have respectively 8, 6, and 4 output registers.

3-State Outputs

The PLUS16XX series devices also feature 3-State output buffers on each output pin which can be programmed for individual control of all outputs. The registered outputs (Qn) are controlled by an external input (/OE), and the combinatorial outputs (On, Bn) use a product term to control the enable function.

Programmable Bidirectional Pins

The PLUS16XX products feature variable Input/Output ratios. In addition to 8 dedicated inputs, each combinatorial output pin of the registered devices can be individually programmed as an input or output. The PLUS16L8 provides 10 dedicated inputs and 6 Bidirectional I/O lines that can be individually configured as inputs or outputs.

Output Registers

The PLUS16R8 has 8 output registers, the 16R6 has 6, and the 16R4 has 4. Each output register is a D-type flip-flop which is loaded on the Low-to-High transition of the clock input. These output registers are capable of feeding the outputs of the registers back into the array to facilitate design of synchronous state machines.

Power-up Reset

By resetting all flip-flops to a logic Low, as the power is turned on, the PLUS16R8, R6, R4 enhance state machine design and initialization capability.

Software Support

Like other Programmable Logic Devices from Philips Semiconductors, the PLUS16XX series are supported by SLICE, the PC-based software development tool from Philips Semiconductors. The PLUS16XX family of devices are also supported by standard CAD tools for PAL devices, including ABEL and CUPL.

SLICE is available free of charge to qualified users.

Logic Programming

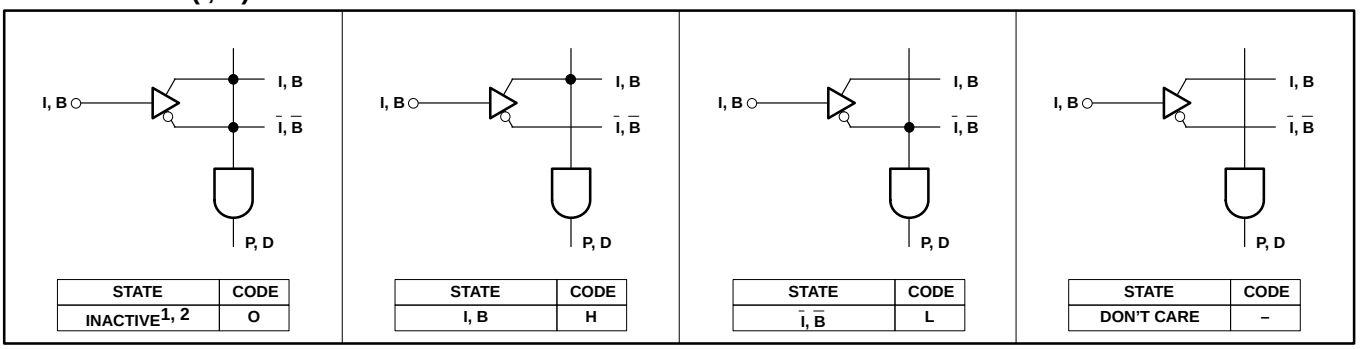
The PLUS16XX series is fully supported by industry standard (JEDEC compatible) PLD CAD tools, including Philips Semiconductors SNAP design software package. ABEL™ CUPL™ and PALASM® 90 design software packages also support the PLUS16XX architecture.

All packages allow Boolean and state equation entry formats. SNAP, ABEL and CUPL also accept, as input, schematic capture format.

Programming/Software Support

Ref to Section 9 *(Development Software)* and Section 10. *(Third-Party Programmer/ Software Support*) of the PLD data handbook for additional information.

AND ARRAY – (I, B)



STATE	CODE
INACTIVE[1, 2]	O

STATE	CODE
I, B	H

STATE	CODE
$\overline{I}$, $\overline{B}$	L

STATE	CODE
DON'T CARE	–

VIRGIN STATE

A factory shipped virgin device contains all fusible links intact, such that:

1. All outputs are at “H” polarity.
2. All P_n terms are disabled.
3. All P_n terms are active on all outputs.

ABEL is a trademark of Data I/O Corp.
CUPL is a trademark of Logical Devices, Inc.
PALASM is a registered trademark of AMD Corp.

ABSOLUTE MAXIMUM RATINGS[1]

SYMBOL	PARAMETER	RATINGS		UNIT
		MIN	MAX	
V_{CC}	Supply voltage	–0.5	+7	V_{DC}
V_{IN}	Input voltage	–1.2	+8.0	V_{DC}
V_{OUT}	Output voltage	–0.5	V_{CC} + 0.5V	V_{DC}
I_{IN}	Input currents	–30	+30	mA
I_{OUT}	Output currents		+100	mA
T_{stg}	Storage temperature range	–65	+150	°C

NOTE:
1. Stresses above those listed may cause malfunction or permanent damage to the device. This is a stress rating only. Functional operation at these or any other condition above those indicated in the operational and programming specification of the device is not implied.

THERMAL RATINGS

TEMPERATURE	
Maximum junction	150°C
Maximum ambient	75°C
Allowable thermal rise ambient to junction	75°C

OPERATING RANGES

SYMBOL	PARAMETER	RATINGS		UNIT
		MIN	MAX	
V_{CC}	Supply voltage	+4.75	+5.25	V_{DC}
T_{amb}	Operating free–air temperature	0	+75	°C

DC ELECTRICAL CHARACTERISTICS

$0°C \leq T_{amb} \leq +75°C$, $4.75 \leq V_{CC} \leq 5.25V$

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			MIN	TYP[1]	MAX	
Input voltage[2]						
V_{IL}	Low	V_{CC} = MIN			0.8	V
V_{IH}	High	V_{CC} = MAX	2.0			V
V_{IC}	Clamp	V_{CC} = MIN, I_{IN} = –18mA		–0.8	–1.5	V
Output voltage						
		V_{CC} = MIN, V_{IN} = V_{IH} or V_{IL}				
V_{OL}	Low	I_{OL} = 24mA			0.5	V
V_{OH}	High	I_{OH} = –3.2 mA	2.4			V
Input current						
		V_{CC} = MAX				
I_{IL}	Low[3]	V_{IN} = 0.40V			–250	µA
I_{IH}	High[3]	V_{IN} = 2.7V			25	µA
I_I	Maximum input current	V_{IN} = V_{CC} = V_{CCMAX}			100	µA
Output current						
		V_{CC} = MAX				
I_{OZH}	Output leakage	V_{OUT} = 2.7V			100	µA
I_{OZL}	Output leakage	V_{OUT} = 0.4V			–100	µA
I_{OS}	Short circuit [4, 5]	V_{OUT} = 0V	–30		–90	mA
I_{CC}	V_{CC} supply current	V_{CC} = MAX		160	180	mA
Capacitance[6]						
C_{IN}	Input	V_{CC} = 5V				
		V_{OUT} = 2.0V		8		pF
C_B	I/O (B)	V_{OUT} = 2V, f = 1MHz		8		pF

NOTES:
1. All typical values are at V_{CC} = 5V, T_{amb} = +25°C.
2. All voltage values are with respect to network ground terminal.
3. Leakage current for bidirectional pins is the worst case of I_{IL} and I_{OZL} or I_{IH} and I_{OZH}.
4. Test one at a time.
5. Duration of short circuit should not exceed 1 second.
6. These parameters are not 100% tested but periodically sampled.

AC ELECTRICAL CHARACTERISTICS

$R_1 = 200\Omega$, $R_2 = 390\Omega$, $0°C \le T_{amb} \le +75°C$, $4.75 \le V_{CC} \le 5.25V$

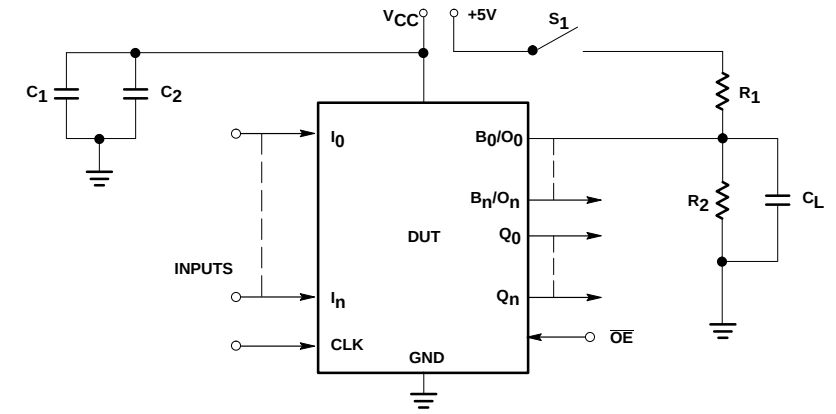
SYMBOL	PARAMETER	FROM	TO	LIMITS					UNIT
				–7			D		
				MIN[1]	TYP	MAX	MIN[1]	MAX	
Pulse Width									
t_{CKH}	Clock High	CK+	CK–	5			7		ns
t_{CKL}	Clock Low	CK–	CK+	5			7		ns
t_{CKP}	Period	CK+	CK+	10			14		ns
Setup & Hold time									
t_{IS}	Input	Input or feedback	CK+	7			9		ns
t_{IH}	Input	CK+	Input or feedback	0			0		ns
Propagation delay									
t_{CKO}	Clock	CK±	Q±	3		6.5	3	7.5	ns
t_{CKF}	Clock[3]	CK±	$\overline{Q}$			3		6.5	ns
t_{PD}	Output (16L8, R6, R4)[2]	I, B	Output	3		7.5	3	10	ns
t_{OE1}	Output enable[4]	$\overline{OE}$	Output enable	3		8	3	10	ns
t_{OE2}	Output enable[4,5]	I	Output enable	3		10	3	10	ns
t_{OD1}	Output disable[4]	$\overline{OE}$	Output disable	3		8	3	10	ns
t_{OD2}	Output disable[4,5]	I	Output disable	3		10	3	10	ns
t_{SKW}	Output	Q	Q			1		1	ns
t_{PPR}	Power-Up Reset	V_{CC}+	Q+			10		10	ns
Frequency (16R8, R6, R4)									
f_{MAX}	No feedback $1/(t_{CKL} + t_{CKH})$[6]				100		71.4		MHz
	Internal feedback $1/(t_{IS} + t_{CKF})$[6]				90		64.5		MHz
	External feedback $1/(t_{IS} + t_{CKO})$[6]				74		60.6		MHz

* For definitions of the terms, please refer to the Timing/Frequency Definitions tables.

NOTES:

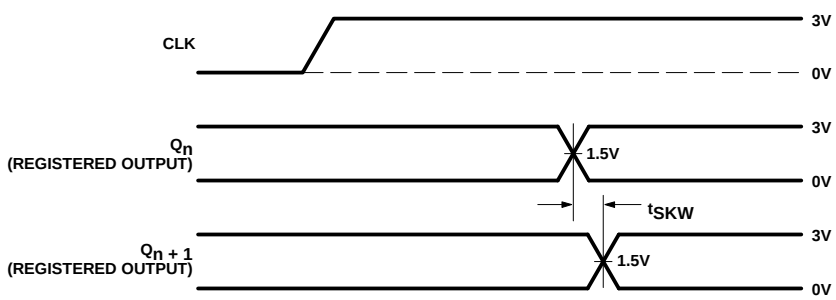
1. CL = 0pF while measuring minimum output delays.
2. t_{PD} test conditions: CL = 50pF (with jig and scope capacitance), $V_{IH} = 3V$, $V_{IL} = 0V$, $V_{OH} = V_{OL} = 1.5V$.
3. t_{CKF} was calculated from measured Internal f_{MAX}.
4. For 3-State output; output enable times are tested with $C_L = 50pF$ to the 1.5V level, and S_1 is open for high-impedance to High tests and closed for high-impedance to Low tests. Output disable times are tested with $C_{L\,=}$ 5pF. High-to-High impedance tests are made to an output voltage of $V_T = (V_{OH} – 0.5V)$ with S_1 open, and Low-to-High impedance tests are made to the $V_T = (V_{OL} + 0.5V)$ level with S_1 closed.
5. Same function as t_{OE1} and $t_{OD1,}$ with the difference of using product term control.
6. Not 100% tested, but calculated at initial characterization and at any time a modification in design takes place which may affect the frequency.

TEST LOAD CIRCUIT

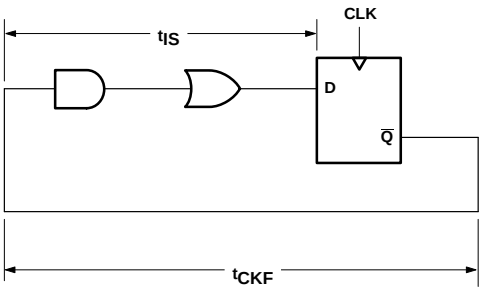


NOTE:
C_1 and C_2 are to bypass V_{CC} to GND.

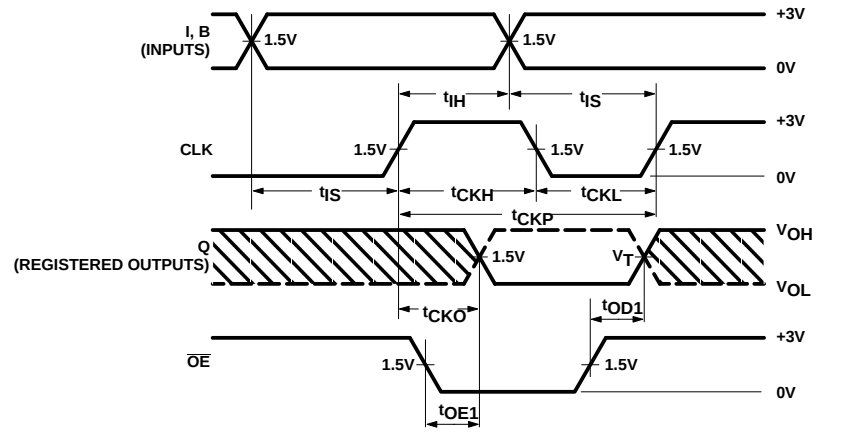
OUTPUT REGISTER SKEW



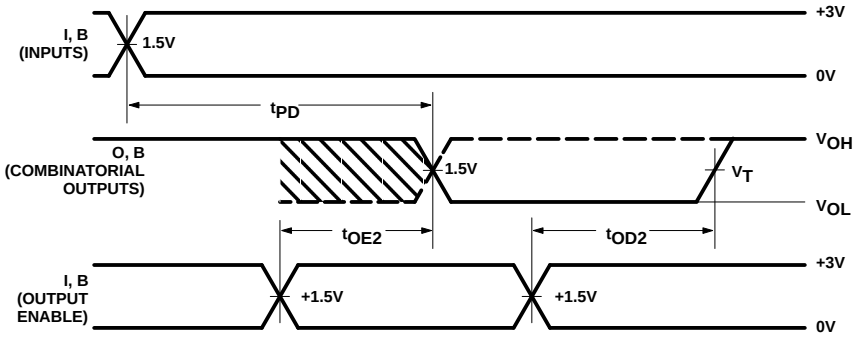
CLOCK TO FEEDBACK PATH



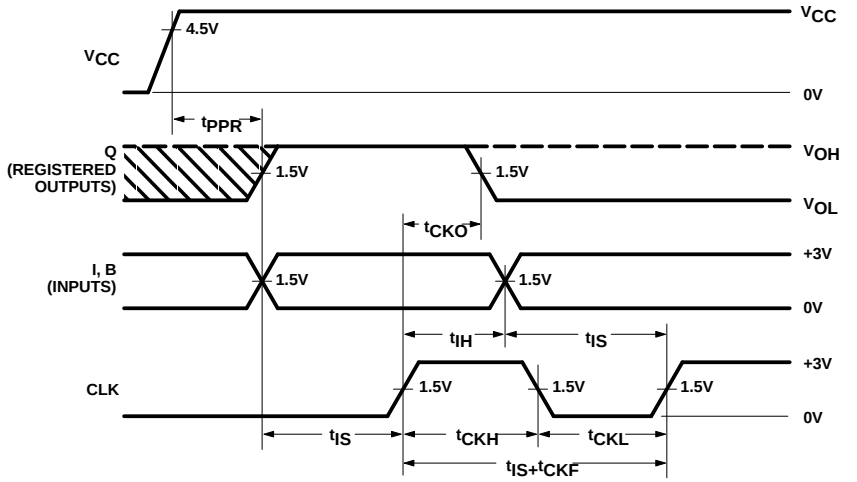
TIMING DIAGRAMS[1, 2]



Flip-Flop Outputs



Gate Outputs



Power–Up Reset

NOTES:
1. Input pulse amplitude is 0V to 3V.
2. Input rise and fall times are 2.5ns.

TIMING DEFINITIONS

SYMBOL	PARAMETER
t_{CKH}	Width of input clock pulse.
t_{CKL}	Interval between clock pulses.
t_{CKP}	Clock period.
t_{IS}	Required delay between beginning of valid input and positive transition of clock.
t_{IH}	Required delay between positive transition of clock and end of valid input data.
t_{CKF}	Delay between positive transition of clock and when internal $\overline{Q}$ output of flip-flop becomes valid.
t_{CKO}	Delay between positive transition of clock and when outputs become valid (with $\overline{OE}$ Low).
t_{OE1}	Delay between beginning of Output Enable Low and when outputs become valid.
t_{OD1}	Delay between beginning of Output Enable High and when outputs are in the Off-State.
t_{OE2}	Delay between predefined Output Enable High, and when combinational outputs become valid.
t_{OD2}	Delay between predefined Output Enable Low and when combinational outputs are in the Off-State.
t_{PPR}	Delay between V_{CC} (after power-on) and when flip-flop outputs become preset at “1” (internal Q outputs at “0”).
t_{PD}	Propagation delay between combinational inputs and outputs.

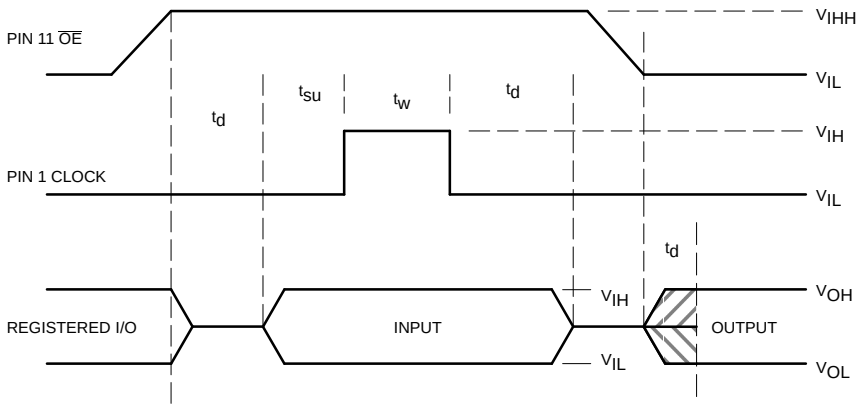
FREQUENCY DEFINITIONS

f_{MAX}	**No feedback:** Determined by the minimum clock period, $1/(t_{CKL} + t_{CKH})$. **Internal feedback:** Determined by the internal delay from flip-flop outputs through the internal feedback and array to the flip-flop inputs, $1/(t_{IS} + t_{CKF})$. **External feedback:** Determined by clock-to-output delay and input setup time, $1/(t_{IS} + t_{CKO})$.

OUTPUT REGISTER PRELOAD

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 5V 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.

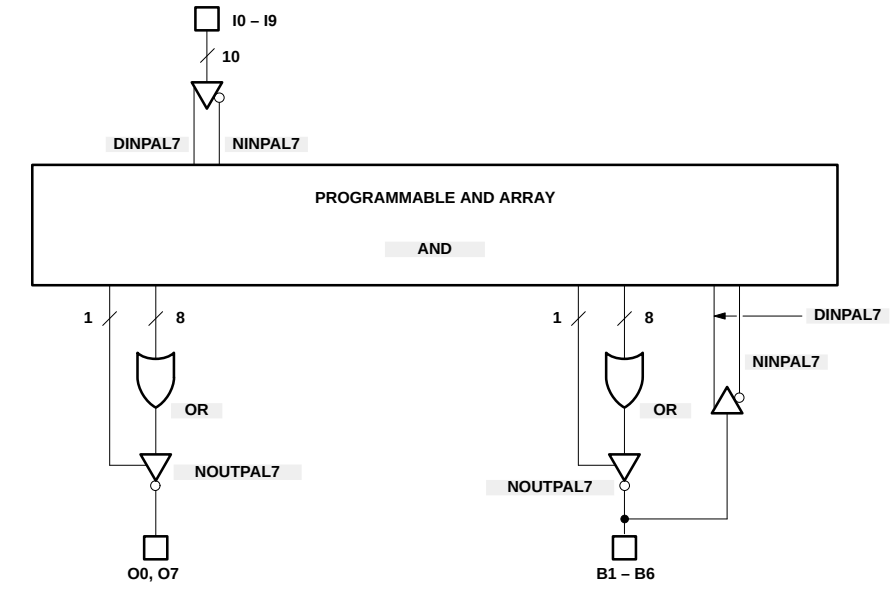


NOTE: $t_d = t_{su} = t_w$ = 100ns to 1000ns.
V_{IHH} = 10.25V to 10.75V.
Pin number references for DIP package.

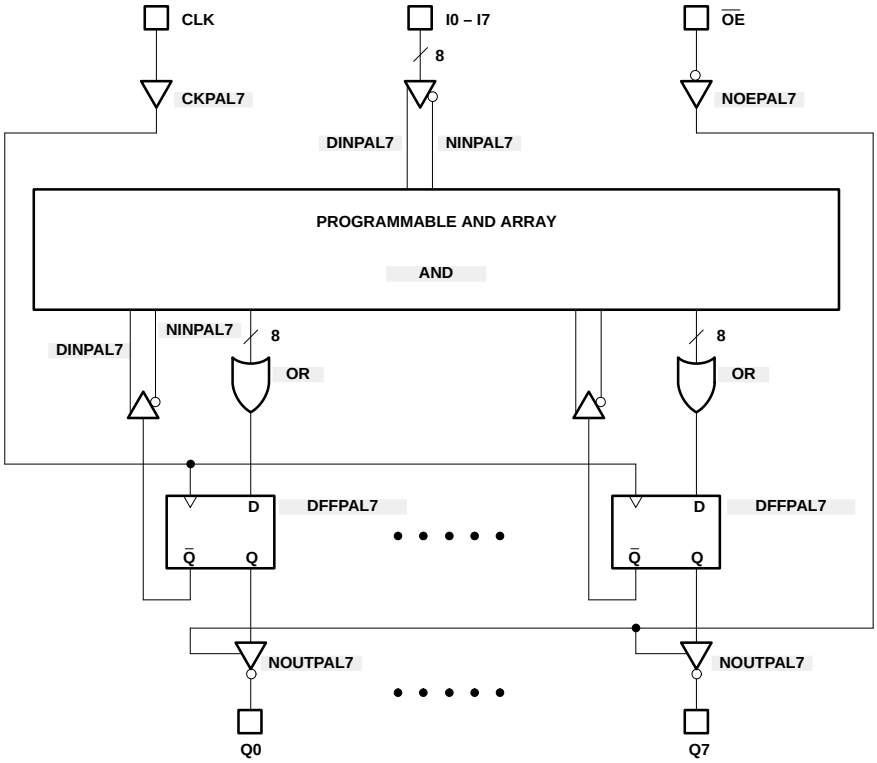
PROGRAMMING/SOFTWARE

Refer to Section 9 (*Development Software*) and Section 10 (*Third-Party Programmer/Software Support*) of this data handbook for additional information.

SNAP RESOURCE SUMMARY DESIGNATIONS

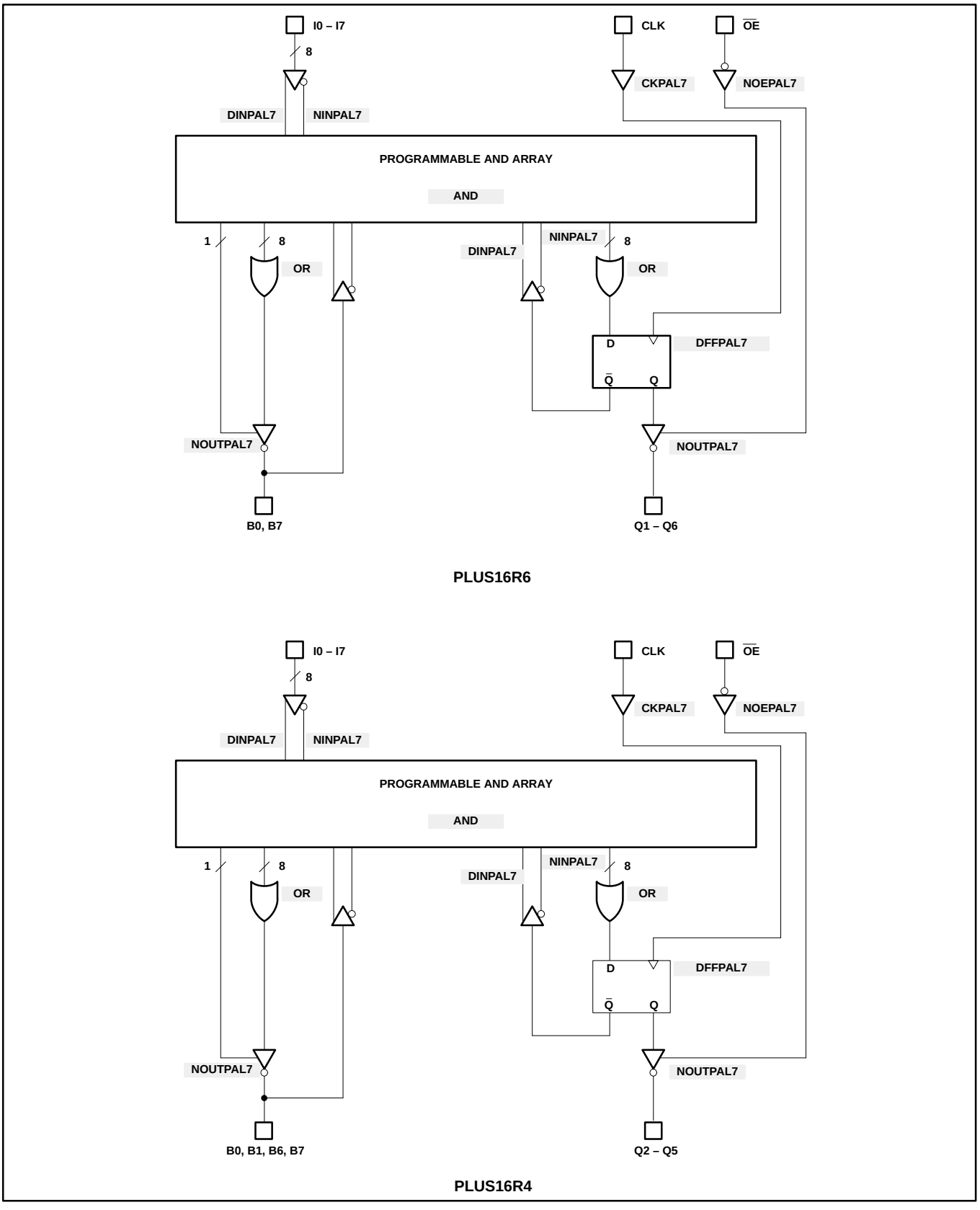


PLUS16L8



PLUS16R8

SNAP RESOURCE SUMMARY DESIGNATIONS (Continued)



PLUS16R6

PLUS16R4