National Semiconductor

PRELIMINARY

PAL10/10016P4-2 (DIP Only)
2 ns ECL ASPECT™ Programmable Array Logic

General Description

The PAL10/10016P4-2 is a member of the National Semiconductor 28-pin high speed ECL PAL® family. This device utilizes National Semiconductor's ASPECT (Advanced Single Poly Emitter Coupled Technology) process with a newly developed tungsten fuse technology to provide the highest-speed user-programmable replacements for conventional ECL SSI-MSI logic with significant chip-count reduction. The JEDEC fuse-map format and programming algorithm of this device is compatible with those of all prior ECL PAL products from National.

Programmable logic devices provide convenient solutions for a wide variety of application-specific functions, including random logic, custom decoders, state machines, etc. By programming fuse links to configure AND/OR gate connections, the system designer can implement custom logic as convenient sum-of-products Boolean functions. System prototyping and design iterations can be performed quickly using these off-the-shelf products.

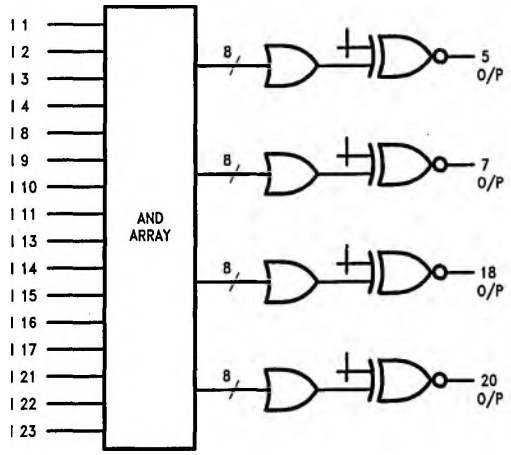
The PAL10/10016P4-2 logic array has a total of 16 complementary input pairs, 32 product terms and 4 programmable polarity output functions. Each output function is the OR-sum of 8 product terms. Each product term is satisfied when all array inputs which are connected to it (via intact fuses) are in the correct state as defined by the equation for that product term. Each output function is provided with output polarity fuses. These fuses permit the designer to configure each output independently to produce either a logic high (by leaving the fuse intact) or a logic low (by programming the fuse) when the equation defining that output is satisfied.

Programming equipment and software make PAL design development quick and easy. Programming is accomplished using TTL voltage levels and is therefore supported by industry standard TTL PLD programmers. After programming and verifying the logic array, an additional security fuse may be programmed to prevent direct copying of proprietary logic designs.

Features

- Highest speed: t_{PD} = 2.5 ns max
- Programmable replacement for ECL logic
- Both 100K and 10 KH I/O compatible versions
- Four output functions with programmable polarity
- Improved programmability tungsten fuses
- Security fuse to prevent direct copying
- Programmed on conventional TTL PLD programmers
- Fully Supported by PLAN™ Software
- Commercial and Military ranges

Block Diagram PAL10/10016P4-2



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V_{EE} = 12, V_{CC} = 24, V_{CCO} (5, 7) = 6
V_{CCO} (18, 20) = 19
Pinout applies to 24-pin DIP

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Temperature Under Bias	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
V_{EE} Relative to V_{CC}	−7V to +0.5V
Input Voltage	V_{EE} to +0.5V
Output Current	−50 mA
Lead Temperature (Soldering, 10 seconds)	300°C
ESD Tolerance	TBD
C_{ZAP} = 100 pF	
R_{ZAP} = 1500Ω	
Test Method: Human Body Model	
Test Specification: NSC SOP-5-028	

Recommended Operating Conditions for Commercial Range

Symbol	Parameter		Min	Typ	Max	Units
V_{EE}	Supply Voltage	10 KH	−5.46	−5.2	−4.94	V
		100K	−4.80	−4.5	−4.20	
T	Operating Temperature (Note)	10 KH	0		+75	°C
		100K	0		+85	

Electrical Characteristics Over Recommended Operating Conditions

Output Load = 50Ω to −2.0V

Symbol	Parameter	Conditions		T_A	Min	Max	Units
V_{IH}	High Level Input Voltage	Guaranteed Input Voltage High For All Inputs	10 KH	0°C	−1170	−840	mV
				+25°C	−1130	−810	
				+75°C	−1070	−735	
			100K	0°C to +85°C	−1165	−880	
V_{IL}	Low Level Input Voltage	Guaranteed Input Voltage Low For All Inputs	10 KH	0°C	−1950	−1480	mV
				+25°C	−1950	−1480	
				+75°C	−1950	−1450	
			100K	0°C to +85°C	−1810	−1475	
V_{OH}	High Level Output Voltage	V_{IN} = V_{IH} Max. or V_{IL} Min.	10 KH	0°C	−1020	−840	mV
				+25°C	−980	−810	
				+75°C	−920	−735	
			100K	0°C to +85°C	−1025	−880	
V_{OL}	Low Level Output Voltage	V_{IN} = V_{IH} Max. or V_{IL} Min.	10 KH	0°C	−1950	−1630	mV
				+25°C	−1950	−1630	
				+75°C	−1950	−1600	
			100K	0°C to +85°C	−1810	−1620	
I_{IH}	High Level Input Current	V_{IN} = V_{IH} Max.	10 KH	0°C to +75°C		220	μA
			100K	0°C to +85°C			
I_{IL}	Low Level Input Current	V_{IN} = V_{IL} Min.	10 KH	0°C to +75°C	0.5		μA
			100K	0°C to +85°C			
I_{EE}	Supply Current	V_{EE} = Min.	10 KH	0°C to +75°C	−220		mA
		All Inputs and Outputs Open	100K	0°C to +85°C			

Note: Operating temperatures for circuits in N and J packages are specified as ambient temperatures (T_A) with circuits in a test socket or mounted on a printed circuit board and transverse air flow greater than 500 linear fpm is maintained.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Temperature Under Bias	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
V_{EE} Relative to V_{CC}	−7V to +0.5V
Input Voltage	V_{EE} to +0.5V
Output Current	−50 mA
Lead Temperature (Soldering, 10 seconds)	300°C
ESD Tolerance	TBD
C_{ZAP} = 100 pF	
R_{ZAP} = 1500Ω	
Test Method: Human Body Model	
Test Specification: NSC SOP-5-028	

Recommended Operating Conditions for Extended (Military) Range*

Symbol	Parameter		Min	Typ	Max	Units
V_{EE}	Supply Voltage	10 KH	−5.46	−5.2	−4.94	V
		100K	−4.80	−4.5	−4.20	
T	Operating Temperature (Note)	10 KH	−55		+125	°C
		100K	0		+125	

Electrical Characteristics Over Recommended Operating Conditions

Output Load = 50Ω to −2.0V

Symbol	Parameter	Conditions		T_A	Min	Max	Units
V_{IH}	High Level Input Voltage	Guaranteed Input Voltage High For All Inputs	10 KH	−55°C	−1250	−930	mV
				+25°C	−1130	−810	
				+125°C	−1000	−660	
			100K	0°C to +125°C	−1165	−880	
V_{IL}	Low Level Input Voltage	Guaranteed Input Voltage Low For All Inputs	10 KH	−55°C	−1950	−1480	mV
				+25°C	−1950	−1480	
				+125°C	−1950	−1420	
			100K	0°C to +125°C	−1810	−1475	
V_{OH}	High Level Output Voltage	V_{IN} = V_{IH} Max. or V_{IL} Min.	10 KH	−55°C	−1110	−930	mV
				+25°C	−980	−810	
				+125°C	−830	−660	
			100K	0°C to +125°C	−1025	−880	
V_{OL}	Low Level Output Voltage	V_{IN} = V_{IH} Max. or V_{IL} Min.	10 KH	−55°C	−1950	−1630	mV
				+25°C	−1950	−1630	
				+125°C	−1950	−1570	
			100K	0°C to +125°C	−1810	−1620	
I_{IH}	High Level Input Current	V_{IN} = V_{IH} Max.	10 KH	−55°C to +125°C		220	µA
			100K	0°C to +125°C			
I_{IL}	Low Level Input Current	V_{IN} = V_{IL} Min.	10 KH	−55°C to +125°C	0.5		µA
			100K	0°C to +125°C			
I_{EE}	Supply Current	V_{EE} = Min.	10 KH	−55°C to +125°C	−220		mA
		All Inputs and Outputs Open	100K	0°C to +125°C			

Note: Operating temperatures for circuits in J and N packages are specified as ambient temperatures (T_A) with circuits in a test socket or mounted on a printed circuit board and transverse air flow greater than 500 linear fpm is maintained.

***Note:** Extended (Military) Range available in J package only.

Switching Characteristics

Over Recommended Operating Conditions, Output load: $R_L = 50\Omega$ to $-2.0V$, $C_L = 5$ pF to GND

Symbol	Parameter	Measured Test Conditions	Commercial		Military		Units
			Min	Max	Min	Max	
t_{PD}	Input to Output	Measured at Threshold Points (Note 1)		2.5		3.0	ns
t_r	Output Rise Time	Measured between 20% and 80% points	0.25	1.25	0.25	1.25	ns
t_f	Output Fall Time		0.25	1.25	0.25	1.25	ns

Note 1: All AC Measurements are to be made from Threshold Point.

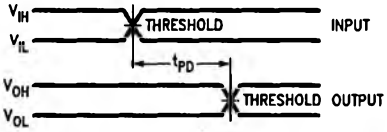
V_{IH} = Threshold + 400 mV

V_{IL} = Threshold − 400 mV

$$\text{Threshold} = \frac{V_{IH_{Min}} + V_{IL_{Max}}}{2}$$

Part	Temp	$V_{IN_{Min}}$	$V_{IL_{Max}}$	Threshold	V_{IH}	V_{IL}
10 kH	−55°C	−1250	−1480	−1365	−965	−1765
10 kH	0°C	−1170	−1480	−1325	−925	−1725
10 kH	25°C	−1130	−1480	−1300	−900	−1700
10 kH	75°C	−1070	−1450	−1260	−860	−1660
10 kH	125°C	−1000	−1420	−1210	−810	−1610
100k	All	−1165	−1475	−1300	−900	−1700

Timing Measurements



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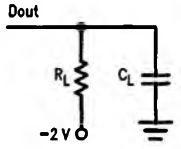
Test Load



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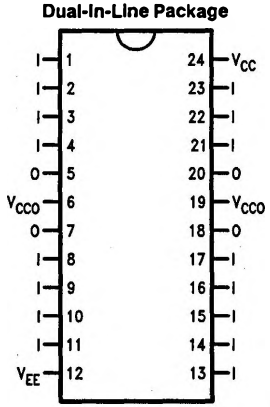
Connection Diagram

Dual-In-Line Package



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Top View

Functional Testing

As with all field-programmable devices, the user of the ECL PAL devices provides the final manufacturing step. While National's PAL devices undergo extensive testing when they are manufactured, their logic function can be fully tested only after they have been programmed to the user's pattern.

To ensure that the programmed PAL devices will operate properly in your system, National Semiconductor (along with most other manufacturers of PAL devices) strongly recommends that devices be functionally tested before being installed in your system. Even though the number of post-programming functional failures is small, testing the logic function of the PAL devices before they reach system assembly will save board debugging and rework costs. For more information about the functional testing of PAL devices, please refer to National Semiconductor's Application Note #351 and the *Programmable Logic Design Guide.*

Design Development Support

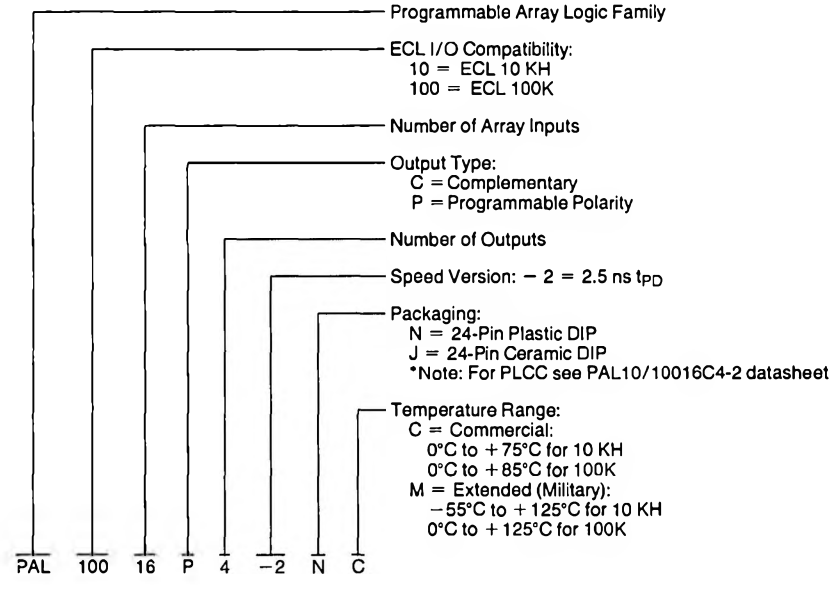
A variety of software tools and programming hardware is available to support the development of designs using PAL products. Typical software packages accept Boolean logic equations to define desired functions. Most are available to run on personal computers and generate JEDEC-compatible "fuse maps". The industry-standard JEDEC format ensures that the resulting fuse-map files can be downloaded into a large variety of programming equipment. Many software packages and programming units support a large variety of programmable logic products as well. The PLAN software package from National Semiconductor supports all programmable logic products available from National and is fully JEDEC-compatible. PLAN software also provides automatic device selection based on the designer's Boolean logic equations.

A detailed logic diagram showing all JEDEC fuse-map addresses for the PAL10/10016P4-2 is provided for direct map editing and diagnostic purposes. For a list of current software and programming support tools available for these devices, please contact your local National Semiconductor sales representative or distributor. If detailed specifications of the ECL PAL programming algorithm are needed, please contact the National Semiconductor Programmable Device Support Department.

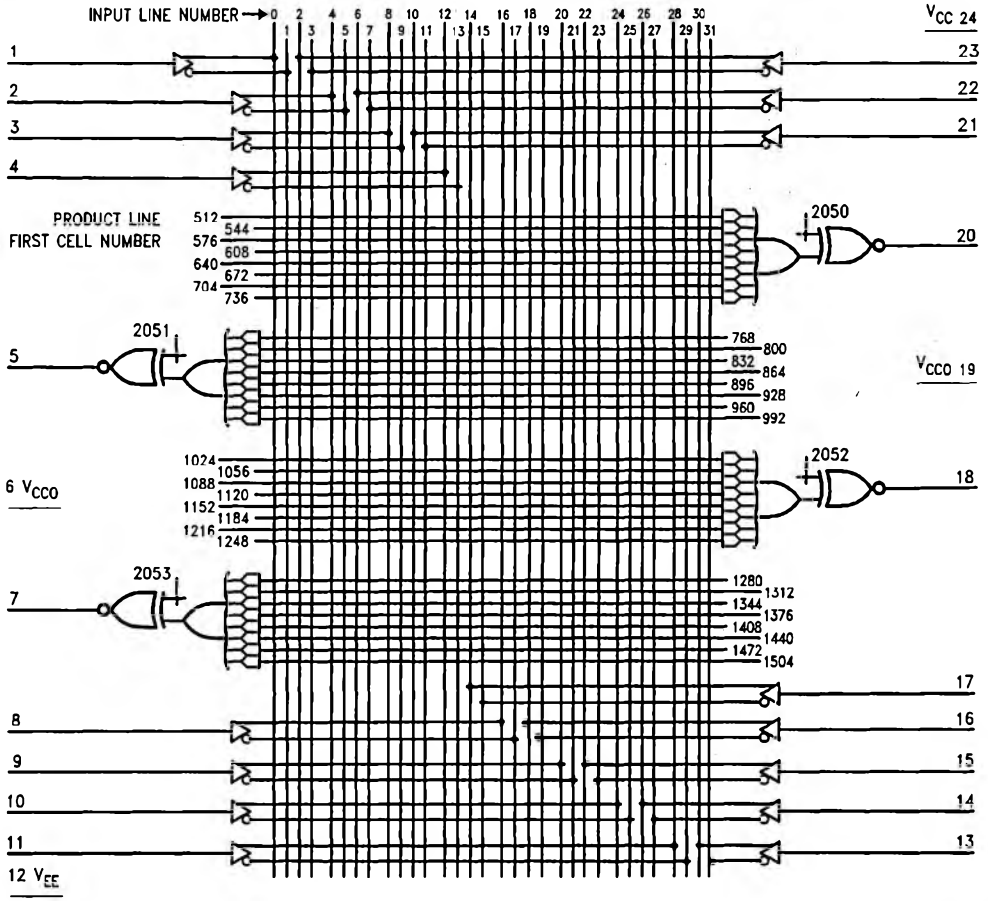
Programmer Support

Advin Systems	Sailor PAL	V8.40
Data I/O	Unisite 40	V2.20
Digelec	Model 860	VA-3.2
International Microsystems	ECL-2	V1.44C
Logical Devices	Allpro	V4.0
SMS	Palpro 2X	V31
Stag Microsystems	ZL30A	V32.J
Sprint Plus		

Ordering information



Logic Diagram—PAL1016P4-2/PAL10016P4-2



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JEDEC logic array cell number = product line first cell number + input line number