NEC Electronics Inc.

Preliminary

CMOS-8LCX 3-VOLT, 0.50-MICRON CMOS GATE ARRAYS CROSSCHECK TEST SUPPORT

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Description

NEC's 3-volt CMOS-8LCX family consists of ultra-high performance, sub-micron gate arrays, targeted for applications requiring extensive integration and high speeds. The device processing includes a true 3-volt, 0.5-micron (drawn) silicon-gate CMOS technology and three-layer metalization. This technology features channelless (sea-of-gates) architecture with an internal gate delay of 131 ps (F/O = 1; L = 0 mm).

The µPD658xx series of 3-volt CrossCheck®-supported devices consists of 10 masters, offered in densities of 10K gates to 486K gates. Usable gates range from 32K gates to 389K gates. These gate arrays are ideal for use in engineering workstations, high-end PCs, mainframes and LAN products, where extensive integration and high speed are primary design goals. CMOS-8LCX gate arrays are also well-suited for all battery-operated applications where high performance and low power consumption are critical; and feasible only with a truly optimized 3-volt CMOS process.

Features

- Supports CrossCheck on-chip testability circuitry
- Internal gate delays of 131 ps (F/O = 1; L = 0 mm)
- Channelless, 0.50 µm CMOS architecture
- Power (typ.) = 1.24 (3.3V) = 0.80 (3.0V)
- Process technology designed for 3V operation
- I/Os interface directly to 5V logic
- 48mA GTL I/O buffers are in development
- Phase Locked Loop (PLL) for chip-to-chip clock synchronization in development
- Automated generation of clock network for skew minimization
- High pad to gate ratio optimizes silicon usage
- Fully configurable high-speed RAM compiler
- Advanced package options include TAB/QFP, TQFP, PQFP, PGA and TAB
- Libraries characterized at 3V±10% and 3.3V±0.3V
- Variable output drive: 3, 6, 9, 12, 18, 24 or 48 mA
- Slew-rate controlled output buffers
- Supports scan test methodology
- Single/Dual-Port RAM and ROM memory blocks

Figure 1. Various CMOS-8LCX Packages

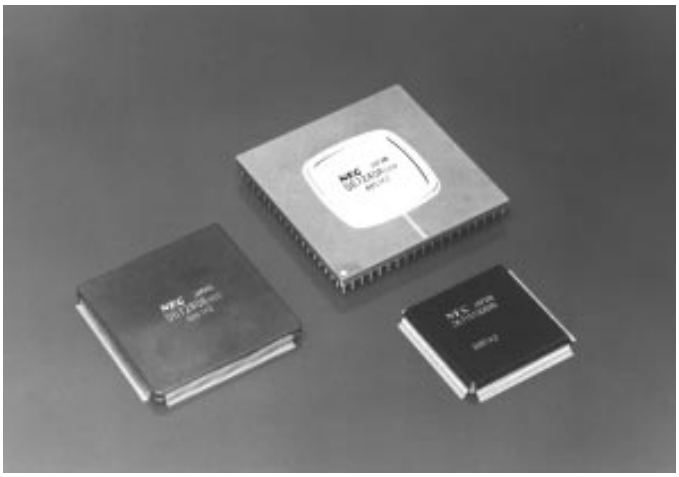


Table 1 Gate Array Sizes

Device µPD658xx	Metal Layers	Available Gates	Usable Gates	Total Pads
23	3	39,856	31,884	284
25	3	50,880	40,704	316
26	3	60,320	48,256	340
28	3	80,400	64,320	388
30	3	103,360	82,688	436
31	3	153,264	122,611	524
32	3	200,128	160,102	596
33	3	255,360	204,288	688
35	3	347,200	277,760	772
38	3	486,048	388,838	908

Actual gate utilitization may vary depending on circuit implementation. Utilization is 70% for three-layer metal.
Depending on package and circuit specification, some pads are used for V_{DD} and GND and are not available as signal pads.

CMOS-8LCX products are fully supported by NEC's advanced ASIC design technology. NEC's OpenCAD® integration system lets the designer choose the most powerful design tools and services available.

CMOS-8LCX gate arrays support automatic test generation through CrossCheck Technology's testability structures. This results in high fault coverage ATPT of synchronous and asynchronous designs with no netlist modifications and without designer involvement.

® OpenCAD is a registered trademark of NEC Electronics Inc.
® CrossCheck is a registered trademark of CrossCheck Technology, Inc.

Circuit Architecture

CMOS-8LCX products are built with NEC's 0.50-micron (drawn) channelless gate array architecture. As shown in figure 2, CMOS gate array chips are divided into I/O and internal cell areas. The I/O cell area contains input and output buffers that isolate the internal cells from high-energy external signals. The internal cell area is an array of basic cells, each composed of two p-channel MOS transistors and two n-channel MOS transistors, as well as four additional n-channel MOS transistors for compact RAM design. A cell configured as a two-input NAND gate is shown in figure 3. These p-channel and n-channel transistors are sized to offer a superb ratio of speed to silicon area.

Output Slew-Rate Selection

Fast rise and fall times of CMOS output buffers can cause system noise and signal overshoot. When an unterminated line is being driven by a buffer, the maximum line length is determined by the rise and fall time of the output buffers and the round-trip signal delay of the line.

Figure 2. Chip Layout and Internal Cell Configuration

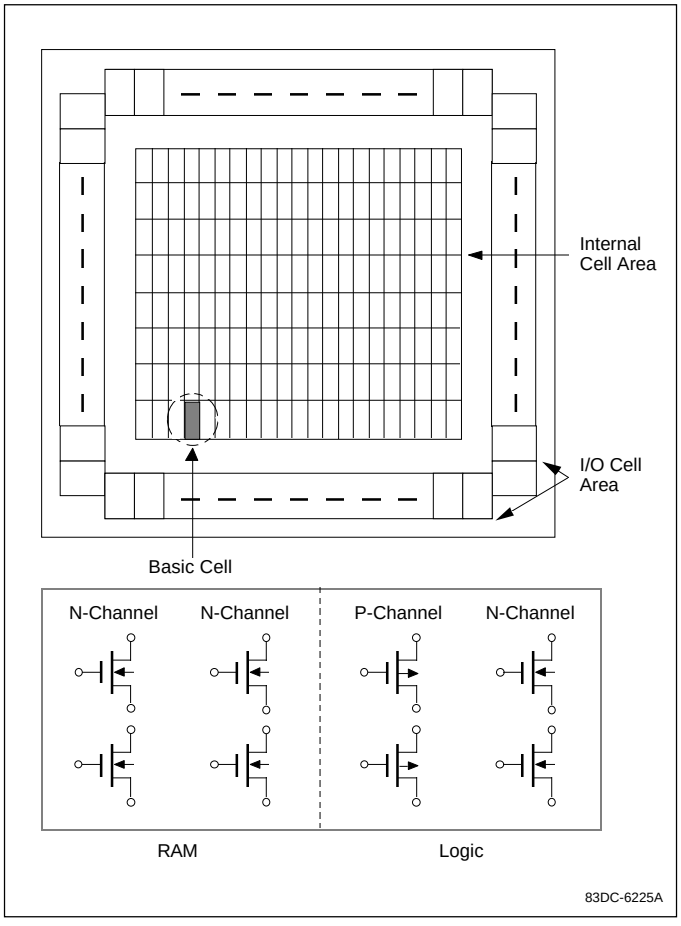
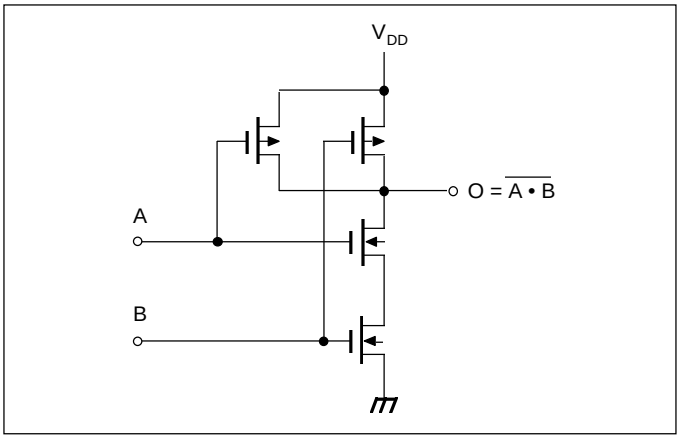


Figure 3. Cell Configured as a Two-Input NAND



As a general rule, the round-trip delay of the line should not exceed the rise or fall time of the driving signal. Transmission lines that are longer than those determined by this rule can degrade system performance due to reflections and ringing. One benefit of slew-rate output buffers is that longer interconnections on a PC board and routing flexibility are possible.

ASIC designers, therefore, can slow down the output edge-rate by using a slew-rate output buffer and thus accommodate longer transmission lines on PC boards.

Slew-rate buffers also inject less noise into the internal power and ground busses of the device, than their non-slew-rate counterparts. As a consequence, slew-rate buffers require fewer power/ground pairs for simultaneous switching outputs.

Publications

This data sheet contains preliminary specifications, package information, and operational data for the CMOS-8LCX gate array families. Additional design information will be available in NEC's CMOS-8LCX Block Library and CMOS-8LCX Design Manual. Contact your local NEC Design Center or the NEC Literature Center for further ASIC design information; see the back of this data sheet for locations and phone numbers.

Absolute Maximum Ratings

Power supply voltage, V_{DD}	–0.5 to +4.6 V
3V interface I/O voltage, V_I, V_O	–0.5 V to V_{DD} + 0.5 V
5V interface I/O voltage, V_I, V_O	–0.5 V to V_{DD} + 3.0 V
Latch-up current, I_{LATCH}	>1 A (typ)
Operating temperature, T_{OPT}	–40 to +85°C
Storage temperature, T_{STG}	–65 to +150°C

Caution: Exposure to absolute maximum ratings for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The device should not be operated outside the recommended operating conditions.

Input/Output Capacitance

$V_{DD} = V_I = 0$ V; f = 1 MHz

Terminal	Symbol	Typ	Max	Unit
Input	C_{IN}	10	20	pF
Output	C_{OUT}	10	20	pF
I/O	$C_{I/O}$	10	20	pF

Note: (1) Values include package pin capacitance.

Power Consumption at V_{DD} = 3.3V ± 0.3V

Description	Limits	Unit
Internal cell	1.24	µW/MHz
Input block (FI01)	10.0	µW/MHz
Output block	0.181	mW/MHz

Recommended Operating Conditions at V_{DD} = 3.3V ± 0.3V

Parameter	Symbol	Min	Max	Unit
Power supply voltage	V_{DD}	2.7	3.6	V
Ambient temperature	T_A	–40	+85	°C
Low-level input voltage, 3V	V_{IL}	0	0.3 V_{DD}	V
High-level input voltage, 3V	V_{IH}	0.7 V_{DD}	V_{DD}	V
Low-level input voltage, 5V	V_{IL}	0	0.8	V
High-level input voltage, 5V	V_{IH}	2.2	V_{PP}	V
Input rise or fall time	t_R, t_F	0	200	ns
Input rise or fall time, Schmitt	t_R, t_F	0	10	ms
Positive Schmitt-trigger voltage	V_P	TBD	TBD	V
Negative Schmitt-trigger voltage	V_N	TBD	TBD	V
Hysteresis voltage	V_H	TBD	TBD	V

AC Characteristics at V_{DD} = 3.3V ± 0.3V; T_j = –40°C to +125°C

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Toggle frequency	f_{TOG}	175			MHz	D-F/F; F/O = 2
Delay time, 2-input NAND gate						
Standard gate (F302)	t_{PD}		131		ps	F/O = 1; L = 0 mm
			243		ps	F/O = 2; L = 1 mm
Low power gate (L302)	t_{PD}		149		ps	F/O = 1; L = 0 mm
			371		ps	F/O = 2; L = 1 mm
Delay time, buffer						
Input (FI01)	t_{PD}		1.1		ns	F/O = 1; L = 0 mm @ V_{DD} = 3.3 V
Output (FO06)	t_{PD}		2.0		ns	C_L = 15 pF @ V_{DD} = 3.3V
Output rise time (FO06)	t_R		1.1		ns	C_L = 15 pF @ V_{DD} = 3.3V
Output fall time (FO06)	t_F		1.1		ns	C_L = 15 pF @ V_{DD} = 3.3V

DC Characteristics at V_{DD} = 3.3V ± 0.3V

V_{DD} = 3.3V ± 0.3V or 3V ± 10%; T_j = –40°C to +125°C

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Quiescent current (Note 1)	I_L		TBD	TBD	µA	$V_I = V_{DD}$ or GND
Input leakage current						
Regular	I_I		10^{-5}	10	µA	$V_I = V_{DD}$ or GND
50 kΩ pull-up	I_I	TBD	TBD	TBD	µA	V_I = GND
5 kΩ pull-up	I_I	TBD	TBD	TBD	mA	V_I = GND
50 kΩ pull-down	I_I	TBD	TBD	TBD	µA	$V_I = V_{DD}$
Off-state output leakage current	I_{OZ}			TBD	µA	$V_O = V_{DD}$ or GND
Input clamp voltage	V_{IC}	TBD			V	I_I = 18 mA
Output short circuit current (Note 2)	I_{OS}	TBD			mA	V_O = 0 V
Low-level output current, 3V buffers						
3 mA	I_{OL}	3			mA	V_{OL} = 0.4 V
6 mA	I_{OL}	6			mA	V_{OL} = 0.4 V
9 mA	I_{OL}	9			mA	V_{OL} = 0.4 V
12 mA	I_{OL}	12			mA	V_{OL} = 0.4 V
18 mA	I_{OL}	18			mA	V_{OL} = 0.4 V
24 mA	I_{OL}	24			mA	V_{OL} = 0.4 V
48 mA	I_{OL}	48			mA	V_{OL} = 0.4 V
Low-level output current, 5V buffers						
3 mA	I_{OL}	3			mA	V_{OL} = 0.4 V
6 mA	I_{OL}	6			mA	V_{OL} = 0.4 V
9 mA	I_{OL}	9			mA	V_{OL} = 0.4 V
12 mA	I_{OL}	12			mA	V_{OL} = 0.4 V
18 mA	I_{OL}	18			mA	V_{OL} = 0.4 V
High-level output current, 3V buffers						
3 mA	I_{OH}	-3			mA	V_{OH} = 2.4 V
6 mA	I_{OH}	-6			mA	V_{OH} = 2.4 V
9 mA	I_{OH}	-9			mA	V_{OH} = 2.4 V
12 mA	I_{OH}	-12			mA	V_{OH} = 2.4 V
18 mA	I_{OH}	-18			mA	V_{OH} = 2.4 V
24 mA	I_{OH}	-24			mA	V_{OH} = 2.4 V
48 mA	I_{OH}	-48			mA	V_{OH} = 2.4 V
High-level output current, 5V buffers						
3 mA	I_{OH}	-3			mA	V_{OH} = 2.4 V
6 mA	I_{OH}	-3			mA	V_{OH} = 2.4 V
9 mA	I_{OH}	-3			mA	V_{OH} = 2.4 V
12 mA	I_{OH}	-6			mA	V_{OH} = 2.4 V
18 mA	I_{OH}	-6			mA	V_{OH} = 2.4 V
Low-level output voltage, 3V and 5V	V_{OL}			0.1	V	I_{OL} = 0 mA
High-level output voltage, 3V and 5V	V_{OH}	V_{DD} – 0.1			V	I_{OH} = -0.2 mA

Notes: (1) The maximum value reflects the use of pull-up/pull-down resistors and oscillator blocks. Contact an NEC ASIC Design Center for assistance in calculation.

(2) Rating is for only one output operating in this mode for less than 1 second.

Absolute Maximum Ratings

Power supply voltage, V_{DD}	–0.5 to +4.6 V
3V interface I/O voltage, V_I, V_O	–0.5 V to V_{DD} + 0.5 V
5V interface I/O voltage, V_I, V_O	–0.5 V to V_{DD} + 3.0 V
Latch-up current, I_{LATCH}	>1 A (typ)
Operating temperature, T_{OPT}	–40 to +85°C
Storage temperature, T_{STG}	–65 to +150°C

Caution: Exposure to absolute maximum ratings for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The device should not be operated outside the recommended operating conditions.

Input/Output Capacitance

$V_{DD} = V_I = 0$ V; f = 1 MHz

Terminal	Symbol	Typ	Max	Unit
Input	C_{IN}	10	20	pF
Output	C_{OUT}	10	20	pF
I/O	$C_{I/O}$	10	20	pF

Power Consumption at V_{DD} = 3.0V ± 10%

Description	Limits	Unit
Internal cell	0.80	µW/MHz/cell
Input block (FI01)	8.0	µW/MHz
Output block	0.164	mW/MHz

Recommended Operating Conditions at V_{DD} = 3.0V ± 10%

Parameter	Symbol	Min	Max	Unit
Power supply voltage	V_{DD}	2.7	3.6	V
Ambient temperature	T_A	–40	+85	°C
Low-level input voltage, 3V	V_{IL}	0	0.3 V_{DD}	V
High-level input voltage, 3V	V_{IH}	0.7 V_{DD}	V_{DD}	V
Low-level input voltage, 5V	V_{IL}	0	0.8	V
High-level input voltage, 5V	V_{IH}	2.2	V_{DD}	V
Input rise or fall time	t_R, t_F	0	200	ns
Input rise or fall time, Schmitt	t_R, t_F	0	10	ms
Positive Schmitt-trigger voltage	V_P	TBD	TBD	V
Negative Schmitt-trigger voltage	V_N	TBD	TBD	V
Hysteresis voltage	V_H	TBD	TBD	V

AC Characteristics at V_{DD} = 3.0V ± 10%; T_j = –40°C to +125°C

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Toggle frequency	f_{TOG}	175			MHz	D-F/F; F/O = 2
Delay time, 2-input NAND gate						
Standard gate (F302)	t_{PD}		147		ps	F/O = 1; L = 0 mm
			272		ps	F/O = 2; L = 1 mm
Low power gate (L302)	t_{PD}		167		ps	F/O = 1; L = 0 mm
			416		ps	F/O = 2; L = 1 mm
Delay time, buffer						
Input (FI01)	t_{PD}		309		ps	F/O = 1; L = 0 mm @ V_{DD} = 3.0 V
Output (FO06)	t_{PD}		1.62		ns	C_L = 15 pF @ V_{DD} = 3.0V
Output rise time (FO06)	t_R		TBD		ns	C_L = 15 pF @ V_{DD} = 3.0V
Output fall time (FO06)	t_F		TBD		ns	C_L = 15 pF @ V_{DD} = 3.0V

DC Characteristics at V_{DD} = 3.0V ± 10%

V_{DD} = 3.3V ± 0.3V or 3V ± 10%; T_j = –40°C to +125°C

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Quiescent current (Note 1)	I_L		TBD	TBD	µA	$V_I = V_{DD}$ or GND
Input leakage current						
Regular	I_I		10^{-5}	10	µA	$V_I = V_{DD}$ or GND
50 kΩ pull-up	I_I	TBD	TBD	TBD	µA	V_I = GND
5 kΩ pull-up	I_I	TBD	TBD	TBD	mA	V_I = GND
50 kΩ pull-down	I_I	TBD	TBD	TBD	µA	$V_I = V_{DD}$
Off-state output leakage current	I_{OZ}			TBD	µA	$V_O = V_{DD}$ or GND
Input clamp voltage	V_{IC}	TBD			V	I_I = 18 mA
Output short circuit current (Note 2)	I_{OS}	TBD			mA	V_O = 0 V
Low-level output current, 3V buffers						
3 mA	I_{OL}	3			mA	V_{OL} = 0.4 V
6 mA	I_{OL}	6			mA	V_{OL} = 0.4 V
9 mA	I_{OL}	9			mA	V_{OL} = 0.4 V
12 mA	I_{OL}	12			mA	V_{OL} = 0.4 V
18 mA	I_{OL}	18			mA	V_{OL} = 0.4 V
24 mA	I_{OL}	24			mA	V_{OL} = 0.4 V
48 mA	I_{OL}	48			mA	V_{OL} = 0.4 V
Low-level output current, 5V buffers						
3 mA	I_{OL}	3			mA	V_{OL} = 0.4 V
6 mA	I_{OL}	6			mA	V_{OL} = 0.4 V
9 mA	I_{OL}	9			mA	V_{OL} = 0.4 V
12 mA	I_{OL}	12			mA	V_{OL} = 0.4 V
18 mA	I_{OL}	18			mA	V_{OL} = 0.4 V
High-level output current, 3V buffers						
3 mA	I_{OH}	-3			mA	V_{OH} = 2.4 V
6 mA	I_{OH}	-6			mA	V_{OH} = 2.4 V
9 mA	I_{OH}	-9			mA	V_{OH} = 2.4 V
12 mA	I_{OH}	-12			mA	V_{OH} = 2.4 V
18 mA	I_{OH}	-18			mA	V_{OH} = 2.4 V
24 mA	I_{OH}	-24			mA	V_{OH} = 2.4 V
48 mA	I_{OH}	-48			mA	V_{OH} = 2.4 V
High-level output current, 5V buffers						
3 mA	I_{OH}	-2			mA	V_{OH} = 2.2 V
6 mA	I_{OH}	-2			mA	V_{OH} = 2.2 V
9 mA	I_{OH}	-2			mA	V_{OH} = 2.2 V
12 mA	I_{OH}	-4			mA	V_{OH} = 2.2 V
18 mA	I_{OH}	-4			mA	V_{OH} = 2.2 V
Low-level output voltage, 3V and 5V	V_{OL}			0.1	V	I_{OL} = 0 mA
High-level output voltage, 3V	V_{OH}	V_{DD} – 0.1			V	I_{OH} = 0 mA
High-level output voltage, 5V	V_{OH}	V_{DD} – 0.2			V	I_{OH} = 0 mA

Notes: (1) The maximum value reflects the use of pull-up/pull-down resistors and oscillator blocks. Contact an NEC ASIC Design Center for assistance.
(2) Rating is for only one output operating in this mode for less than 1 second.

Table 2 CMOS-8 Package Options

Maximum I/O Pins	Package Dimensions			Master Slice μPD65xxx									
	Body Size	Pitch	Height	-823	-825	-826	-828	-830	-831	-832	-833	-835	-838
Plastic Quad Flatpack (PQFP)													
120-pin	28 mm □	0.8 mm	3.7 mm	A	A	A	A	A	A	A	A	A	A
136-pin	28 mm □	0.65 mm	3.7 mm	A	A	A	A	A	A	A	A	A	A
160-pin	28 mm □	0.65 mm	3.7 mm	D	D	A	A	A	A	A	A	A	A
160-pin (H/S)	28 mm □	0.65 mm	3.2 mm	–	D	D	D	D	D	D	D	D	–
184-pin	32 mm □	0.65 mm	3.2 mm	D	D	D	D	D	D	D	D	D	D
Plastic Quad Flatpack (PQFP-FP)													
100-pin	14 mm □	0.5 mm	1.45 mm	A	A	A	–	–	–	–	–	–	–
120-pin	20 mm □	0.5 mm	2.7 mm	A	A	A	A	A	A	A	A	–	–
144-pin	20 mm □	0.5 mm	2.7 mm	A	A	A	A	A	A	A	A	–	–
160-pin	24 mm □	0.5 mm	2.7 mm	D	A	A	A	A	A	A	A	A	–
160-pin (H/S)	24 mm □	0.5 mm	2.7 mm	–	P	P	P	P	P	P	P	P	–
176-pin	24 mm □	0.5 mm	2.7 mm	D	D	A	A	A	A	A	A	A	–
176-pin (H/S)	24 mm □	0.5 mm	2.7 mm	–	–	D	D	D	D	D	D	D	–
208-pin	28 mm □	0.5 mm	3.2 mm	D	D	D	D	A	A	A	A	A	A
208-pin (H/S)	28 mm □	0.5 mm	3.2 mm	–	–	–	–	D	D	D	D	D	D
240-pin	32 mm □	0.5 mm	3.2 mm	D	D	D	D	D	A	A	A	A	A
256-pin	28 mm □	0.4 mm	3.2 mm	D	D	D	D	D	A	A	A	A	A
272-pin	36 mm □	0.5 mm	3.2 mm	D	D	D	D	D	A	A	A	A	A
304-pin	40 mm □	0.5 mm	3.7 mm	D	D	D	D	D	D	A	A	A	A
Thin Quad Flatpack (TQFP) PRELIMINARY													
80-pin	12 mm □	0.5 mm	1.05 mm	P	–	–	–	–	–	–	–	–	–
100-pin	14 mm □	0.5 mm	1.0 mm	P	P	P	–	–	–	–	–	–	–
120-pin	14 mm □	0.4 mm	1.0 mm	P	P	P	P	P	P	P	P	–	–
144-pin	20 mm □	0.5 mm	1.4 mm	P	P	P	P	P	P	P	P	–	–
160-pin	24 mm □	0.5 mm	1.4 mm	P	P	P	P	P	P	P	P	P	–
176-pin	24 mm □	0.5 mm	1.4 mm	P	P	P	P	P	P	P	P	P	–
208-pin	28 mm □	0.5 mm	1.4 mm	P	P	P	P	P	P	P	P	P	P
Ceramic Pin Grid Array (CPGA)													
72-pin	27.94 mm □	100 mils	4.57 mm	A	A	A	A	A	A	A	A	A	A
132-pin	35.56 mm □	100 mils	4.57 mm	A	A	A	A	A	A	A	A	A	A
176-pin	38.10 mm □	100 mils	4.57 mm	D	D	D	A	A	A	A	A	A	A
208-pin	43.18 mm □	100 mils	5.08 mm	D	D	D	D	A	A	A	A	A	A
280-pin	48.26 mm □	100 mils	4.57 mm	D	D	D	D	D	D	A	A	A	A
364-pin	43.18 mm □	50 mils	3.0 mm	–	–	–	D	D	D	D	D	A	A
Ceramic Pin Grid Array (CPGA) Butt-Lead													
288-pin	27.94 mm □	50 mils	5.58 mm	D	D	D	D	D	D	D	D	D	D
528-pin	48.26 mm □	50 mils	10.6 mm	–	–	–	–	–	D	D	D	D	D

Notation: A = Available; P = Planned; D = In Development; "–" = Unavailable; H/S = Heat Spreader.
Note: NEC reserves the right to alter the package plan based on the results of qualification. For current package availability, please contact your local NEC Design Center.

NEC's ASIC Design System

NEC supports its ASIC products with a comprehensive CAD system that significantly reduces the time and expense usually associated with the development of semi-custom devices. Designers can choose from today's most popular third-party software tools, shown in the table on the adjacent page. NEC's OpenCAD Design System is a front-end to back-end ASIC design package that merges several advanced CAE/CAD tools into a single structure. Designers can now choose a single CAE platform, or mix and match tools from a variety of third-party vendors. The design flow combines tools for floorplanning, logic synthesis, automatic test generation, accelerated fault-grading, full timing simulation, and advanced place-and-route algorithms. This flexible design environment thereby ensures accurate, on schedule designs.

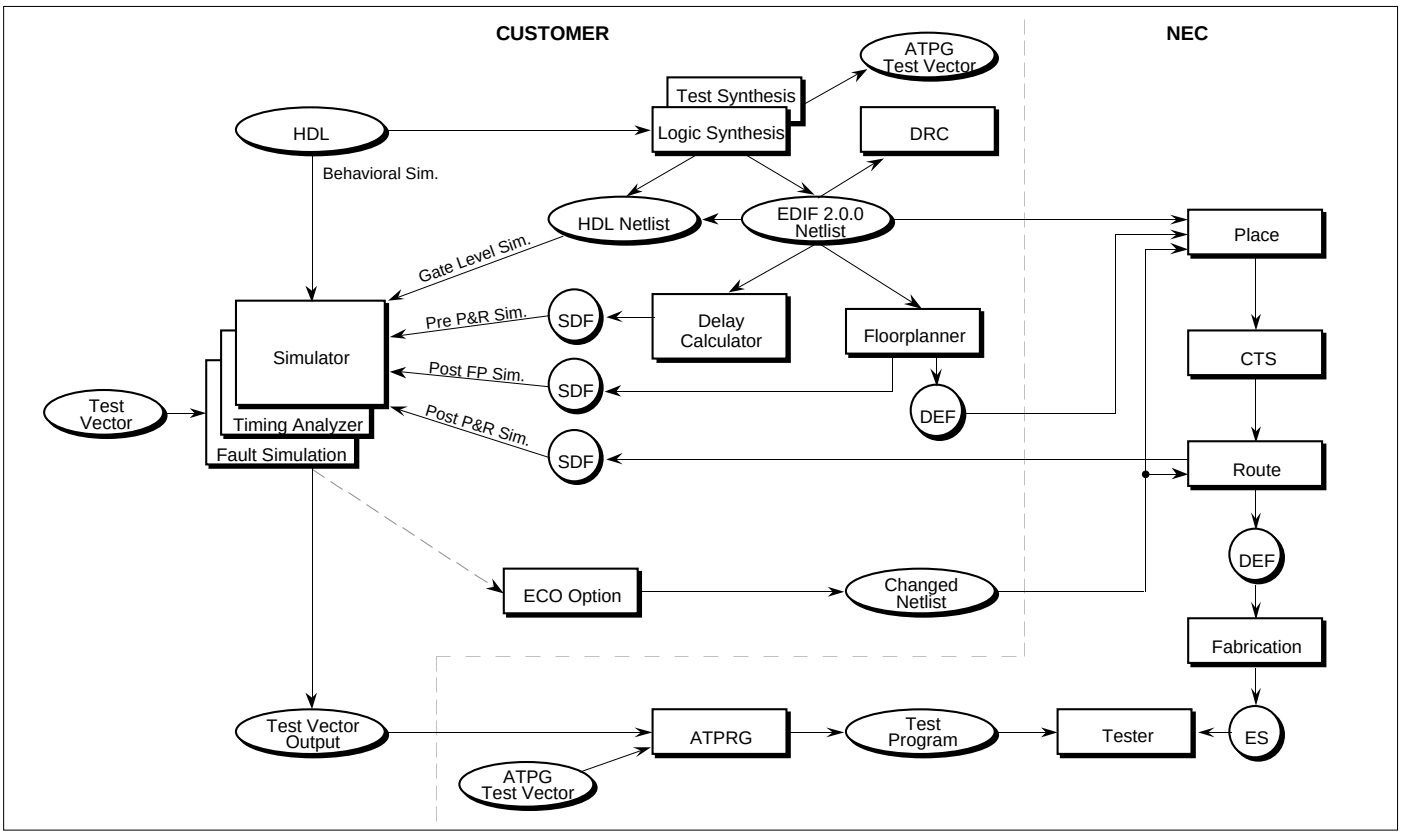
There are two basic methods for design entry, the first is by HDL specification, figure 4; the second is via schematic capture, figure 5. Note that after the initial EDIF netlist is generated, there is little difference in the basic design flow for either method. Figure 6 shows the location of the CrossCheck tools in the high-level design flow.

A top-down modeling methodology is possible using the HDL specification approach. Designers can concentrate their design effort at a higher level of abstraction, specifying, modeling, and simulating their designs at a systems level. This leaves the details of the gate-level implementation to the synthesis tools. After verification confirms the design's functionality, designers are then free to explore various functional and architectural trade-offs, and can optimize chip performance while minimizing chip area. An engineer can evaluate several architectures and select the best solution before committing the design to silicon.

The more traditional method of design entry, schematic capture, figure 5, is available with a wide variety of third-party tools. The supported tools, described in Table 3, provide the designer with a productive way to manage the hierarchical elements of a CMOS-8 design, utilizing the macro symbol library provided by NEC. For those designers who are experienced and already well-versed with graphical design entry, this provides an efficient migration path for ASIC development.

One of the key benefits of NEC's ASIC design flow is that post place-and-route simulation can be accomplished at the customer's site, since NEC offers designers a choice of simulators within the "golden simulator" category. Golden simulator status means that upon receiving post place-and-route simulation results from a customer, NEC can then proceed directly to photomask production, bypassing any additional post-simulation steps. This can save a lot of time.

Figure 4. HDL Specification Design Flow



The floorplanner tool provides realistic estimates of wire length by grouping hierarchical blocks into specific physical locations on the chip. This minimizes critical path interconnect delays for more accurate simulation. The floorplanner also provides graphical I/O assignment capabilities and generates a delay file for post-floorplanner simulation.

The ECO (Engineering Change Order) option in figures 4 and 5 allows the designer to make minor corrections in the design without requiring an entirely new placement and routing of the device. This tool improves turnaround time by ensuring that relatively small changes, such as connectivity changes, will not greatly impact the current design timing.

NEC also incorporates proprietary tools to facilitate the design process. A single delay calculator is used for all CAE platforms to ensure consistent timing and simulation results. A comprehensive design rule check (DRC) program reports design rule violations as well as chip utilization statistics for the design netlist. The generated report contains such information as net-count calculation, total pin-count and cell-count use, and usage rate calculations. Unused input pins, violations in pin naming conventions and fan-out limits, are examples of the design rule violations reported by this program.

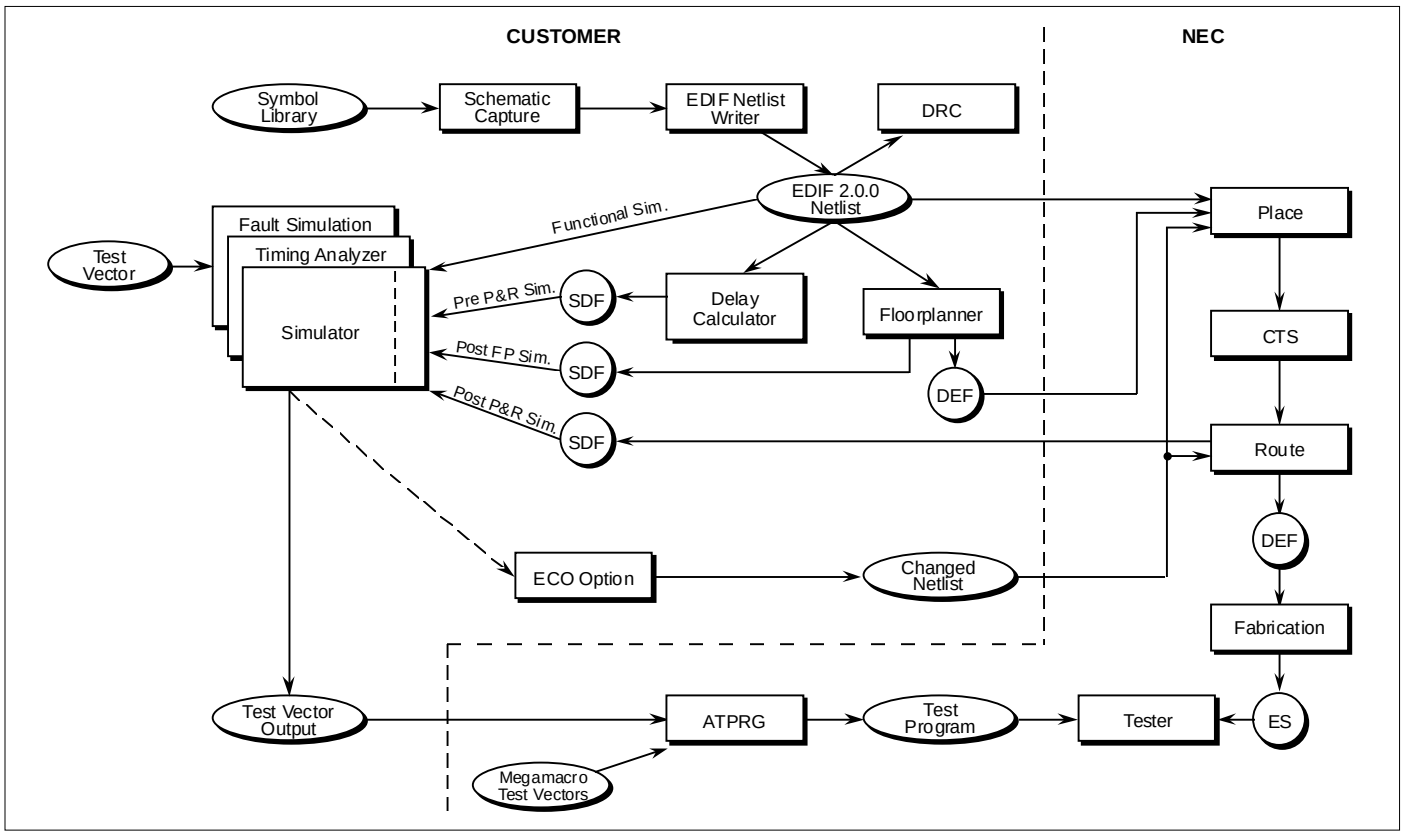
Sample design kits are available at no charge to qualified users. A software license agreement is required. For more information, contact your nearest NEC ASIC Design Center, listed on the back of this data sheet.

Table 3 Third-Party Supported Tools

Tools / CAD Company	Schematic Entry	Synthesis	Simulation	Static Timing Analysis	Floorplanner	Place and Route	Fault Simulation	ATPG
Synopsys		|	|	|				|
Cadence	|	|	*	|		|	|	
Mentor	|		|	+			+	
Viewlogic	|	|	|					
Valid (Cadence)	|		|	+			|	
IKOS			|				|	
Zycad/NECplus			*				|	
Intelligen								|
NEC			*		|	|		

Key:
- * indicates "Golden Simulator" status.
- | indicates planned support-check with local Design Center for exact availability.
- + indicates function is available via software library, and software support is through third-party vendor.

Figure 5. Schematic-Based Design Flow



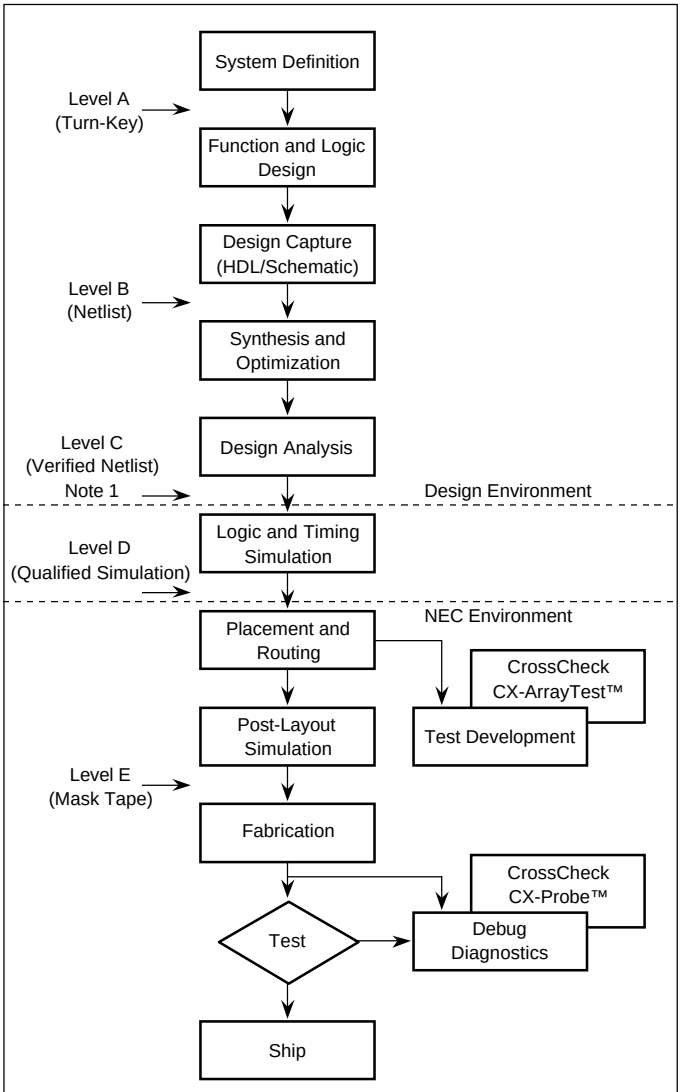
CrossCheck Test Design Flow

The CMOS-8LCX (CrossCheck) ASICs makes use of a unique test structure, called On-Chip Test Engine™, that allows testability to be incorporated into a CMOS-8LCX design, using a process that is totally transparent to the designer. This unique approach transfers the burden of test development from the designer to NEC, where the testability is incorporated automatically during the manufacturing phase of the device. A summary of the benefits to CrossCheck Test are described below.

CrossCheck Test Benefits

- Push-button automatic test pattern generation (ATPG)
- No functional or initialization vectors required
- Negligible performance impact
- Netlist modifications not required
- High fault coverage tests including stuck at, bridging and manufacturing faults
- Tests all design styles, including:
  - Synchronous single clock
  - Synchronous multiple gated clock
  - Asynchronous
- Enhanced prototype diagnostic capability

Figure 6. Gate Array Design Flow with CrossCheck



Notes :

(1) NEC supports the most popular CAD tools, including Cadence/ Valid, DAZIX®, IKOS®, Mentor Graphics™, Synopsys™, Viewlogic™ and Zycad™ for the NEC ASIC product line. However, NEC does not support all CAD tools for all products. Please contact your nearest NEC ASIC Design Center for more information.

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Zycad is a trademark of Zycad Corporation
CX-ArrayTest is a trademark of CrossCheck Technologies, Inc.
CX-Probe is a trademark of CrossCheck Technologies, Inc.

83RD-9079A

™ On-Chip Test Engine is a trademark of CrossCheck Technology, Inc.

Designing with CrossCheck

In using CrossCheck, the designer's only test consideration is in the selection of a CMOS-8LCX base array. In the design phase, the designer is free to use any preferred CAE tools and methodology supported by NEC.

This design freedom extends to the nature of the design, synchronous or asynchronous, as shown in figure 4, where the CMOS-8LCX gate array design flow with the CrossCheck solution is illustrated. During simulation the designer uses NEC's CrossCheck library. The only input to test development is the netlist that is sent to NEC for manufacturing CMOS-8LCX devices.

When the design is placed and routed, NEC automatically connects the On-Chip Test Engine to the circuit design. The test structure affords massive observability and controllability of the design even though the CMOS-8LCX looks exactly like a conventional ASIC. The connections of the test structures have a negligible performance impact on the design and require no modification to the user's netlist.

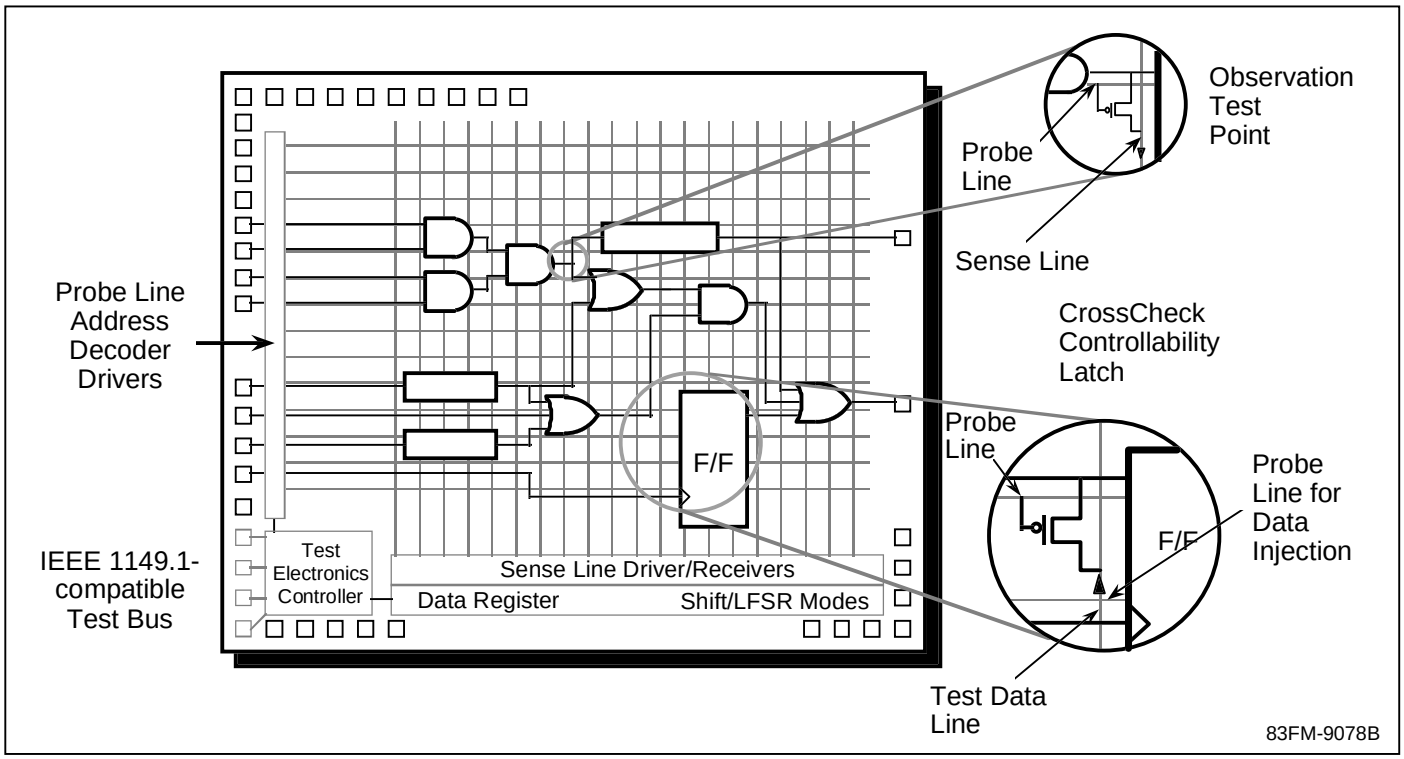
NEC uses the CX-ArrayTest™ software to automatically generate high fault coverage test patterns. The test development process requires only the design netlist and placement information. There is no need for designer-supplied functional or initialization vectors, a significant benefit. CX-ArrayTest software performs design analysis, ATPG, and fault grading. The CX-Probe™, a software program developed by CrossCheck Technology, uses the on-chip test structures to automate prototype debug and diagnostics. With these tools, CMOS-8LCX gate arrays with the embedded test solution resolve three of the key parameters for testing the quality of ASICs: high fault coverage, rapid failure analysis and time-to-market.

Embedded Test Structures

In the CMOS-8LCX, the test structure is embedded directly in the base array, as shown in figure 5. The On-Chip Test Engine consists of a grid of sense transistors, which provide massive observability and which are transparent to the designer. An address matrix of probe and sense lines select and control the node under test. A test controller then manages the address matrix and activates the sense transistors. The small transistor used has a negligible impact on the overall performance of the gate array. There is one observation point for each four transistors or gate.

™ CX-Probe and CX-ArrayTest are trademarks of CrossCheck Technology, Inc.

Figure 5. CMOS-8LCX CrossCheck On-Chip Test Engine



The key to this on-chip test system is the patented CrossCheck Controllability Latch (CCL), shown in figure 5, which allows fully automated test pattern generation without modification to the user's netlist. The CCL uses two embedded probe lines and a sense line to control the latch data injection. Thus, the CCLs are not connected as a synchronous chain. For this reason CX-ArrayTest software can perform ATPG on asynchronous circuitry. The CCL implementation has negligible impact on performance.

Test Controller

The on-chip test electronics controller, shown in figure 5, performs four major functions:

- Interface to the CrossCheck Test Access Port
- Test vector generation
- Signature generation
- On-Chip Test Engine self-test

Access to the On-Chip Test Engine is through CrossCheck's Test Access Port. This test bus, compatible with IEEE 1149.1, interfaces with automatic test equipment (ATE). The ATE sends instructions and data to the on-chip controller and in return receives test results from it. The On-Chip Test Engine produces test vectors on the chip acting on instructions and/or data received from the CX-ArrayTest software. This compatibility significantly reduces the ATE test vector memory requirements for high fault coverage testing. To further reduce the amount of ATE vector memory used, the state of the test points on the device are read and compressed into a signature in the data register.

Fault Models

Because macrocells generally contain multiple test points, defects within cells are detected. Traditional methods test only the inputs and outputs of the macrocells, detecting only the symptoms of a fault rather than the fault itself, and often not detecting the fault at all. The CMOS-8LCX CrossCheck test solution models nine different defect types:

- Stuck-at-faults:
  - Input stuck-at "1"
  - Input stuck-at "0"
  - Output stuck-at "1"
  - Output stuck-at "0"
- Comprehensive manufacturing defects:
  - Shorted FET
  - Shorted intra-macro interconnect
  - Open FET
  - Open intra-macro interconnect
  - Shorted inter-macro networks

Table 4 Typical Fault Coverage with CX-ArrayTest

Design Style	Stuck at Faults	Bridging Faults
Synchronous	> 98%	>99%
Multiple gated clocks	> 95%	>99%
Asynchronous	90% – 95%	>98%

The fault coverage that can be achieved is dependent upon the design style used. Synchronous designs have a single clock for the complete design. Gated clock designs are generally synchronous but have several clocks and flip-flop clocks that are gated by combinatorial logic.

Asynchronous is all other design styles. Asynchronous is a design style often used in interface circuits, and is generally not testable with approaches such as SCAN. The CMOS-8LCX's ability to test asynchronous design is a significant advantage of this test solution. Examples of typical fault coverage using CMOS-8LCX are shown in Table 4.

NEC uses CrossCheck's CX-Fault™ tool to analyze the transistor-level descriptions of the macrocells to produce a model library. The library contains the test generation fault models that are used by the ATPG.

Automatic Test Pattern Generation

ATPG requires only the user netlist, placement file, and the results of the test strategy developed from the netlist analysis. CX-ArrayTest generates values for the test strategy waveform template and avoids the hazard circuit states. A full timing simulation is performed to determine circuit stability after each vector is generated and applied. Simulating the On-Chip Test Engine allows creation of the signature of the internal circuit node states. Faults are marked as detected only when the circuit is stable and a signature is generated. The ATPG also correctly handles any unavoidable hazard circuit states. The CX-ArrayTest software monitors and reports fault coverage, test time and vector length as it generates new vectors.

The ATPG process continues until one of the user-defined limits is reached, specifically fault coverage, number of test vectors, test time, or elapsed ATPG processing time. At the end of test generation, a set of vectors, including tests of the On-Chip Test Engine, are packaged for translation onto automatic test equipment.

Using the CrossCheck test solution allows automation of the process of failure analysis, reducing diagnostics from days or weeks to just hours.

™ CX-Fault is a trademark of CrossCheck Technology, Inc.

Block Library List

The CMOS-8L family offers a variety of blocks, including gates, flip-flop circuits, and shift registers. The functions of these blocks are designed to be compatible with those of the CMOS-8, CMOS-7 and CMOS-6 families. In addition, memory blocks such as RAM and ROM will be provided, and low-power gates are available. The low-power blocks are designed for gate count reduction; the number of cells are fewer than that of the standard block, contributing to lower power consumption and higher efficiency. Another feature is the I/Os can directly interface to 5V logic.

Block List

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks		
	3V CMOS Input Buffers		
FI01	3V CMOS input	-	1 (3)
FID1	3V CMOS input, 50 kΩ pull-down	-	1 (3)
FIU1	3V CMOS in, 50 kΩ pull-up	-	1 (3)
FIW1	3V CMOS in, 5 kΩ pull-up	-	1 (3)
FIS1	3V CMOS Schmitt input	-	1 (8)
FDS1	3V CMOS Schmitt input, 50 kΩ pull-down	-	1 (8)
FUS1	3V CMOS Schmitt input, 50 kΩ pull-up	-	1 (8)
FWS1	3V CMOS Schmitt input, 5 kΩ pull-up	-	1 (8)
FIB1	3V CMOS input, high fanout for clock driver	-	1 (24)
FDB1	3V CMOS input, high fanout for clock driver, 50 kΩ pull-down	-	1 (24)
FUB1	3V CMOS input, high fanout for clock driver, 50 kΩ pull-up	-	1 (24)
FWB1	3V CMOS input, high fanout for clock driver, 5 kΩ pull-up	-	1 (24)
	3V CMOS Input Buffers without Protection Diode up to V_{DD}		
FIA1	3V CMOS input	-	1 (3)
FDA1	3V CMOS input, 50 kΩ pull-down	-	1 (3)
FUA1	3V CMOS input, 50 kΩ pull-up	-	1 (3)
FWA1	3V CMOS input, 5 kΩ pull-up	-	1 (3)
FIE1	3V CMOS Schmitt input	-	1 (8)
FDE1	3V CMOS Schmitt input, 50 kΩ pull-down	-	1 (8)
FUE1	3V CMOS Schmitt input, 50 kΩ pull-up	-	1 (8)
FWE1	3V CMOS Schmitt input, 5 kΩ pull-up	-	1 (8)
FIH1	3V CMOS input, high fanout for clock driver	-	1 (24)
FDH1	3V CMOS input, high fanout for clock driver, 50 kΩ pull-down	-	1 (24)
FUH1	3V CMOS input, high fanout for clock driver, 50 kΩ pull-up	-	1 (24)
FWH1	3V CMOS input, high fanout for clock driver, 5 kΩ pull-up	-	1 (24)
	5V CMOS Input Buffers		
FIV1	5V CMOS input	-	1 (3)
FDV1	5V CMOS input, 50 kΩ pull-down	-	1 (3)
FIF1	5V CMOS Schmitt input	-	1 (8)
FDF1	5V CMOS Schmitt input, 50 kΩ pull-down	-	1 (8)
FIG1	5V CMOS input, high fanout for clock driver	-	1 (24)
FDG1	5V CMOS input, high fanout for clock driver, 50 kΩ pull-down	-	1 (24)
	Interface Blocks (Cont.)		
	3V CMOS Output Buffers		
FO0A	3V CMOS output	1.0	1 (4)
FO0B	3V CMOS output	2.0	1 (4)
FO09	3V CMOS output	3.0	1 (4)
FO04	3V CMOS output	6.0	1 (4)
FO01	3V CMOS output	9.0	1 (4)
FO02	3V CMOS output	12.0	1 (4)
FO03	3V CMOS output	18.0	1 (8)
FO06	3V CMOS output	24.0	1 (8)
FO0C	3V CMOS output	48.0	2 (8)
	3V CMOS Slew-Rate Output Buffers		
FE02	3V CMOS output, low noise	12.0	1 (3)
FE03	3V CMOS output, low noise	18.0	1 (3)
FE06	3V CMOS output, low noise	24.0	1 (3)
FE0C	3V CMOS output, low noise	48.0	2 (3)
	5V CMOS Output Buffers		
FV0A	5V CMOS output	1.0	1 (4)
FV0B	5V CMOS output	2.0	1 (4)
FV09	5V CMOS output	3.0	1 (4)
FV04	5V CMOS output	6.0	1 (4)
FV01	5V CMOS output	9.0	1 (8)
FV02	5V CMOS output	12.0	2 (8)
FV03	5V CMOS output	18.0	2 (8)
FV06	5V CMOS output	24.0	3 (8)
	5V CMOS Slew-Rate Output Buffers		
FW02	5V CMOS output, low noise	12.0	2 (3)
FW02	5V CMOS output, low noise	18.0	2 (3)
FW06	5V CMOS output, low noise	24.0	3 (3)
	3V CMOS Three-State Output Buffers		
B00T	3V CMOS output	3.0	1 (6)
B0DT	3V CMOS output, 50 kΩ pull-down	3.0	1 (6)
B0UT	3V CMOS output, 50 kΩ pull-up	3.0	1 (6)
B0WT	3V CMOS output, 5 kΩ pull-up	3.0	1 (6)
B00E	3V CMOS output	6.0	1 (6)
B0DE	3V CMOS output, 50 kΩ pull-down	6.0	1 (6)
B0UE	3V CMOS output, 50 kΩ pull-up	6.0	1 (6)
B0WE	3V CMOS output, 5 kΩ pull-up	6.0	1 (6)
B008	3V CMOS output	9.0	1 (6)
B0D8	3V CMOS output, 50 kΩ pull-down	9.0	1 (6)
B0U8	3V CMOS output, 50 kΩ pull-up	9.0	1 (6)
B0W8	3V CMOS output, 5 kΩ pull-up	9.0	1 (6)
B007	3V CMOS output	12.0	1 (6)
B0D7	3V CMOS output, 50 kΩ pull-down	12.0	1 (6)
B0U7	3V CMOS output, 50 kΩ pull-up	12.0	1 (6)
B0W7	3V CMOS output, 5 kΩ pull-up	12.0	1 (6)
B009	3V CMOS output	18.0	1 (9)
B0D9	3V CMOS output, 50 kΩ pull-down	18.0	1 (9)
B0U9	3V CMOS output, 50 kΩ pull-up	18.0	1 (9)
B0W9	3V CMOS output, 5 kΩ pull-up	18.0	1 (9)
B00H	3V CMOS output	24.0	1 (9)
B0DH	3V CMOS output, 50 kΩ pull-down	24.0	1 (9)
B0UH	3V CMOS output, 50 kΩ pull-up	24.0	1 (9)
B0WH	3V CMOS output, 5 kΩ pull-up	24.0	1 (9)

Note: Number of internal cells required is shown in parentheses.

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks (Cont.)		
	3V CMOS Three-State Output Buffers (Cont.)		
B00J	3V CMOS output	48.0	2 (9)
B0DJ	3V CMOS output, 50 kΩ pull-down	48.0	2 (9)
B0UJ	3V CMOS output, 50 kΩ pull-up	48.0	2 (9)
B0WJ	3V CMOS output, 5 kΩ pull-up	48	2 (9)
	3V CMOS Slew-Rate Three-State Output Buffers		
BE07	3V CMOS output	12.0	1 (5)
BED7	3V CMOS output, 50 kΩ pull-down	12.0	1 (5)
BEU7	3V CMOS output, 50 kΩ pull-up	12.0	1 (5)
BEW7	3V CMOS output, 5 kΩ pull-up	12.0	1 (5)
BE09	3V CMOS output	18.0	1 (5)
BED9	3V CMOS output, 50 kΩ pull-down	18.0	1 (5)
BEU9	3V CMOS output, 50 kΩ pull-up	18.0	1 (5)
BEW9	3V CMOS output, 5 kΩ pull-up	18.0	1 (5)
BE0H	3V CMOS output	24.0	1 (5)
BEDH	3V CMOS output, 50 kΩ pull-down	24.0	1 (5)
BEUH	3V CMOS output, 50 kΩ pull-up	24.0	1 (5)
BEWH	3V CMOS output, 5 kΩ pull-up	24.0	1 (5)
BE0J	3V CMOS output	48.0	2 (5)
BEDJ	3V CMOS output, 50 kΩ pull-down	48.0	2 (5)
BEUJ	3V CMOS output, 50 kΩ pull-up	48.0	2 (5)
BEWJ	3V CMOS output, 5 kΩ pull-down	48.0	2 (5)
	5V CMOS Three-State Output Buffers		
BV0Q	5V CMOS output	1.0	1 (16)
BVDQ	5V CMOS output, 50 kΩ pull-down	1.0	1 (16)
BV0M	5V CMOS output	2.0	1 (16)
BVDM	5V CMOS output, 50 kΩ pull-down	2.0	1 (16)
BV0T	5V CMOS output	3.0	1 (16)
BVDT	5V CMOS output, 50 kΩ pull-down	3.0	1 (16)
BVOE	5V CMOS output	6.0	1 (16)
BVDE	5V CMOS output, 50 kΩ pull-down	6.0	1 (16)
BV08	5V CMOS output	9.0	1 (19)
BVD8	5V CMOS output, 50 kΩ pull-down	9.0	1 (19)
BV07	5V CMOS output	12.0	2 (19)
BVD7	5V CMOS output, 50 kΩ pull-down	12.0	2 (19)
BV09	5V CMOS output	18.0	2 (19)
BVD9	5V CMOS output, 50 kΩ pull-down	18.0	2 (19)
BV0H	5V CMOS output	24.0	3 (19)
BVDH	5V CMOS output, 50 kΩ pull-down	24.0	3 (19)
	5V CMOS Slew-Rate Three-State Output Buffers		
BY07	5V CMOS output	12.0	2 (15)
BYD7	5V CMOS output, 50 kΩ pull-down	12.0	2 (15)
BY09	5V CMOS output	18.0	2 (15)
BYD9	5V CMOS output, 50 kΩ pull-down	18.0	2 (15)
BY0H	5V CMOS ouputt	24.0	3 (15)
BYDH	5V CMOS output, 50 kΩ pull-down	24.0	3 (15)
	3V CMOS Open Drain Output Buffers		
EXTH	3V N-ch open drain	3.0	1 (4)
EXUH	3V N-ch open drain, 50 kΩ pull-up	3.0	1 (4)
EXWH	3V N-ch open drain, 5 kΩ pull-up	3.0	1 (4)
EXTJ	3V N-ch open drain	6.0	1 (4)
EXUJ	3V N-ch open drain, 50 kΩ pull-up	6.0	1 (4)
EXWJ	3V N-ch open drain, 5 kΩ pull-up	6.0	1 (4)

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks (Cont.)		
	3V CMOS Open Drain Output Buffers (Cont.)		
EXT1	3V N-ch open drain	9.0	1 (4)
EXT3	3V N-ch open drain, 50 kΩ pull-up	9.0	1 (4)
EXW3	3V N-ch open drain, 5 kΩ pull-up	9.0	1 (4)
EXT9	3V N-ch open drain	12.0	1 (4)
EXTB	3V N-ch open drain, 50 kΩ pull-up	12.0	1 (4)
EXWB	3V N-ch open drain, 5 kΩ pull-up	12.0	1 (4)
EXT5	3V N-ch open drain	18.0	1 (8)
EXT7	3V N-ch open drain, 50 kΩ pull-up	18.0	1 (8)
EXW7	3V N-ch open drain, 5 kΩ pull-up	18.0	1 (8)
EXTD	3V N-ch open drain	24.0	1 (8)
EXTF	3V N-ch open drain, 50 kΩ pull-up	24.0	1 (8)
EXWF	3V N-ch open drain, 5 kΩ pull-up	24.0	1 (8)
EXTL	3V N-ch open drain	48.0	2 (2)
EXUL	3V N-ch open drain, 50 kΩ pull-up	48.0	2 (8)
EXWL	3V N-ch open drain, 5 kΩ pull-up	48.0	2 (8)
EXTQ	3V P-ch open drain	*3.0	1 (4)
EXDQ	3V P-ch open drain, 50 kΩ pull-down	*3.0	1 (4)
EXTR	3V P-ch open drain	*6.0	1 (4)
EXDR	3V P-ch open drain, 50 kΩ pull-down	*6.0	1 (4)
EXT2	3V P-ch open drain	*9.0	1 (4)
EXT4	3V P-ch open drain, 50 kΩ pull-down	*9.0	1 (4)
EXTA	3V P-ch open drain	*12.0	1 (4)
EXTC	3V P-ch open drain, 50 kΩ pull-down	*12.0	1 (4)
EXT6	3V P-ch open drain	*18.0	1 (4)
EXT8	3V P-ch open drain, 50 kΩ pull-down	*18.0	1 (4)
EXTE	3V P-ch open drain	*24.0	1 (8)
EXTG	3V P-ch open drain, 50 kΩ pull-down	*24.0	1 (8)
EXTS	3V P-ch open drain	*48.0	2 (8)
EXDS	3V P-ch open drain, 50 kΩ pull-down	*48.0	2 (8)
	3V CMOS Slew-Rate Open Drain Output Buffers		
EET9	3V N-ch open drain	12.0	1 (2)
EETB	3V N-ch open drain, 50 kΩ pull-up	12.0	1 (2)
EEWB	3V N-ch open drain, 50 kΩ pull-up	12.0	1 (2)
EET5	3V N-ch open drain	18.0	1 (2)
EET7	3V N-ch open drain, 50 kΩ pull-up	18.0	1 (2)
EEW7	3V N-ch open drain, 5 kΩ pull-up	18.0	1 (2)
EETD	3V N-ch open drain	24.0	1 (2)
EETF	3V N-ch open drain, 50 kΩ pull-up	24.0	1 (2)
EEWF	3V N-ch open drain, 5 kΩ pull-up	24.0	1 (2)
EETL	3V N-ch open drain	48.0	2 (2)
EEUL	3V N-ch open drain, 50 kΩ pull-up	48.0	2 (2)
EEWL	3V N-ch open drain, 5 kΩ pull-up	48.0	2 (2)
EETA	3V P-ch open drain	*12.0	1 (2)
EETC	3V P-ch open drain, 50 kΩ pull-down	*12.0	1 (2)
EET6	3V P-ch open drain	*18.0	1 (2)
EET8	3V P-ch open drain, 50 kΩ pull-down	*18.0	1 (2)
EETE	3V P-ch open drain	*24.0	1 (2)
EETG	3V P-ch open drain, 50 kΩ pull-down	*24.0	1 (2)
EETS	3V P-ch open drain	*48.0	2 (2)
EEDS	3V P-ch open drain, 50 kΩ pull-down	*48.0	2 (2)

Note: Number of internal cells required is shown in parentheses.
* Indicates I_{OH}

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks (Cont.)		
	5V CMOS Open Drain Output Buffers		
EVTH	5V N-ch open drain	3.0	1 (4)
EVTJ	5V N-ch open drain	6.0	1 (4)
EVT1	5V N-ch open drain	9.0	1 (8)
EVT9	5V N-ch open drain	12.0	1 (8)
EVT5	5V N-ch open drain	18.0	2 (8)
EVTD	5V N-ch open drain	24.0	2 (8)
	5V CMOS Slew-Rate Output Buffers		
EYT9	5V N-ch open drain	12.0	1 (2)
EYT5	5V N-ch open drain	18.0	2 (2)
EYTD	5V N-ch open drain	24.0	2 (2)
	3V CMOS Bi-Directional Output Buffers		
B00U	CMOS input, CMOS 3-state output	3.0	1 (9)
B0DU	CMOS input, CMOS 3-state out, 50 kΩ pull-down	3.0	1 (9)
B0UU	CMOS input, CMOS 3-state out, 50 kΩ pull-up	3.0	1 (9)
B0WU	CMOS input, CMOS 3-state out, 5 kΩ pull-up	3.0	1 (9)
B00C	CMOS input, CMOS 3-state output	6.0	1 (9)
B0DC	CMOS input, CMOS 3-state out, 50 kΩ pull-down	6.0	1 (9)
B0UC	CMOS input, CMOS 3-state out, 50 kΩ pull-up	6.0	1 (9)
B0WC	CMOS input, CMOS 3-state out, 5 kΩ pull-up	6.0	1 (9)
B003	CMOS inut, CMOS 3-state output	9.0	1 (8)
B0D3	CMOS input, CMOS 3-state out, 50 kΩ pull-down	9.0	1 (8)
B0U3	CMOS input, CMOS 3-state out, 50 kΩ pull-up	9.0	1 (8)
B0W3	CMOS in, CMOS 3-state out, 5 kΩ pull-up	9.0	1 (8)
B001	CMOS input, CMOS 3-state out	12.0	1 (9)
B0D1	CMOS input, CMOS 3-state out, 50 kΩ pull-down	12.0	1 (9)
B0U1	CMOS input, CMOS 3-state out, 50 kΩ pull-up	12.0	1 (9)
B0W1	CMOS input, CMOS 3-state out, 5 kΩ pull-up	12.0	1 (9)
B005	CMOS input, CMOS 3-state out	18.0	1 (12)
B0D5	CMOS input, CMOS 3-state out, 50 kΩ pull-down	18.0	1 (12)
B0U5	CMOS input, CMOS 3-state out, 50 kΩ pull-up	18.0	1 (12)
B0W5	CMOS input, CMOS 3-state out, 5 kΩ pull-up	18.0	1 (12)
B00F	CMOS input, CMOS 3-state out	24.0	1 (12)
B0DF	CMOS input, CMOS 3-state out, 50 kΩ pull-down	24.0	1 (12)
B0UF	CMOS input, CMOS 3-state out, 50 kΩ pull-up	24.0	1 (12)
B0WF	CMOS input, CMOS 3-state out, 5 kΩ pull-up	24.0	1 (12)
B00W	CMOS input, CMOS 3-state output	48.0	2 (12)
B0DW	CMOS input, CMOS 3-state output, 50 kΩ pull-down	48.0	2 (12)
B0UW	CMOS input, CMOS 3-state out, 50 kΩ pull-up resistor	48.0	2 (12)
B0WW	CMOS input, CMOS 3-state output, 5 kΩ pull-up resistor	48.0	2 (12)
BSIU	CMOS Schmitt input, CMOS 3-state ouput	3.0	1 (14)
BSDU	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	3.0	1 (14)
BSUU	CMOS Schmitt input, CMOS 3-state out, 50 kΩ pull-up	3.0	1 (14)
BSWU	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	3.0	1 (14)
BSIC	CMOS Schmitt input, CMOS 3-state output	6.0	1 (14)
BSDC	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	6.0	1 (14)
BSUC	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	6.0	1 (14)
BSWC	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	6.0	1 (14)

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks (Cont.)		
	3V CMOS Bi-Directional Output Buffers		
BSI3	CMOS Schmitt input, CMOS 3-state output	9.0	1 (14)
BSD3	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	9.0	1 (14)
BSU3	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	9.0	1 (14)
BSW3	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	9.0	1 (14)
	3V CMOS Three-State I/O Buffers		
BSI1	CMOS Schmitt input, CMOS 3-state output	12.0	1 (14)
BSD1	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	12.0	1 (14)
BSU1	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	12.0	1 (14)
BSW1	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	12.0	1 (14)
BSI5	CMOS Schmitt input, CMOS 3-state output	18.0	1 (17)
BSD5	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	18.0	1 (17)
BSU5	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	18.0	1 (17)
BSW5	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	18.0	1 (17)
BSIF	CMOS Schmitt input, CMOS 3-state output	24.0	1 (17)
BSDF	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	24.0	1 (17)
BSUF	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	24.0	1 (17)
BSWF	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	24.0	1 (17)
BSIW	CMOS Schmitt input, CMOS 3-state output	48.0	2 (17)
BSDW	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	48.0	2 (17)
BSUW	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	48.0	2 (17)
BSWW	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	48.0	2 (17)
	3V CMOS Slew-Rate Three-State Output Buffers		
BE01	CMOS input, CMOS 3-state output	12.0	1 (8)
BED1	CMOS input, CMOS 3-state output, 50 kΩ pull-dn	12.0	1 (8)
BEU1	CMOS input, CMOS 3-state output, 50 kΩ pull-up	12.0	1 (8)
BEW1	CMOS input, CMOS 3-state output, 5 kΩ pull-up	12.0	1 (8)
BE05	CMOS input, CMOS 3-state output	18.0	1 (8)
BED5	CMOS input, CMOS 3-state output, 50 kΩ pull-dn	18.0	1 (8)
BEU5	CMOS input, CMOS 3-state output, 50 kΩ pull-up	18.0	1 (8)
BEW5	CMOS input, CMOS 3-state output, 5 kΩ pull-up	18.0	1 (8)
BE0F	CMOS input, CMOS 3-state output	24.0	1 (8)
BEDF	CMOS input, CMOS 3-state output, 50 kΩ pull-dn	24.0	1 (8)
BEUF	CMOS input, CMOS 3-state output, 50 kΩ pull-up	24.0	1 (8)
BEWF	CMOS input, CMOS 3-state output, 5 kΩ pull-up	24.0	1 (8)
BE0W	CMOS input, CMOS 3-state output	48.0	2 (8)
BEDW	CMOS input, CMOS 3-state output, 50 kΩ pull-dn	48.0	2 (8)
BEUW	CMOS input, CMOS 3-state output, 50 kΩ pull-up	48.0	2 (8)
BEWW	CMOS input, CMOS 3-state output, 5 kΩ pull-up	48.0	2 (8)

Note: Number of internal cells required is shown in parentheses.

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks (Cont.)		
	3V CMOS Slew-Rate Three-State Output Buffers (Cont.)		
BFI1	CMOS Schmitt input, CMOS 3-state output,	12.0	1 (13)
BFD1	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	12.0	1 (13)
BFU1	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	12.0	1 (13)
BFW1	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	12.0	1 (13)
BFI5	CMOS Schmitt input, CMOS 3-state output	18.0	1 (13)
BFD5	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	18.0	1 (13)
BFU5	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	18.0	1 (13)
BFW5	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	18.0	1 (13)
BFIF	CMOS Schmitt input, CMOS 3-state output,	24.0	1 (13)
BFDF	CMOSSchmitt input, CMOS 3-state output, 50 kΩ pull-down	24.0	1 (13)
BFUF	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	24.0	1 (13)
BFWF	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	24.0	1 (13)
BFIW	CMOS Schmitt input, CMOS 3-state output,	48.0	2 (13)
BFDW	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	48.0	2 (13)
BFUW	CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-up	48.0	2 (13)
BFWW	CMOS Schmitt input, CMOS 3-state output, 5 kΩ pull-up	48.0	2 (13)
	5V CMOS Bi-Directional Output Buffers		
BW0X	5V CMOS input / CMOS 3-state output	1.0	1 (19)
BWDX	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	1.0	1 (19)
BW0K	5V CMOS input / CMOS 3-state output	2.0	1 (19)
BWDK	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	2.0	1 (19)
BW0U	5V CMOS input / CMOS 3-state output	3.0	1 (19)
BWDU	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	3.0	1 (19)
BW0C	5V CMOS input / CMOS 3-state output	6.0	1 (19)
BWDC	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	6.0	1 (19)
BW03	5V CMOS input / CMOS 3-state output	9.0	1 (22)
BWD3	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	9.0	1 (22)
BW01	5V CMOS input / CMOS 3-state output	12.0	2 (22)
BWD1	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	12.0	2 (22)
BW05	5V CMOS input / CMOS 3-state output	18.0	2 (22)
BWD5	5V CMOS input/ CMOS 3-state output, with 50KΩ pull-down	18.0	2 (22)
BW0F	5V CMOS input/ CMOS 3-state output,	24.0	3 (22)
BWDF	5V CMOS input/ CMOS 3-state output, with 50KΩ pull-down	24.0	3 (22)

Block Name	Description	I_{OL} (mA)	Cells
	Interface Blocks (Cont.)		
	5V CMOS Bi-Directional Output Buffers (Cont.)		
BKIX	5V CMOS Schmitt input, CMOS 3-state output	1.0	1 (24)
BKDX	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	1.0	1 (24)
BKIK	5V CMOS Schmitt input, CMOS 3-state output	2.0	1 (24)
BKDK	5V CMOS Schmitt input, CMOS 3-state output, 50kΩ pull-down	2.0	1 (24)
BKIU	5V CMOS Schmitt input, CMOS 3-state output	3.0	1 (24)
BKDU	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	3.0	1 (24)
BKIC	5V CMOS Schmitt in, CMOS 3-state output	6.0	1 (24)
BKDC	5V CMOS Schmitt input, CMOS 3-state out, 50 kΩ pull-down resistor	6.0	1 (24)
BKI3	5V CMOS Schmitt input, CMOS 3-state output	9.0	1 (27)
BKD3	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	9.0	1 (24)
BKI1	5V CMOS Schmitt input, CMOS 3-state output	12.0	2 (27)
BKD1	5V CMOS Schmitt input, CMOS 3-state output, 50kΩ pull-down	12.0	2 (27)
BKI5	5V CMOS Schmitt input, CMOS 3-state output	18.0	2 (27)
BKD5	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down resistor	18.0	2 (27)
BKIF	5V CMOS Schmitt input, CMOS 3-state output	24.0	3 (27)
BKDF	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	24.0	3 (27)
	5V CMOS Slew-Rate Bi-Directional Output Buffers		
BX01	5V CMOS input / CMOS 3-state output	12.0	2 (18)
BXD1	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	12.0	2 (18)
BX05	5V CMOS input / CMOS 3-state output	18.0	2 (18)
BXD5	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	18.0	2 (18)
BX0F	5V CMOS input / CMOS 3-state output	24.0	3 (18)
BXDF	5V CMOS input / CMOS 3-state output, with 50KΩ pull-down	24.0	3 (18)
BZI1	5V CMOS Schmitt input, CMOS 3-state output	12.0	2 (23)
BZD1	5V CMOS Schmitt in, CMOS 3-state output, 50kΩ pull-down	12.0	2 (23)
BZI5	5V CMOS Schmitt input, CMOS 3-state output	18.0	2 (23)
BZD5	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	18.0	2 (23)
BZ1F	5V CMOS Schmitt input, CMOS 3-state output	24.0	3 (23)
BZDF	5V CMOS Schmitt input, CMOS 3-state output, 50 kΩ pull-down	24.0	3 (23)

Note: Number of internal cells required is shown in parentheses.

Block Name	Description	Cells
Interface Blocks		
Inverters		
F101	Inverter (F/O = 17)	1
F102	Inverter (F/O = 37)	2
F103	Inverter (F/O = 60)	3
F104	Inverter (F/O = 92)	4
F108	Inverter (F/O = 160)	12
Buffers		
F111	Non-inverting buffer (F/O = 17)	2
F112	Non-inverting buffer (F/O = 35)	3
F113	Non-inverting buffer (F/O = 54)	4
F114	Non-inverting buffer (F/O = 74)	5
F118	Non-inverting buffer (F/O = 180)	11
NOR Gates		
F202	2-input NOR	2
F203	3-input NOR	3
F204	4-input NOR	4
F205	5-input NOR	5
F206	6-input NOR	5
F208	8-input NOR	7
F222	2-input NOR, power	4
F223	3-input NOR, power	6
F224	4-input NOR, power	8
OR Gates		
F212	2-input OR	2
F213	3-input OR	3
F214	4-input OR	3
F215	5-input OR	5
F216	6-input OR	5
F232	2-input OR, power	3
F233	3-input OR, power	4
F234	4-input OR, power	4
NAND Gates		
F302	2-input NAND	2
F303	3-input NAND	3
F304	4-input NAND	4
F305	5-input NAND	5
F306	6-input NAND	5
F308	8-input NAND	6
F322	2-input NAND, power	4
F323	3-input NAND, power	6
F324	4-input NAND, power	8
AND Gates		
F312	2-input AND	2
F313	3-input AND	3
F314	4-input AND	3
F315	5-input AND	5
F316	6-input AND	5
F332	2-input AND, power	3
F333	3-input AND, power	4
F334	4-input AND, power	4

Block Name	Description	Cells
Function Blocks – Normal Power		
AND-NOR Gates		
F421	2-wide 1-2-input AND-OR inverter	3
F422	3-wide 1-1-2-input AND-OR inverter	4
F423	2-wide 1-3-input AND-OR inverter	4
F424	2-wide 2-2-input AND-OR inverter	4
F425	3-wide 2-2-2-input AND-OR inverter	6
F426	2-wide 3-3-input AND-OR inverter	6
F429	4-wide 2-2-2-2-input AND-OR inverter	8
F442	2-wide 4-4-input AND-OR inverter	8
F462	3-wide 1-2-3-input AND-OR inverter	6
OR-NAND Gates		
F431	2-wide 1-2-input OR-AND inverter	3
F432	3-wide 1-1-2-input OR-AND inverter	4
F433	2-wide 1-3-input OR-AND inverter	4
F434	2-wide 2-2-input OR-AND inverter	4
F435	2-wide 2-3-input OR-AND inverter	5
F436	2-wide 3-3-input OR-AND inverter	6
F454	4-wide 2-2-2-2-input OR-AND inverter	8
Clock Drivers		
FCK1	Clock driver (F/O = 360)	40
FCK2	Clock driver (F/O = 720)	80
FCK3	Clock driver (F/O = 1080)	120
FCK4	Clock driver (F/O = 1440)	160
FCK5	Clock driver (F/O = 1800)	200
Exclusive OR Functions		
F511	2-input Exclusive-OR	4
F512	2-input Exclusive-NOR	4
Parity Generators		
F581	8-bit odd parity generator	19
F582	8-bit even parity generator	19
Adders		
F521	1-bit full-adder	9
F523	4-bit binary full-adder	32
F526	Carry look-ahead generator	34
F527	4-bit full-adder	66
Miscellaneous		
F091	H, L level generator	1
F093	Interface block for oscillator buffer	1
Three-state Buffers		
F531	3-state buffer with enable	5
F532	3-state buffer with active low enable	5
Decoders		
F561	2-to-4 decoder	10
F981	2-to-4 decoder with active low enable	13
F982	3-to-8 decoder with active low enable	26
Multiplexers		
F569	8-to-1 multiplexer	18
F570	4-to-1 multiplexer	10
F571	2-to-1 multiplexer	6
F572	Quad 2-to-1 multiplexer	14

Note: Number of internal cells required is shown in parentheses.

Block Name	Description	Cells
Function Blocks – Normal Power (Cont.)		
Latches		
F595	R-S latch	5
F601	D-latch	6
F602	D-latch with reset	6
F603	D-latch with reset low	7
F604	D-latch with active low gate (G)	6
F605	D-latch with active low gate (G), reset low	7
F901	4-bit D-latch, buffered output	20
F902	8-bit D-latch, buffered output	38
Flip-Flops		
F596	Synchronous R-S F/F with set-reset	11
F611	D-F/F	8
F614	D-F/F with set-reset	10
F615	D-F/F with reset low	9
F616	D-F/F with set low	9
F617	D-F/F with set-reset low	10
F631	D-F/F active low clock	8
F637	D-F/F active low clock with set-reset low	10
F641	D-F/F, buffered output	8
F644	D-F/F with set-reset, buffered output	10
F647	D-F/F with set-reset low, buffered output	10
F661	D-F/F active low clock, buffered output	8
F667	D-F/F active low clock with set-reset low, buffered output	10
F714	Toggle F/F with set-reset	9
F717	Toggle F/F with set-reset low	9
F737	Toggle low F/F with set-reset low	9
F744	Toggle F/F with set-reset, buffered output	9
F747	Toggle F/F with set-reset low, buffered output	9
F767	Toggle active low F/F with set-reset low, buffered output	9
F771	J-K F/F, buffered output	10
F774	J-K F/F with set-reset, buffered output	12
F777	J-K F/F with set-reset low, buffered output	12
F781	J-K F/F active low clock, buffered output	10
F787	J-K F/F active low clock with set-reset low, buffered output	12
F791	Toggle F/F with set-reset and toggle enable	12
F792	Toggle active low F/F with set-reset low and toggle enable low	12
F922	4-bit D-F/F with reset	33
F924	4-bit D-F/F	28
Shift Registers		
F911	4-bit shift register with reset	33
F912	4-bit serial/parallel shift register	35
F913	4-bit serial/parallel shift register with reset low	39
F914	4-bit shift register	28
F915	4-bit shift register w/direct load low, buffered output	44
Counters		
F961	4-bit synchronous binary up counter with reset low, load low, buffered output	52
F962	4-bit synchronous binary up counter with reset low	38
F963	4-bit presettable synchronous up/down binary counter (dual clock with clear)	72
F964	4-bit presettable synchronous up/down binary counter	86

Block Name	Description	Cells
Function Blocks – Normal Power (Cont.)		
Comparator		
F985	4-bit magnitude comparator	32
Scan		
S000	Scan path D-F/F with set-reset	11
S002	Scan path D-F/F	9
S050	Scan path D-F/F with set-reset, hold	14
S052	Scan path D-F/F with hold	12
S100	Scan path J-K F/F with set-reset	14
S102	Scan path J-K F/F	12
S150	Scan path J-K F/F with set-reset, hold	17
S152	Scan path J-K F/F with hold	15
S201	Scan path D-latch with reset	12
S202	Scan path D-latch	11
S301	Scan path D-latch with reset	8
S302	Scan path D-latch	7
S999	Scan path 2-to-1 data selector	4
Delays		
F130	Delay block (for monostable multivibrator)	8
F131	Delay gate	6
F132	Delay gate	1
Function Blocks – Low Power		
Inverter		
L101	Inverter	1
Buffer		
L111	Non-inverting buffer	1
NOR Gates		
L202	2-input NOR	1
L203	3-input NOR	2
L204	4-input NOR	2
OR Gates		
L212	2-input OR	2
L213	3-input OR	2
L214	4-input OR	3
NAND Gates		
L302	2-input NAND	1
L303	3-input NAND	2
L304	4-input NAND	2
L305	5-input NAND	3
L306	6-input NAND	3
AND Gates		
L312	2-input AND	2
L313	3-input AND	2
L314	4-input AND	3
AND-NOR Gates		
L421	2-wide 1-2-input AND-OR inverter	2
L422	3-wide 1-1-2-input AND-OR inverter	2
L423	2-wide 1-3-input AND-OR inverter	2
L424	2-wide 2-2-input AND-OR inverter	2

Block Name	Description	Cells
Function Blocks – Low Power (Cont.)		
AND-NOR Gates		
L425	3-wide 2-2-2-input AND-OR inverter	3
L426	2-wide 3-3-input AND-OR inverter	3
L429	4-wide 2-2-2-2-input AND-OR inverter	4
L442	2-wide 4-4-input AND-OR inverter	4
L462	3-wide 1-2-3-input AND-OR inverter	3
OR-NAND Gates		
L431	2-wide 1-2-input OR-AND inverter	2
L432	3-wide 1-1-2-input OR-AND inverter	2
L433	2-wide 1-3-input OR-AND inverter	2
L434	2-wide 2-2-input OR-AND inverter	2
L435	2-wide 2-3-input OR-AND inverter	3
L436	2-wide 3-3-input OR-AND inverter	3
L454	4-wide 2-2-2-2-input OR-AND inverter	4
Exclusive OR Functions		
L511	2-input EX-OR	3
EX-NOR Gate		
L512	2-input EX-NOR	3
Decoders		
L561	2-to-4 decoder	6
L981	2-to-4 decoder with active low enable	8
L982	3-to-8 decoder with active low enable	17
Latches		
L601	D-latch	3
L602	D-latch with reset	4
L603	D-latch with reset low	4
L604	D-latch with active low gates (G)	3
L605	D-latch with active low gates (G), reset low	4
L901	4-bit latch	10
L902	8-bit latch	18
Flip-Flops		
L611	D-F/F	5
L614	D-F/F with set-reset	7
L617	D-F/F with set-reset low	7
L631	D-F/F with active low clock	5
L637	D-F/F with active low clock, set-reset low	7
L714	Toggle-F/F with set-reset	7
L717	Toggle-F/F with set-reset low	7
L737	Toggle active low F/F with set-reset low	7
L922	4-bit D-F/F with reset	23
L924	4-bit D-F/F	18
Multiplexer		
L571	2-to-1 multiplexer	6
L572	Quad 2-to-1 multiplexer	10
Shift Registers		
L911	4-bit shift register with reset	23
L912	4-bit serial/parallel shift register	23
L913	4-bit serial/parallel in shift register with reset low	27
L914	4-bit shift register	18

Block	Description	Basic RAM	BIST	Cells
RAM Memory Blocks				
High-Speed Basic RAM Blocks - Hard Macros				
KD49	Single-port RAM (32 word x 4 bit)	—	—	578
KD8B	Single-port RAM (64 word x 8 bit)	—	—	1712
KD8F	Single-port RAM (256 word x 8 bit)	—	—	6070
KDAB	Single-port RAM (64 word x 10 bit)	—	—	2020
KDAF	Single-port RAM (256 word x 10 bit)	—	—	7292
KE49	Dual-port RAM (32 word x 4 bit)	—	—	798
KE87	Dual-port RAM (16 word x 8 bit)	—	—	634
KE8B	Dual-port RAM (64 word x 8 bit)	—	—	2178
KE8F	Dual-port RAM (256 word x 8 bit)	—	—	6408
KEAB	Dual-port RAM (64 word x 10 bit)	—	—	2486
KEAF	Dual-port RAM (256 word x 10 bit)	—	—	7630
KE9H	Dual-port RAM (512 word x 9 bit)	—	—	12682
High-Speed Single Port RAM Blocks - Soft Macros				
RJ49	Single-port RAM (32 word x 4 bit)	KD49	RU49	782
RJ4B	Single-port RAM (64 word x 4 bit)	KD49	RU4B	1389
RJ4D	Single-port RAM (128 word x 4 bit)	KD49	RU4D	2572
RJ4F	Single-port RAM (256 word x 4 bit)	KD49	RU4F	4940
RJ89	Single-port RAM (32 word x 8 bit)	KD49	RU89	1382
RJ8B	Single-port RAM (64 word x 8 bit)	KD8B	RU8B	1964
RJ8D	Single-port RAM (128 word x 8 bit)	KD8B	RU8D	3712
RJ8F	Single-port RAM (256 word x 8 bit)	KD8B	RU8F	6354
RJ8H	Single-port RAM (512 word x 8 bit)	KD8B	RU8H	12460
RJAB	Single-port RAM (64 word x 10 bit)	KDAB	RUAB	2290
RJAD	Single-port RAM (128 word x 10 bit)	KDAB	RUAD	4350
RJAF	Single-port RAM (256 word x 10 bit)	KDAB	RUAF	7592
RJAH	Single-port RAM (512 word x 10 bit)	KDAB	RUAH	14924
RJC9	Single-port RAM (32 word x 16 bit)	KD49	RUC9	2618
RJCB	Single-port RAM (64 word x 16 bit)	KD8B	RUCB	3746
RJCD	Single-port RAM (128 word x 16 bit)	KD8B	RUCD	7223
RJCF	Single-port RAM (256 word x 16 bit)	KD8B	RUCF	12493
RJEB	Single-port RAM (64 word x 20 bit)	KDAB	RUEB	4394
RJED	Single-port RAM (128 word x 20 bit)	KDAB	RUED	8494
RJEF	Single-port RAM (256 word x 20 bit)	KDAB	RUEF	14968
RJH9	Single-port RAM (32 word x 32 bit)	KD49	RUH9	5062
RJHB	Single-port RAM (64 word x 32 bit)	KD8B	RUHB	7303
RJHD	Single-port RAM (128 word x 32 bit)	KD8B	RUHD	14235
RJKB	Single-port RAM (64 word x 40 bit)	KDAB	RUKB	8399
RJKD	Single-port RAM (128 word x 40 bit)	KDAB	RUKD	16779
High-Speed Dual Port RAM Blocks - Soft Macros				
RK49	Dual-port RAM (32 word x 4 bit)	KE49	RU49	1029
RK4B	Dual-port RAM (64 word x 4 bit)	KE49	RU4B	1866
RK4D	Dual-port RAM (128 word x 4 bit)	KE49	RU4D	3502
RK4F	Dual-port RAM (256 word x 4 bit)	KE49	RU4F	6768
RK87	Dual-port RAM (16 word x 8 bit)	KE87	RU87	885
RK89	Dual-port RAM (32 word x 8 bit)	KE49	RU89	1860
RK8B	Dual-port RAM (64 word x 8 bit)	KE8B	RU8B	2463
RK8D	Dual-port RAM (128 word x 8 bit)	KE8B	RU8D	4687
RK8F	Dual-port RAM (256 word x 8 bit)	KE8F	RU8F	6733
RK8H	Dual-port RAM (512 word x 8 bit)	KE8F	RU8H	13187
RKAB	Dual-port RAM (64 word x 10 bit)	KEAB	RUAB	2787
RKAD	Dual-port RAM (128 word x 10 bit)	KEAB	RUAD	5323
RKAF	Dual-port RAM (256 word x 10 bit)	KEAF	RUAF	7971
RKAH	Dual-port RAM (512 word x 10 bit)	KEAF	RUAH	15651

Block	Description	Basic RAM	BIST	Cells
Memory Blocks (Cont.)				
High-Speed RAM Blocks - Soft Macros (Cont.)				
RKC9	Dual-port RAM (32 word x 16 bit)	KE49	RUC9	3524
RKCB	Dual-port RAM (64 word x 16 bit)	KE8B	RUCB	4709
RKCD	Dual-port RAM (128 word x 16 bit)	KE8B	RUCD	9127
RKCF	Dual-port RAM (256 word x 16 bit)	KE8F	RUCF	13209
RKEB	Dual-port RAM (64 word x 20 bit)	KEAB	RUEB	5357
RKED	Dual-port RAM (128 word x 20 bit)	KEAB	RUED	10399
RKEF	Dual-port RAM (256 word x 20 bit)	KE49	RUH9	15256
RKH9	Dual-port RAM (32 word x 32 bit)	KE8B	RUHB	6849
RKHB	Dual-port RAM (64 word x 32 bit)	KE8B	RUHD	9198
RKHD	Dual-port RAM (128 word x 32 bit)	KE8B	RUHD	18004
RKKB	Dual-port RAM (64 word x 40 bit)	KEAB	RUKB	10494
RKKD	Dual-port RAM (128 word x 40 bit)	KEAB	RUKD	20548
High-Density Single-Port RAM Blocks - Soft Macros				
RB4D	Single-port RAM (128 word x 4 bit)	K14D	RU4D	1315
RB4F	Single-port RAM (256 word x 4 bit)	K14D	RU4F	2423
RB4H	Single-port RAM (512 word x 4 bit)	K14D	RU4H	4610
RB4M	Single-port RAM (1K word x 4 bit)	K14D	RU4M	8986
RB4S	Single-port RAM (2K word x 4 bit)	K14D	RU4S	17754
RB4U	Single-port RAM (4K word x 4 bit)	K14D	RU4U	35172
RB8D	Single-port RAM (128 word x 8 bit)	K14D	RU8D	2472
RB8F	Single-port RAM (256 word x 8 bit)	K18F	RU8F	3978
RB8H	Single-port RAM (512 word x 8 bit)	K18F	RU8H	7711
RB8M	Single-port RAM (1K word x 8 bit)	K18M	RU8M	12523
RB8S	Single-port RAM (2K word x 8 bit)	K18M	RU8S	24770
RBAF	Single-port RAM (256 word x 10 bit)	K1AF	RUAF	4877
RBAH	Single-port RAM (512 word x 10 bit)	K1AF	RUAH	9495
RBAM	Single-port RAM (1K word x 10 bit)	K1AM	RUAM	15499
RBAS	Single-port RAM (2K word x 10 bit)	K1AM	RUAS	30710
RBCD	Single-port RAM (128 word x 16 bit)	K14D	RUCD	4657
RBCF	Single-port RAM (256 word x 16 bit)	K18F	RUCF	7744
RBCH	Single-port RAM (512 word x 16 bit)	K18F	RUCH	15188
RBCM	Single-port RAM (1K word x 16 bit)	K18M	RUCM	24801
RBEF	Single-port RAM (256 word x 20 bit)	K1AF	RUEF	9539
RBEH	Single-port RAM (512 word x 20 bit)	K1AF	RUEH	18756
RBEM	Single-port RAM (1K word x 20 bit)	K1AM	RUHM	30754
RBHD	Single-port RAM (128 word x 32 bit)	K14D	RUHD	9109
RBHF	Single-port RAM (256 word x 32 bit)	K18F	RUHF	15268
RBHH	Single-port RAM (512 word x 32 bit)	K18F	RUHH	30137
RBKF	Single-port RAM (256 word x 40 bit)	K1AF	RUKF	18861
RBKH	Single-port RAM (512 word x 40 bit)	K1AF	RUKH	37273

Block	Description	Cells
ROM Memory Blocks		
ROM Blocks		
J14D	128 word x 4 bit ROM	720
J14F	256 word x 4 bit ROM	1040
J14H	512 word x 4 bit ROM	1512
J14M	1K word x 4 bit ROM	2408
J14S	2K word x 4 bit ROM	3960
J14U	4K word x 4 bit ROM	6776
J18D	128 word x 8 bit ROM	1040
J18F	256 word x 8 bit ROM	1456
J18H	512 word x 8 bit ROM	2352
J18M	1K word x 8 bit ROM	3784
J18S	2K word x 8 bit ROM	6600
J18U	4K word x 8 bit ROM	11704
J18W	8K word x 8 bit ROM	21584
J1CD	128 word x 16 bit ROM	1456
J1CF	256 word x 16 bit ROM	2352
J1CH	512 word x 16 bit ROM	3696
J1CM	1K word x 16 bit ROM	6512
J1CS	2K word x 16 bit ROM	11400
J1CU	4K word x 16 bit ROM	21280
J1HF	256 word x 32 bit ROM	3696
J1HH	512 word x 32 bit ROM	6512
J1HM	1K word x 32 bit ROM	11248
J1HS	2K word x 32 bit ROM	21128
RAM Test (BIST)		
RU49	32 word x 4 bit	
RU4B	64 word x 4 bit	
RU4D	128 word x 4 bit	
RU4F	256 word x 4 bit	
RU87	16 word x 8 bit	
RU89	32 word x 8 bit	
RU8B	64 word x 8 bit	
RU8D	128 word x 8 bit	
RU8F	256 word x 8 bit	
RU8H	512 word x 8 bit	
RUAB	64 word x 10 bit	
RUAD	128 word x 10 bit	
RUAF	256 word x 10 bit	
RUAH	512 word x 10 bit	
RUC9	32 word x 16 bit	
RUCB	64 word x 16 bit	
RUCD	128 word x 16 bit	
RUCF	256 word x 16 bit	
RUEB	64 word x 20 bit	
RUED	128 word x 20 bit	
RUEF	256 word x 20 bit	
RUH9	32 word x 32 bit	
RUHB	64 word x 32 bit	
RUHD	128 word x 32 bit	
RUKB	64 word x 40 bit	
RUKD	128 word x 40 bit	

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