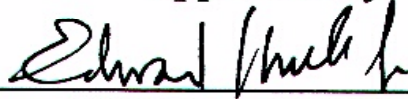


# UMC 0.18 $\mu\text{m}$ CMOS 1Poly4Metal Wafer Fab Process Qualification Report

*Built In Reliability*

# Reliability By Design

*Approved by:*



---

*Edward J. Mello Jr., Director, Quality Systems*



---

*Alex Hui, President and CEO*

**INDEX:**

<b>Commitment To Quality:</b>	<b>Page 4</b>
<b><u>Product Family:</u></b>	
<b>Wafer Fab Process:</b>	<b>Page 5</b>
<b>Wafer Fab Supplier:</b>	<b>Page 5</b>
<b>Assembly Subcontractor</b>	<b>Page 5</b>
<b>Product Group:</b>	<b>Page 5</b>
<b>Product Part Numbers &amp; Descriptions (Table 1):</b>	<b>Page 5</b>
<b>Package Type Codes (Table 2):</b>	<b>Page 6</b>
<b><u>Product Information:</u></b>	
<b>PCI Express (Figure [1]):</b>	<b>Page 7</b>
<b><u>Reliability Testing Methodology:</u></b>	
<b>Reliability Process Qualification Tests:</b>	<b>Page 8</b>
<b>JEDEC Standard (Table 3):</b>	<b>Page 8</b>
<b>Test Condition (Table 4):</b>	<b>Page 8</b>
<b><u>Process/Design Test Data:</u></b>	
<b>Latch-Up Test Data (Table 5):</b>	<b>Page 9</b>
<b>ESD Test Data (Table 6):</b>	<b>Page 9</b>
<b>Failure Rate Summary (Table 7)</b>	<b>Page 10</b>
<b>Dynamic High Temperature Operating Life (DHTOL)(Table 8):</b>	<b>Page 11</b>
<b>High Temperature Storage Test Data (HTSL) (Table 9):</b>	<b>Page 11</b>
<b>Temperature Cycle Test (TMCL) (Table 10):</b>	<b>Page 11</b>
<b>Un-biased Highly Accelerated Stress Testing (UHAST) (Table 11):</b>	<b>Page 11</b>

## COMMITMENT TO QUALITY:

Pericom supports the Quality Systems and Management concepts of the ISO-9000 series of international standards for Quality. A corporate Quality Policy (detailed below) has been established as the basis of our commitment to maintain a world-class quality supplier status. Adhering to this policy is required for *all* employees, as Quality is not the responsibility of any one person or group; each and every employee shares it.

In recognition of our commitment, Pericom completed an ISO-9001 Registration Assessment Audit with Underwriter's Laboratories (UL), and Certificate Registration File Number A3151 was issued on March 27, 1995. We have successfully passed all Reassessment Audits since that time, and our Certificate is available for review on the Pericom website. For customers requiring Pericom's Commercial and Government Entity (CAGE) identification, our assigned code is 06MQ5

### *Quality Policy:*

***Pericom will deliver products and services that conform to customer requirements. We shall perform each job correctly the first time, emphasizing constant improvement in the quality of our work.***


*"Pericom will deliver..."* - delivery, not just intentions, is one of the key measures of Pericom's commitment to deliver a quality product to customers.

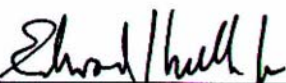
*"...products and services..."* - quality performance is not limited to physical products; sending a letter without spelling errors, or promptly and politely answering a telephone are services which demand our best quality.

*"...that conform to customer requirements."* - a clear understanding of all requirements are needed *before* one can deliver quality products or services. This also signifies mutual agreement, with clear, two-way communications, which applies to customers within as well as outside the company. The entire Pericom team understands that each customer has a set of requirements and expectations that must be met.

*"We shall perform each job correctly the first time, ..."* - doing jobs correctly the first time means meeting agreements, that quality improvement measures are driven to determine the source of defects and preventing those defects from reoccurring. The continual *process* of preventing defects will drive down the costs we and our customer's experience, because costs associated with rework, redesign, etc. are dollars taken from being price competitive.

*"...emphasizing constant improvement in the quality of our work."* - each employee shall strive to find better, faster, more economical ways to perform their job, to ensure that quality continues to improve along with cost effectiveness.

  
\_\_\_\_\_  
Alex Hui  
President and CEO

  
\_\_\_\_\_  
Edward J. Mello, Jr.  
Director, Quality Systems

# PERICOM PRODUCT FAMILY AND WAFER FAB PROCESS

The Pericom product data presented in this report qualifies the following products from a marketing defined product family manufactured on the following wafer fab process:

**Product Family:** *PCI-Express Signal Re-Driver*  
**Wafer Fab Process:** *0.18µm, 1.8V, Single-Poly Quadruple-Metal CMOS*  
**Wafer Supplier:** *UMC (United Microelectronics Corp.), Taiwan*  
**Assembly Subcontractor:** *NS Electronics Bangkok (NSEB), Thailand*  
*Orient Semiconductor Electronics (OSE), Taiwan*  
**Product Group:** *PCI-Express Signal Re-Driver*

**Table 1: List of Devices**

Part Number* <sup>1</sup>	Product Description	Solder Balls	Packages* <sup>2</sup>
PI2EQX4402NBE* <sup>3</sup>	2.5 Gbps x2 Lane Serial PCI-Express Repeater/Equalizer	84	Pb-Free & Green LFBGA
PI2EQX4402NB	2.5 Gbps x2 Lane Serial PCI-Express Repeater/Equalizer	84	LFBGA
PI2EQX4401ZFE* <sup>3</sup>	2.5 Gbps x1 Lane Serial PCI-Express Repeater/Equalizer with Clock Buffer	36	Pb-Free & Green TQFN

Note:

Part Number: 'E' indicate Pb-free & Green.

Datasheet: <http://www.pericom.com/products/logic/psempart.php?productID=PI2EQX4401>

## AVAILABLE PACKAGE TYPE CODES

**Table 2: List of Packages**

CODE	TYPE	PACKAGE INFORMATION
NB	84-Ball LFBGA	<a href="http://www.pericom.com/pdf/packaging/NB84.pdf">http://www.pericom.com/pdf/packaging/NB84.pdf</a>
NBE	Pb-Free & Green 84-Ball LFBGA	<a href="http://www.pericom.com/pdf/packaging/NB84.pdf">http://www.pericom.com/pdf/packaging/NB84.pdf</a>
ZFE	Pb-Free & Green 36-Pad TQFN	<a href="http://www.pericom.com/pdf/packaging/ZF36.pdf">http://www.pericom.com/pdf/packaging/ZF36.pdf</a>

## PERICOM RELIABILITY TESTING METHODOLOGY

*Pericom employs a commonly used industry method to generically qualify product. It is based on the premise that if one product of a specific wafer fab/package assembly process/materials is already qualified, then a second product that has similar design, manufacturing process, and materials can be qualified by extending the data used to qualify the first product to the second product without generating additional data. This methodology allows the ability to benchmark suppliers to ensure continuous process improvements and minimize cost and time required for new product availability.*

*The basis of this “qualification by similarity or extension” is the following rules:*

*A. For Wafer Fabrication Process and Materials:*

- i) The wafer fabrication process technology and location are the same or similar*
- ii) The die array design rules and die size are the same or similar*
- iii) The standard and customized cell design and layout rules are the same or similar*
- iv) The density and complexity are the same or similar*
- v) The wafer fabrication materials are the same or similar*

*B. For Package Assembly Process and Materials:*

- i) The package assembly process technology and location are the same or similar*
- ii) The die paddle to package aspect ratio is the same or smaller*
- iii) The package dimensions width and thickness dimensions are the same or similar*
- iv) The leadframe/substrate design and lead/ball pitch are the same or similar*
- v) The package assembly materials are the same or similar*

*Where a product of interest is not sampled during this period, it is valid to use the reliability data of the particular process technology or package type family to which the part belongs. All parts within the same family are designed to the same rules, and manufacturing is controlled by SPC. Within a product family, a device can only be fabricated on one process technology/ option, and only assembled on one package type process.*

## Product Information

For further information on PCI Express Re-Driver, products refer to Pericom website.

The screenshot shows the Pericom website interface in Microsoft Internet Explorer. The browser's address bar displays the URL: <http://www.pericom.com/products/logic/family.php?familyID=26>. The website header features the Pericom logo and navigation links for Products, Design Resources, Investors, Corporate, and Contact. A search bar is located in the top right corner. Below the navigation menu, there is a banner with the text "You are not logged in [Login] [Register]". The main content area is titled "Logic Device Listing: EQX" and includes two links: "back to Products Overview" and "back to Logic Overview". A table lists two product entries:

Part No.	Description	Drive	Prop Delay	Speed Grade	IO Tol.	Bus Hold	Pins	Voltage	Function	PbFree	Package
<a href="#">PI2EQX4401</a>	Dual Differential PCI-Express Signal Re-Driver	0:6.5dB	0.0	n/a	YES	n/a	36	1.8V (nominal)	PCI Express Re-Driver	Yes	TQFN (ZF36)
<a href="#">PI2EQX4402</a>	Quad Differential PCI-Express Signal Re-Driver	0:6.5dB	0.0	n/a	YES	n/a	84	1.8V (nominal)	PCI Express Re-Driver	Yes	LFPGA (NB84)

At the bottom of the page, there is a section titled "Complete Interface Solution" with links for "products", "quality", "applications", and "investor". The footer contains links for "terms and conditions", "copyright", and "privacy". The browser's taskbar shows the Office application and the Internet Explorer icon.

Figure [1]: Pericom Website: <http://www.pericom.com/products/logic/family.php?familyID=26>

## Reliability Process Qualification Tests

**Table 3 – JEDEC Standard**

PERICOM RELIABILITY TEST DESCRIPTION (ALTERNATIVE NAME)	PERICOM TEST CODE	EIA JEDEC STANDARD
Latch-Up Sensitivity	LU	JESD78
Electrostatic Discharge (ESD) Sensitivity Testing Human Body Model (HBM)	ESD – HBM	JESD22-A114-C
Electrostatic Discharge (ESD) Sensitivity Testing Machine Model (MM)	ESD – MM	JESD22-115-A
Temperature, Bias, and Operating Life (Dynamic High Temperature Operating Life)	DHTOL	JESD22-A108C
High Temperature Storage Life (Bake)	HTSL	JESD22-A103C
Unbiased Highly Accelerated Stress Testing	UHAST	JESD22-A118
Temperature Cycle Test	TMCL	JESD22-A104A

**Table 4 – Test Condition**

PERICOM Test Code (Refer to Table 3)	TEST Condition (Temp., Voltage, Cycles, Humidity, Time, Pressure)	Total Quantity/Number of Rejects (Number of Lots)	Amplitude or Duration Stress
LU	25°C	6/0 (1 lot)	≥200mA/ 2.0 V
ESD-HBM	25°C	3/0 (1 lot)	≥4000V(HBM)
ESD-MM	25°C	3/0 (1 lot)	≥300V(MM)
DHTOL	Temperature=150°C Voltage = 1.9 V (min. Bias: Vcc+10%)	135/0 (2 lots)	168, 500, 1000 Hrs. (Cumulative)
HTSL	150°C (no bias)	46/0 (3 lots)	168, 1000 Hrs. (Cumulative)
TMCL	Condition C T <sub>a</sub> = -65°C to +150°C 10 min dwell Cycles = 100 & 500 (Cumulative)	76/0 (4 lots)	100 & 500 Cycles (Cumulative)
UHAST	T <sub>a</sub> = 130°C RH= 85% P= 33.3 PSIG Voltage=0 V Time=96 hours	45/0 (2 lots)	96 Hrs.

# Process Latch-Up & ESD Characterization Data

## *Latch-Up Test (LU)*

*UMC, 0.18 $\mu$ m 1P4M 1.8V CMOS Process*

**Table 5 – Latch-Up**

<i>Test</i>	<i>Device</i>	<i>Date Code</i>	<i>SS</i>	<i>Rej.</i>	<i>V<sub>cc</sub><sub>max</sub></i>	<i>T<sub>a</sub></i>	<i>Remarks</i>
LU	PI2EQX4401	0533	6	0	2.0V	25°C	JESD78

## *ESD Test (ESD)*

*Human Body Model (HBM)*

*Machine Model (MM)*

*UMC, 0.18 $\mu$ m 1P4M 1.8V CMOS Process*

**Table 6 – ESD**

<i>Test</i>	<i>Device</i>	<i>Date Code</i>	<i>SS</i>	<i>Rej.</i>	<i>V<sub>min</sub></i>	<i>T<sub>a</sub></i>	<i>Remarks</i>
ESD-HBM	PI2EQX4401	0533	3	0	4000V	25°C	JESD22-A114-C
ESD-MM	PI2EQX4401	0533	3	0	300V	25°C	JESD22-115-A

# Process High Temperature Biased & Storage Die Life Test Data

## Temperature, Bias, and Operating Life (Dynamic High Temperature Operating Life) (*DHTOL*)

### Reliability Failure Rate Summary

**Table 7 – FIT & MTBF**

Reliability Stress Test	REL Lot #	Devices Tested	Hours Tested	Device Hours	Number of Fails	Activation Energy (E <sub>A</sub> ) (ev)
<b>DHTOL</b>	QDU05004-1A	135	1000	135,000	0	0.5
Process Average	→	135	1000	135,000	0	0.5
<b>FIT</b>	→	→	→	→	→	<i>114.7</i>
<b>MTBF / MTTF<sup>1</sup></b>	→	→	→	→	→	<i>8,719,908 Hrs.</i>

### NOTES ON TABLE ABOVE AND ACCELERATION FACTORS:

1. *MTBF / MTTF* = Mean Time Between/To Failure = 1/*F<sub>r</sub>* (*F<sub>r</sub>* ≥ 1)
2. *PPM* = parts per million = 10<sup>-6</sup>
3. *FIT* = Failures In Time = *F<sub>r</sub>* × 10<sup>9</sup>
4. *F<sub>r</sub>* = Failure rate (% reject per 1000 hours) = *F<sub>r</sub>* × 10<sup>5</sup> =  $\chi^2(x, \nu)/2 Ndt$
5.  $\chi^2$  = Chi-squared value
6. *x* = (1-CL) where CL = confidence level = 60%
7.  $\nu$  = (2N+2) = degrees of freedom where N is the number of rejects
8. *Ndt* = the equivalent device hours = device hours × AF
9. *Device hours* = devices tested × hours tested
10. *AF* = Acceleration Factor:
  - Arrhenius equation for accelerated temperature (*A<sub>t</sub>*):  $A_t = \exp\{-E_A/k(1/T_2 - 1/T_1)\}$
  - Arrhenius equation for accelerated voltage (*A<sub>v</sub>*):  $A_v = \exp\{C(V_S - V_o)\}$
11. *A<sub>t</sub>* = thermal acceleration Factor
12. *A<sub>v</sub>* = voltage acceleration Factor
13. *E<sub>A</sub>* = average thermal activation energy for expected failure mechanisms = 0.5 eV
14. *k* = Boltzmann's constant = 8.62 × 10<sup>-5</sup> eV/°K
15. *T<sub>1</sub>* = life test operating temperature
16. *T<sub>2</sub>* = system use operating temperature = 55°C
17. *C* = constant that is a function of the dielectric thickness (*t<sub>ox</sub>*) = *t<sub>ox</sub>*/100
18. *V<sub>s</sub>* = life test operating voltage
19. *V<sub>o</sub>* = system use operating voltage

## ***Dynamic High Temperature Operating Life Test (DHTOL)***

*UMC, 0.18 $\mu$ m 1P4M 1.8V CMOS Process*

**Table 8 – DHTOL**

<b><i>Lot #</i></b>	<b><i>Device</i></b>	<b><i>Date Code</i></b>	<b><i>SS</i></b>	<b><i>Rej.</i></b>	<b><i>Hours</i></b>	<b><i>T<sub>a</sub></i></b>	<b><i>Remarks</i></b>
QDU05004-1A	PI2EQX4401	0533	135	0	1000	150°C	Vcc = 1.9 Volts

## ***High Temperature Storage Life Test (HTSL)***

*UMC, 0.18 $\mu$ m 1P4M 1.8V CMOS Process*

**Table 9 – HTSL**

<b><i>Lot #</i></b>	<b><i>Device</i></b>	<b><i>Date Code</i></b>	<b><i>SS</i></b>	<b><i>Rej.</i></b>	<b><i>Hours</i></b>	<b><i>T<sub>a</sub></i></b>	<b><i>Remarks</i></b>
QDU05004-1B	PI2EQX4401	0533	46	0	1000	150°C	No Bias

## ***Temperature Cycle Test (TMCL)***

*UMC, 0.18 $\mu$ m 1P4M 1.8V CMOS Process*

**Table 10 – TMCL**

<b><i>Lot #</i></b>	<b><i>Device</i></b>	<b><i>Package</i></b>	<b><i>Date Code</i></b>	<b><i>SS</i></b>	<b><i>Rej.</i></b>	<b><i>Cycles</i></b>	<b><i>T<sub>a</sub></i></b>	<b><i>Remarks</i></b>
QDU05004-1C	PI2EQX4401ZFE	ZF-36	0533	76	0	500	-65°C to +150°C	

## ***Un-biased Highly Accelerated Stress Testing (UHASt)***

*UMC, 0.18 $\mu$ m 1P4M 1.8V CMOS Process*

**Table 11 – UHASt**

<b><i>Lot #</i></b>	<b><i>Device</i></b>	<b><i>Package</i></b>	<b><i>Date Code</i></b>	<b><i>SS</i></b>	<b><i>Rej.</i></b>	<b><i>Hours</i></b>	<b><i>T<sub>a</sub></i></b>	<b><i>Remarks</i></b>
QDU05004-1D	PI2EQX4401ZFE	ZF-36	0533	45	0	96	130°C	RH= 85% P= 33.3 PSIG Voltage=0 V