

## *Self Qualification Results*

*NiPdAu lead-free solution of*

*TSSOP14 assembled at subcon NS Electronics Bangkok.*

---

Author: ***Rob de Heus***  
Sr. Project Leader Advanced Development  
ATO Innovation  
Philips Semiconductors Nijmegen  
Building BY-1.052  
Gerstweg 2, 6534 AE Nijmegen, the Netherlands

Tel: +31-243534835  
Tel: +31-243533085  
Fax: +31-243533350  
E-mail: *rob.de.heus@philips.com*

Issue Date: *September 13th, 2004*

Assembly & Test Organization Philips Semiconductors	<b>Self Qualification Results: NiPdAu TSSOP14 at NSEB</b>	Document Number RNR-83-04/RdH/RdH-2070
--	---	---

## Table of Contents

<b>1. Introduction</b> .....	3
<b>2. Assembly Facility</b> .....	3
<b>3. Materials selection background</b> .....	4
<b>4. Constructional Details of Test vehicles</b> .....	4
<b>5. Reliability Test Program</b> .....	5
<b>5.1 Reliability Test Descriptions</b> .....	5
<b>5.2 Construction Analysis Tests Descriptions</b> .....	6
<b>5.3 Summary of Solder Joint Reliability Tests for lead-free, leadframe based packages.</b> .....	7
<b>5.4 Self-qualification results NiPdAu packages</b> .....	8
<b>6. Conclusion</b> .....	9
<b>7. Implementation</b> .....	9
<b>8. Document Revision Sheet</b> .....	9

Assembly & Test Organization Philips Semiconductors	<b>Self Qualification Results: NiPdAu TSSOP14 at NSEB</b>	Document Number RNR-83-04/RdH/RdH-2070
--	---	---

## 1. Introduction

The intention of the change to lead-free IC packages from Philips has been announced in the Advance CPCN for Pb-free, issued in May 2003, CPCN # 200305025.

The final CPCN will be issued in different phases, each phase showing qualification results of a certain group of packages.

This self qualification report presents an overview of the qualification data completed to release the following packages in NiPdAu :

- TSSOP14 assembled at subcon NS Electronics Bangkok.

In order to validate assembly quality and reliability, a self-qualification program has been performed for above mentioned packages.

The results of this qualification demonstrate that Philips Semiconductors can achieve distinctive assembly quality with equal or better product quality and reliability when compared to the lead-tin plated versions of these products.

With the introduction of NiPdAu as lead-free solution, the Bill of Materials (BoM) of the mentioned packages is fully compliant to the RoHS legislation requirements.

## 2. Assembly Facility

### *NSEB*

NS Electronics Bangkok (NSEB) facility has been operated in Bangkok since 1973 under the flag of National Semiconductors and operates as an independent Assembly and Test subcontractor since 1993. Presently NSEB employs approximately 2,800 employees. The building has a total floor space of 180,000 square feet. NSEB is capable in assembly and test of a wide range of IC packages, which include DIP, SO, SSOP, TSSOP and PLCC packages.

NSEB obtained ISO9002 in 1994 and ISO14001 in 1998 and is certified SAC level 1.

### 3. Materials selection background

#### NiPdAu pre-plated leadframes

main characteristics :

- good solderability with lead-containing and lead free solders
- good solder joint reliability
- used in high volume
- offered by major lead frame suppliers
- non whisker-sensitive technology

### 4. Constructional Details of Test vehicles

Lot	NSEB-6-04	NSEB-6-05	NSEB-6-06
Assy Site	NSEB	NSEB	NSEB
Package / Pin	TSSOP14	TSSOP14	TSSOP14
Outline	SOT402-1	SOT402-1	SOT402-1
Moulding compound	MP8000	MP8000	MP8000
Die-Attach Adhesive	8390P	8390P	8390P
Pitch/ E or P	0.65/P	0.65/P	0.65/P
Die Pad Size (mm)	1.78x1.78	1.78x1.78	1.78x1.78
Die Size (mm)	0.49x0.61	0.49x0.61	0.49x0.61
Vehicle name	74LVC08APW	74LVC08APW	74LVC08APW
Subpack old	SOT402CA4	SOT402CA4	SOT402CA4

Assembly & Test Organization Philips Semiconductors	<b>Self Qualification Results: NiPdAu TSSOP14 at NSEB</b>	Document Number RNR-83-04/RdH/RdH-2070
--	---	---

## 5. Reliability Test Program

An extensive qualification program has been executed to demonstrate that NSEB can assemble lead-free NiPdAu packages with a high quality and reliability.

### 5.1 Reliability Test Descriptions

In this section the reliability tests are described in detail. These tests are stated in Philips Semiconductors' General Quality Specification (SNW-FQ-611) and the Plastic Package Qualification Guideline (SNW-FA-04-07). AEC\_Q100 is used as a guideline for specific automotive products.

#### *Pcon – Preconditioning*

SMD Qualification samples for PPOT, HAST/THBS and TMCL undergo SMD reflow preconditioning before reliability test is performed. This preconditioning is performed in accordance with the latest revision of the IPC/JEDEC J-STD-020B specification, as described in Philips Semiconductors specification SNW-FQ-225A. SMD Packages are preconditioned to the appropriate MSL level, peak temperature applied is 260°C.

#### *PPOT – Pressure Pot Test*

Pressure Pot Test – autoclave (121°C, 100%R.H., 96 hrs release time point), unbiased with Pcon. This test is particularly suitable to evaluate the moisture resistance of the package.

#### *HAST – Highly Accelerated Stress Test*

Highly Accelerated Stress Test (130°C/85% R.H., 96 hrs release time point), with electrical bias and Pcon. This test stresses both the electrical endurance of the design/process, as well as the resistance to moisture of the package.

#### *THBS – Temperature Humidity Bias Stress*

Temperature Humidity Bias Stress (85°C/85% R.H., 1000 hrs release time point), with electrical bias and Pcon. This test stresses both the electrical endurance of the design/process, as well as the resistance to moisture of the package. This test is sometimes done instead of HAST.

#### *TMCL – Temperature Cycling*

Temperature Cycling (air to air -65°C ⇔ +150°C, 500 cyc release point) with Pcon. This test is aimed at the mechanical integrity of the whole product, under the severe circumstances of rapid changes in temperature.

#### *HTSL – High Temperature Storage Life*

High Temperature Storage Life (150°C, 1000 hrs release time point). This test evaluates the reliability of the product after long term storage.

Assembly & Test Organization Philips Semiconductors	<b>Self Qualification Results: NiPdAu TSSOP14 at NSEB</b>	Document Number RNR-83-04/RdH/RdH-2070
--	---	---

## 5.2 Construction Analysis Tests Descriptions

In addition to the reliability evaluation, qualification lots will be subjected to Construction Analysis and Moisture Sensitivity Level assessment testing per the following test methods :

- Visual/Mechanical Inspection (V/M) SNW-FQ-612B
- Lead Finish Inspection (LFNH) Local document
- Moisture Sensitivity Level Assessment SNW-FQ-225B
- Solderability Inspection (SOLD) SNW-FQ-221
- X-Ray Inspection (X-RAY) SNW-FQ-312
- SCAT Inspection (SCAT) SNW-FQ-311
- Die Shear Testing (DISH) SNW-FQ-322
- Bond Pull Testing (BPT) SNW-FQ-322
- Bond Shear Testing (BST) SNW-FQ-322
- Cross Section Inspection (CROSS) SNW-FQ-314

Assembly & Test Organization Philips Semiconductors	<b>Self Qualification Results:</b> <b>NiPdAu TSSOP14 at NSEB</b>	Document Number RNR-83-04/RdH/RdH-2070
--	---	---

### 5.3 Summary of Solder Joint Reliability Tests for lead-free, leadframe based packages.

#### Variants included in the Investigation

- SMD packages with gull wing and J-leads (SO, VSO, QFP, PLCC.....)
- Lead frame material : Copper-alloy.
- Terminal finish : Matte Tin and NiPdAu.
- 2 layer FR4 board, (CE 5004)
- Reflow soldering : SnPb36Ag2 and SnAg 3.8Cu0.7
- Wave soldering with SnPb38Bi2 and SnAg3.8Cu0.7
- Temperature Cycling -40°C/125°C according to IEC60068-2-14.
- Electrical test (Daisy Chain) at around 2k intervals and visual inspection.

#### Conclusions

- No rejects up to 2000 cycles for all combinations.
- Mean time to failure over 6600 cycles except for HTQFP100.
- Reflow solder : No significant difference in failure times/fracture modes between SnPb paste and SnAgCu paste.
- Wave solder : No significant difference in failure times/fracture modes between SnPb solder and SnAgCu solder.
- High profile packages / lead forms show less degradation due to a better compliancy.

#### Remarks

- All package variants applied with lead-containing and lead-free soldering process
- Weibull graphs are shown in the E3 presentation which can be found on the Pb-free CPCN website : [http://www.semiconductors.philips.com/acrobat/other/green\\_roadmap/e3\\_presentation.pdf](http://www.semiconductors.philips.com/acrobat/other/green_roadmap/e3_presentation.pdf)

#### 5.4 Self-qualification results NiPdAu packages

**Table 1 : Reliability Tests Results**

Package	Lot No.	Device	PPOT			HAST			TMCL			HTSL	
			Pcon	<b>96 hrs</b>	192 hrs	pcon	<b>96 hrs</b>	192 hrs	Pcon	<b>200c</b>	500c	<b>1000h</b>	2000h
TSSOP14	NSEB-6-04	74LVC08APW	L1	0/77	0/77	L1	0/45	0/45	L1	0/77	0/77	0/77	0/77
TSSOP14	NSEB-6-05	74LVC08APW	L1	0/77	0/77	L1	-	-	L1	0/77	-	0/77	
TSSOP14	NSEB-6-06	74LVC08APW	L1	0/77	0/77	L1	-	-	L1	0/77	-	0/77	

Reliability qualification requirements time points are shown in **bold**, additional points are for engineering evaluation.

**Table 2 : Construction Analysis Tests Results**

Package	Lot No.	Device	Construction Analysis Tests								
			MSLA 260°C	V/M	LFNH	SOLD See note	XRAY	SCAT	DISH	BP/BS	CROSS
TSSOP14	NSEB-6-04	74LVC08APW	L1	0/15	0/9	4x 0/11	0/10	0/12	0/5		0/10
TSSOP14	NSEB-6-05	74LVC08APW	L1	0/15	0/9	4x 0/11	0/10	0/12	0/5		0/10
TSSOP14	NSEB-6-06	74LVC08APW	L1	0/15	0/9	4x 0/11	0/10	0/12	0/5		0/10

Note:

11 parts tested in SnPb solder after 8h steam age, 5 sec, 215 °C

11 parts tested in SnPb solder after 16h dry-bake, 5 sec, 215 °C

11 parts tested in SAC solder after 8h steam age, 3 sec, 245 °C

11 parts tested in SAC solder after 16h dry-bake, 3 sec, 245 °C

RMA flux used for all tests.

**Table 3 : Construction Analysis Tests, additional tests for automotive.**

Package	Lot No.	Device	Construction Analysis Tests Extended		
			BPT after TMCL 500c		
TSSOP14	NSEB-6-06	74LVC08APW	0/50 wires		

Assembly & Test Organization Philips Semiconductors	<b>Self Qualification Results:  NiPdAu TSSOP14 at NSEB</b>	Document Number RNR-83-04/RdH/RdH-2070
---	--	---

## 6. Conclusion

An extensive qualification program has been executed to demonstrate that NSEB can assemble TSSOP14 packages in NiPdAu pre-plated lead-frames at a high quality and reliability level.

With the positive completion of the Qualification tests, the Assembly and Test Organization Philips Semiconductors announces the release of NiPdAu pre-plated leadframes for use in TSSOP assembled in NSEB via final CPCN 20030525F supplement 4.

## 7. Implementation

Deliveries will start from December 2004 onwards.

## 8. Document Revision Sheet

R E V I S I O N   S H E E T			
DATE yyyy/mm/dd	REV	DESCRIPTION	AUTHOR
2004-09-13	01	Self Qualification Results phase 4c for Lead (Pb) free lead-finish of leadframe-based IC packages. TSSOP14 at NSEB.	Rob de Heus