

Self Qualification Results

NiPdAu lead-free solution of

- *SSOP24/28 assembled in Philips Semiconductors Thailand.*
 - *SSOP24/28 assembled in Philips Semiconductors Calamba.*
 - *TSSOP8 assembled at subcon NS Electronics Bangkok.*
 - *SO8 assembled at subcon NS Electronics Bangkok.*
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Assembly & Test Organization Philips Semiconductors	Self Qualification Results: NiPdAu SSOP24/28 at PST + PSC, and SO8/TSSOP8 at NSEB.	Document Number RNR-83-04/RdH/RdH-2086
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1. Introduction

The intention of the change to lead-free 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 :

- SSOP24/28 assembled in Philips Semiconductors Thailand.
- SSOP24/28 assembled in Philips Semiconductors Calamba.
- TSSOP8 assembled at subcon NS Electronics Bangkok
- SO8 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 Facilities

PST

Philips Semiconductors Thailand has been in operation in Bangkok Thailand since 1974. With a current workforce of approximately 3,800 personnel and its 60,000 square meter site, PST is capable of assembly and test of a wide range of DIP, SILP, SO, T/SSOP, IC Module and Contactless Module packages. Testing for QFP and PLCC is also available at PST.

PST obtained ISO9001 certification in 1991, ISO14001 certification and the internal Philips Quality Award (PQA-90) in 1996, and QS9000 certification in 1997. A strong emphasis on quality improvement programs has also resulted in PST receiving the Golden Pentastar Award from Chrysler Corporation. In August 2003, PST was ISO/TS 16949 2002 certified.

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PSC

Philips Semiconductors Calamba is a new, state-of-art facility for the assembly and testing of IC's located at the Light Industry and Science Park II in Calamba. The plant occupies an area of 85,000 square meters of land. Construction of the first phase with a floor area of 17,900 square meters was completed in 1998, while the second phase is already in construction.

Package family portfolio and test capabilities of PSC consists of SSOP/TSSOP, QFP, HVQFN and LF/TFBGA. Philips Semiconductors Calamba successfully passed certification to the QS9000 standard, while ISO 14001 certification was achieved in March 2000.

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

NiPdAu pre-plated leadframes are chosen as alternative lead-free solution and will be applied in SO, SSOP and TSSOP packages. Initially just for in-house assembly, later also at subcontractors delivering to Philips.

Untill subcontractors can offer NiPdAu, their packages will be in matte Sn.

In the long term roadmap, the part of NiPdAu might be increased to other families.

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4. Constructional Details of Test vehicles

Lot	PST-4-06	PST-4-07	PST-4-08	PST-4-09
Assy Site	PST	PST	PST	PST
Package / Pin	SSOP24	SSOP24	SSOP28	SSOP28
Outline	SOT340-1	SOT340-1	SOT341-1	SOT341-1
Moulding compound	MP8000	MP8000	MP8000	MP8000
Die-Attach Adhesive	8390P	8390P	8390P	8390P
Pitch/ E or P	0.65/P	0.65/P	0.65/P	0.65/E
Die Pad Size (mm)	2.70x3.50	3.65x4.50	3.90x5.10	3.50x3.50
Die Size (mm)	1.58x1.77	2.51x3.45	3.53 x 4.20	1.85x2.22
Vehicle name	74LVC823ADB	SAA1501TS/N3	P87C749EBDDBC	UBA2032TS/N2/S1
Subpack old	SOT340BC3	SOT340BC5	SOT341BE5	SOT341BE9

Lot	PST-4-10	PST-5-02	PST-5-03	PSC-4-01
Assy Site	PST	PST	PST	PSC
Package / Pin	SSOP28	SSOP56	SSOP56	SSOP20
Outline	SOT341-1	SOT371-1	SOT371-1	SOT339-1
Moulding compound	MP8000	MP8000	MP8000	MP8000
Die-Attach Adhesive	8390P	8390P	8390P	8390P
Pitch/ E or P	0.65 / P	0.65/P	0.65/P	0.65/P
Die Pad Size (mm)	3.90 x 6.60	2.60x4.00	2.60x4.00	2.40x2.70
Die Size (mm)	3.05 x 3.66	1.75x2.97	1.75x2.97	0.705x0.96
Vehicle name	P83C754EBDDDB	74ALVT16601DL	74ALVT16601DL	74HC574DB
Subpack old	SOT341BE6	SOT371DB3	SOT371DB3	SOT339DC3

Lot	PSC-4-02	PSC-4-05	PSC-4-06	PSC-4-07
Assy Site	PSC	PSC	PSC	PSC
Package / Pin	SSOP24	SSOP28	SSOP24	SSOP28
Outline	SOT340-1	SOT	SOT340-1	SOT341-1
Moulding compound	MP8000	MP8000	MP8000	MP8000
Die-Attach Adhesive	8390P	8390P	8390P	8390P
Pitch/ E or P	0.65/P	0.65/P	0.65/P	0.65/P
Die Pad Size (mm)	2.70x3.50	3.50x3.50	3.65x4.50	3.9 x 5.10
Die Size (mm)	2.52x1.85	1.68 x 1.85	2.56x2.83	2.09 x 2.11
Vehicle name	TDA5737M/C1	TDA6503ATS/C1	TDA8003TS/C2	UDA1352TS/N3
Subpack old	SOT340CC3	SOT314CE4	SOT340CC5	SOT341CE5

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Lot	NSEB-6-01	NSEB-6-02	NSEB-6-03
Assy Site	NSEB	NSEB	NSEB
Package / Pin	TSSOP8	TSSOP8	TSSOP8
Outline	SOT530-1	SOT530-1	SOT530-1
Moulding compound	KMC184	KMC184	KMC184
Die-Attach Adhesive	8390P	8390P	8390P
Pitch/ E or P	0.65/P	0.65/P	0.65/P
Die Pad Size (mm)	3.00x2.00	3.00x2.00	3.00x2.00
Die Size (mm)	0.69x0.72	0.69x0.72	0.69x0.72
Vehicle name	CBTS3306PW	CBTS3306PW	CBTS3306PW
Subpack old	SOT530AA3	SOT530AA3	SOT530AA3

Lot	NSEB-3-01	NSEB-3-02	NSEB-3-03
Assy Site	NSEB	NSEB	NSEB
Package / Pin	SO8	SO8	SO8
Outline	SOT96-1	SOT96-1	SOT96-1
Moulding compound	6210	6210	6210
Die-Attach Adhesive	84-1LMISR4	84-1LMISR4	84-1LMISR4
Pitch/ E or P	1.27/P	1.27/P	1.27/P
Die Pad Size (mm)	2.03x2.03	2.03x2.03	2.03x2.03
Die Size (mm)	1.10x0.79	1.10x0.79	1.10x0.79
Vehicle name	NE532-M	NE532-M	NE532-M
Subpack old	SOT96AJ15	SOT96AJ15	SOT96AJ15

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5. Reliability Test Program

An extensive qualification program has been executed to demonstrate that PST and PSC 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 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 255-260°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.

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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
- 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
- Solderability Inspection (SOLD) SNW-FQ-221

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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 (mainly) and FeNi42 .
- Terminal finish : Matte Tin 100 , NiPdAu (only for Copper alloy)

- 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 FeNi based VSO56 and 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

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5.4 Self-qualification results NiPdAu packages

Table 1 : Reliability Tests Results

Package	Lot No.	Device	PPOT			HAST			TMCL			HTSL	
			Pcon	96 hrs	192 hrs	pcon	96 hrs	192 hrs	Pcon	200c	500c	1000h	2000h
SSOP24	PST-4-06	74LVC823ADB	L1	0/77	0/77	L1	0/45	0/45	L1	0/77	0/77	0/77	0/77
SSOP24	PST-4-07	SAA1501TS/N3	L1	0/77	-	-	-	-	L1	0/77	-	0/77	-
SSOP28	PST-4-08	P87C749EBDDBC	L3	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	0/77
SSOP28	PST-4-09	UBA2032TS/N2/S1	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	
SSOP28	PST-4-10	P83C754EBDDDB	L3	0/77	0/77	-	-	-	L3	0/77	0/77	0/77	
SSOP56	PST-5-02	74ALVT16601DL	L1	0/77	0/77	L1	0/45	0/45	L1	0/77	0/77	0/77	-
SSOP56	PST-5-03	74ALVT16601DL	L1	0/77	0/77	L1	0/45	0/45	L1	0/77	0/77	0/77	-
SSOP20	PSC-4-01	74HC574DB	L1	0/77	0/77	L1	0/45	0/45	L1	0/77	0/77	0/77	-
SSOP24	PSC-4-02	TDA5737M/C1	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	
SSOP28	PSC-4-05	TDA6503ATS/C1	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	
SSOP28	PSC-4-07	UDA1352TS/N3	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	
TSSOP8	NSEB-6-1	CBTS3306PW	L1	0/77	0/77	L1	0/45	-	L1	0/77	0/77	0/77	0/77
TSSOP8	NSEB-6-2	CBTS3306PW	L1	0/77	0/77	L1	0/45	-	L1	0/77	0/77	0/77	-
TSSOP8	NSEB-6-3	CBTS3306PW	L1	0/77	0/77	L1	0/45	-	L1	0/77	0/77	0/77	-
SO8	NSEB-3-01	NE532-M	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	-
SO8	NSEB-3-02	NE532-M	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	-
SO8	NSEB-3-03	NE532-M	L1	0/77	0/77	-	-	-	L1	0/77	0/77	0/77	-

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

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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
SSOP24	PST-4-06	74LVC823ADB	L1	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3
SSOP24	PST-4-07	SAA1501TS/N3	L1	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3
SSOP28	PST-4-08	P87C749EBDDBC	L3	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3
SSOP28	PST-4-09	UBA2032TS/N2/S1	L1	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3
SSOP24	PSC-4-02	TDA5737M/C1	L1	0/45	0/9	4x 0/11	0/22	0/22	0/3	0/3	0/3
SSOP28	PSC-4-05	TDA6503ATS/C1	L1	0/45	0/9	4x 0/11	0/22	0/22	0/3	0/3	0/3
SSOP24	PSC-4-06	TDA8003TS/C2	L1	-	-	-	-	-	-	-	-
SSOP28	PSC-4-07	UDA1352TS/N3	L1	0/45	0/9	4x 0/11	0/22	0/22	0/3	0/3	0/3
TSSOP8	NSEB-6-1	CBTS3306PW	L1	0/15	0/9	4x 0/11	0/10	0/12	0/5	0/7	0/10
TSSOP8	NSEB-6-2	CBTS3306PW	L1	0/15	0/9	4x 0/11	0/10	0/12	0/5	0/7	0/10
TSSOP8	NSEB-6-3	CBTS3306PW	L1	0/15	0/9	4x 0/11	0/10	0/12	0/5	0/7	0/10
SO8	NSEB-3-01	NE532-M	L1	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3
SO8	NSEB-3-02	NE532-M	L1	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3
SO8	NSEB-3-03	NE532-M	L1	0/15	0/9	4x 0/11	0/8	0/8	0/3	0/3	0/3

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.

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6. Conclusion

An extensive qualification program has been executed to demonstrate that PST and PSC can assemble SSOP24/28 packages in NiPdAu pre-plated lead-frames at a high quality and reliability level.

An extensive qualification program has been executed to demonstrate that NSEB can assemble SO8 / 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 SSOP24/28 assembled in PST+PSC, and SO8/TSSOP8 assembled at NSEB, via final CPCN 20030525F supplement 5.

7. Implementation

Deliveries will start from January 2005 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
2004-10-19	01	Self Qualification Results phase 6 for Lead (Pb) free lead-finish of leadframe-based IC packages. SSOP24/28 at PST and PSC, SO8/TSSOP8 at NSEB.	Rob de Heus