IMO Backend Innovation
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Self Qualification Results

TSSOP packages using:
- NiPdAu preplated frames
- Hysol QMI-519 die-attach
- Nitto GE7470 plastic

assembled at Philips Semiconductors Calamba

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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.

TSSOP packages have been qualified by using the original BOM of 8390 and MP8000.
However, due to the increased reflow temperatures as defined by J-STD 020C, for several TSSOP packages Philips observed MSL degradation to levels 3 or 4.
KMC184 was tested and also showed unacceptable MSL levels.

To restore these MSL levels, Philips has qualified the following new material set to be used in critical TSSOP packages :
This material set is Hysol QMI-519 die-attach in combination with Nitto GE7470 plastic.

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 above mentioned materials, these packages fully comply to the RoHS 2006 legislations and also fulfils the future legislation on banning of Halogenes and Antimony Oxides. Combination of the new die-attach glues and the new molding compounds improves the package quality, especially towards the higher reflow temperatures which are required for leadfree soldering.

2. Assembly Facilities

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.

3. Material details

3.1 Molding Compounds

Nitto GE7470 is a SiO_2 filled epoxy moulding compounds designed for improved JEDEC moisturizing performance and HTSL performance. In Table 1 the properties of Nitto 7470 are compared to the reference materials MP8000 and KMC184.

Table 1: Manufacturers Typical Properties of KMC184, MP8000 and Nitto GE7470

Molding Compound Properties	**Current Production KMC184 SHIN-ETSU**	**Current Production MP8000 NITTO**	**Planned Change GE7470 NITTO**
Resin type	epoxy cresol novalac	epoxy cresol novalac	hydrophobic epoxy resin
Hardener type	phenol novalac	phenol novalac	
Filler content (%)	81	75	89.5
Flame-retardant system	brominated epoxy + antimony oxide	brominated epoxy + antimony oxide	Magnesium hydroxide
Antimony oxide	yes	yes	No
T_g (ºC)	160	140	130
Specific gravity	1.89	1.88	2.00
α_1 (ppm/ºC)	13	16.1	9
α_2 (ppm/ºC)	59	64.7	34
Flexural strength @RT (N/mm^2)	120	140	187
Flexural modulus @RT (N/mm^2)	12300	12200	25000
Flexural strength @240ºC (N/mm^2)	16/17	20	15 @ 260ºC
Flexural modulus @240ºC (N/mm^2)	1200	1000	420 @ 260ºC
Dielectric Constant at 1MHz	3.9	3.8	3.6
Dissipation Factor at 1MHz	0.007	0.8	0.003
Volume Resistivity at 150ºC (Ωcm)	$3X10^{12}$	$7X10^{13}$	$0.5X10^{12}$
Thermal Conductivity (W/mK)	0.63	0.75	1.04
UL94-V0 Flammability	1/8"	1/8"	1/8”
Oxygen index	<35	38	
Polymer mass (%)	25	22	11.5

3.2 Die Attach Glues

Hysol QMI-519 is a silver filled die-attach glue, designed for improved JEDEC moisturizing performance. In Table 2 the properties of QMI-519 is compared to the reference materials Ablebond 84-1LMISR4 and Ablebond 8390.

Table 2: Manufacturers Typical Properties of Ablebond 84-LMISR4/8390 and Hysol QMI-519.

Die Attach Properties	**Current Production Ablebond 84-1LMISR4 ABLESTIK**	**Current Production Ablebond 8390 ABLESTIK**	**Planned Change QMI-519 HYSOL**
Adhesive Type	Epoxy	Epoxy	Epoxy
Filler	Silver	Silver	Silver
Viscosity @ 25°C	8,000 cps	9,800 cps	7,800 cps
Thixotropic Index	5.6	4.5	4.4
Volume Resistivity	0.0001 Ω-cm	0.002 Ω-cm	0.00007 Ω-cm
Thermal Conductivity @ 121°C	2.5 W/m°K	1.0 W/m°K	3.8 W/m°K
Glass Transition Temp	120°C	60°C	40 °C
Coefficient of Thermal Expansion - Below Tg - Above Tg	 40 ppm/°C 150 ppm/°C	 83 ppm/°C 165 ppm/°C	 20 ppm/°C 80 ppm/°C
Ionic Data - Chlorine - Sodium - Potassium	 < 5 ppm < 3 ppm < 1 ppm	 < 1 ppm < 3 ppm < 1 ppm	 < 20 ppm < 20 ppm < 20 ppm
Water Extract - Conductivity - pH	 13 µmhos/cm 6.0	 70 µmhos/cm 7.4	 --
Storage Life	1 year at –40°C	1 year at –40°C	1 year at –40°C

4. Constructional Details of Test vehicles

Lot	1	2	3
Assy Site	PSC	PSC	PSC
Package / Pin	TSSOP20	TSSOP20	TSSOP20
Outline	SOT360-1	SOT360-1	SOT360-1
Moulding compound	Nitto 7470	Nitto 7470	Nitto 7470
Die-Attach Adhesive	QMI-519	QMI-519	QMI-519
Pitch/ E or P	0.65 / P	0.65 / P	0.65 / P
Die Pad Size (mm)	2.75 x 4.00	2.75 x 4.00	2.75 x 4.00
Die Size (mm)	0.88 x 0.76	0.88 x 0.76	0.88 x 0.76
Vehicle name	74LVC574APW	74LVC574APW	74LVC574APW
Wire diameter (µm)	20	20	20

Lot	4	5	6
Assy Site	PSC	PSC	PSC
Package / Pin	TSSOP32	TSSOP32	TSSOP32
Outline	SOT487-1	SOT487-1	SOT487-1
Moulding compound	Nitto 7470	Nitto 7470	Nitto 7470
Die-Attach Adhesive	QMI-519	QMI-519	QMI-519
Pitch/ E or P	0.65 / E	0.65 / E	0.65 / E
Die Pad Size (mm)	4.00 X 5.00	4.00 X 5.00	4.00 X 5.00
Die Size (mm)	3.06 X 3.67	3.06 X 3.67	3.06 X 3.67
Vehicle name	CV8732DR	CV8732DR	CV8732DR
Wire diameter (µm)	25		

Lot	7	8	9
Assy Site	PSC	PSC	PSC
Package / Pin	TSSOP56	TSSOP56	TSSOP56
Outline	SOT364-1	SOT364-1	SOT364-1
Moulding compound	Nitto 7470	Nitto 7470	Nitto 7470
Die-Attach Adhesive	QMI-519	QMI-519	QMI-519
Pitch/ E or P	0.5 / P	0.5 / P	0.5 / P
Die Pad Size (mm)	2.60 x 4.00	2.60 x 4.00	2.60 x 4.00
Die Size (mm)	1.08 x 3.03	1.08 x 3.03	1.08 x 3.03
Vehicle name	PCD9504ADGG	PCD9504ADGG	PCD9504ADGG
Wire diameter (µm)	25	25	25

Lot	10	11	12
Assy Site	PSC	PSC	PSC
Package / Pin	TSSOP56	TSSOP56	TSSOP56
Outline	SOT364-1	SOT364-1	SOT364-1
Moulding compound	Nitto 7470	Nitto 7470	Nitto 7470
Die-Attach Adhesive	QMI-519	QMI-519	QMI-519
Pitch/ E or P	0.5 / P	0.5 / P	0.5 / P
Die Pad Size (mm)	2.90 x 5.00	2.90 x 5.00	2.90 x 5.00
Die Size (mm)	2.53 x 3.73	2.53 x 3.73	2.53 x 3.73
Vehicle name	SC28L202	SC28L202	SC28L202
Wire diameter (µm)	25	25	25

5. Reliability Test Program

An extensive qualification program has been executed to demonstrate that PSC can assemble TSSOP packages with a high quality and reliability, using NiPdAu leadframes, Nitto GE7470 molding compound and Hysol QMI-519 die-attach glue.

The reliability qualification test matrix can be found in Section 6.

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 tests.

5.1 Reliability Test Details

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-020C specification, as described in Philips Semiconductors specification SNW-FQ-225A. SMD Packages are preconditioned to the appropriate MSL level using 260 ºC reflow temperature only.

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.

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

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. Abbreviations used in the tables:

- 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

6. Self-qualification results.

Table 3: *"Wet" Reliability Stress Tests*

Package	Lot No.	Device	PCON 260 °C	PPOT			HAST		
				pcon	96 hrs	192 hrs	pcon	96 hrs	192 hrs
TSSOP20	1	74LVC574APW	L1	**0/45**	**0/45**	0/45	**0/45**	**0/45**	0/45
TSSOP20	2	74LVC574APW	L1	**0/45**	**0/45**	0/45	**0/45**	**0/45**	0/45
TSSOP20	3	74LVC574APW	L1	**-**	**-**	-	**0/45**	**0/45**	0/45
TSSOP32	4	CV8732DR	L1	**-**	**-**	-	**0/45**	**0/45**	0/45
TSSOP32	5	CV8732DR	L1	**-**	**-**	-	**0/45**	**0/45**	0/45
TSSOP32	6	CV8732DR	L1	**-**	**-**	-	**0/45**	**0/45**	0/45
TSSOP56	7	PCD9504ADGG	L1	**0/77**	**0/77**	0/77	**0/45**	**0/45**	0/45
TSSOP56	8	PCD9504ADGG	L1	**0/77**	**0/77**	0/77	**0/45**	**0/45**	0/45
TSSOP56	9	PCD9504ADGG	L1	**0/77**	**0/77**	0/77	**0/45**	**0/45**	0/45
TSSOP56	10	SC28L202	L1	**0/77**	**0/77**	0/77	**-**	**-**	-
TSSOP56	11	SC28L202	L1	**0/77**	**0/76**	0/74	**-**	**-**	-
TSSOP56	12	SC28L202	L1	**0/77**	**0/71**	going	**-**	**-**	-

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

Table 4: *"Dry" Reliability Stress Tests*

Package	Lot No.	Device	PCON 260 °C	TMCL				HTSL
				Pcon	**200 cyc**	500 cyc	1000 cyc	**1000 hrs**
TSSOP20	1	74LVC574APW	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP20	2	74LVC574APW	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP20	3	74LVC574APW	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP32	4	CV8732DR	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP32	5	CV8732DR	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP32	6	CV8732DR	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP56	7	PCD9504ADGG	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP56	8	PCD9504ADGG	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP56	9	PCD9504ADGG	L1	**0/77**	**0/77**	0/77	0/77	**0/77**
TSSOP56	10	SC28L202	L1	**0/77**	**0/77**	0/77	going	**0/77**
TSSOP56	11	SC28L202	L1	**0/77**	**0/77**	0/75	going	**0/77**
TSSOP56	12	SC28L202	L1	**0/77**	**0/77**	going	going	**0/77**

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

Table 5: *Construction Analysis*

	Lot		**Construction Analysis Tests**								
Package	**No.**	**Device**	MSLA 260 °C	V/M	LFNH	SOLD See note	XRAY	SCAT	DISH	BP/BS	CROSS
TSSOP20	1	74LVC574APW	L1	0/15	0/5	-	0/22	0/22	0/3	0/5	0/3
TSSOP20	2	74LVC574APW	L1	-	-	-	-	-	-	-	-
TSSOP20	3	74LVC574APW	L1	-	-	-	-	-	-	-	-
TSSOP32	4	CV8732DR	L1	0/15	0/5	-	0/22	0/22	0/3	0/5	0/3
TSSOP32	5	CV8732DR	L1	-	-	-	-	-	-	-	-
TSSOP32	6	CV8732DR	L1	-	-	-	-	-	-	-	-
TSSOP56	7	PCD9504ADGG	L1	0/15	0/5	-	0/22	0/22	0/3	0/5	0/3
TSSOP56	8	PCD9504ADGG	L1	-	-	-	-	-	-	-	-
TSSOP56	9	PCD9504ADGG	L1	-	-	-	-	-	-	-	-
TSSOP56	10	SC28L202	L1	0/15	0/5	-	0/22	0/22	0/3	0/5	0/3
TSSOP56	11	SC28L202	L1	-	-	-	-	-	-	-	-
TSSOP56	12	SC28L202	L1	-	-	-	-	-	-	-	-

Note:
11 parts tested in SnPb solder after 8h steam age, 5 sec, 215 ºC
11 parts tested in SnPb solder after 16h dry-bake, 5 sec, 215 ºC
11 parts tested in SAC solder after 8h steam age, 3 sec, 245 ºC
11 parts tested in SAC solder after 16h dry-bake, 3 sec, 245 ºC
RMA flux used for all tests.

7. Conclusion

An extensive qualification program has been executed to demonstrate that PSC can assemble TSSOP packages in NiPdAu, QMI-519 and Nitto GE7470 plastic at a high quality and reliability level.

With the positive completion of the Qualification tests, the IC Manufacturing Operations of Philips Semiconductors announces the release of NiPdAu pre-plated leadframes for use in TSSOP assembled in PSC.

8. Implementation

Deliveries will start from August 2005 onwards.

9. Document Revision Sheet

R E V I S I O N S H E E T			
DATE yyyy/mm/dd	REV	DESCRIPTION	AUTHOR
2005-03-11	01	Self Qualification Results for NiPdAu pre-plated leadframes for TSSOP packages in PSC, using QMI-519 and Nitto GE7470.	Rob de Heus
2005-04-11	02	Minor updates	Rob de Heus