
DIE2HR/D2HR manufacturing and quality specification

Introduction

This specification describes the manufacturing flow and quality insurance requirements to be fulfilled for STMicroelectronics space-grade dice related to ESCC qualified products and, with some restrictions described in the document, to any product in die form. It is compliant with ECSS-Q-ST-60-05C.

ST QML qualified products, available in die form, comply with the MIL-PRF-38535 specification, which provides all details on the manufacturing flow and quality insurance of these products. QML products are not covered in this specification.

1 Space-grade description

1.1 Eligible products

ST has developed a dedicated proprietary space-grade, largely inspired by the American QML specifications. Most ESCC-qualified product can be provided in die form in compliance with this specification. The ST space-grade can be applied to non-ESCC and non-QML qualified products. Contact ST for further details. ST can provide the engineering model (EM) in die form (see details in [TN1181](#)).

1.2 Product identification

The ST space-grade for products in die form can be identified by a specific suffix (either DIE2HR or D2HR) in the ST part number.

Example: 2N2222ADIE2HR;

1.3 Product specification

1.3.1 Electrical specification

The products in die form manufactured as per this technical note are 100% tested at 25°C using the exact same wafer probe sorting program as their packaged counterparts. Their specification from -55°C to 125°C is guaranteed by sampling with 25 packaged versions screened as per the relevant ESCC specification for FM (ESCC5000 or ESCC9000), including in particular a final test of all parts at -55°C, +25°C and +125°C. The parameters guaranteed by design or by characterization in the packaged versions stay so for the die form versions.

With this test and screening flow, ST space-grade products in die form are by default specified, with respect to their packaged version, as described below:

- Same radiation level
- Able to meet the same electrical characteristics (whenever relevant to products in die form) as their packaged counterparts, including absolute maximum ratings, operation conditions, electrical and timing characteristics, provided they are properly mounted and bonded, unless otherwise specified in a dedicated document

Any deviation the default specification is documented in a product specific technical note, available upon request.

1.3.2 Mechanical specification

The die specific mechanical information is provided in a dedicated document available upon request. It includes:

- Wafer size
- Wafer fab
- Waffle Pack reference
- Orientation:
 - Top side
 - Upper left corner identification (optional)
- Die size
- Die thickness
- Back metallization
- Top metallization
- Die pad size
- Die pad identification with the corresponding die layout

1.4 Production flow

For all products with an ESCC qualified version, ST guarantees that the mask set, diffusion plant and diffusion process of any ST space-grade die are exactly the same as for the corresponding ESCC qualified packaged parts.

In addition, ST guarantees that all space grade products in die form (flight parts) ordered within a unique line item are issued from a unique wafer lot made up of wafers processed and on the same equipment, following the same process steps including diffusion, metallization and passivation.

The manufacturing flow of space-grade die is made from wafers qualified as described above. Eligible wafers go through the production flow summarized in [Table 1](#).

Table 1. Summary of production flow

Step description	Discrete products	Integrated circuits	Comments
Electrical wafer sort	100%	100%	See Section 1.4.1 Electrical wafer sort .
Wafer lot S.E.M inspection	Bipolar transistors: 100% MOSFET: 100% Diodes: No	100%	See Section 1.4.2 S.E.M inspection .
Radiation test	Bipolar transistors: if applicable MOSFET: 100% Diodes: 100% ⁽¹⁾	100%	See Section 1.4.3 Radiation test .
Wafer qualification	100%	100%	See Section 1.4.4 Wafer qualification .
Visual test	Diodes : MIL-STD-750 TM2078 Bipolar Transistors : MIL-STD-750 TM2072 MOSFETs : ESCC2045000 at 100%	MIL-STD-883 Cond A	See Section 1.4.5 Visual test .
Conditioning	Waffle pack		See Section 1.4.6 Conditioning and packing .
Packing	Vacuum sealed anti-static bag		See Section 1.4.6 Conditioning and packing .

1. Rad guaranteed diodes only. No radiation test on others.

1.4.1 Electrical wafer sort

The electrical wafer sort carried out on the parts ensures that the tested parts comply with the functional and electrical specification of the packaged versions as described in the datasheet.

1.4.2 S.E.M inspection

The S.E.M inspection is made in compliance with the governing specification, which depends on the product family:

- Diodes: no S.E.M inspection
- Bipolar transistor: S.E.M inspection as per MIL-STD-750 method 2077 for all orders
- MOSFET: S.E.M inspection as per MIL-STD-750 method 2077 for all orders
- Logic and other ICs: S.E.M inspection as per MIL-STD-883 method 2018 for all orders

For bipolar transistors and MOSFETs, an S.E.M inspection report is optional and incurs costs. An S.E.M inspection report is provided by default with each shipment of integrated circuits in die form with the ST space-grade.

1.4.3 Radiation test

Products with a guaranteed radiation level are qualified in radiation with the flow of their packaged counterparts, either as per the qualifying agency specification or according to an ST internal specification (the latter only for product without version with guaranteed radiation level qualified as such by an agency).

The radiation verification test (RVT) report is provided with each shipment of radiation guaranteed parts. The details of the test (total dose, dose rate, biasing conditions, etc) are product family dependent.

1.4.4 Wafer qualification

Wafers eligible for the ST space-grade level (see [Section 1.1 Eligible products](#)) are screened as described in [Table 2](#). Only wafers that have been successfully screened can be used to produce dice of the ST space-grade level.

Table 2. Space-grade level

Step #	Step definition	Conditions	Acceptance level n = 25 ⁽¹⁾	Acceptance level n = 38 ⁽¹⁾
1	Samples assembly ⁽²⁾	According to the ST qualified PID as applicable	(3)	(3)
2	Serialization ⁽⁴⁾	n samples		
3	Electrical test read and record at 25 °C	As per ESCC detail specification (DC/AC parameters for ICs or DC for discrete)	A2/R3 ⁽⁵⁾	A3/R4 ⁽⁵⁾
4	Electrical test read and record at -55 °C/+125 °C ⁽⁶⁾	As per ESCC detail specification (DC parameters)		
5	Electrical test read and record at 25 °C for drift parameters	As per ESCC detail specification drift table	-/-	-/-
6	High temperature reverse bias ⁽⁶⁾	As per ESCC detail specification conditions	-/-	-/-
7	Electrical test read and record at 25°C for drift parameters ⁽⁶⁾	As per ESCC detail specification drift table	A1/R2	A2/R3
8	Burn-in (240 hrs)	As per ESCC detail specification conditions	-/-	-/-
9	Electrical test read and record at 25° C for drift parameters	As per ESCC detail specification drift table	A1/R2	A2/R3
10	Electrical test read and record at 25 °C	As per ESCC detail specification (DC/AC parameters or DC for discrete)	A2/R3	A3/R4
11	Electrical test read and record at -55 °C/+125 °C	As per ESCC detail specification (DC parameters)		
12	Life test 1000 hrs	As per ESCC detail specification conditions	-/-	-/-
13	Electrical test read and record at 25 °C	As per ESCC detail specification end- point electrical measurements	A0/R1	A0/R1
14	Check for lot failure	Check from step 3 to step 11	A2/R3	A3/R4

1. Ax/Ry: accepted if x rejects or less / refused if y rejects or more.
2. According to applicable ESCC 5000 or ESCC 9000 (chart F2 and F3 up to PIND test).
3. The number of samples allows the qualification of up to 3 wafers, therefore limiting the maximum quantity of the product in die form per line item to: 1000 dice maximum per line item for the 54HCMOS/CMOS4000B and diodes and 5000 dice maximum per line item for bipolar transistors. The number of samples can be increased in the Premium option. Contact ST for the corresponding acceptance level.
4. Sample size and acceptance criteria are based on the ECSS-Q-ST-60-05C specification, with limited sample size to 25 and 38 pieces. Data provided are for the default 25 samples.
5. Electrical rejects are not counted as failures if due to the ST assembly process.
6. Electrical tests at high/low temp and/or HTRB are optional and shall be done only on customer request and specified on the purchase order at additional cost.

1.4.5 Visual test

All products must successfully pass the applicable ESCC space level visual test:

- Discrete products:
 - Diodes: MIL-STD-750 TM2078
 - Bipolar Transistors: MIL-STD-750 TM2072
 - MOSFETs: ESCC2045000 at 100 %
- Integrated circuits: MIL-STD-883 Cond A

1.4.6 Conditioning and packing

Dice are packed in suitable antistatic waffle packs, vacuum sealed with adequate protection in order to avoid contamination or mechanical stress during shipment and handling.

Each waffle pack contains dice from a single wafer.

The standard orientation of dice within each waffles depends on the product, as described below. Contact ST for specific request:

- CMOS4000B - HCMOS - MOSFET: all dice within any waffle have the same orientation. Orientation may vary from one waffle to the other
- Diodes - bipolar transistors: the size of the dice doesn't allow to guarantee a single orientation within a waffle

Each waffle pack is marked as described below:

- ST logo
- Sales type reference
- Wafer number
- Diffusion lot number
- Quantity of dice
- ESD warning label identification

1.5 Documentation

Each shipment of DIE2HR / D2HR product includes, in addition to the parts, the default documentation (see [Table 3. Default documentation](#)) and optional documentation, if applicable.

Table 3. Default documentation

Item	Description
CoC	Certificate of Conformance including the information listed below: <ul style="list-style-type: none"> • Customer name • Customer purchase order number • ST sales order and item • ST part number • Quantity delivered • Wafer fab location • Wafer lot and wafer traceability • Applicable visual specification • Reference to the ESCC detail specification of the corresponding packaged parts • Reference to this technical note (TN) • Rennes die lot identification number (lot ID)
Die layout	see Section 1.3 Product specification .
SEM report	Scanning electronic microscope report: ICs only ⁽¹⁾ .
RVT report	Radiation verification test ⁽²⁾ .

1. No SEM reports for diodes, bipolar transistors and MOSFETs.

2. Radiation guaranteed products only.

1.6 Quality requirements

All documentation or traceability information corresponding to each ST space-grade dice is retained for 10 years in a safe storage area.

Upon request, this traceability and documentation may be reviewed by the customer or a copy provided, submitted to a lot charge defined by the ST sales area.

2 Deliverables and ordering information

Two delivery options are proposed, each corresponding to specific deliverables as described below. However, the standard option is available only for ESCC qualified parts.

ST guarantee that order line-items of space-grade parts are supported by default with parts coming from the same wafer lot whatever the delivery option.

2.1 Standard option

2.1.1 Description of the standard option

The standard option gives access to parts in die form, processed as described in [Section 1 Space-grade description](#), certified by a certificate of conformance, and the documentation set described below:

- Certificate of conformance includes:
 - Customer purchase order number
 - Wafer lot traceability
 - Detailed specification used for associated packaged parts
 - Reference of the manufacturing lot traveller for the die item
 - Reference of the manufacturing lot traveller for the customer qualification lot
- RVT report (if applicable)
- S.E.M report (if applicable)
- Die layout

2.1.2 Order entry for the standard option

To select this option each order of a die product must include two line items:

- The order for the product in die form
- An order for a fixed contribution to the qualification of the wafer

A maximum quantity per order line-item applies. Contact ST for sales office for details.

There is a fixed qualification contribution for each die line item. The part number to be used depends on the ordered product, as described in [Table 4. Fixed qualification contribution: part number per product family](#):

Table 4. Fixed qualification contribution: part number per product family

Product family of the die	Part number of the fixed contribution
Diodes	DIE-QA-LOT-78
Bipolar transistors and Power MOSFETs	DIE-QA-LOT-02
Logic	DIE-QA-LOT-71
Other	TBD

2.2 Premium option

2.2.1 Description of the premium option

In addition to parts and CoC provided as per the standard option, the premium option gives access to a complete set of qualification data of the specific wafers used for the parts, in compliance with either of the supported options of the ECSS-Q-ST-60-05C specification.

This data is obtained from parts specifically processed, which are therefore sent together with the dice.

Parts delivered with the premium option are issued from the same wafer lot whenever technically possible (see details in section 2.2.2)

The documentation set consists of:

- Certificate of conformance including:
 - Customer purchase order number
 - Wafer lot traceability
 - Detailed specification used for associated packaged parts
 - Reference of the manufacturing lot traveller for the die item
 - Reference of the manufacturing lot traveller for the customer qualification lot
- RVT report (if applicable)
- S.E.M report (if applicable)
- Test data for each part (25 by default) of the wafer qualification lot of each of the electrical tests described in the ESCC detail specification (steps 3, 4, 5, 6, 7, 9, 10, 11, and 13 of [Section 1.4.4 Wafer qualification](#))
- Die layout

The parts used to qualify the wafer are shipped together with the dice and the documentation in strip pack containers. Each part is marked with its part number (example: 2N2222AHR, 54HC00KT or HCC4001BKG) and its serial number.

The strip pack is marked with the part number of the component, its serial number and the corresponding manufacturing traveller lot number. It is packed in an individual antistatic strip pack (intermediate packing) labeled as follows:

- PO number
- Part number
- Marking
- Date code
- Quantity of pieces
- OC number and item
- Serial number

2.2.2 Order entry for the premium option

To select this option, each order of a die product must include 3 line items:

- 1 line-item order for the quantity of the product in die form
- 1 line-item order for at least 25 samples (packaged parts)
- 1 line-item order for the qualification charge of up to 3 wafers

A maximum quantity of dice per line item applies.

Important notes :

- A qualification charge can covers several die line items
- The maximum number of dice a qualification charge can covers depends on the number of good dice from 3 wafers. This number is product dependent. Contact ST for details for a specific product.

In this option, a wafer qualification is made for each die product line item. The part number to be used for the samples is the ST part number corresponding to the packaged ESCC flight model. The part number to be used for the qualification depends on the ordered product, as described in [Table 5](#):

Table 5. Qualification charge: part number per product family

Product family of the die	Part number of the fixed contribution
Diodes	WLQ-78
Bipolar transistors and Power MOSFETs	WLQ-02
Logic	WLQ-71
Other	TBD

By default, parts are shipped after completion of the associated qualification lot (i.e. after LT 1000 hours, parts are ready for shipment).

Contact an ST sales office for earlier shipment, after completion of the 240-hour burn-in.

3 Early delivery possibility

Regardless of selected option, the lead time of product in die form is in most cases directly impacted by the 1000 hour reliability test performed during wafer qualification (step 12 in [Section 1.4.4 Wafer qualification](#)). It is possible for customers to reduce this lead time by formally accepting a delivery prior to the completion of the 1000 hours. ST may accept such requests "at customer risk" when the risk of subsequent issues is deemed low, generally after a successful 240 hour test.

The Certificate of Conformance is provided together with the parts, describing the actual test they have been subjected to. By default, no further information is provided.

In case of unexpected issues after 240 hours, ST responsibility is strictly limited to the notification of the issue and the replacement of the shipped parts.

4 References

- ESCC 5000 - “Generic Specification for Discrete Semiconductor Components”
- ESCC 9000 - “Generic Specification for Integrated Circuits Monolithic”
- ECSS-Q-ST-60-05C - “Generic procurement requirements for hybrids”
- ESCC 22900 - “Basic Specification - Total Dose Steady-state Irradiation Test Method”
- ESCC 2045000 - “Internal Visual Inspection of Discrete Non-Microwave Semiconductors”
- MIL-STD-883 for monolithic integrated circuits
- MIL-STD-750 for discrete semiconductors

Revision history

Table 6. Document revision history

Date	Version	Changes
10-May-2012	1	Initial release.
28-Jun-2012	2	Updated reference into Section 2.2.1: Description of the Premium.option.
13-Jun-2013	3	<p>Updated Introduction (added "ECSS-Q-ST-60-05C", minor modifications).</p> <p>Updated Table 2: Space-grade level (modified and added "Acceptance level", updated steps, added steps 12 to 14).</p> <p>Updated Section 2: Deliverables and ordering information (added information for ESCC qualified parts).</p> <p>Updated Section 2.1.1: Description of the Standard option (specified references).</p> <p>Updated Section 2.2.1: Description of the Premium option (specified information of results and references, updated number of default parts, updated number of steps).</p> <p>Section 2.2.2: Order entry for the Premium option (updated sample number, added information below Table 4).</p> <p>Updated Section 3: References (updated name (ECSS-Q-ST-60-05C) and titles of specifications).</p> <p>Minor corrections throughout document.</p>
18-Feb-2014	4	<p>Modified title and text, reordered sections and added Table 1 to Section 1.4: Production flow</p> <p>Modified first paragraph and made minor text corrections in Section 2.2.1: Description of the Premium option.</p> <p>Updated list of references in Section 3.</p> <p>Minor text corrections throughout the document.</p>
21-Sep-2017	5	<p>In Section 1.1: "Eligible products":</p> <ul style="list-style-type: none"> - added reference to Engineering Model in die form <p>In Section 1.3: "Die layout":</p> <ul style="list-style-type: none"> - updated die layout documentation elements <p>Added Section 1.5: "Documentation"</p> <p>Added Section 3: "Early delivery possibility"</p>
11-Jun-2021	6	Updated Table 1. Summary of production flow . Minor text changes.

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