

## Q2, 2024 Quarterly Reliability Report

### 1. S34ML-1 product family, 41nm SLC NAND

41 nm SLC NAND were introduced in Jun 2012 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 41 nm SLC NAND is using Copper.

#### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                               | Read Point / Test Result |                     | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|--|--------------------------|---------------------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|  | Early Life (hrs)         | Inherent Life (hrs) | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|  | 96                       | 1000                |                            |     |     |     |            |                      |                      |
| Sample Size<br>125C, Zero fails, Process ave. Ea | 500<br>0                 | 150<br>0            | 0.7                        | 74  | 1   | 74  | 9259       | 0                    | 0.9                  |

#### Data Retention Bake - 150°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 1000               | 77          | 0      | 0   | <1   |

#### Endurance - 90°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 10000              | 60          | 0      | 0   | 2    |
| 100000(Decade)     | 64          | 0      | 0   |      |

## 2. S34ML-2 product family, 32nm SLC NAND

32 nm SLC NAND were introduced in October 2012 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 32 nm SLC NAND is using Copper

### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                | Read Point / Test Result |                     | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|-----------------------------------|--------------------------|---------------------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|                                   | Early Life (hrs)         | Inherent Life (hrs) | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|                                   | 96                       | 1000                |                            |     |     |     |            |                      |                      |
| Sample Size                       | 500                      | 150                 |                            |     |     |     |            |                      |                      |
| 125C, Zero fails, Process ave. Ea | 0                        | 0                   | 0.7                        | 74  | 1   | 74  | 12198      | 0                    | 0.9                  |

### Data Retention Bake - 150°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 1000               | 77          | 0      | 0   | <1   |

### Endurance - 90°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 10000              | 60          | 0      | 0   | 2    |
| 100000(Decade)     | 64          | 0      | 0   |      |

### 3. S34/S35ML-3 product family, 16nm SLC NAND

16 nm SLC NAND were introduced in November 2019 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 16 nm SLC NAND is using Copper

#### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                | Read Point / Test Result |                     | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|-----------------------------------|--------------------------|---------------------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|                                   | Early Life (hrs)         | Inherent Life (hrs) | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|                                   | 96                       | 1000                |                            |     |     |     |            |                      |                      |
| Sample Size                       | 500                      | 150                 |                            |     |     |     |            | 5.52                 | 1.59                 |
| 125C, Zero fails, Process ave. Ea | 0                        | 0                   | 0.66                       | 61  | 1   | 62  |            |                      |                      |
|                                   |                          |                     |                            |     |     |     | 5708       |                      |                      |

#### Data Retention Bake - 150°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 1000               | 77          | 0      | 0   | <1   |

#### Endurance - 90°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 10000              | 60          | 0      | 0   | 2    |
| 100000(Decade)     | 64          | 0      | 0   |      |

#### 4. S40FC004 product family, 4GB eMMC

4GB eMMC were introduced in November 2020 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 16 nm MLC NAND is using Copper

#### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                               | Read Point / Test Result |                     |          | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|--|--------------------------|---------------------|----------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|  | Early Life (hrs)         | Inherent Life (hrs) |          | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|  | 168                      | 504                 | 1000     |                            |     |     |     |            |                      |                      |
| Sample Size<br>125C, Zero fails, Process ave. Ea | 231                      | 231<br>0            | 231<br>0 | 0.7                        | 61  | 1   | 62  | 3747       | 58.51                | 16.97                |

#### Data Retention Bake - 150°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 1000               | 77          | 0      | 0   | <1   |

#### Endurance - 90°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 10000              | 60          | 0      | 0   | 2    |
| 100000(Decade)     | 64          | 0      | 0   |      |

#### 5. S40FC008 product family, 8GB eMMC

8GB eMMC were introduced in April 2022 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 16 nm MLC NAND is using Copper

#### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                               | Read Point / Test Result |                     |          | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|--|--------------------------|---------------------|----------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|  | Early Life (hrs)         | Inherent Life (hrs) |          | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|  | 168                      | 504                 | 1000     |                            |     |     |     |            |                      |                      |
| Sample Size<br>125C, Zero fails, Process ave. Ea | 231                      | 231<br>0            | 231<br>0 | 0.7                        | 61  | 1   | 62  | 3747       | 39.88                | 11.78                |

#### Data Retention Bake - 150°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 1000               | 77          | 0      | 0   | <1   |

## Endurance - 90°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 10000              | 60          | 0      | 0   | 2    |
| 100000(Decade)     | 64          | 0      | 0   |      |

## 6. S40FC016 product family, 16GB eMMC

16GB eMMC were introduced in June 2023 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals. The 1st Metal layer for 14 nm MLC NAND is using Copper

### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                               | Read Point / Test Result |                     |          | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|--|--------------------------|---------------------|----------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|  | Early Life (hrs)         | Inherent Life (hrs) |          | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|  | 168                      | 504                 | 1000     |                            |     |     |     |            |                      |                      |
| Sample Size<br>125C, Zero fails, Process ave. Ea | 231                      | 231<br>0            | 231<br>0 | 0.7                        | 61  | 1   | 62  | 3747       | 59.95                | 17.90                |

## Data Retention Bake - 150°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 1000               | 77          | 0      | 0   | <1   |

## Endurance - 90°C

| Reliability Stress | Sample Size | Reject | PPM | FITS |
|--------------------|-------------|--------|-----|------|
| 10000              | 60          | 0      | 0   | 2    |
| 100000(Decade)     | 64          | 0      | 0   |      |

## 7. S6AA8803 product family, 8+8Gb MCP

8+8Gb MCP were introduced in July 2023 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals.

### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                               | Read Point / Test Result |                     |          | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|--|--------------------------|---------------------|----------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|  | Early Life (hrs)         | Inherent Life (hrs) |          | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|  | 168                      | 504                 | 1000     |                            |     |     |     |            |                      |                      |
| Sample Size<br>125C, Zero fails, Process ave. Ea | 231                      | 231<br>0            | 231<br>0 | 0.7                        | 61  | 1   | 62  | 45,480     | 7.39                 | 6.99                 |

## 8. S6AA1616 product family, 16+16Gb MCP

16+16Gb MCP were introduced in Aug 2024 and utilize tunnel Oxide, Polysilicon floating gate and interconnections are three metal layers with contact plugs and barrier metals.

### Data Summary and Failure Rate Estimation using Exponential Model HTOL Stress Temperature - 125°C

| Failure Mechanisms                               | Read Point / Test Result |                     |          | Modeling Parameters @ 55°C |     |     |     |            | Average Failure Rate |                      |
|--|--------------------------|---------------------|----------|----------------------------|-----|-----|-----|------------|----------------------|----------------------|
|  | Early Life (hrs)         | Inherent Life (hrs) |          | Ea eV                      | TAF | VAF | OAF | MTTF (yrs) | Early Life (PPM)     | Inherent Life (FITS) |
|  | 168                      | 504                 | 1000     |                            |     |     |     |            |                      |                      |
| Sample Size<br>125C, Zero fails, Process ave. Ea | 231                      | 231<br>0            | 231<br>0 | 0.7                        | 61  | 1   | 62  | 45,480     | 7.39                 | 4.45                 |

## 9. Data Summaries by Package Family BGA 63 (Ball Grid Array)

| Reliability Stress        | Sample Size | Reject | Failure Rate PPM |
|---------------------------|-------------|--------|------------------|
| HAST 96hrs                | 433         | 0      | 0                |
| HAST 264hrs               | 557         | 0      | 0                |
| HIGH TEMP STORAGE 1000hrs | 770         | 0      | 0                |
| TEMP CYCLE 500cycle       | 563         | 0      | 0                |
| TEMP CYCLE 1000cycle      | 75          | 0      | 0                |
| UNBIASED HAST TEST 96hrs  | 611         | 0      | 0                |
| UNBIASED HAST TEST 264hrs | 173         | 0      | 0                |

### TSOP 48 (Thin Small Outline Package)

| Reliability Stress        | Sample Size | Reject | Failure Rate PPM |
|---------------------------|-------------|--------|------------------|
| HAST 96hrs                | 490         | 0      | 0                |
| HAST 264hrs               | 120         | 0      | 0                |
| HIGH TEMP STORAGE 1000hrs | 847         | 0      | 0                |



|                      |          |     |   |   |
|----------------------|----------|-----|---|---|
| PRESSURE COOKER TEST | 96hrs    | 500 | 0 | 0 |
|                      | 168hrs   | 30  | 0 | 0 |
| TEMP CYCLE           | 500cycle | 490 | 0 | 0 |
| UNBIASED HAST TEST   | 96hrs    | 435 | 0 | 0 |

### BGA 153 (Ball Grid Array)

| Reliability Stress |          | Sample Size | Reject | Failure Rate PPM |
|--------------------|----------|-------------|--------|------------------|
| PC                 | 192hrs   | 693         | 0      | 0                |
| HAST               | 164hrs   | 231         | 0      | 0                |
| HIGH TEMP STORAGE  | 1000hrs  | 231         | 0      | 0                |
| TEMP CYCLE         | 500cycle | 231         | 0      | 0                |
| UNBIASED HAST TEST | 96hrs    | 231         | 0      | 0                |

### BGA 149 (Ball Grid Array)

| Reliability Stress |          | Sample Size | Reject | Failure Rate PPM |
|--------------------|----------|-------------|--------|------------------|
| PC                 | 192hrs   | 693         | 0      | 0                |
| HAST               | 164hrs   | 231         | 0      | 0                |
| HIGH TEMP STORAGE  | 1000hrs  | 231         | 0      | 0                |
| TEMP CYCLE         | 500cycle | 231         | 0      | 0                |
| UNBIASED HAST TEST | 96hrs    | 231         | 0      | 0                |

SkyHigh Memory