

# S29AL004D Known Good Die

4 Megabit (512K x 8-Bit/256 K x 16-Bit)  
CMOS 3.0 Volt-only, Boot Sector Flash Memory



## Supplement

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### Distinctive Characteristics

- **Single power supply operation**
  - 2.7V to 3. V for read, program, and erase operations
- **Manufactured on 0.20µm process technology**
- **High performance**
  - Access times as fast as 70 ns
- **Ultra low power consumption (typical values at 5 MHz)**
  - 200 nA Automatic Sleep mode current
  - 200 nA standby mode current
  - 9 mA read current
  - 20 mA program/erase current
- **Flexible sector architecture**
  - One 16 Kbyte, two 8 Kbyte, one 32 Kbyte, and seven 64 Kbyte sectors (byte mode)
  - One 8 Kword, two 4 Kword, one 16 Kword, and seven 32 Kword sectors (word mode)
  - Supports full chip erase
  - Sector Protection features:
- **A hardware method of locking a sector to prevent any program or erase operations within that sector**
  - Sectors can be locked in-system or via programming equipment
  - Temporary Sector Unprotect feature allows code changes in previously locked sectors
- **Unlock Bypass Program Command**
  - Reduces overall programming time when issuing multiple program command sequences
- **Top or bottom boot block configurations available**
- **Embedded Algorithms**
  - Embedded Erase algorithm automatically preprograms and erases the entire chip or any combination of designated sectors
  - Embedded Program algorithm automatically writes and verifies data at specified addresses
- **Minimum one million write cycle guarantee per sector**
- **Compatibility with JEDEC standards**
  - Pinout and software compatible with single-power supply Flash
  - Superior inadvertent write protection
- **Data# Polling and toggle bits**
  - Provides a software method of detecting program or erase operation completion
- **Ready/Busy# pin (RY/BY#)**
  - Provides a hardware method of detecting program or erase cycle completion
- **Erase Suspend/Erase Resume**
  - Suspends an erase operation to read data from, or program data to, a sector that is not being erased, then resumes the erase operation
- **Hardware reset pin (RESET#)**
  - Hardware method to reset the device to reading array data
- **20-year data retention at 125°C**
  - Reliable operation for the life of the system
- **Tested to data sheet specifications at temperature**
- **Quality and reliability levels equivalent to standard packaged components**

## 1. General Description

The S29AL004D in Known Good Die (KGD) form is an 4 Mbit, 3.0 volt-only Flash memory. Spansion defines KGD as standard product in die form, tested for functionality and speed. Spansion KGD products have the same reliability and quality as Spansion products in packaged form.

### 1.1 S29AL004D Features

The S29AL004D is an 4 Mbit, 3.0 volt-only Flash memory organized as 524,288 bytes or 262,144 words. The word-wide data (x16) appears on DQ15–DQ0; the byte-wide (x8) data appears on DQ7–DQ0. To eliminate bus contention, the device has separate chip enable (CE#), write enable (WE#) and output enable (OE#) controls.

The device requires only a **single 3.0 volt power supply** for both read and write functions. Internally generated and regulated voltages are provided for the program and erase operations. No  $V_{PP}$  is required for program or erase operations. The device can also be programmed in standard EPROM programmers.

The device is entirely command set compatible with the **JEDEC single-power-supply Flash standard**. Commands are written to the command register using standard microprocessor write timings. Register contents serve as input to an internal state-machine that controls the erase and programming circuitry. Write cycles also internally latch addresses and data needed for the programming and erase operations. Reading data out of the device is similar to reading from other Flash or EPROM devices.

Device programming occurs by executing the program command sequence. This initiates the **Embedded Program** algorithm—an internal algorithm that automatically times the program pulse widths and verifies proper cell margin. The **Unlock Bypass** mode facilitates faster programming times by requiring only two write cycles to program data instead of four.

Device erasure occurs by executing the erase command sequence. This initiates the **Embedded Erase** algorithm—an internal algorithm that automatically preprograms the array (if it is not already programmed) before executing the erase operation. During erase, the device automatically times the erase pulse widths and verifies proper cell margin.

The host system can detect whether a program or erase operation is complete by observing the RY/BY# pin, or by reading the DQ7 (Data# Polling) and DQ6 (toggle) **status bits**. After a program or erase cycle is completed, the device is ready to read array data or accept another command.

The **sector erase architecture** allows memory sectors to be erased and reprogrammed without affecting the data contents of other sectors. The device is fully erased when shipped from the factory.

**Hardware data protection** measures include a low  $V_{CC}$  detector that automatically inhibits write operations during power transitions. The **hardware sector protection** feature disables both program and erase operations in any combination of the sectors of memory. This can be achieved in-system or via programming equipment.

The **Erase Suspend** feature enables the user to put erase on hold for any period of time to read data from, or program data to, any sector that is not selected for erasure. True background erase can thus be achieved.

The **hardware RESET# pin** terminates any operation in progress and resets the internal state machine to reading array data. The RESET# pin may be tied to the system reset circuitry. A system reset would thus also reset the device, enabling the system microprocessor to read the boot-up firmware from the Flash memory.

The device offers two power-saving features. When addresses are stable for a specified amount of time, the device enters the **automatic sleep mode**. The system can also place the device into the **standby mode**. Power consumption is greatly reduced in both these modes.

Spansion's Flash technology combines years of Flash memory manufacturing experience to produce the highest levels of quality, reliability and cost effectiveness. The device electrically erases all bits within a sector simultaneously via Fowler-Nordheim tunneling. The data is programmed using hot electron injection.

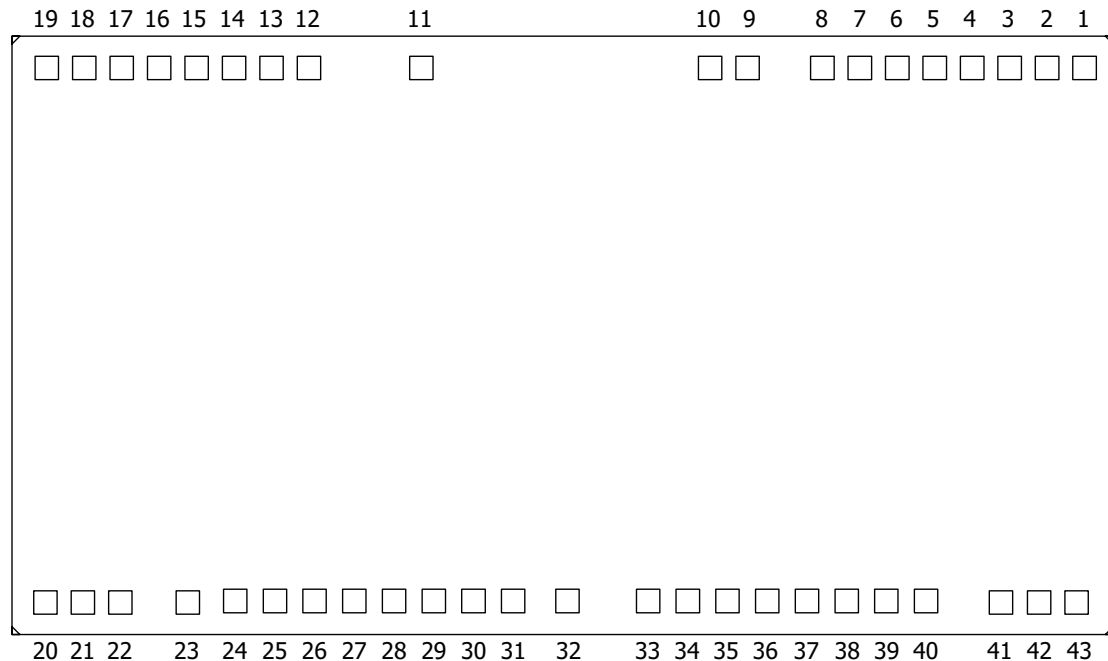
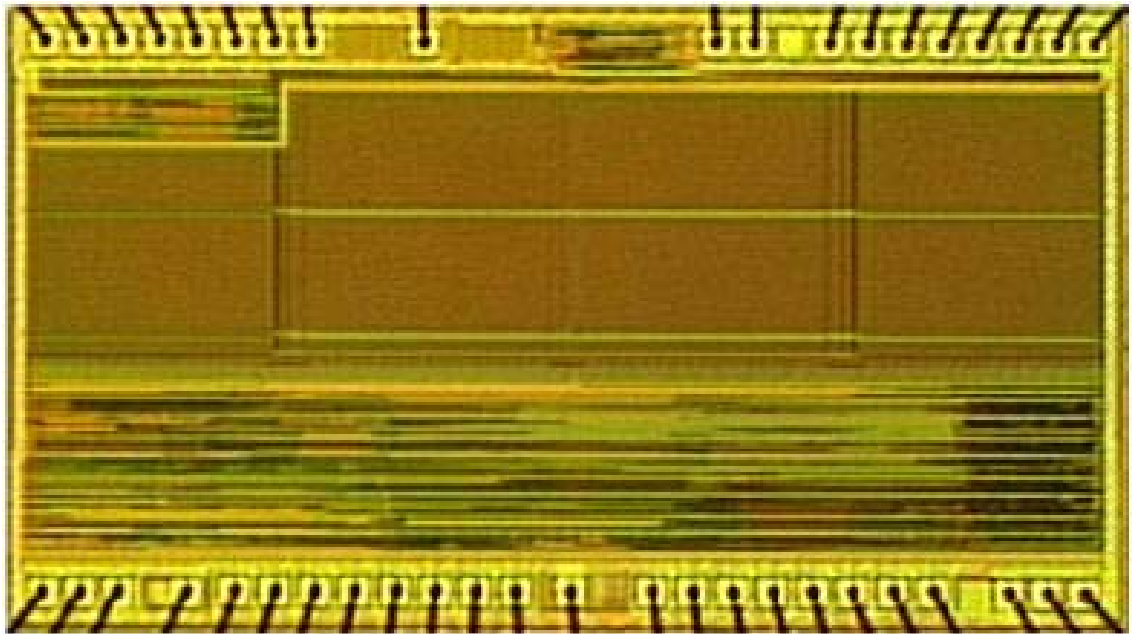
### 1.2 Electrical Specifications

Refer to the S29AL004D data sheet, publication number S29AL004D\_00, for full electrical specifications on the S29AL004D in KGD form.

## 2. Product Selector Guide

Family Part Number	S29AL004D KGD	
Speed Option ( $V_{CC} = 2.7V - 3.6V$ )	70	90
Max Access Time, $t_{ACC}$ (ns)	70	90
Max CE# Access, $t_{CE}$ (ns)	70	90
Max OE# Access, $t_{OE}$ (ns)	30	35

## 3. Die Photograph & Pad Locations



**Note:** Wirebond must be 100% within bondpad opening.

## 4. Pad Description

### 4.1 Pad Relative to Die Center

Pad No.	Pad Name	Pad Center (mils)		Pad Center (millimeters)	
		X	Y	X	Y
1	A15	71.110	36.428	1.806	0.925
2	A14	66.008	36.428	1.677	0.925
3	A13	60.905	36.428	1.547	0.925
4	A12	55.803	36.428	1.417	0.925
5	A11	50.700	36.428	1.288	0.925
6	A10	45.598	36.428	1.158	0.925
7	A9	40.496	36.428	1.029	0.925
8	A8	35.393	36.428	0.899	0.925
9	WE#	25.189	36.428	0.640	0.925
10	RESET#	20.086	36.428	0.510	0.925
11	RY/BY#	-19.245	36.428	-0.489	0.925
12	A17	-34.553	36.428	-0.878	0.925
13	A7	-39.655	36.428	-1.007	0.925
14	A6	-44.757	36.428	-1.137	0.925
15	A5	-49.860	36.428	-1.266	0.925
16	A4	-54.962	36.428	-1.396	0.925
17	A3	-60.064	36.428	-1.526	0.925
18	A2	-65.167	36.428	-1.655	0.925
19	A1	-70.269	36.428	-1.785	0.925
20	A0	-70.467	-36.407	-1.790	-0.925
21	CE#	-65.365	-36.407	-1.660	-0.925
22	VSS	-60.261	-36.407	-1.531	-0.925
23	OE#	-51.071	-36.407	-1.297	-0.925
24	DQ0	-44.610	-36.201	-1.133	-0.920
25	DQ8	-39.196	-36.201	-0.996	-0.920
26	DQ1	-33.792	-36.201	-0.858	-0.920
27	DQ9	-28.378	-36.201	-0.721	-0.920
28	DQ2	-22.965	-36.201	-0.583	-0.920
29	DQ10	-17.551	-36.201	-0.446	-0.920
30	DQ3	-12.146	-36.201	-0.309	-0.920
31	DQ11	-6.732	-36.201	-0.171	-0.920
32	VCC	0.649	-36.201	0.016	-0.920
33	DQ4	11.644	-36.201	0.296	-0.920
34	DQ12	17.058	-36.201	0.433	-0.920
35	DQ5	22.462	-36.201	0.571	-0.920
36	DQ13	27.876	-36.201	0.708	-0.920
37	DQ6	33.289	-36.201	0.846	-0.920
38	DQ14	38.703	-36.201	0.983	-0.920
39	DQ7	44.108	-36.201	1.120	-0.920
40	DQ15/A-1	49.522	-36.201	1.258	-0.920
41	VSS	59.721	-36.407	1.517	-0.925
42	BYTE#	64.913	-36.407	1.649	-0.925
43	A16	70.016	-36.407	1.778	-0.925

**Note**

The coordinates above are relative to the die center and can be used to operate wire bonding equipment.

## 5. Pad Description

### 5.1 Pad Relative to $V_{CC}$

Pad No.	Pad Name	Pad Center (mil)		Pad Center (millimeters)	
		X	Y	X	Y
1	A15	70.461	72.629	1.790	1.845
2	A14	65.359	72.629	1.661	1.845
3	A13	60.256	72.629	1.531	1.845
4	A12	55.154	72.629	1.401	1.845
5	A11	50.051	72.629	1.272	1.845
6	A10	44.949	72.629	1.142	1.845
7	A9	39.847	72.629	1.013	1.845
8	A8	34.744	72.629	0.883	1.845
9	WE#	24.540	72.629	0.624	1.845
10	RESET#	19.437	72.629	0.494	1.845
11	RY/BY#	-19.894	72.629	-0.505	1.845
12	A17	-35.202	72.629	-0.894	1.845
13	A7	-40.304	72.629	-1.023	1.845
14	A6	-45.406	72.629	-1.153	1.845
15	A5	-50.509	72.629	-1.282	1.845
16	A4	-55.611	72.629	-1.412	1.845
17	A3	-60.713	72.629	-1.542	1.845
18	A2	-65.816	72.629	-1.671	1.845
19	A1	-70.918	72.629	-1.801	1.845
20	A0	-71.116	-0.206	-1.806	-0.005
21	CE#	-66.014	-0.206	-1.676	-0.005
22	VSS	-60.910	-0.206	-1.547	-0.005
23	OE#	-51.720	-0.206	-1.313	-0.005
24	DQ0	-45.259	0.000	-1.149	0.000
25	DQ8	-39.845	0.000	-1.012	0.000
26	DQ1	-34.441	0.000	-0.874	0.000
27	DQ9	-29.027	0.000	-0.737	0.000
28	DQ2	-23.614	0.000	-0.599	0.000
29	DQ10	-18.200	0.000	-0.462	0.000
30	DQ3	-12.795	0.000	-0.325	0.000
31	DQ11	-7.381	0.000	-0.187	0.000
32	VCC	0.000	0.000	0.000	0.000
33	DQ4	10.995	0.000	0.280	0.000
34	DQ12	16.409	0.000	0.417	0.000
35	DQ5	21.813	0.000	0.555	0.000
36	DQ13	27.227	0.000	0.692	0.000
37	DQ6	32.640	0.000	0.830	0.000
38	DQ14	38.054	0.000	0.967	0.000
39	DQ7	43.459	0.000	1.104	0.000
40	DQ15/A-1	48.873	0.000	1.242	0.000
41	VSS	59.072	-0.206	1.501	-0.005
42	BYTE#	64.264	-0.206	1.633	-0.005
43	A16	69.367	-0.206	1.762	-0.005

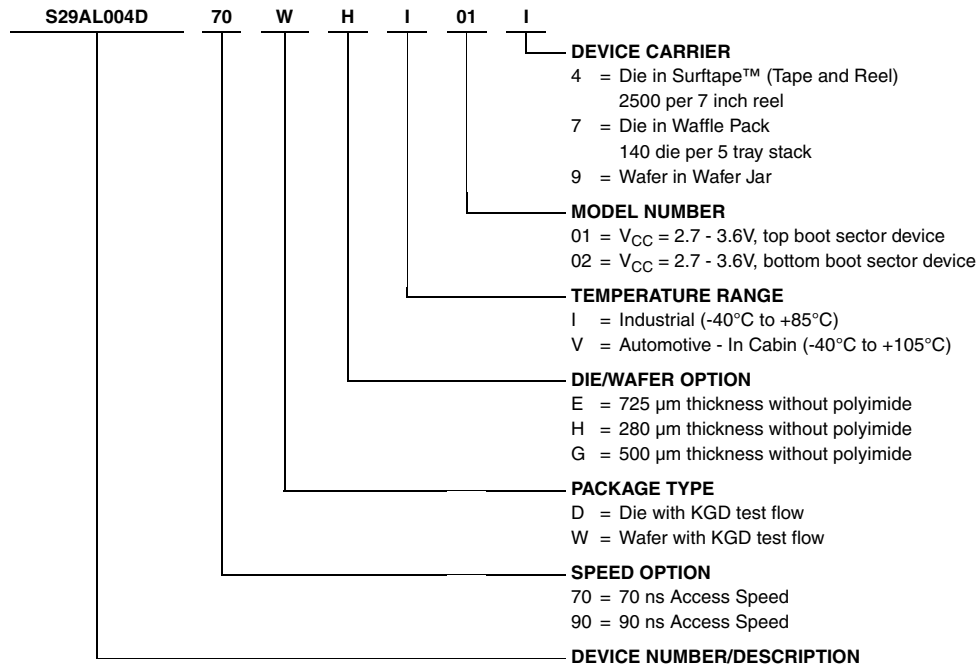
**Note**

The coordinates above are relative to  $V_{CC}$  and can be used to operate wire bonding equipment.

## 6. Ordering Information

### 6.1 Standard Products

Spansion standard products are available in several packages and operating ranges. The order number (Valid Combination) is formed by a combination of the elements below.



#### Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local Spansion sales office to confirm availability of specific valid combinations and to check on newly released combinations.

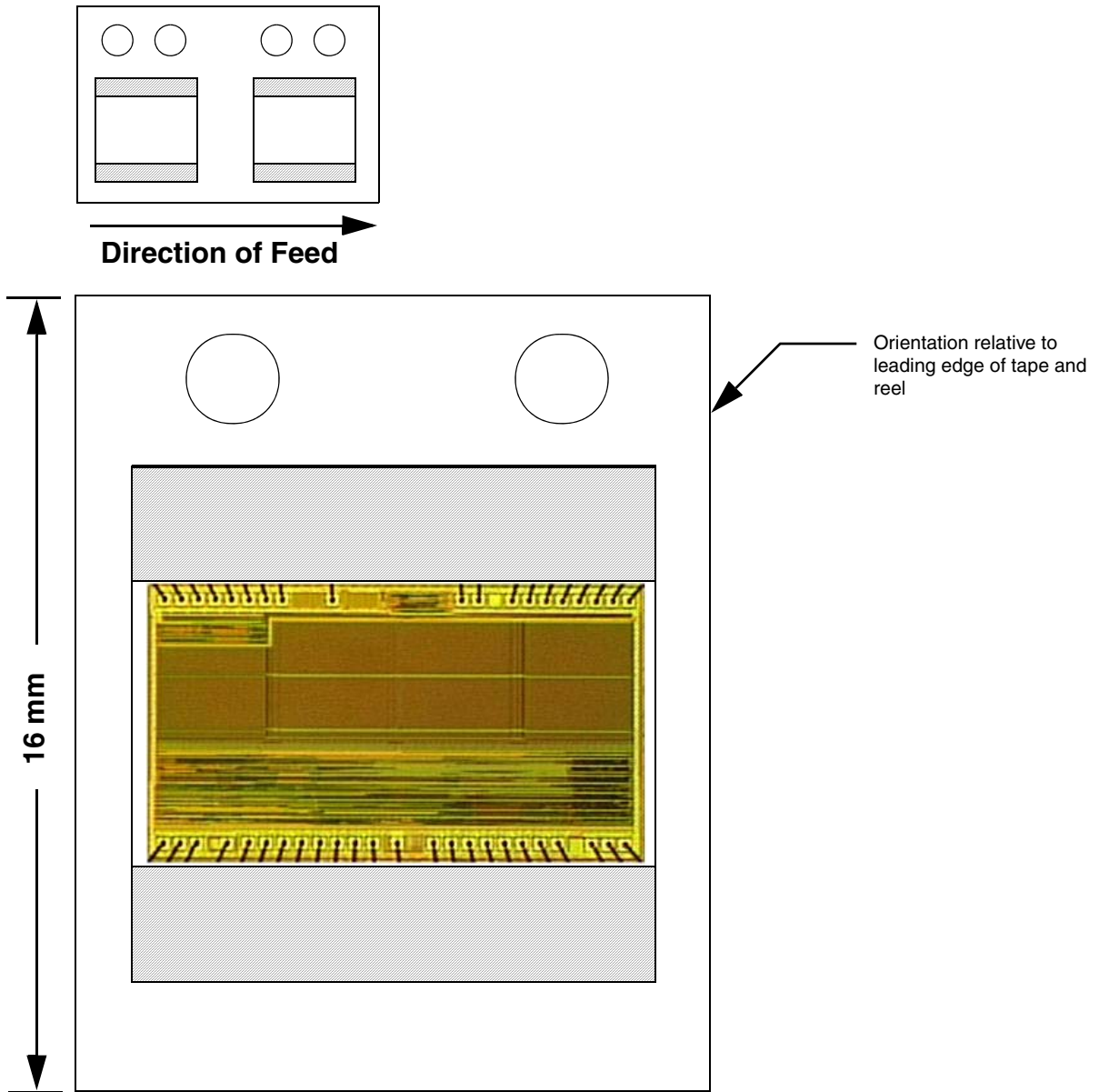
S29AL004D Valid Combinations				
Device Number	Speed Option	Package Type, and Temperature Range	Model Number	Die Revision
S29AL004D	70, 90	DHI, DGI, DHV, DGV	01, 02	4, 7
		WEV, WHI, WGI, WHV, WGV		9

**Note:**

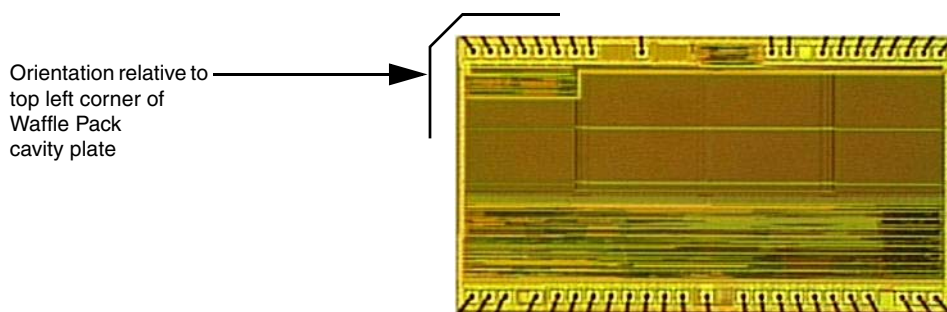
725 μm is only available in S29AL004D70WEV019

## 7. Packaging Information

### 7.1 Surftape Packaging



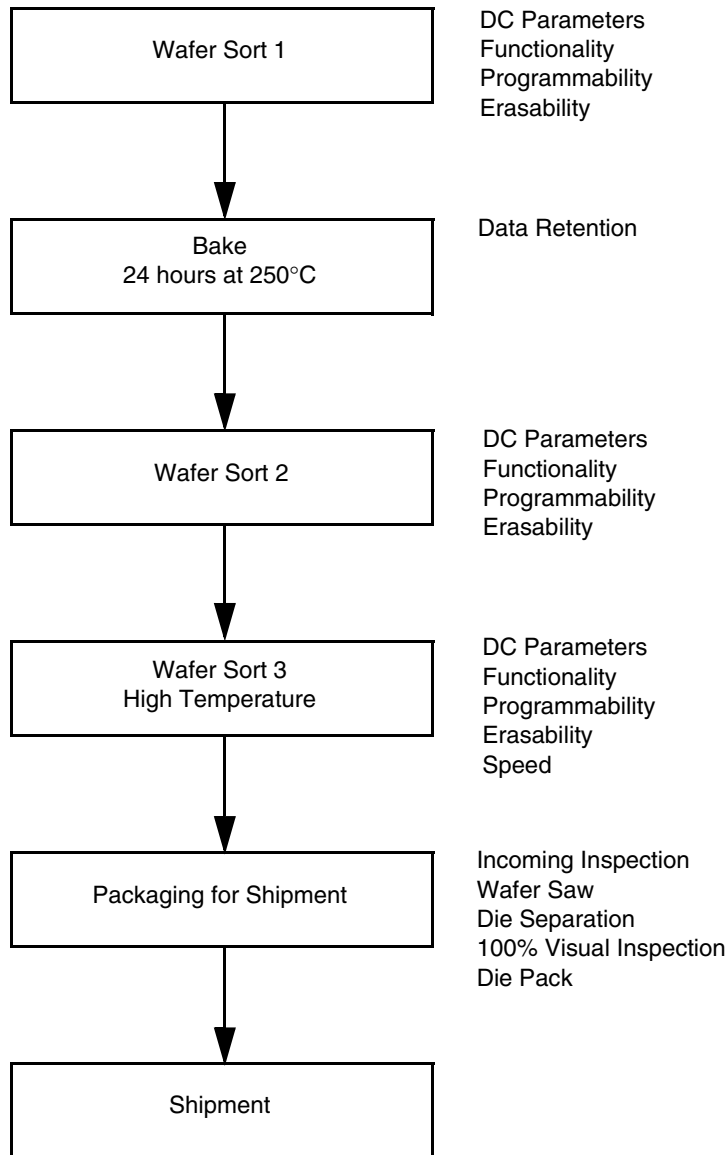
### 7.2 Waffle Pack Packaging



## 8. Product Test Flow

Figure 8.1 provides an overview of Spansion’s Known Good Die test flow. For more detailed information, refer to the S29AL004D product qualification database supplement for KGD. Spansion implements quality assurance procedures throughout the product test flow. In addition, an off-line quality monitoring program (QMP) further guarantees Spansion quality standards are met on Known Good Die products. These QA procedures also allow Spansion to produce KGD products without requiring or implementing burn-in.

Figure 8.1 Spansion KGD Product Test Flow





## 9. Physical Specifications

Die dimensions .....	153 mils X 87 mils
.....	3.9 mm x 2.33 mm
Die Thickness .....	500 $\mu\text{m}$
Bond Pad Size .....	3.19 mils x 3.19 mils
.....	81 $\mu\text{m}$ x 81 $\mu\text{m}$
Pad Area Free of Passivation .....	10.18 mils <sup>2</sup>
.....	6,561 $\mu\text{m}^2$
Pads Per Die .....	44
Bond Pad Metalization .....	Al/Cu
Die Backside .....	No metal
Passivation.....	Nitride/SOG/Nitride

## 10. DC Operating Conditions

$V_{CC}$ (Supply Voltage) .....	2.7 V to 3.6 V
Operating Temperature	
Commercial .....	0°C to +70°C
Industrial .....	-40°C to +85°C
Automotive in Cabin .....	-40°C to +105°C

## 11. Manufacturing Information

Manufacturing .....	Spansion
Test .....	Penang, Malaysia
Manufacturing ID (Top Boot).....	98F10AK, 98F10AG
(Bottom Boot).....	98F10ABK, 98F10ABG
Preparation for Shipment .....	Penang, Malaysia
Fabrication Process .....	CS49SS
Die Revision .....	1

## 12. Special Handling Instructions

### 12.1 Processing

Do not expose KGD products to ultraviolet light or process them at temperatures greater than 250°C. Failure to adhere to these handling instructions will result in irreparable damage to the devices. For best yield, Spansion recommends assembly in a Class 10K clean room with 30% to 60% relative humidity.

### 12.2 Storage

Store at a maximum temperature of 30°C in a nitrogen-purged cabinet or vacuum-sealed bag. Observe all standard ESD handling procedures.

### 13. Terms and Conditions of Sale for Spansion Non-Volatile Memory Die

All transactions relating to unpackaged die under this agreement shall be subject to Spansion's standard terms and conditions of sale, or any revisions thereof, which revisions Spansion reserves the right to make at any time and from time to time. In the event of conflict between the provisions of Spansion's standard terms and conditions of sale and this agreement, the terms of this agreement shall be controlling.

Spansion warrants its manufactured unpackaged die whether shipped to customer in individual dice or wafer form ("Known Good Die," "KGD", "Die," "Known Good Wafer", "KGW", or Wafer(s)) will meet Spansion's published specifications and against defective materials or workmanship for a period of one (1) year from date of shipment.

This limited warranty does not extend beyond the first purchaser of said Die or Wafer(s).

Buyer assumes full responsibility to ensure compliance with the appropriate handling, assembly and processing of KGD or KGW (including but not limited to proper Die preparation, Die attach, backgrinding, singulation, wire bonding and related assembly and test activities), and compliance with all guidelines set forth in Spansion's specifications for KGD or KGW, and Spansion assumes no responsibility for environmental effects on KGD or KGW or for any activity of Buyer or a third party that damages the Die or Wafer(s) due to improper use, abuse, negligence, improper installation, improper backgrinding, improper singulation, accident, loss, damage in transit, or unauthorized repair or alteration by a person or entity other than Spansion ("Limited Warranty Exclusions")

The liability of Spansion under this limited warranty is limited, at Spansion's option, solely to repair the Die or Wafer(s), to send replacement Die or Wafer(s), or to make an appropriate credit adjustment or refund in an amount not to exceed the original purchase price actually paid for the Die or Wafer(s) returned to Spansion, provided that: (a) Spansion is promptly notified by Buyer in writing during the applicable warranty period of any defect or nonconformity in the Die or Wafer(s); (b) Buyer obtains authorization from Spansion to return the defective Die or Wafer(s); (c) the defective Die or Wafer(s) is returned to Spansion by Buyer in accordance with Spansion's shipping instructions set forth below; and (d) Buyer shows to Spansion's satisfaction that such alleged defect or nonconformity actually exists and was not caused by any of the above-referenced Warranty Exclusions. Buyer shall ship such defective Die or Wafer(s) to Spansion via Spansion's carrier, collect. Risk of loss will transfer to Spansion when the defective Die or Wafer(s) is provided to Spansion's carrier. If Buyer fails to adhere to these warranty returns guidelines, Buyer shall assume all risk of loss and shall pay for all freight to Spansion's specified location. The aforementioned provisions do not extend the original limited warranty period of any Die or Wafer(s) that has either been replaced by Spansion.

THIS LIMITED WARRANTY IS EXPRESSED IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, THE IMPLIED WARRANTY OF MERCHANTABILITY OR NONINFRINGEMENT AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON Spansion's PART, AND IT NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR Spansion ANY OTHER LIABILITIES. THE FOREGOING CONSTITUTES THE BUYER'S SOLE AND EXCLUSIVE REMEDY FOR THE FURNISHING OF DEFECTIVE OR NON CONFORMING KNOWN GOOD DIE OR KNOWN GOOD WAFER(S) AND Spansion SHALL NOT IN ANY EVENT BE LIABLE FOR INCREASED MANUFACTURING COSTS, DOWNTIME COSTS, DAMAGES RELATING TO BUYER'S PROCUREMENT OF SUBSTITUTE DIE OR WAFER(S) (i.e., "COST OF COVER"), LOSS OF PROFITS, REVENUES OR GOODWILL, LOSS OF USE OF OR DAMAGE TO ANY ASSOCIATED EQUIPMENT, OR ANY OTHER INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES BY REASON OF THE FACT THAT SUCH KNOWN GOOD DIE OR KNOWN GOOD WAFER(S) SHALL HAVE BEEN DETERMINED TO BE DEFECTIVE OR NON CONFORMING.

Buyer agrees that it will make no warranty representations to its customers which exceed those given by Spansion to Buyer unless and until Buyer shall agree to indemnify Spansion in writing for any claims which exceed Spansion's limited warranty. Known Good Die or Known Good Wafer(s) are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of the Die or Wafer(s) can reasonably be expected to result in a personal injury. Buyer's use of Known Good Die or Known Good Wafer(s) for use in life support applications is at Buyer's own risk and Buyer agrees to fully indemnify Spansion for any damages resulting in such use or sale.

Known Good Die or Known Good Wafer are not designed or authorized for use as components in life support appliances, devices or systems where malfunction of the die or wafer can reasonably be expected to result in a personal injury. Buyer's use of Known Good Die or Known Good Wafer for use in life support applications is at Buyer's own risk and Buyer agrees to fully indemnify Spansion for any damages resulting in such use or sale.

## 14. Revision History

Section	Description
<b>Revision A0 (June 13, 2005)</b>	
	Initial release.
<b>Revision A1 (September 1, 2005)</b>	
<b>Pad Locations</b>	Replaced Pad Locations diagram
<b>Revision A2 (April 14, 2006)</b>	
<b>Pad Locations</b>	Corrected Pad Locations diagram
<b>Revision A3 (May 3, 2006)</b>	
<b>Pad Locations</b>	Enlarged numbers in Pad Locations diagram
<b>Revision A4 (February 9, 2007)</b>	
<b>Manufacturing Information</b>	Changed test location to Penang, Malaysia
<b>Revision A0 (July 17, 2007)</b>	
<b>Ordering Information</b>	Modified Temperature Range options and Die/Wafer Options
<b>Valid Combinations Table</b>	Modified Options and added note
<b>Packaging Information</b>	Removed references to Gel-Pak

**Colophon**

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