S29AL016D Known Good Die

16 Megabit (2 M x 8-Bit/1 M x 16-Bit) CMOS 3.0 Volt-only, Boot Sector Flash Memory

Supplement

General Description

The S29AL016D in Known Good Die (KGD) form is 16 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.

Distinctive Characteristics

- **Single power supply operation**
  - 2.7 to 3.6 V for read, program, and erase operations
- **Manufactured on 200 µm process technology**
- **High performance**
  - Access times as fast as 90 ns
- **Ultra low power consumption (typical values at 5 MHz)**
  - 200 nA Automatic Sleep mode current
  - 200 nA standby mode current
  - 7 mA read current
  - 15 mA program/erase current
- **Flexible sector architecture**
  - One 16 Kbyte, two 8 Kbyte, one 32 Kbyte, and thirty-one 64 Kbyte sectors (byte mode)
  - One 8 Kword, two 4 Kword, one 16 Kword, and thirty-one 32 Kword sectors (word mode)
  - Supports full chip erase
- **Sector Protection**
  - 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
- **CFI (Common Flash Interface) compliant**
  - Provides device-specific information to the system, allowing host software to easily reconfigure for different Flash devices
- **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**

Publication Number S29AL016D_KGD_SP **Revision** 06 **Issue Date** July 18, 2007

S29AL016D Features

The S29AL016D is a 16 Mbit, 3.0 volt-only Flash memory organized as 2,097,152 bytes or 1,048,576 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 VPP 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#** input 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.

SPANSION®

Table of Contents

General Description . . . 1

Distinctive Characteristics . . . 1

S29AL016D Features . . . 2

1. Electrical Specifications . . . 4

2. Die Photograph & Pad Locations . . . 4

3. Pad Description . . . 5

3.1 Pad Relative to Die Center . . . 5
3.2 Pads Relative to V_{CC} . . . 6

4. Ordering Information . . . 7

4.1 Valid Combinations . . . 7

5. Packaging Information . . . 8

5.1 Surftape Packaging . . . 8
5.2 Waffle Pack Packaging . . . 8

6. Product Test Flow . . . 9

7. Physical Specifications . . . 10

8. DC Operating Conditions . . . 10

9. Manufacturing Information . . . 10

10. Special Handling Instructions . . . 10

10.1 Processing . . . 10
10.2 Storage . . . 10

11. Terms and Conditions of Sale for Spansion Non-Volatile Memory Die . . . 11

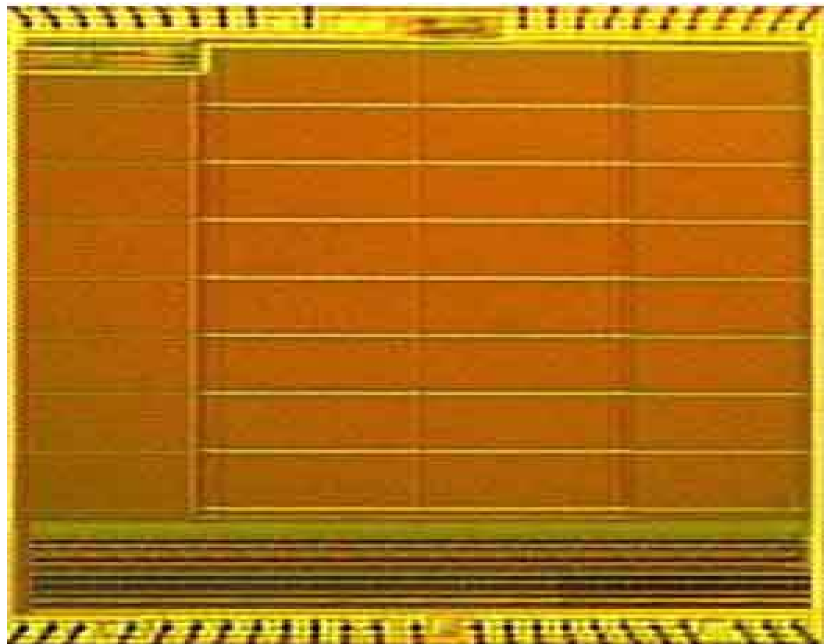
12. Revision History . . . 12

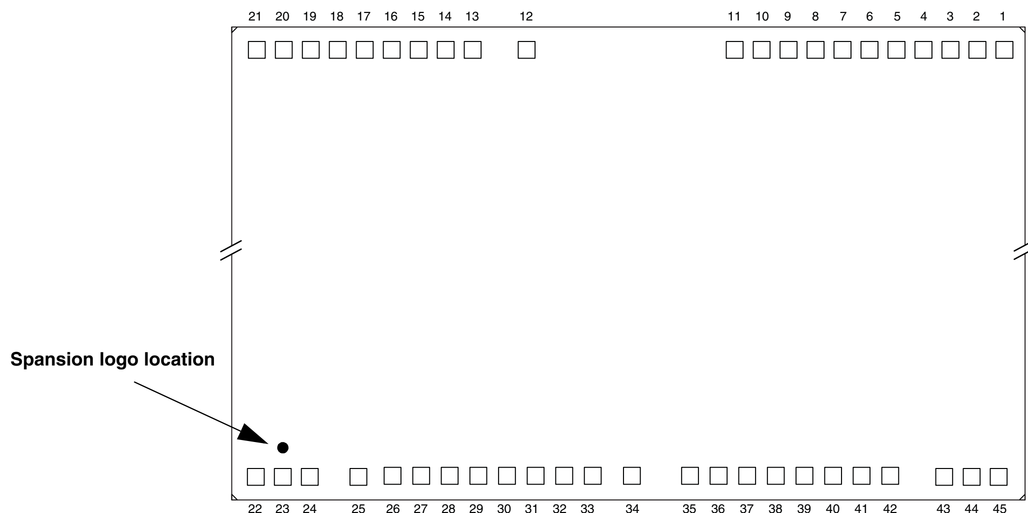
1. Electrical Specifications

Refer to the S29AL016D data sheet, publication number S29AL016D_00, for full electrical specifications on the S29AL016D in KGD form.

Family Part Number	S29AL016D KGD
Speed Option (V_{CC} = 2.7 – 3.6 V)	90
Max Access Time, t_{ACC} (ns)	90
Max CE# Access, t_{CE} (ns)	90
Max OE# Access, t_{OE} (ns)	35

2. Die Photograph & Pad Locations





Note
Wirebond must be 100% within bond pad opening.

3. Pad Description

3.1 Pad Relative to Die Center

See pad description relative to die center in Table 3.1.

Table 3.1 Pads Relative to Die Center

Pad No.	Signal	Pad Center (mils)		Pad Center (millimeters)		Pad No.	Signal	Pad Center (mils)		Pad Center (millimeters)	
		X	Y	X	Y			X	Y	X	Y
1	A15	71.110	85.330	1.806	2.167	24	VSS	–60.261	–85.309	–1.531	–2.167
2	A14	66.008	85.330	1.677	2.167	25	OE#	–51.071	–85.309	–1.297	–2.167
3	A13	60.905	85.330	1.547	2.167	26	DQ0	–44.610	–85.103	–1.133	–2.162
4	A12	55.803	85.330	1.417	2.167	27	DQ8	–39.196	–85.103	–0.996	–2.162
5	A11	50.700	85.330	1.288	2.167	28	DQ1	–33.792	–85.103	–0.858	–2.162
6	A10	45.598	85.330	1.158	2.167	29	DQ9	–28.378	–85.103	–0.721	–2.162
7	A9	40.496	85.330	1.029	2.167	30	DQ2	–22.965	–85.103	–0.583	–2.162
8	A8	35.393	85.330	0.899	2.167	31	DQ10	–17.551	–85.103	–0.446	–2.162
9	A19	30.291	85.330	0.769	2.167	32	DQ3	–12.146	–85.103	–0.309	–2.162
10	WE#	25.189	85.330	0.640	2.167	33	DQ11	–6.732	–85.103	–0.171	–2.162
11	RESET#	20.086	85.330	0.510	2.167	34	VCC	0.649	–85.103	0.016	–2.162
12	RY/BY#	–19.245	85.330	–0.489	2.167	35	DQ4	11.644	–85.103	0.296	–2.162
13	A18	–29.450	85.330	–0.748	2.167	36	DQ12	17.058	–85.103	0.433	–2.162
14	A17	–34.553	85.330	–0.878	2.167	37	DQ5	22.462	–85.103	0.571	–2.162
15	A7	–39.655	85.330	–1.007	2.167	38	DQ13	27.876	–85.103	0.708	–2.162
16	A6	–44.757	85.330	–1.137	2.167	39	DQ6	33.289	–85.103	0.846	–2.162
17	A5	–49.860	85.330	–1.266	2.167	40	DQ14	38.703	–85.103	0.983	–2.162
18	A4	–54.962	85.330	–1.396	2.167	41	DQ7	44.108	–85.103	1.120	–2.162
19	A3	–60.064	85.330	–1.526	2.167	42	DQ15/A–1	49.522	–85.103	1.258	–2.162
20	A2	–65.167	85.330	–1.655	2.167	43	VSS	59.735	–85.309	1.517	–2.167
21	A1	–70.269	85.330	–1.785	2.167	44	BYTE#	64.914	–85.309	1.649	–2.167
22	A0	–70.467	–85.309	–1.790	–2.167	45	A16	70.016	–85.309	1.778	–2.167
23	CE#	–65.365	–85.309	–1.660	–2.167						

Note

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

3.2 Pads Relative to V_{CC}

See pad description relative to V_{CC} in Table 3.2.

Table 3.2 Pads Relative to V_{CC}

Pad No.	Signal	Pad Center (mils)		Pad Center (millimeters)		Pad No.	Signal	Pad Center (mils)		Pad Center (millimeters)	
		X	Y	X	Y			X	Y	X	Y
1	A15	70.460	170.433	1.790	4.329	24	VSS	–60.910	–0.206	–1.547	–0.005
2	A14	65.358	170.433	1.660	4.329	25	OE#	–51.721	–0.206	–1.314	–0.005
3	A13	60.256	170.433	1.530	4.329	26	DQ0	–45.260	0.000	–1.150	0.000
4	A12	55.153	170.433	1.401	4.329	27	DQ8	–39.846	0.000	–1.012	0.000
5	A11	50.051	170.433	1.271	4.329	28	DQ1	–34.441	0.000	–0.875	0.000
6	A10	44.949	170.433	1.142	4.329	29	DQ9	–29.027	0.000	–0.737	0.000
7	A9	39.846	170.433	1.012	4.329	30	DQ2	–23.614	0.000	–0.600	0.000
8	A8	34.744	170.433	0.882	4.329	31	DQ10	–18.200	0.000	–0.462	0.000
9	A19	29.642	170.433	0.753	4.329	32	DQ3	–12.796	0.000	–0.325	0.000
10	WE#	24.539	170.433	0.623	4.329	33	DQ11	–7.381	0.000	–0.187	0.000
11	RESET#	19.437	170.433	0.494	4.329	34	VCC	0.000	0.000	0.000	0.000
12	RY/BY#	–19.895	170.433	–0.505	4.329	35	DQ4	10.994	0.000	0.279	0.000
13	A18	–30.100	170.433	–0.765	4.329	36	DQ12	16.408	0.000	0.417	0.000
14	A17	–35.202	170.433	–0.894	4.329	37	DQ5	21.813	0.000	0.554	0.000
15	A7	–40.304	170.433	–1.024	4.329	38	DQ13	27.227	0.000	0.692	0.000
16	A6	–45.407	170.433	–1.153	4.329	39	DQ6	32.640	0.000	0.829	0.000
17	A5	–50.509	170.433	–1.283	4.329	40	DQ14	38.054	0.000	0.967	0.000
18	A4	–55.611	170.433	–1.413	4.329	41	DQ7	43.458	0.000	1.104	0.000
19	A3	–60.714	170.433	–1.542	4.329	42	DQ15/A–1	48.872	0.000	1.241	0.000
20	A2	–65.816	170.433	–1.672	4.329	43	VSS	59.086	–0.206	1.501	–0.005
21	A1	–70.919	170.433	–1.801	4.329	44	BYTE#	1.632	–0.005	64.265	–0.206
22	A0	–71.117	–0.206	–1.806	–0.005	45	A16	1.762	–0.005	69.367	–0.206
23	CE#	–66.014	–0.206	–1.677	–0.005						

4. Ordering Information

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.

S29AL016D 90 W H V 01 4

DEVICE CARRIER (4)
- 4 = Die in Surftape™ (Tape and Reel) 2500 per 7 inch reel
- 7 = Die in Waffle Pack 140 die per 5 tray stack
- 9 = Wafer in Wafer Jar

MODEL NUMBER (01)
- 01 = V_{CC} = 2.7 - 3.6V, top boot sector device
- 02 = V_{CC} = 2.7 - 3.6V, bottom boot sector device

TEMPERATURE RANGE (V)
- I = Industrial (–40°C to + 85°C)
- V = Automotive, In Cabin (–40°C to +105°C)

DIE/WAFER OPTION (H)
- H = 280 µm thickness without polyimide
- G = 500 µm thickness without polyimide
- E = 725 µm thickness without polyimide

PACKAGE TYPE (W)
- D = Die with KGD test flow
- W = Wafer with KGD test flow

SPEED OPTION (90)
- 90 = 90 ns Access Speed

DEVICE NUMBER/DESCRIPTION (S29AL016D)
S29AL016D
16 Megabit Flash Memory manufactured using 200 nm process technology
3.0 Volt-only Read, Program, and Erase

4.1 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.

S29AL016D Valid Combinations				
Device Number	**Speed Option**	**Package Type, and Temperature Range**	**Model Number**	**Device Carrier**
S29AL016D	90	DHI, DHV, DGI, DGV,	01, 02	4, 7
		WHI, WHV, WGI, WGV WEI, WEV		9

5. Packaging Information

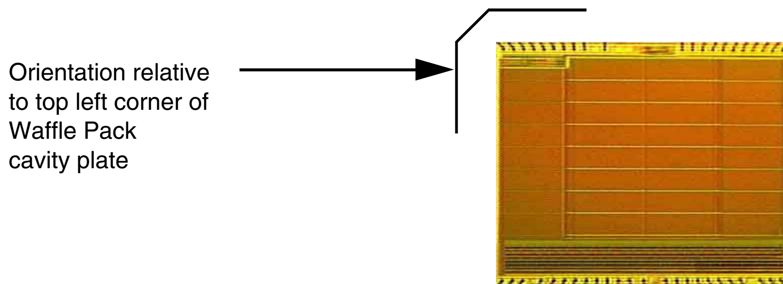
5.1 Surftape Packaging

Direction of Feed

16 mm

Orientation relative to leading edge of tape and reel

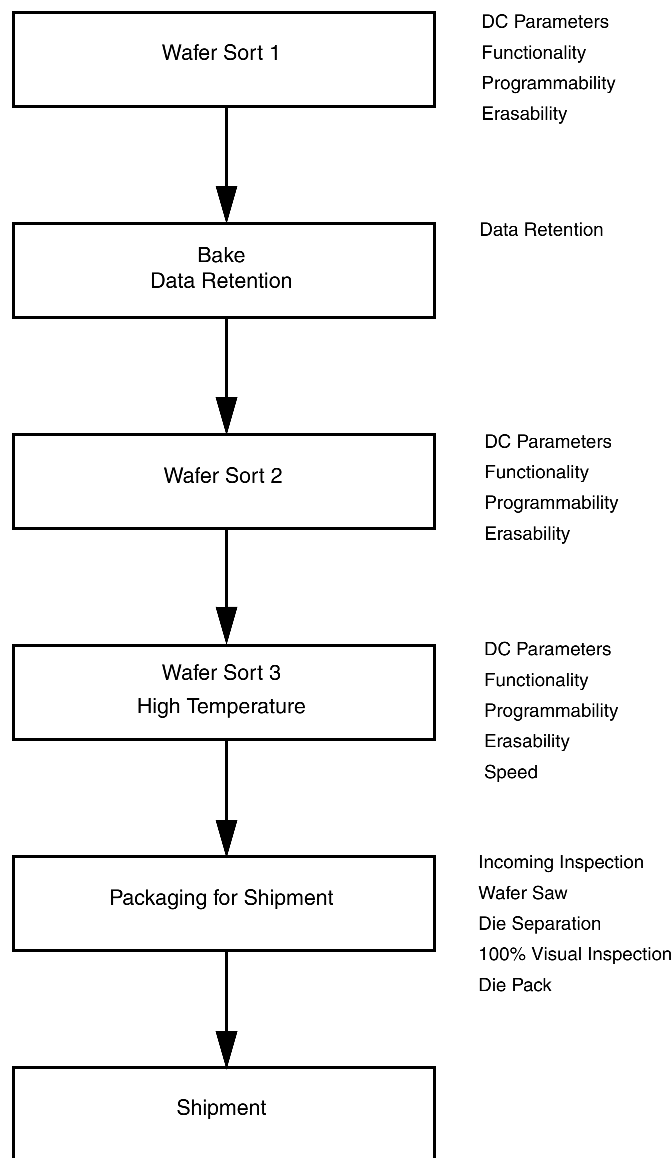
5.2 Waffle Pack Packaging



6. Product Test Flow

Figure 6.1 provides an overview of Spansion's Known Good Die test flow. For more detailed information, refer to the S29AL016D 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 6.1 Spansion KGD Product Test Flow



7. Physical Specifications

Description	Specification
Die dimensions	153.54 mils X 185.04 mils 3.9 mm x 4.7 mm
Die Thickness	500 µm
Bond Pad Size	3.19 mils x 3.19 mils 81µm x 81 µm
Pad Area Free of Passivation	10.18 $mils^2$ 6,561 $µm^2$
Pads Per Die	45
Bond Pad Metalization	Al/Cu
Die Backside	No metal
Passivation	Nitride/SOG/Nitride

8. DC Operating Conditions

Description	Specification
V_{CC} (Supply Voltage)	2.7 V to 3.6 V
Operating Temperature	0°C to +70°C (Commercial) –40°C to +85°C (Industrial)

9. Manufacturing Information

Description	Specification
Manufacturing	Spansion
Test	Penang, Malaysia
Manufacturing ID	(Top Boot)98K33A (Bottom Boot)98K33AB
Preparation for Shipment	Penang, Malaysia
Fabrication Process	CS49SS
Die Revision	1

10. Special Handling Instructions

10.1 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.

10.2 Storage

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

11. 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 ORDAMAGE 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.

12. Revision History

Section	Description
Revision A0 (December 1, 2005)	
Global	Initial release
Revision 02 (September 8, 2006)	
Global	Changed publication number to conform to current conventions. A0 is the first revision, 02 is the second. Changed document type from product brief to supplement to match other KGD products. Changed all formatting to new template. Deleted cover page from document.
Ordering Information	Temperature range options: Deleted E and C options, and added V option. Updated valid combinations table.
Revision 03 (February 9, 2006)	
Manufacturing Information	Changed test location to Penang, Malaysia.
Revision 04 (April 23, 2007)	
Die Photograph & Pad Locations	Added location of Spansion logo.
Revision 05 (June 28, 2007)	
Valid Combinations	Added note.
Revision 06 (July 18, 2007)	
Packaging Information	Removed references to Gel-Pak, replaced die photo
Valid Combinations Table	Modified table and deleted note

Colophon

The products described in this document are designed, developed and manufactured as contemplated for general use, including without limitation, ordinary industrial use, general office use, personal use, and household use, but are not designed, developed and manufactured as contemplated (1) for any use that includes fatal risks or dangers that, unless extremely high safety is secured, could have a serious effect to the public, and could lead directly to death, personal injury, severe physical damage or other loss (i.e., nuclear reaction control in nuclear facility, aircraft flight control, air traffic control, mass transport control, medical life support system, missile launch control in weapon system), or (2) for any use where chance of failure is intolerable (i.e., submersible repeater and artificial satellite). Please note that Spansion will not be liable to you and/or any third party for any claims or damages arising in connection with above-mentioned uses of the products. Any semiconductor devices have an inherent chance of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions. If any products described in this document represent goods or technologies subject to certain restrictions on export under the Foreign Exchange and Foreign Trade Law of Japan, the US Export Administration Regulations or the applicable laws of any other country, the prior authorization by the respective government entity will be required for export of those products.

Trademarks and Notice

The contents of this document are subject to change without notice. This document may contain information on a Spansion product under development by Spansion. Spansion reserves the right to change or discontinue work on any product without notice. The information in this document is provided as is without warranty or guarantee of any kind as to its accuracy, completeness, operability, fitness for particular purpose, merchantability, non-infringement of third-party rights, or any other warranty, express, implied, or statutory. Spansion assumes no liability for any damages of any kind arising out of the use of the information in this document.

Copyright © 2005–2007 Spansion Inc. All rights reserved. Spansion®, the Spansion Logo, MirrorBit®, MirrorBit® Eclipse™, ORNAND™, HD-SIM™ and combinations thereof, are trademarks of Spansion LLC in the US and other countries. Other names used are for informational purposes only and may be trademarks of their respective owners.