S29CD016G Known Good Die

16 Megabit (512 K x 32-Bit) CMOS 2.5 Volt-only Burst Mode, Dual Boot, Simultaneous Read/Write Flash Memory

Data Sheet Supplement

Distinctive Characteristics

Architecture Advantages

- **Simultaneous Read/Write operations**
  - Data can be continuously read from the 75% bank while executing erase/program functions in the 25% bank
  - Zero latency between read and write operations
  - Two bank architecture: 75%/25%
- **User-Defined x32 Data Bus**
- **Dual Boot Block**
  - Top and bottom boot in the same device
- **Flexible sector architecture**
  - Eight 8 Kbytes, thirty 64 Kbytes, and eight 8 Kbytes sectors
- **Manufactured on 0.17 µm process technology**
- **SecSi (Secured Silicon) Sector (256 Bytes)**
  - *Factory locked and identifiable*: 16 bytes for secure, random factory Electronic Serial Number; remainder may be customer data programmed by Spansion
  - *Customer lockable:* Can be read, programmed or erased just like other sectors. Once locked, data cannot be changed
- **Programmable Burst interface**
  - Interface to any high performance processor
  - Modes of Burst Read Operation:
  - *Linear Burst*: 4 double words and 8 double words with wrap around
- **Single power supply operation**
  - Optimized for 2.5 to 2.75 Volt read, erase, and program operations
- **Compatibility with JEDEC standards (JC42.4)**
  - Software compatible with single-power supply Flash
  - Backward-compatible with Spansion Am29LV and Am29F, and Fujitsu MBM29LV and MBM29F flash memories

Performance Characteristics

- **High performance read access**
  - Initial/random access times as fast as 64 ns
  - Burst access time as fast as 10 ns
- **Ultra low power consumption**
  - Burst Mode Read: 90 mA @ 56 MHz max
  - Program/Erase: 50 mA max
  - Standby mode: CMOS: 150 µA max
- **1 million write cycles per sector typical**
- **20 year data retention typical**
- **Versatile I/O™ control**
  - Device generates data output voltages and tolerates data input voltages as determined by the voltage on the V_{IO} pin
  - 1.65 V to 2.75 V compatible I/O signals
  - 3.6 V tolerant I/O signals

Software Features

- **Persistent Sector Protection**
  - A command sector protection method to lock combinations of individual sectors and sector groups to prevent program or erase operations within that sector (requires only V_{CC} levels)
- **Password Sector Protection**
  - A sophisticated sector protection method to lock combinations of individual sectors and sector groups to prevent program or erase operations within that sector using a user-definable 64-bit password
- **Supports Common Flash Interface (CFI)**
- **Unlock Bypass Program Command**
  - Reduces overall programming time when issuing multiple program command sequences
- **Data# Polling and toggle bits**
  - Provides a software method of detecting program or erase operation completion

Hardware Features

- **Program Suspend/Resume & Erase Suspend/Resume**
  - Suspends program or erase operations to allow reading, programming, or erasing in same bank
- **Hardware Reset (RESET#), Ready/Busy# (RY/BY#), and Write Protect (WP#) inputs**
- **ACC input**
  - Accelerates programming time for higher throughput during system production
- **Quality and reliability levels equivalent to standard packaged components**

Publication Number S29CD016G_KGD **Revision** A **Amendment** 0 **Issue Date** January 17, 2005

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General Description

The S29CD016G in Known Good Die (KGD) form is an 16 Mbit, 2.5 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.

S29CD016G Features

The S29CD016G is a 16 Megabit, 2.5 Volt-only single power supply burst mode flash memory device. The device is configured for 524,288 double words. The device can also be programmed in standard EPROM programmers.

To eliminate bus contention, each device has separate chip enable (CE#), write enable (WE#) and output enable (OE#) controls. Additional control inputs are required for synchronous burst operations: Load Burst Address Valid (ADV#), and Clock (CLK).

Each device requires only a **single 2.5 or 2.6 Volt power supply** (2.5 V to 2.75 V) for both read and write functions. A 12.0-volt V_{PP} is not required for program or erase operations, although an acceleration pin is available if faster programming performance is required.

The device is entirely command set compatible with the **JEDEC single-power-supply Flash standard**.

The **Unlock Bypass** mode facilitates faster programming times by requiring only two write cycles to program data instead of four.

The **Simultaneous Read/Write architecture** provides simultaneous operation by dividing the memory space into two banks. The device can begin programming or erasing in the small bank, and then simultaneously read from the large bank, with zero latency.

The device provides a 256-byte **SecSi™ (Secured Silicon) Sector** with an one-time-programmable (OTP) mechanism.

In addition, the device features several levels of sector protection, which can disable both the program and erase operations in certain sectors or sector groups: **Persistent Sector Protection** is a command sector protection method that replaces the old 12 V controlled protection method; **Password Sector Protection** is a highly sophisticated protection method that requires a password before changes to certain sectors or sector groups are permitted; **WP# Hardware Protection** prevents program or erase in the two outermost 8 Kbytes sectors of the larger bank.

The device defaults to the Persistent Sector Protection mode. The customer must then choose if the Standard or Password Protection method is most desirable. The WP# Hardware Protection feature is always available, independent of the other protection method chosen.

The **Versatile I/O™ (V_{CCQ})** feature allows the output voltage generated on the device to be determined based on the V_{IO} level. This feature allows this device to operate in the 1.8 V I/O environment, driving and receiving signals to and from other 1.8 V devices on the same bus. In addition, inputs and I/Os that are driven externally are capable of handling 3.6 V.

The host system can detect whether a program or erase operation is complete by observing the RY/BY# pin, by reading the DQ7 (Data# Polling), or DQ6 (toggle)

status bits. After a program or erase cycle has been 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 **password and software sector protection** feature disables both program and erase operations in any combination of sectors of memory. This can be achieved in-system at V_{CC} level.

The **Program / Erase Suspend / Erase Resume** 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 device offers two power-saving features. When addresses have been 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.

AMD'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.

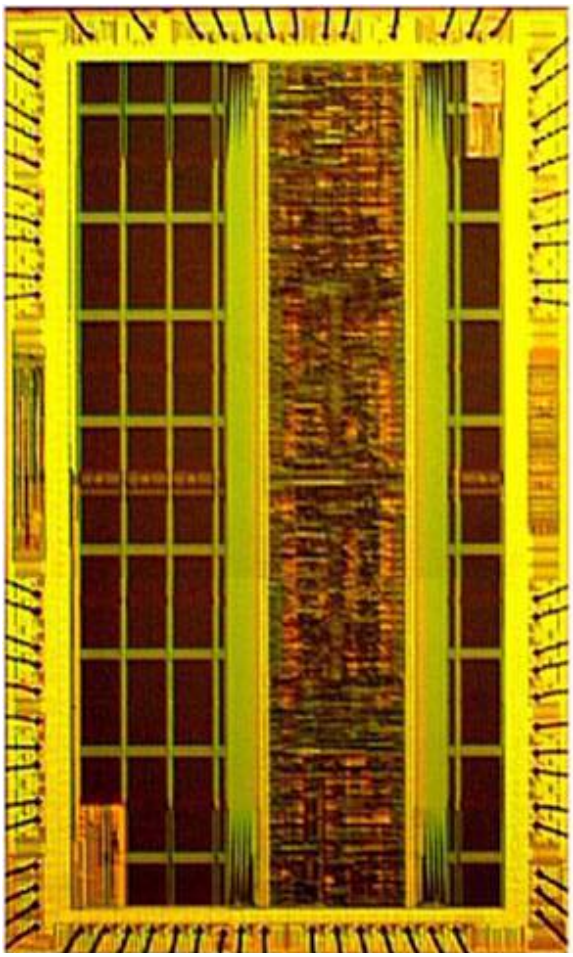
Electrical Specifications

Refer to the S29CD016G data sheet, publication number 24960, for full electrical specifications on the S29CD016G in KGD form.

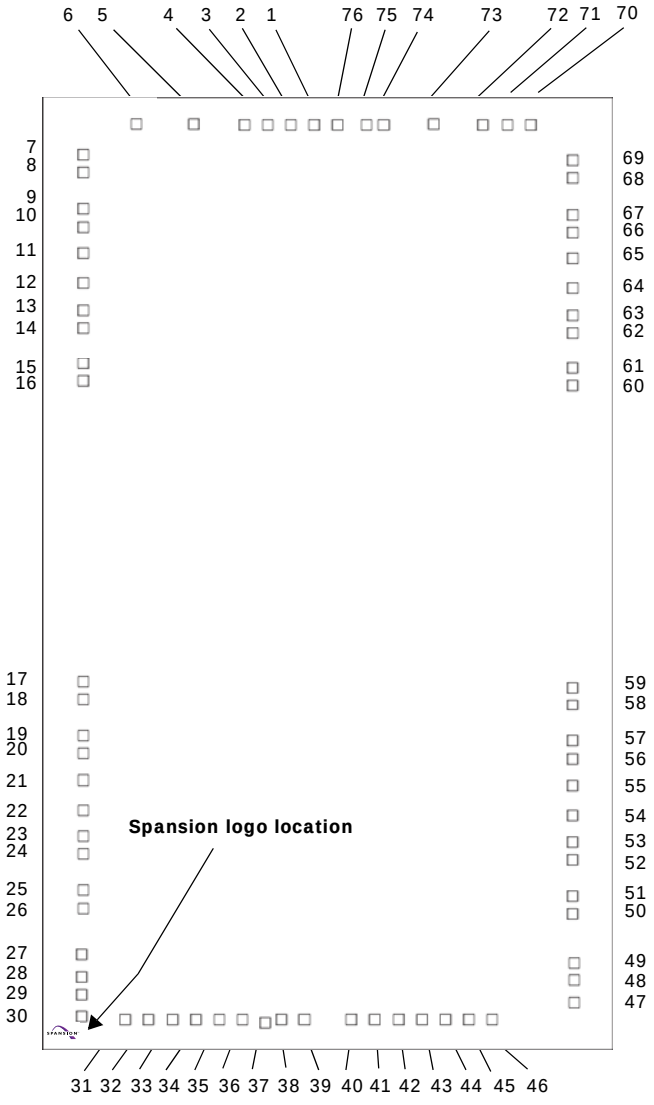
Product Selector Guide

Part Number	S29CD016G KGD Synchronous/Burst or Asynchronous	
Standard Voltage Range: V_{CC} = 2.5 – 2.75 V		
Speed Option (Clock Rate)	**56 MHz**	**40 MHz**
Max Initial/Asynchronous Access Time, ns (t_{ACC})	64	67
Max Burst Access Delay (ns)	10	17
Max Clock Rate (MHz)	56	40
Max CE# Access, ns (t_{CE})	69	71
Max OE# Access, ns (t_{OE})	20	28

Die Photograph



Die Pad Locations



Pad Description

Table I. Pads Relative To Die Center

Pad	Signal	Pad Center (mils)		Pad Center (µm)		Pad	Signal	Pad Center (mils)		Pad Center (µm)	
		X	Y	X	Y			X	Y	X	Y
1	CE#	137.593	4.11	3494.869	104.405	39	V_{CC}	-137.624	7.053	-3495.639	179.151
2	OE#	137.593	11.306	3494.869	287.185	40	A9	-137.624	-7.462	-3495.639	-189.525
3	WE#	137.593	18.503	3494.869	469.965	41	A10	-137.624	-14.658	-3495.639	-372.305
4	WP#	137.593	25.699	3494.869	652.745	42	A11	-137.624	-21.854	-3495.639	-555.085
5	IND/WAIT#	137.823	41.296	3500.712	1048.914	43	A12	-137.624	-29.05	-3495.639	-737.865
6	MCH	137.593	59.106	3494.869	1501.304	44	A13	-137.624	-36.246	-3495.639	-920.645
7	DQ16	128.262	75.281	3257.864	1912.141	45	A14	-137.624	-43.442	-3495.639	-1103.425
8	DQ17	122.8	75.281	3119.125	1912.141	46	A15	-137.624	-50.638	-3495.639	-1286.205
9	DQ18	111.643	75.281	2835.721	1912.141	47	A16	-132.322	-75.784	-3360.967	-1924.918
10	DQ19	106.18	75.281	2696.983	1912.141	48	A17	-125.504	-75.784	-3187.801	-1924.918
11	V_{CCQ}	98.166	75.281	2493.417	1912.141	49	A18	-120.144	-75.784	-3051.647	-1924.918
12	V_{SS}	88.992	75.281	2260.402	1912.141	50	DQ0	-105.22	-75.237	-2672.587	-1911.03
13	DQ20	80.757	75.281	2051.24	1912.141	51	DQ1	-99.758	-75.237	-2533.85	-1911.03
14	DQ21	75.295	75.281	1912.502	1912.141	52	DQ2	-88.6	-75.237	-2250.446	-1911.03
15	DQ22	64.138	75.281	1629.098	1912.141	53	DQ3	-83.138	-75.237	-2111.708	-1911.03
16	DQ23	58.676	75.281	1490.36	1912.141	54	V_{CCQ}	-75.124	-75.237	-1908.141	-1911.03
17	DQ24	-33.786	75.281	-858.164	1912.141	55	V_{SS}	-65.95	-75.237	-1675.125	-1911.03
18	DQ25	-39.248	75.281	-996.901	1912.141	56	DQ4	-57.715	-75.237	-1465.964	-1911.03
19	DQ26	-50.406	75.281	-1280.306	1912.141	57	DQ5	-52.253	-75.237	-1327.226	-1911.03
20	DQ27	-55.868	75.281	-1419.043	1912.141	58	DQ6	-41.095	-75.237	-1043.822	-1911.03
21	V_{CCQ}	-64.103	75.281	-1628.205	1912.141	59	DQ7	-35.633	-75.237	-905.084	-1911.03
22	V_{SS}	-73.276	75.281	-1861.221	1912.141	60	DQ8	57.146	-75.237	1451.515	-1911.03
23	DQ28	-81.291	75.281	-2064.787	1912.141	61	DQ9	62.608	-75.237	1590.252	-1911.03
24	DQ29	-86.753	75.281	-2203.525	1912.141	62	DQ10	73.766	-75.237	1873.656	-1911.03
25	DQ30	-97.911	75.281	-2486.929	1912.141	63	DQ11	79.228	-75.237	2012.395	-1911.03
26	DQ31	-103.373	75.281	-2625.667	1912.141	64	V_{CCQ}	87.463	-75.237	2221.556	-1911.03
27	MCH	-117.607	75.828	-2987.228	1926.03	65	V_{SS}	96.637	-75.237	2454.572	-1911.03
28	A0	-124.425	75.828	-3160.394	1926.03	66	DQ12	104.651	-75.237	2658.138	-1911.03
29	A1	-129.785	75.828	-3296.548	1926.03	67	DQ13	110.113	-75.237	2796.876	-1911.03
30	A2	-136.603	75.828	-3469.713	1926.03	68	DQ14	121.271	-75.237	3080.28	-1911.03
31	A3	-137.624	62.39	-3495.639	1584.695	69	DQ15	126.733	-75.237	3219.018	-1911.03
32	A4	-137.624	55.194	-3495.639	1401.915	70	V_{CCQ}	137.593	-62.45	3494.869	-1586.234
33	A5	-137.624	47.997	-3495.639	1219.135	71	RESET#	137.593	-55.334	3494.869	-1405.487
34	A6	-137.624	40.801	-3495.639	1036.355	72	CLK#	137.593	-47.54	3494.869	-1207.507
35	A7	-137.624	33.605	-3495.639	853.575	73	RY/BY#	137.823	-32.453	3500.712	-824.315
36	A8	-137.624	26.409	-3495.639	670.795	74	ADV#	137.593	-17.131	3494.869	-435.119
37	V_{SS}	-138.446	19.405	-3516.539	492.898	75	V_{SS}	137.593	-11.782	3494.869	-299.269
38	ACC	-137.624	14.057	-3495.639	357.048	76	V_{CC}	137.593	-2.893	3494.869	-73.492

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

Ordering Information

The order number (Valid Combination) is formed by the following:

S29CD0I6G 0J D E I 00 4

PACKING TYPE
4 = Surf Tape TGR
5 = Emboss Tape
7 = Waffe Pack

ADDITIONAL ORDERING OPTIONS
00 = 4 Mb in Bank 1, 12 Mb in Bank 2, WP# protects sectors 76 and 77
01 = 12 Mb in Bank 1, 4 Mb in Bank 2, WP# protects sectors 0 and 1

TEMPERATURE RANGE
I = Industrial (–40°C to +85°C)
E = Extended (–40°C to +125°C)
H = Hot (–40°C to +145°C)

DIE THICKNESS
E = 750 µm
G = 500 µm

PACKAGE TYPE
D = Die

CLOCK FREQUENCY
0J = 40 MHz
0M = 56 MHz

DEVICE NUMBER / DESCRIPTION
S29CD016G
16 Megabit (512K x 32-Bit) CMOS 2.5 Volt-only Burst Mode,
Dual Boot, Simultaneous Read/Write Flash Memory
Manufactured on 170 nm floating gate technology

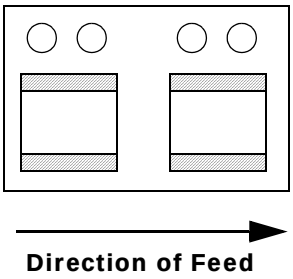
OPN Valid Combinations						
S29CD016G	OJ, OM	D	E, G	I, E, H	00, 01	4, 5, 7

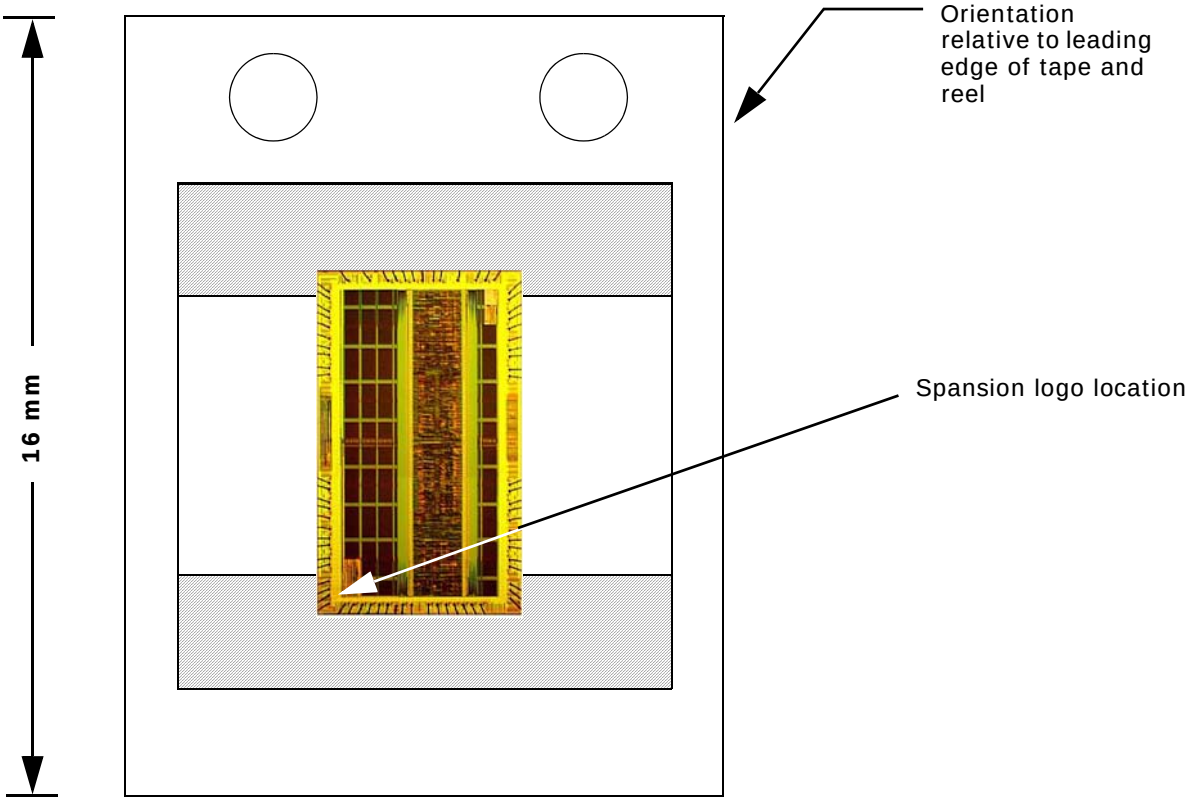
Valid Combinations

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

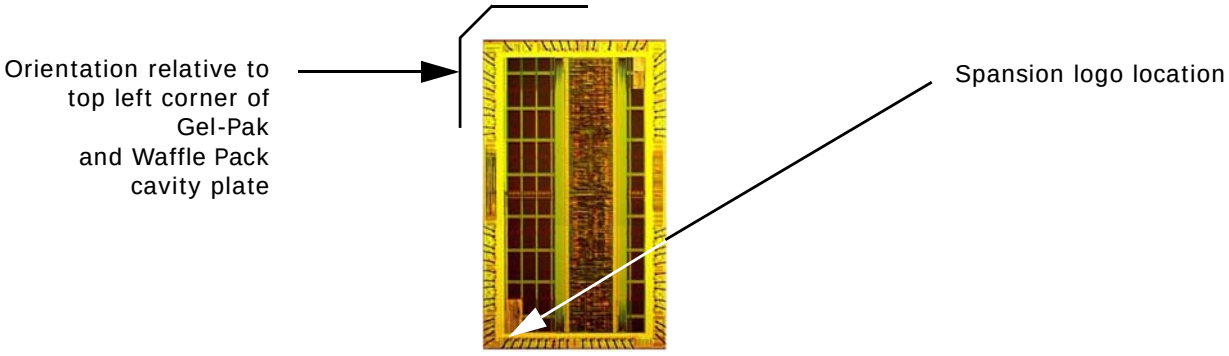
Packaging Information

Surftape Packaging





Gel-Pak and Waffle Pack Packaging



Product Test Flow

Figure 1 provides an overview of Spansion's Known Good Die test flow. For more detailed information, refer to the S29CD016G product qualification database. Spansion implements quality assurance procedures throughout the product test flow. These QA procedures also allow Spansion to produce KGD products without requiring or implementing burn-in. In addition, an off-line quality monitoring program (QMP) further guarantees Spansion quality standards are met on Known Good Die products.

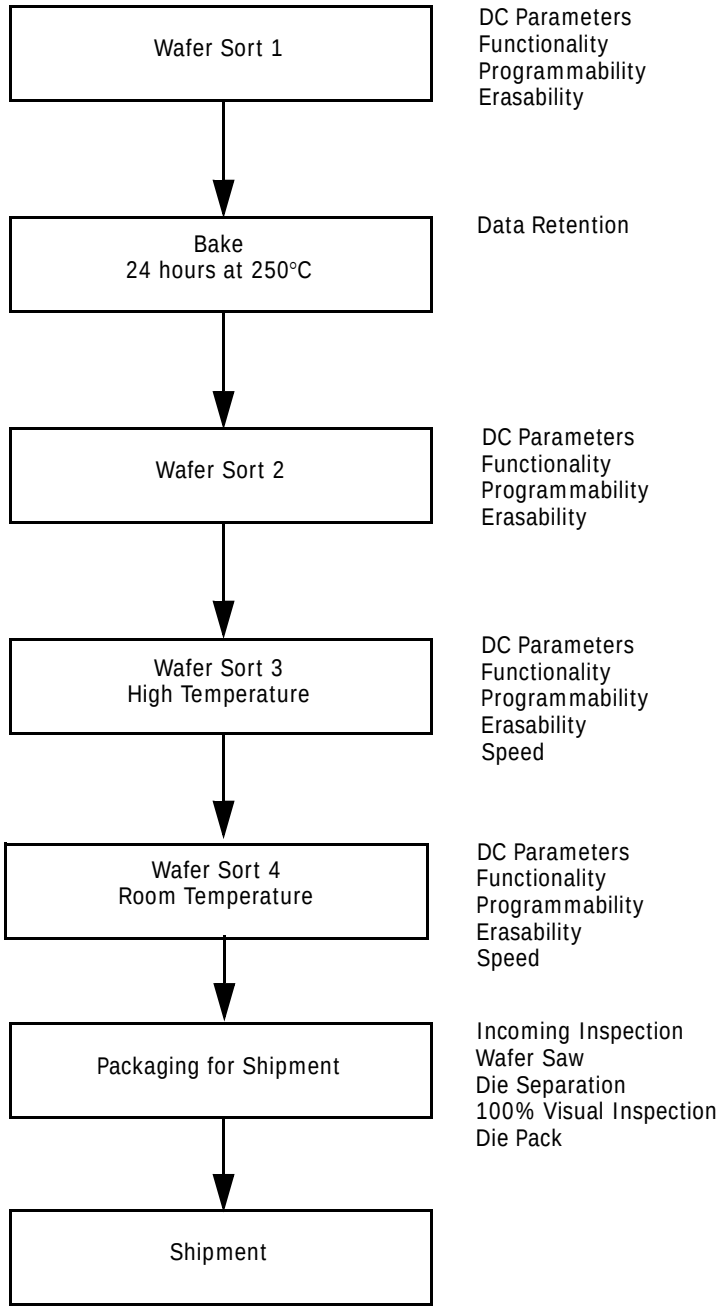


Figure 1. Spansion KGD Product Test Flow

Absolute Maximum Ratings

Storage Temperature, Plastic Packages . . . . . –65°C to +150°C

Ambient Temperature with Power Applied . . . . . –65°C to +145°C

V_{CC}, V_{IO} (Note 1) . . . . . –0.5 V to + 3.0 V

ACC, A9, OE#, and RESET# (Note 2) . . . . . –0.5 V to +13.0 V

Address, Data, Control Signals
(Note 1) . . . . . –0.5 V to 3.60 V

All other pins (Note 1) . . . . . –0.5 V to +3.60 V

Output Short Circuit Current (Note 3). . . . . 200 mA

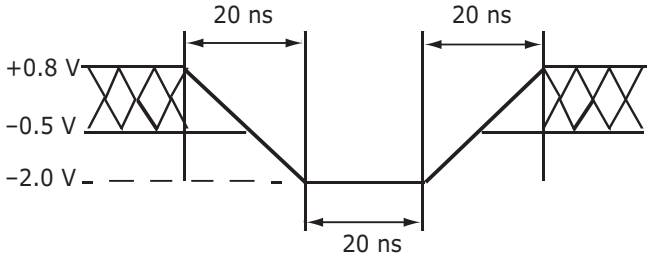


Figure 2. Maximum Negative Overshoot Waveform

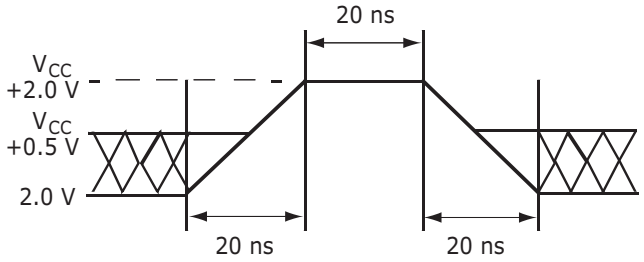


Figure 3. Maximum Positive Overshoot Waveform

Notes:

1. *Minimum DC voltage on input or I/O pins is –0.5 V. During voltage transitions, input at I/O pins may overshoot V_{SS} to –2.0 V for periods of up to 20 ns. Maximum DC voltage on output and I/O pins is 3.6 V. During voltage transitions output pins may overshoot to V_{CC} + 2.0 V for periods up to 20 ns.*
2. *Minimum DC input voltage on pins ACC, A9, OE#, and RESET# is -0.5 V. During voltage transitions, A9, OE#, and RESET# may overshoot V_{SS} to –2.0 V for periods of up to 20 ns. Maximum DC input voltage on pin A9 and OE# is +13.0 V which may overshoot to 14.0 V for periods up to 20 ns.*
3. *No more than one output may be shorted to ground at a time. Duration of the short circuit should not be greater than one second.*
4. *Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational sections of this data sheet is not implied. Exposure of the device to absolute maximum rating conditions for extended periods may affect device reliability.*

Operating Ranges

Ambient Temperature (T_A), Industrial Range . . . . . –40°C to +85°C
Ambient Temperature (T_A), Extended Range . . . . . –40°C to +125°C
Ambient Temperature (T_A), Hot Range . . . . . –40°C to +150°C
V_{CC} Supply Voltage for regulated voltage range . . . . . 2.5 V to 2.75 V
V_{IO} Supply Voltage . . . . . 1.65 V to 2.75 V

Note: *Operating ranges define those limits between which the functionality of the device is guaranteed.*

Physical Specifications

Die dimensions . . . . . 7.44 x 4.46 mm
Die Thickness . . . . . 750 or 500 µm
Bond Pad Size . . . . . 86 x 86 µm
Pad Area Free of Passivation . . . . . 6,724 μm^2
Pads Per Die 76
Bond Pad Metalization . . . . . Al/Cu
Passivation . . . . . SiN/SOG/SiN

Manufacturing Information

Manufacturing . . . . . FASL
Test . . . . . FASL
Manufacturing ID (Top Boot) 98P04AK
(Bottom Boot) 98P04ABK
Preparation for Shipment . . . . . Penang, Malaysia
Fabrication Process CS59LS
Die Revision 1

Special Handling Instructions

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.

Storage

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

DC characteristics for KGD Devices at I45°C

CMOS Compatible

Parameter	Description	Test Conditions		Min	Typ	Max	Unit
I_{CC1}	V_{CC} Active Asynchronous Read Current	CE# = V_{IL}, OE# = V_{IL}	1 MHz		5	10	mA
I_{CC3}	V_{CC} Active Burst Read Current	CE# = V_{IL}, OE# = V_{IL}, 8 Double-Word	56 MHz		60	90	mA
I_{CC5} (Note 1)	V_{CC} Standby Current (CMOS)	V_{CC} = V_{CCmax}, CE# = V_{CC} ± 0.3 V			15	150	µA
I_{CC7} (Note 1)	V_{CC} Reset Current	Reset = V_{IL}				150	µA
I_{CC8} (Note 1)	Automatic Sleep Mode Current	V_{IH} = V_{CC} ± 0.3 V, V_{IL} = V_{SS} ± 0.3 V				150	µA

Notes:

1. *Current maximum has been significantly increased (x27) from KGD Supplement Revision A, Amendment 1, dated April 21, 2003.*
2. *The I_{CC} current listed includes both the DC operating current and the frequency dependent component.*

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.

Revision Summary

Revision A (January 17, 2005)

Initial release.