

A storm raging for centuries.

A volcano almost twice as high
as Mount Everest.

Temperatures hot enough to melt lead. (662°F)

VOLCANOES SPEWING ICE AND SULFUR COMPOUNDS.

Winds reaching speeds of 1,200 miles per hour.

Space isn't for the faint of heart.

It also isn't for semiconductors
not built with this in mind.



Satellite systems, space flight and exploration requirements continue to outgrow the available space level component technologies. The industry needs greater performance, lower power, higher integration levels and cost-effective solutions. Texas Instruments is supporting the demanding nature of space applications through MIL-PRF-38535 QML Class V products.

TI continues investing in technologies that help make space programs successful. TI's extensive portfolio of QML Class V devices includes Digital Signal Processors, Power Management, Analog, Mixed-Signal, Digital Logic and ASICs. Additional releases are under evaluation. If there is some function or technology TI offers that is not currently included in our QML Class V line, contact TI's Space Products Marketing Team at:

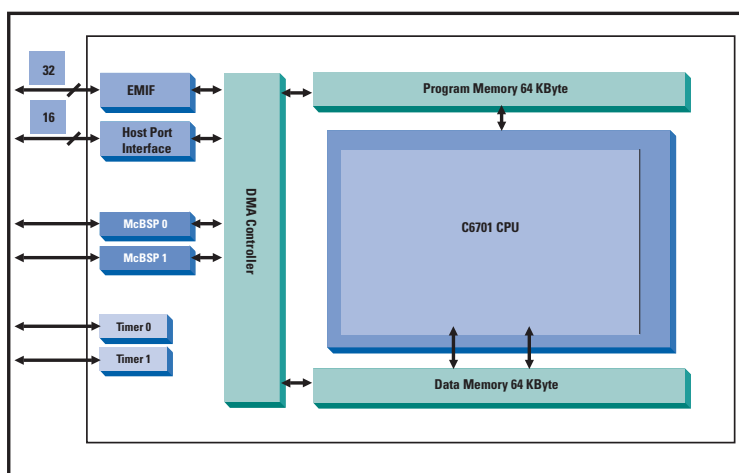
www.ti.com/sc/docs/general/military/feedback.htm

TI QML Class V Semiconductor Product Benefits

- Industry's first Class V floating-point 32-bit DSP (SMV320C6701) at 840 MFLOPS
- Cost-effective solutions
- Short lead times
- Customer-driven portfolio
- Broad product offering including Uniprode power management devices
- Latest available technology
- High performance devices
- Lot sequestering (same diffusion lot) available upon request
- All TI QML Class V flows are approved by DSCC, NASA and Aerospace Corporation
- Large selection of 3.3-V Digital Logic functions

Industry's First QML Class V C6701 Floating-Point DSP

- Advanced VelociTI™ very-long-instruction-word (VLIW) architecture
- Up to 1120 MIPS & 840 MFLOPS @ 140 MHz
- 1 Mbit On-Chip SRAM for fast program/data access
- 2 Multi-Channel Buffered Serial Ports (McBSPs) provide glueless connect to codecs & framers, full duplex operation, and support SPI and ST-Bus
- 429-pin CBGA dimpled package
- Order as 5962-9866101VXA (-55°C to 115°C Tcase) or order as 5962-9866102VXA (-55°C to 125°C Tcase)



Test Device: SMV320C6701GLPW14

SMV320C6701 Representative Radiation Data Summary

- SMV3206701 is not susceptible to SEL up to tested LET of 89 MeV/mg/cm² and max temperature of 125°C
- The DSP has an estimated worst-case SEU rate of 4.0E-03 upsets/device-day or ~250 days per upset (GEO orbit)



- The DSP did not show significant sensitivity to different bias voltages and temperatures during SEE testing
- The total gamma dose hardness level is 100 krad(Si)
- SMV3206701 is suitable for Space and for all spacecraft orbits (GEO, LEO, etc.)
- Proton upset rate estimation applicable for LEO orbits is underway

SMV320C6701 Total Ionizing Dose Test Results

- Radiation Levels: 40, 50, 60, 70, 100, 150 and 200 krad(Si)
- Pre and post-radiation deltas were calculated on a per device basis, then organized by group.
- Total of 214 Test parameters characterized for each device.
- The ANOVA (Analysis of Variance) Study:
40, 50, 60, 70, 100 krad(Si)
 - There were few device parameters which exhibited any statistically significant difference
 - In every case, the maximum delta observed was well within the resolution of the tester
- No device failures up to Total Dose of 100 krad(Si)
- All devices subjected to 150 krad(Si) failed Tri-state leakage on multiple pins
- All devices subjected to 200 krad(Si) failed Supply shorts and Tri-state leakage on multiple pins
- Full report available at www.ti.com/space



SMV320C6701C6701 SEE Test Summary

The Single Event Effects (SEE) response of the SMV320C6701 was tested with heavy ions.

The processor was tested for Single Event Latch-up (SEL) and Single Event Upsets (SEU) at room and high temperature. An

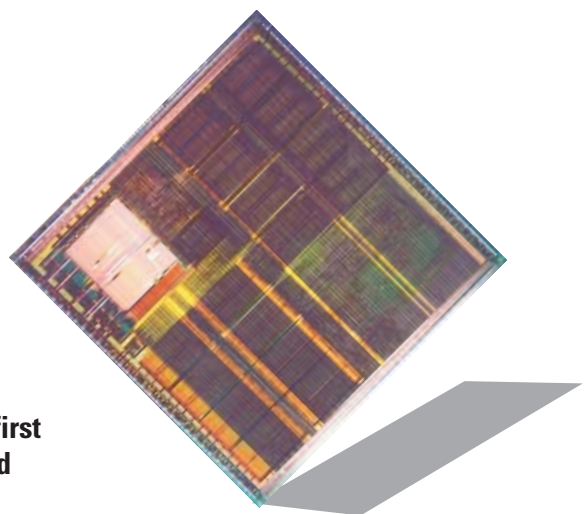
innovated test methodology and test flow was developed for evaluating the SEU response of different functional blocks. The SEU response of various functional blocks of the DSP at different LET was documented.

SMV320C6701 SEE Test Details and Key Parameters

SEE Test Device—Key Parameters

F.Y.I.

Design Features		Process Features		Library Features	
Core Vdd	1.90 V	Starting Substrate (Baseline for Class-V)	EPI (3.5 μm)	Metal Levels	5
IO Vdd	3.3 V	STI Depth	5000 Å	Flip Chip	Yes
Core Lpoly	0.18 μm	—	—	PLL	Yes
Core tox	40 Å	—	—	—	—
IO Lpoly	0.45 μm	—	—	—	—
IO tox	80 Å	—	—	—	—



The SMV320C6701, a high performance floating-point device, is the industry's first digital signal processor (DSP) qualified for space-based applications.

Test Details—Heavy Ion Beam Parameters

Ions	Incident Angle	LET eff MeV/mg/cm ²	# of Units	Test Temperature
Ar	0°	6.24	1	25°
Ar	45°	9.16	2	25°
Kr	0°	23.6	2	25°
Kr	45°	35.4	2	25°
Xe	0°	47.1	1	25°
Xe	45°	71.1	1	25°
Xe	45°	71.1	3	125°
Xe	45°+ #2 Degraded	89	3	125°

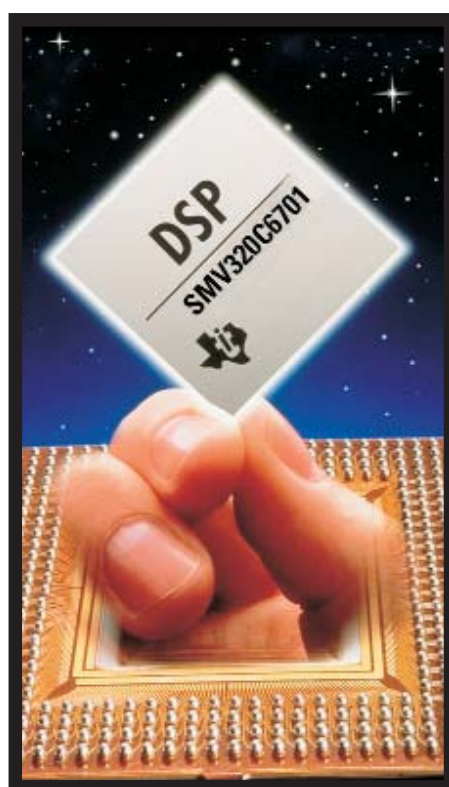
Test Location: Texas A&M University Cyclotron Facility (TAMU-CF), College Station, Texas, USA

Website: <http://cyclotron.tamu.edu>

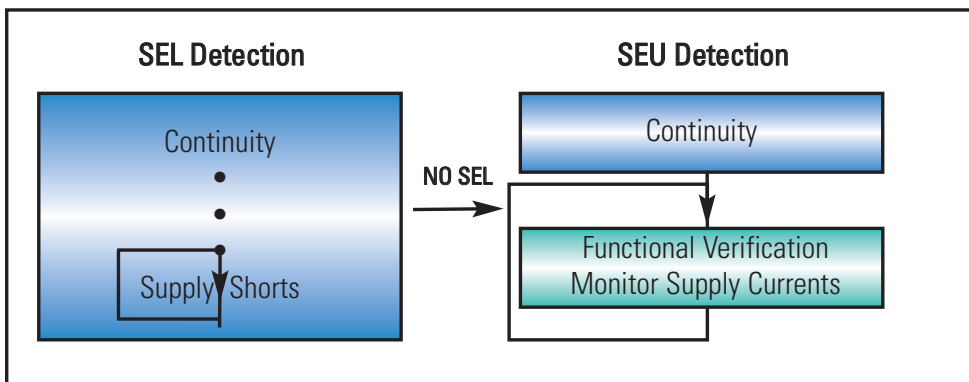
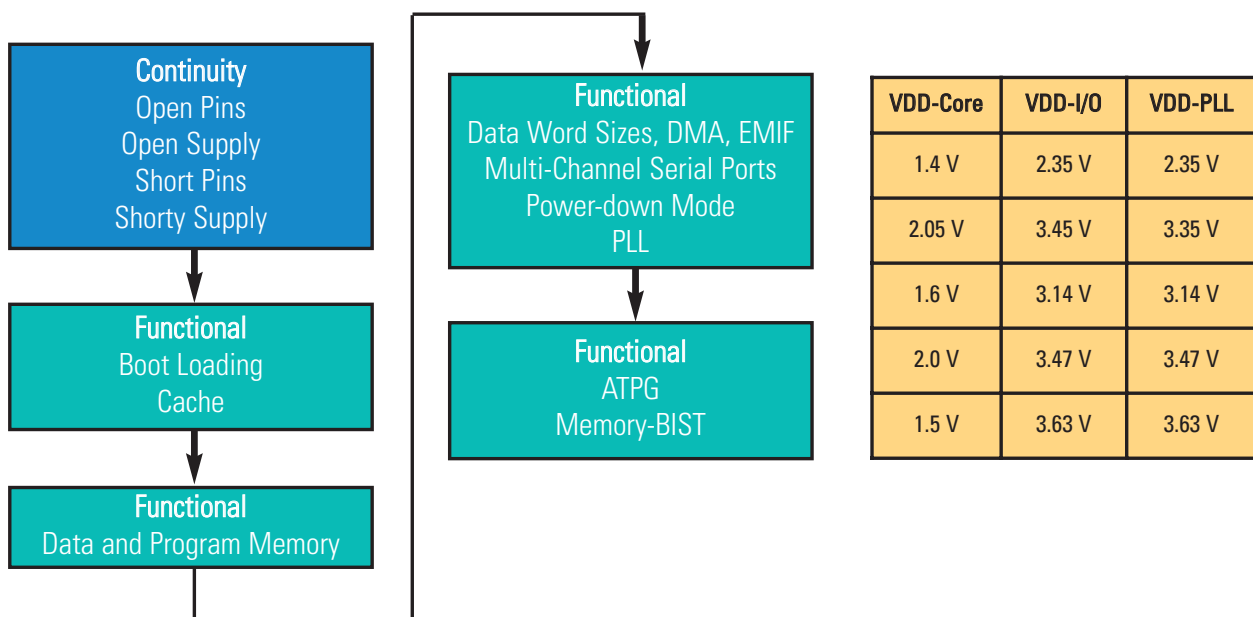
Test Date: May 18, 2004

SEE Test System: Monitoring and Recording Equipment

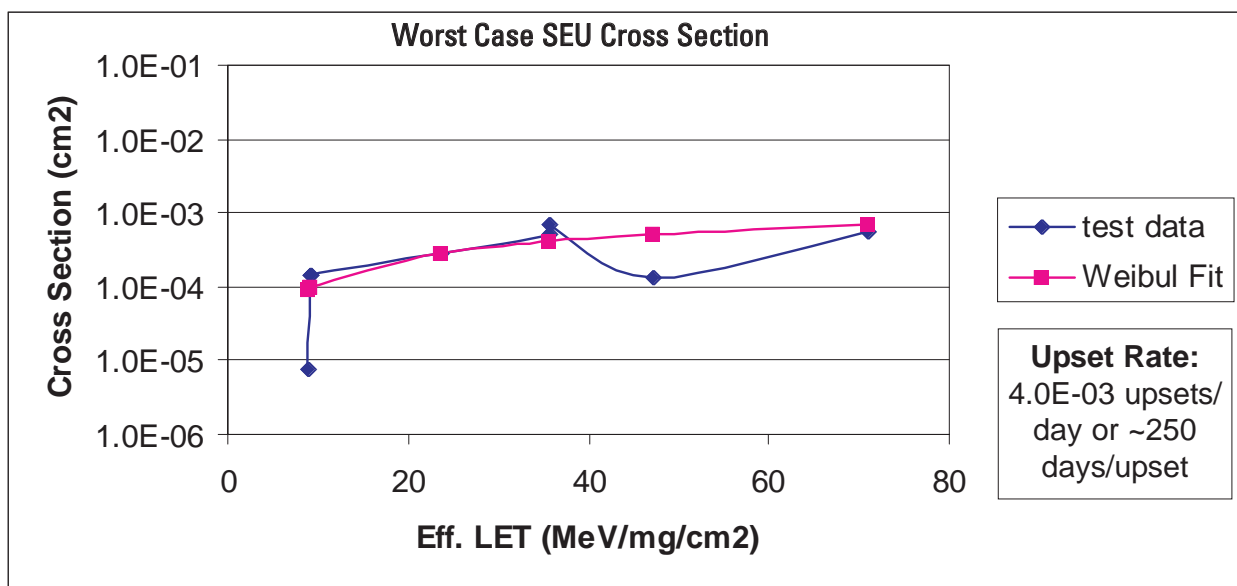
- Texas Instruments 256-pins Automatic Test Equipment (ATE)
- Monitor supply currents (I/Os and Core)
- Automatic power-down when supply currents exceed user programmed limits
- Event-Driven, exhaustive Functional and SCAN testing
-Analogous to ~5-10 MHz test frequency
- High-speed (167 MHz) memory testing via internal-BIST
- Log parameters and fail counts



SMV320C6701 SEE Test Flow



SMV320C6701 SEU Characteristics



The SMV320C6701 is not susceptible to SEL up to tested LET of 89 MeV/mg/cm² and max temperature of 125°C.

SMV320C6701 High Energy Neutrons

- Test Site: Los Alamos Neutron Science center
- 800 MeV proton linear accelerator (linac)
- 238U Fission Foil used for upper level counts
- Four devices tested at 125°C
- Supply currents and fail signature for functional failures were monitored.
- No latch-up events were observed
- Based on neutron count, latch-up free operation of device in terms of years at sea level and 40k feet is calculated.

Unit 1: 3.5-V I/O, 1.9-V Core				Neutrons/cm ² /Hr			Equivalency (Years)	
Temp	Duration (hours)	Upper Level Count	Neutrons/Count	Beam	Sea Level	40k Feet	Sea Level	40k Feet
25°C	4.50	851,780	16,600	1.41E + 10	20	5016	3.63E + 05	1.45E + 03
125°C	0.75	165,000	16,600	2.74E + 09	20	5016	1.17E + 04	4.68E + 01
25°C	11.75	1,886,600	16,600	3013E + 10	20	5016	2.10E + 06	8.37E + 03
Unit 2: 3.58-V I/O, 2.05-V Core				Neutrons/cm ² /Hr			Equivalency (Years)	
Temp	Duration (hours)	Upper Level Count	Neutrons/Count	Beam	Sea Level	40k Feet	Sea Level	40k Feet
125°C	8.00	1,387,519	16,600	2.30E + 10	20	5016	1.05E + 06	4.19E + 03
Unit 3: 3.58-V I/O, 2.05-V Core				Neutrons/cm ² /Hr			Equivalency (Years)	
Temp	Duration (hours)	Upper Level Count	Neutrons/Count	Beam	Sea Level	40k Feet	Sea Level	40k Feet
25°C	8.00	1,326,906	16,600	2.20E + 10	20	5016	1.01E + 06	4.01E + 03
125°C	7.75	1,156,381	16,600	1.92E + 10	20	5016	8.49E + 05	3.39E + 03
Unit 4: 3.58-V I/O, 2.05-V Core				Neutrons/cm ² /Hr			Equivalency (Years)	
Temp	Duration (hours)	Upper Level Count	Neutrons/Count	Beam	Sea Level	40k Feet	Sea Level	40k Feet
125°C	13	2,082,260	16,600	3.46E + 10	20	5016	2.56E + 06	1.02E + 04





TI purchased Unitrode in 1999 and started delivering Class V-level Unitrode devices in mid-2000. The Unitrode Merrimack fab facility was shut down in 2001 with TI Military Semiconductor acquiring a significant die bank of Merrimack material for TI's Class V Unitrode business. Today,

TI has 25 unique Class V Unitrode device functions released in typically 2 package flavors (ceramic LCC and DIP).

The majority of these functions are being sourced from Merrimack material as shown:

- 20 device functions have 5 year plus Merrimack die supply
- 2 device functions have 1-3 year plus Merrimack die supply
- 3 device functions have moved to TI Sherman fab die as the Merrimack die supply is exhausted/minimal

The Unitrode link at www.ti.com/space and contains a complete Class V Unitrode matrix outlining fab supply, duration, etc. The matrix and web site also have links to existing radiation data.

TI Worldwide Technical Support

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Asia

Internet support.ti.com/sc/pic/asia.htm