Space Solutions

DDC®
Connectivity Power Control

Your Solution Provider for...

Space Grade Radiation Hardened Components & Subsystems

DDC is a world-class supplier of space grade, radiation hardened components and subsystems, enabled with RAD-PAK® technology, Rad-Hard by Design and/or Process, Triple Mode Redundancy and Error-Correction Codes, as well as memories that are Reed Solomon protected with Double Device Correction.

DDC offers certified radiation hardened solutions to meet the most critical and extreme space mission requirements. Our tightly controlled manufacturing processes utilize the latest production equipment to produce the industry leading products that have been successfully deployed over the past 30 years, in the harshest space environments.

Space Orbits

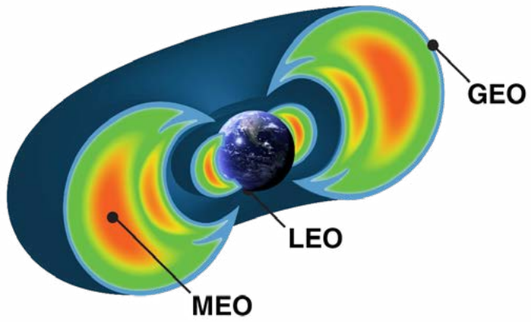
Low Earth Orbits (LEO) — 200km < LEO < 2,000km
Severe proton environment due to the South Atlantic Anomaly.
Orbital Environment:
South Atlantic Anomaly, radiation belts, coronal mass ejection, & proton SEU (Single Event Upset)
Missions deployed with DDC solutions:*
ISS, Hubble, Gonets, Proba III, ALOS, GOSAT-2, Meteor-3, and Pleiade

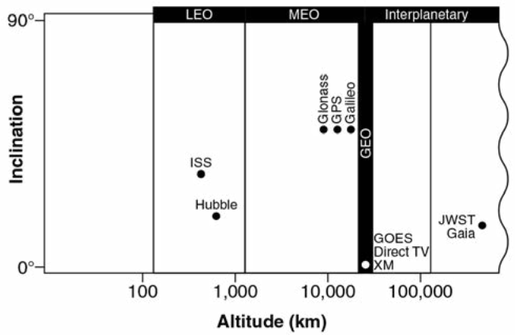
Medium Earth Orbits (MEO) — 2000km < MEO < 35,000km
High proton and electron flux due to operation in the Van Allen Belts.
Orbital Environment:
Highly variable radiation belts, coronal mass ejection, geomagnetically trapped radiation and particles, and proton SEU
Missions deployed with DDC solutions:*
GPS, Galileo, and Glonass

Geostationary Earth Orbits (GEOs) and Near-Earth Interplanetary — GEO = 35760km, L2 = 1,500,000km
Exposed to galactic cosmic rays and solar flare particles.
Orbital Environment:
Galactic cosmic rays, heavy ion SEU, and coronal mass ejection
Missions deployed with DDC solutions:*
Gaia, JWST, Kepler, Planck, Dawn, Hershel Space Observatory, and Jason

Interplanetary Missions
Exposed to galactic cosmic rays, solar flare particles, and may face additional threats from the planetary radiation environment (e.g. Jupiter).
Orbital Environment:
Galactic cosmic rays, coronal mass ejection, trapped radiation (planet dependent), and Heavy Ion SEU
Missions deployed with DDC solutions:*
Messenger, OSIRIS-REx, Rosetta, Juno, Rovers (Spirit, Opportunity, Curiosity)

**Note: Sample listing of missions deployed with DDC products on-board.*





Manufacturing & Testing

Space & Radiation Hardened Microelectronics Testing & Analytics

Modeling and Analysis:
- Circuit Upset Rate
- Error Correction Code Effectiveness
- Space Radiation Environments
- Shielding Attenuation
- Telemetry Correlation

Radiation Testing Capabilities:
- High Dose Rate TID
- ELDRS Effect
- Displacement Damage
- Single Event Effects
- Prompt Dose

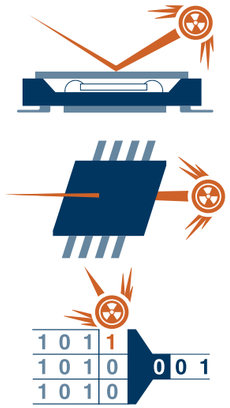
QCI & Other Services

Components:
- Quality Conformance Inspection:
  - Group A: Electrical Performance
  - Group B: Assembly Verification
  - Group C: Life Test
  - Group D: Package Qualifications
- Destructive Physical Analysis (DPA)
- Element Evaluation
- Variables Data
- Screening Attributes Summary
- Die Lot Specific TID Report
- Customer Source Inspection
- Particle Impact Noise Detection
- 100% Non-Destructive Wirebond Pull Test
- Real-time X-ray Inspection
- Class A Grade Flow with Reduced Screening Enables Lower Cost

Boards & Subsystems:
- Program Management
- Reviews (MRR, TRR, PSR)
- J-STD-001ES Certified
- NASA-STD-8739.1B Certified
- In-House EMI/EMC Test Lab
- Acceptance & Qual Testing
- End Item Data Pack/EIDP
- PTC Integrity Traceability

DDC Sp-COTS Assurance (CERTIFIED, RADIATION, PERFORMANCE)

Sp-COTS
Space Commercial Off-The-Shelf (Sp-COTS™) radiation hardened microelectronic solutions offer the optimal combination of high-performance functionality, in a highly-reliable, and economical package. Utilizing advanced commercially-available microelectronics, with DDC's best-in-class radiation-mitigation expertise (error correction, TMR and Rad- Pak® radiation shielding technology), Sp-COTS products are assembled, screened and qualified at DDC's MIL-PRF-38534/5 certified production facilities, and come with a radiation-performance guarantee, ensuring confidence and satisfaction for the most challenging space missions.



Radiation Hardening Techniques

Advanced Commercially-Available Components with RAD-PAK® Technology

DDC's RAD-PAK® technology improves TID (Total Ionizing Dose) hardness by shielding the semiconductor die. RAD-PAK® enables the latest commercially-available electronic integrated circuits to be deployed on various space missions, by tailoring the shielding thickness to mitigate the specific space-radiation environment.

Radiation Hardened by Design & Process

DDC has successfully deployed mixed-signal and digital ASICs on multiple space missions via its portfolio of MIL-STD-1553 interface, motion feedback, and motor control and drive solutions. To mitigate TID & SEE (Single Event Effects) these Multi-Chip Modules (MCMs) incorporate ICs employing the latest state-of-the-art rad-hard by design techniques, as well as modern dielectrically-isolated semiconductor processes. DDC selectively applies rad-hard libraries and or processes that are proven to be radiation hardened to optimize performance.

Triple Mode Redundancy (TMR) & Error-Correction Codes (ECC)

In high-reliability systems, DDC employs TMR and ECC to mitigate TID & SEE. In both methods, failure-free operation is ensured by the use of redundancy. In the case of TMR, the output of three processors is run through a voting algorithm, and an error in one processor may then be "out-voted" by the other two processors. Additionally, incorrect data is resolved by applying Error Correction Codes and computing algorithms with redundant data-bits. With multiple error-correction tools, the level of correction can be tailored to the severity of the environment.

Quality Assurance & Capabilities

Our commitment to achieving the highest levels of quality and performance has distinguished DDC as the leader in the production of high reliability, space-grade solutions. DDC's manufacturing facilities ensure customer satisfaction with quality products, dependable processing, and superior designs.

DDC's Manufacturing Certifications

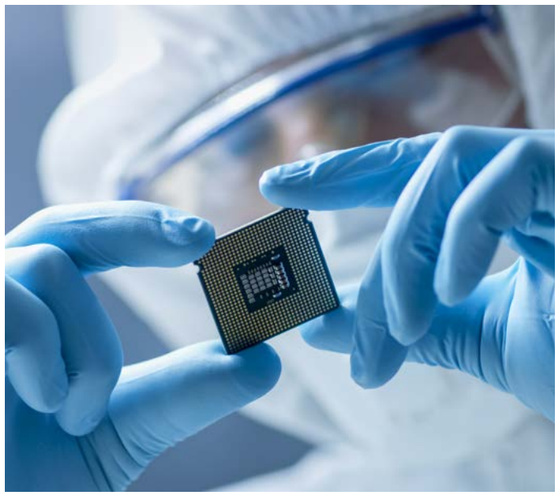
Underwriters Laboratories (UL) Certified:
- AS9100, Rev. D Certified
- EN9100 Compliant
- JIS Q9100 Compliant

DLA Land and Maritime Certified:
- MIL-PRF-38534 Class D, G, H & K
- MIL-PRF-38535 Class B, Q, S & V

Audited by and Approved Supplier for:

NASA JAXA esa

DDC's solutions offer a total dose immunity of 100 krads or higher, and have been qualified by NASA, ESA, JAXA on hundreds of missions for more than 20 years without any flight failures.



www.ddc-web.com/Space-Solutions

Capabilities

Subsystems

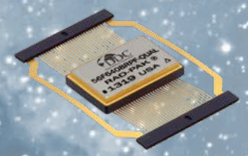
DDC's capabilities to produce subsystems for computing, data networking, motion control, and power management applications, are enabled by our extensive portfolio of radiation hardened components and techniques, along with an experienced team including our radiation physicist. These subsystems are tailored to provide unparalleled protection from the radiation, protons, cosmic rays, and solar-heavy ions encountered in space.

Data Networking
- 200 to 1800 MIPS
- SDRAM & NAND Flash
- SpaceWire Ports - 200Mbps
- MIL-STD-1553 Ports
- Ethernet & CANbus Ports

Motion Control
- Motor Control
- Motor Drives
- Position Feedback & Control
- Embedded Software

Power Management
- Solid-State Power Control
- Power Conversion
- Power Management and Distribution (PMAD)

Radiation Mitigation



DDC's RAD-PAK® shielding technology enables the most up-to-date, commercially-available non-Rad-Hard semiconductors to be used in high total-dose environments. With a variety of techniques available, radiation mitigation can be optimized for missions ranging from LEO to interplanetary space.

TID Mitigation
- Radiation Testing & Lot Characterization
- Space Qualified Radiation Hardened Parts
- RAD-PAK® Spot Shielding

SEE & TID Mitigation
- Triple Mode Redundancy (TMR)
- Error Correcting Codes (ECC)
- Error Detection & Correction (EDAC)

SEE Mitigation
- Latch-Up Protection ASIC

Prompt Dose Mitigation
- Nuclear Event Detectors
- XRAY-PAK®

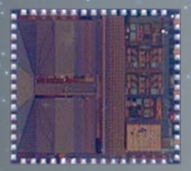
Microelectronic Packaging

DDC's space grade electronic components range from plastic encapsulated ball grid arrays (BGA) to Class K hermetically sealed hybrid components; meeting the critical standards of space, where failure can be mission-ending and repair is not an option.

Packaging Technique
- RAD-PAK®
- Radiation Tolerant (RT)
- Plastic Encapsulated BGA
- High-Temp Co-Fired Ceramic
- Flip Chip
- Chip-On-Board
- Die Stacking
- Power Hybrids
- Seam Welded Lids
- Hermetic Hybrids & MCMs
- Embedded Magnetics Produced In-House

In-House Screening
- High Definition Leak Detection
- Screened PEMs
- Real Time X-Ray

ASIC Design

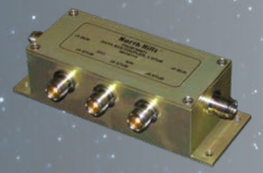


DDC's radiation hardened standard products include our proprietary SEE /SEU Immune Rad Hard ASICs. DDC's engineering staff includes a team of dedicated ASIC design and test engineers that bring to your project, decades of experience, along with the design tools and test capabilities required to deliver space grade solutions. The DDC ASIC team works closely with DDC's customers and foundry suppliers to optimize solutions for robust operation in the targeted environment.

Specializing In...
- Data Bus & Networking Solutions
- DO-254 & DO-178 Compliant Designs
- Mixed Signal for Motion Control & Power Management Applications

Experienced with the Following Processes
- CMOS
- BiCMOS
- BCDMOS
- HVIC
- GaAs
- SOI

Magnetics & Couplers



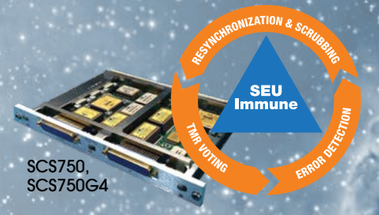
DDC's Beta Transformer and North Hills magnetics group supplies space-grade transformers and magnetics to the International Space Station, as well as numerous satellites and space systems.

Specifications
- MIL-PRF-27
- MIL-PRF-21038
- MIL-STD-202
- MIL-STD-981
- MIL-STD-1553
- SSQ-22676
- NASA-STD-8739.3
- TOR-2006 (1590)-4430

Processes
- NASA Level B Soldering
- Quality Assurance and Testing per MIL-STD-981
- Seam Welded Hermetic Cases with Glass Ferrules, tested to MIL-STD-202, method 112
- Sole Source MIL-STD-1553 Supplier for the ISS SSQ-22676 Specification

Product Solutions

Single Board Computers



SCS750, SCS750G4

Having achieved TRL-9 on multiple missions, DDC's Single Board Computers (SBC) satisfy the industries' need for medium to high-performance computing, combining IBM PowerPC® processors with volatile & non-volatile data storage, as well as a variety of interfaces in a 6U form factor with cPCI backplane.

Configurations and Features:
- Interfaces: SpaceWire or optional MIL-STD-1553
- VxWorks®, RTEMS, & Linux Development Platforms
- Volatile Memory: 256 MB SDRAM
  - Reed-Solomon protected
  - Double Device Data Correction
- ECC Corrected, Non-Volatile Memory: 8 to 20 MB EEPROM
- TID Greater than 100krad (Si)
- BCH – ECC Corrected, Non-Volatile Memory: 64 GB NAND Flash
- Latch-up Immune
- SEU Hard; 1 Board Upset Every 80 / 155 Years (GEO/LEO)
- Temperature Range: -30°C to +65°C

MIL-STD-1553

With more than 25 years of experience as the leading supplier of radiation hardened MIL-STD-1553 data bus components, DDC continues to innovate and advance the state of data bus technology for space.

Configurations and Features:
- Total Space RT: Complete Remote Terminal, with protocol, dual transceivers & transformers
- Total-Space ACE: Complete Terminal with SRAM, protocol, dual transceivers & transformers
- SPACE-PHY: Physical Layer interface, includes dual transceivers and transformers
- +3.3V or +5V Operation
- Radiation Hardened from 100kRads to 1MRad
- Latch-up Immune to 85.4 MeV-cm²/mg
- Temperature Range: -55°C to +125°C
- Technical Operating Report (TOR) Screening
- Contact DDC for Non-Hermetic Packaging

Radiation Hardened Microelectronics

DDC Space Microelectronics, formerly part of Maxwell Technologies, has provided space-qualified products to the space industry for more than two decades, with 100,000+ parts flown and zero failures.

Configurations and Features:
- Memories: NAND Flash (to 256Gb), NOR Flash (to 512Mb), EEPROM, PROM, SRAM, and DDR2 SDRAM
- Analog-to-Digital Converters
- Digital-to-Analog Converters
- Amplifiers and Comparators
- Nuclear Event Detectors
- Multiplexers & Logic
- Optocouplers: Transistor, High Speed, High Gain, & High Gain Photon
- Best-in-Class Radiation Hardening for Commercial Microelectronics
- Low Power Dissipation
- Radiation Mitigation Technologies
  - RAD-PAK® and XRAY-PAK®
  - Triple Mode Redundancy (TMR)
  - Error-Code Correction (ECC)
  - Latch-Up Protection ASIC
- Radiation Tolerant (RT) solutions available for missions with lower TID requirements

Motor Control & Feedback Components

DDC is a leader in high-reliability motion control technology for space, with motor controllers, motor drives, and motion feedback products deployed on applications including the ISS robotic arm, satellites and space vehicles.

Configurations and Features:
- 3-Phase Motor Controller/Drive Hybrids
- Resolver-to-Digital Conversion Functions
- Sine Reference Oscillator Functions
- Radiation Hardening Available to 100Krads, Contact DDC for Details per Product Type
- MIL-PRF-38534 Class K Processing Available
- Latch-Up Immunity
- Temperature Range of -55°C to +125°C
- Technical Operating Report (TOR) Screening
- Standard Microcircuit Drawings (SMD) Available
- Contact DDC for Non-Hermetic Packaging

Transformers & Couplers

DDC has manufactured space-qualified standard and custom radiation hardened magnetic solutions, compliant and certified to NASA standards for more than 25 years. 100% variables data and material traceability is available for all space grade products.

MIL-STD-1553 Transformers & Couplers:
- Hermetic Isolation Transformers
- Sole Source Supplier to ISS SSQ-22676
- Data Bus Couplers, In-line or Flange Mounted
- Harness Assemblies
- Testing to MIL-PRF-21038

Power Transformers:
- Power Transformers
- Power Voltage Range: 1VA to 1000VA
- Temperature Range: -65°C to +135°C
- Meets Stringent Levels of NASA Outgassing Requirements
- Inductors

RSGS
- SBC

Mars Rover
- Memories
- Data Converters
- Other

LEO

MEO

GEO

L2

ISS
- Memories
- Data Converters
- MIL-STD-1553
- Motor Drives
- Motion Feedback

GPS
- Memories
- Data Converters
- MIL-STD-1553

Communication
- Memories
- Data Converters
- MIL-STD-1553
- Motion Feedback

Gaia
- SBC
- Data Converters

Euclid
- SBC

History of Space Exploration & Innovation

Serving the aerospace & defense community for more than 50 years, DDC has provided field-proven rad-hard solutions for space systems for more than 3 decades.

1960

1953 North Hills Signal Processing founded

1956 XCEL Power Systems founded

1961 Vostok program: first human crewed orbital spaceflight

1964 Data Device Corporation (DDC) founded

1966 Gemini 8 Program - first docking of 2 spacecraft

1969 Apollo 11 launches, first man on the moon

1970

1970 DDC introduces the world's first Synchro/Resolver-to-Digital module

1971 Mars 3 - first soft landing on Mars

1973 Galileo Orbiter - first Jupiter flyby

1974 Mariner 10 - first Mercury flyby

1977 Pascall Electronics Ltd founded

1979 Beta Transformer Technology Corporation founded

1980

1981 Space Shuttle Columbia - first reusable manned spacecraft

1982 Venera program - first Venus soil sample & sound recording

1983 DDC introduces MIL-STD-1553 Bus Controller & Remote Terminal Unit

1984 DDC is the 1st company to be MIL-STD-1772 Certified (equivalent to MIL-PRF-38534 QML)

1985 DDC introduces MIL-STD-1553 Interface Transformers

1988 DDC introduces Space AIM & Space-RT components

1989 USAF deploys Global Positioning System (GPS)

1990

1990 NASA launched Hubble Space Telescope

1991 Beta introduces space qualified Data Bus Transformers

1993 DDC Space Microelectronics (formerly of Maxwell Technologies) founded

1995 Sp'ACE introduced by DDC

1996 Ariane 5 rocket launched

1997 RAD-PAK® Technology introduced

1998 International Space Station (ISS) launched

1999 DDC MIL-PRF-38534 Class K certified SRAM introduced

2000

2000 DDC Space Microelectronics attains MIL-PRF-38535 lab suitability
DDC Designed into the ISS Canadian Arm
First Latch-Up protected ASIC

2002 First MIL-PRF-38535 Class Q QML part number submitted

2003 NAND Flash & Sp'ACE RT II introduced
DDC MIL-PRF-38535 Class Q certified

2004 Sp'ACE II and SDRAM introduced
DDC Space Microelectronics attains MIL-PRF-38535 Class V certification
Rovers Spirit & Opportunity

2007 DDC attains DQS AS9100 certification

2008 Beta Transformers attains DQS AS9100 certification

2010

2010 First Advanced Extremely High Frequency (AEHF) satellite launched

2011 Space-Based Infra-Red System (SBIRS) GEO-1 satellite launched

2012 High-Density NOR Flash introduced by DDC
SpaceX Dragon, the 1st unmanned commercial spacecraft, docked with the ISS
Rover Curiosity lands on Mars

2013 DDC acquires National Hybrid Inc
First SCS750 launched
ESA launches Gaia Billion Star Surveyor

2014 DDC celebrates its 50th anniversary
DDC introduces: Total-Space ACE, Total-Space RT, and High-Density NAND Flash modules

2016 DDC acquires the Space Electronics product line from Maxwell Technologies
DDC introduces Total Space-ACE, Total Space RT, and Space-PHY MIL-STD-1553 Rad-Hard Solutions

2017 Single Board Computer with SpaceWire and Flash developed by DDC
DDC acquires North Hills Signal Processing Corp.

2018 DDC designed into the ESA Euclid Spacecraft, DARPA Robotic Servicing of GEO Satellites (RSGS), BioSentinel Cube-Sat, and JAXA's Second Greenhouse Gas Observing Satellite (GOSAT-2)

Connectivity Power Control

Your Solution Provider for... Connectivity, Power, and Control

Contact Us

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The first choice for more than 50 years!

DDC is a world leader in the design and manufacture of high-reliability Connectivity, Power and Control solutions (Data Networking Components to Processor Based Subsystems, Space Qualified SBCs & Radiation Hardened Components; Power Distribution, Control & Conversion; Motor Control & Motion Feedback), has served the aerospace, defense, and space industries as a trusted resource for more than 55 years.