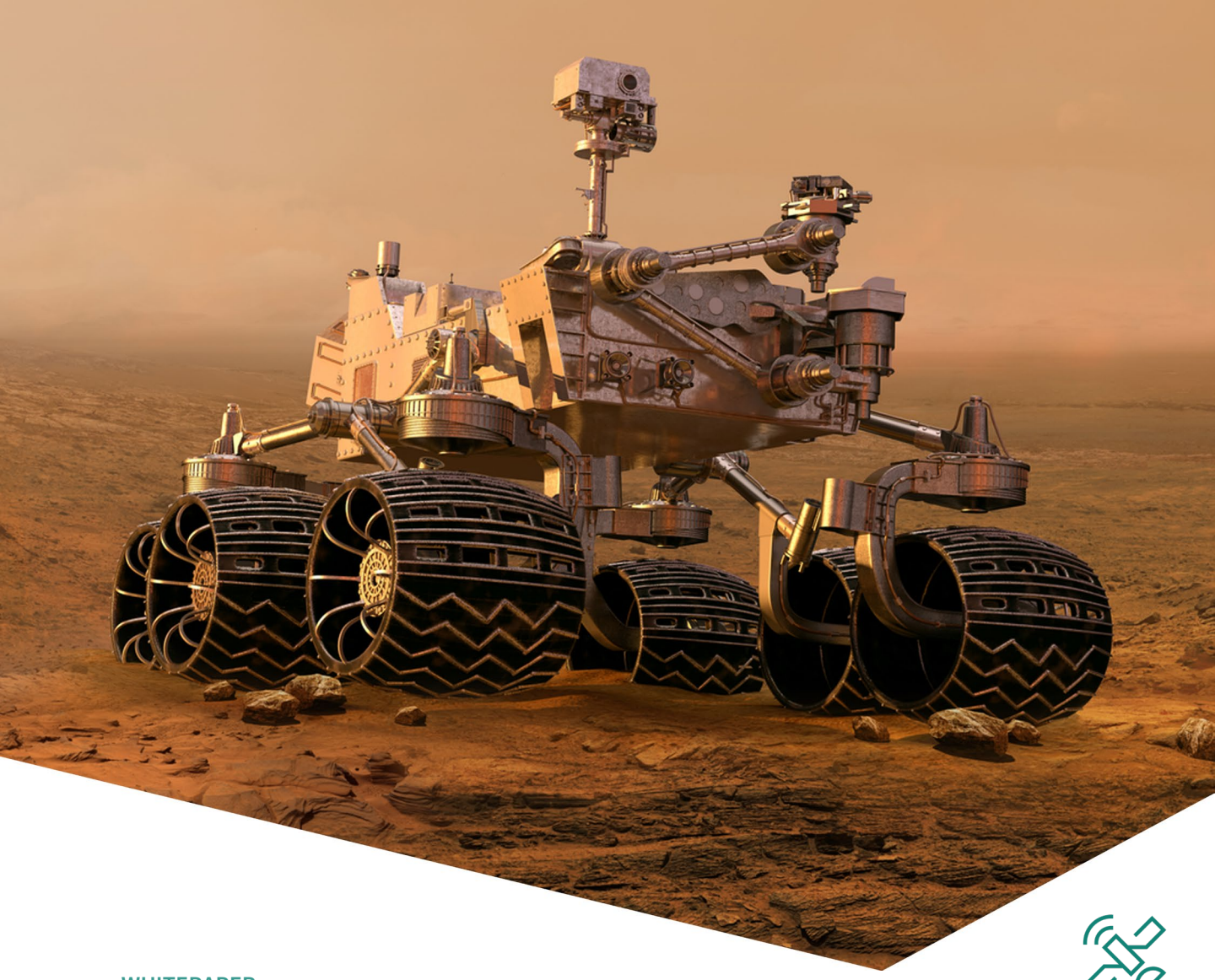


WHITEPAPER

Space

Journey through space and time: A closer look at the powering innovations and milestones that have shaped space exploration

Advancing power management technology to unlock humankind's full potential

www.infineon.com

Abstract

This whitepaper delves into the critical role of advanced power management innovations in enabling humanity's exploration of the universe. From the earliest days of spaceflight to today's ambitious interplanetary endeavors, reliable and efficient power systems have been fundamental to mission success—powering spacecraft, instruments, communications, and life-support systems in the harshest environments imaginable.

This paper highlights the pioneering contributions of Infineon IR HiRel, whose high reliability power solutions have evolved in tandem with the demands of modern space exploration. Tracing the journey from early discrete power components to today's integrated, radiation hardened systems. We examine how Infineon IR HiRel's continuous innovations—such as robust power conversion, advanced semiconductors, and miniaturized modules—have not only addressed the challenges of space but also unlocked new mission possibilities.

As humanity sets its sights on the Moon, Mars, and beyond, Infineon IR HiRel's technologies remain at the forefront, empowering the next generation of space missions and ensuring the reliability and efficiency that exploration demands.

Decades of powering innovation, helping to inspire generations of space exploration

For over half a century, Infineon's IR HiRel division has been at the forefront of technical innovation in power electronics for space exploration. Our pioneering solutions have powered and protected generations of space missions, enabling humankind to reach farther, explore deeper, and unlock the mysteries of the universe. As trusted partners to leading space agencies and commercial ventures, we are dedicated to delivering the reliability, performance, and technological excellence that fuel the dreams of discovery. Infineon IR HiRel: empowering the next era of space exploration and inspiring the quest to understand our cosmos.

1940s

International Rectifier (IR) is founded in California in 1947 by Eric and Leon Lidow. The company launches the selenium rectifier upon its finding. Bell Labs discovers the transistor effect that same year. Shortly after, IR introduces selenium plates 50% larger than existing ones.

1950s

IR commercializes the germanium rectifier in 1953. The Space Race grows as Sputnik 1 is launched in 1957 and the US launches its first satellite with the Explorer series the next year. IR pioneers silicon-controlled rectifier (SCR) devices.

1960s

IR introduces radiation resistant solar cells for space applications early in the decade. By the late 60s, IR supplies Zener voltage regulators for Apollo 11 and the Saturn V Booster, helping bring humans to the Moon.

1970s

IR launches the first commercially viable photo-isolated solid state power relays and power module concept for DC drivers and power supplies. In 1976, NASA's Viking 1 lands on Mars. IR establishes the first MOS lab to develop the world's highest rated power FET and introduces planar MOSFET technology that same year. By 1979, IR invents and patents the HEXFET.

1980s

NASA's Voyager 1 captures images of Saturn to inaugurate the decade. IR offers high reliability power semiconductor devices for space programs. By 1987, IR is the first to offer rad hard MOSFETs with the GEN 5 HEXFET. IR introduces the first high-voltage power IC.

1990s

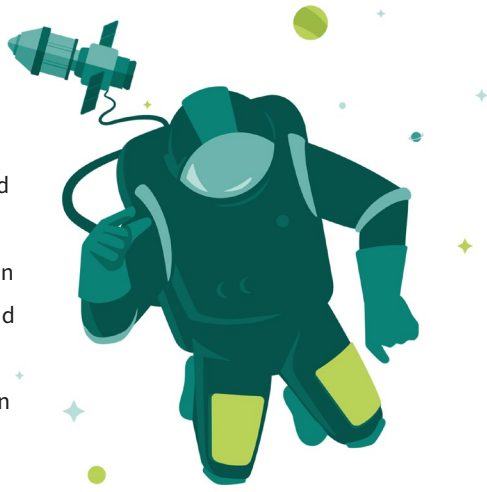
IR releases R5 rad hard MOSFETs using strip technology. Later that decade, IR's SOIC HEXFET Power MOSFETs set an industry standard for the lowest RDS(ON).

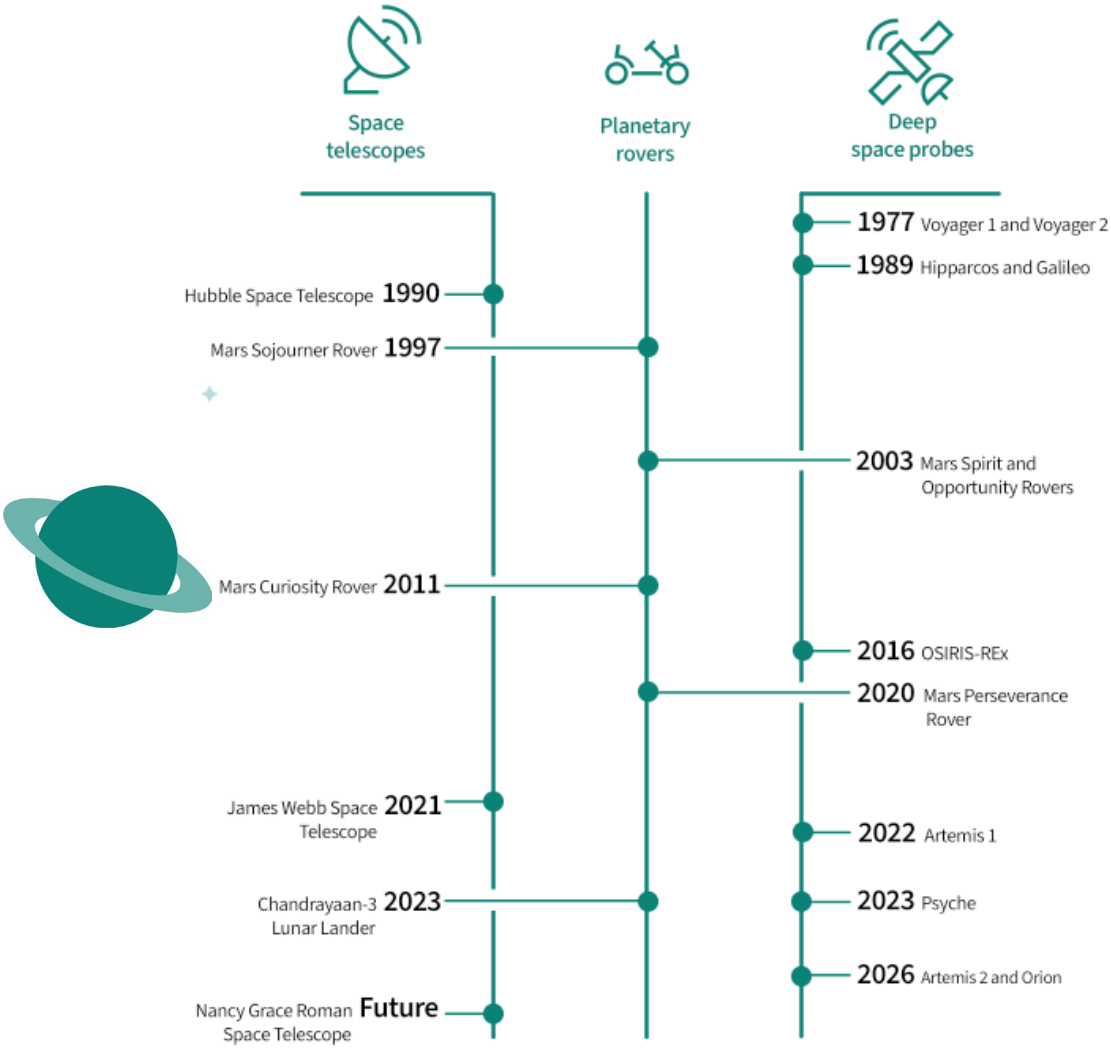
2000s

IR's space-grade power control parts launch on the Mars' Curiosity and Perseverance rovers, plus the Ingenuity helicopter. Infineon Technologies acquires IR in 2015; that year, 500+ IR parts visit Pluto onboard New Horizons. HiRel parts launch on OSIRIS-REx, the Jame Webb Space Telescope, the Chandrayaan-3 Lunar Lander, Psyche, and more. IR continues to pave the way for emerging space and commercial space explorations.

Fifty years of proven space heritage and counting

For over five decades, Infineon IR HiRel has played a pivotal role in powering some of humanity's most iconic space missions. Its high reliability power solutions have been integral to the success of landmark programs such as the Voyager missions launched in the 1970s, which continue to communicate with Earth from the edge of our solar system. IR HiRel's technology has also supported the Hubble Space Telescope's decades-long exploration of the cosmos and enabled the groundbreaking capabilities of the James Webb Space Telescope. On Mars, multiple generations of rovers—including Spirit, Opportunity, Curiosity, and Perseverance—have relied on IR HiRel components to withstand harsh Martian conditions and conduct transformative science. As the Artemis program ushers in a new era of lunar exploration, IR HiRel continues to provide the robust, reliable power management systems critical for Artemis II and future missions, ensuring the continued advancement of space discovery.





An unparalleled commitment and tradition to quality, reliability, and performance

Infineon IR HiRel's unwavering commitment to quality, reliability, and performance stands unmatched in the industry. With over 50 years of proven heritage supporting the most demanding space applications, IR HiRel has established a legacy of excellence built on rigorous testing, meticulous engineering, and continuous innovation. Every component is designed, tested, and qualified to meet the most stringent space requirements, ensuring mission-critical systems can withstand extreme environments and perform flawlessly over extended lifetimes. Backed by the vast resources and global expertise of Infineon Technologies, IR HiRel combines deep space heritage with the latest advancements in semiconductor technology, reaffirming its position as a trusted partner for mission success.

Key quality standards:

- MIL-PRF-19500/MIL-STD-750: Governs quality conformance testing for discrete MOSFET semiconductors
- MIL-PRF-38534/MIL-STD-883: Defines screening requirements for high reliability military applications
- MIL-PRF-38535/MIL-STD-883: Specifies screening requirements for high reliability space applications
- JANS: Space level screening as specified in MIL-PRF-19500 for a DLA qualified device
- JANTX: Military screening level as specified in MIL-PRF-19500 for a DLA qualified device
- JANTXV: Military with visual inspection screening level as specified in MIL-PRF-19500 for a DLA qualified device

Screening and Quality Conformance Inspections (QCI):

- 100% Screening: All components undergo rigorous screening to ensure high reliability Periodic Quality Conformance
- Testing: Products undergo various levels of periodic testing to maintain compliance with specifications

European standards:

- ESA ESCC 5000: Standard for discrete semiconductors, hermetically sealed and die, used in space applications

Product portfolio highlights:

Rad tolerant N-channel MOSFET
Plastic package shown

Rad hard buck controller
Hermetic package shown

Rad hard GaN transistor
Hermetic package shown

SMD-0.5 rad hard MOSFET
Hermetic package shown

SMD-0.2e rad hard MOSFET
Hermetic package shown

Rad hard gate driver
Hermetic package shown

Local expertise backed by a global technology leader

High reliability office locations

Andover (R&D, design, and marketing)
35 New England Business Center
Suite 100
Andover, MA 01810

Dallas (Design and marketing)
801 E. Campbell Rd.
Richardson, TX 75080

El Segundo (Applications support and marketing)
101 Pacific Coast Hwy
El Segundo, CA 90245

Leominster (Design and production)
205 Crawford Street
Leominster, MA 01453

Munich (Marketing, production, and R&D)
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