



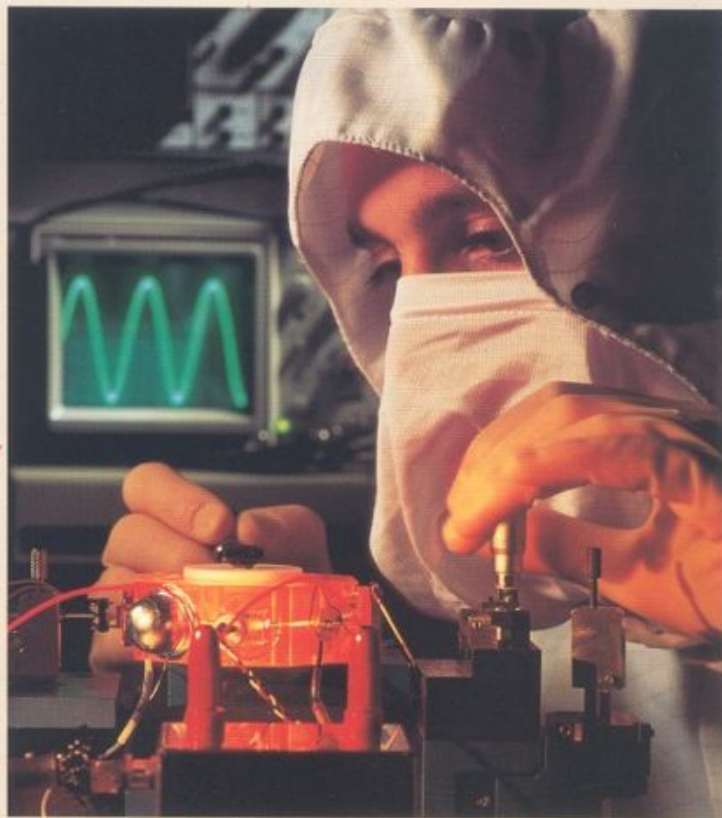
**Guidance &
Control Systems
For Space
Applications**

Inertial Measurement/
Attitude Systems

Momentum Exchange
Devices

Space Avionics

Star Sensor Technology





Space systems: helping NASA, the U.S. military, and the scientific community stretch human imagination to its outer limits ... and beyond.

AlliedSignal Guidance & Control Systems has been a leading supplier of space products since the dawn of the space age in the 1950's and 1960's.

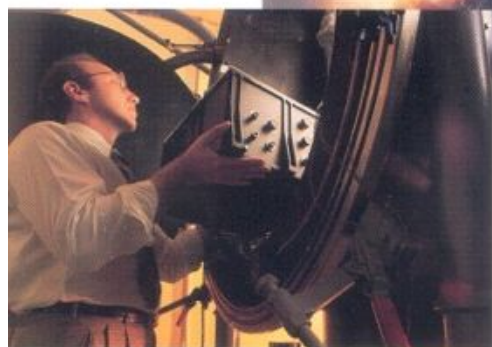
Today AlliedSignal designs, manufactures, and supports a wide range of inertial guidance components and avionics for military, government and commercial space applications. Products include primary guidance packages, inertial reference units, attitude reference units, momentum exchange devices and star trackers plus a wide range of electronic components and subsystems.

Meeting the highest levels of performance for space exploration and commercialization. Space systems typically require the highest levels of reliability, performance, accuracy and equipment life.

AlliedSignal has met these needs in numerous space programs over the past four decades, from guidance platforms that helped launch the first manned lunar mission, to the control moment gyroscope for Space Station Freedom and the redundant inertial flight control assembly for the Delta II launch vehicle.

In addition, we have developed equipment for many other complex spacecraft and launch vehicle programs including several that will become operational in the mid 1990's.

Our space components and systems are based on our proven technical expertise in expanding the state of the art for advanced guidance and attitude control systems and avionics. We build the most accurate guidance and control products in existence today. And we make more of them than anyone else in the world.



TRIHEX™ undergoing thermal-vacuum testing for the Delta II Launch Vehicle.

Process variability reduction in the RLG manufacturing clean room.



A tradition of leadership in space technology.

Here's just a sampling of space systems whose performance has been enhanced through the use of AlliedSignal hardware and software

Attitude Control Systems

Hubble Space Telescope. Orbiting the Earth miles above obscuring atmosphere and cloud cover, the Hubble Space Telescope offers a view into space 50 times farther than can be achieved with ground-based telescopes. AlliedSignal was chosen to develop the pointing and control subsystem, to provide safe-mode electronics and to design rate gyros for this attitude control system.

The rate gyro assembly, designed for in-orbit servicing to support a mission life of at least 15 years, enables the Hubble Space Telescope to achieve its ultra-accurate pointing stability.

The pointing system enables the Hubble Space Telescope to point to the stars with a line of sight stability of better than 0.007 arcseconds (two-millionths of a degree).

Functions performed by the safe-mode electronics assembly include supplying currents to magnetic torquers, checking magnetometer and rate gyro performance, solar array positioning and coarse sun sensor processing. Should primary systems fail, an independent back-up processor autonomously takes control of the vehicle.

Commercial Space. AlliedSignal has been selected to develop a low-cost momentum wheel assembly and a three-axis ring laser gyro assembly for 125 satellites to be used as part of a global personal communications satellite system. This

commercial low-Earth-orbit wireless telecommunications network is designed to provide users with instantaneous, global transmission of voice, data, images and fax.

The AlliedSignal gyro assembly offers rapid response, low environmental sensitivity, stable performance, high reliability, low life cycle cost, digital output and an operating life in excess of 10 years.

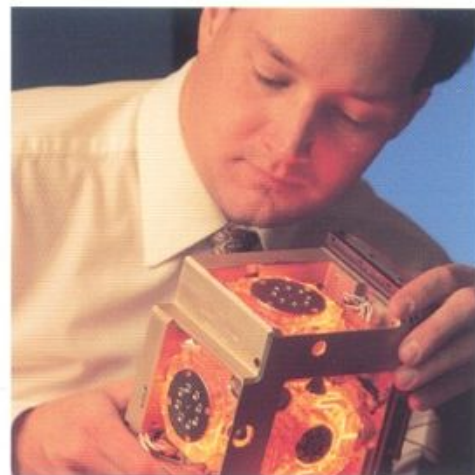
Inertial Measurement Systems

Saturn V Booster. AlliedSignal's entry into the space program began in 1961 when we were awarded a contract to develop the Stable Reference Platform for the Saturn Booster, the launch vehicle for the Apollo program.

The Stable Reference Platform was based on proven technology AlliedSignal developed for the Pershing Missile program. The platform presents on-board attitude and acceleration data to keep the booster rocket on course from lift-off through Earth orbit insertion.

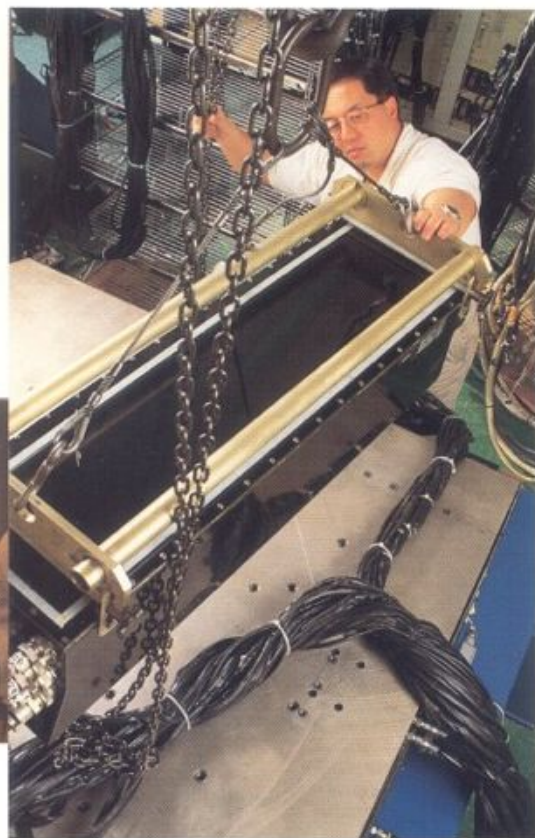
Delta Launch Vehicle. The Delta II Launch vehicle utilizes AlliedSignal Guidance & Control Systems' TRIHEX™ assembly for guidance, navigation and flight control from launch to orbit.

The TRIHEX assembly is a fault-tolerant inertial sensing system consisting of six accelerometers, triple modular redundant hardware, three BX1750A microprocessors and six ring laser gyros. Superior in many ways to conventional mechanical gyroscopes, ring laser gyros are solid-state devices incorporating lasers, precision optics, and semiconductors.



Compact, rugged inertial sensor assembly mechanical configuration undergoes rigorous in-process testing to ensure performance to customer requirements.





Integrated electronics assembly undergoing acceptance vibration and thermal testing.

Small reaction wheel assembly.



Space station prototype CMG under test.

Space Avionics

Guidance & Control Systems is a reliable producer of quality circuit card assemblies, components and integrated electronic assemblies for a variety of space systems.

Space Shuttle. AlliedSignal provides integrated electronics assemblies and range safety distributors for the shuttle.

Integrated electronic assemblies are installed in the Space Shuttle's two solid rocket boosters. They are commanded by control computers on the ground and in the shuttle and used for such critical functions as ignition of booster engines, control of rocket nozzle position, separation of boosters from the external fuel tank, and deployment of booster parachutes during descent.

The range safety distributors are used to detonate explosive charges and destroy the external tank and twin boosters after separation from the shuttle — should a problem arise.

Space Station. AlliedSignal is contributing space avionics — including a large quantity of circuit card assemblies using double-sided surface mount technology, ASICs, hybrids, and other advanced technology — to the Space Station Freedom. These circuit boards are used in various space station subsystems including the common berthing mechanism, internal thermal control system, carbon dioxide removal assembly, environmental control life support system, and integrated motor control assembly.

Momentum Exchange Devices

Approximately 600 AlliedSignal momentum exchange devices have been built — and more than 400 have flown in orbit.

COBE (Cosmic Background Explorer). The Cosmic Background Explorer was launched into deep space to track the movement of stars. The objective is to prove the Big Bang Theory by precisely measuring cosmic background radiation thought to be the remnant of the primeval explosion that created the universe. AlliedSignal Guidance & Control Systems provided four reaction wheel assemblies (RWAs) for the attitude control system. These RWAs operated successfully throughout the mission.

Skylab. The Saturn Booster from the Apollo program was also used to put the first manned space station, Skylab, into orbit. AlliedSignal Guidance & Control Systems provided the double-gimbal control moment gyros (DGCMGs) used to maintain Skylab's attitude.

Space Station Freedom. AlliedSignal Guidance & Control Systems is designing and manufacturing four control moment gyros (CMGs) which will be used to counteract disturbance torque and control vehicle attitude on the space station. Our control moment gyros feature ultra-high reliability and torque output of up to 3,400 foot-pounds.

We design and build both single- and double-gimbal control moment gyros for a wide range of commercial space applications.

Our control moment gyros have a stored angular momentum range from 5 to 3,500 foot-pounds. Reliability of these units is demonstrated by accumulated life testing in excess of 400,000 hours.

S-SAT. S-SAT is a small-size satellite designed as a "space bus" for transporting payloads into Earth orbit more economically than current satellites. We are providing the S-SAT's attitude control system with ring laser gyros and reaction wheels.



Star Sensor Technology

Precision instruments for star scanning, gimballed star tracking and fixed-head star tracking.

Improved Star Sensor Assembly (ISSA)

Star scanners are hard-mounted to a spacecraft; they use the rotation of the vehicle to search for and detect stars.

The ISSA is the latest production model in the AlliedSignal line of space-qualified star scanners. It incorporates linear charged coupled device (CCD) arrays in a hexagonal pattern to enable star detection at any crossing angle through the field-of-view.

The ISSA provides two-axis attitude updates with sub arcsecond accuracy per star detection for the 2,400 brightest stars at vehicle scan rates up to 8 degrees per second. Microprocessor-imbedded algorithms adjust for dynamically changing background environments and can reject false star indications induced by radiation.

A new generation of robust star scanners employ on-station compensation of defocus and imbedded star detection schemes to minimize hardware complexity. This in turn reduces size, weight and power consumption. An in-process upgrade to this system, incorporating an area array CCD focal plane assembly (FPA), will provide a substantial improvement in attitude accuracy. This evolution towards "smart sensors" is being applied to develop low-cost systems.

An earlier generation photomultiplier-based scanner is currently deployed on the Jet Propulsion Laboratory's Galileo spacecraft. This system is designed to provide star updates while enroute to—and in orbit around—Jupiter.

Gimballed Star Trackers Consisting of a refractive telescope mounted on precision gimbals, this star tracker is used to track and maintain the star image centered in the telescope's field-of-view.

Optical encoders mounted on each axis provide the angular position information needed to generate a roll reference for the telescope. Our gimballed trackers have performed successfully on three Skylab missions, logging an accumulated usage period of over 3,500 hours.

Fixed-Head Trackers Fixed-head star trackers, hard-mounted to the spacecraft, feature a narrow instantaneous field-of-view (FOV) within a relatively wide field-of-view.

Wide FOV fixed-head trackers were among the first star sensors AlliedSignal Guidance & Control Systems produced. One of our 8°x8° FOV trackers—with a 10 arcsecond accuracy and +4 magnitude star threshold—was used aboard the Orbiting Astronomical Observatory satellite Copernicus.

Fiber Optic Gyroscopes

AlliedSignal Guidance & Control Systems is a leader in the development of Fiber Optic Gyroscopes (FOGs). We hold numerous patents in fiber optic gyroscope design and continue to develop manufacturing technologies to reduce FOG costs. Our IR&D efforts are developing a family of FOGs with tactical grade, inertial grade and pointing grade performance.



Environmental testing of high-performance fiber optic gyro.

The pointing grade FOG is the successor to our high accuracy spinning wheel gyro (64 PMRIG), which is currently flying on the Hubble Space Telescope. Our line of FOGs will enable GCS to provide improved inertial reference performance, with miniaturized electronics at reduced cost and increased reliability, for future space applications.



Incorporation of area arrays into star sensors leads to improved performance.



Winding and inspection of precision fiber optic sensor coils.



Computer-aided design is key to cycle time reduction.

"Man has always been an explorer. There's a fascination in thrusting out and going to new places. It's like going through a door because you find the door in front of you."

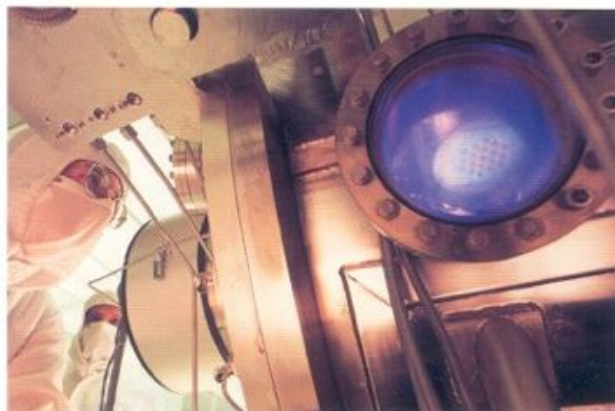
Neil Armstrong

AlliedSignal Guidance & Control Systems: manufacturing capabilities.

AlliedSignal Guidance & Control Systems has an extensive manufacturing facility for the mechanical and electrical integration of high-reliability inertial components, subassemblies, and systems.

With special processes, procedures and tooling for the assembly of high-reliability electronics used in space, it offers clean rooms, high-purity cleaning, hybrid microelectronics packaging and testing and specialized environmental testing.

Our facilities are also equipped with such state-of-the-art equipment as CAD/CAM workstations, printed circuit digitizing systems, a metallurgical laboratory and an ion beam coating and characterization lab. Our semiautomatic assembly equipment and advanced automatic test equipment allow us to maintain the highest quality standards of ISO 9000 and NHB-5300.



Automated fabrication of RLG mirrors provides process control.

Our people make the difference.

Of our thousands of employees across the country, approximately 50 percent are degreed engineers and scientists directly engaged in research, development, and related technical support activities. Key skills and areas of technology provided by our team include systems engineering, simulation and analysis, electrical and mechanical engineering, reliability and failure mode analysis, optical design and packaging, software and testing. We also hold almost 5,000 patents in gyroscope design and related technologies.



Active involvement by program management and manufacturing ensures product quality and repeatability.

About AlliedSignal. Headquartered in Teterboro, New Jersey with additional facilities across the country, AlliedSignal Guidance & Control Systems is part of AlliedSignal Aerospace.

Aerospace is one of the three primary businesses of AlliedSignal, Inc. — our parent company. A \$12 billion diversified manufacturing corporation, AlliedSignal also has major operations in automotive products and engineered materials.

**Talk to AlliedSignal
Guidance & Control
Systems before
launching your next
space program!**

Tell us your space guidance and control needs. We will supply an existing product — or customize one to meet your most demanding specifications and mission requirements at a competitive cost. Call AlliedSignal Guidance & Control Systems at (201) 393-2557. Or write us today.



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*Making affordable space
technology a reality*



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