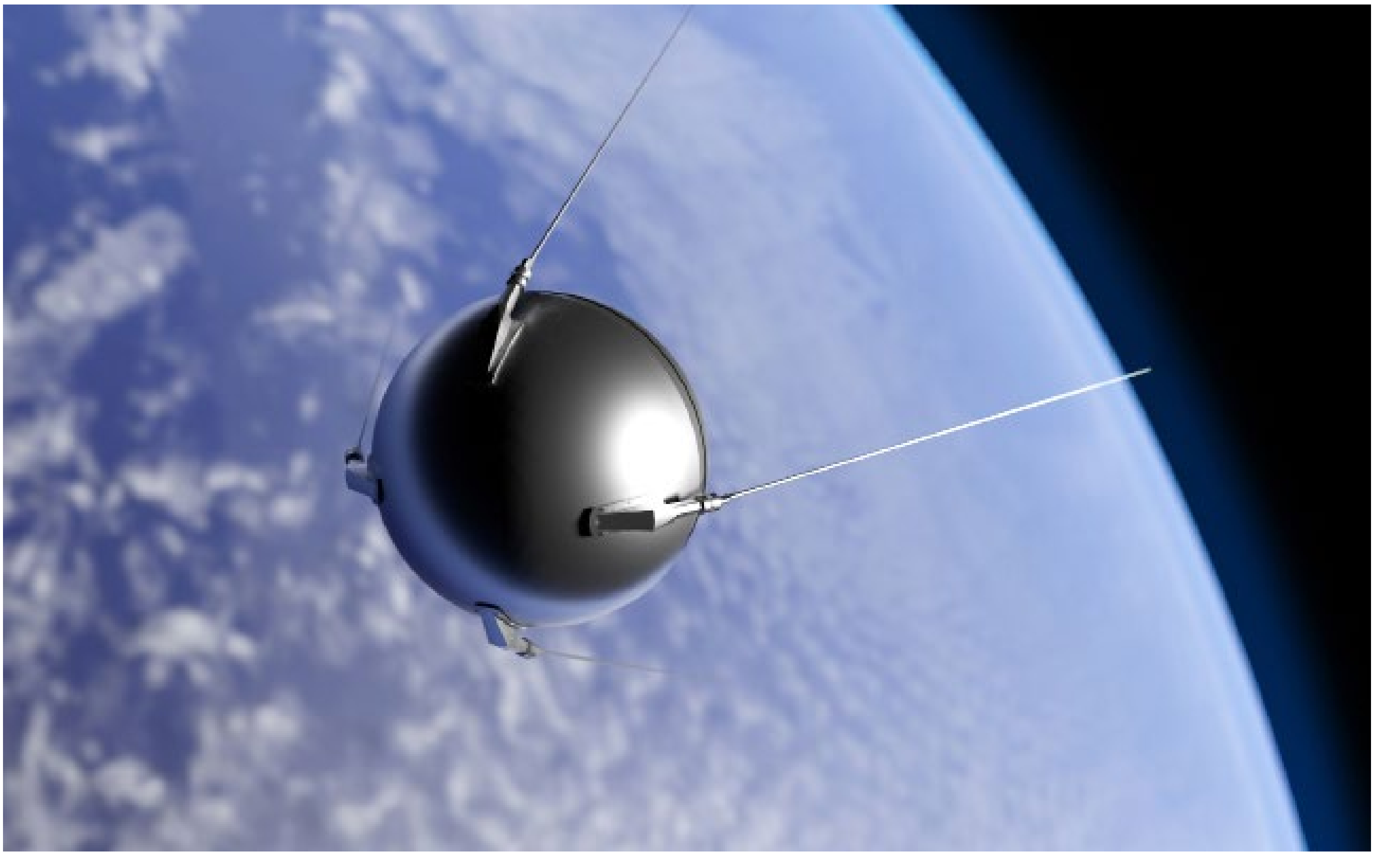
Industrialization of satellites

The use of space by satellites has so far focused on scientific, communicative and military aspects. This will change massively in the future. Whole swarms of small satellites are to orbit the globe and supply mankind with Internet from orbit.



Sputnik 1 – the first earth satellite. Source: iStockphot

On October 4, 1957, the Soviets launched the first artificial earth satellite from the Baikonur spaceport with a modified R-7 intercontinental rocket: the Sputnik 1. The space pioneer was just 83.6 kg light. His transmitter had a power of 1 watt. And yet this Sputnik 1 led to a veritable Sputnik shock. His unforgettable beeping panicked the West. Khrushchev had won the race into space.

With this first satellite, the communication, weather and spy satellites we are now familiar with have little in common. These are mostly high-tech monsters weighing tons, the production of which costs a fortune. And that's not all. The satellite wants to be brought into orbit. For this it needs a launcher. And they are (still) really expensive! The prices of the established model families Ariane, Atlas or Soyuz vary between 60 and 170 million US dollars for the payload versions. Converted this results in a kilo price of between 4000 and 8000 US dollars. The costs depend enormously on the mass of the satellite, the desired orbital height and the choice of launch vehicle.

Reliability and new players

Anyone who spends millions on the construction of a satellite naturally does not want to have to write it off in a fireball seconds after the launch. Not all launchers offer the same reliability. Only the Russian Soyuz is currently used to transport astronauts/cosmonauts to the International Space Station ISS.

But new players are in the process of revolutionizing the business with launchers for commercial satellites: SpaceX, for example, wants to mix up the field with the partially reusable Falcon 9. At prices that the Europeans and Russians can't keep up with. However, the idea is not new, nor are the SpaceX engineers the only ones working on this cost-cutting technology. Europe, Russia and Amazon founder Jeff Bezos (Blue Origin) are also working on similar concepts. The first attempts in this direction were already made decades ago by the Soviets with their Energija launcher, whose successor Energija 2 should have been completely reusable. The end of the Soviet Union also means the end for the final development of this construction.

Number of satellites

There are currently considerably fewer than 2000 satellites in earth orbit. These are almost exclusively satellites, most of which are financed by the state. Such satellites are usually built very complex and should have a long lifetime (>15 years). Accordingly, the greatest attention is paid to maximum reliability when selecting the components to be installed.

But this is set to change very soon. The commercialization of the orbit is imminent. More than a dozen different companies (OneWeb, SpaceX, Blue Origin, Virgin Galactic, Google, Boeing, Samsung and many more) want to place whole swarms of small and micro satellites at altitudes between 600 and 10'000 km. If all these projects are actually fully implemented, well over 10,000 additional satellites should be added in the next ten to twenty years. It will therefore be close to orbit.
The goal of these small satellites is almost exclusively a broadband Internet connection. Anytime, anywhere and fast.
OneWeb is planning 900 satellites for this purpose. Born in South Africa, Elon Musk is going one better. His SpaceX Starlink concept already includes 4425 satellites. A little more ambitious, but less advanced, is Samsung's plan for a global Internet from orbit. The South Koreans want to use 4600 satellites for this purpose.

Geostationary Satellites

A geostationary satellite is an earth satellite that is located on a circular orbit about 36,000 km above the earth's surface above the equator. This is where the geostationary orbit (GEO) is located. This means that a satellite stationed there moves at an angular velocity of one orbit around the Earth per day and follows the Earth's rotation at its own speed of about 3 km/s. This means that geostationary orbits are located in the equator. This means that geostationary satellites are ideally always above the same point. Examples of geostationary satellites are communication, TV or weather satellites.

LEO and MEO

The novel small satellites will travel in lower orbits. This means on the one hand that they are not fixed above a point, but on the other hand that it will take much less energy to lift them into this orbit. In addition, short distances are massively faster for an Internet connection. The signal has to travel less distance.
LEO (Low Earth Orbit) refers to orbits between 200 and 2000 km high. LEO satellites only need around 100 minutes to orbit the earth. The visibility and thus the radio contact to a ground station is at most 15 minutes per orbit. This short time span is also the reason for the large number of satellites for the respective satellite Internet concepts, all of which probably work according to the peer-to-peer principle.
The area between LEO and GEO is called MEO (Medium Earth Orbit). It is used, for example, for global communication satellite systems such as Globalstar or navigation satellites such as GPS, Galileo or GLONASS.

Energy supply in space

In order for a satellite to be able to perform its tasks, it needs energy. Energy supply in space is demanding, and a wide variety of technologies are used, depending on the purpose and duration of the mission. The two most common are chemical energy in the form of batteries (primary cells) and solar energy. Nuclear energy in the form of radionuclide generators is mainly used in satellites that are moving away from the sun or where solar cells cannot provide the required power.
Virtually all geostationary and most research satellites therefore use solar modules for energy supply. In most cases, the solar energy supply is realized with the support of secondary cells (accumulators or fuel cells) if there is sufficient brightness of the sun in the near-earth space. The energy supply normally consists of four subsystems: energy generation, energy conversion, energy storage with the corresponding charging and discharging electronics (balancing) and energy distribution.
The secondary cells used are mainly nickel-cadmium, nickel-hydrogen and increasingly lithium-ion accumulators. In addition to the operating time, the service life of the batteries depends above all on the number of charging cycles, the depth of discharge and the discharge current. Depending on these values, the nominal capacity and nominal voltage decrease over time, while the internal resistance of the cells increases. Operation of the cells outside the specified operating parameters can greatly shorten their service life or even lead to their destruction (danger of explosion with Li-Ion cells in the event of overcharging). As in the case of electric cars, the accumulators consist of a large number of cells in series and parallel connection. Balancing systems ensure that the parameters are maintained for all cells during the charging and discharging process.

Power supply of the satellites

In contrast to the Sputnik 1, the geostationary as well as the novel small satellites are packed with state-of-the-art electronics. They must be as small as possible, as light as possible and yet particularly powerful. This reduces the cost of transporting them into orbit and enables them to function correctly. On the other hand, high-performance electronics must fit into the smallest possible space. Enormously high power densities with their known problems (Application Note Protection against thermal runnaway [1]) are the result.
The high power required is achieved by increasing the operating voltage. Operating voltages up to 400 VDC become standard. High voltages have the advantage of lower losses, as the currents at the same power are significantly lower. This in turn means that the cabling can be thinner and thus lighter. Every kilogram counts and is worth cash.

HCF: sealed and robust fuse for high current applications

Specialist for fuses in space

For more than ten years now, SCHURTER has been ESA's only supplier of fuses for space applications (ESCC Qualified Manufacturer SCHURTER AG [2]). With two fuse families (MGA-S [3] and HCSF [4]), the globally operating Swiss technology company covers all current requirements for geostationary satellites. Close networking and many years of cooperation with the space industry lead to a high level of specialist knowledge about the problems and possible solutions in this segment (Aviation and Space Technology [5] .

New requirements

With the entry of new players into orbit and the downright industrialization of satellite technology, new requirements arise which SCHURTER meets with suitable products. From the production of fully qualified fuses for the aerospace industry, SCHURTER now also offers partially or non-qualified components, which, similar to the automotive standard IATF16949, are manufactured and supplied together with the customer specifically and according to agreed AEC-Q200 criteria (White paper AEC-Q200 [6]). This means that reliable and cost-effective fuses can be provided for the highest requirements.

MGA-A: whisker- and dendrite-free

OTS options
The MGA-A [7] fuse was developed specifically for "industrial" aviation and satellite technology. The technical design corresponds to that of the MGA-S space security system. The MGA-A does completely without a leaded coating and uses gold instead. Gold plated end caps offer neither whiskers nor dendrites any attack surface. Such crystalline tin dendrites and whiskers pose a considerable risk to the high density of the electronics in the form of price conclusions.
Another highly interesting option is the SCHURTER HCF [8] . The HCF is an extremely robust high-performance fuse in thin-film technology for higher current ratings, which goes to ESA as HCSF in a extensively selected form.

Thermal and combination fuses
SCHURTER's competence and experience also lie in numerous other areas of power electronics. Thermal and overcurrent fuses and their combinations are offered (Thermofuses [9]). SCHURTER fuses can be found wherever highest reliability and durability are required.

About SCHURTER
SCHURTER continues to be a progressive innovator and manufacturer of electronic and electrical components worldwide. Our products ensure safe and clean supply of power, while making equipment easy to use.

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