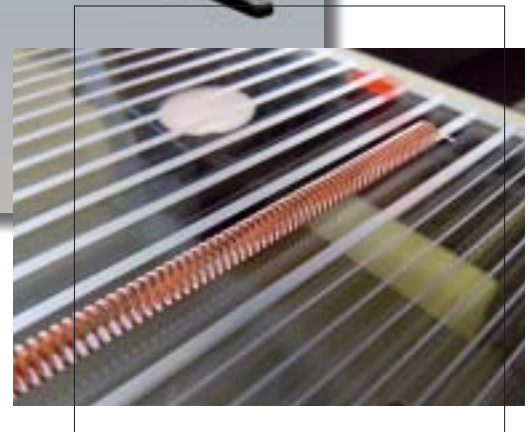


**QUALITY
ENGINEERING**

Flying high with precision

Application Report Thales

Special Edition



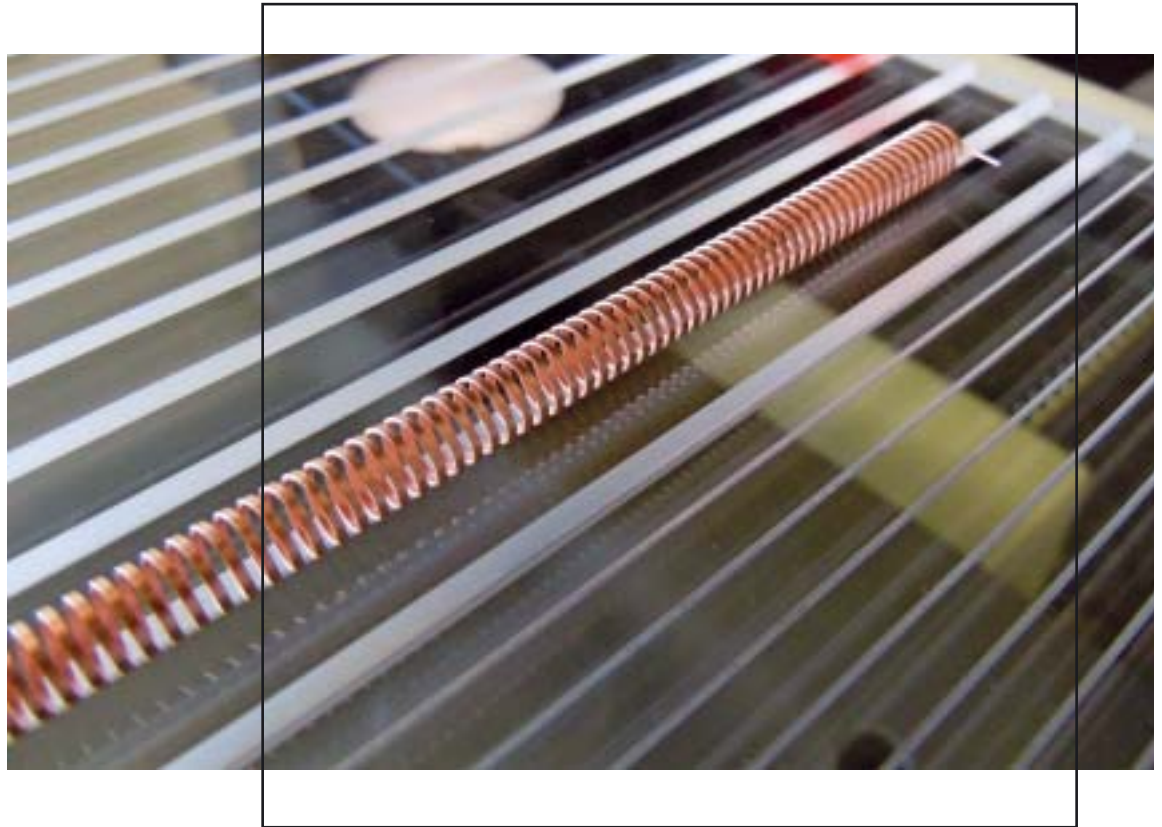
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Wire coils for various models of traveling wave tubes used as signal amplifiers in satellites are produced in a complicated process with extremely high precision requirements at Thales Electronic Systems.

Images: Werth



Optimizing Wire Processing With Multisensor Coordinate Measuring Machines

Flying high with precision

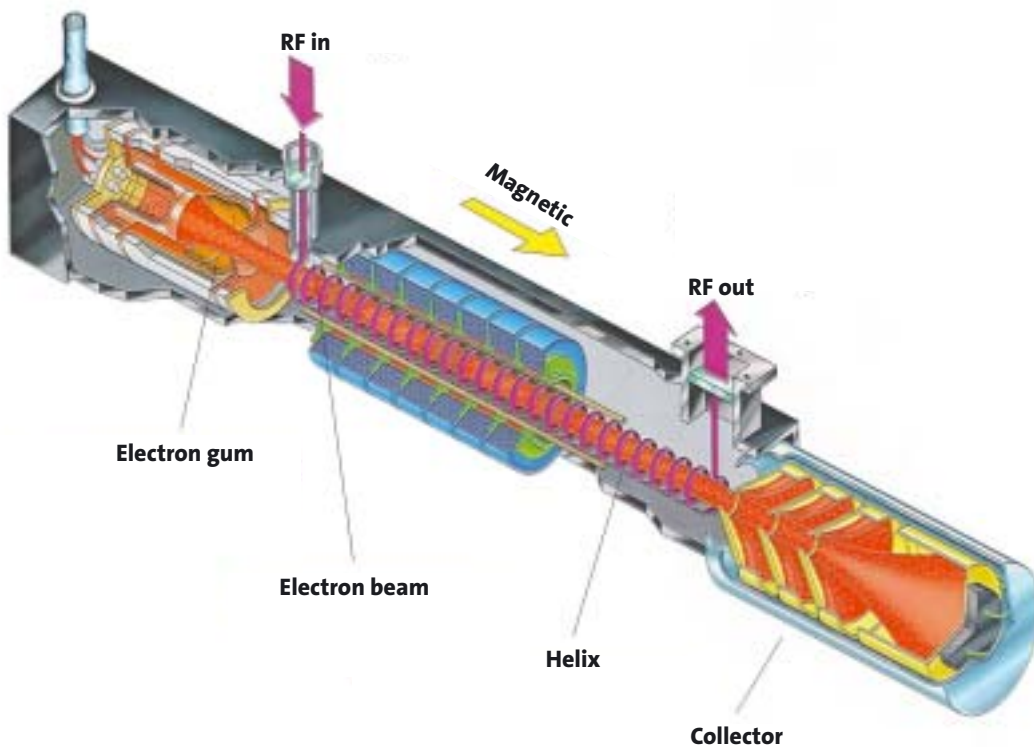
When Thales Electronic Systems produces traveling wave tubes for amplifying signals in satellites, top quality and reliability are indispensable. The manufacturing process for the core component, the helical wire coil, incorporates 3D multisensor coordinate measuring machines from Werth Messtechnik. They can reliably detect very slight deviations from tolerances. Without modern satellite technology, many areas of our daily life would be inconceivable, including TV reception, telecommunications, weather forecasting, and GPS navigation. The critical functions of these man-made heavenly bodies are often based on technology from Thales Electronic Systems in Ulm.

Bruno Wanderer is the head of the Wire Processing department at Thales. This is where the wire coils for a wide range of products are produced with extremely high precision requirements in a complex process that has been optimized over several decades. Every component must be shipped by the department according to a predefined schedule without the slightest defect. The 3D multisensor coordinate measuring technology from Werth contributes significantly to the fulfillment of this requirement. Wanderer is happy that he and his five colleagues have two Werth coordinate measuring machines that are manufactured in Giessen. He knows that precise metrology information about the com-

ponent gives manufacturing more room to maneuver. Only precise knowledge of the actual dimensions prevents the already extreme manufacturing tolerances from being further limited by reserves for measurement uncertainty.

Efficient amplifier technology from Thales

The Wire Processing team produces about 20 different types of coils for traveling wave tubes. The unimposing structures, whose length is typically between a few 10's of mm and a few 100's of mm, consist of a molybdenum or tungsten wire wound into the shape of a helix. The



Principle construction of a traveling wave tube.

heart of the traveling wave tube, this wire coil adapts the high velocity of the input signal wave (longer path through the coil) to the lower velocity (depending on cathode voltage) of the electrode beam guided along the coil axis in the tube. The coil geometry must be precisely matched for the input signal wave (traveling wave) to have the same velocity as the electron beam. The electron beam is modulated by the input signal, giving rise to the amplification effect. This technology is characterized by a very high efficiency level.

The order books are currently full, primarily thanks to satellite operators. Currently about 560 employees work in the "old tube plant" in Ulm, and the number is rising. In 2011 and 2012 alone, 100 new employees were hired. One single satellite typically carries several traveling wave amplifiers as it orbits. The satellites of the European navigation system Galileo, for example, are equipped with high-frequency amplification technology from Ulm. Their elementary function quickly makes it clear that the standard for the coils in the traveling wave tubes is perfection.

Wanderer says, "We essentially perform one hundred percent testing. If a component has to be scrapped in our department, the cost is still reasonable. If the error is not detected until it is in the next assembly, however, then we already have relatively higher costs." Wanderer estimates that the scrap rate for coil production is about 10% on an annual basis. The sources of defects are generally found in the raw material or in handling. Sometimes machine errors or the coating baths will cause the

extremely tight tolerance limits to be exceeded. "It is important to understand that our helical coils are coated with copper after they run through the winding machine, before they are measured again by one of the two Werth VideoCheck[®] machines," says Wanderer.

In 1998, when a coordinate measuring machine from Werth Messtechnik arrived, it was like a mini-revolution for the company. A manually operated measuring microscope was replaced with a fully equipped CNC multisensor coordinate measuring machine. This investment was a huge step forward for the workers in the wire processing department. The measuring machine is equipped with a special high-precision, constant-tension guideway system. This makes it possible to achieve reliable precision on the order of a few microns, or even less than one micron, depending on the measurement task.

The Werth image processing sensor has a very powerful contour image processing function. This not only affects the excellent precision of the measuring machine, but also ensures reliable automated functioning of the machine. Thales Electronic Systems has had very good experience with the coordinate measuring machine over time, so the company decided in 2011 to purchase another VideoCheck machine.

Werth Messtechnik ensures quality

"The reasons for our uncompromising accuracy requirements are certainly clear when you think about



The Wire Processing team finds that the two VideoCheck® machines from Werth have become an indispensable part of their daily work. From left: Peter Wöhrle, Stefan Nothdurft, Björn Bendel, Tobias Haug und Bruno Wanderer.



Tobias Haug, an experienced operator of WinWerth® software, has many functions available to him. Deviations from specified values are immediately evident from a measuring data chart. Operation is graphically interactive and thus ideal for applications in the lab and the shop floor.

it,” says Wanderer, “because if the part doesn’t work when it’s up there in a satellite that costs millions, then we have a problem. You can’t just pull into the shop like you do with a car, or send a technician to fix it.” In outer space the temperature varies between extremes and the radiation is intense. Even a tiny defect can mean the failure of an entire mission. Wanderer says, “Our requirements for a measuring machine are therefore maximum precision and suitability for the testing process. The tolerances are often just a few microns — so we need the measurement uncertainty to be about 0.5 µm to make sure the measurement process is capable.”

Wanderer and his colleagues have to pay special attention to make sure that the diameter, pitch, parallelism, and wire width do not wander outside of the defined tolerances. It takes about 30 to 40 minutes to inspect several hundred features of the coil using the VideoCheck® machines. The Werth VideoCheck® is typically loaded with a batch of 15 items. The machine then performs the measurements automatically overnight. The measured values are then immediately visible as a progression curve on the monitor. For the pitch inspection, tolerances of 6 µm must be maintained, while the tolerance for parallelism of the windings is only 3 µm.

Wanderer remembers well when the first VideoCheck® machine was installed. It took a while for the specific

requirements to be developed and implemented together with the Werth engineers and technicians. “Werth is very good to work with,” says the department head. “Not just during the installation phase; the same goes for running operations as well. If we have a problem at 2:00 in the afternoon, then the machine must be running again as quickly as possible.”

In these rare cases, Wanderer is happy to have the Service Hotline, where he can always reach Werth in Giessen. We get a call back right away, and the technicians for southwest Germany are on the spot quickly to tackle the problem. Weekends, too, if necessary.” Because of this high level of satisfaction, a third VideoCheck® machine has been recently ordered for incoming goods inspection.

The next investment is already planned. A few months ago, members of Wanderer’s team visited Werth to get information about the patent-pending “Rotary On The Fly®” measurement method that can be retrofitted to the VideoCheck®. This is a process that is used to measure geometries on the surface of round components. Images are captured continuously as the part is rotated. This has the advantage of eliminating the typical start-stop cycles. Previous measurement times can be drastically reduced by applying this method. Werth’s strategy of making new technologies available as upgrades to existing machines is another reason that the Thales team is in favor of partnering with Werth Messtechnik.

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