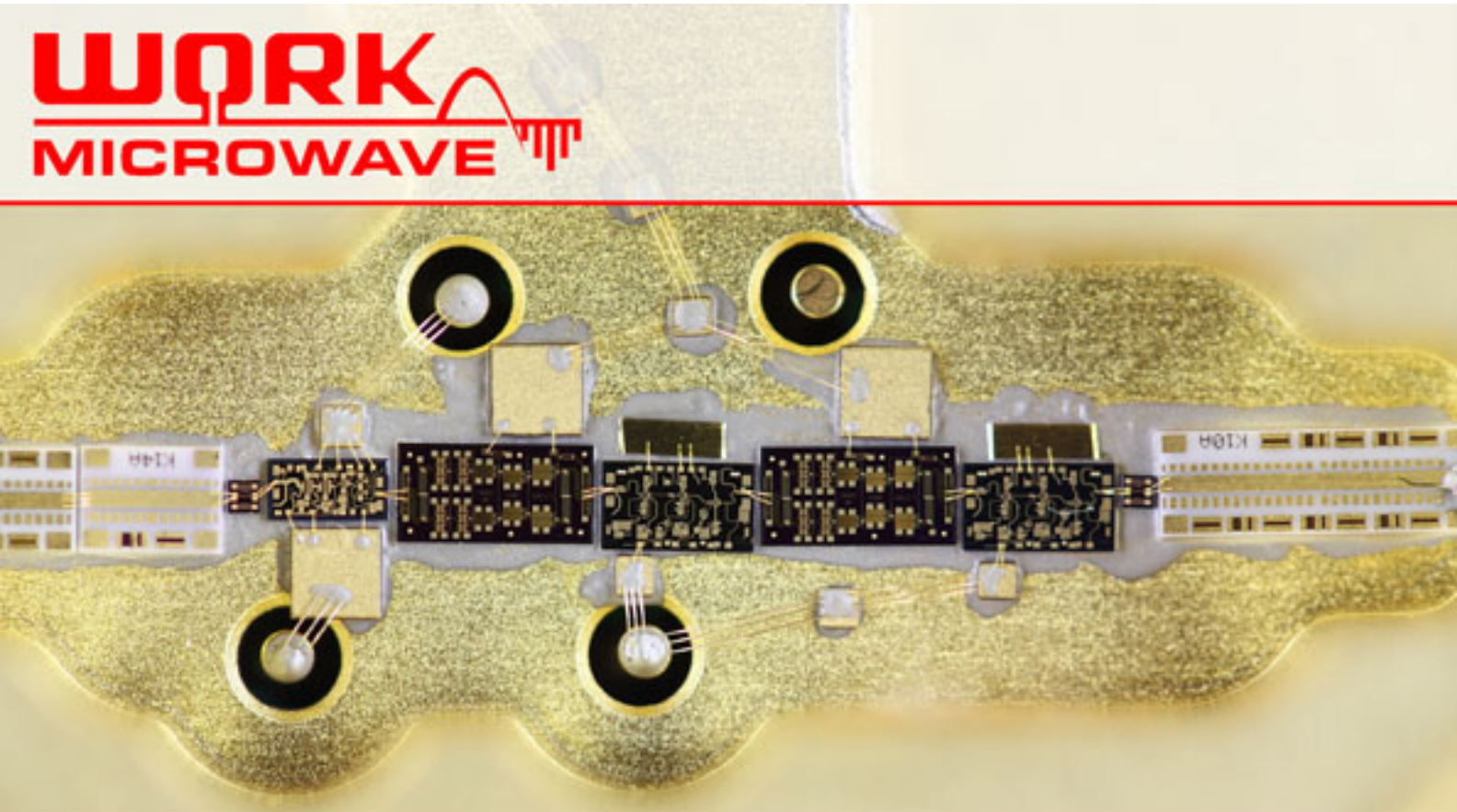


# MARKET Briefs

Executive Summaries of Market Trends and Opportunities in Key Market Segments and Regions Worldwide

**WORK**  
**MICROWAVE**



## RF & Microwave Technology Leadership



# WORK Microwave: Leading the Way in RF and Microwave Technology

by Virgil Labrador

Editor-in-Chief, Satellite Markets and Research

The harnessing of Radio Frequencies (RF) and microwaves are the core technologies that permeate the satellite, telecommunications and related fields. RF and microwave technology has made possible the growth and development of the satellite industry and all the invaluable communication services it provides society.

RF and microwave technology are vital components in both the ground and space sectors of the satellite industry. The global high power RF amplifier module market is set to record spectacular growth through 2026 according to a report of Transparency Market Research. Worldwide sales of high power RF amplifier modules are envisaged to surpass revenues worth US\$ 2.5 Billion by 2026.

## WORK Microwave

A company synonymous with RF and microwave technology is WORK Microwave based in Holzkirchen, Germany. WORK Microwave is a leading company in RF and microwave technology with a proven track record of success and reliability.

Headquartered in Holzkirchen (near Munich), Germany, and comprising of four operating divisions—Satellite Communication, Navigation Simulators, Defense Electronics, and Sensors and Measurement—WORK Microwave leverages 34 years of experience to anticipate market needs and apply an innovative and creative approach to the development of frequency converters, DVB-S2/S2X equipment, and other digital signal processing technologies while maintaining the highest standards for quality, reliability, and performance.

WORK Microwave's satellite technologies have been deployed by operators worldwide to support a range of applications within the satellite broadcast and satellite communications markets, including SNG/contribution, direct-to-home, IP networking, teleport management, governmental, among others.

The company's Satellite Communication products include: Modems/Modulators/Demodulators; Satellite Frequency Converters and Test Loop Translators.

What differentiates the company's products include unique features such as:

- Full coverage up to 50 GHz.
- Exceptionally high MTBF.
- Superior spectral purity.
- Customizable modular architecture.
- Extremely low power consumption.
- DVB-S/S2/S2X fully compliant.
- Intuitive user interface.

## A History of Developing Cutting Edge Technology

Established in 1986, WORK Microwave originally focused on a series of research projects and product design on behalf of other industry player before moving into design, manufacturing and distribution of its own product lines from 1992.

WORK Microwave's central competence at the beginning was the ability to build clean clock sources. The first products developed from this core competency were signal generators, microwave sensors and the 1st and 2nd generation of frequency converters (analog RF solutions).

In 1992, the company expanded into design, manufacturing, and distribution of its own product lines for OEM applications. During this time period, RF signal generators were added to WORK Microwave's portfolio.

Defense electronic modules became a specialty of WORK Microwave in 1995. A few years later, the company introduced microwave sensors.

Starting in 2001 WORK Microwave responded to the market becoming more digital by broadening the product range to also include digital RF solutions developing a comprehensive range of video and network devices. They started with the introduction of modulators before further adding demodulators and modems.

In 2006 as a spin off from the digital efforts the know-how derived from the development of modulators was used to help design the Multi-GNSS Laboratory RF Navigation Constellation Simulator (NCS).

From 2010 IP based devices have been introduced and today WORK Microwave is a established leader in RF technology. It is particularly known for its ability to combine RF and microwave expertise with IP and digital signal processing competencies.

"We have extensive expertise in developing electronics and software to manage, analyze, convert, and process data and



**WORK Microwave's engineering, manufacturing and test operations are all under one roof in Holzkirchen (near Munich), Germany and is one of the most efficiently integrated facilities in the industry.**

waveforms. Our software expertise ranges from ARM to PowerPC, x86, microcontrollers, applications and front-ends, embedded Linux, Userland, Kernel drivers, Buildroot, OpenEmbedded, Yocto, with experience in multiple languages (i.e., C/C++, C#, Javascript, Java, Perl, Python, Javascript, Lua, Delphi/Pascal, HTML, CSS)." said Dr.-Ing. Gunther Prokoph, the company's Chief Technical Officer (CTO).

"We're also specialists in digital signal processing and designing RF PCBs and modules, delivering schematics, layouts and assembled modules of analog and digital hardware. Need help with high-speed digital circuitry for busses and memories? No problem. We've handled everything from integration of exceptionally large FPGAs, RF frequencies up to 75 GHz, PCB boards up to 20 layers, and everything in between," added Prokoph.

### **State-of-the-Art Facility**

In 2019 the company moved into new 3,500 sqm facilities, double the size of the old space. This expansion demonstrates its commitment to continuously improving customer service by boosting the company's production capabilities reinforced with investment in new machinery, quality and process control.

The company's engineering, manufacturing and test operations are all one roof and is one of the most efficiently integrated facilities in the industry.

WORK Microwave is proud of its German engineering heritage and adherence to best practices and high quality standards in the industry.

To develop state of the art products for a wide range of

# Pioneering V-Band Technology

WORK Microwave is defined by a passionate team of technologists with a strong vision for the future. As the satellite industry continues to evolve, the company stands at the forefront as a pioneer in innovative satellite communication technologies, and in providing solutions to the challenges in 5G communications, aerospace, autonomous driving, among others.

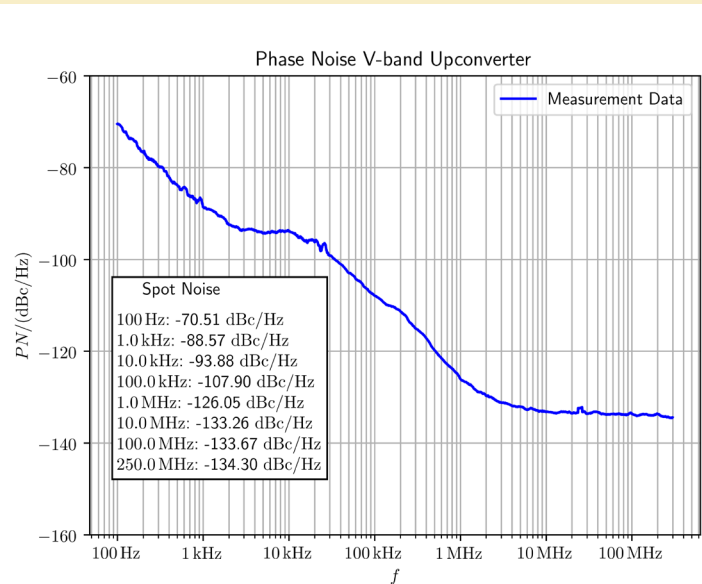
As data throughput in satellite communication rises, the focus of the RF technology shifts to higher frequency bands. Addressing this need, WORK Microwave has been the first company in the world to provide a full band V-band upconverter for satellite ground stations. The converter combines four L-band input channels to be converted to a 4 GHz bandwidth output signal in the range of 47.2 GHz to 51.4 GHz. The challenging performance regarding gain flatness, linearity, phase noise, and spurious output required electronic and mechanical engineering at its best.

With its production facility, engineering competence and testing facility under one roof, WORK Microwave is the leader when it comes to design and production of state-of-the-art RF-converters for the Satcom market, especially for high frequency bands.

In the process of achieving series production of the V-band converter, the company had to deal with many challenges to reach the outstanding performance.

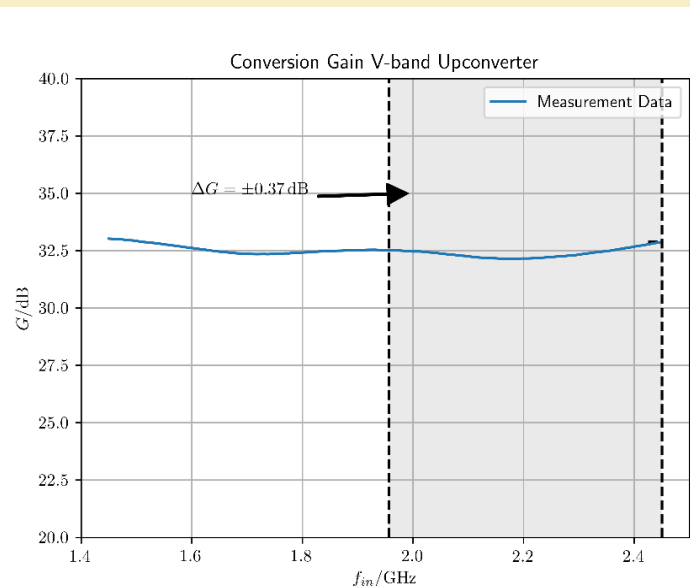
For the excellent phase noise performance (Figure 1), WORK Microwave used sophisticated PLL and mixing circuits that allow the use of integer-N PLLs and therefore reduce the presence of spurious outputs. Regarding the gain flatness, we were able to reach better than  $\pm 0.5$  dB over the entire 1 GHz bandwidth (Figure 2). To achieve this goal, WORK Microwave

**Figure 2: Gain flatness of the V-band converter vs. input frequency**



**Figure 1: Phase noise of the V-band converter at 51.4 GHz output frequency**

uses electromagnetic field simulation tools to optimize critical components like hybrid modules at V-band frequencies. The final tuning of these modules is done manually by RF-experts in house. Another field of expertise of WORK Microwave is in the software department--this helped in further optimizing gain flatness and equalization by developing automatic



tuning algorithms. All WORK Microwave converters go through temperature testing in climatic chambers before delivery and are compensated for any temperature drifts. The housing of the converters can be individually customized as it is also designed in house by the mechanical engineering department.

WORK Microwave's new wideband Demodulator that, when combined with the company's broadcast modulator and the V-band converter, provides satellite operators with one of the first end-to-end wideband transmission and reception solutions with symbol rates of up to 500Mpsps. To not lose track of the demodulation signal when the V-band converter is switched from the internal backup reference signal to external reference signal or vice versa, they included a digital PLL in the converter that limits the frequency shifting speed to 0.2 ppm/s in this case.

With the wideband modulators/demodulators and the V-band converter, WORK Microwave can offer a solution from a single source for the emerging V-band market. Potential drivers for market development are the high-throughput satellites but also mobile services that use backbone technology in Q-/V-band or the higher integration of subsystems where e.g. a broad IF-signal of 4 GHz bandwidth is converted to V-band.

WORK Microwave V-band converter series is also ready for the new allocation of 1 GHz spectrum in the 51.4 GHz to 52.4 GHz band, extending the V-band to a total bandwidth of 5 GHz (WRC-19 decision).

"Over the years, we have seen the industry move into new bands, from C- to Ku- and Ka-Band, in order to relieve pressure on available bandwidth. Now is the time to make use of the tremendous potential of future-forward technology like the V-Band," said Matthias Stangl, Director of Analog Satcom Products at WORK Microwave.

"Our V-Band converters set the benchmark for innovation thanks to a unique feature set and readiness to deploy in the real world. We

***"...Over the years, we have seen the industry move into new bands, from C- to Ku- and Ka-Band, in order to relieve pressure on available bandwidth. Now is the time to make use of the tremendous potential of future-forward technology like the V-Band..."***



**V-band upconverter**

are excited to lead this industry initiative and address the emerging commercial need for high-frequency Satcom equipment," Stangl added.

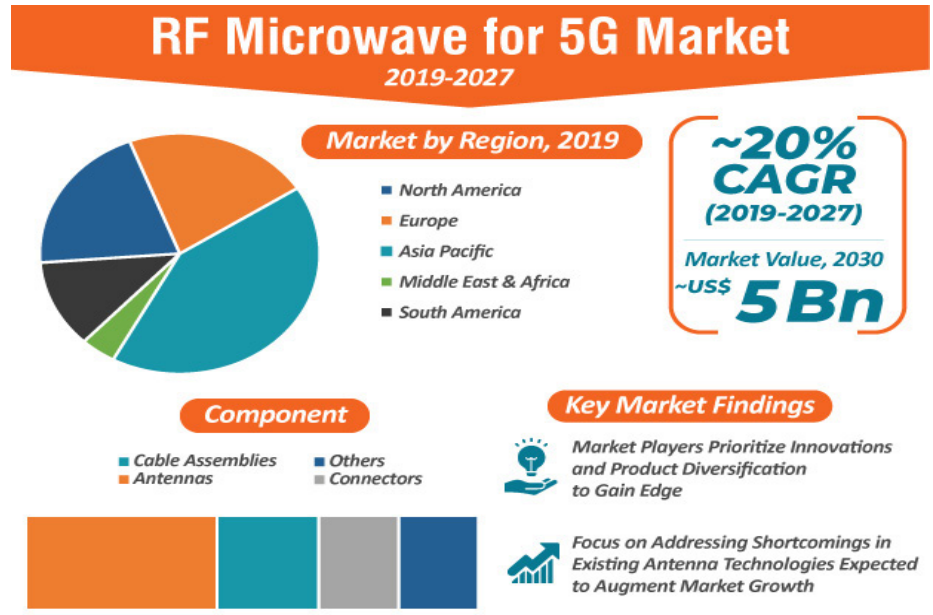
Offering the first commercial delivery of V-Band converters validates WORK Microwave's position as the industry's leading provider of Satcom equipment. WORK Microwave's converters offer unrivalled features and performance, including excellent phase noise, gain flatness, spurious response, group delay, and a multichannel architecture that allows wider coverage of each frequency band.

users, WORK Microwave has assembled a team of highly qualified software and hardware engineers with extensive know how in microwave and digital signal processing technology, plus a production and mechanics team who are skillful in manufacturing.

## Maximizing 5G Opportunities for Satellite

One of the most promising areas for satellite technology is in the rollout of 5G networks. 5G is a disruptive technology that is set to transform wireless connectivity, enabling ultra-fast broadband speeds, increased efficiency, reduced network costs, and more scalability, among a wide range of other benefits that will open up new markets and drive technology innovation. And 5G comes at the perfect time. The number of connected devices that are in use worldwide now exceeds 17 billion, according to the latest research from IoT Analytics. With 5G, the industry can better address today's connected world and its growing connectivity requirements.

Satellite communications will be an essential part of the 5G infrastructure, with LEO and MEO constellations used to offload networks, reach areas where there is no terrestrial connection, and reduce end-to-end network latency. 5G will be a network of networks — an ecosystem that leverages fiber and terrestrial networks, complemented by satellite connectivity, as needed. The possibilities are endless for the role that satellite can play:



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- Autonomous vehicles
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- Smart cities
- Intelligent manufacturing
- Government infrastructure
- Science missions
- Earth observation

“5G is set to have a huge impact on the satellite industry, and we’re here to help operators make the most of those opportunities. With 30 years of experience in high frequencies and digital signal processing, WORK Microwave is in a unique position to provide 5G and satellite engineering services. Leveraging our breadth of industry expertise spread across four product divisions, including Satcom, Defence Electronics, Navigation Simulators, and

Industrial Process Sensors, operators can design innovative solutions for LEO/MEO constellations that are a critical part of the 5G infrastructure,” said Dr. Thomas Fröhlich, the company’s CEO.

“Our world-class engineering solutions team are a valuable resource for satellite operators that want to deploy LEO/MEO constellations and play a pivotal role in the 5G environment. Our team is experienced in both satellite and 5G technologies. With a foothold in both worlds, we can help you design cutting-edge products and support your project across all phases, from concept to production. Whether you need help launching new constellations, designing a customized Satcom solution, exploring applications for 5G, or ensuring interoperability with ecosystem vendors, we’ve got your needs covered,” added Fröhlich.

## Engineering Services

In addition to designing and manufacturing its own product lines, WORK Microwave can provide customized solutions that can easily be adapted for any application, offering satellite service providers, telcos, broadcasters, and Internet service providers the most flexible product to meet their everyday business needs. The company's products provides a combination of higher performance and greater reliability than other products on the market.

"As well as adapting any of our standard products for any specific requirements, we offer the opportunity for customers to have bespoke products made to their exact specifications," said Fröhlich.

Drawing on its over 30 years of experience, WORK Microwave also provides engineering consultancy services. This gives the client direct access to the company's technology know-how, design experience and engineering creativity. The same teams that designed its cutting-edge products are available to support your project, create a solution that addresses your problem and bring fresh, innovative ideas to your system design.

## The Future

Dr. Thomas Fröhlich, CEO of WORK Microwave, who has led the company through four years of continued growth sees some challenges ahead for the industry. The global COVID-19

pandemic has not affected the company as much and may have actually strengthened its position in the market. The company has been fully operational during this pandemic, and has managed to avoid some of the disruptions in the supply chain that other companies have faced. "We are optimistic for the future and we see WORK Microwave well prepared for sustained presence in the traditional GEO satcom market as well as for the new non-GEO (LEO and MEO) constellation business," said Fröhlich.

The company has adopted a strategy of preparing for the future by developing cutting edge products which can be used for various applications and verticals and new technologies such as virtualization, "RFoIP", cloud processing, Artificial Intelligence, among others.

"We try to support our customers in their technological orientation process by jointly identifying and developing optimized system solutions," said Fröhlich.

WORK Microwave has also



**Virgil Labrador** is the Editor-in-Chief of Los Angeles, California-based Satellite Markets and Research which publishes a web portal on the satellite industry [www.satellitemarkets.com](http://www.satellitemarkets.com), the monthly Satellite Executive Briefing magazine and occasional industry reports called MarketBriefs. Virgil is one of the few trade journalists who has a proven track record working in the commercial satellite industry. He worked as a senior executive for a teleport in Singapore, the Asia Broadcast Center, then-owned by the US broadcasting company CBS. He has co-authored two books on the history of satellite communications and satellite technology. He holds a Master's in Communications Management from the University of Southern California (USC). He can be reached at [virgil@satellitemarkets.com](mailto:virgil@satellitemarkets.com)

View a video tour of  
**WORK Microwave's  
brand new headquar-  
ters, R&D and  
manufacturing facility  
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investing in R&D efforts in optical technology for Satcom or Earth observation business such as optical base band or intermediate frequency connectivity in ground installations, and modem development for optical earth stations (laser space to ground communication).

Fröhlich is very bullish in their other business segments such as Defense Electronics. He sees increasing demand and growth in military radar systems. This year, it will be launching its Navigation system simulator product. The company's diversified product portfolio and extensive expertise puts it in very good stead in facing the challenges ahead.

Over 30 Years Experience

## Next Generation of Satellite Communications

### Ultra High Frequencies



Multi Channel  
V-Band Upconverter

Industry's first qualified **V-Band** Frequency Converters. Covering the full ITU uplink bandwidth range from **47.20 to 51.40 GHz**.

### End-to-End Wideband Modem



A-Series AX-80 Modem

All-IP Platform designed to support ultra-wideband transponders up to **500 Msps**. Full throughput with **256 APSK** up to 3 Gbps per direction.

WORK Microwave devices are deployed by operators worldwide to support a range of broadcast and data applications in satellite communications markets, including HTS/UHTS, SNG/contribution, direct-to-home, IP networking, government and defence, and more.

Learn more at [www.work-microwave.com](http://www.work-microwave.com)