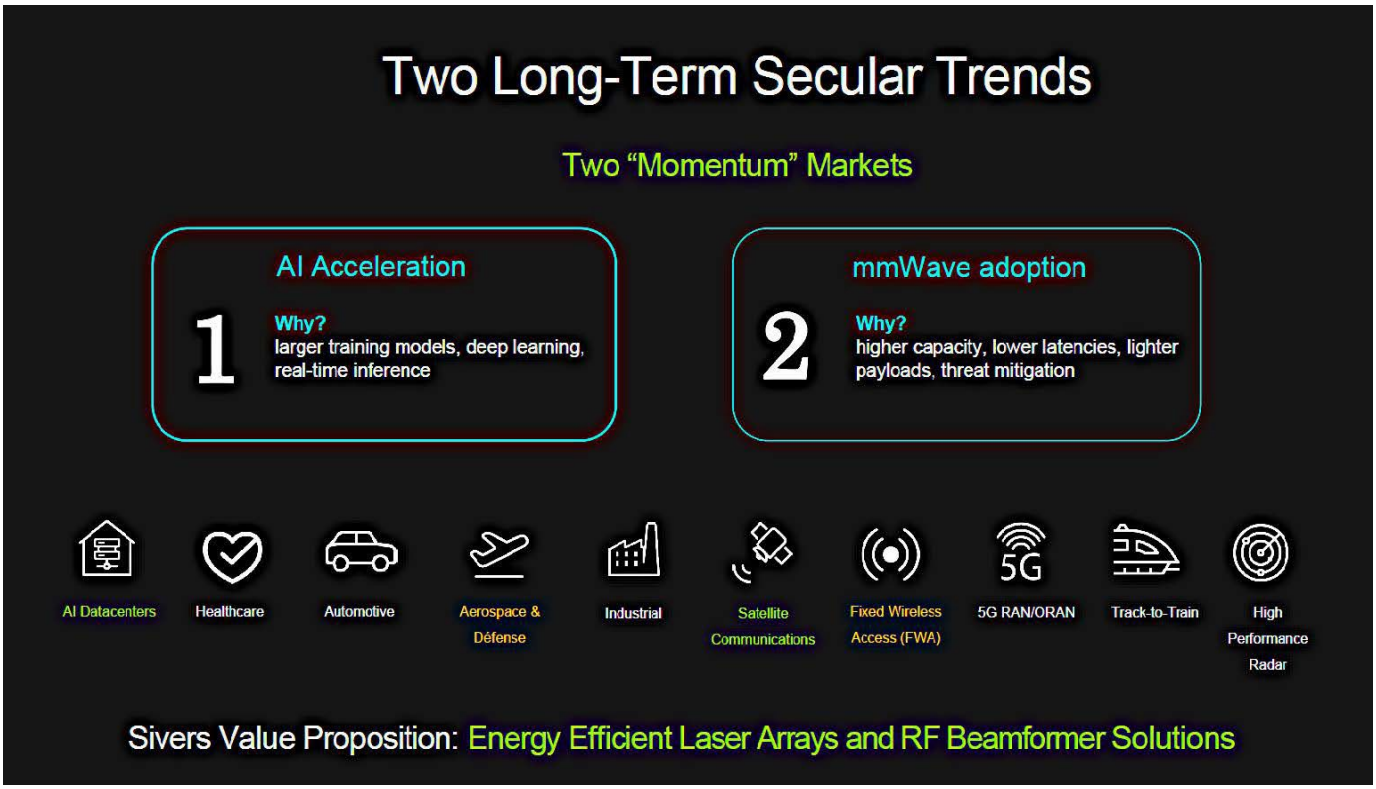
Critical Enablers of a Greener Data Economy

sivers SEMICONDUCTORS

Sivers Semiconductors

is a critical enabler of a greener data economy with energy efficient photonics and wireless solutions. The company's differentiated high precision laser and RF beamformer technologies cater to two long-term secular trends: AI Accelaration and mmWave adoption.

The company helps customers in key markets such as AI datacenters, satellite communications, defense and telecom, to solve essential performance challenges while enabling a much greener footprint.



236
MSEK in Net Sales in 2024

3
percent sales growth in 2024

20,000
shareholders

752
MSEK in MCAP end of 2024

Sivers Semiconductors is listed on Nasdaq Stockholm under the SIVE ticker. The Group's head office is in Kista, Stockholm.

Photonics
offers the world's highest performance multi-wavelength lasers and laser arrays to enable the paradigm shift from copper to optical interconnects in AI Datacenters

Wireless'
RF beamformer products are enabling highly energy efficient terminal and satellite solutions for SATCOM

Total number of employees
128
of whom
28
employees hold a PhD

Sweden
Head office & Wireless / R&D and sales / Fabless
28 employees

USA
Wireless SATCOM & radar / R&D and sales / Fabless
17 employees

Scotland
Photonics AI R&D and Sales/ Fab
83 employees

This is Sivers Semiconductors

We are Critical Enablers of a Greener Data Economy with Energy Efficient Photonics & Wireless Solutions

Total number of employees

128

of whom

28

employees hold a PhD

At the end of the fourth quarter 2024, Sivers Semiconductors had 128 employees in the US, Scotland and Sweden. 28 of the employees hold a PhD.

Sivers Semiconductors is listed on Nasdaq Stockholm under the SIVE ticker. The Group's head office is in Kista, Stockholm.

Sivers Photonics
offers the world's highest performance multi-wavelength lasers and laser arrays to enable the paradigm shift from copper to optical interconnects in AI Datacenters

Sivers Wireless'
RF beamformer products are enabling highly energy efficient terminal and satellite solutions for SATCOM

Our differentiated high precision laser and RF beamformer technologies help our customers in key markets such as AI datacenters, SATCOM, Defense and Telecom solve essential performance challenges while enabling a much greener footprint

Sweden
Head office & Wireless / R&D and sales / Fabless
28 employees

USA
Wireless SATCOM & radar / R&D and sales / Fabless
17 employees

Scotland
Photonics AI R&D and Sales/ Fab
83 employees

Sivers – mission critical focus on two markets with tremendous momentum

AI Datacenters

Satellite Communications (SATCOM)

sivers SEMICONDUCTORS

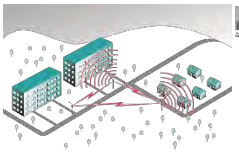
WIRELESS

BUSINESS AREA WIRELESS SIVERS WIRELESS has been consistently innovating for almost 70 years, developing an enviable reputation for quality in every component. As our demand for data grows, you need solutions that can offer the speed and flexibility that industry requires. The proliferation of wireless devices – and the congestion on current frequency bands – drive data and telecoms companies to find solutions that can reliably exploit higher frequencies, increasing speed, power, and reliability. Sivers Wireless is a leading innovator of mmWave semiconductor and antenna technologies that meet – and exceed – these needs.

EXPERTS IN MMWAVE, WITH PROVEN APPLICATIONS

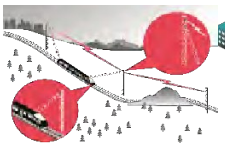
OPEN RADIO ACCESS NETWORK

The Open Radio Access initiative reduces cost and complexity by allowing operators to mix and match hardware as they choose.



FIXED WIRELESS ACCESS

A genuine, Gigabit speed alternative or complement to fiber connections, operating in the licensed and unlicensed spectrums.

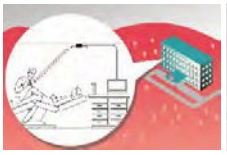


TRACK TO TRAIN

The ever increasing demand for mobile data at volume has now exceeded the capabilities of 3G and 4G. 5G offers the ability to move data at gigabit speeds to vehicles on the move.

MOBILE / WIFI BACKHAUL

Since the introduction of GSM, microwave connectivity has been one of the leading ways to connect mobile base stations, offering rapid deployment, flexibility, and low TCO.



UNCOMPRESSED REAL-TIME DATA

Millimeter-wave technology opens up new use cases, with the possibility to transport uncompressed real-time data.

SATCOM

We provide antennas and chipsets for the SatCom vendors. For mobile, private and government network suppliers.

COMPLETE PRODUCT PORTFOLIO FOR LICENSED AND UNLICENSED 5G

5G mmWave RFICs

Family of RFIC with highest level of integration including BF, UDC and PLL

Support for both IF and Zero IF i/f (configurable).

Part of verified solution Integrated with 4x4 antenna array

Optimized for CPE and Small cell implementation

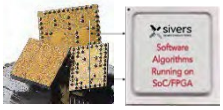
Unlicensed 5G RFICs and Antenna modules

Highest level of performance and widest frequency coverage with one Hardware

Sivers offer "Chip only" or integrated with antenna (several antenna options available)

Support for 802.11ad and 60 GHz 5G NR-U

Optimized for infrastructure applications in the unlicensed 60 GHz space



Algorithms

Performance boosting algorithms that run on a customer's baseband

World's first array predistortion algorithm

Adds value and "stickiness" to Open RAN and Open RF architectures

5G NR FR2 Beamformers and Antenna In package

Family of highly integrated beamformer ICs with remarkable output power and efficiency

GlobalFoundries Enhanced 45RFSOI, following 10 years of collaboration

Chip-scale package and industry-first Antenna-in-Package technology

Satcom Tx and Rx Chipsets

Dual-pol 4-antenna multi-beam Ka Band Satcom RX and TX Chipset

Developed for and funded by Satellite Terminal vendor

Prototype systems in trial, production ramp in 2022

Evaluation Kits & Evaluation Boards

Leverage our integration test platform to reduce costs and time to market

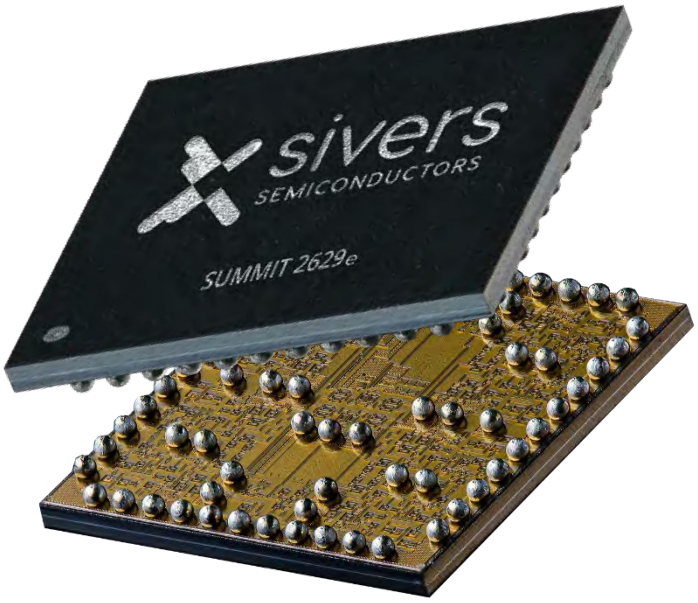
Seamless operation together with any Zero-IF based

24 - 29.5 GHz Portfolio

PRODUCT BRIEF - WIRELESS

SUMMIT2629e™

Address challenges constraining 5G mmWave with our 28 GHz Beamforming front end IC



Operating from 26.5 to 29.5 GHz, the SUMMIT2629e™ integrates power amplifiers (PA), low noise amplifiers, T/R switching, beamformers with beam table memory, calibration, gain control and temperature and power telemetry with a high-speed system peripheral interface (SPI) for control. A single SUMMIT2629e™ provides two sets of four channels for two antenna polarizations – a total of eight channels per RFIC.

"Sivers Semiconductors is indeed offering a real performance breakthrough which will translate to higher performance and lower cost mmWave phased array systems."

Daniel Kang,
Head of Digital Solution Team, Dreamtech

Sivers Semiconductor products and services enable 5G manufacturers to simplify product design, integrate components to reduce footprint and improve system reliability. Of course, with best-in-class RF performance.

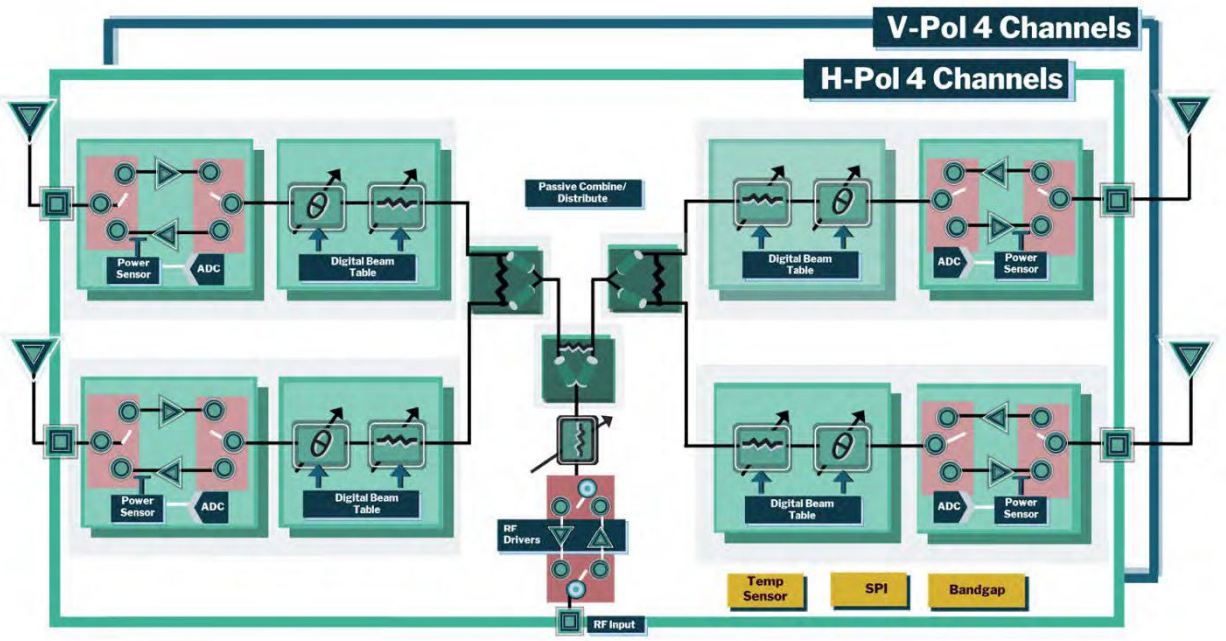
SUMMIT2629e™ is an eight-channel RF front-end for 28 GHz, 5G phased array antenna system fabricated in RF-Silicon on Insulator (RF-SOI). SUMMIT2629e™ is designed to address the challenges constraining 5G mmWave performance by:

- Extending the link range to decrease infrastructure costs and improve customer satisfaction.
- Reducing power consumption and thermal dissipation.
- Reducing antenna array complexity and overall RF front-end cost.

KEY FEATURES

- 26.5 GHz-29.5 GHz
- Beamforming transceiver with 8 (2x4 H+V) ports enabling two data streams supporting 2 MIMO layers
- Tx/Rx independent beam directions enabled by 6-bit phase shifting and 16 dB variable gain in each path
- High-power, high-efficiency SOI CMOS power amplifiers
- Integrated low-loss T/R switches, linear power and state-of-the-art low noise amplifiers
- Ultra-low Transmit- and Receive-Mode power consumption
- 6-bit full-360° phase shifting and 0.5dB-step 16dB-range variable gain in each path
- Fully calibrated for Gain/Phase matching across ICs
- Extensive on-chip temperature and power sensing
- On-chip gain control for temperature compensation
- High-Speed SPI with large on-chip beam table storage
- Wafer-Level Chip-Scale Package (WLCSP) compatible with low-cost PCB manufacturing
- Support for large-scale arrays through multiple chip-addressing modes

High power and efficiency will be success factors when designing larger Base Transceiver Station (BTS) antenna arrays, where thermal design is critical. SUMMIT2629e™ is a greener and more compelling solution reaching more customers, still using less energy.



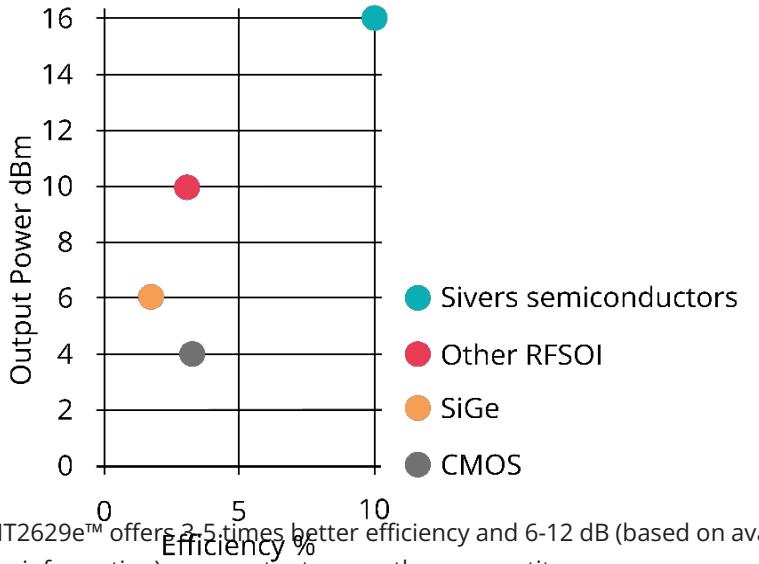
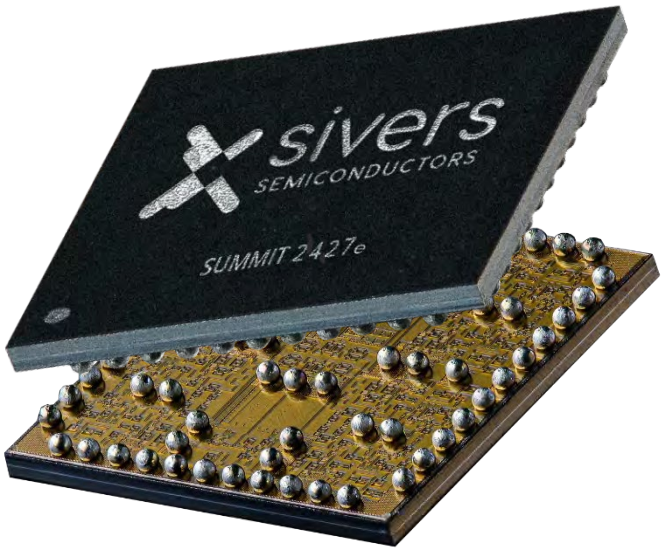


Figure 2. The SUMMIT2629e™ offers 2-5 times better efficiency and 6-12 dB (based on available information) more output power than competitors

PRODUCT BRIEF - WIRELESS

SUMMIT2427e™

Address challenges constraining 5G mmWave with our 24 GHz Beamforming front end IC



Operating from 24.25 to 27.5 GHz, the SUMMIT2427e™ integrates power amplifiers (PA), low noise amplifiers, T/R switching, beamformers with beam table memory, calibration, gain control and temperature and power telemetry with a high-speed system peripheral interface (SPI) for control. A single SUMMIT2427e™ provides two sets of four channels for two antenna polarizations – a total of eight channels per RFIC.

"Sivers Semiconductors is indeed offering a real performance breakthrough which will translate to higher performance and lower cost mmWave phased array systems."

Daniel Kang,

Head of Digital Solution Team, Dreamtech

Sivers Semiconductor products and services enable 5G manufacturers to simplify product design, integrate components to reduce footprint and improve system reliability. Of course, with best-in-class RF performance.

SUMMIT2427e™ is an eight-channel RF front-end for 28 GHz, 5G phased array antenna system fabricated in RF-Silicon on Insulator (RF-SOI). SUMMIT2427e™ is designed to address the challenges constraining 5G mmWave performance by:

- Extending the link range to decrease infrastructure costs and improve customer satisfaction.
- Reducing power consumption and thermal dissipation.
- Reducing antenna array complexity and overall RF front-end cost.

KEY FEATURES

- 24.25 GHz-27.5 GHz
- Beamforming transceiver with 8 (2x4 H+V) ports enabling two data streams supporting 2 MIMO layers
- Tx/Rx independent beam directions enabled by 6-bit phase shifting and 16 dB variable gain in each path
- High-power, high-efficiency SOI CMOS power amplifiers
- Integrated low-loss T/R switches, linear power and state-of-the-art low noise amplifiers
- Ultra-low Transmit- and Receive-Mode power consumption

- 6-bit full-360° phase shifting and 0.5dB-step 16dB-range variable gain in each path
- Fully calibrated for Gain/Phase matching across ICs
- Extensive on-chip temperature and power sensing
- On-chip gain control for temperature compensation
- High-Speed SPI with large on-chip beam table storage
- Wafer-Level Chip-Scale Package (WLCSP) compatible with low-cost PCB manufacturing
- Support for large-scale arrays through multiple chip-addressing modes

High power and efficiency will be success factors when designing larger Base Transceiver Station (BTS) antenna arrays, where thermal design is critical. SUMMIT2427e™ is a greener and more compelling solution reaching more customers, still using less energy.

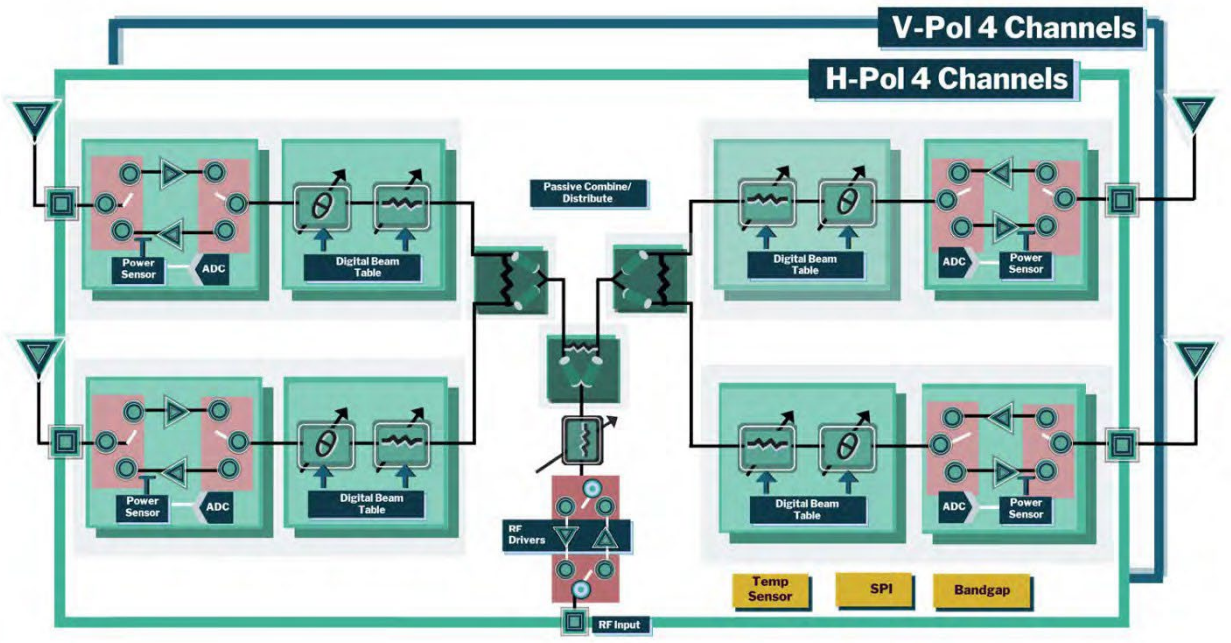


Figure 1. Block schematics SUMMIT2427e™

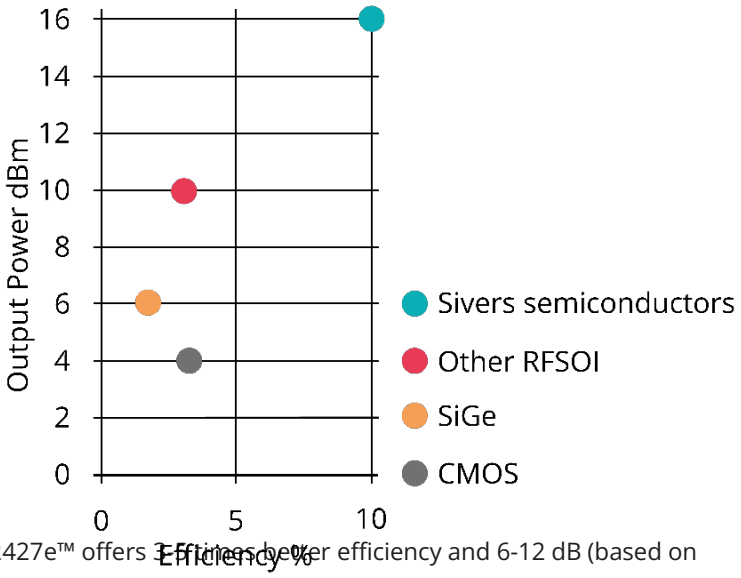


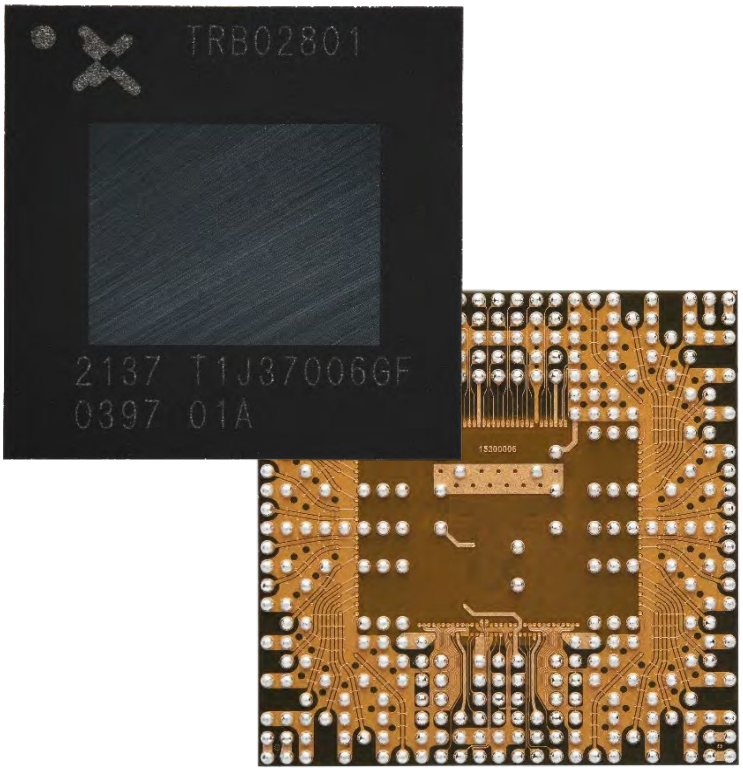
Figure 2. The SUMMIT2427e™ offers 3 times better efficiency and 6-12 dB (based on available information) more output power than competitors

For more information, please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

TRB02801 (24.25-29.5 GHz)

Highly integrated, state of the art 5G NR RFIC



Sivers Semiconductors pushes ahead with more 5G innovations.

The TRB02801 support the full frequency range from 24.25 to 29.5 GHz with speeds up to 5 Gbit/s. The unique level of integration enables support for different markets and frequency bands using the same hardware. Explore how this groundbreaking RFIC will improve and speed-up your licensed 5G rollout.

TRB02801 is a 32 channel beam forming transceiver Radio Frequency Integrated Circuit (RFIC). With support for both Zero-IF and IF baseband interface, it may easily be integrated to your product with any 5G mmWave modem.

KEY FEATURES

- 24.25 GHz-29.5 GHz
- Wide band transmit and receive antenna array optimized for the 28 and 39 GHz bands
- Designed for 3GPP NR 5G Fixed Wireless Access (FWA) applications
- Beamforming transceiver with 32 (2x16 H+V) ports enabling two data streams supporting 2 MIMO layers
- RF tiling of multiple transceivers for large array antenna configurations
- Integrated T/R-switches, linear power and low noise amplifiers
- Excellent RF performance providing best in class EVM performance
- High-performance synthesizer
- Connection to the baseband modem through:
  - Analog IQ-interface (Zero IF) or
  - IF-interface
- Integrated programmable baseband filters
- Easy to use with autonomous calibration routines and simple baseband interface

The unique high level of integration enables full transceiver design. Several RFICs may be tiled together in bigger arrays for longer reach and greater performance.

Less components means less cost and higher quality - critical parameters to consider when designing a Customer Premises Equipment (CPE) or small "hot spot" base stations. The transceiver IC supports unique wide band coverage of 24.25 – 29.5 GHz, superior link budget, excellent Error Vector Magnitude (EVM) performance enabling more than 256 QAM OFDM modulation, full temperature range of -40 to +85 deg C, small form-factor and flexible channelization. All of which make the RFIC uniquely well fitted for outdoor infrastructure 5G mmWave applications.

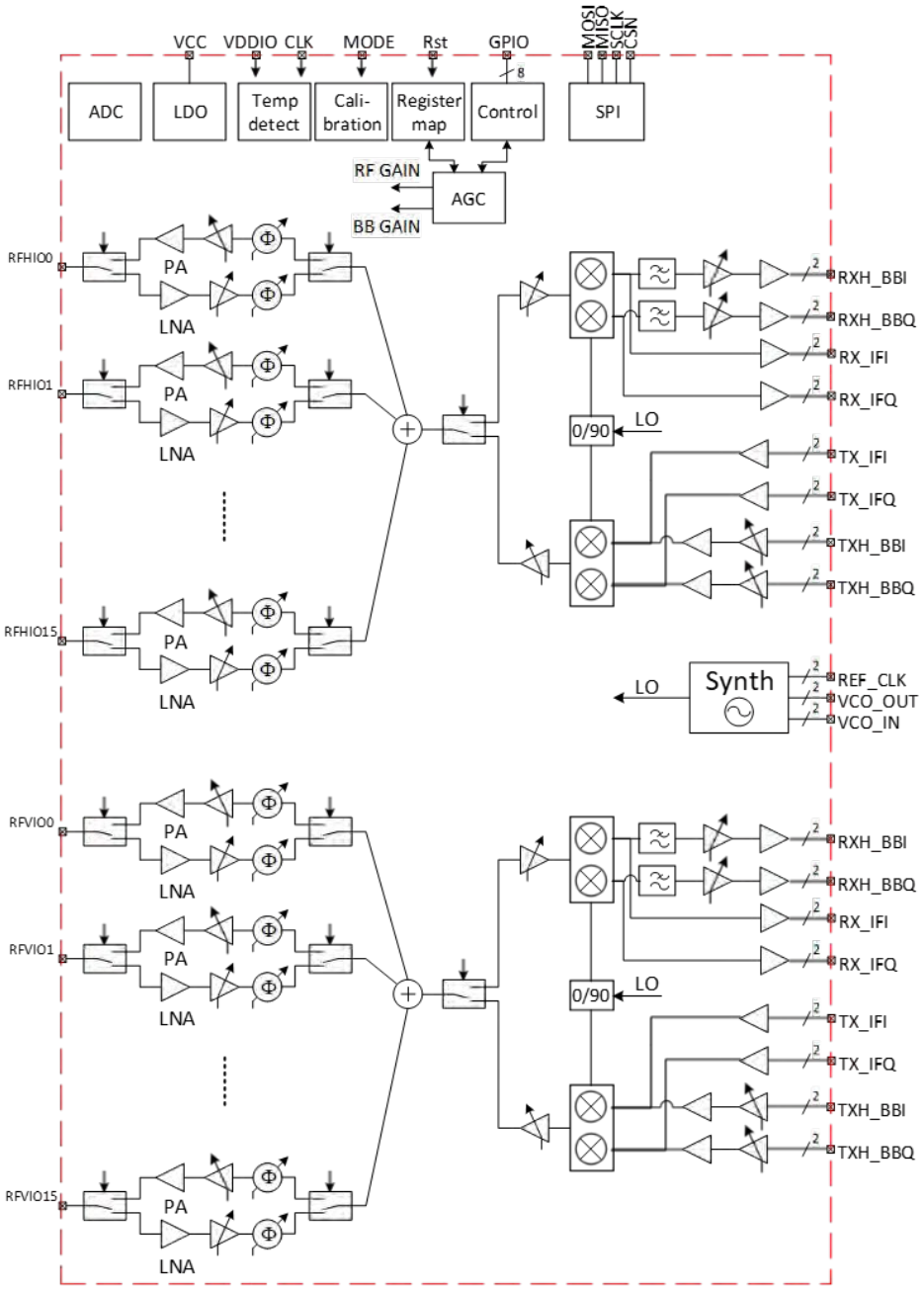


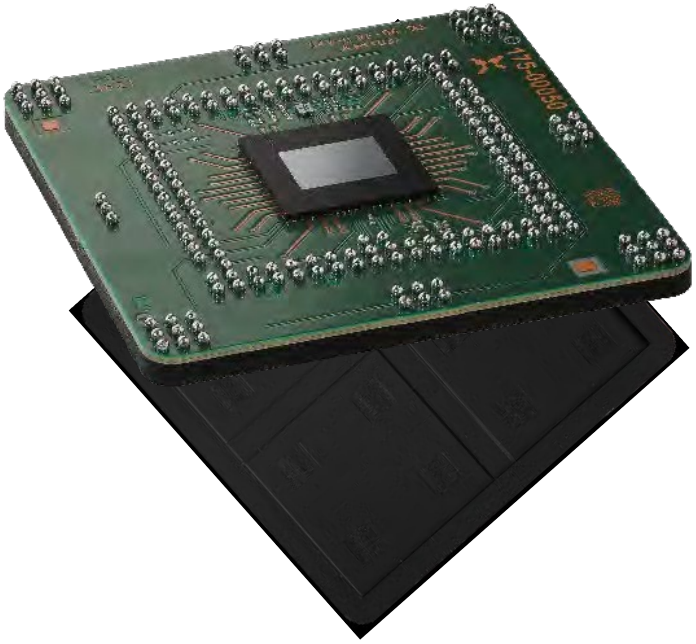
Figure 1. Block schematics TRB02801

For more information please contact: *sales@sivers-wireless.com*

PRODUCT BRIEF - WIRELESS

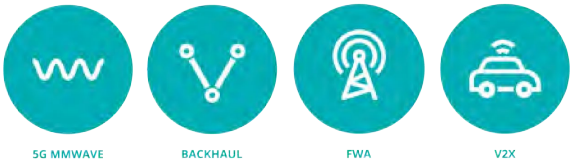
BFM02801 (24.25 GHz - 29.5 GHz)

Best in class beamforming antenna module covering the licensed 28 GHz 5G mmWave band



Utilize the award-winning experienced RF engineering team at Sivers Semiconductors and let us design the Radio Frequency part in your 5G-NR mmwave access product. Our RF module BFM02801 has unmatched power performance and throughput together with an integrated antenna that gives you a competitive advantage in the licensed 5G race.

By combining the unmatched performance of the TRB02801 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of your licensed 5G networks.



KEY FEATURES

- 24.25 GHz - 29.5 GHz
- Wide band transmit and receive antenna array optimized for the 28 GHz band
- Designed for 3GPP NR 5G Fixed Wireless Access (FWA) applications
- Dual polarisation beamforming transceiver with 32 (2x16 H+V) ports enabling two data streams supporting 2x2 MIMO
- RF tiling of multiple transceivers for large array antenna configurations
- Beam steering:
  - Azimuth ± 45 degrees
  - Elevation ± 45 degrees
- Integrated T/R-switches, linear power and low noise amplifiers
- Excellent RF performance providing best in class EVM performance
- High-performance synthesizer
- Connection to the baseband modem through:
  - Analog IQ-interface (Zero IF) or
  - IF-interface
- Integrated programmable baseband filters
- Easy to use with autonomous calibration routines and simple baseband interface

Transmitted power of up to +48 dBm with electronic beam steering in one single module enable product deployments in the most diverse applications. Furthermore, autonomous calibration routines and simple baseband interfaces make it easy to install and manage.

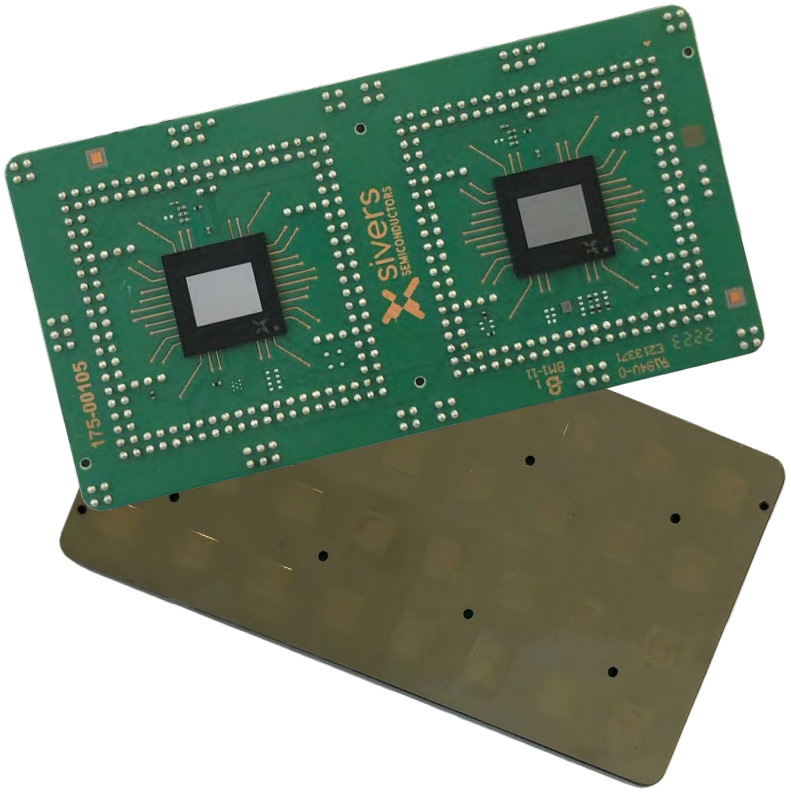
Small form factor will be key going forward addressing FWA/RAN/O-RAN solutions. This module is setting the scene for 5G-NR RFIC and antenna modules through its high output power levels, intelligent power management and flexibility.

For more information please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

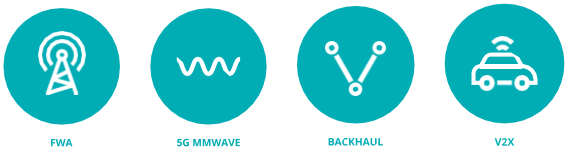
BFM02803 (24.25–29.5 GHz)

Differentiate your 28 GHz Fixed Wireless Access product



Sivers Semiconductors presents a new, innovative low-cost RF Module covering the 5G FR2 mmWave bands N257, N258, and N261 i.e. from 24.25 to 29.5 GHz. It supports 2x2 MIMO with dual polarization in both downlink and uplink for channels up to 1.2 GHz. BFM02803 includes 32 dual-polarized antenna elements with 2D beam steering (in azimuth and elevation) capabilities. This module is optimized for high-performance, high power FWA applications and enables you to differentiate and meet the requirements of large-scale manufacturing of your FWA products. It is designed to interface with leading baseband modems.

By combining the market leading performance of the TRB02801 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 28 GHz FWA networks. Transmitted power greater than +50 dBm per polarization enables FWA product deployments in the most diverse applications with the lowest total cost of ownership.



KEY FEATURES

- 24.25 GHz -29.5 GHz
- Enables up to 256 QAM CP-OFDM with integrated synthesizer
- Consists of two TRB02801 RFICs. 32 paths per polarisation. 64 in total
- Supports both Zero IF (baseband mode) and Low IF mode (between 3.5 – 5 GHz)
- Analog filtering in both receive and transmit mode which suppresses out of band interferers
- Integrated beambook for instant beamforming/ steering
- Beam steering in Azimuth, elevation: ± 45 degrees
- >50 dBm TX EIRP per polarisation
- 6 dB NF (Noise Figure)

Autonomous calibration routines and simple baseband interfaces make the module easy to install and manage. With the use of air-filled cavity in the PCB the module is optimized for large scale, low loss, and low-cost assembly. This module will improve your business case and make your 28 GHz fixed wireless access product truly competitive.

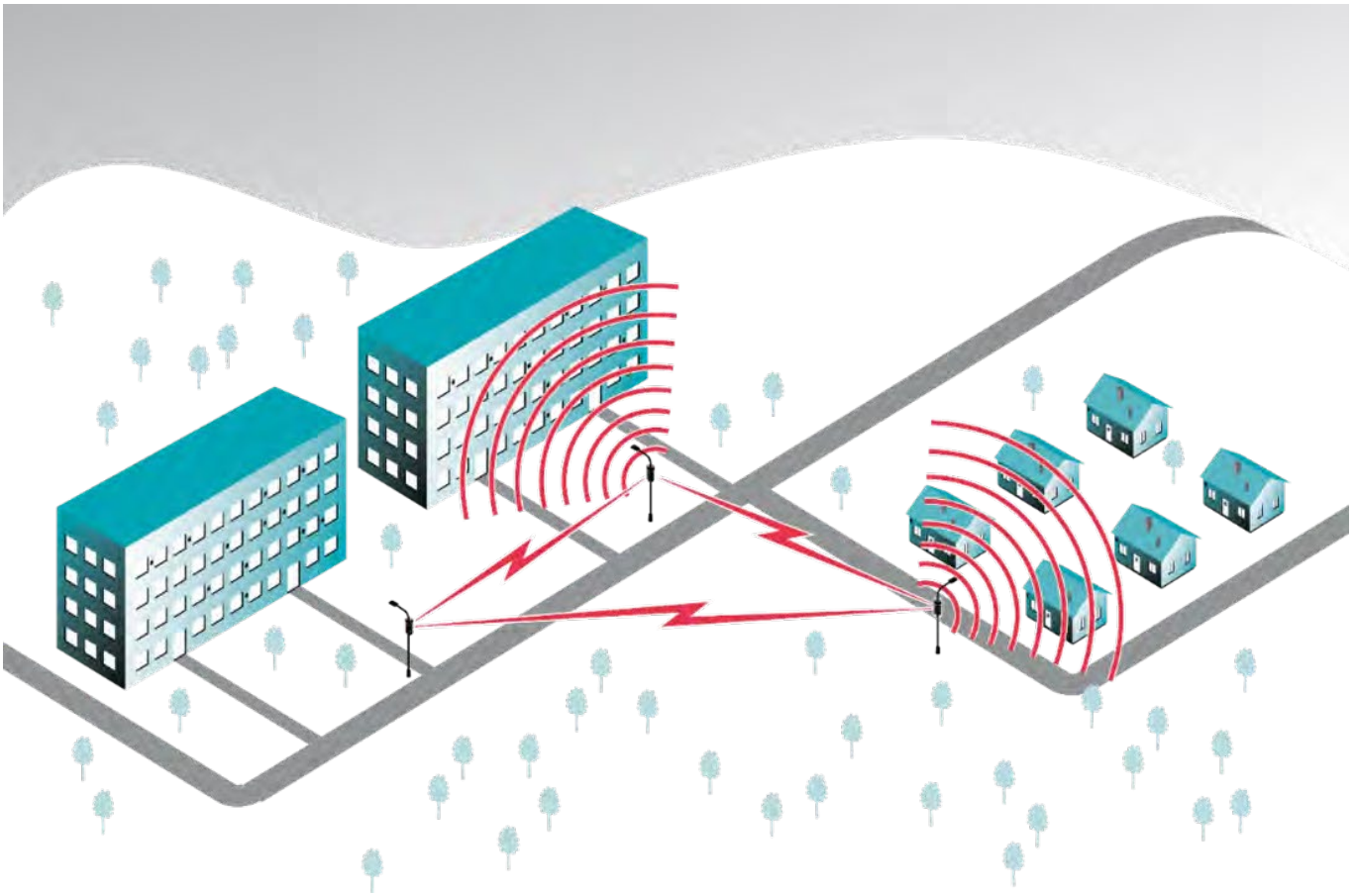


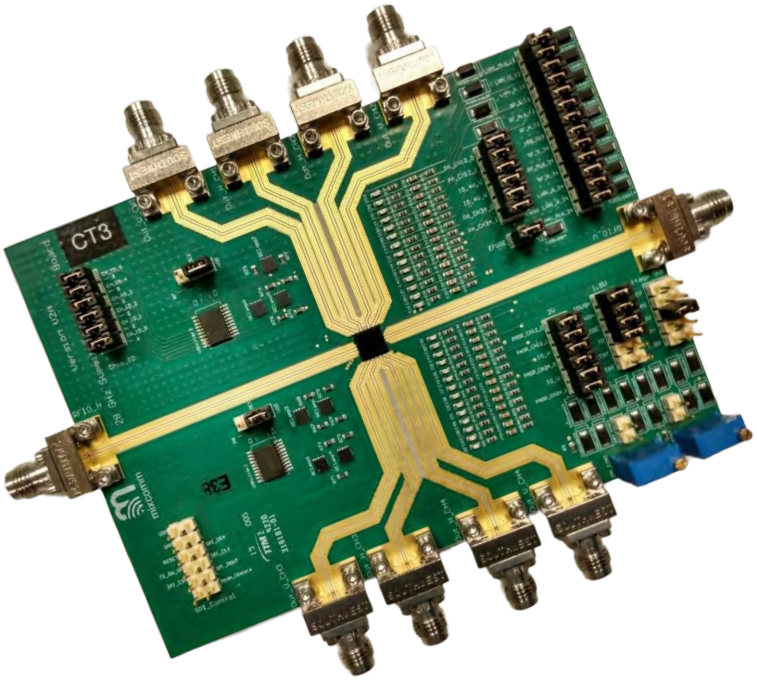
Figure: Fixed Wireless Access
A genuine, Gigabit speed alternative or complement to fiber connections, operating in the licensed and unlicensed spectrums.

For more information please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

SUMMIT2629eEVB (26.5-29.5 GHz)

Speed up mmWave phased array antenna's development using our BFIC evaluation boards



SUMMIT2629eEVB is a connectorized evaluation board featuring the beam former IC SUMMIT2629e, which is a highly integrated beam-forming front end for use in 5G phased array antennas, covering FR2 band n257 from 26.5 to 29.5GHz.

The SUMMIT2629e allows for lower cost, more compact, and higher data rate 5G systems with exceptionally high linear output power, efficiency, and integration.

KEY FEATURES

- Four-Element Dual-Polarization (8 Total Channels)
- Full TX/RX TDD RF chains
- Ultra-low TX and RX Power Consumption
- High-Power Stacked SOI CMOS PAs
- Low-loss T/R switches for TDD applications
- Independent dual polarization beam directions
- Wide band receive and transmit antenna array optimized for operation in the n257 GHz band
- 1V, 1.8V, and 4V Power Supplies
- 125MHz SPI
- 2048-entry on-chip Beam Table Storage

The SUMMIT2629eEVB provides connectorized access to all RF ports of the IC, which includes the 4 antenna-side ports in each of the horizontal and vertical polarizations, and the common ports in each polarization (10 RF ports in total).

The evaluation board needs 4V, 1.8V and 1V DC power supplies and comes with a USB-to-SPI adaptor for easy programming of the IC through MATLAB scripts or command line interface.

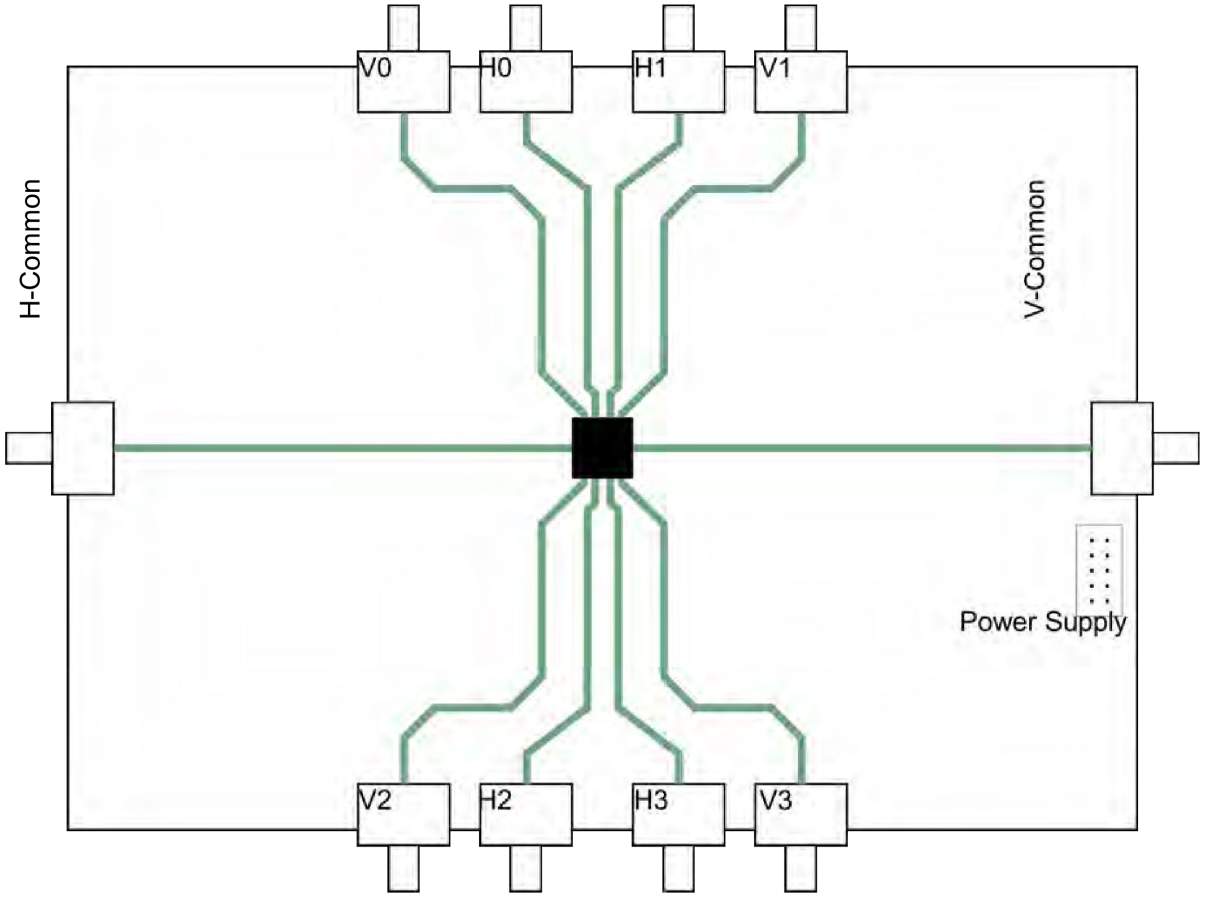


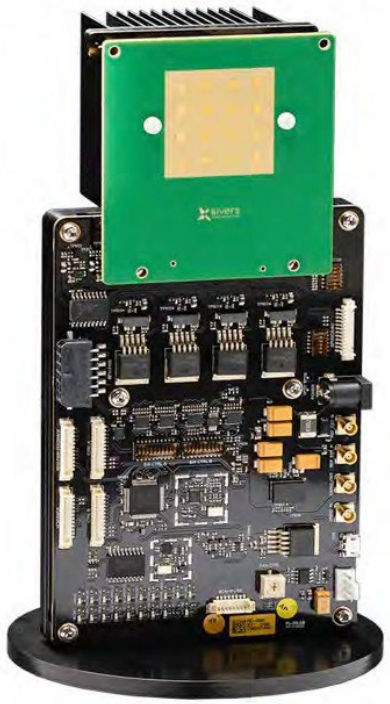
Figure 1. SUMMIT2629eEVB Schematic

For more information please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

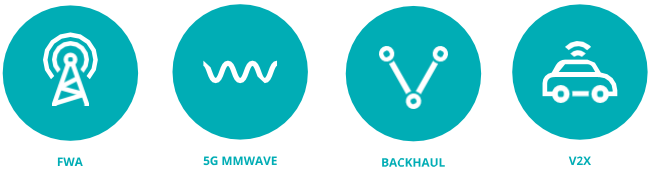
EVK02004 (24.0-29.5 GHz)

Reduce time to market – speed up your mmWave product design using the Evaluation Kit



EVK02004 is designed to help you validate the RF part of your licensed 5G mmWave system. It is easy to 'Plug and Play' with a minimum of configuration activities and is easily controlled through standardized interfaces. Configuration support and user guidelines are included.

By combining the market leading performance of the TRB02801 RFIC with innovative antenna design, you get the flexibility and performance required for 5G FR2 mmWave products.
Transmitted power close to +47 dBm and 2D beam steering possibilities in one module enable FWA product deployments in the most diverse applications with the lowest total cost of ownership.



KEY FEATURES

- Beam steering with Integrated patch array antenna
- Quick validation and proof of concept
- Plug and Play with a minimum of configuration activities
- Easy control of the EVK using the USB interface
- User guideline included
- Configuration support included
- Frequency Range:
  - 24.0 GHz -29.5 GHz
- Supports dual polarized baseband inputs which can be:
  - Zero IF signals
  - Low IF signals between 3.5-5 GHz
- Including RF Module, Mother Board and Graphical User Interface (GUI)
- Integrated synthesizer with support for 64 or 256 QAM
- Tx/Rx LO frequency control
- Integrated Beam book for beam steering settings

The RF Module EVKs are "plug and play" platforms, including patch antennas to evaluate the Sivers Semiconductors beam steering RFICs - TRB02801, TRXBF02, TRB03901 for licensed 5G and TRXBF01 for unlicensed 5G (IEEE 802.11ad).

They are designed for seamless operation together with any Zero-IF or low IF based baseband solution. Some adaptations may be necessary depending on the functionality and characteristics of the baseband solution.

Everything is included for straight forward operation and will enable the user to quickly validate beam steering capabilities together with other system defining RF parameters - critical features when developing a new product with tough requirements on time to market.

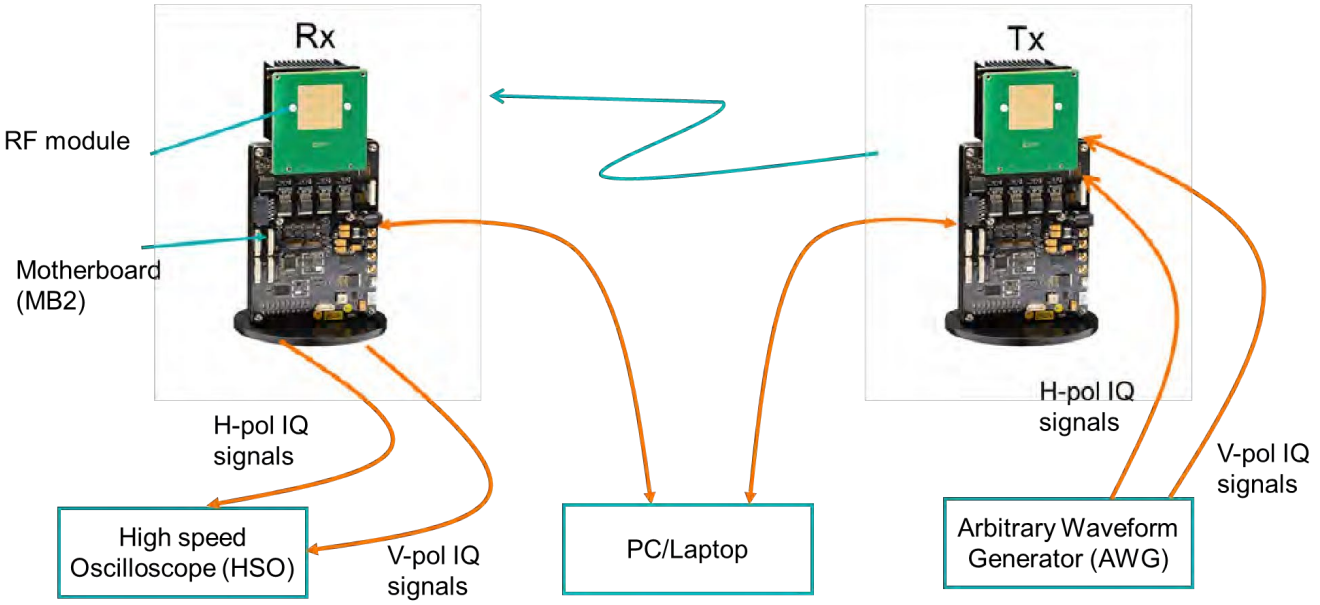


Figure 1. Graphical User Interface (GUI) and software for easy configuration and display of results are included in the EVK0204 package**.**

For more information please contact: sales@sivers-wireless.com

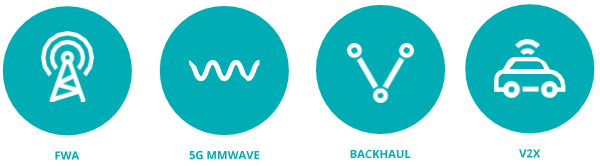
PRODUCT BRIEF – WIRELESS

5G mmWave System Test Platform STP02801

Simplify your 5G NR mmWave system integration

Getting a complete 5G solution to the market is both time-consuming and costly. To test your 5G mmWave RFIC you need expensive solutions with a lot of adjacent equipment. We now give you the possibility to leverage on our integration test platform to drastically save costs and simplify the system integration.

Sivers Semiconductors has developed a 5G mmWave System Platform including our 5G New Radio (NR) Beamforming RFIC, our patch antenna RF module and the Xilinx Radio Frequency System-on-Chip (RFSoC). The platform includes a modem simulation framework in Matlab which allows radio performance evaluation using real 5G NR waveforms. Leverage on our integration test platform to drastically simplify the System integration of your 5G NR mmWave System.



KEY FEATURES

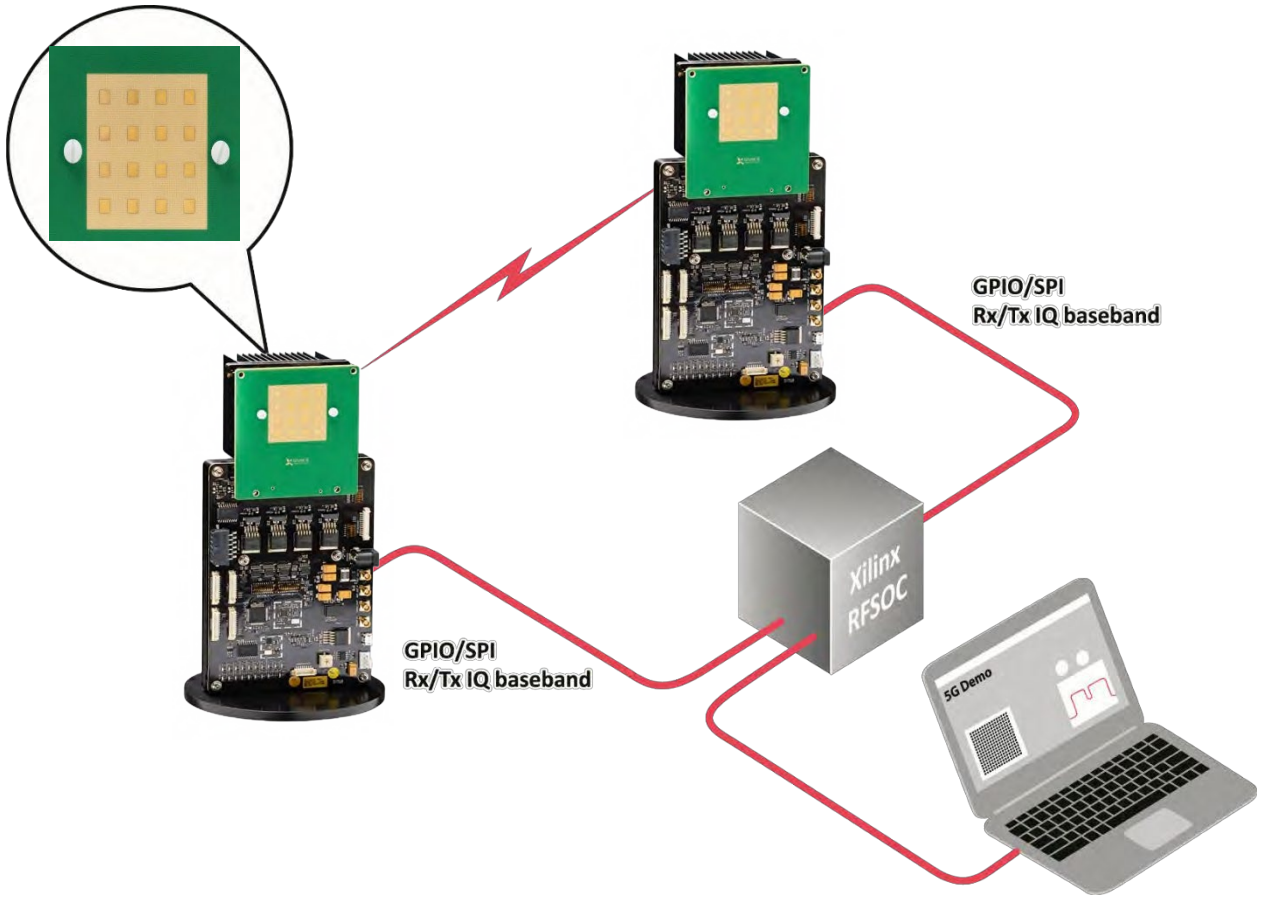
- Operating frequency range: 24.0-29.5 GHz and prepared for 57-71 GHz (pre-3GPP R17 support)
- Radio calibration
- 5G NR frame structure and waveform
- Electronic beam forming
- Modulation up to 256 QAM
- Subcarrier spacing up to 120 kHz
- Channel bandwidth up to 400 MHz
- Figures of Merit:
  - EVM
  - Spectrum
  - Packet Error Rate
- RX AGC Compensation algorithms for analogue impairments:
  - RX DC offset compensation
  - IQ compensation TX and RX
  - Phase noise compensation and channel estimation
  - Frequency offset and Channel estimation
- RFIC control:
  - Matlab Via SPI
  - FPGA through GPIO

Transmitter Side

5G NR waveforms with different configurations may be generated in the modem simulation framework and uploaded To the RFSoC. The waveform/IQ samples are then transmitted through the data-converters to the Radio Frequency Integrated Circuit (RFIC). The RF Module EVKs are "plug and play" platforms, including patch antennas to evaluate the Sivers Semiconductors beam steering RFICs – TRB02801 for licensed 5G and TRXBF01 for unlicensed 5G (and IEEE 802.11ad).

Receiver Side

The data received by the RFIC is sampled into the RFSoC. Some basic RFIC control is performed real-time in the FPGA logic (Gain control and beamforming) before the data is passed on to the modem simulation framework for decoding and calculation of figures of merit.



For more information please contact: *sales@sivers-wireless.com*

PRODUCT BRIEF - WIRELESS

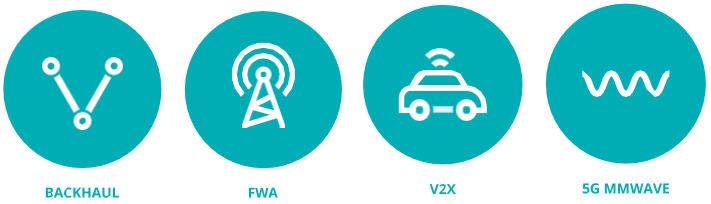
EVK02001 (24.0 - 29.5 GHz)

sivers SEMICONDUCTORS

Reduce time to market – speed up your mmWave product design using the Evaluation Kit for your licensed 5G mmWave system

The Evaluation Kit (EVK) is designed to help you validate the RF part of your licensed 5G mmWave system. It helps you Plug and Play with a minimum of configuration activities and is easily controlled through standardized interfaces. Configuration support and user guidelines are included.

By combining the market leading performance of the TRXBF02 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 28 GHz FWA and RU networks. Transmitted power close to +35 dBm and beam steering possibilities in one module enable product deployments in the most diverse applications with the lowest total cost of ownership.



KEY FEATURES

- Beam steering with Integrated patch array antenna
- Quick validation and proof of concept
- Plug and Play with a minimum of configuration activities
- Easy control of the EVK using the USB interface
- User guideline included
- Configuration support included
- Frequency Range:
  - 24-29.5 GHz
- Including RF Module, Mother Board and Graphical User Interface (GUI)
- Support for 256 QAM modulation
- Support for n257, n258 and n261 FR2 bands
- Tx/Rx LO frequency control
- Integrated Beam book for beam steering settings

The RF Module EVK is a "plug and play" platform, including patch antennas to evaluate the Sivers Semiconductors beam steering RFIC TRXBF02 for licensed 5G.

It is designed for seamless operation together with any Zero-IF based baseband solution. Some adaptations may be necessary depending on the functionality and characteristics of the baseband solution.

Everything is included for straight forward operation and will enable the user to quickly validate beam steering capabilities together with other system defining RF parameters - critical features when developing a new product with tough requirements on time to market.

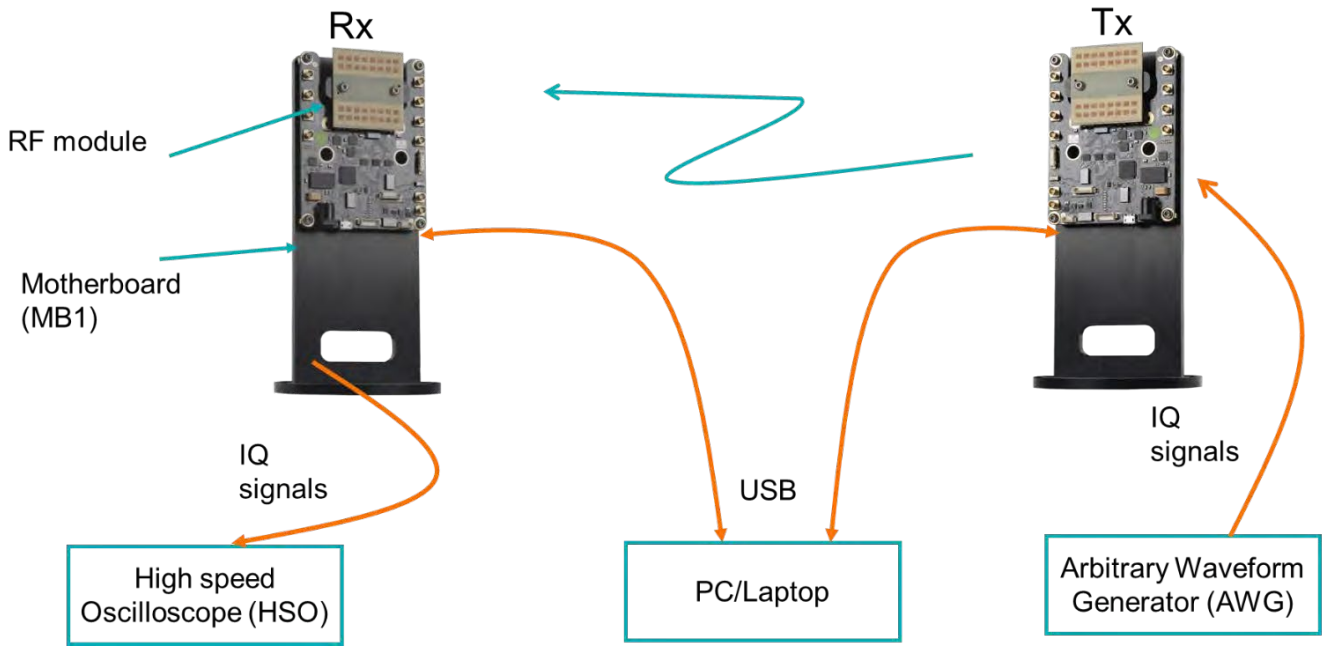


Fig.1: Graphical User Interface (GUI) and software for easy configuration and display of results are included in the EVK ki

For more information please contact *sales@sivers-wireless.com*

PRODUCT BRIEF – WIRELESS

5G mmWave System Test Platform STP02800

Simplify your 5G NR mmWave system integration

Getting a complete 5G solution to the market is both time-consuming and costly. To test your 5G mmWave RFIC you need expensive solutions with a lot of adjacent equipment. We now give you the possibility to leverage on our integration test platform to drastically save costs and simplify the system integration.

Sivers Semiconductors has developed a 5G mmWave System Platform including our 5G New Radio (NR) Beamforming RFIC, our patch antenna RF module and the Xilinx Radio Frequency System-on-Chip (RFSoC). The platform includes a modem simulation framework in Matlab which allows radio performance evaluation using real 5G NR waveforms. Leverage on our integration test platform to drastically simplify the System integration of your 5G NR mmWave System.

KEY FEATURES

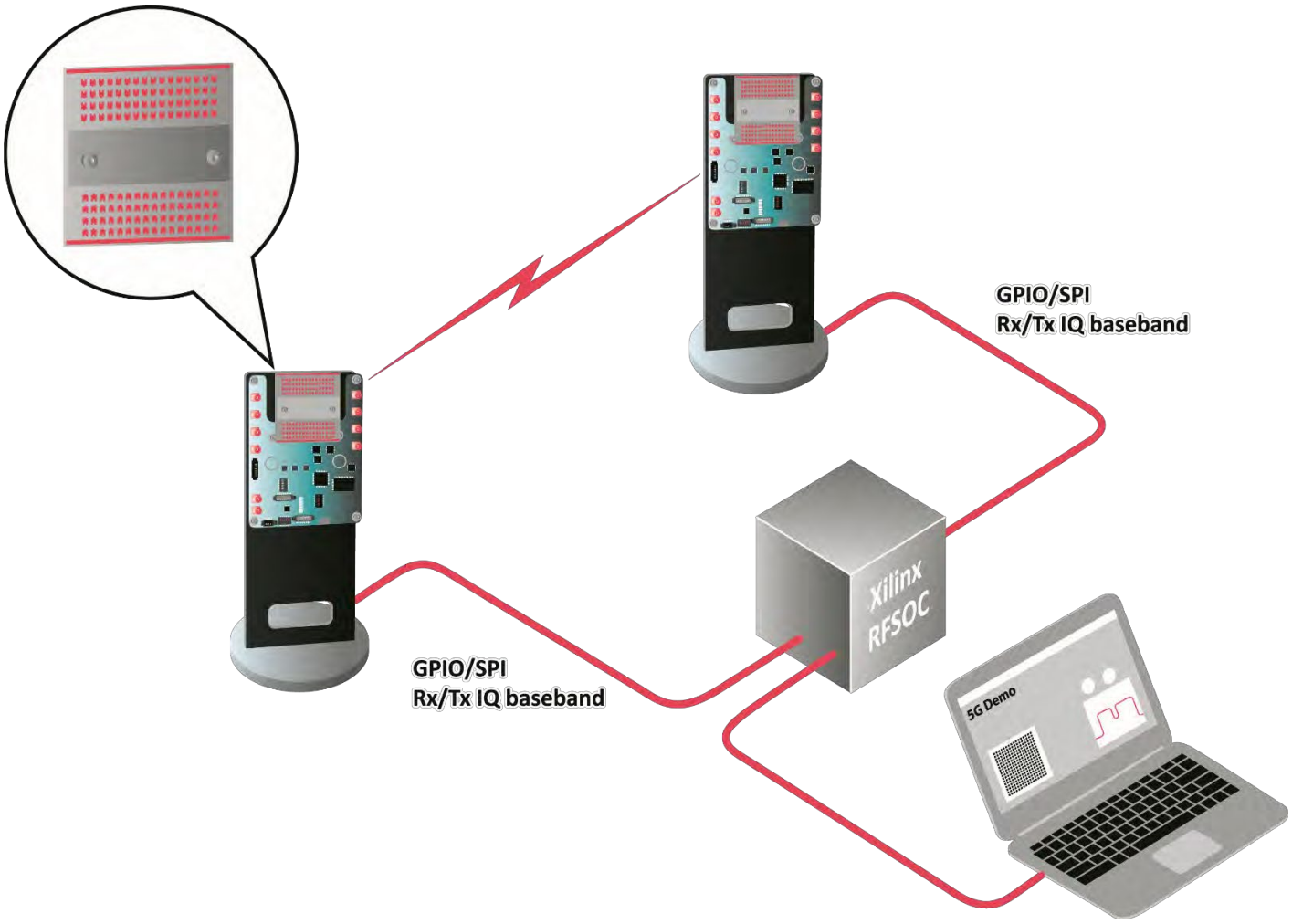
- Operating frequency range: 24.0-29.5 GHz and prepared for 57-71 GHz (pre-3GPP R17 support)
- Radio calibration
- 5G NR frame structure and waveform
- Electronic beam forming
- Modulation up to 256 QAM
- Subcarrier spacing up to 120 kHz
- Channel bandwidth up to 400 MHz
- Figures of Merit:
  - EVM
  - Spectrum
  - Packet Error Rate
- RX AGC Compensation algorithms for analogue impairments:
  - RX DC offset compensation
  - IQ compensation TX and RX
  - Phase noise compensation and channel estimation
  - Frequency offset and Channel estimation
- RFIC control:
  - Matlab Via SPI
  - FPGA through GPIO

Transmitter Side

5G NR waveforms with different configurations may be generated in the modem simulation framework and uploaded to the RFSoC. The waveform/IQ samples are then transmitted through the data-converters to the RF module on the evaluation kit (EVK). The RF Module EVKs are "plug and play" platforms which include patch antennas to evaluate the Sivers Semiconductors beam steering RFICs: TRXBF02 for licensed 5G and TRXBF01 for unlicensed 5G (IEEE 802.11ad).

Receiver Side

The data received by the Rx EVK is sampled into the RFSoC. Some basic RFIC control is performed real-time in the FPGA logic (Gain control and beamforming), before the data is passed on to the modem simulation framework for decoding and calculation of figures of merit.



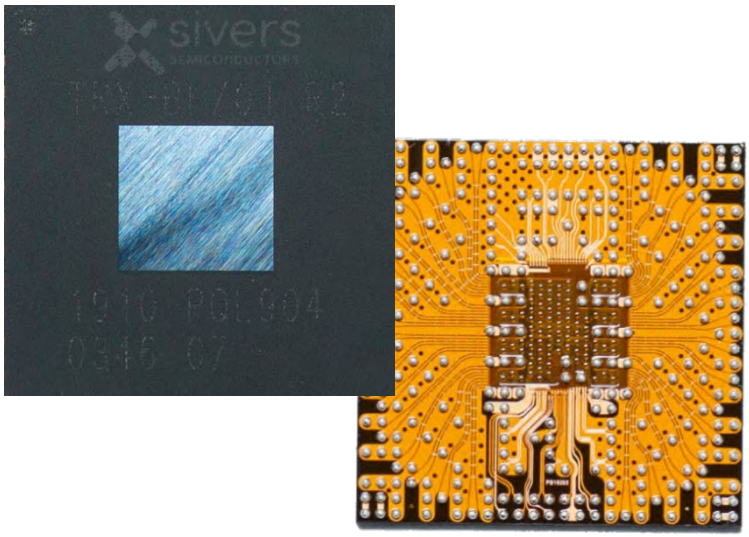
For more information please contact: *sales@sivers-wireless.com*

57 - 71 GHz Portfolio

PRODUCT BRIEF - WIRELESS

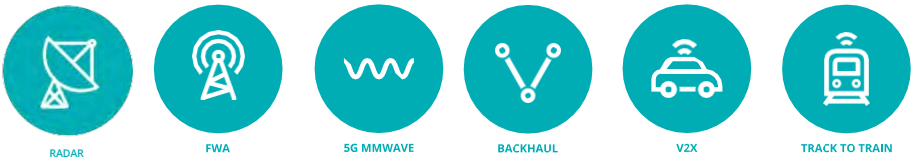
TRXBF01 (57 GHz- 71 GHz)

Unrivalled ready-to-use WiGig RFIC for 57 GHz to 71 GHz



The license free 60 GHz band enables new opportunities to operators where high data rates and range are of essence. The Sivers Semiconductors TRXBF01 supports the full frequency range from 57 GHz to 71 GHz with speeds up to 7 Gbit/s and beyond, long-range. The perfect choice for unlicensed 5G.

The award winning TRXBF01, is a WiGig/802.11ad compliant 16+16 channel beam forming transceiver Radio Frequency Integrated Circuit (RFIC) with integrated synthesizer. It supports any mmWave modem with zero-IF interface. Today the transceiver is fully integrated with the RapidWave™ RWM6050/51 mmWave modem from Renesas. Both create ready-to-use 802.11ad (WiGig) communication modules.

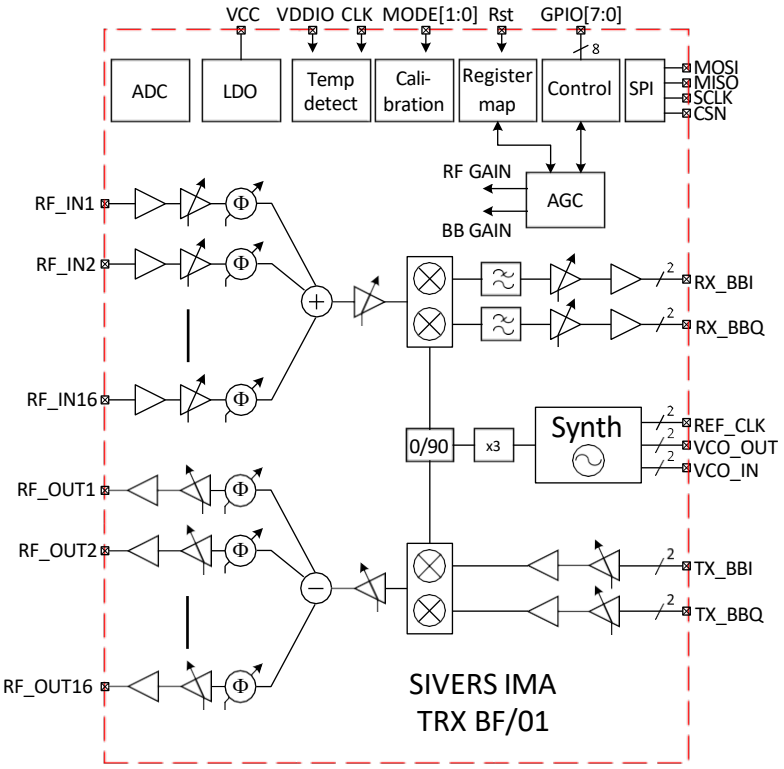


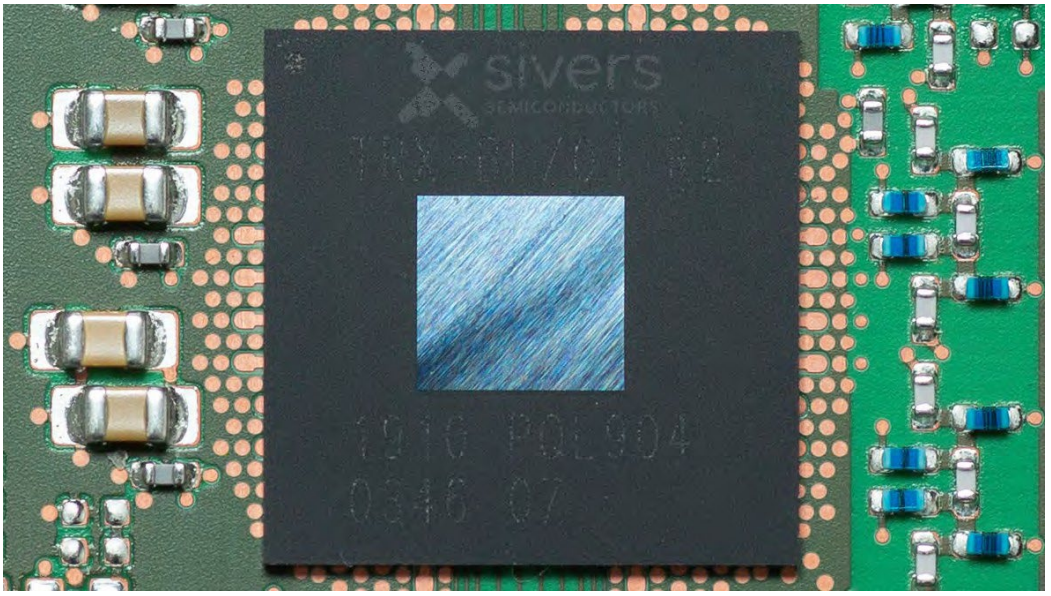
KEY FEATURES

- 57 GHz -71 GHz
- Optimized for 802.11ad/WiGig
- Supports FDD utilizing two transceivers
- Supported throughput 7 Gbit/s
- Enables 64 QAM and beyond (with internal LO)
- Superior phase noise
- 16+16 Tx/Rx Array
- Direct conversion I/Q transceiver
- Integrated beam book for instant beam steering/ forming
- Zero-IF with 1.2 GHz bandwidth
- +25 dBm combined linear output power
- 7 dB NF (Noise Figure)
- eWLB (embedded Wafer Level Ball Grid Array) package device
- Seamless modem integration through integrated analog baseband
- Future-proof pre-802.11ay support

The TRXBF01 can transmit higher data rates at longer distances with greater robustness to interferers. These features enable an extra dimension of flexibility to the final product including TRXBF01.

The transceiver supports the full temperature range of -40 to +85 deg C, a unique wide band coverage of 57-71 GHz, superior link budget, flexible channelization and excellent Error Vector Magnitude (EVM) performance which enable 64 QAM modulation or more. All of which makes the TRXBF01 uniquely well fitted for outdoor infrastructure applications.



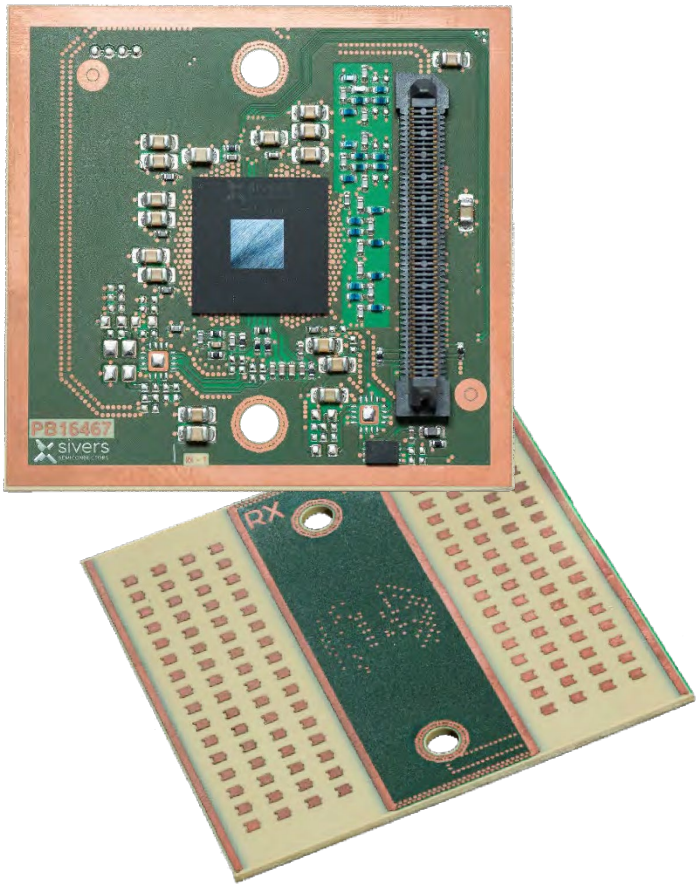


For more information please contact: *sales@sivers-wireless.com*

PRODUCT BRIEF - WIRELESS

BFM06010

Powerful 60 GHz Fixed Wireless Access product with great range



Why should you design the Radio Frequency part in your 60 GHz beamforming access product, when Sivers Semiconductors has done the work for you? Utilize the benefits of our RF module BFM06010. Unmatched power performance and throughput together with an integrated antenna gives you a competitive advantage in the unlicensed 5G race. Separate Tx and Rx antenna elements provide good options for radar application.

By combining the market leading performance of the TRXBF01 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 60 GHz FWA networks. Transmitted power of +40 dBm also for the highest data rates with electronic beam steering in one single module enable FWA product deployments in the most diverse applications.

This is the module that can differentiate your 60 GHz fixed wireless access product.

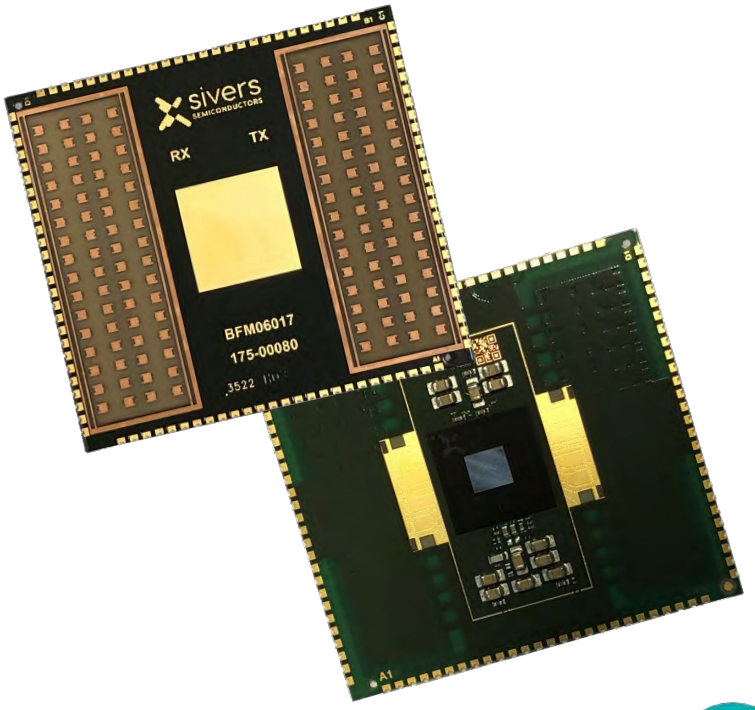
KEY FEATURES

- 57 - 71 GHz
- Optimized for 802.11ad/WiGig TDD
- Supported throughput 7 Gbit/s
- Enables 64 QAM and beyond (with internal synthesizer)
- 16+16 Tx/Rx Array
- Direct conversion I/Q transceiver
- IF bandwidth 1.2 GHz
- Integrated beam book for instant beam steering / forming
- +40 dBm TX EIRP using 16 QAM modulation scheme
- 7 dB NF (Noise Figure)
- Reference clock support:
  - External (BFM06010)
- eWLB (embedded Wafer Level Ball Grid Array) packaged device
- Seamless low-cost modem integration through integrated analog baseband

PRODUCT BRIEF - WIRELESS

BFM06017 (57-71 GHz)

Differentiate your 60 GHz Fixed Wireless Access product



Sivers Semiconductors presents a new, innovative low-cost RF Module covering the full 14 GHz of bandwidth (57-71 GHz) with 1D beam steering (steering in azimuth). This module is optimized for high-performance FWA applications and enables you to differentiate and meet the requirements of large-scale manufacturing of your FWA products. It is compliant with the IEEE 802.11ad standard and designed to interface with leading baseband modems.

By combining the market leading performance of the TRXBF01 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 60 GHz FWA networks. Transmitted power close to +40 dBm in one module enables FWA product deployments in the most diverse applications with the lowest total cost of ownership.

KEY FEATURES

- 57 GHz - 71 GHz
- Optimized and prepared for unlicensed 5G spectrum (802.11ad and 5G NR-U, TDD)
- Supported throughput 10 Gbit/s
- Enables up to 256 QAM SC with integrated synthesizer
- 16+16 Tx/Rx Array
- Direct conversion I/Q transceiver
- Baseband signal bandwidth 1.2 GHz
- Cost effective solution with only 6 RF layers and castellated vias
- Integrated beambook for instant beamforming/steering
- Beam steering: Azimuth ± 45 degrees
- +40 dBm TX EIRP
- 7 dB NF (Noise Figure)

With the use of a solder-in castellated-via electrical interface, and just 6 RF layers the module is optimized for large scale, low-cost assembly. This module will improve your business case and make your 60 GHz fixed wireless access product truly competitive.

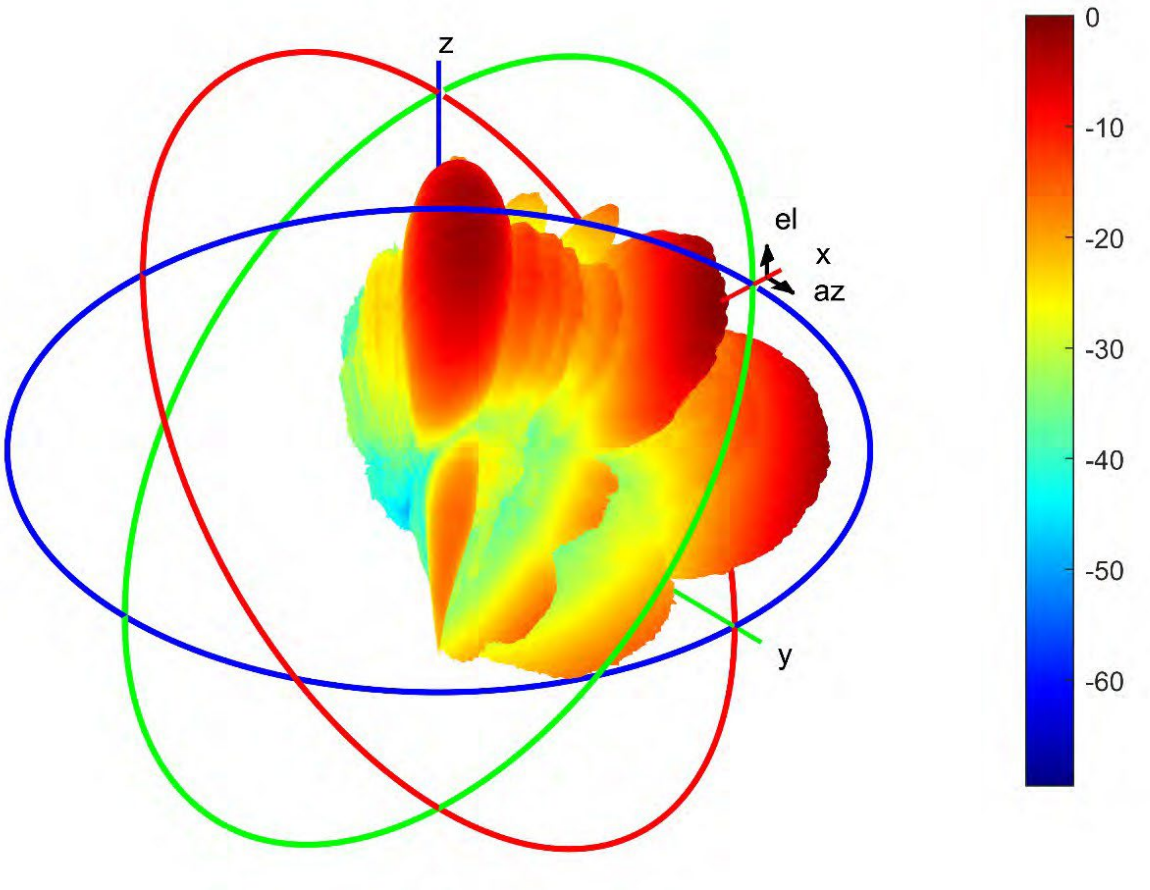


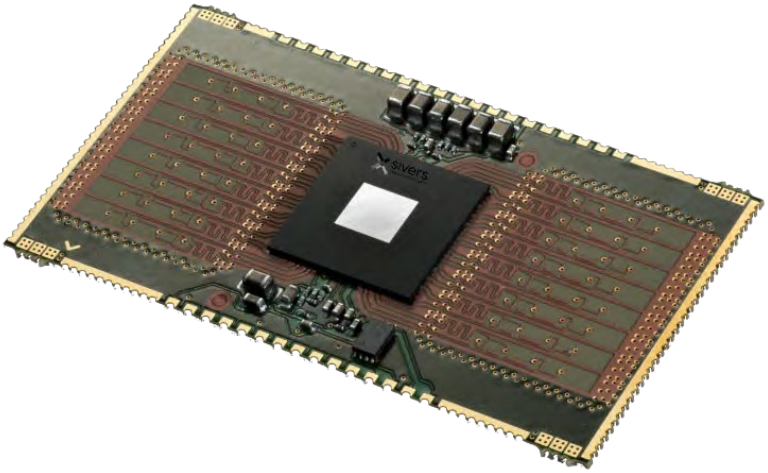
Figure: 3D Antenna plot beam 1, 32, 63

For more information please contact: *sales@sivers-wireless.com*

PRODUCT BRIEF - WIRELESS

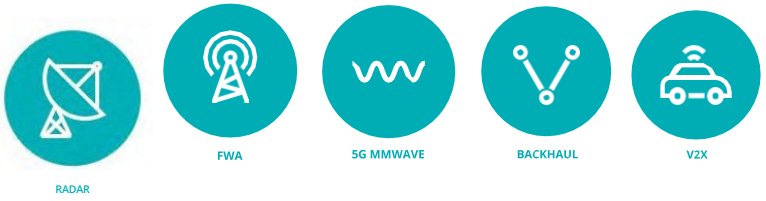
BFM06009

Differentiate your 60 GHz Fixed Wireless Access product



Sivers Semiconductors presents a new, innovative RF Module covering the full 14 GHz of bandwidth (57-71 GHz) with 2D beam steering (steering in both azimuth and elevation). This module enables you to differentiate and meet the requirements of large-scale manufacturing of your 60 GHz Fixed Wireless Access (FWA) products without sacrificing competitive performance. Separate Tx and Rx antenna elements provide good options for radar applications.

By combining the market leading performance of the TRXBF01 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 60 GHz FWA networks.
Transmitted power close to +40 dBm and 2D beam steering possibilities in one module enable FWA product deployments in the most diverse applications with the lowest total cost of ownership.



KEY FEATURES

- 57-71 GHz
- Optimized and prepared for unlicensed 5G spectrum (802.11ad and 5G NR-U, TDD)
- Supported throughput 10 Gbit/s
- Enables up to 256 QAM SC with integrated synthesizer
- 16+16 Tx/Rx Array
- Direct conversion I/Q transceiver
- IF bandwidth 1.2 GHz
- Optimized for radar applications
- Integrated beambook for instant beam steering / forming
- Beam steering:
  - Azimuth ± 54 degrees
  - Elevation ± 25 degrees
- +39 dBm TX EIRP
- 7 dB NF (Noise Figure)
- Electrical interface: Castellated vias to baseband board
- Seamless low-cost modem integration through integrated analog baseband and autonomous calibration

With the use of a solder-in castellated-via electrical interface, the module is optimized for large-scale, low-cost assembly. For existing customers using previous modules the BFM06009 is fully backward compatible using a simple adapter board. This module will improve your business case and make your 60 GHz fixed wireless access product truly competitive.

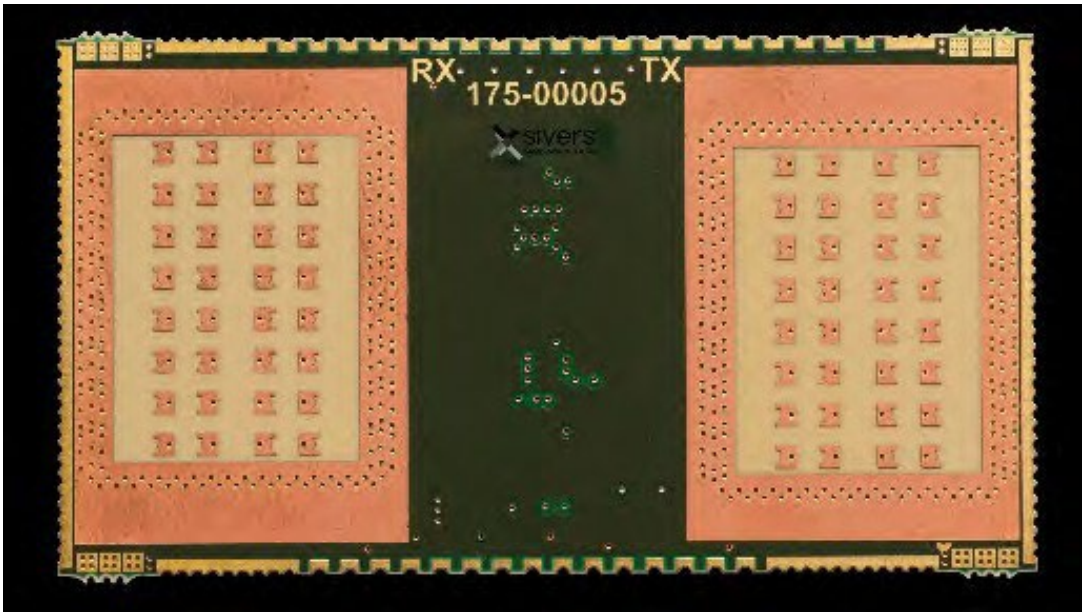


Image: BFM06009

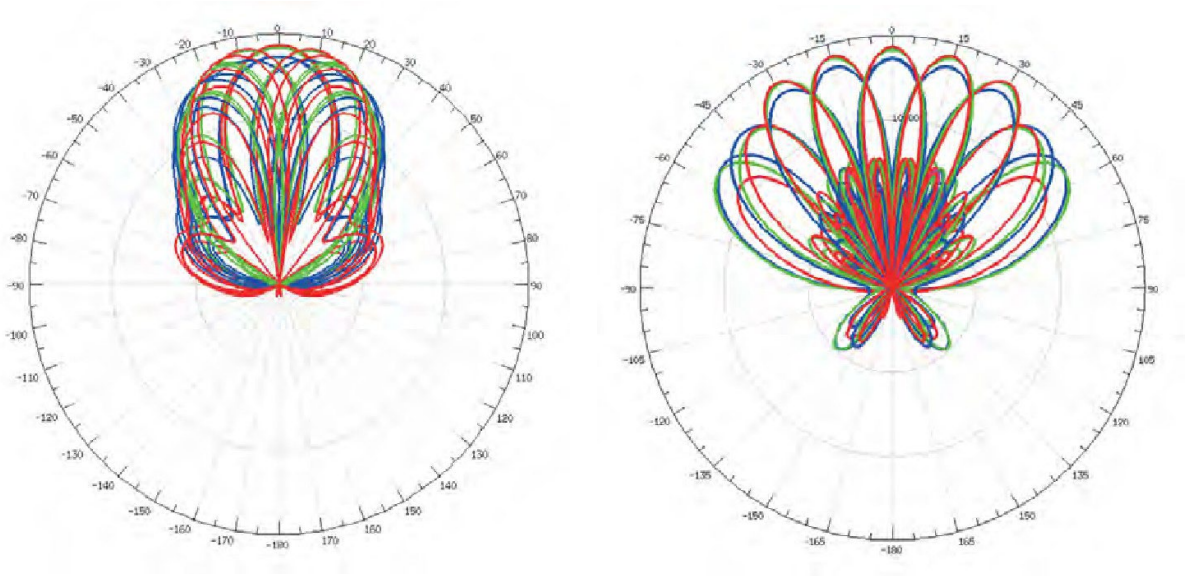


Figure: BFM06009 beam array for elevation and azimuth.

For more information please contact: *sales@sivers-wireless.com*

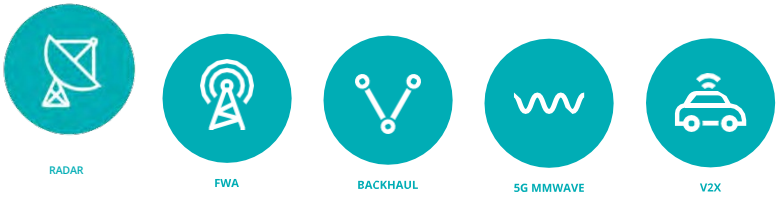
PRODUCT BRIEF - WIRELESS

EVK06002 (57 - 71 GHz)

Reduce time to market – speed up your mmWave product design using the Evaluation Kit

The Evaluation Kit (EVK) is designed to help you validate the RF part of your licensed or unlicensed 5G mmWave system. It helps you Plug and Play with a minimum of configuration activities and is easily controlled through standardized interfaces. Configuration support and user guidelines are included.

By combining the market leading performance of the TRX BF/01 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 60 GHz FWA networks. Transmitted power close to +40 dBm and 2D beam steering possibilities in one module enable FWA product deployments in the most diverse applications with the lowest total cost of ownership.



KEY FEATURES

- Beam steering with Integrated patch array antenna
- Quick validation and proof of concept
- Plug and Play with a minimum of configuration activities
- Easy control of the EVK using the USB interface
- User guideline included
- Configuration support included
- Frequency Range:
  - 57-71 GHz (TRX BF/01)
- Including RF Module, Mother Board and Graphical User Interface (GUI)
- Integrated synthesizer with support for 64 or 256 QAM
- Support for 6 full RF channels according to IEEE802.11 ad standard
- Additional support for fractional RF channels (1⁄2 and 1⁄4 channels)
- Tx/Rx LO frequency control
- Integrated Beam book for beam steering settings

The RF Module EVK is a “plug and play” platform, including patch antennas to evaluate the Sivers Semiconductors
beam steering RFICs - TRX BF/01 for unlicensed 5G (IEEE 802.11ad) and TRX BF/02 for licensed 5G.

They are designed for seamless operation together with any Zero-IF based baseband solution. Some adaptations may be necessary depending on the functionality and characteristics of the baseband solution.

Everything is included for straight forward operation and will enable the user to quickly validate beam steering capabilities together with other system defining RF parameters - critical features when developing a new product with tough requirements on time to market.

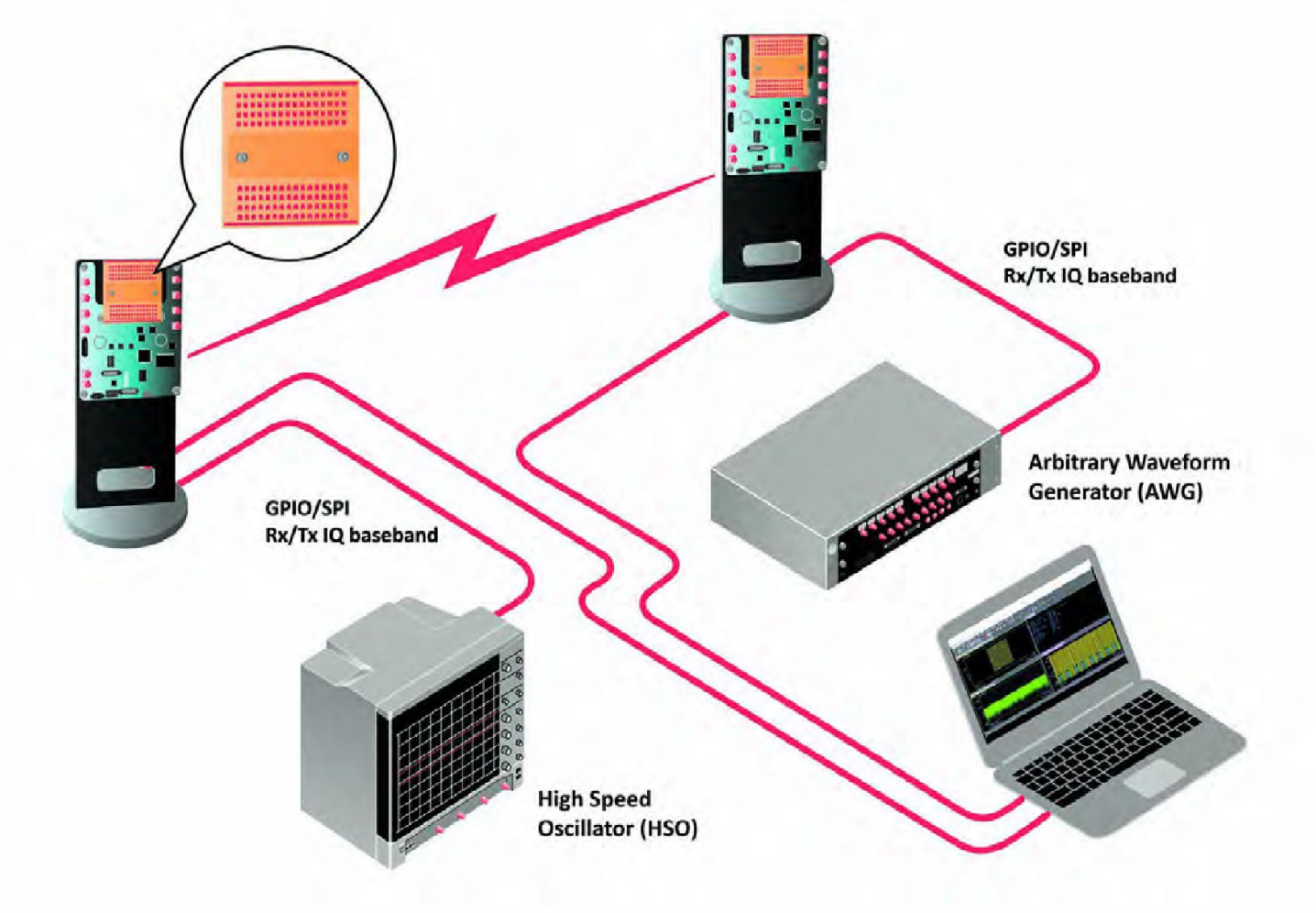


Figure: Graphical User Interface (GUI) and software for easy configuration and display of results are included in the EVK kit.

For more information please contact: *sales@sivers-wireless.com*

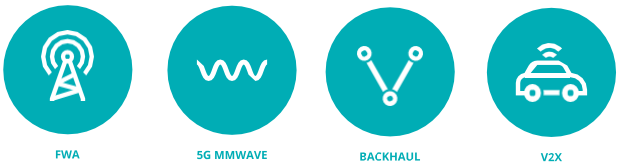
PRODUCT BRIEF - WIRELESS

EVK06003 (57 - 71 GHz)

Reduce time to market – speed up your mmWave product design using the Evaluation Kit

The Evaluation Kit (EVK) is designed to help you validate the RF part of your unlicensed 5G mmWave system. It helps you Plug and Play with a minimum of configuration activities and is easily controlled through standardized interfaces. Configuration support and user guidelines are included.

By combining the market leading performance of the TRXBF01 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of 60 GHz FWA networks. Transmitted power close to +40 dBm, and 2D beam steering possibilities in the RF module enable FWA product deployments in the most diverse applications with the lowest total cost of ownership.



KEY FEATURES

- Beam steering with Integrated patch array antenna
- Quick validation and proof of concept
- Plug and Play with a minimum of configuration activities
- Easy control of the EVK using the USB interface
- User guideline included
- Configuration support included
- Frequency Range:
  - 57-71 GHz
- Throughput:
  - Up to 7 Gbit/s
- Including RF Module, Mother Board and Graphical User Interface (GUI)
- Integrated synthesizer with support for 64 or 256 QAM
- Support for 6 full RF channels according to IEEE802.11 ad standard
- Additional support for fractional RF channels (1⁄2 and 1⁄4 channels)
- Tx/Rx LO frequency control
- Integrated Beam book for beam steering settings

The RF Module EVK is a "plug and play" platform, including patch antennas to evaluate the Sivers Semiconductors beam steering RFIC TRX BF01 for unlicensed 5G (IEEE 802.11ad).

The EVK06003 is designed for seamless operation together with any Zero-IF based baseband solution. Some adaptations may be necessary depending on the functionality and characteristics of the baseband solution.

Everything is included for straight forward operation and will enable the user to quickly validate beam steering capabilities together with other system defining RF parameters - critical features when developing a new product with tough requirements on time to market.

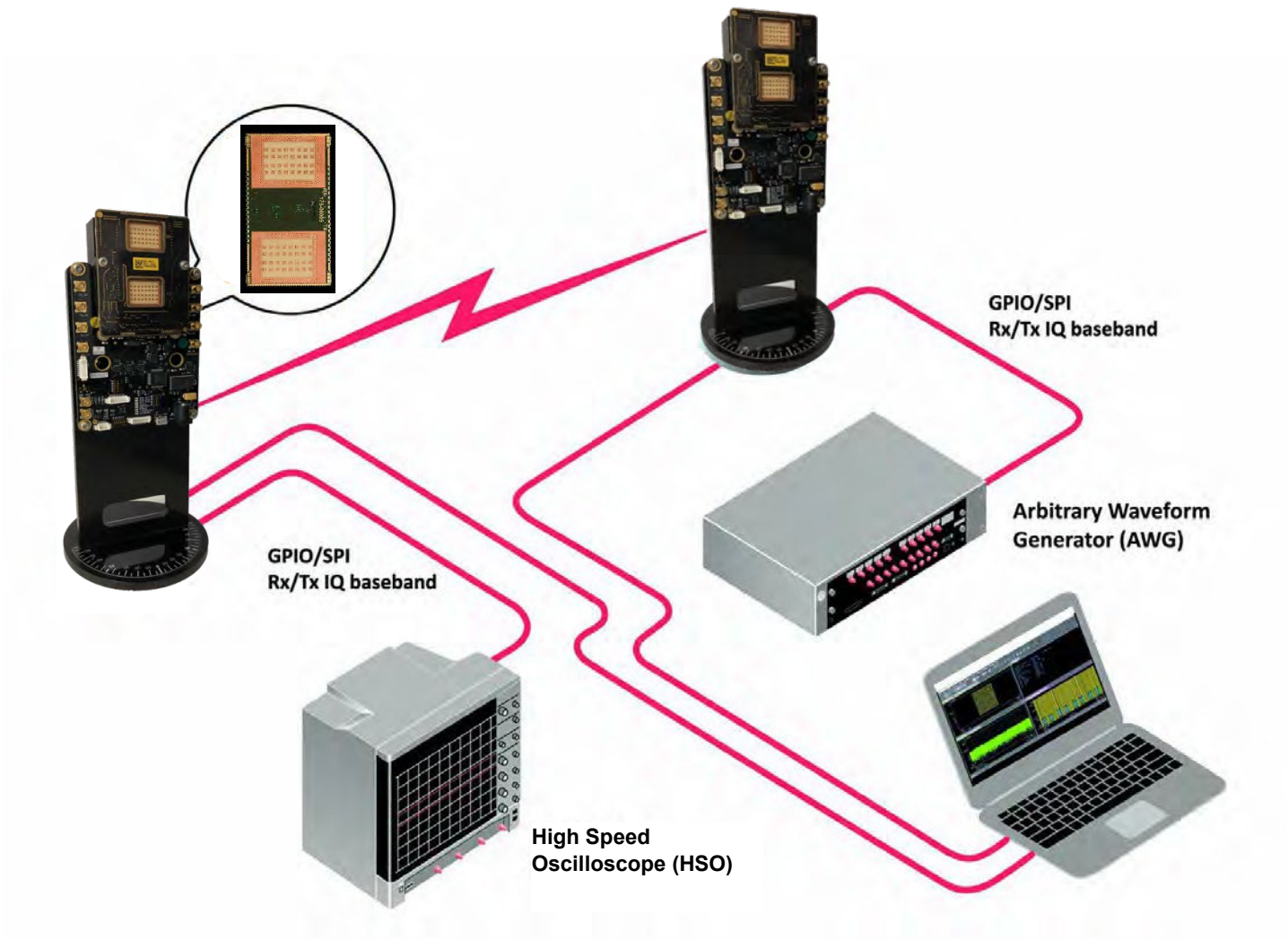


Figure: Graphical User Interface (GUI) and software for easy configuration and display of results are included in the EVK kit.

For more information, please contact: *sales@sivers-wireless.com*

PRODUCT BRIEF – WIRELESS

EVK06005 (57-71 GHz)

Mix-and-match different 60 GHz RF modules to speed up your mmWave product design

This Evaluation Kit (EVK) is designed to help you validate the RF part of your unlicensed 5G mmWave system. With an easy Plug and Play and a minimum of configuration activities it is easily controlled through standardized interfaces. Configuration support and user guidelines are included.

The EVK06005 provides an opportunity to utilise three 60 GHz RF modules in your design validation. Depending on your requirements, modules with different features may be plugged into the EVK. The package includes two modules with 1D beam steering (Azimuth) and one module with 2D beam steering (Azimuth and Elevation), each with different EIRP. This provides a unique way to assess the design and test its various capabilities.

By combining the market leading performance of Sivers Semiconductors RFICs with innovative antenna design, you get the flexibility and performance required for large deployments of 60 GHz FWA networks. The RF modules supported by the EVK06005 are BFM06009, BFM06005 and BFM06010. Each module has supporting mechanics for easy installation and configuration.

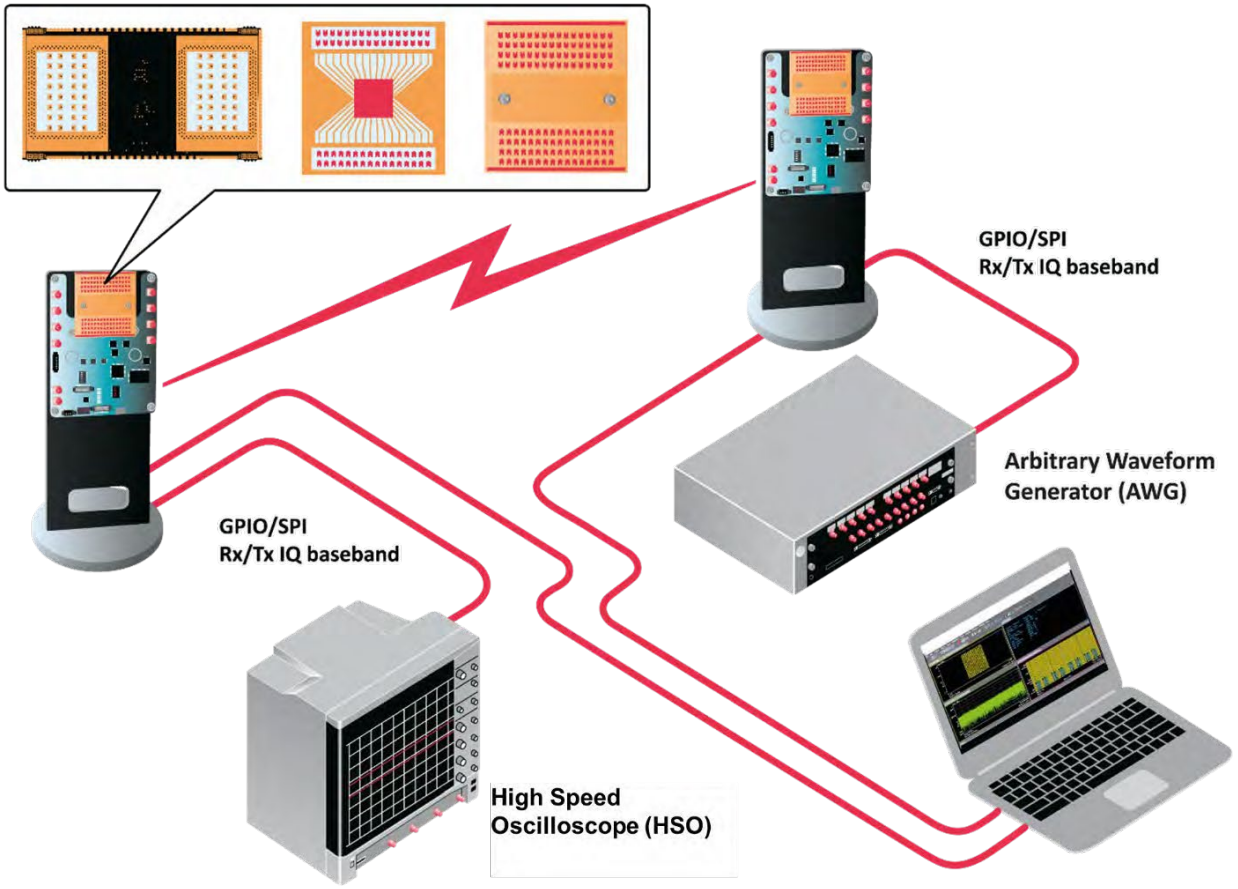
KEY FEATURES

- Beam steering with integrated patch array antenna
- Quick validation and proof of concept
- Plug and Play with a minimum of configuration activities
- Easy control of the EVK using the USB, SPI and GPIO interfaces
- User manual included
- Configuration support included
- Frequency Range: 57-71 GHz
- Throughput: Up to 10 Gbit/s
- Including RF Module, Mother Board and Graphical User Interface (GUI)
- Integrated synthesizer with support up to 256 QAM
- Support for 6 full channels according to IEEE802.11 ad standard
- Tx/Rx LO frequency control
- Tx/Rx Analog Base Band I/Q interface
- Integrated Beam book for beam steering settings

The RF Module EVKs are "plug and play" platforms, including patch antennas to evaluate the Sivers Semiconductors beam steering RFICs for unlicensed 5G (and IEEE 802.11ad).

They are designed for seamless operation together with any Zero-IF based baseband solution. Some adaptations may be necessary depending on the functionality and characteristics of the baseband solution.

Everything is included for straight forward operation and will enable the user to quickly validate beam steering capabilities together with other system defining RF parameters - critical features when developing a new product with tough requirements on time to market.



The EVK test setup. RF modules supported by the EVK06005 are BFM06009, BFM06005 and BFM06010. Each module has supporting mechanics for easy installation and configuration.

For more information, please contact: *sales@sivers-wireless.com*

37 – 43.5 GHz Portfolio

PRODUCT BRIEF - WIRELESS

SUMMIT3741™

Address challenges constraining 5G mmWave with our 39 GHz Beamforming front end IC

Operating from 37.0 to 41.0 GHz, the SUMMIT3741™ integrates power amplifiers (PA), low noise amplifiers, T/R switching, beamformers with beam table memory, calibration, gain control and temperature and power telemetry with a high-speed system peripheral interface (SPI) for control. A single SUMMIT3741™ provides two sets of four channels for two antenna polarizations – a total of eight channels per RFIC.

"Sivers Semiconductors is indeed offering a real performance breakthrough which will translate to higher performance and lower cost mmWave phased array systems."

Daniel Kang,
Head of Digital Solution Team, Dreamtech

Sivers Semiconductor products and services enable 5G manufacturers to simplify product design, integrate components to reduce footprint and improve system reliability. Of course, with best-in-class RF performance.

SUMMIT3741™ is an eight-channel RF front-end for 39 GHz, 5G phased array antenna system fabricated in RF-Silicon on Insulator (RF-SOI). SUMMIT3741™ is designed to address the challenges constraining 5G mmWave performance by:

- Extending the link range to decrease infrastructure costs and improve customer satisfaction.
- Reducing power consumption and thermal dissipation.
- Reducing antenna array complexity and overall RF front-end cost.

KEY FEATURES

- 37.0 GHz-41.0 GHz
- Beamforming transceiver with 8 (2x4 H+V) ports enabling two data streams supporting 2 MIMO layers
- Tx/Rx independent beam directions enabled by 6-bit phase shifting and 16 dB variable gain in each path
- High-power, high-efficiency SOI CMOS power amplifiers
- Integrated low-loss T/R switches, linear power and state-of-the-art low noise amplifiers

- 6-bit full-360° phase shifting and 0.5dB-step 16dB-range variable gain in each path
- Fully calibrated for Gain/Phase matching across ICs
- Extensive On-chip temperature and power sensing
- On-chip gain control for temperature compensation
- High-Speed SPI with large on-chip beam table storage
- Wafer-Level Chip-Scale Package (WLCSP) compatible with low-cost PCB manufacturing
- Support for large-scale arrays through multiple chip-addressing modes 7 dB NF (Noise Figure)

PRODUCT BRIEF - WIRELESS

SUMMIT3741™

Address challenges constraining 5G mmWave with our 39 GHz Beamforming front end IC

Operating from 37.0 to 41.0 GHz, the SUMMIT3741™ integrates power amplifiers (PA), low noise amplifiers, T/R switching, beamformers with beam table memory, calibration, gain control and temperature and power telemetry with a high-speed system peripheral interface (SPI) for control. A single SUMMIT3741™ provides two sets of four channels for two antenna polarizations – a total of eight channels per RFIC.

"Sivers Semiconductors is indeed offering a real performance breakthrough which will translate to higher performance and lower cost mmWave phased array systems."

Daniel Kang,
Head of Digital Solution Team, Dreamtech

Sivers Semiconductor products and services enable 5G manufacturers to simplify product design, integrate components to reduce footprint and improve system reliability. Of course, with best-in-class RF performance.

SUMMIT3741™ is an eight-channel RF front-end for 39 GHz, 5G phased array antenna system fabricated in RF-Silicon on Insulator (RF-SOI). SUMMIT3741™ is designed to address the challenges constraining 5G mmWave performance by:

- Extending the link range to decrease infrastructure costs and improve customer satisfaction.
- Reducing power consumption and thermal dissipation.
- Reducing antenna array complexity and overall RF front-end cost.

KEY FEATURES

- 37.0 GHz-41.0 GHz
- Beamforming transceiver with 8 (2x4 H+V) ports enabling two data streams supporting 2 MIMO layers
- Tx/Rx independent beam directions enabled by 6-bit phase shifting and 16 dB variable gain in each path
- High-power, high-efficiency SOI CMOS power amplifiers
- Integrated low-loss T/R switches, linear power and state-of-the-art low noise amplifiers

- 6-bit full-360° phase shifting and 0.5dB-step 16dB-range variable gain in each path
- Fully calibrated for Gain/Phase matching across ICs
- Extensive On-chip temperature and power sensing
- On-chip gain control for temperature compensation
- High-Speed SPI with large on-chip beam table storage
- Wafer-Level Chip-Scale Package (WLCSP) compatible with low-cost PCB manufacturing
- Support for large-scale arrays through multiple chip-addressing modes 7 dB NF (Noise Figure)

High power and efficiency will be success factors when designing larger Base Transceiver Station (BTS) antenna arrays, where thermal design is critical. SUMMIT3741™ is a greener and more compelling solution reaching more customers, still using less energy.

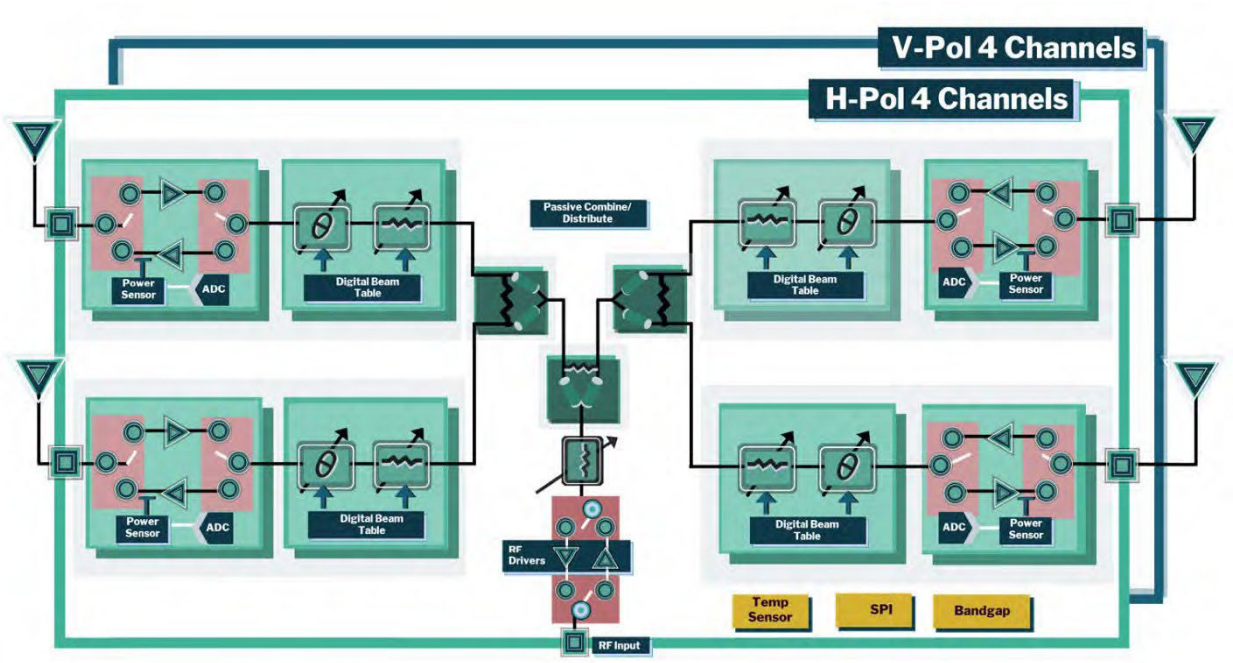


Figure 1. Block schematics SUMMIT3741™

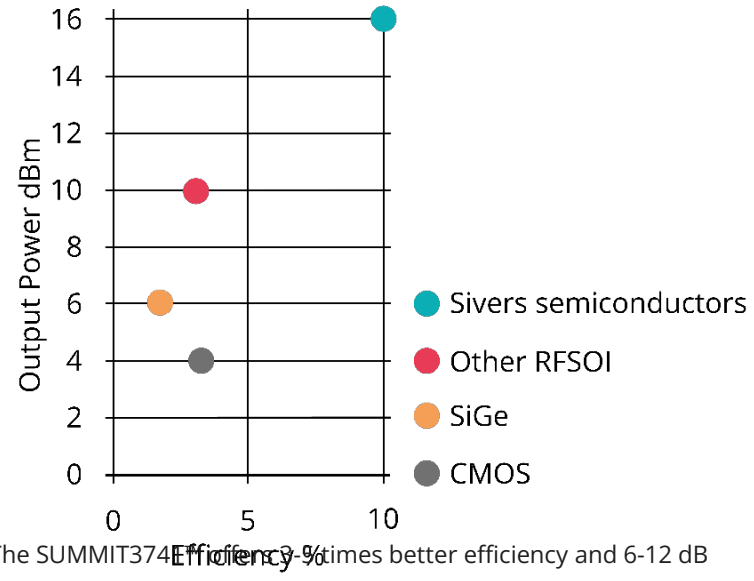


Figure 2. The SUMMIT3741 offers 3-5 times better efficiency and 6-12 dB more output power than competitors

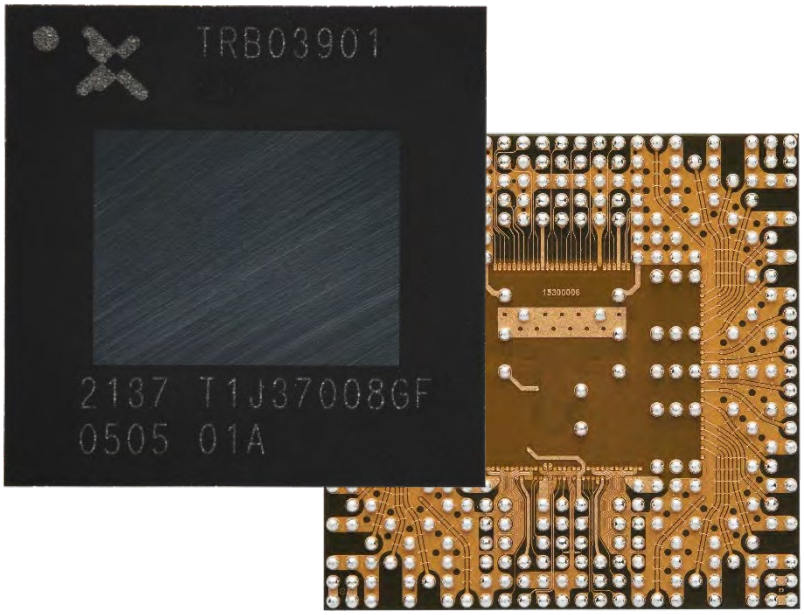
For more information, please contact sales: *sales@sivers-wireless.com*

PRODUCT BRIEF - WIRELESS

TRB03901 (37.0-43.5 GHz)

sivers SEMICONDUCTORS

Highly integrated, state of the art 5G NR RFIC



Sivers Semiconductors pushes ahead with more 5G innovations.

The TRB03901 support the full frequency range from 37.0 to 43.5 GHz with speeds up to 5 Gbit/s. The unique level of integration enables support for different markets and frequency bands using the same hardware. Explore how this groundbreaking RFIC will improve and speed-up your licensed 5G rollout.

TRB03901 is a 32 channel beam forming transceiver Radio Frequency Integrated Circuit (RFIC). With support for both Zero-IF and IF baseband interface, it may easily be integrated to your product with any 5G mmWave modem.

KEY FEATURES

- 37.0 GHz - 43.5 GHz
- Wide band transmit and receive antenna array optimized for the 28 and 39 GHz bands
- Designed for 3GPP NR 5G Fixed Wireless Access (FWA) applications
- Beamforming transceiver with 32 (2x16 H+V) ports enabling two data streams supporting 2 MIMO layers
- RF tiling of multiple transceivers for large array antenna configurations
- Integrated T/R-switches, linear power and low noise amplifiers
- Excellent RF performance providing best in class EVM performance
- High-performance synthesizer
- Connection to the baseband modem through:
  - Analog IQ-interface (Zero IF) or
  - IF-interface
- Integrated programmable baseband filters
- Easy to use with autonomous calibration routines and simple baseband interface

The unique high level of integration enables full transceiver design. Several RFICs may be tiled together in bigger arrays for longer reach and greater performance.

Less components means less cost and higher quality - critical parameters to consider when designing a Customer Premises Equipment (CPE) or small "hot spot" base stations. The transceiver IC supports unique wide band coverage of 37.0 - 43.5 GHz, superior link budget, excellent Error Vector Magnitude (EVM) performance enabling more than 256 QAM OFDM modulation, full temperature range of -40 to +85 deg C, small form-factor and flexible channelization. All of which make the RFIC uniquely well fitted for outdoor infrastructure 5G mmWave applications.

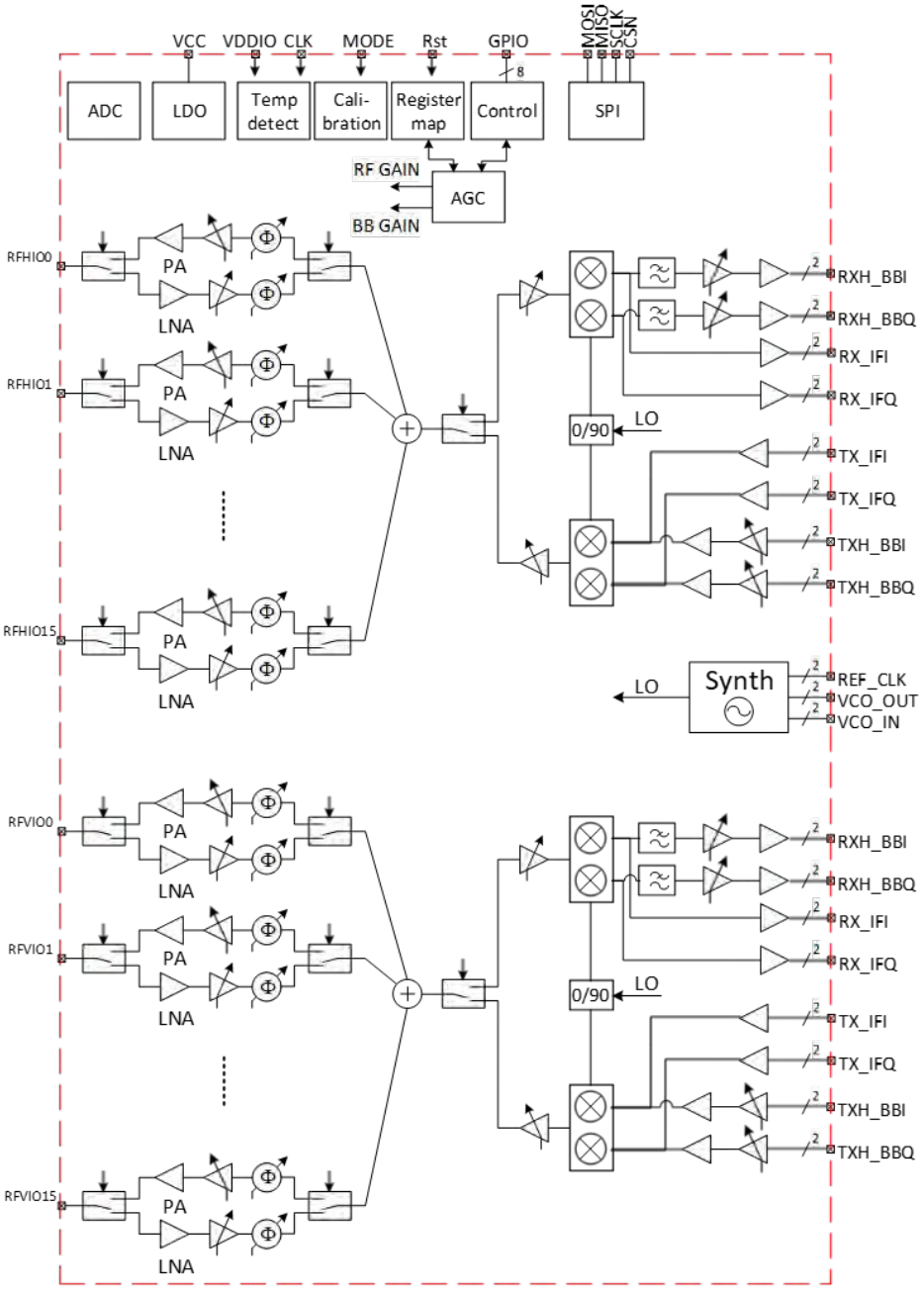


Figure 1. Block schematics TRB03901

For more information please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

ECLIPSE3741™

The 1st Antenna in Package for 5G mmWave infrastructure is here. Enjoy our 39 GHz dual polarization phased array antenna module.

Savers Semiconductor products and services enable 5G manufacturers to simplify product design, integrate components to reduce footprint and improve system reliability. Of course, with best-in-class RF performance.

The ECLIPSE 3741™ is a highly integrated 5G beam-former phased array Antenna in Package (AiP) module. Covering FR2 band n260 from 37.0 to 41.0 GHz, it offers exceptionally high linear output power, efficiency, and extreme integration. This AiP module has been designed to enable λ/2 lattice spacing when tiled together for higher EIRP applications. It has also been extensively optimized for heat management.

ECLIPSE3741™ is designed to address the challenges constraining 5G mmWave performance by;

- Easier implementation
- Lower cost
- Compact solution
- Higher data rate FR2 5G system

Applications include Cellular Base Stations (gNodeB), Consumer Premises Equipment (CPE), Fixed Wireless Access (FWA) and Mobile User Equipment (UE).

ECLIPSE3741 39GHz
16 Antenna Elements in a Tiny 15x15mm Module

KEY FEATURES

- 37.0 GHz-41.0 GHz
- Sixteen-element dual polarization phased array antenna module
- +45 dBm EIRP @3% EVM for full BW 64-QAM OFDM
- Full TX/RX TDD Beam forming RF chains
- Ultra-low TX and RX power consumption
  - TX ON: 10.24W Both polarizations @3% EVM for full BW 64-QAM OFDM
  - RX ON: 640 mW per polarization
- Independent dual polarization beam directions
- Low-loss T/R switches for TDD applications
- Phase shifting
  - 6-bit full 360° with 11.25 degrees step and 6'th bit for linearization
  - 0.5dB-step 15dB-range variable gain per path
- 20 dB common gain control
- Fully-calibrated for gain/phase matching channel-to-channel and chip-to-chip up to and including the antenna
- On-chip
  - Temperature sensor
  - Power sensor for each TX path
- 100 MHz SPI
- 2048-entry on-chip beam table storage
- 8-bit chip addressing supports 1020 element dual polarization arrays
- Antenna in Package (AiP) BGA Module
  - 15mm x 15mm
  - 0.65mm BGA pitch
- Operable temperature range -40° to +120°C case

High power and efficiency will be success factors when designing larger Base Transceiver Station (BTS) antenna arrays, where thermal design is critical. ECLIPSE3741™ is a greener and more compelling solution reaching more customers, still using less energy.

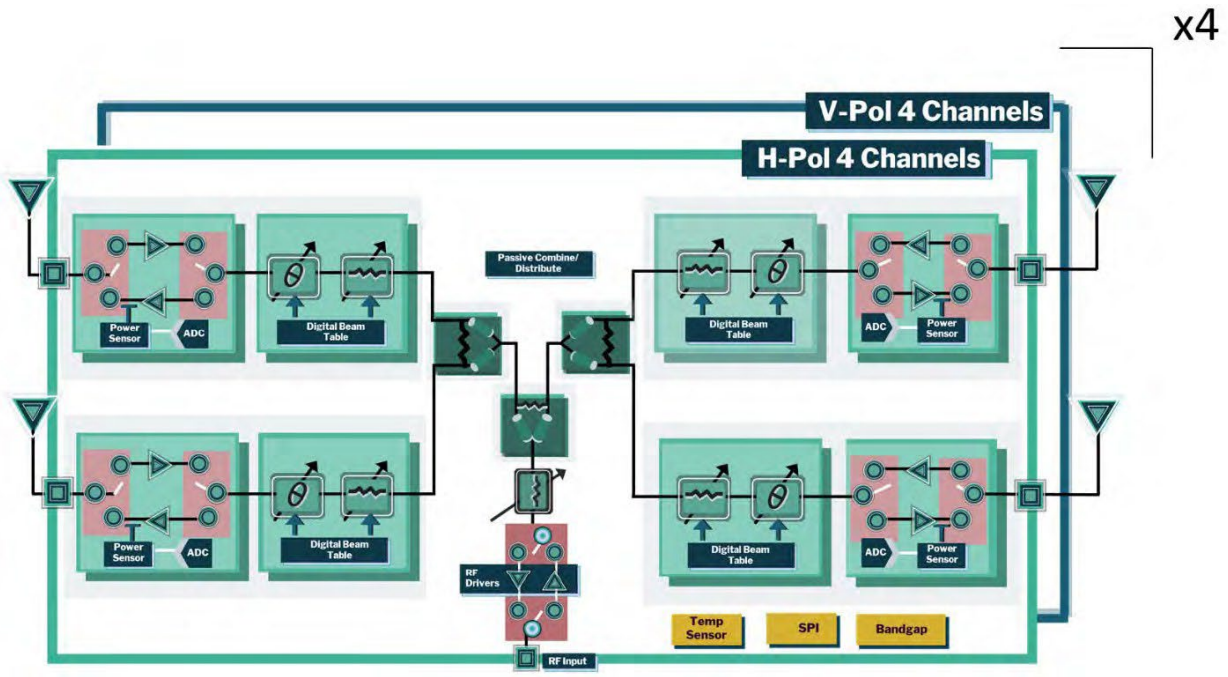


Figure 1. Block schematics ECLIPSE3741™ including four SUMMIT3741 ICs

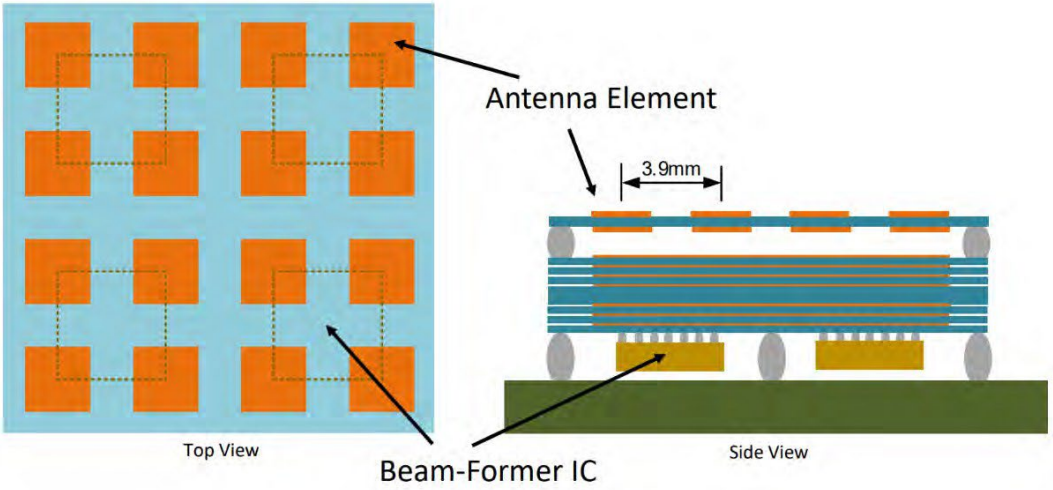


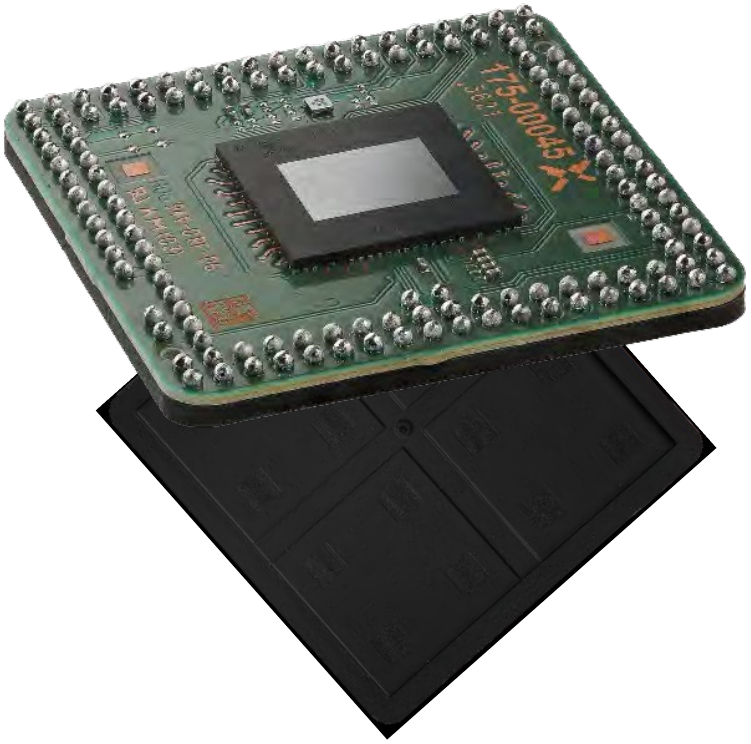
Figure 2. AiP module: IC and antenna arrangement ECLIPSE3741™

For more information, please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

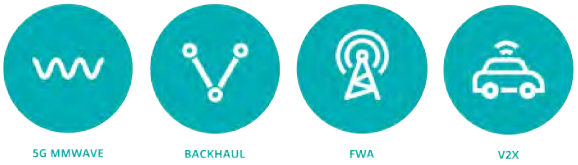
BFM03901 (37.0 GHz - 43.5 GHz)

Best in class beamforming antenna module covering the licensed 39 GHz 5G mmWave band



Utilize the award-winning experienced RF engineering team at Sivers Semiconductors and let us design the Radio Frequency part in your 5G-NR mmwave access product. Our RF module BFM03901 has unmatched power performance and throughput together with an integrated antenna that gives you a competitive advantage in the licensed 5G race.

By combining the unmatched performance of the TRB03901 RFIC with innovative antenna design, you get the flexibility and performance required for large deployments of your licensed 5G networks.



KEY FEATURES

- 37.0 GHz - 43.5 GHz
- Wide band transmit and receive antenna array optimized for the 39 GHz band
- Designed for 3GPP NR 5G Fixed Wireless Access (FWA) applications
- Dual polarisation beamforming transceiver with 32 (2x16 H+V) ports enabling two data streams supporting 2x2 MIMO
- RF tiling of multiple transceivers for large array antenna configurations
- Beam steering:
  - Azimuth ± 45 degrees
  - Elevation ± 45 degrees
- Integrated T/R-switches, linear power and low noise amplifiers
- Excellent RF performance providing best in class EVM performance
- High-performance synthesizer
- Connection to the baseband modem through:
  - Analog IQ-interface (Zero IF) or
  - IF-interface
- Integrated programmable baseband filters
- Easy to use with autonomous calibration routines and simple baseband interface

Transmitted power of up to +48 dBm with electronic beam steering in one single module enable product deployments in the most diverse applications. Furthermore, autonomous calibration routines and simple baseband interfaces makes it easy to install and manage.

Small form factor will be key going forward addressing FWA/RAN/O-RAN solutions. This module is setting the scene for 5G-NR RFIC and antenna modules through its high output power levels, intelligent power management and flexibility

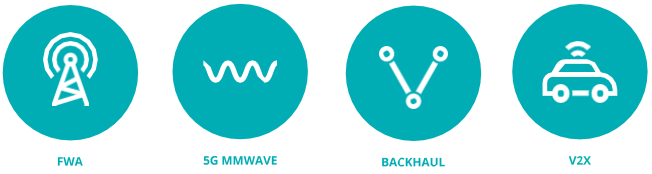
For more information please contact: sales@sivers-wireless.com

PRODUCT BRIEF - WIRELESS

EVK03001 (37.0-43.5 GHz)

Reduce time to market – speed up your mmWave product design using the Evaluation Kit

EVK03001 is designed to help you validate the RF part of your licensed 5G mmWave system. It is easy to 'Plug and Play' with a minimum of configuration activities and is easily controlled through standardized interfaces. Configuration support and user guidelines are included.



KEY FEATURES

- Frequency Range: 37.0 GHz - 43.5 GHz
- Support for dual polarized TX and RX data streams
- Analog Zero IF or IF signals connectors
- Includes BFM03901 RF Module, Motherboard and Graphical User Interface (GUI)
- Beam steering with Integrated TR and RX patch array antennas
- TX and RX beambooks for beam settings
- Integrated synthesizer with support for up to 256 QAM modulation
- TX and RX LO frequency control
- External reference clock connector for sync of more than one EVK
- Additional SPI, GPIO, TX/RX switch connectors for control of the RFM from external controller
- SMP baseband connectors, for easy connection to external equipment
- Python SW package

Included in the EVK03001 package:

1. RF Module and motherboard attached to a mechanical support tower
2. 5V, 8A power supply adaptor (AC input 100-250V)
3. USB-A to micro-B USB cable
4. Python SW package, including USB/FTDI driver and GUI software for controlling the EVK (provided via SFTP)
5. User manual (provided via SFTP)
6. 8 SMA male to SMP female cables, 25 cm long. SMA to SMA extension might be needed.

For more information please contact:
sales@sivers-wireless.com

Customer Cases and References

The worldwide 5G race pushes the industry to use more cost-effective solutions and the ever-increasing appetite for broadband increases the demand for high capacity wireless solutions. Sivers Semiconductors together with MaxLinear can now provide a unique solution combining two market leading technologies to enable cost effective 10 Gbps wireless transmission systems.

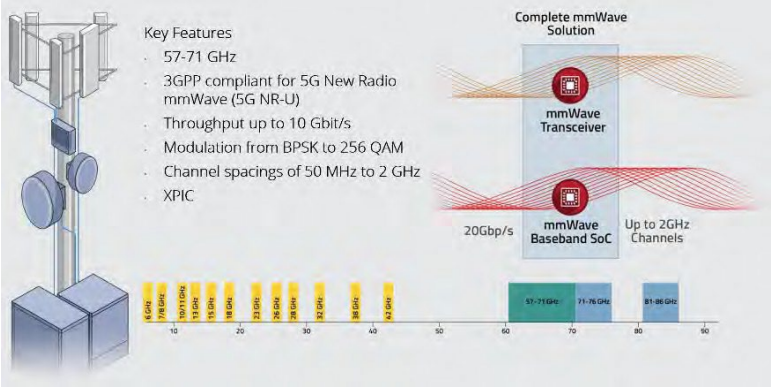


Figure 1. Disruptive use of the unlicensed 60 GHz band

By combining the MaxLinear MxL85110 baseband SoC with Sivers Semiconductors TRXBF/01 RFIC, customers can build flexible and cost effective products meeting the demands by fronthaul and backhaul applications. This combined solution will operate on the unlicensed 60 GHz band, supporting the full 14 GHz of available bandwidth. By means of channel bandwidths up to 2 GHz in combination with modulation rates from binary phase-shift keying (BPSK) to 256-QAM link capacities of 10 Gbps can be achieved.

By using the unlicensed 60 GHz band, it is possible to benefit from the unique characteristics given 14 GHz of available spectrum. The lower band (57-64 GHz) represent higher attenuation per km, making it suitable when you have a need for shorter link distances and higher level of frequency re-use, whereas the upper part of the spectrum (64-71 GHz) has characteristics similar to the E-band (71-76/81-86 GHz), which opens up for longer distances and more attractive link budgets. By using the 60 GHz spectrum, you will not only enjoy the simplicity of using an unlicensed band, you will also get access to truly wide channels of 2 GHz, which opens up tremendous possibilities for increased throughput.

Key features

- 57-71 GHz
- 3GPP compliant for 5G New Radio (NR) mmWave
- Throughput up to 10 Gbit/s
- Modulation from BPSK to 256 QAM
- Channel spacings of 50 MHz to 2 GHz
- XPIC
- Full duplex, single carrier, FDD modem combined with
- Highly integrated "all inclusive" mmWave transceiver IC
- Synchronous Ethernet (SyncE)
- 1588v2, transparent clock (TC) mode
- Ethernet, GPIO and SPI interfaces
- Fixed mode and low latency mode

Combining one MxL85110 together with 2 TRXBF/01 RFICs, one configured as TX and one as RX in the FDD configuration a compelling cost effective, yet high performing solution can be realized. The comprehensive functionality supported by the MxL85110 and the TRXBF/01 includes a complete signal and processing chain, from the various user IP interface technologies via the analog baseband signals through to the RF signal generation, up- and down conversion and the mmWave front end amplifiers.

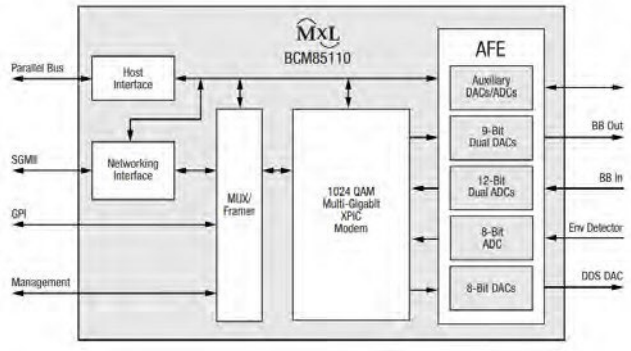


Figure 2 Block schematics overview MxL85110.

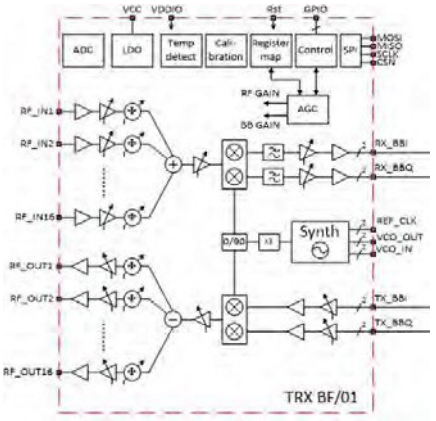


Figure 3. Block schematics overview TRXBF/01

MxL85110 Technical Features

■ Glueless connectivity to the RF/IF analog circuitry via integrated AFE DACs and ADCs
■ Synchronous Ethernet (SyncE)
■ 1588v2, transparent clock (TC) mode
■ Full-duplex, single carrier, FDD modem
■ XPIC
■ Bit rates up to 10Gbps
■ Modulation from BPSK to 1024 QAM
■ Channels spacing of 50MHz to 2GHz
■ Baud rate up to 1600 Mbaud
■ Configurable LDPC or RS FEC channel codes
■ High phase noise immunity
■ Ethernet and GPI interfaces
■ In-band management link

TRXBF/01 Technical features

- 57-71GHz with 2.16GHz RF channel spacing
- 16 Receive and 16 Transmit Beamforming Transceiver
- RF tiling for 32/48/64 element arrays
- Excellent RF performance providing best in class EVM performance
- Integrated Fixed-N synthesizer
- Integrated analog Receive channel filter
- DC connection to the baseband modem
- Pout1dB > +10 dBm per antenna path, providing a combined output power of > +22dBm from the chip
- 7 dB noise figure
- EVM performance in both receive and transmit mode: -27dB

CUSTOMER CASE STUDY

CCS Metnet 60G integrated with Sivers Semiconductors 60 GHz mmWave radio/antenna solution

> "After an extensive search, we concluded that Sivers Semiconductors offered truly unique capabilities and performance that we could integrate within our hardware platform and utilise to deliver a differentiated solution – offering highest capacity per node, use of all six channels in the 57-71 GHz band, and best range performance."
>
> *Martin Harriman*
> *Executive Chairman, CCS*

Broadway Partners rural broadband

If possible, operators would build fibre networks everywhere; however, in some locations, this is simply not practical, or economically viable. With the Metnet 60G solution CCS assists service providers to extend the reach of their fibre assets to deliver the services wherever they are needed.

CCS Metnet 60G consists of CCS's own software integrated with Sivers Semiconductors 60 GHz mmWave radio/ antenna solution and Renesas IDT modems instantiated with the Blu Wireless IPR to provide gigabit connectivity to the global market. CCS has established a global relationship with ADTRAN to deliver industry-leading solutions to service providers. CCS rigorously evaluated the market and selected Sivers Semiconductors as a key technology partner when designing the integrated hardware platforms for today and tomorrow.

Strategic background to market opportunity

CCS helps service providers extend the reach of their fibre networks to deliver connectivity wherever it is needed. The two most compelling use cases are fixed wireless access –ultra-fast, gigabit connectivity to businesses and homes – and mobile backhaul, with high-speed, low latency connectivity delivered via street furniture assets to support mobile operators as they densify their networks and build out 5G capability.

The Metnet 60G solution has already more than 30 customer deployments, trials, and Proof of Concepts underway. Due to the strategic partnership with ADTRAN, CCS has solved the scaling of manufacturing and go-to-market, and is well-positioned for long-term success.

In 2010 the company founders' ambition was to build mmWave radio solutions that were intelligent and incorporated machine-learning into a multi-point to multi-point mesh network. The initial products CCS brought to market operated in the licensed 24-29 GHz bands, however, the time to market was hampered by the lack of available technology partners from which to source key elements of the solution.

THE CASE STUDY IN BRIEF

Customer

CCS (Cambridge Communication System)
Cambridge | United Kingdom
www.ccsl.com | info@ccsl.com

Challenge

- Help operators build hybrid fibre-wireless networks delivering the lowest overall network TCO
- Address the 60 GHz market for FWA and mobile backhaul
- Design a complete best-in-class 60 GHz solution
- Reduce time-to-market
- Achieve scale to business and manufacturing

Solution

- CCS software together with Sivers-Semiconductors 60 GHz mmWave radio/antenna solution and Renesas IDT modem and Blu Wireless IPR - **Metnet 60G**
- Sales and manufacturing agreement with ADTRAN reaching hundreds of service providers across the globe

Result

- Maximise the full-fibre service reach at the lowest possible total cost of ownership
- Engineering project completed thanks to close collaboration between the engineering and management teams of CCS and Sivers Semiconductors
- Highest capacity per node, use of all six channels in the 57-71 GHz band, and best range performance

> **As you would expect with any engineering project, building our hardware platform and achieving the integration with our Metnet software was not without its challenges, but the strong working partnership and close collaboration between the engineering and management teams of our two companies has always found solutions to overcome these.**
>
> **Martin Harriman**
> Executive Chairman, CCS

Trafalgar Square, January 2020

In 2010 the company founders' ambition was to build mmWave radio solutions that were intelligent and incorporated machine-learning into a multi-point to multi-point mesh network. The initial products CCS brought to market operated in the licensed 24-29 GHz bands, however, the time to market was hampered by the lack of available technology partners from which to source key elements of the solution. *"As a result, we spent years designing radios and antennas when our real interest was the underlying software that delivered the self-organising, self-optimising and self-healing networks",* Martin Harriman the company Executive Chairman says.

Even so, the 28GHz solution went on to be successfully deployed in some incredible use cases, including the landmark network in the City of London, where it is being used to backhaul all of Telefonica's Wi-Fi and LTE small cells.

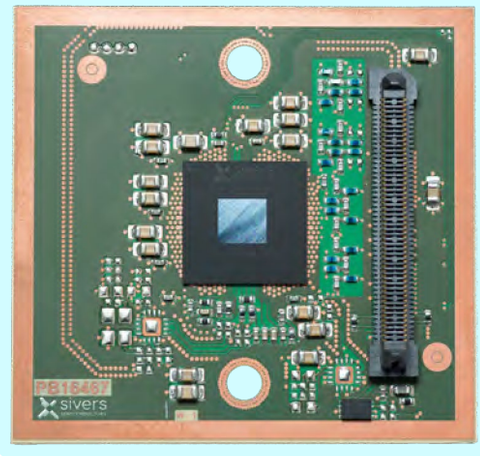
"When we identified the need to develop a solution to address the significant opportunity that 60 GHz spectrum presented, we scoured the market looking for suitable technology partners with best- in-class capability to incorporate alongside our Metnet software and maximise its applications and potential. After an extensive search, we concluded that Sivers Semiconductors offered truly unique capabilities and performance that we could integrate within our hardware platform and utilise to deliver a differentiated solution – offering highest capacity per node, use of all six channels in the 57-71 GHz band, and best range performance. As you would expect with any engineering project, building our hardware platform and achieving the integration with our Metnet software was not without its challenges, but the strong working partnership and close collaboration between the engineering and management teams of our two companies has always found solutions to overcome these" Harriman continues.

Status of commercial deployment of solution

In 2019, CCS signed sales and manufacturing agreements with ADTRAN. These agreements were designed to deliver scale to their business, allowing access to both ADTRAN's manufacturing scale – the company ships 2 million units per annum – and to its global sales team that services more than 500 customers in over 60 countries. The CCS solutions now form an integral part of the ADTRAN fibre extension portfolio.

One of the earliest adopters of the solution was Ontix in London, which acquired the rights to access street furniture assets across two London boroughs, including Westminster. Ontix has already built-out more than 100 sites as part of its next-generation neutral host network, to backhaul mobile operator small cells and Wi-Fi access points, as well as delivering gigabit Fixed Wireless Access directly to businesses in the capital.

Sivers Semiconductors
Radio Frequency Module
BFM 06010
57-71 GHz



CCS Metnet 60G

sivers SEMICONDUCTORS

PHOTONICS

Advanced III-V Semiconductor Photonics Devices, from design to High Volume Manufacturing

BUSINESS AREA PHOTONICS SIVERS PHOTONICS is the world's most advanced supplier of customised III-V semiconductor photonics devices, enabling next generation applications in optical communications and sensing markets, and a key strategic supplier to many Fortune-100 and Silicon Valley customers. With over 20 years of expertise designing and manufacturing III-V photonic devices across diverse material systems, our foundry provides end-to-end in-house capability, from prototype design to qualified high-volume manufacturing. With a particular focus on InP sources optimised for silicon photonics integration, we offer customisable high power, InP-based DFB lasers and gain chips, as single emitters or arrays, on our InP100 Product Platform.

FOUNDRY & DESIGN SERVICES

DESIGN

Library of epitaxy designs for high-power, high-speed lasers
Advanced chip design with focus on reliability and performance

PROTOTYPING

Complex 3D architectures
Add-on modules for application specific functionalities
Full on-wafer front and back side processing
Optical coatings for non-hermetic packaging
Low volume samples

VOLUME PRODUCTION

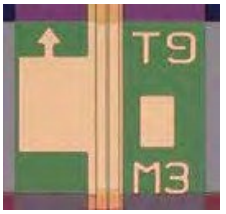
100mm/4" wafer processing
Automated bar cleave and device singulation
Automated test & inspection
High-volume test capacity (>2M lasers/month)
On-wafer optical testing
GR468 qualification
Damp-heat testing

DEVICE TYPES Our photonic devices are enabling next generation applications across a wide range of growth markets including optical communications, sensing and SiPh applications.

Optical Communications

O-band 25Gbps CWDM DFB
O-band CWDM DFB for PAM4

1310nm DFB -50°C to +95°C



1270nm 2.5 Gbps PON DFB
1270nm 10 Gbps PON DFB

Optical Sensing

Reflective SOA for tuneable lasers

C-band High Power DFB Phased DFB laser arrays

High power GAAs laser diodes
Resonant Cavity LEDs

InP100 PRODUCT PLATFORM

The InP100 Product Platform is a common design and manufacturing framework for InP photonics devices that uses established process modules to produce a broad range of device types on 100mm wafers.

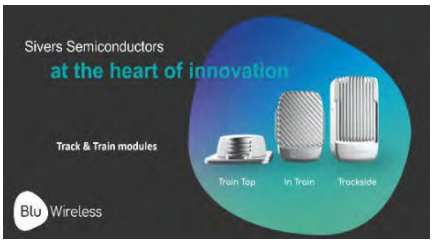
Sivers Semiconductors adds value to customers

WIRELESS

CCS Metnet 60G - Fixed Wireless Access and Small Cell networks delivering gigabit broadband connectivity in cities and rural regions

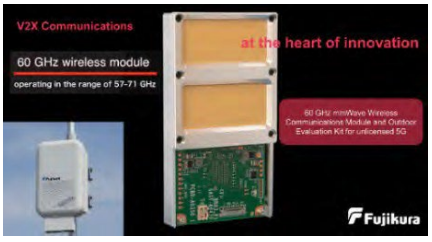
Ontix FWA Service - Ultra-fast Fixed Wireless Access broadband service in central London

MicroNät 6XG – Fixed Wireless Access network in northern Sweden



Blu Wireless - Track & Train modules provide high-speed rail connectivity

Blu Wireless AutoAir Project – 5G Testbed for Connected and Autonomous Vehicles

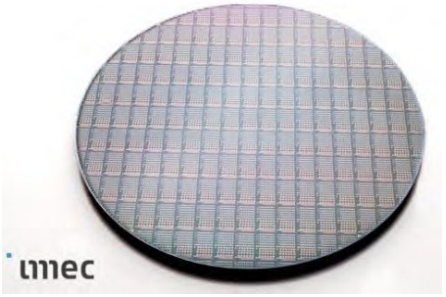


Fujikura - 60 GHz mmWave Wireless Communications Module & Outdoor Evaluation Kit

Fujikura High-speed V2X communication enabling safe driving support for local bus service in Japan

Airvine - The All-Wireless Enterprise: Indoor Wireless Backbones at Gigabit Speeds

PHOTONICS



DFB laser dies bonded onto 300mm silicon photonics wafer

The collaboration with **imec,** a world-leading research and innovation center in nanoelectronics and digital technologies, began in 2019. The aim of the project is to accelerate hybrid integration of InP Lasers and Amplifiers with silicon photonics.

NOTES