

# Multifractal Semiconductors

## CMOS E-band front-ends

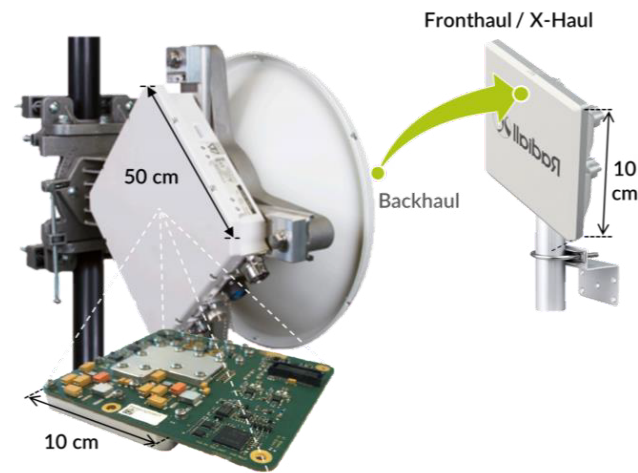
### Opportunity

mmWave E-band fronthaul (also known as "fibre-in-the-air") will enable high-throughput (100 Gbps), low-latency (<10 us) & high-density (1 M/km<sup>2</sup>) street level connectivity. The key enabler of fronthaul is link densification, first through last-mile link deployment followed by aggressive small-cell densification (every 300 m).

Existing E-band front-ends meet backhaul requirements, but are too expensive (\$1k+), too big (10 x 10 cm) & power hungry (5 W) for fronthaul deployment.

### Solution & Products

Multifractal Semiconductors is the only company in the world that has developed single-chip E-band front ends in bulk CMOS (28 nm), with the diplexer integrated directly in the BT package (eliminating waveguide diplexers and components from the BOM). As a result our front-end is 10x smaller (1x1 cm), 10x cheaper (\$100), 5x lower power (1 W) and supports 10-100x higher production volume (100M+) than competing solutions. This will for the first time enable low-cost high-volume fronthaul last-mile and small-cell links.



# Multifractal Semiconductors

To make this possible, we have developed (enabling technology):

- The world's first commercial BT laminate diplexer – which occupies only 3.8 x 4.5 mm – compared to waveguide diplexers of 6 x 3 cm. Our diplexer integrates directly in the plastic IC package with a WR12 antenna transition.
- An attractive portfolio of CMOS mmWave IP @ E-band, as shown in the table.
- A Python based PCELL framework which integrates with Synopsys PyCELL and enables rapid DRC orientated mmWave layout design.

### Market Opportunity

The global RF semiconductor market was valued at \$17.4B in 2020 and is expected to grow to \$40B by 2030 (CAGR of 8.5%). The E-band semiconductor space is expected to capture \$24B of this market (SAM). MF expects to capture at least 5% of the SAM by 2028 through IC sales, with an exit valuation of \$1.2B.

### Business Model

We will enter the market with E-TRX-HP front-end IC sales in the E-band last-mile space from Q3 2022 and ramp up in Q3 2023 with E-TRX-LP sales in the small-cell market. CMOS IP licencing will also be considered in Q4 2023+ in the NR 5G UE space.

### Progress to Date

- 2017: proof of concept and incorporation.
- 2018: SAAB defence NRE project (\$25k).
- 2020: Seed funding of \$1.22M + Si Catalyst in-kind.
- 2021: First prototype run (CMOS & BT package).
- 2022: First set of measurements, second prototype.

### Team

- Joe Valliarampath, CXO - PhD Eng, ex. Nokia Siemens Networks, Denel Dynamics
- Piotr Osuch, CXO - PhD Eng, ex. SAAB as RF/MW engineer
- Nish Singh, MMIC Eng. - MEng, previously 5 years of business management experience, currently at IMEC IDLab at UGent (5G-PHOS - 5G integrated Fiber-Wireless networks)
- Paul Pickering, BOD, advisor, Si Catalyst managing partner
- Johannes Venter, RF/MW Eng. – PhD Eng.
- Hendrik Nel, MMIC Eng. – MEng.
- Maxwell Ballot, MMIC Eng. – MEng.

### Ask

Raising \$4M (pre)-Series-A: deadline Dec 2022, for 10% equity.

<b>ELNA7176/8186</b> Low-noise amplifier 	<ul style="list-style-type: none"> <li>• Gain: 18.5 dB</li> <li>• NF: 4.5-5 dB</li> <li>• IP1dB: 10 dBm</li> <li>• 0.4 mm.sq</li> </ul> ✓ MPW run 1 - Dec 2021 ✓ Measurements - Apr 2022 ○ MPW run 2 - Jun 2022
<b>EPA7176/8186</b> Power amplifier 	<ul style="list-style-type: none"> <li>• Gain: 12 dB</li> <li>• OP1dB: 17.5 dBm</li> <li>• PAE: 15%</li> <li>• 1.03 mm.sq</li> </ul> ✓ MPW run 1 - Dec 2021 ✓ Measurements - Apr 2022 ○ MPW run 2 - Jun 2022
<b>EVGA7176/8186</b> Variable-gain amplifier 	<ul style="list-style-type: none"> <li>• Gain max: 12 dB</li> <li>• Tuning range: 17 dB</li> <li>• Return loss: 15 dB +</li> <li>• OP1dB: 9 dBm</li> <li>• 0.6 mm.sq</li> </ul> ✓ MPW run 1 - Dec 2021 ✓ Measurements - Apr 2022 ○ MPW run 2 - Jun 2022
<b>EMULT7176/8186</b> x6 frequency multiplier In progress 	<ul style="list-style-type: none"> <li>• Out. freq: 71 – 86 GHz</li> <li>• Out. power: 5 dBm</li> <li>• 5<sup>th</sup> harm. iso: 25 dBc</li> <li>• 7<sup>th</sup> harm. iso: 35 dBc</li> <li>• 0.7 mm.sq</li> </ul> ○ MPW run 1 - Jun 2022
<b>EMIX7176/8186</b> Up/down converter In progress 	<ul style="list-style-type: none"> <li>• Conversion gain: -4 dB</li> <li>• LO power: 2 dBm (min)</li> <li>• IP1dB: 5 dBm</li> <li>• LO-RF Isolation: 40 dB</li> </ul> ○ MPW run 1 - Jun 2022

