

LiDAR for Automotive

(ADAS and robotic vehicles)

Patent Landscape Analysis

January 2022

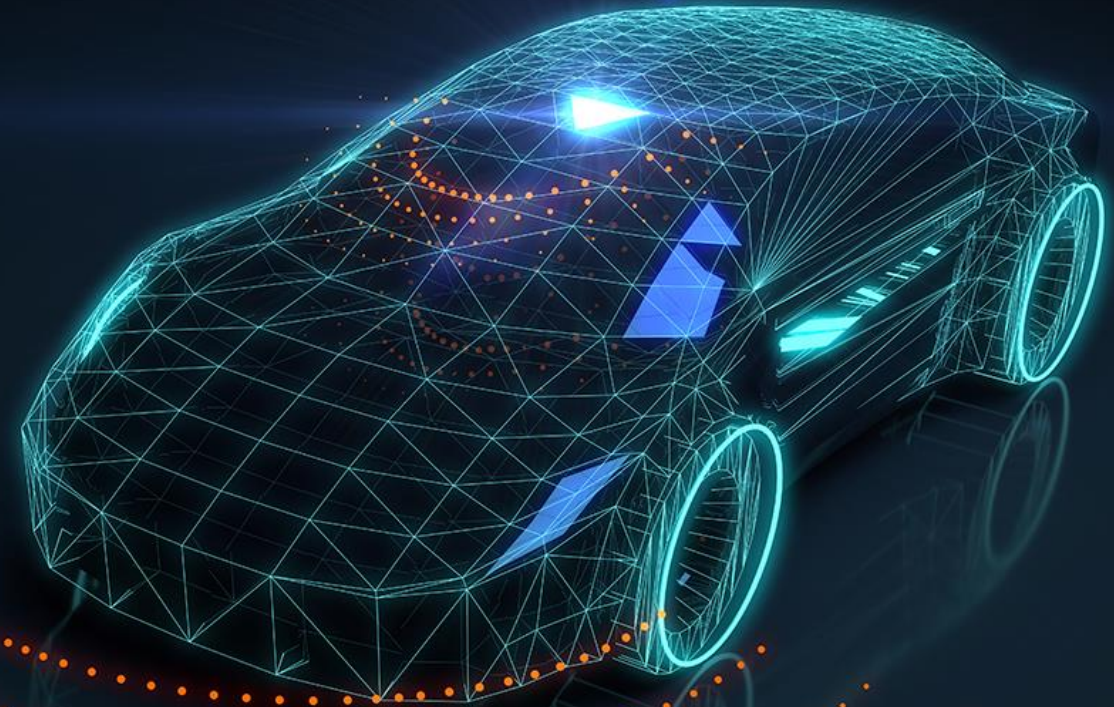


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SCOPE OF THE REPORT

- This report provides a detailed picture of the patent landscape for **LiDAR dedicated to automotive applications (ADAS and robotic vehicles)**, covering the whole value chain (LiDAR components, LiDAR optical systems, LiDAR systems in vehicle, ADAS systems using LiDAR, 3D and environment mapping using LiDAR).
- This report covers **patents published worldwide** up to **July 2021**. We have selected and analyzed more than **24,200 patents and patent applications** representing more than **11,900 patent families** (inventions) relevant to the scope of this report.

Type of patents	In scope	Out of scope
Generic patents describing LiDAR devices without describing any specific applications	X	
Patents describing electrical or optical components especially dedicated to LiDAR systems	X	
Patents describing LiDAR driving systems	X	
Patents describing LiDAR systems for automotive applications (ADAS and robotic vehicles)	X	
Patents describing method for LiDAR-based driver assisted systems	X	
Patents claiming the use of LiDAR in ADAS systems, anti-collision, etc.	X	
Patents describing non-embedded LiDAR for vehicle traffic surveillance		X
Patents describing LiDAR systems for consumer applications (AR/VR, 3D sensing, etc.)		X
Patents describing LiDAR systems for industrial applications (construction, logistics, factory automation, energy, smart building, security, smart agriculture, meteorology, etc.)		X
Patents describing LiDAR systems for defense and aerospace applications (including drones)		X
Generic patents describing laser, optical components, detectors, etc. and non-directly related to LiDAR applications		X

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KEY FEATURES OF THE REPORT

- The report provides **essential patent data** for **LiDAR for automotive applications (ADAS and robotic vehicles)**.
- It provides **in-depth patent analyses of key technologies and key players** including:
 - IP trends including time evolutions and countries of patent filings for each technological approach.
 - Current legal status of patents for each technological approach.
 - Ranking of main patent applicants related to LiDAR devices and systems.
 - IP position of key players and relative strength of their patent portfolios.
 - Segmentation of patents by LiDAR technologies
 - Identification of main key technologies and related issue.
 - Key patents.
 - Portfolio analysis of key IP players
 - Portfolio analysis of IP newcomers (pure players, Chinese players, etc.)
- The report also includes an **Excel database** with the 11,900+ patent families (inventions) analyzed in this study. This useful patent database allows **multi-criteria searches** and includes patent publication numbers, **hyperlinks to an updated online database** (original documents, legal status, etc.), priority dates, title, abstract, patent assignees, patent 's current legal status, and **segments (mechanical, MEMS mirrors, OPA, Flash, etc.)**



Disclaimer: This report **does not provide** any insight **analyses or counsel regarding legal aspects** or the **validity** of any individual patent. Knowmade is a research firm that provides technical analysis and technical opinions. Knowmade is not a law firm. The research, technical analysis and/or work proposed or provided by Knowmade and contained herein is not a legal opinion and should not be construed as such.

OBJECTIVES OF THE REPORT

Understanding the **competitive landscape** and **technology developments** from a **patent perspective**

- **Key IP players** (key patents, IP strategy, technology roadmap)
- **Newcomers** (technology and markets of interest)
- **Technology trends & Emerging technologies**
- **Benchmark patent portfolios** (competitors' strength & weakness)
- **Key patents** (blocking, valuable)
- **Key technical solutions**
- **Risks** (patent infringement, new entrants, etc.)
- **Opportunities** (partnership, technology acquisition, licensing, etc.)



Very complementary to market research

Give another point of view of the competitors, technologies and markets

Links between patents and

- Key market players
- Supply chain
- Technology Readiness Levels (TRL)
- Market product
- Emerging technologies/applications
- Forecast

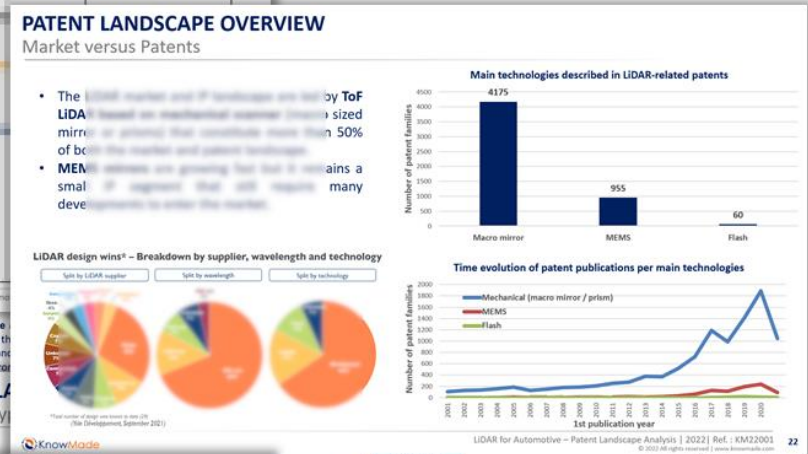
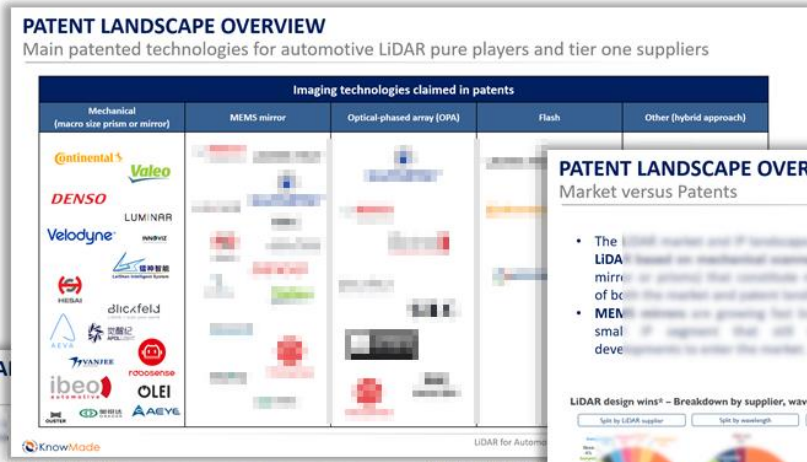
PATENT SEGMENTATION AND IP POSITION

Technical developments and IP position

SAMPLE

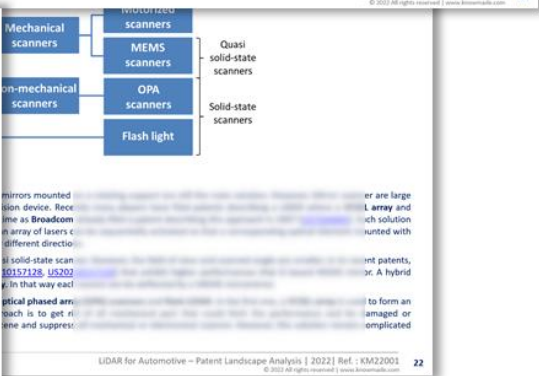
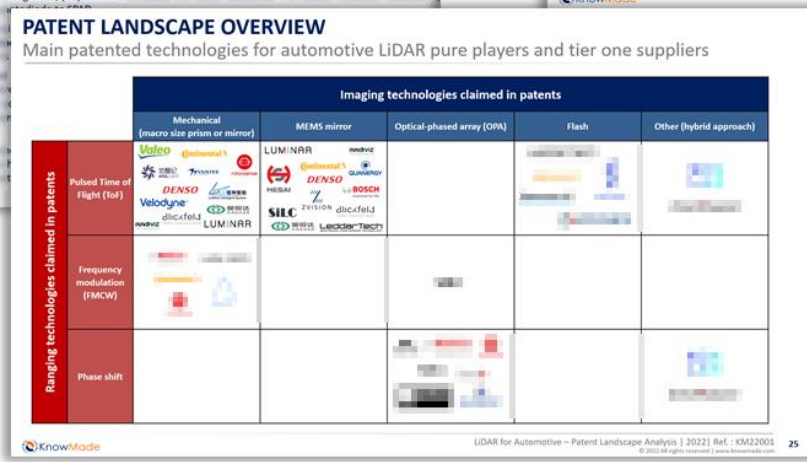
The patents have been categorized by LiDAR technologies:

- Mechanical motorized LiDAR (macro prism or mirror)
- MEMS micro mirror LiDAR (quasi solid-state scanner)
- Optical phased array (OPA) LiDAR (solid-state scanner)
- Flash LiDAR (solid-state non-scanning LiDAR)
- Hybrid approach
- Pulsed Time of Flight (ToF)
- Frequency modulation (FMCW)
- Phase shift



PATENT LANDSCAPE Summary

- The LiDAR many hist patents at
- According vehicles Li capacity L embedd early pate
- Mechanic time, play laser sour sequence from EEL t
- Today, inv patents ai in all conc
- MEMS mi technolog LiDAR see technolog and resol
- Optical-pl resolution the OPA a



IP PROFILE OF KEY PLAYERS

IP portfolio summary, IP strategy, key patents and recent IP developments

SAMPLE

A focus on key IP players and newcomers is provided in a dedicated section. For each patent assignee, the LiDAR patent portfolio is statistically analyzed to provide an overview of its strengths, weaknesses and level of IP activity. Most notable patents and recent IP developments are described in light of the main LiDAR challenges.

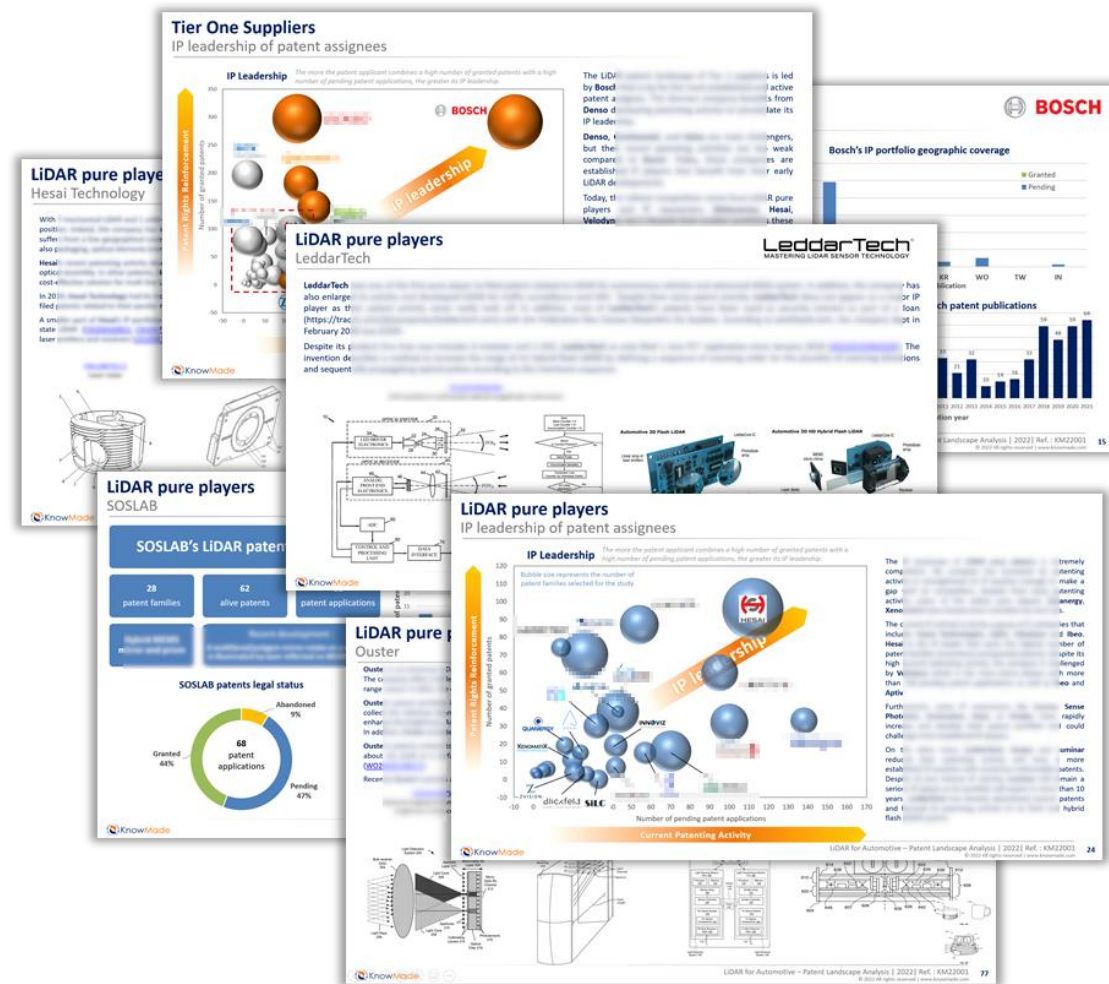
Tier one suppliers



LiDAR pure players



Autonomous vehicle makers (robotic cars / robotaxis)



PATENT DATABASE

Excel file containing all the patents analyzed in this report with corpus segmentation

SAMPLE

The report also includes an **Excel database** with the 11,900+ patent families (inventions) analyzed in this study. This useful patent database allows **multi-criteria searches** and includes patent publication numbers, **hyperlinks to an updated online database** (original documents, legal status, etc.), priority dates, title, abstract, patent assignees, patent 's current legal status, and **segments** (mechanical, MEMS micro mirrors, OPA, flash, ToF, FMCW, etc.).

											SEGMENTS					
Family number (Questel unique family ID from FamPat database)	Members of the family (publication numbers)	Title	Abstract	Link to biblio summary of the family (original documents, etc.)	Patent assignees	Earliest application date of the family	Earliest publication date of the family	Grant date of each member	Legal status of each member (As of Jan 2022)	Expected expiry date of each member	Mechanical (macro mirrors or prisms)	MEMS micro mirrors	Optical-phased array (OPA)	Flash	Time of Flight (ToF)	Frequency modulation (FMCW)
97552867	US20130194426	(US7561181) Vehicular vision system	(US20060206100) A vehicle vision system	Open	DONNELLY MAGNA ELECTRONICS	2005-05-05	2005-09-15	(US1301101) 2009-07-14	(US1301102) LAPSED	(US1301103) 2021-08-16	X					
97234184	CN110573328	Angle calibration in light detection and ranging	A light detection and ranging system	Open	INNOVATION	2017-04-28	2018-11-01	(US8452200) 2019-05-21	(US8452201) LAPSED	(US8452202) 2021-08-02	X					
96731088	CN212341442	The invention also	The utility model	Open	SUZHOU	2020-10-28	2021-01-12	(US1059902) 2021-01-12	(US1059903) GRANTED	(US1059904) 2030-10-28						
96270739	CN113447310	A multiple laser radar	The invention provides a	Open	SHANGHAI CHENGYI	2017-06-19	2017-09-01	(CN113447311) PENDING	(CN113447312) PENDING	(CN113447313) 2037-06-19	X					
96123473	US11063408	Laser emitting unit and	A vertical cavity surface	Open	SOS LAB	2020-08-28	2021-03-04	(US11063409) GRANTED	(US11063410) GRANTED	(US11063411) 2040-08-28		X				
96023182	US10914841	Lidar system for	Techniques for	Open	SENSORS & APPLICATIONS	2019-12-23	2020-04-30	(US10914842) GRANTED	(US10914843) GRANTED	(US10914844) 2039-04-22	X		X			X
96009146	US20210278851	System and method for	An auto	Open	SENSORS & APPLICATIONS	2021-01-14	2021-02-03	(US20210278852) PENDING	(US20210278853) PENDING	(US20210278854) 2023-01-10	X					
95723257	US10866312	Lidar system for	A method is presented	Open	SENSORS & APPLICATIONS	2019-12-23	2020-05-28	(US10866313) GRANTED	(US10866314) GRANTED	(US10866315) 2039-07-25	X					
95617537	WO2021156464	A laser detection and	Method of application	Open	SENSORS & APPLICATIONS	2020-12-15	2021-12-15	(WO2021156464A1) PENDING	(WO2021156464A2) PENDING	(WO2021156464A3) 2023-08-05	X					
95528224	CN113219438	High-precision	Method of application	Open	ZVISION	2021-01-28	2021-08-06	(CN113219439) PENDING	(CN113219440) PENDING	(CN113219441) 2040-01-21						
95522474	CN113219441	Precision verification	The embodiment of the	Open	ZVISION	2021-04-28	2021-08-06	(CN113219442) PENDING	(CN113219443) PENDING	(CN113219444) 2041-04-28						
95405524	WO2021148680	A laser detection and	Method of application	Open	SENSORS & APPLICATIONS	2020-12-15	2021-12-15	(WO2021148680A1) PENDING	(WO2021148680A2) PENDING	(WO2021148680A3) 2023-07-24	X					
95405505	WO2021148679	A multiple	Method of application	Open	SENSORS & APPLICATIONS	2020-12-15	2021-12-15	(WO2021148679A1) PENDING	(WO2021148679A2) PENDING	(WO2021148679A3) 2023-07-24	X				X	
95283481	CN213749089	Acceptance and	The utility model	Open	INNOVATION	2020-12-07	2021-07-20	(CN213749090) GRANTED	(CN213749091) GRANTED	(CN213749092) 2030-12-07						
95274845	US20210223790	Using neural networks to	In various examples,	Open	INNOVATION	2020-07-18	2021-07-20	(US20210223791) PENDING	(US20210223792) PENDING	(US20210223793) 2040-01-16	X					
95195966	WO2021139670	Laser transceiver	Disclosed are a laser	Open	ZVISION TECHNOLOGY	2021-01-06	2021-07-15	(WO2021139671) PENDING	(WO2021139672) PENDING	(WO2021139673) 2023-07-06		X				
95191381	US20210215807	Pipelined histogram pixel	A Light Detection and	Open	UNIVERSITY OF	2021-01-07	2021-07-15	(US20210215808) PENDING	(US20210215809) PENDING	(US20210215810) 2023-07-09					X	
95099338	US10921452	Lidar system	Techniques for	Open	SENSORS & APPLICATIONS	2020-01-07	2020-05-07	(US10921453) GRANTED	(US10921454) GRANTED	(US10921455) 2039-08-14	X					
95090027	US20210208281	Adaptive scan pattern	An imaging sensor is	Open	LUMINAR	2020-02-12	2021-07-08	(US20210208282) PENDING	(US20210208283) PENDING	(US20210208284) 2023-07-06	X					
95090016	US20210208263	Calibration of sensor	A system includes	Open	LUMINAR	2020-05-07	2021-07-08	(US20210208264) PENDING	(US20210208265) PENDING	(US20210208266) 2023-07-07	X					
95090015	WO2021142487	Lidar system including	A Lidar system includes	Open	ALTIMETIC	2020-01-07	2021-07-08	(WO2021142488) PENDING	(WO2021142489) PENDING	(WO2021142490) 2023-07-07			X			

Patent information
Dates and numbers of application/publication/grant, title, abstract, patent assignees, patents' legal status of patents (granted, pending, expired, etc.), hyperlinks to an updated online database (original documents, legal status, etc.)

Segments
Mechanical, MEMS mirrors, OPA, Flash, ToF, FMCW, etc.

ORDER FORM

LiDAR for Automotive

Patent Landscape Analysis – January 2022

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BIC/SWIFT: CCBPFRPPMAR

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BIC or SWIFT code: CCBPFRPPMAR

IBAN: : FR76 1460 7003 6360 6214 5695 139

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6.4 The Buyer shall define within its company point of contact for the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

7. TERMINATION

7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer shall indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may also apply for any other direct or indirect consequential loss that may be borne by the Seller, following this decision.

7.2 In the event of breach by one Party under these conditions or the order, the non-breaching Party may send a notification to the other by recorded delivery letter upon which, after a period of thirty (30) days without solving the problem, the non-breaching Party shall be entitled to terminate all the pending orders, without being liable for any compensation.

8. MISCELLANEOUS

All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce those provisions against the Buyer.

Any notices under these Terms and Conditions shall be given in writing. They shall be effective upon receipt by the other Party.

The Seller may, from time to time, update these Terms and Conditions and the Buyer, is deemed to have accepted the latest version of these terms and conditions, provided they have been communicated to him in due time.

9. GOVERNING LAW AND JURISDICTION

9.1 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in application of these Terms and Conditions shall be settled by the French Commercial Courts of Grasse, which shall have exclusive jurisdiction upon such issues.

9.2 French law shall govern the relation between the Buyer and the Seller, in accordance with these Terms and Conditions.

KNOWMADE

Patent and Technology Intelligence

KNOWMADE PURPOSE

Turning **patents** and **scientific information** into **business-oriented report** for **decision makers** working in **R&D, Innovation Strategy, Intellectual Property, and Marketing**

Competitive landscape | Technology trends | Opportunities / Risks | R&D and IP strategy



Intellectual Property

Patent your inventions
Assert your patents and defend your position in case of licensing/litigation
Evaluate the risks to infringe patents

Prior art search, Freedom-to-operate analysis, Patent invalidation, Evidence of use, Patent valuation

Understand, anticipate and evaluate the competitive landscape and current technology developments

Patent landscape, Monitoring service, IP due diligence

Innovation Strategy

Improve your R&D and IP strategy
Identify and get access to external innovation

Technology scouting, Scientific literature analysis

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Patent Landscape Analysis
to give an overview on IP dynamics, IP trends and IP players

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Monitors

Patent Monitoring Service
to track current R&D activity and early detect weak signals, opportunities and risks

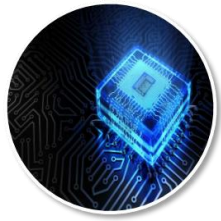


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MAIN FIELDS OF EXPERTISE

Communication

- RF, Microwaves, mm-Waves
- RF Front End Module
- Antenna & Networks
- Digital Optical Communication (datacom, telecom, photonics)



Advanced Packaging
Innovative Materials
AI & Computing

Energy Mgt & Storage

- Power electronics
- Batteries & Fuel-cell
- Power management
- PV



MEMS, Sensors & Optoelectronics

- Micro-systems
- Sensors & Imaging
- Lighting & Display

Life Sciences & Healthcare

- MedTech
- Microfluidics
- Biotech & Pharmaceuticals
- Agrifood



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