Microphones, Microspeakers, and Audio Solutions

Market and Technology Trends 2019 - Sample
# TABLE OF CONTENTS

## Part 1/2

- Glossary and definition \(2\)
- Table of contents \(4\)
- Report scope \(6\)
- Report methodology \(9\)
- About the authors \(10\)
- Companies cited in this report \(11\)
- What we got right, What we got wrong \(12\)
- Executive summary \(18\)
- Context \(50\)
  - Introduction
  - A voice-connected world
  - The digital audio chain
  - Microphones
  - Microspeakers
  - Audio IC
- Market forecasts \(66\)
  - Microphones
  - Microspeakers
  - Audio IC
- Market trends \(103\)
  - Consumer trends
  - Automotive trends
  - Industrial trends
  - Medical trends
  - Military trends
- Market shares and supply chain \(158\)
  - Competition in the microphone market
  - The audio industry galaxy
  - MEMS-based audio supply chain
  - Partnerships, mergers and acquisitions
  - 2018 microphone revenue market share
  - MEMS microphone players and offered technologies
  - MEMS microphone revenue rankings
  - MEMS microphone value chain
  - MEMS speaker value chain
  - Audio IC landscape
  - Audio IC market share
  - Supply chain for audio IC for mobile devices
  - Current value of components
  - Potential value of components
  - MEMS-based audio value chain

---

Microphones, Microspeakers, and Audio Solutions 2019 | Sample | www.yole.fr | ©2019
# TABLE OF CONTENTS

Part 2/2

- Technology trends
  - Microphones
  - Speakers
  - Audio IC
  - Packaging
- IP analyses
  - MEMS microphone patent analysis
  - MEMS speaker patent analysis
- Reverse Costing® - Structure, Process and Cost analyses
- Outlook
- Related reports
- How to use our data?
- About Yole Développement
SCOPE OF THE REPORT

MEMS microphones

Microspeakers

Audio solutions

Electret condenser microphones (ECMs)

Not included in the report

Yours needs are out of the report’s scope?
Contact us for a custom:
SCOPE OF THE REPORT

Technology
- Microphones
- Microspeakers
- Audio Solutions

Markets
- Consumer
- Industrial
- Medical
- Military

Applications
- ASICs
- DSPs and codecs

Markets
- Consumer
- Industrial
- Medical
- Military

Applications
- Smartphone
- Basic/feature phones
- Smart speakers
- Action cam
- PC laptops and tablets
- Smart TV/TV remote
- Set top box
- Personal robotics
- Smart watches
- Headsets: over-, on- and in-ear
- Wireless earbuds
- HMD: AR and VR
- Smart home automation
- Smart building voice command
- Automotive interfaces
- Automotive shock detection
- Failure diagnostics
- Business communication
- Film and audio industry
- Smart cities
- Hearing aids
- Home care
- Predictive diagnosis
- Office and building surveillance
- Headset/battlefield equipment
- Bomb defusal and assault robots

©Yole Développement – November 2019
Yole’s market forecast model is based on the matching of several sources:

**Comparison with existing data**
- Monitoring of corporate communication
- Using other market research data
- Yole analysis (consensus or not)

**Comparison with prior Yole reports**
- Recursive improvement of dataset
- Customer feedback

---

**Top-to-bottom approach**
- Aggregate of market forecasts @ System level

**Bottom-up approach**
- Ecosystem analysis
- Aggregate of all players’ revenue @ System level

---

**Top-to-bottom approach**
- Aggregate of market forecast @ Semiconductor device level

**Bottom-up approach**
- Ecosystem analysis
- Aggregate of key players’ revenues @ Semiconductor device level

---

**Market**
- Volume (in Munits)
- ASP (in $)
- Revenue (in $M)

---

**Preexisting Information**

**Primary data**
- Reverse costing
- Patent analysis
- Annual reports
- Direct interviews

**Secondary data**
- Press releases
- Industry organization reports
- Conferences

---

**Semiconductor foundry activity**
- Capacity investments and equipment needs
ABOUT THE AUTHORS

Biographies & contacts

Dimitrios DAMIANOS

Dimitrios Damianos, PhD joined Yole Développement (Yole) as a Technology and Market Analyst in the Photonics & Sensing division. Dimitrios is daily working with his team to deliver valuable technology & market reports regarding the imaging and sensor industry including photonics & MEMS. He holds a BSc in Physics and a MSc degree in Photonics from the University of Patras (Greece). After his research on theoretical and experimental quantum optics and laser light generation, Dimitrios pursued a Ph.D. at Grenoble's university (France) in optics and microelectronics. He has also authored and co-authored several scientific papers in international peer-reviewed journals.

Contact: dimitrios.damianos@yole.fr

Alexis DEBRAY

Alexis Debray is a Technology & Market Analyst in the MEMS and Sensors team at Yole Développement, the ‘More than Moore’ market research and strategy consulting company. Alexis spent 17 years in Japan, including 2 years at the University of Tokyo where he studied MEMS technologies, and 15 years at Canon Inc. where he was a research engineer. There he contributed to works on MEMS devices, lingualprehension, and terahertz imaging devices. He is the author of various scientific publications and patents.

Alexis graduated from ENSICAEN and holds a PhD in applied acoustics.

Contact: alexis.debray@yole.fr
COMPANIES CITED IN THIS REPORT

WHAT WE GOT RIGHT, WHAT WE GOT WRONG

- The emergence and growth of MEMS microphones in other consumer applications due to the pervasiveness of voice based human-machine interaction (Voice Personal Assistants)
- Our global MEMS microphone forecast forecast is good.
- MEMS microspeakers have started being produced (low volumes).

- Smartphones and automotive markets are levelling off more than expected, thus lowering the growth of microspeakers and MEMS microphones for these applications.
- Wireless earbuds and smart speaker markets were underestimated. On a system-level they experienced very strong growth between 2017/2018 and expected to grow even more in the period 2018/2019.
- MEMS mic for the automotive market was overestimated. In 2018, car growth stagnated and 2019 will not be much different. Also microphones are not yet fully established in cars, but they are gaining momentum due to the VPAs starting to be integrated in cars (either in the media player system or as a stand-alone car-smart speaker).
- Piezo-MEMS have grown slower than expected in these 2 years time.
- Stand-alone audio processors are not there yet.
OBJECTIVES OF THE REPORT

To provide market data on MEMS microphones, microspeakers and audio solutions using key market metrics and dynamics:

- Unit shipments and revenue by application.
- ASP analysis and expected market developments.
- Market share for each category of application, technology and performance grade.

To describe key applications in existing and emerging markets:

- Functions, critical specification requirements, level of assembly and technology choices.
- What are the major drivers? What will the market look like in 2024?

To analyze major technological trends:

- Developments in existing technologies such as performance and price.
- Insights on emerging technologies.

To enable a thorough understanding of the value chain, infrastructure and players for the microphone, microspeaker and audio IC market:

- Extensive listing of sensor manufacturers worldwide and their technology portfolios.
- List of key integrators worldwide.
- Industrial supply chain information for each application.
WHO SHOULD BE INTERESTED IN THIS REPORT?

Integrators
• Learn of system level technology trends and requirements for each application.
• Evaluate the market potential of your components, depending on required performance and technology.
• Understand the differentiated value of your products and technologies.
• Identify new business opportunities and partners.
• Monitor and benchmark your competitors’ advances.

OEMs and integrators
• Evaluate the market potential of your product portfolio.
• Define diversification strategies for new applications.
• Find the best technologies for integration and the best suppliers depending on your target market.
• Identify new business opportunities and partners.
• Find an exhaustive analysis of competition in the acoustic MEMs industry.

Material suppliers and manufacturing service companies
• Spot new business opportunities and prospects.
• Understand the market’s activity level.
• Understand which applications will drive up volumes.

R&D centers
• Evaluate the potential of future technologies and products for new applicative markets.
• Identify the best candidates for technology transfer.

Financial and strategic investors
• Understand the structure and value chain of the acoustic MEMs industry.
• Find a list of the global industry’s key players and emerging start-ups.
At the time of Yole Développement’s first report in 2006, the MEMS microphone industry was in its very early stages. The current leaders were only just emerging, and the entire market was worth just $116M for 260M units.

In 2016, the microphone industry reached the $1B mark, displaying tremendous growth.

Microphones have become a key technology for major MEMS and semiconductor companies such as Knowles, Goertek and AAC as well as some newcomers like VesperMEMS.

Mobile phones remain the key application market for microphones. Until recently, the consumer market was very demanding in terms of volumes, but less so in terms of performance. As such, ASPs rapidly decreased from $0.35 in 2012 to $0.22 in 2018.

Virtual Personal Assistants (VPA) are expanding in beyond smartphones in smart speakers, smartwatches, and smart TV. They also require better signal-to-noise ratio (SNR) in order to properly and efficiently capture humans voices in noisy environments. This creates new market opportunities as well as technological challenges for MEMS microphones.

Finally, MEMS has also entered the speaker domain with the commercialization of MEMS based speakers by USound.
THE AUDIO CHAIN

Sound source → Microphone → Low pass filter → Sampling → Quantizing → Digital microphone or Codec IC or SoC or AP

Digital microphone or Codec IC or SoC or AP → Analog signal → Low pass filter

Digital signal → Sampling → Quantizing → Analog signal → Low pass filter

Analyzing
• Data mining

Computing
• Source localization
• Speech recognition

Processing
• Noise cancellation
• Echo cancellation
• Beam forming

Cloud or AP or SoC or Codec IC or SoC or AP

Digital to analog conversion

Codec IC or SoC or AP

Amplifier IC

Pressure waves → Amplifier → Loudspeaker

AP: Application Processor
Codec IC: Coding decoding Integrated Circuit
SoC: System on a Chip

©Yole Développement – November 2019
THE AUDIO MEMS INDUSTRY ECOSYSTEM

2018-2024 forecast

- Total audio industry
- Microphone industry
- Audio IC industry
- Microspeaker industry
- MEMS-based microphone industry
- AI sound processor (embedded or stand-alone)
- MEMS-based microspeaker industry

2018
$14.1B

$3.4B
$9.1B

$1.7B CAGR 6.6%

2024
$20.8B

$10.9B CAGR 3%
$7.9B CAGR 15%
$2B CAGR +3%

©Yole Développement – November 2019
To provide added value, information must be extracted and analyzed.

Technology, market penetration and added value

**Playback**
- Speaker processing
- Consumer, professional audio

**Communication**
- Microphone
- Speaker
- Consumer, mobile phones

**Voice input**
- Audio as a UI
- Event Detection
- IoT, mobile phones, consumer

**Analytics**
- Contextual awareness
- Smart devices
- Big Data
- IoT, mobile phones, wearables, medical

Source: DSP Concept. Modified by Yole.
TECHNOLOGY PROLIFERATION ROADMAP

Voice capture/emission
- Microphone/speaker array
- Optical mics
- 3D sound perception

« Acoustic cameras » ?

Voice processing & computing
- Far-field recognition
- Edge computing
- Contextual AI
- Conversational AI
- Full awareness ???

Far-field recognition
Edge computing
Contextual AI
Conversational AI
Full awareness ???

©Yole Développement – November 2019

Microphones, Microspeakers, and Audio Solutions 2019 | Sample | www.yole.fr | ©2019
AI Computing for Consumer Applications

Status of the MEMS Industry 2019

Medical Wearables: Market and Technology Trend 2019
USound Achelous UT-P 2016 MEMS Speaker

Apple iPhone X: MEMS Microphones from Goertek, Knowles, and AAC Technologies

Vesper VM1000 Piezoelectric Microphone
Yole Développement

From Technologies to Market
YOLE DEVELOPPEMENT – FIELDS OF EXPERTISE WITHIN 3 MAIN DOMAINS

Photonics & Sensing
- Photonics
- Lighting
- Imaging
- Sensing & Actuating
- Display

Semiconductor & Software
- Semiconductor Packaging and Substrates
- Semiconductor Manufacturing
- Memory
- Computing and Software

Power & Wireless
- RF Devices & Technologies
- Compound Semiconductors & Emerging Materials
- Power Electronics
- Batteries & Energy Management
4 BUSINESS MODELS

- Consulting and Analysis
  - Market data & research, marketing analysis
  - Technology analysis
  - Strategy consulting
  - Reverse engineering & costing
  - Patent analysis
  - Design and characterization of innovative optical systems
  - Financial services (due diligence, M&A with our partner)

- Syndicated reports
  - Market & technology reports
  - Patent investigation and patent infringement risk analysis
  - Teardowns & reverse costing analysis
  - Cost simulation tool
    - www.i-Micronews.com/reports

- Monitors
  - Monthly and quarterly update
  - Excel database covering supply, demand, and technology
  - Price, market, demand and production forecasts
  - Supplier market shares

- Media
  - i-Micronews.com website and application
  - i-Micronews e-newsletter
  - Communication & webcast services
  - Events: TechDays, forums,…

www.i-Micronews.com/reports
Yole Group of Companies

**Yole Développement**
Market, technology and strategy consulting
www.yole.fr

**SystemPlus Consulting**
Manufacturing costs analysis
Teardown and reverse engineering
Cost simulation tools
www.systemplus.fr

**KnowMade**
IP analysis
Patent assessment
www.knowmade.fr

**Piseo**
Design and characterization of innovative optical systems
www.piseo.fr

**Blumorpho**
Innovation and business maker
www.blumorpho.com

**Yole Finance**
Due diligence
www.yole.fr

---

6 COMPANIES TO SERVE YOUR BUSINESS
OUR GLOBAL ACTIVITY

40% of our business

Yole Deutschland
Frankfurt

30% of our business

Yole Deutschland
Nantes
Yole Korea
Seoul

30% of our business

Yole Inc.
Palo Alto

KnowMade
Nice

Greater China office
Hsinchu

About Yole Développement | www.yole.fr | ©2019
ANALYSIS SERVICES - CONTENT COMPARISON

- Technology and Market Report
- Leadership Meeting
- Q&A Service
- Meet the Analyst
- Custom Analysis
SERVING THE ENTIRE SUPPLY CHAIN

- Integrators, end-users and software developers
- Device manufacturers
- Suppliers: material, equipment, OSAT, foundries...
- Financial investors, R&D centers
SERVING MULTIPLE INDUSTRIAL FIELDS

We work across multiple industries to understand the impact of More-than-Moore technologies from device to system.
Over the course of more than 20 years, Yole Développement has grown to become a group of companies. Together with System Plus Consulting and KnowMade, we now provide marketing, technology and strategy consulting, media and corporate finance services, reverse costing, structure, process and cost analysis services and well as intellectual property (IP) and patent analysis. Together, our group of companies is collaborating ever closer and therefore will offer, in 2019, a collection of over 125 reports, 10 new monitors and 120 teardowns. Combining respective expertise and methodologies from the three companies, they cover:

- MEMS & Sensors
- RF devices & technologies
- Medical technologies
- Semiconductor Manufacturing
- Advanced packaging
- Memory
- Batteries and energy management
- Power electronics
- Compound semiconductors
- Solid state lighting
- Displays
- Software
- Imaging
- Photonics

If you are looking for:
- An analysis of your product market and technology
- A review of how your competitors are evolving
- An understanding of your manufacturing and production costs
- An understanding of your industry’s technology roadmap and related IPs
- A clear view supply chain evolution

Our reports and monitors are for you!

Our team of over 70 analysts, including PhD and MBA qualified industry veterans from Yole Développement, System Plus Consulting and KnowMade, collect information, identify trends, challenges, emerging markets, and competitive environments. They turn that information into results and give you a complete picture of your industry’s landscape. In the past 20 years, we have worked on more than 2,000 projects, interacting with technology professionals and high-level opinion makers from the main players of their industries and realized more than 3,000 interviews per year.

WHAT TO EXPECT IN 2019?
In 2019 we will extend our offering with a new ‘monitor’ product which provides more updates on your industry during the year. The Yole Group of Companies is also building on and expanding its investigations of the memory industry. Moreover, in parallel, the Yole Group reaffirms its commitment to a new collection of reports mixing software and hardware and is increasing its involvement in displays, radio-frequency (RF) technology, advanced substrates, batteries and compound semiconductors. Last but not least, System Plus Consulting is developing its teardowns service providing 120+ offers related to phones, smart home, wearables and connected devices. Discover our 2019 program right now, and ensure you get a true vision of the industry. Stay tuned!
18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

**Market – Technology – Strategy – by Yole Développement**
Yole Développement (Yole) offers market reports including quantitative market forecasts, technology trends, company strategy evaluation and in-depth application analyses. Yole will publish more than 55 reports in 2019, with our partner PISEO contributing to some of the lighting reports.

The Reverse Costing® report developed by System Plus Consulting provides full teardowns, including detailed photos, precise measurements, material analyses, manufacturing process flows, supply chain evaluations, manufacturing cost analyses and selling price estimations. The reports listed below are comparisons of several analyzed components from System Plus Consulting. More reports are however available, and over 60 reports will be released in 2019. The complete list is available at www.systemplus.fr.

**Patent Reports – by KnowMade**
More than describing the status of the IP situation, these analyses provide a missing link between patented technologies and market, technological and business trends. They offer an understanding of the competitive landscape and technology developments from a patent perspective. They include key insights into key IP players, key patents and future technology trends. For 2019 KnowMade will release over 15 reports.

**The markets targeted are:**
- Mobile & Consumer
- Automotive & Transportation
- Medical
- Industrial
- Telecom & Infrastructure
- Defense & Aerospace

Linked reports are dealing with the same topic to provide a more detailed analysis.
OUR 2019 REPORTS COLLECTION (1/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

MEMS & SENSORS

- **MARKET AND TECHNOLOGY REPORT**
  - Status of the MEMS Industry 2019 - Update
  - Status of the Audio Industry 2019 - New
  - Uncooled Infrared Imagers and Detectors 2019 – Update
  - Consumer Biometrics: Technologies and Market Trends 2018
  - MEMS Pressure Sensor Market and Technologies 2018
  - Gas & Particle Sensors 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - MEMS & Sensors Comparison 2019
  - MEMS Pressure Sensor Comparison 2018
  - Particle Sensors Comparison 2019
  - Miniaturized Gas Sensors Comparison 2018

- **PATENT REPORT**
  - MEMS Foundry Business Portfolio 2019 - New
  - Miniaturized Gas Sensors 2019 - New

PHOTONIC AND OPTOELECTRONICS

- **MARKET AND TECHNOLOGY REPORT**
  - Silicon Photonics and Photonic Integrated Circuits 2019
  - LiDARs for Automotive and Industrial Applications 2019 - Update

- **PATENT REPORT**
  - Silicon Photonics for Data Centers: Optical Transceiver 2019 - New
  - LiDAR for Automotive 2018

RF DEVICES AND TECHNOLOGIES

- **MARKET AND TECHNOLOGY REPORT**
  - 5G's Impact on RF Front-End Module and Connectivity for Cell Phones 2019 – Update
  - 5G Impact on Telecom Infrastructure 2019 - New
  - Radar and Wireless for Automotive: Market and Technology Trends 2019 - Update
  - Passive & Active Antenna Systems for Telecom Infrastructure 2019 - New
  - RF Standards and Technologies for Connected Objects 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - RF Front-End Module Comparison 2019 - Update
  - Automotive Radar RF Chipset Comparison 2018

- **PATENT REPORT**
  - Antenna for 5G Wireless Communications 2019 - New
  - RF Front End Modules for Cellphones 2018
  - RF Filter for 5G Wireless Communications: Materials and Technologies 2019
  - RF GaN 2019 – Patent Landscape Analysis

Update: 2018 version still available

About Yole Développement | www.yole.fr | ©2019
OUR 2019 REPORTS COLLECTION (2/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

IMAGING

• MARKET AND TECHNOLOGY REPORT
  - Status of the CIS Industry 2019: Technology and Foundry Business - Update
  - Imaging for Automotive 2019 - Update
  - Neuromorphic Sensing and Computing 2019 - Update
  - Status of the Camera Module Industry 2019 - Focus on Wafer Level Optics – Update
  - 3D Imaging & Sensing 2018
  - Machine Vision for Industry and Automation 2018

• STRUCTURE, PROCESS & COST REPORT
  - Compact Camera Modules Comparison 2019
  - CMOS Image Sensors Comparison 2019

• PATENT REPORT
  - Optical Coherence Tomography Medical Imaging 2018

MICROFLUIDICS

• MARKET AND TECHNOLOGY REPORT
  - Status of the Microfluidics Industry 2019 - Update
  - Organs-on-chips Market and Technology Landscape 2019 - Update
  - Point-of-Need Testing Application of Microfluidic Technologies 2018
  - Liquid Biopsy: from Isolation to Downstream Applications 2018
  - Chinese Microfluidics Industry 2018

• PATENT REPORT
  - Microfluidic Manufacturing Technologies 2019 – New
  - Nanopore Sequencing 2019 - New

INKJET AND ACCURATE DISPENSING

• MARKET AND TECHNOLOGY REPORT
  - Inkjet Printheads - Dispensing Technologies & Market Landscape 2019 - Update
  - Emerging Printing Technologies for Microsystem Manufacturing 2019 - New
  - Piezoelectric Devices from Bulk to Thin Film 2019 - New
  - Inkjet Functional and Additive Manufacturing for Electronics 2018

• STRUCTURE, PROCESS & COST REPORT
  - Piezoelectric Materials from Bulk to Thin Film Comparison 2019

MEDICAL IMAGING AND BIOPHOTONICS

• MARKET AND TECHNOLOGY REPORT
  - X-Ray Detectors for Medical, Industrial and Security Applications 2019- New
  - Microscopy Life Science Cameras: Market and Technology Analysis 2019
  - Ultrasound technologies for Medical, Industrial and Consumer Applications 2018

• PATENT REPORT
  - Facial & Gesture Recognition Technologies in Mobile Devices 2019 - New
  - Apple iPhone X Proximity Sensor & Flood Illuminator 2018

About Yole Développement | www.yole.fr | ©2019
OUR 2019 REPORTS COLLECTION (3/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

BIOMEMS & MEDICAL MICROSYSTEMS
- MARKET AND TECHNOLOGY REPORT
  - Medical Wearables: Market & Technology Analysis 2019 - New
  - Neurotechnologies and Brain Computer Interface 2018
  - BioMEMS & Non-Invasive Sensors: Microsystems for Life Sciences & Healthcare 2018
- PATENT REPORT
  - 3D Cell Printing 2019 - New
  - Circulating Tumor Cells Isolation 2019 - New

SOFTWARE AND COMPUTING
- MARKET AND TECHNOLOGY REPORT
  - Artificial Intelligence Computing For Automotive 2019 - New
  - Artificial Intelligence Computing for Consumer 2019 - Update
  - Image Signal Processor and Vision Processor Market and Technology Trends 2019
  - xPU (Processing Units) for Cryptocurrency, Blockchain, HPC and Gaming 2019 – New
  - Artificial Intelligence for Medical Imaging 2019 - New
- PATENT REPORT
  - Artificial Intelligence for Medical Diagnostics - New

MEMORY
- MARKET AND TECHNOLOGY REPORT
  - Status of the Memory Industry 2019 - New
  - MRAM Technology and Business 2019 - New
  - Emerging Non Volatile Memory 2018
- STRUCTURE, PROCESS & COST REPORT
  - Memory Comparison 2019
- PATENT REPORT
  - Magnetoresistive Random-Access Memory (MRAM) 2019 - New
  - 3D Non-Volatile Memory 2018

ADVANCED PACKAGING
- MARKET AND TECHNOLOGY REPORT
  - Fan Out Packaging Technologies and Market Trends 2019 - Update
  - 2.5D/3D TSV & Wafer-Level Stacking:Technology & Market Updates 2019- Update
  - Advanced RF SiP for Cellphones 2019 - Update
  - Status of the Advanced Packaging Industry 2019 - Update
  - Status of the Advanced Substrates 2019 - Update
  - Automotive Packaging Market & Technology Trends 2019 - New
  - Trends in Automotive Packaging 2018
  - Thin-Film Integrated Passive Devices 2018
  - Die Attach Equipment Trends 2019 en Semiconductor Manufacturing - New
- STRUCTURE, PROCESS & COST REPORT
  - Advanced RF SiP for Cellphones Comparison 2019
OUR 2019 REPORTS COLLECTION (4/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

SEMICONDUCTOR MANUFACTURING

- **MARKET AND TECHNOLOGY REPORT**
  - Nano-Imprint Technology Trends for Semiconductor Applications 2019 - New
  - Equipment and Materials for Fan Out Packaging 2019 - Update
  - Equipment for More than Moore: Thin Film Deposition & Etching 2019 - New
  - Wafer Starts for More Than Moore Applications 2018
  - Polymeric Materials at Wafer-Level for Advanced Packaging 2018 Bonding and Lithography Equipment Market for More than Moore Devices 2018

- **STRUCTURE, PROCESS & COST REPORT**
  - Wafer Bonding Comparison 2018

- **PATENT REPORT**
  - Hybrid Bonding for 3D Stack 2019 - New

SOLID STATE LIGHTING

- **MARKET AND TECHNOLOGY REPORT**
  - Status of the Solid-State Lighting Source Industry 2019 - New
  - Edge Emitting Lasers (EELS) 2019 - New
  - Light Shaping Technologies 2019 – New
  - Automotive Advanced Front Lighting Systems 2019 - New

- **PATENT REPORT**
  - MicroLED Displays : Intellectual Property Landscape 2018

DISPLAY

- **MARKET AND TECHNOLOGY REPORT**
  - Next Generation 3D Displays 2019 - New
  - Next Generation Human Machine Interaction (HMI) in Displays 2019 - New
  - MicroLED Displays 2019 - Update
  - MiniLED 2019 - Update
  - Displays & Optical/Vision Systems for VR, AR & MR 2018

- **PATENT REPORT**
  - MicroLED Displays
### OUR 2019 REPORTS COLLECTION (5/5)

18 fields of excellence combined with six markets to provide a complete picture of your industry landscape

#### POWER ELECTRONICS
- **MARKET AND TECHNOLOGY REPORT**
  - Power SiC: Materials, Devices and Applications 2019 - Update 📁
  - Power Electronics for EV/HEV and e-mobility: Market, Innovations and Trends 2019 - Update 📁
  - Status of the Power Electronics Industry 2019 - Update 📁
  - Discrete Power Packaging : Material Market and Technology Trends 2019 - New 📁
  - Status of the Power ICs Industry 2019 - Update 📁
  - Status of the Inverter Industry 2019 - Update 📁
  - Status of the Power Module Packaging Industry 2019 - Update 📁
  - Wireless Charging Market Expectations and Technology Trends 2018 📁
  - Power GaN 2018: Epitaxy, Devices, Applications and Technology Trends 📁

- **STRUCTURE, PROCESS & COST REPORT**
  - Automotive Power Module Packaging Comparison 2018 📁
  - GaN-on-Silicon Transistor Comparison 2019 📁
  - SiC Transistor Comparison 2019 📁

- **PATENT REPORT**
  - Power SiC : Materials, Devices and Modules 2019 - New 📁
  - Power GaN : Materials, Devices and Modules 2019 - Update 📁

#### BATTERY & ENERGY MANAGEMENT
- **MARKET AND TECHNOLOGY REPORT**
  - Status of the Rechargeable Li-ion Battery Industry 2019 - New 📁

- **PATENT REPORT**
  - Battery Energy Density Increase: Materials and Emerging Technologies 2019 - New 📁
  - Solid-State Batteries 2019 - New 📁
  - Status of the Battery Patents 2018 📁

#### COMPOUND SEMI.
- **MARKET AND TECHNOLOGY REPORT**
  - Emerging Semiconductor Substrates: Market & Technology Trends 2019- New 📁
  - InP Wafer and Epiwafer Market - Photonic and RF Applications 2019- New 📁
  - GaAs Wafer and Epiwafer Market: RF, Photonics, LED and PV Applications 2018 📁

- **PATENT REPORT**
  - GaN-on-Silicon Substrate: Materials, Devices and Applications 2019 - Update 📁

#### BIOTECHNOLOGIES
- **MARKET AND TECHNOLOGY REPORT**
  - CRISPR-Cas9 Technology: From Lab to Industries 2018 📁

- **PATENT REPORT**
  - Personalized Medicine 2019 – New 📁
OUR 2019 MONITORS COLLECTION (1/2)

Get the most updated overview of your market to monitor your strategy

Yole Développement, System Plus Consulting and KnowMade, all part of the Yole Group of Companies, are launching a collection of 10 monitors in 2019. The monitors aim to provide updated market, technology and patent data as well dedicated quarterly analyses of the evolution in your industry over the previous 12 months. Furthermore, you can benefit from direct access to the analyst for an on-demand Q&A and discussion session regarding trend analyses, forecasts and breaking news.

Topics covered will be compact camera modules (CCMs), advanced packaging, compound semiconductors, microfluidics, batteries, RF and memory.

MARKET MONITOR by Yole Développement

A FULL PACKAGE:
The monitors will provide the evolution of the market in units, wafer area and revenues. They will also offer insights into what is driving the business and a close look at what is happening will also be covered in it.

The following deliverables will be included in the monitors:
- An Excel database with all historical and forecast data
- A PDF slide deck with graphs and comments/analyses covering the expected evolutions

ADVANCED PACKAGING – NEW
This monitor will provide the evolution of the advanced packaging platforms. It will cover Fan-Out Wafer Level Packaging (WLP), Fan-Out Panel Level Packaging (PLP), Wafer-Level Chip Scale Packaging (WLCSP), Flip Chip packaging platforms, and 2.5D and 3D Through Silicon Via (TSV) integration. Frequency: Quarterly, starting from Q4 2019

COMPOUND SEMI. – NEW
This monitor will describe how the compound semiconductor industry is evolving. It will offer a close look at GaAs, InP, SiC, GaN and other compounds of interest providing wafer volumes, revenues, application breakdowns and momentum. Frequency: Quarterly, starting from Q 2019

CMOS IMAGE SENSORS – NEW
This monitor will provide the evolution of the imaging industry, with a close look at image sensor, camera module, lens and VCM. Volumes, revenues and momentum of companies like Sony, Samsung, Omnivision and OnSem will thus be analysed. Frequency: Quarterly, starting from Q3 2019

MEMORY – UPDATE
For the memory industry you can have access to a quarterly monitor, as well as an additional service, a monthly pricing. Both services can be bought separately:
- DRAM Service: Including a quarterly monitor and monthly pricing.
- NAND Service: Including a quarterly monitor and monthly pricing.

REVERSE TECHNOLOGY MONITOR by System Plus Consulting

SMARTPHONES – NEW
To stay updated on the latest components, packaging and silicon chip choices of the smartphone makers, System Plus Consulting has created its first Smartphone Reverse Technology monitor. This year, get access to the packaging and silicon content database of at least 20 different flagship smartphones – more than five per quarter. Starting at the beginning of 2020, the monitor will include an Excel database report for each phone and a quarterly comparison.
Get the most updated overview of your market to monitor your strategy

PATENT MONITOR by KnowMade

A FULL PACKAGE:
Starting at the beginning of the year, the KnowMade monitors include the following deliverables:

- An Excel file including the monthly IP database of:
  - New patent applications
  - Newly granted patents
  - Expired or abandoned patents
  - Transfer of IP rights through re-assignment and licensing
  - Patent litigation and opposition

- Quarterly report including a PDF slide deck with the key facts & figures of the quarter: IP trends over the three last months, with a close look to key IP players and key patented technologies.

- GaN for Power & RF Electronics
  Wafers and epiwafers, GaN-on-SiC, silicon, sapphire or diamond; semiconductor devices such as transistors, and diodes, devices and applications including converters, rectifiers, switches, amplifiers, filters, and Monolithic Microwave Integrated Circuits (MMICs), packaging, modules and systems.

- GaN for Optoelectronics & Photonics
  Wafers and epiwafers, GaN-on-sapphire, SiC or silicon; semiconductor devices such as LEDs and lasers; and applications including lighting, display, visible communication, photonics, packaging, modules and systems.

- Li-ion Batteries
  Anodes made of lithium metal, silicon, and lithium titanate (LTO); cathodes made of Lithium Iron Phosphate (LFP), Nickel-Manganese-Cobalt (NMC), Lithium Nickel Cobalt Aluminium Oxide (NCA), Lithium Nickel Metal Dioxide (LiNiMO2), Lithium Metal Phosphate (LiMPO4), and Lithium Metal Tetroxide (LiMO4); electrolytes including liquid, polymer/gel, and solid inorganics; ceramic and other separators; battery cells including thin film/microbattery, flexible, cylindrical and prismatic; and battery packs and systems.

- Post Li-ion Batteries
  Battery technologies including redox-flow batteries, sodium-ion, lithiumsulfur, lithium-air, and magnesium-ion, and their supply chains, including electrodes, electrolytes, battery cells and battery packs/systems.

- Solid-State Batteries
  Supply chain including electrodes, battery cells, battery packs/systems and electrolytes, including polymer, inorganic and inorganic/polymer, inorganic materials, including argyrodites, Lithium Super Ionic CONductor, (LISICONs), Thio-LISICONs, sulfide glasses, oxide glasses, perovskites, antiperovskites and garnets.

- RF Acoustic Wave Filters
  Including Surface Acoustic Wave (SAW), Temperature Compensated (TC)- SAW, Bulk Acoustic Wave- Free-standing Bulk Acoustic Resonator (BAWFBAR), BAW-Solidly-Mounted Resonator (BAW-SMR), and Packaging.

- RF Power Amplifiers
  Including Low Noise Amplifiers, Doherty Amplifiers, Packaging, and Millimeter-Wave technology.

- RF Front-End Modules

- Microfluidics
  From components to chips and systems, including all applications.

About Yole Développement | www.yole.fr | ©2019
To meet the growing demand for market, technological and business information, i-Micronews Media integrates several tools able to reach each individual contact within its network.

We will ensure your company benefits from this

**ONLINE**

i-Micronews e-newsletter  
i-Micronews.com  
FreeFullPDF.com

Unique, cost-effective ways to reach global audiences.  
Online display advertising campaigns are great strategies for improving your product/brand visibility. They are also an efficient way to adapt with the demands of the times and to evolve an effective marketing plan and strategy.

- #15,800+ monthly unique visitors on i-Micronews.com  
- #10,900+ weekly readers of i-Micronews e-newsletter

**ONSITE**

Events  
Brand visibility, networking opportunities  
Today’s technology makes it easy for us to communicate regularly, quickly, and inexpensively – but when understanding each other is critical, there is no substitute for meeting in-person. Events are the best way to exchange ideas with your customers, partners, prospects while increasing your brand/product visibility.

- #110 attendees on average  
- #7+ key events planned for 2019 on different topics

**INPERSON**

Webcasts  
Targeted audience involvement equals clear, concise perception of your company’s message. Webcasts are a smart, innovative way of communicating to a wider targeted audience. Webcasts create very useful, dynamic reference material for attendees and also for absentees, thanks to the recording technology.

- #380 registrants per webcast on average to gain new leads for your business

**Contact:** Camille Veyrier (veyrier@yole.fr), Marketing & Communication Director
CONTACT INFORMATION

○ CONSULTING AND SPECIFIC ANALYSIS, REPORT BUSINESS
  • North America:
    • Steve LaFerriere, Senior Sales Director for Western US & Canada
      Email: laferriere@yole.fr – +1 310 600-8267
    • Chris Youman, Senior Sales Director for Eastern US & Canada
      Email: chris.youman@yole.fr – +1 919 607 9839
  • Japan & Rest of Asia:
    • Takashi Onozawa, General Manager, Asia Business Development (India & ROA)
      Email: onozawa@yole.fr - +81 34405-9204
    • Miho Ohtake, Account Manager (Japan)
      Email: ohtake@yole.fr - +81 3 4405 9204
    • Itsuyo Oshiba, Account Manager (Japan & Singapore)
      Email: oshiba@yole.fr - +81-80-3577-3042
  • Korea: Peter Ok, Business Development Director
      Email: peter.ok@yole.fr - +82 10 4089 0233
  • Greater China: Mavis Wang, Director of Greater China Business Development
      Email: wang@yole.fr - +86 979 336 809
  • Europe: Lizzie Levenez, EMEA Business Development Manager
      Email: levenez@yole.fr - +49 15 123 544 182
  • RoW: Jean-Christophe Eloy, CEO & President, Yole Développement
      Email: eloy@yole.fr - +33 4 72 83 01 80

○ FINANCIAL SERVICES (in partnership with Woodside Capital Partners)
  • Jean-Christophe Eloy, CEO & President
      Email: eloy@yole.fr - +33 4 72 83 01 80
  • Ivan Donaldson, VP of Financial Market Development
      Email: ivan.donaldson@yole.fr - +1 208 850 3914

○ CUSTOM PROJECT SERVICES
  • Jérome Azémar, Technical Project Development Director
      Email: azemar@yole.fr - +33 6 27 68 69 33

○ GENERAL
  • Camille Veyrier, Director, Marketing & Communication
      Email: veyrier@yole.fr - +33 472 83 01 01
  • Sandrine Leroy, Director, Public Relations
      Email: leroy@yole.fr - +33 4 72 83 01 89 / +33 6 33 11 61 55
  • Email: info@yole.fr - +33 4 72 83 01 80
The Voice is not only an international reality television singing competition which started in 2010. It is at the heart of new audio industry applications. The audio industry has seen numerous evolutionary stages. The 1960s saw the advent of hi-fi and stereo music, and popular groups like Pink Floyd. The 1980s saw the advent of digital music, where clarity of sound has characterized other popular bands, like Dire Straits. However at the end of the 1990s and beginning of the 2000s the popularization of mobile phones led to technical progress in voice processing. At the beginning of the 2010s, voice-based Virtual Personal Assistants (VPAs) such as Siri by Apple, Alexa by Amazon, and Google Assistant by Google, appeared. Voice-based VPA proliferation is the main driver for the audio industry today. An interesting feature of this new application is that it spreads through various systems. VPAs are in smartphones, smart speakers, smart watches, wireless earbuds, cars, smart TVs and their remote controllers; even trash cans with voice recognition have appeared. This application is based on traditional components of audio systems: microphones, speakers, audio codecs, and audio amplifiers. But it also relies on new components related to computing and analyzing voice data, fueled by the emergence of consumer-level Artificial Intelligence (AI). All these systems and technologies are covered in this report.

Cumulatively, the consumer market for microphones, audio ICs, and microspeakers is expected to increase from $14.1B in 2018 to $20.8B in 2024 with a 6.6% Compound Annual Growth Rate (CAGR). Looking at the volume growth of MEMS microphones gives an idea of the products involved. MEMS microphones in smart speakers will experience a 13% CAGR, reaching 1.2 billion units in 2024. In wireless earbuds, MEMS microphones will have a 29% CAGR, reaching 1.3 billion units in 2024.

The audio MEMS industry ecosystem - 2018-2024 forecast

2018 $14.1B  
$3.4B MEMS-based microphone industry  
$9.1B Total audio industry  
$1.7B MEMS-based microphone industry  
$1.3B Total microphone industry  
$0.2B MEMS-based microphone industry

2024 $20.8B  
$7.9B CAGR 15%  
$10.9B AI sound processor (embedded or stand-alone)  
$2B CAGR 3%  
$52M CAGR 6.6%

Artificial Intelligence (AI) is bringing value

Part of the growth of the audio industry relies on the value brought by AI. More precisely, AI technology enables the VPA application to spread into smart speakers, wireless earbuds, and smart watches among others, and sustains the growth of all audio components. AI enables two key functions for audio: Computing and analyzing. Computing enables complex audio functions such as source localization and speech recognition, and is performed either on the cloud or at the edge, in consumer devices. Analyzing consists of even more complex operations such as big data analysis for marketing, and is performed in the cloud.
The usage of AI in audio is a huge opportunity for business, since it pushes audio components into new systems. It is also an opportunity for humans, allowing them to talk and give hands-free commands to a VPA in their smart speakers while cooking or in their wireless earbuds while jogging. It could also save lives if it becomes a standard for automotive human machine interfaces. However, these always-listening systems could be a threat to this new audio business. The global surveillance disclosures made by Edward Snowden in 2013 have shown how these new technologies could lead to massive surveillance societies.

Nevertheless, there is a battle in the 'audio chain' over which component to put these new AI functions into. Analyzing, which requires heavy processing power and access to lots of data, is expected to remain in the cloud. AI processing, such as for speech recognition, today happens mainly in the cloud. However, it is expected to reach the edge were the application processor (AP) possesses more computing power, and will allow lower latency and more privacy. In high end models, dedicated codec and amplifier chips for audio are expected to remain, since they require careful analog design and manufacturing.

**WHO IS EATING THE AUDIO PIE?**

How is this market shared among the different players? For MEMS microphones, Knowles and Goertek are the main players, with 39% and 28% of this $1.2B market in 2018 respectively. Knowles' revenues might have saturated in recent years, however it's still holding its ground in an expanding market against Chinese players who offer lower cost solutions. Furthermore, Infineon traditionally supplied the microphone die to players such as Goertek and AAC, but seems to be changing its strategy and has started offering complete MEMS microphones.

For audio codecs and amplifiers, Cirrus Logic, Qualcomm, and Texas Instruments are the main players in a $3.4B market in 2018 with shares of 35%, 18%, and 12% respectively. Cirrus Logic is
the clear market leader but is dependent on Apple. In the future, AI processing will probably spread among players. AP makers like Apple, Qualcomm, and HiSilicon will integrate AI processing. Knowles and Goertek are proposing dedicated audio chips integrating AI capabilities along with codecs and digital signal processing functions. On the other side, IP providers like CEVA and Xperi are working towards chip designs for AI processing. No matter the approach, AI is attracting all the attention.

Finally, ever expanding use-cases are generating a wealth of new data that are fueling AI, giving much more functionality. And what’s better than one’s own voice to control these devices seamlessly? That’s the next battleground for the audio players across the whole supply chain: the voice arena.

COMPANIES CITED IN THE REPORT (non exhaustive list)

AAC Technologies, Alibaba, Amazon, ams AG, Analog Devices, Apple, ASE, Audience, Audiopixels, Bosch Sensortec, BSE, CEVA, Cirrus Logic, DSP Group, Gettop, Goertek, Google, Harman, Hosiden, HTC, Huawei, Infineon, Intel, InvenSense, Knowles, MEMSensing, Merus Audio, Motorola, NeoMEMS, Nokia, NXP, Omron, Oppo, Qualcomm, Samsung, SensiBel, Sony, STMicroelectronics, TDK-Invensense, Texas Instruments, TSMC, USound, Vesper, XFab, Xiaomi, xMOS and many more...

**TABLE OF CONTENTS**

<table>
<thead>
<tr>
<th>Glossary and definition</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of contents</td>
<td>4</td>
</tr>
<tr>
<td>Report scope</td>
<td>6</td>
</tr>
<tr>
<td>Report methodology</td>
<td>9</td>
</tr>
<tr>
<td>About the authors</td>
<td>10</td>
</tr>
<tr>
<td>Companies cited in this report</td>
<td>11</td>
</tr>
<tr>
<td>What we got right, what we got wrong</td>
<td>12</td>
</tr>
<tr>
<td>Executive summary</td>
<td>18</td>
</tr>
<tr>
<td>Context</td>
<td>50</td>
</tr>
<tr>
<td>&gt; Introduction</td>
<td></td>
</tr>
<tr>
<td>&gt; A voice-connected world</td>
<td></td>
</tr>
<tr>
<td>&gt; The digital audio chain</td>
<td></td>
</tr>
<tr>
<td>&gt; Microphones</td>
<td></td>
</tr>
<tr>
<td>&gt; Microspeakers</td>
<td></td>
</tr>
<tr>
<td>&gt; Audio IC</td>
<td></td>
</tr>
<tr>
<td>Market forecasts</td>
<td>66</td>
</tr>
<tr>
<td>&gt; Microphones</td>
<td></td>
</tr>
<tr>
<td>&gt; Microspeakers</td>
<td></td>
</tr>
<tr>
<td>&gt; Audio ICs</td>
<td></td>
</tr>
<tr>
<td>Market trends</td>
<td>103</td>
</tr>
<tr>
<td>&gt; Consumer trends</td>
<td></td>
</tr>
<tr>
<td>&gt; Automotive trends</td>
<td></td>
</tr>
<tr>
<td>&gt; Industrial trends</td>
<td></td>
</tr>
<tr>
<td>&gt; Medical trends</td>
<td></td>
</tr>
<tr>
<td>&gt; Military trends</td>
<td></td>
</tr>
<tr>
<td>Market shares and supply chain</td>
<td>158</td>
</tr>
<tr>
<td>&gt; Competition in the microphone market</td>
<td></td>
</tr>
<tr>
<td>&gt; The audio industry galaxy</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS-based audio supply chain</td>
<td></td>
</tr>
<tr>
<td>&gt; Partnerships, mergers and acquisitions</td>
<td></td>
</tr>
<tr>
<td>&gt; 2018 microphone revenue market share</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS microphone players and offered technologies</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS microphone revenue rankings</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS microphone value chain</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS speaker value chain</td>
<td></td>
</tr>
<tr>
<td>&gt; Audio IC landscape</td>
<td></td>
</tr>
<tr>
<td>&gt; Audio IC market share</td>
<td></td>
</tr>
<tr>
<td>&gt; Supply chain for audio ICs for mobile devices</td>
<td></td>
</tr>
<tr>
<td>&gt; Current value of components</td>
<td></td>
</tr>
<tr>
<td>&gt; Potential value of components</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS-based audio value chain</td>
<td></td>
</tr>
<tr>
<td>Technology trends</td>
<td>183</td>
</tr>
<tr>
<td>&gt; Microphones</td>
<td></td>
</tr>
<tr>
<td>&gt; Speakers</td>
<td></td>
</tr>
<tr>
<td>&gt; Audio IC</td>
<td></td>
</tr>
<tr>
<td>&gt; Packaging</td>
<td></td>
</tr>
<tr>
<td>IP analyses</td>
<td>260</td>
</tr>
<tr>
<td>&gt; MEMS microphone patent analysis</td>
<td></td>
</tr>
<tr>
<td>&gt; MEMS speaker patent analysis</td>
<td></td>
</tr>
<tr>
<td>Reverse costing® - structure, process and cost analyses</td>
<td>263</td>
</tr>
<tr>
<td>Outlook</td>
<td>271</td>
</tr>
<tr>
<td>Related reports</td>
<td>276</td>
</tr>
<tr>
<td>How to use our data?</td>
<td>278</td>
</tr>
<tr>
<td>About Yole Développement</td>
<td>279</td>
</tr>
</tbody>
</table>

**RELATED REPORTS**

Benefit from our Bundle & Annual Subscription offers and access our analyses at the best available price and with great advantages

- Artificial Intelligence Computing for Consumer 2019
- Status of the MEMS Industry 2019
- Medical Wearables: Market and Technology Trends 2019
- USound Achelous UT-P 2016 MEMS Speaker
- Vesper VM1000 Piezoelectric Microphone
- Apple iPhone X: MEMS Microphones from Goertek, Knowles, and AAC Technologies

Find all our reports on [www.i-micronews.com](http://www.i-micronews.com)
ORDER FORM

Microphones, Microspeakers and Audio Solutions Market and Technology Trends 2019

BILL TO

Name (Mr/Ms/Dr/Pr):
Job Title:
Company:
Address:
City:
State:
Postcode/Zip:
Country:
*VAT ID Number for EU members:
Tel:
Email:
Date:

PAYMENT

BY CREDIT CARD

- Visa- Mastercard- Amex

Name of the Card Holder:
Credit Card Number:
Card Verification Value (3 digits except AMEX: 4 digits):
Expiration date:

BY BANK TRANSFER

BANK INFO: HSBC, 1 place de la Bourse, F-69002 Lyon, France,
Bank code: 30056, Branch code: 00170
Account No: 0170 200 1565 87
SWIFT or BIC code: CCFRFRPP,
IBAN: FR76 3005 6001 7001 7020 0156 587

RETURN ORDER BY

• MAIL: YOLE DÉVELOPPEMENT, Le Quartz,
  75 Cours Emile Zola, 69100 Villeurbanne/Lyon - France

SALES CONTACTS

• Western US & Canada - Steve Laferriere:
  +1 310 600-8267 – laferriere@yole.fr
• Eastern US & Canada - Chris Youman:
  +1 919 607 9839 – chris.youman@yole.fr
• Europe & RoW - Lizzie Levenez:
  +49 15 123 544 182 – levenez@yole.fr
• Japan & Rest of Asia - Takashi Onozawa:
  +81-80-4371-4887 – onozawa@yole.fr
• Greater China - Mavis Wang:
  +886 979 336 809 – wang@yole.fr
• Korea - Peter OK:
  +82 10 4089 0233 – peter.ok@yole.fr
• Specific inquiries: +33 472 830 180 – info@yole.fr

*One user license means only one person at the company can use the report.

I hereby accept Yole Développement's Terms and Conditions of Sale:

Signature:

The present document is valid 24 months after its publishing date:
November 13, 2019

SHARE ORDER - Ref YD19052

Please enter my order for above named report:

☐ One user license*: Euro 5,990
☐ Multi user license: Euro 6,490

- The report will be ready for delivery from November 25, 2019
- For price in dollars, please use the day's exchange rate. All reports are delivered electronically at payment reception. For French customers, add 20% for VAT

I hereby accept Yole Développement’s Terms and Conditions of Sale:

Signature:

*One user license means only one person at the company can use the report.

SHIPPING CONTACT

First Name: ________________________
Email: __________________________

Last Name: ________________________
Phone: __________________________

ABOUT YOLE DEVELOPPEMENT

Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 120 collaborators worldwide covering MEMS and image sensors, Compound semiconductors, RF Electronics, Solid-state lighting, Displays, Software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Power Electronics, Batteries & Energy Management and Memory.

The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO, KnowMade and Blumorpho, supports industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

CONSULTING AND ANALYSIS

• Market data & research, marketing analysis
• Technology analysis
• Strategy consulting
• Reverse engineering & costing
• Patent analysis
• Design and characterization of innovative optical systems
• Financial services (due diligence, M&A with our partner)
More information on www.yole.fr

MEDIA & EVENTS

• i-Micronews.com website, application & related e-newsletter
• Communication & webcast services
• Events: TechDays, forums…
More information on www.i-micronews.com

REPORTS

• Market & technology reports
• Patent investigation and patent infringement risk analysis
• Structure, process and cost analysis and teardowns
• Cost simulation tool
More information on www.i-micronews.com/reports

CONTACTS

For more information about :
• Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
• Reports & Monitors: David Jouard (jouard@yole.fr) & Fayçal Khamassi (khamassi@yole.fr)
• Marketing & Communication: Camille Veyrier (veyrier@yole.fr)
• Public Relations: Sandrine Leroy (leroy@yole.fr)
Definitions: “Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in its entirety. It is done by signing the purchase order which mentions “I hereby accept Yole Developpement’s Terms and Conditions of Sale”.

“Buyer”: Any business user (i.e. any person acting in the course of its business activities, for its business needs) entering into the following general conditions to the exclusion of consumers acting in their personal interests.

“Contracting Parties” or “Parties”: The Seller on one hand and the Buyer on the other hand.

“Intellectual Property Rights” (“IPR”): means any rights held by the Seller in its Products, including any patents, trademarks, registered designs, copyrights, databases rights, know how, commercial secrets and know-how, technical information, company or trading names and any other intellectual property rights or similar in any part of the world, notwithstanding the fact that they have been registered or not or including any pending registration of one of the above mentioned rights.

“Products”: Depending on the purchase order, reports or monitors on MEMS, Imaging, SSL, Advanced Packaging, MedTech, Power Electronics and more, can be bought either on a unit basis or as a bundled offer (i.e. subscription for a period of 12 calendar months).

“Report”: Reports are established in PowerPoint and delivered in Excel. Reports are established and delivered in Excel. An additional PDF can also join it. Q&A with an Analyst is possible for “Monitor” (except the ones bought in one user license). More time can be allocated for “Report”.

“License”: For the reports 3 different licenses are proposed. The buyer has to choose one license type:
- Single user license: one person at the company can use the report.
- Network license: becomes valid and enforceable between the Contracting Parties after clear and non-equivalent consent by any duly authorized person representing the Buyer. For these purposes, the Buyer accepts these conditions of sales when signing the purchase order which mentions “I hereby accept Yole Developpement’s Terms and Conditions of Sale.” This results in acceptance by the Buyer.
- 3 users license: shall be accepted only upon written acceptance and confirmation by the Seller, within 7 days from the date of order, to be sent either by email or to the Buyer’s address. In the absence of written confirmation in writing, orders shall be deemed to have been accepted.

2. MAILING OF THE PRODUCTS

2.1 Products are sent by email to the Buyer:
- Within a few days from the order for Products already released and paid.
- Within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best effort to inform the Buyer of an indicative release date and the evolution of the work in progress.

2.2 The Seller shall by no means be responsible for any delay in receiving the email notification, including delay of any event or access to new contradictory information would require for the analyst extra time to compute or compare the data in order to enable the Seller to deliver a high quality Products.

2.3 The buyer should be notified only upon payment by the Buyer, in accordance with the conditions contained in article 3.

2.4 The mailing is operated through electronic means either by email via the sales department or administratively online automatically or through an email/password. If the Product's electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it is informed of the defective formatting within 90 days from the date of the original download or receipt of the Product.

2.5 The person receiving the Products on behalf of the Buyer shall immediately verify the quality of the Products and their conformity to the order. Any claim for apparent defects or for non-conformity shall be sent in writing to the Seller within 8 days of receipt of the Products. For this purpose, the Buyer agrees to produce sufficient evidence of such defects.

2.6 No return of Products shall be accepted without prior information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information shall be required as under article 2.5 shall remain at the Buyer’s risk.

3. PRICE, INVOICING AND PAYMENT

3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to annual subscriptions. They are made with the added value tax (“VAT” where VAT will be added). The prices are re-evaluated from time to time. The effective price is deemed to be the one applicable at the time of the order.

3.2 Payments due by the Buyer shall be sent by cheque payable to Yole Développement, credit card or by electronic transfer to the following account:

  IBAN: FR76 3005 6001 7001 7020 0156 587
  Account n°: 0170 200 1565 87
  BIC or SWIFT code: CCFRRPFP IBAN: FR76 3005 6001 7001 7020 0156 587

To ensure the payments, the Seller reserves the right to request prepayment by the Buyer. In case of non-compliance with the need of down payments will be mentioned on the order.

3.3 Payment is due by the Seller to the Buyer within 30 days from immediate payment of the Product or issuance of a guaranty written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears following the delay, at all times, of two months starting from the delivery date, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...,) are delivered only after reception of the payment.

3.4 In the event of non-payment of the contract, or of misconduct, during the contract, the Seller will have the right to invoice at the stage in progress, and to take legal action for damages.

4. LIABILITIES

4.1 The Seller or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces from the Products. The Seller shall only be liable for (i) direct and (ii) foreseeable pecuniary loss, caused by the Products or arising from a material breach of this agreement.

4.2 In no event shall the Seller be liable for:
- Damages of any kind, including without limitation, incidental or consequential damages (including, but not limited to, damages for loss of profits, loss of goodwill or other loss of business) arising out of the use of or inability to use the Seller’s website or the Products, or any information provided on the website.
- Any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.
- Any information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

4.3 In no event shall the Seller or any of its licensors, employees or agents be liable for any incidental, or consequential damages of any kind (including lost profits and time, loss of information or data) arising out of use or inability to use the Seller’s website or Products, or any information provided on the website.

5. FORCE MAJEURE

5.1 The Seller will not be liable for any delay in performance directly or indirectly caused by or resulting from acts of nature, fire, flood, accident, riot, war, government intervention, embargoes, strikes, labor difficulties, equipment failure, late delivery by suppliers or other difficulties beyond its reasonable control, which should be beyond the control of the Seller.

6. PROTECTION OF THE SELLER’S IPR

6.1 All the IPR attached to the Products are and remain the property of the Seller and are protected under French and international intellectual property laws and conventions.

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its company (only in the country of the primary user). The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:
- Information storage or retrieval systems;
- Recordings and re-transmissions over any network (including any local area network);
- Use in any timesharing, service bureau, bulletin board or similar arrangement or public display;
- Posting any Product to any other online service (including bulletin boards or the Internet);
- Licensing, leasing, selling, offering for sale or assigning the Product.

6.3 If the Buyer would like to use data coming from the Products for proprietary, press or literary purposes, the Seller will undertake to contact Yole Developpement’s Public Relations Director (info@yole.fr) to get an official authorization and verify data up to date. In return the Seller will make sure to provide up-to-date data under a suitable public format.

6.4 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from employees or others on behalf of the Buyer, the Seller or its licensors. The Seller and Products shall personally care take of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.5 The Buyer shall define a contact point for the needs of the contract. This person will be the recipient of each new report. This person shall also be responsible for respecting the copyrights and will guaranty that the Products are not disseminated out of the context of the contract. The context of Bundle and Annual Subscriptions, the contact person shall decide who within the Buyer, shall be entitled to receive the protected link that will allow the Buyer to access the product.

6.6 Please note that whether in Bundles or Annual Subscription, all unsolicited reports will be cancelled and lost after the 12 month period. In the event that the Buyer, does not want to maintain the agreement.

6.7 As a matter of fact the investor of a company, external consultants, the joint venture done with a third party, and so on can not access the report and should pay a full license price.

7. TERMINATION

7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer will 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 or registered mail, 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

8.1 All 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.

8.2 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. 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 of or linked to these Terms and Conditions or to any contractual undertakings that the Buyer has taken to establish and maintain any product purchased by the Buyer, will be settled by the French Commercial Courts of Lyon, 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.