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高端惯性传感器市场：ADI凭借工业MEMS IMU保持强势[1]

内容概览：

- ADI MEMS IMU[2]：
  ADI公司（亚德诺半导体）已开发出多种加速度计和陀螺仪。System Plus Consulting选择了其中六种进行比较和研究，ADXL203、ADXL355B、ADXL362、ADXRS290、ADXRS295和ADXRS195。
  为了实现高性价比的工业级模块，ADI整合了多个自产分立式陀螺仪、加速度计和IC[3]，从而对其自身产品组合中的组件进行重复利用。
  ADI开发了一种非常智能的机械设计，可以通过三轴技术进行测量，其中两个二轴用于陀螺仪，一个三轴在加速度计中。
  …
- 市场预测：
  Yole Développement（Yole）预期高端惯性系统市场的年增长率为2.7%，至2025年可达38.0亿美元。
  加速度计、陀螺仪、IMU、INS[4]的市场仍比较零散，包含多项应用。
- 技术趋势：
  惯性系统市场已经走过了几个不同技术阶段。
  在从首次应用到成熟这近20年的技术周期内，市场上似乎出现了一些变化。
  MEMS在高端惯性系统市场中首次亮相。

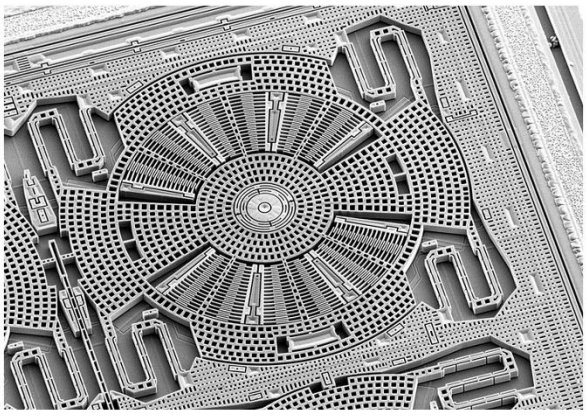
*“在机器人、智能农业、自动驾驶汽车以及导航和稳定应用的发展中，精确的动作捕获传感器发挥了核心作用”，System Plus Consulting的***MEMS、传感器和显示器技术与成本分析师Audrey Lahrach***称。**System Plus Consulting**她补充道：“标准的消费型解决方案无法满足高精度、长寿命和高可靠性方面的要求。”*

[1]摘自：《ADI高端加速度计和陀螺仪比较》，System Plus Consulting，2021
[2]IMU：惯性测量单元
[3]IC：集成电路
[4]INS：惯性导航系统

System Plus Consulting对器件或系统进行拆解，以辨识其技术并判断其制造流程，然后使用内部模型和工具计算其成本。ADI的IMU组件也在System Plus Consulting分析过的组件之中。ADI公司是惯性产业的领导者之一，2020年的营收为56亿美元。
在全球高端惯性传感器市场中，ADI占有3%的市场份额，且在工业应用领域处于领先

ADXRS295 Gyroscope MEMS sensor view

(Source: Analog Devices High-End Accelerometers and Gyroscopes Comparison, System Plus Consulting, 2021)



地位，竞争对手包括Sensonor、赛峰、Silicon Sensing Systems和其他硅MEMS企业。
事实上，根据System Plus Consulting的合作伙伴 Yole Développement（Yole）在 《2020年国防、航空航天和工业应用高端惯性传感器报告》中所述：对于高端惯性市场中的公司来说，根据目标终端应用在正确的技术和合作伙伴上进行投资非常重要。市场仍然由霍尼韦尔、诺斯洛普·格鲁门公司和赛峰主导，这是因为它们拥有庞大的产品组合。由于这一市场的具体要求，所有技术的寿命都较长，并且不会从一种技术突然跳转到另一种技术，但要求市场中的竞争企业都让自己的技术保持在最先进的状态这意味着地区性领导地位不会发生剧烈的变化。
惯性系统的产业格局历来都相当稳定。无论是在美国还是全球，霍尼韦尔仍然领先，其次是诺斯洛普·格鲁门。其他值得关注但规模较小的企业包括KVH、Kearfott和Emcore/SDI。美国公司主导着高端惯性系统市场，欧洲和亚洲位居其后。
在**Yole光子与传感部门的技术与市场分析师Dimitrios Damianos博士**看来：*“欧洲惯性市场由赛峰主导，该公司是迄今为止市场上规模最大的，营收比Raytheon Anschutz、iXblue、Sensonor等其他竞争企业要高出一个数量级。”*

在这样充满动态的形势下，同属Yole企业集团的Yole和System Plus Consulting两家公司对各项MEMS IMU技术及相关市场进行了深入调研。逆向工程与成本分析公司System Plus Consulting指明了领先IMU公司ADI所做的最新技术选择。

System Plus Consulting于今日发布的《ADI高端加速度计和陀螺仪比较》报告分析了来自ADI公司的精度水平各异的不同IMU中这些器件在制造工艺和集成方面的差异[5]。它还提供了包含工艺描述的详细物理性比较分析，以及三个加速度计和三个陀螺仪之间的制造成本比较分析。此外还有所选中的每款IMU的拆解、物料清单、成本和售价估算。

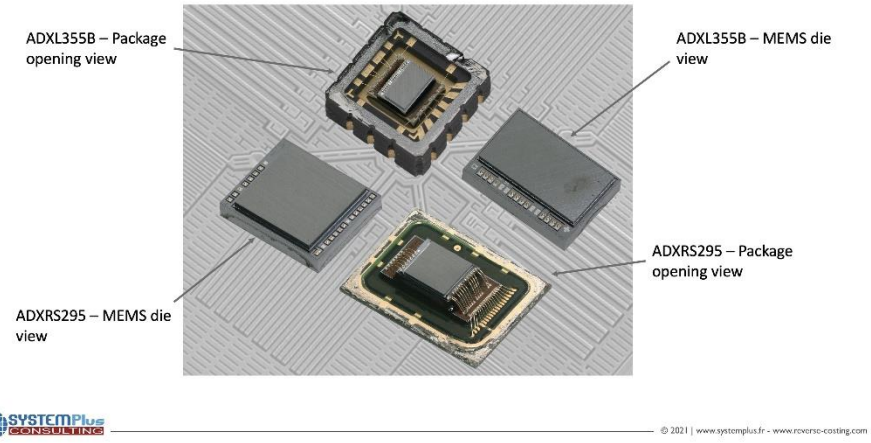
大多数加速度计和所有陀螺仪都会把一个主要MEMS器件和相应的ASIC[6]封装在一起。所有MEMS器件均采用表面微加工技术制造。封盖和MEMS传感器通过共晶键合或玻璃介质接合组装在一起。加速度计采用陶瓷封装或LGA[7]封装，所有陀螺仪都组装在一个LGA封装中。

在**Audrey Lahrach**看来：*“相同的加速度计和陀螺仪集成在不同的IMU中。我们可以找到同样的加速度计和陀螺仪的组合用在不同的应用中。而每种IMU都针对不同的应用等级校准，如机器人、移动物联网、自主机器、航空电子设备、精密仪器、制导和导航……”*

[5]ADI：Analog Devices公司
[6]ASIC：专用集成电路
[7]LGA：基板栅格阵列

Gyroscope and accelerometer opening – Package, MEMS die and MEMS sensor view

(Source: Analog Devices High-End Accelerometers and Gyroscopes Comparison, System Plus Consulting, 2021)



包括System Plus Consulting和Yole Développement在内的Yole企业集团全年发布大量传感与致动相关的报告。此外，专家们还会进行各种重要讲演并组织关键性会议。
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About our analysts

Audrey Lahrach serves as a Technology & Cost Analyst, MEMS, Sensors & Display at System Plus Consulting, part of Yole Développement.With significant expertise in the field of MEMS & sensors, including inertial, pressure and gas, as well as in the field of display technologies, Audrey produces reverse engineering & costing analyses while also running custom projects.Her mission is performed in collaboration with the laboratory team, and together they define the objectives of the analyses and determine the methodologies to reveal the structure of the devices and all materials required for their development and production.Audrey's aim is to determine and understand the technology choices made by the leading sensing companies, from the materials to the device itself.In addition, Audrey runs a technology watch daily to identify innovative MEMS & sensors and related semiconductor manufacturing processes.Her objective is to gain a comprehensive understanding of the evolution of semiconductor technologies and identify the strategy of the leading manufacturers.Thanks to her previous experience with CMOS image sensors and camera manufacturing, Audrey is also involved in the development of System Plus Consulting's imaging activities.Utilizing her knowledge in a combination of MEMS, sensing and imaging, Audrey is overseeing the development of a new System Plus Consulting product, the Smartphone Monitor.Audrey attends international trade shows & conferences to meet the MEMS & sensing companies, from component manufacturers to equipment manufacturers, and to identify the latest innovations.Audrey has taken part in online events to present key results of her teardowns and cost analyses.She has also published some articles in the press.Audrey holds a master's degree in Microelectronics from the University of Nantes (France).

Nicolas Radufe is in charge of physical analysis at System Plus Consulting.He has a deep knowledge in chemical and physical analyses.He previously worked in microelectronics R&D for CEA/LETI in Grenoble and for STMicroelectronics in Crolles.

Dr. Youssef El Gmili has joined System Plus Consulting's team in 2019 after ten years passed on high level research and development on microelectronics.He has a deep knowledge in the study and analysis of semiconductors Materials.He holds a Master Degree in Microelectronics, and a PhD in Physics/Materials Science.

Dimitrios Damianos, Ph.D., is a Technology & Market Analyst, part of the Photonics & Sensing division at Yole Développement (Yole).Based on solid technical expertise in imaging, sensing, display, lighting, and photonics, Dimitrios oversees the day-to-day production of valuable technology & market reports and custom consulting projects.Dimitrios also serves as a member of the Custom Project Business Development division (CPBD), supporting the development of strategic projects and following Yole's leading customers within the semiconductor industry.Dimitrios plays a key role in the expansion of Yole's market & technical knowledge, maintaining long-term relationships with key accounts and ensuring their expectations are met.Dimitrios regularly presents and delivers keynotes at international conferences and exhibitions.He has also authored and co-authored several technical & market reports as well as scientific papers in international peer-reviewed journals.Dimitrios holds a BSc in Physics and an MSc in Photonics, both from the University of Patras (GR), and a Ph.D. in Optics & Microelectronics from the University of Grenoble-Alpes (FR).

Guillaume Girardin, PhD. is Director of Market Intelligence at Yole Développement (Yole).As director he closely works with Yole's Executives to evaluate and inform with strategic decision-making - including insights into the market, customers and competitors.Within the Operating activities, he is engaged in the analysis of financial, strategic data and trends, as well as scenario and business analytics, to support the definition and the development of strategic plannings and structuring projects of the company.Based on his experience in the semiconductor industry and his previous position as Director of the Photonics and Sensing division, Guillaume interacts with Yole's analysts, by increasing synergies between the different teams, around markets and innovations.In addition, he is daily discussing with leading technological companies and analyzing technical and financial data.Guillaume Girardin holds a Ph.D. In Physics and Nanotechnology from the Claude Bernard University Lyon I (Lyon, France) and an M.Sc. in Technology and Innovation Management from EM Lyon School of Business (Lyon, France).

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