

Knowles MEMS Microphones in Apple iPhone 7 Plus: Patent-to-Product Mapping

What are the main patented features of Knowles' MEMS Microphones in the iPhone 7 Plus?

REPORT OUTLINE

- Knowles MEMS Microphones in Apple iPhone 7 Plus: Patent-to-Product Mapping
- April 2017
- PDF (100+ slides)
- €3,990 (corporate license)



KEY FEATURES OF THE REPORT

- **Essential IP analysis** of Knowles' patent portfolio related to the MEMS Microphones of Apple iPhone 7 Plus including:
 - Time evolution of patent publications and countries of patent filings
 - Current legal status of patents
 - Citation network and competitive IP networks
 - Inventor identification
- **Analysis of main patent lawsuits** filed by Knowles
- **Deep insight on technology data**, including teardown analysis, of the Knowles MEMS Microphones in the Apple iPhone 7 Plus

OBJECTIVE OF THE REPORT

- Understand Knowles' IP strategy
- Identify key patents held by Knowles, and related to product features
- Find the link between patented technological solutions and the marketed product.

RELATED REPORTS

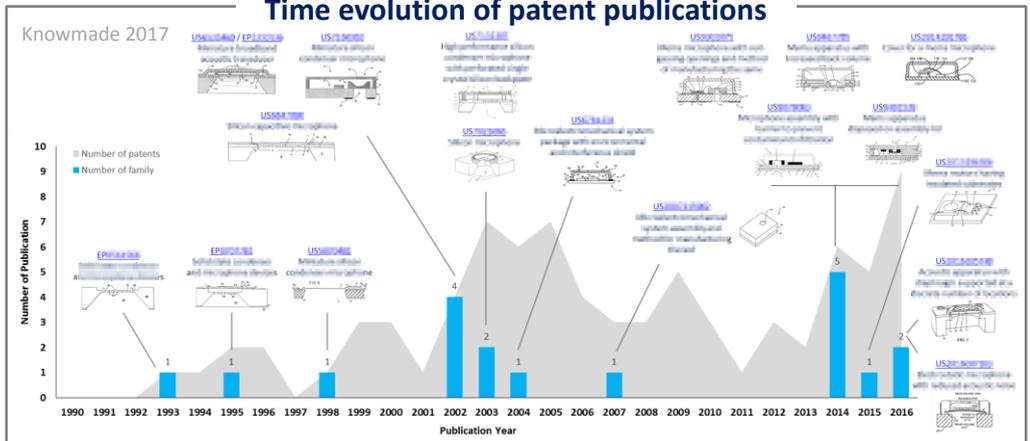
- System Plus Consulting: [Apple iPhone 7 Plus: MEMS Microphones \(2016\)](#)
- System Plus Consulting: [Vesper VM1000 Piezoelectric Microphone \(2017\)](#)
- Yole Développement: [Acoustic MEMS and Audio Solutions 2017](#)

KNOWLES: WORLD-LEADER IN MEMS MICROPHONES

Founded in 1946, Knowles offers a growing range of micro-acoustic, electro-mechanical, and related technology platforms to support its customers. Knowles was the first to introduce MEMS microphones to the market in 2003 and is now the world-leader in MEMS microphones, with its SiSonic technology. Knowles is Apple's main MEMS microphone supplier. Yole Développement estimates the sales of Knowles' MEMS microphones at \$360M in 2016, giving the company over 40% of the market. That year, Knowles shipped over 1.55 billion MEMS microphones. Moreover, Knowles has filed several patent lawsuits in the last ten years against rival manufacturers. In this context, it is important to understand the links between Knowles' MEMS microphones and their related patents.

Our partner, System Plus Consulting, analyzed the MEMS microphone components included in the iPhone 7 Plus, which was launched by Apple in September 2016. The smartphone contains four MEMS microphones: one front-facing top microphone, two front-facing bottom microphones and one rear-facing top microphone. Two different MEMS microphones from Knowles have been found in the iPhone 7 Plus, the KSM microphones, KSM1 or KSM2, and the KMM microphone, KMM1. The models are very similar and the study focuses mainly on the KSM format. Based on the features revealed by the microphone teardowns, we have identified the closest Knowles patents to these technologies, and describe the main claimed features. This helps understand the core technologies developed by Knowles in their MEMS microphones.

Time evolution of patent publications



Knowles microphones in the iPhone 7 Plus include technologies claimed in patents published in the early 2000s and in the mid-2010s. We have also observed new IP activity linked to these microphones. The technologies currently being developed could represent a new angle of attack for infringement litigation from Knowles after the wave of suits the company initiated over the last decade.

Combining the data obtained by System Plus Consulting's teardown of Knowles microphones in the Apple iPhone 7 Plus with Knowmade's IP analysis, this report highlights IP related to these MEMS microphones. Moreover, it analyzes Knowles' related patent portfolio in order to understand the company's IP strategy and to identify main IP competitors.

Benefit from KnowMade and System Plus Consulting's combined added value, highlighting product features and related patents

PATENT-TO-PRODUCT MAPPING

System Plus Consulting tore down the MEMS microphones of Knowles included in Apple’s iPhone 7 Plus, launched in September 2016. Knowmade then compared the features revealed to Knowles’ IP portfolio. The selected features are mainly related to the microphone package, diaphragm and backplate, which uses Knowles’ free-floating technology. The report identifies key patents held by Knowles related to these technology features. For each product feature, we have established links between patented technologies, including legal status.

Technology compared to Patent

TEARDOWN

Design and Packaging:



Backplate – Optical View



Central Support Post Cross-section – Optical View

IDENTIFIED PATENT FAMILIES

Patent family	Claims	Description	Legal
US2015/0123456 (2015) Acoustic apparatus with diaphragm supported at a discrete number of locations	Claim 1: An acoustic apparatus, comprising: a back plate; a diaphragm, the diaphragm and the back plate being disposed in spaced relation to one another; and a central pillar disposed in spaced relation to the back plate and the diaphragm.	Referring now especially to FIG. [below], the first motor 100 includes a central pillar 110 disposed in spaced relation to the back plate 106. [...] The diaphragm 108 is supported by the diaphragm posts 114. In one example, the posts 114 are constructed of silicon nitride and approximately 6 posts are utilized. [...] The diaphragm 108 is supported by the diaphragm posts 114. In one example, the posts 114 are constructed of silicon nitride and approximately 6 posts are utilized. [...] The diaphragm 108 is supported by the diaphragm posts 114. In one example, the posts 114 are constructed of silicon nitride and approximately 6 posts are utilized. [...]	US: Pending EP: No patent* JP: No patent* CN: No patent* KR: No patent* TW: Pending *WO: Pending

Selected images

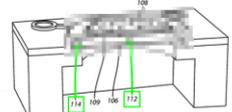


FIG. 2
106: diaphragm
108: backplate
109: backplate electrode
112: central pillar
114: posts
116: substrate

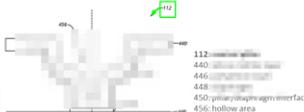
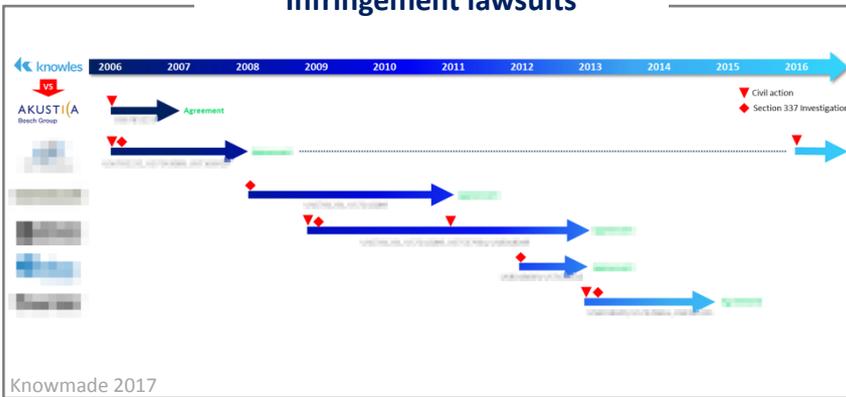


FIG. 4
112: central pillar
440: diaphragm post
444: diaphragm post
448: diaphragm post
450: pillar/diaphragm interface
456: hollow area

Knowmade, System Plus 2017

Infringement lawsuits



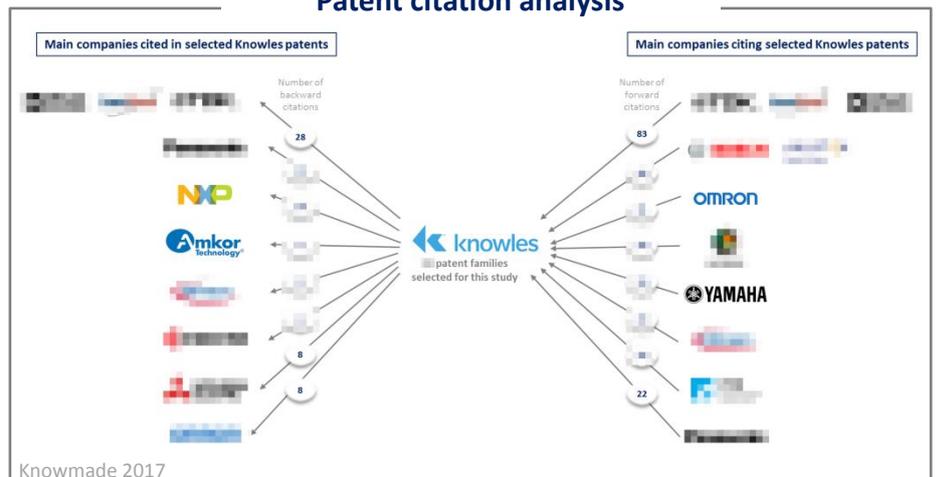
PATENT LITIGATIONS

Knowles has filed patent infringement litigations related to only two patent families of its portfolio. Both families are related to MEMS microphones and to features identified in this patent-to-mapping report. Knowles has filed complaints against six different defendants, including its main IP competitors. The technologies claimed in these patents are key for Knowles.

PATENT ANALYSIS AND IP COMPETITIVE ENVIRONMENT

We have analyzed Knowles’ patents related to MEMS microphones found in the Apple iPhone 7 Plus, including publication trends, country of publication, main inventors, and identified IP competitors. The analysis of forward and backward citations shows that Knowles’ portfolio is cited by many patent applicants. Combining the citation network with analysis of the content of citing/cited patents, we have ranked Knowles’ IP competitors to establish a general view of the IP competitive environment.

Patent citation analysis



COMPANIES CITED IN THE REPORT INCLUDE:

AAC TECHNOLOGIES, AKUSTICA, AMKOR TECHNOLOGY, ANALOG DEVICES, GOERTEK, INVENSENSE, INFINEON, KYOCERA, NXP, OMRON, PANASONIC, TDK and YAMAHA

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AUTHORS



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Brice Sagot

Brice is COO and co-founder of Knowmade. He leads the Biotechnology and Life Sciences department. He holds a PhD in molecular biology from the University of Nice Sophia-Antipolis, France.



Romain Fraux

Romain is the CTO of System Plus Consulting. He is in charge of costing analyses for Advanced Packaging, MEMS and Integrated Circuits. He has published more than 50 Reverse Costing reports on various MEMS devices including inertial, pressure, microphones or RF sensors.

ABOUT KNOWMADE

Headquartered in Sophia-Antipolis, France, **Knowmade** is a Technology Intelligence and IP Strategy consulting company. We provide Patent Search, Patent Analysis, Patent Valuation, IP Landscape, Scientific Literature Landscape, Technology Scouting, Technology Transfer and Technology Tracking. Our service offer consists of custom studies, on-demand tracking, analysis reports and strategy consulting. We combine information search services, scientific expertise, powerful analytics and visualization tools, and proprietary methodologies for analyzing patents and scientific information. With a solid focus on Microelectronics, Compound Semiconductors, LED, MEMS, Nanotechnology and Biotechnology, **Knowmade** supports research laboratories, industrial companies and investors in their business development. <http://www.knowmade.fr>

ABOUT SYSTEM PLUS CONSULTING

Headquartered in Nantes, France, **System Plus Consulting** specializes in technology and cost analysis of electronic components and systems in the fields of Integrated Circuits, Power Devices and Modules, MEMS and Sensors, LED, Image Sensors, Packaging including wafer level, Electronic Boards and Systems. The company offers custom reverse costing analyses, standard reverse costing reports and costing tools. These analyses are used by Purchasing Departments to measure their suppliers' cost structure, R&D Departments to confirm technological choices depending on their impact on costs, and Benchmarking/Marketing Departments to monitor the products on the market. <http://www.systemplus.fr>

ORDER FORM

Knowles MEMS Microphones in Apple iPhone 7 Plus Patent-to-Product Mapping

Ref.: KM17004

SHIP 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 METHODS

Order online for instant download: [Click here](#)

Check

To pay your invoice using a check, please mail your check to the following address:

KnowMade S.A.R.L.
2405 route des Dolines, BP 65
06902 Valbonne Sophia Antipolis
FRANCE

Money Transfer

To pay your invoice using a bank money wire transfer please contact your bank to complete this process. Here is the information that you will need to submit the payment:

Payee: KnowMade S.A.R.L.
Bank: Banque populaire St Laurent du Var CAP 3000 - Quartier du lac- 06700 St Laurent du Var
IBAN: FR76 1560 7000 6360 6214 5695 126
BIC/SWIFT: CCBPFRPPNCE

Paypal

In order to pay your invoice via PAYPAL, you must first register at www.paypal.com. Then you can send money to the KnowMade S.A.R.L. by entering our E-mail address contact@knowmade.fr as the recipient and entering the invoice amount.

RETURN ORDER BY

E-mail: contact@knowmade.fr

Mail: KnowMade S.A.R.L. 2405 route des Dolines, BP 65 06902 Sophia Antipolis FRANCE

PRODUCT ORDER

€3,990 - Corporate license

For price in dollars, please use the day's exchange rate.
For French customer, add 20% for VAT.

All reports are delivered electronically in pdf format at payment reception.

SIGNATURE

I hereby accept Knowmade's Terms and Conditions of Sale

TERMS AND CONDITIONS OF SALES

Definitions

“Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in their entirety. It is done by signing the purchase order which mentions “I hereby accept Knowmade’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 the 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 models, designs, copyrights, inventions, 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 and including any pending registration of one of the above mentioned rights.

“License”: For the reports and databases, 2 different licenses are proposed. The buyer has to choose one license:

1. Single user license: a single individual at the company can use the report.
2. Corporate license: the report can be used by unlimited users within the company. Subsidiaries are not included.

“Products”: Reports are established in PowerPoint and delivered on a PDF format and the database may include Excel files.

“Seller”: Based in Sophia Antipolis (France headquarters), Knowmade is a technology intelligence company specialized in the research and analysis of scientific and technical information. We provide patent landscapes and scientific state of the art with high added value to businesses and research laboratories. Our intelligence digests play a key role to define your innovation and development strategy.

1. Scope

1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, SHALL BE WHOLLY INAPPLICABLE TO ANY SALE MADE HEREUNDER AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

1.2 This agreement becomes valid and enforceable between the Contracting Parties after clear and non-equivocal 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 Knowmade’s Terms and Conditions of Sale”. This results in acceptance by the Buyer.

1.3 Orders are deemed to 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 any 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 [1] month from the order for Products already released; or

- within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.

2.2 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer.

The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including in cases where a new 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 mailing of the Product will occur 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. 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 to the Seller as required 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 expressed to be inclusive of all taxes. The prices may be reevaluated 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 Knowmade, PayPal or by electronic transfer to the following account:

Banque populaire St Laurent du Var CAP 3000 - Quartier du lac- 06700 St Laurent du Var

BIC or SWIFT code: CCBPFRPPNCE

IBAN: : FR76 1560 7000 6360 6214 5695 126

To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this case, the need of down payments will be mentioned on the order.

3.3 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular 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 based on the annual rate Refi of the «BCE» + 7 points, 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 termination 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 Buyer 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 thereof.

4.2 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

4.3 In no event shall the Seller be liable for:

a) damages of any kind, including without limitation, incidental or consequential damages (including, but not limited to, damages for loss of profits, business interruption and loss of programs or information) arising out of the use of or inability to use the Seller's website or the Products, or any information provided on the website, or in the Products;

b) any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 All the 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.

4.5 All the Products that the Seller sells may, upon prior notice to the Buyer from time to time be modified by or substituted with similar Products meeting the needs of the Buyer. This modification shall not lead to the liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 In the case where, after inspection, it is acknowledged that the Products contain defects, the Seller undertakes to replace the defective products as far as the supplies allow and without indemnities or compensation of any kind for labor costs, delays, loss caused or any other reason. The replacement is guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for any event as set out in article 5 below.

4.7 The deadlines that the Seller is asked to state for the mailing of the Products are given for information only and are not guaranteed. If such deadlines are not met, it shall not lead to any damages or cancellation of the orders, except for non-acceptable delays exceeding [4] months from the stated deadline, without information from the Seller. In such case only, the Buyer shall be entitled to ask for a reimbursement of its first down payment to the exclusion of any further damages.

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of saleability and fitness for a particular purpose, with respect to the Products. Although the Seller shall take reasonable steps to screen Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making the Products available, the Seller cannot guarantee that any Product will be free from infection.

5. Force majeure

The Seller shall 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 deliveries by suppliers or other difficulties which are beyond the control, and not the fault 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 copyright law 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. 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 and retrieval systems;
- Recordings and re-transmittals 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 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employees or any person to whom the Buyer has sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

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.

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