REPORT SAMPLE

RF ACOUSTIC WAVE FILTERS

Patent Landscape Analysis

September 2017


Wisol

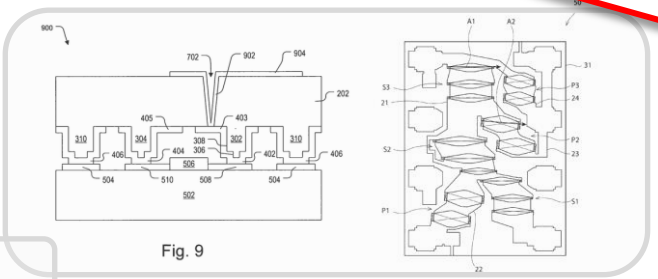
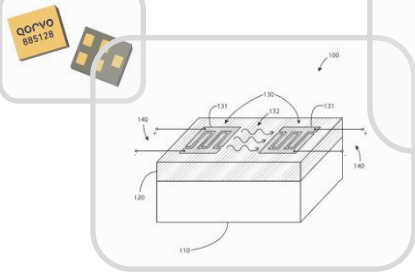
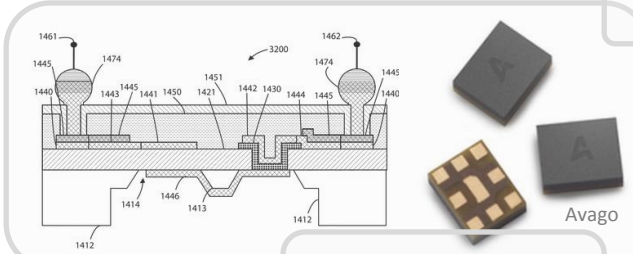
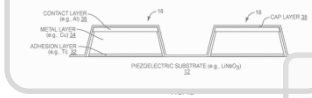
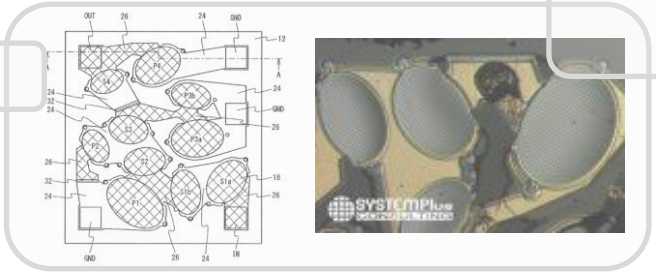


Fig. 9




Avago





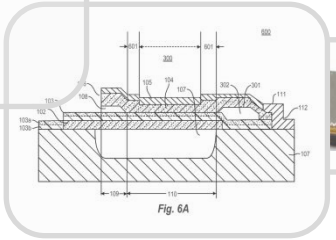


Fig. 6A


Murata

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Patent & Technology Intelligence

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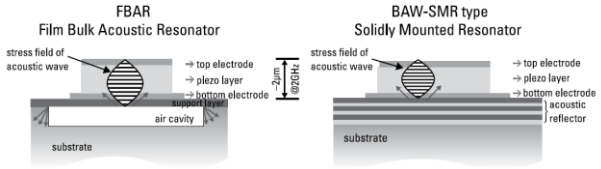
Scope of the report

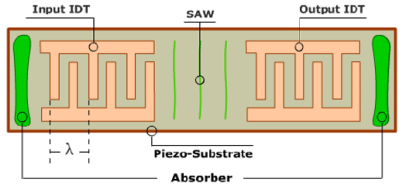
- This report provides a detailed picture of the patent landscape for **RF acoustic wave filter dedicated to mobile applications**. All patents related to RF filters were considered: SAW, TC_SAW, BAW, FBAR, SMR, duplexers, diplexers, multiplexers, filter modules, etc.
- This report covers **patents published worldwide** up to **July 2017**. We have selected and analyzed more than **16,310 patents and patent applications** grouped in more than **6,550 patent families** relevant to the scope of this report.

Included in the report

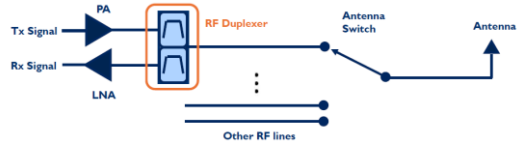
- *Patents related to acoustic wave filters for mobile applications and devices/modules claiming their use such as duplexers, diplexers and multiplexers*

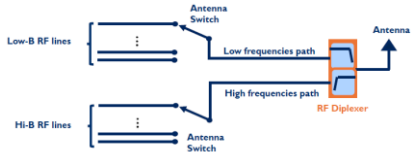
Technologies: SAW, TC-SAW, BAW/FBAR and BAW/SMR





Devices

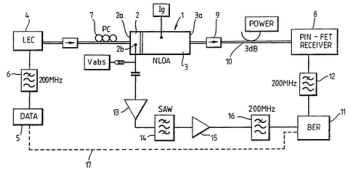




Not included in the report

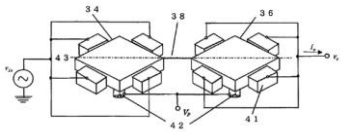
- *Patents related to acoustic wave sensors*
- *Patents related to MEMS resonators using mechanical modes*
- *Patents related to other applications (defense, automotive, medical, etc.) or not compatible with low cost and high-density integration requirements*

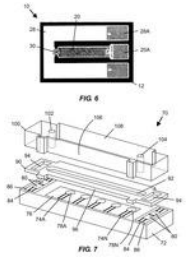
US5444560 (1991-11-18)
BT
Optical clock recovery



US2017168026 (2016-12-15)
QORVO
Temperature compensation and operational configuration for bulk acoustic wave resonator devices

US2008284544 (2005-07-25)
PANASONIC
Mems filter device having a nanosize coupling element and manufacturing method thereof





A sensing method utilizing a bulk acoustic wave (BAW) resonator, the sensing method comprising:
applying an AC signal to the BAW resonator;

Objectives of the report

Understand the competitive environment from technology and patent perspective

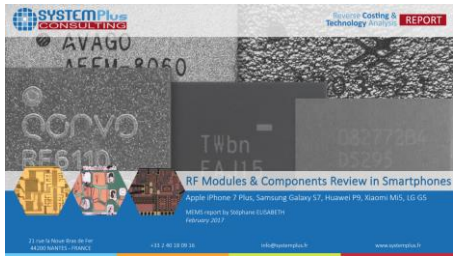
- ✓ Understand technology & market from a patent perspective.
- ✓ Understand the patent landscape.
- ✓ Identify risks & opportunities.
- ✓ Comprehend key trends in IP and technology development.
- ✓ List the major players and the relative strength of their patent portfolio.
- ✓ Name new players.
- ✓ Understand the competitive landscape, your current and future competitors.
- ✓ Understand your competitors' strategic direction and future product offerings.
- ✓ Determine your competitors' strengths and weaknesses.
- ✓ Identify current legal status of patented technologies.
- ✓ Identify key patents by assignees and technology.
- ✓ Identify blocking and valuable patents.
- ✓ Overview of past and current litigations and licensing agreements.
- ✓ Avoid patent infringement.
- ✓ Appreciate the link between the patent landscape and market evolutions.
- ✓ Discover new markets & technology directions.

Related reports

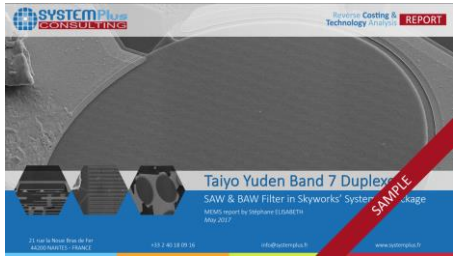
You may also be interested in those market analysis reports of our partner Yole Développement:

"*RF Front End Modules and Components for Cellphones*"
Yole Développement, March 2017
(get the report)

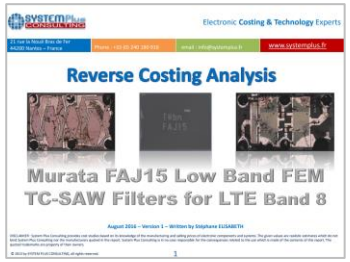
You may also be interested in those teardown & costing analysis reports of our partner System Plus Consulting:



"*Smartphone RF Front-End Module Review*"
System Plus Consulting, March 2017
(get the report)

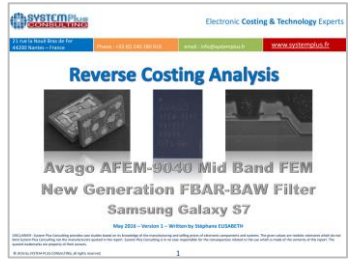


"*Taiyo Yuden SAW and BAW Band 7 Duplexer integrated into Skyworks' System in Package*"
System Plus Consulting, May 2017
(get the report)



"*Murata SAW Thermo-Compensated Band 8 Filter in Low Band Front-End Module*"
System Plus Consulting, August 2016
(get the report)

"*Qorvo TQF6405 in iPhone 6s Plus*"
System Plus Consulting, March 2016
(get the report)

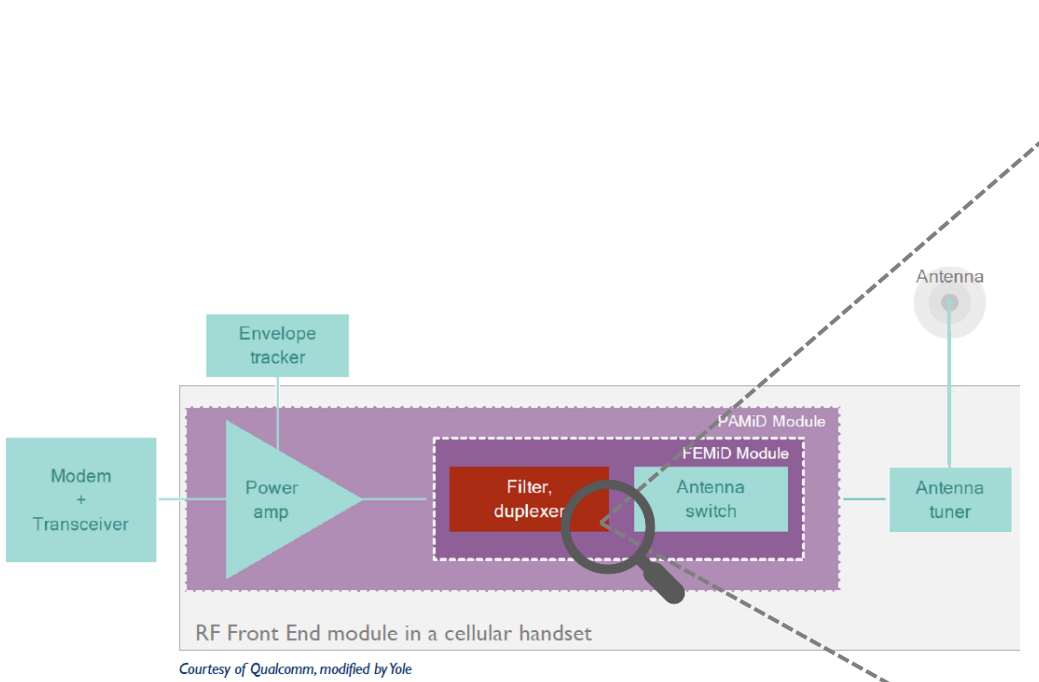


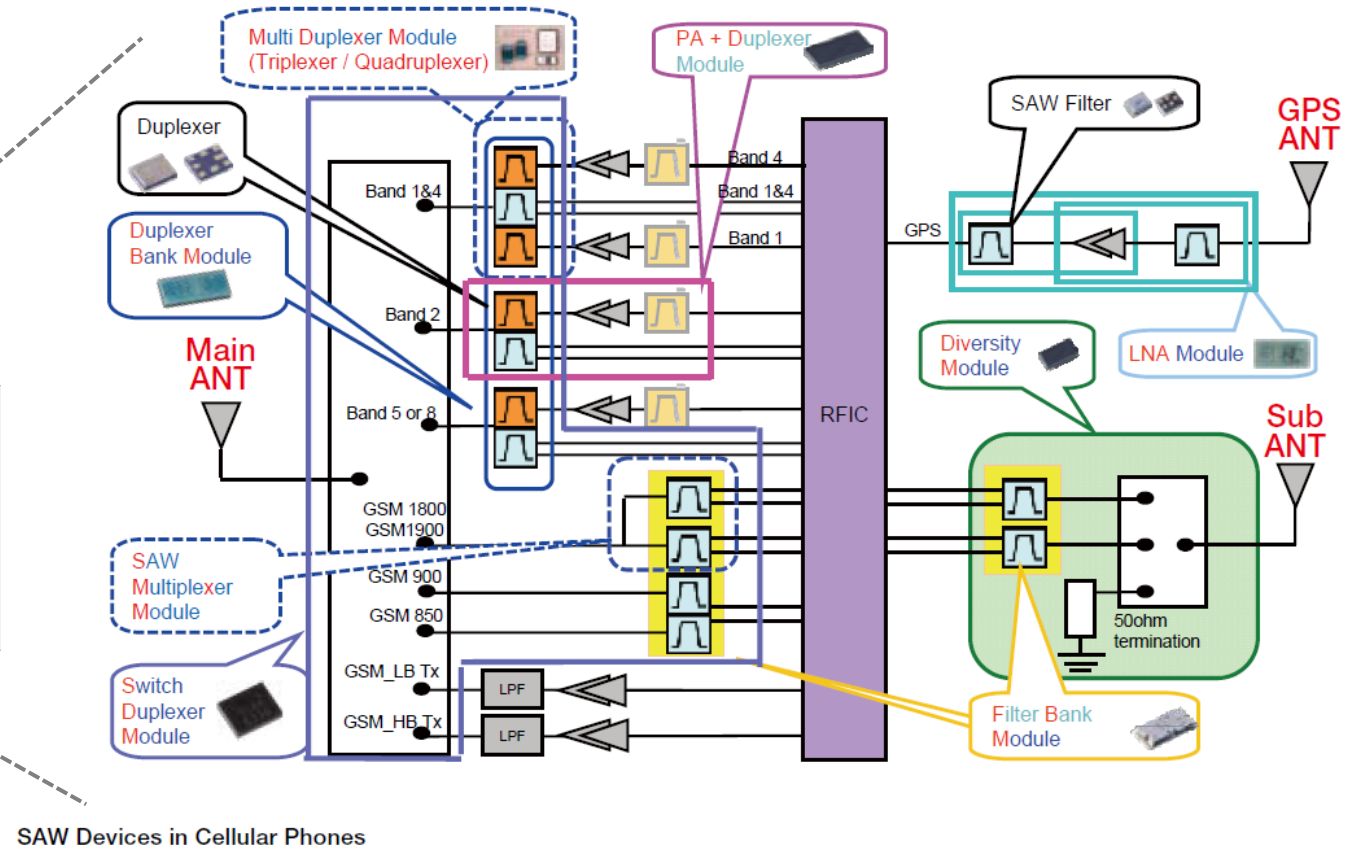
"*Avago AFEM-9040*"
System Plus Consulting, June 2016
(get the report)

Context

Applications of acoustic wave filters in mobile communications : RF front end modu

RF front end module are a key module for today's mobile communications. Placed just next to the antenna, it contains an antenna switch, a power [illegible] and several **filters, duplexers** and **diplexers**.
The set of filters, duplexers and diplexers is used to progressively select the bandwidth that will be treated to extract the signal. To filter different signals among all the available bands, the filters have to exhibit **high selectivity**, **low loss** and **cover all the RF frequency bands**. Furthermore, despite their increasing **number and complexity**, that are required for covering all the frequency bands**, filters modules have to be small and cheap.**



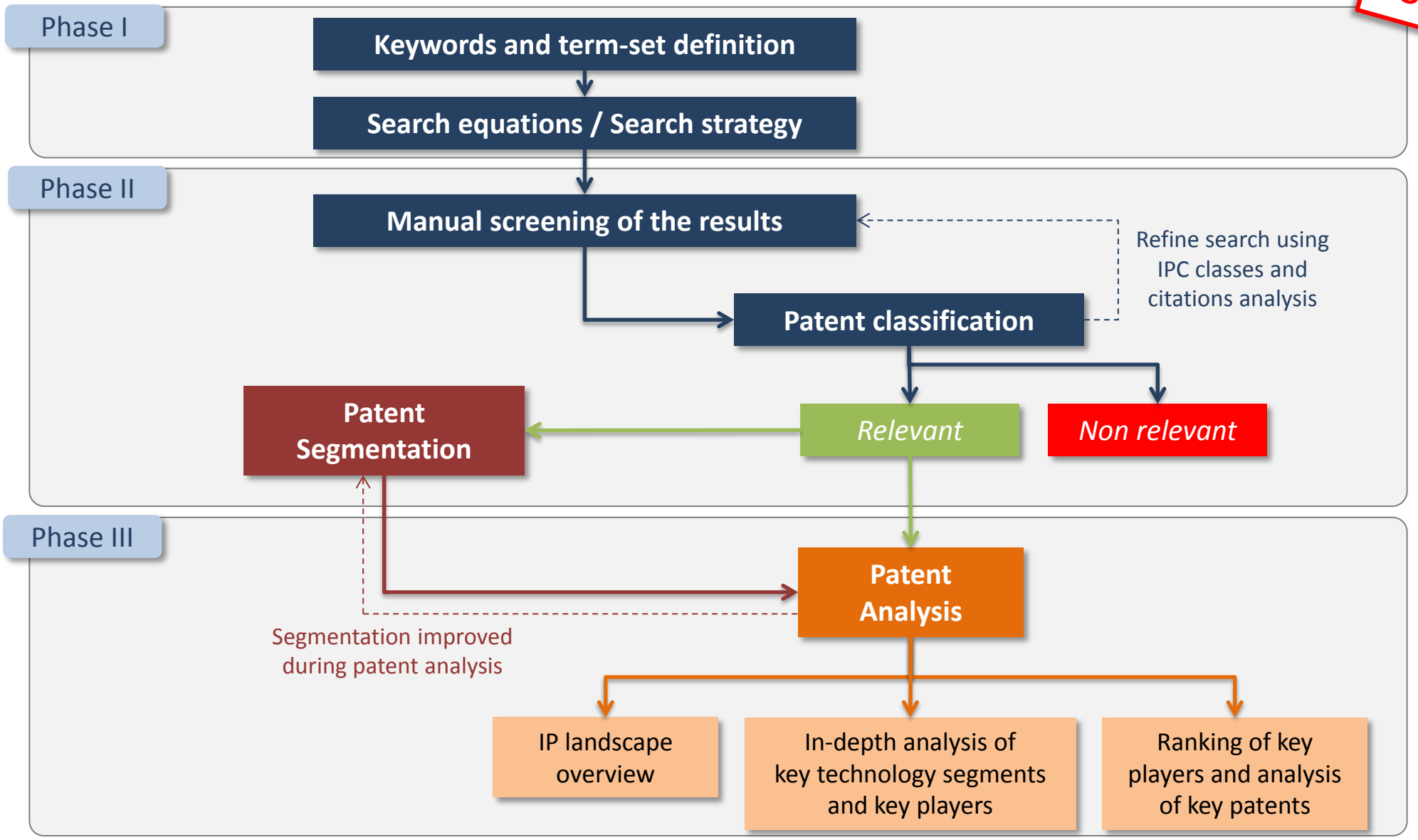


Source : Yole développement 2017

SAW Devices in Cellular Phones

Methodology

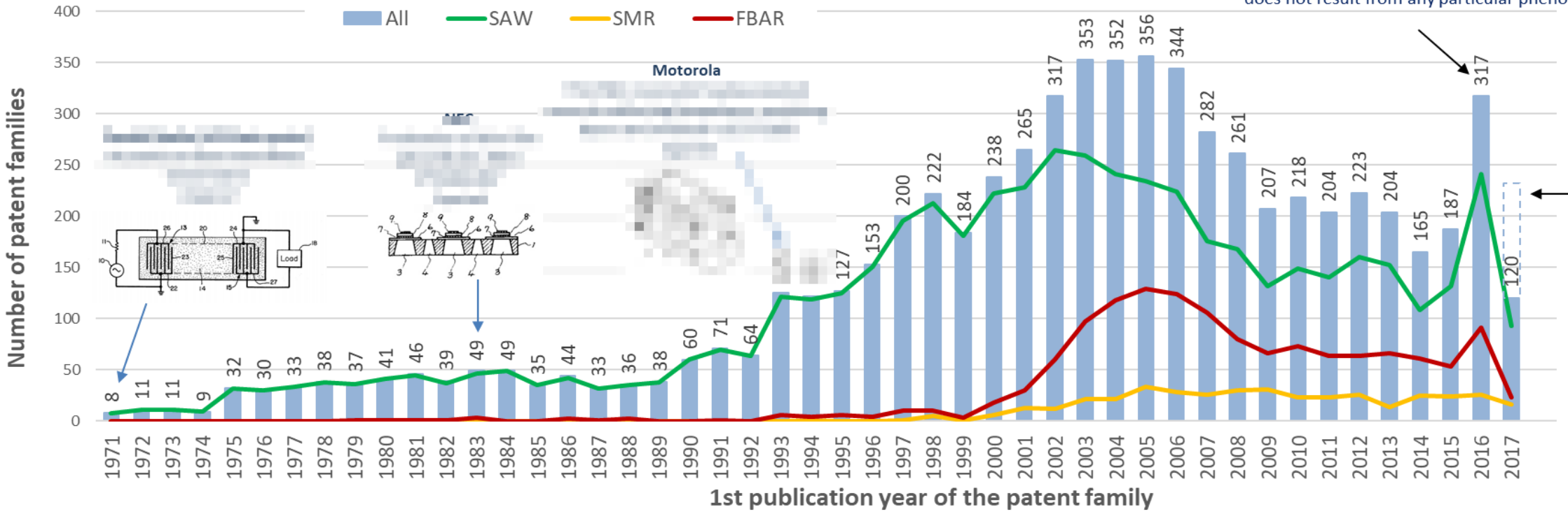
Methodology for patent search, selection and analysis



IP Landscape Overview

Time evolution of patent publications

6,550+ patent families related to RF acoustic wave filters



The high number of patents pu… coincidence of numerous patents fil… and published together the same year in 2016. … does not result from any particular phenomena.

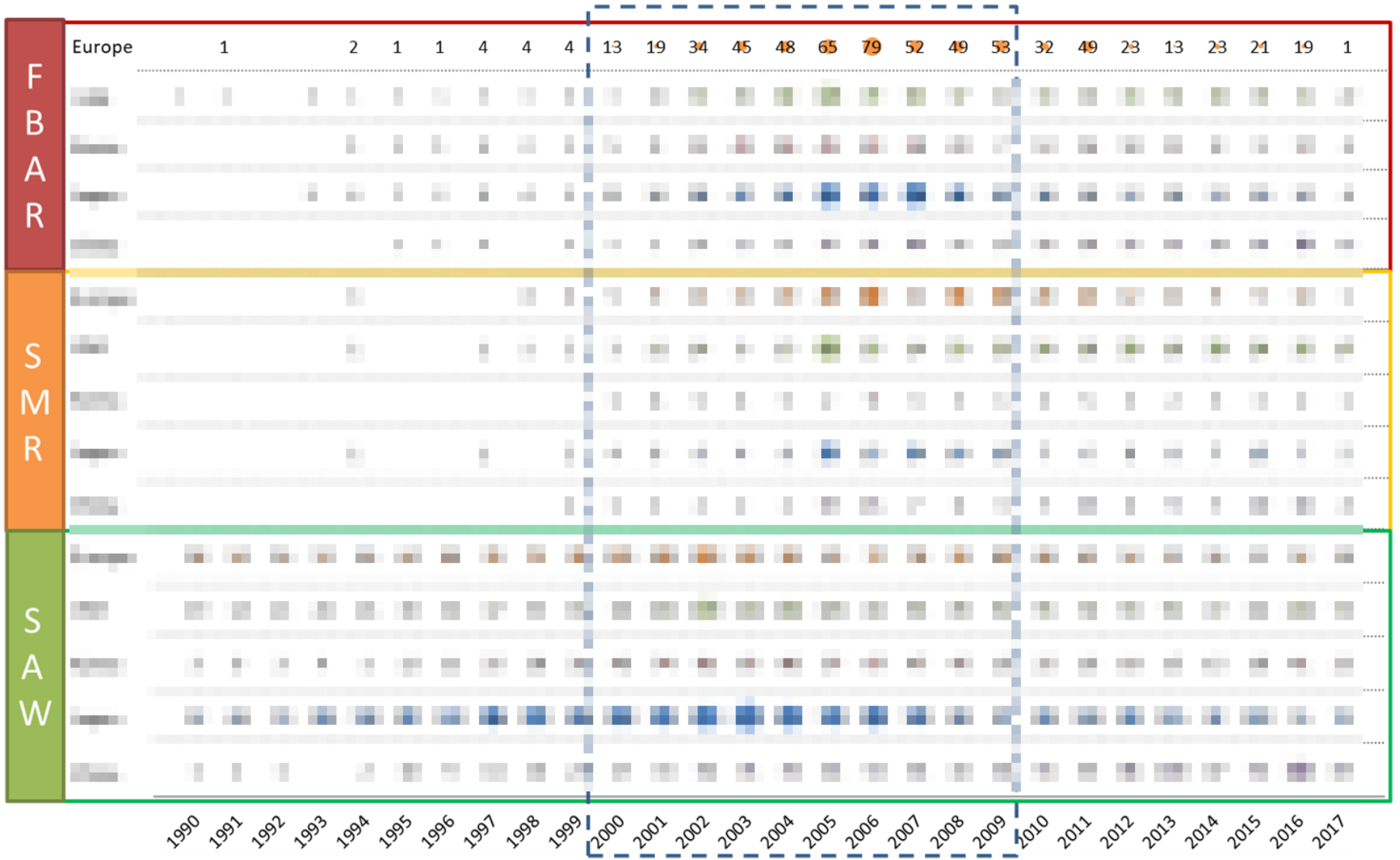
Based on current trend, we expect 240 patent families for 2017.

***Note**: The data corresponding to the year 2017 are not complete since the patent search was performed in June 2017.*

- **Zenith Radio** … was the first main actor to develop saw filter. At that time, **saw filters were dedicated to television receptors** applications.
- After a soft start, … **highly increased in the 90's** due to the mutation from analog to digital signal processing in mobile communication devices. **Since 2009**, the number of patent publication **has exhibited a flat curve** with an average of … **publications per year**.
- Bulk acoustic wave and **especially FBAR came about a decade after SAW filters**. Except for some early adopters like NEC or Motorola, most of the FBAR patent families were published **between 2000 and 2010** when the need for … On the other hand, SMR BAW patents never showed a peak of publication. Because of the need of an acoustic mirror, SMR BAW … Thus, this technology has only been adopted for …
-

IP Landscape Overview

Time evolution of patent publications per country of filings for SAW, SMR and FBAR f



Period of high patent publications related to RF acoustic filters.

XXX exhibits the **most** impo number of published patents related to **BAW SMR or FBAR.**

Since 2011 the **XXX patent publications has been maintaining** its level while **BAW FBAR** patent published in **XX** and **XX** have shown an important **drop.**

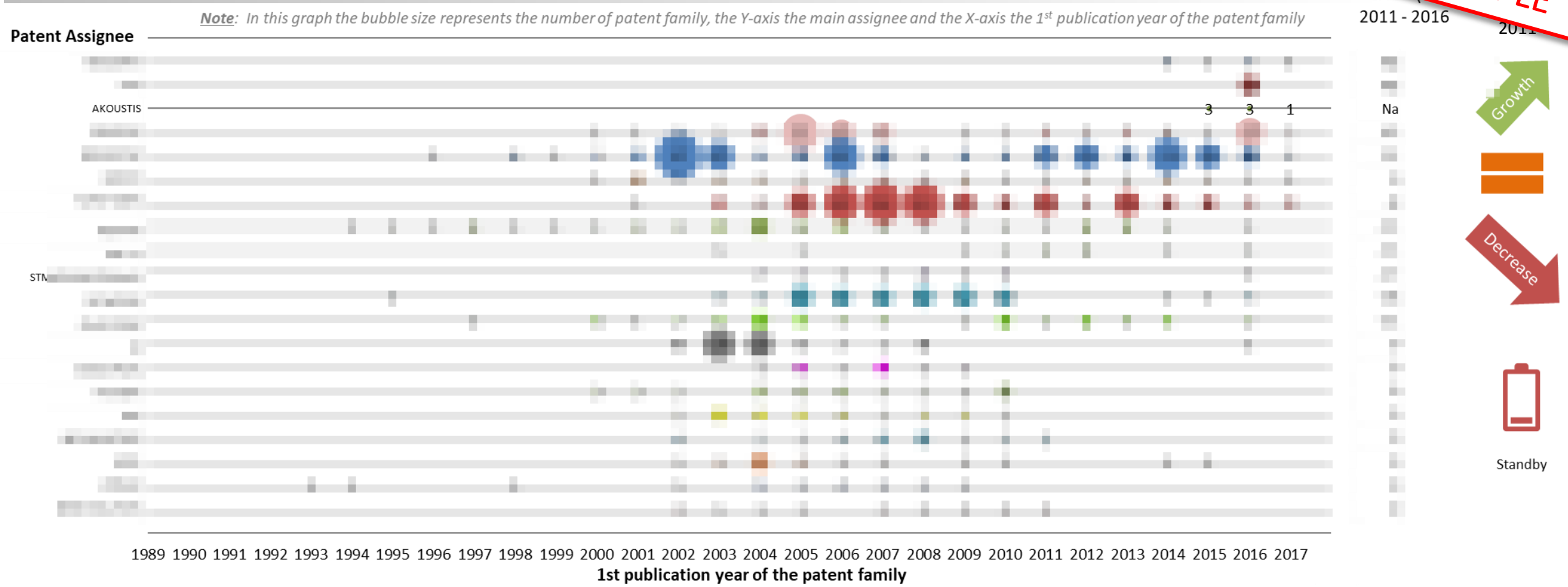
SMR related patenting activity is mainly done in **XXX** with a constant number of about 20 patent publications per year since 2007.

Patent publications in XXX have increased since 2008.

Note: In this graph the bubble size represents the number patent 1st publication of a family, the Y axis, the country of 1st application and the X-axis the year of the 1st publication

IP Landscape Overview

Time evolution of FBAR related patents of main patent applicants



- [redacted] and **Akoustis** are newcomers.
- [redacted] appear as the major applicants regarding FBAR patenting activity. Especially, [redacted] between 2010 and 2016 combine with its long-standing activity is the reason of its current BAW related IP leadership and dominant position [redacted]
- [redacted] of their FBAR patent publications since 2010, but the company **maintains a significant FBAR patenting activity**.
- [redacted] n the early 2000's but it has stopped its FBAR patenting activity since 2008.
- Other players exhibited a high activity between 2002 and 2010 but almost no patenting activity since then.

IP Landscape Overview

Matrix table : Patent Assignees / Technology approach

Number of patent families related to each technology for the main patent assignees

		SAW	BAW	
Assignees	AW Filters	SAW	FBAR	SMR
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SAMSUNG	[illegible]	[illegible]	[illegible]	[illegible]
SEIKO EPSON	137	126	17	1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SAW technology is the main patented technology an[illegible] patenting activity. The other main applicants of SAW filters patents i[illegible]

[illegible] has the highest number of patent publications related to **BAW** filters. Other main IP players related to BAW technology [illegible] Contrary to [illegible] that **covers all BAW technologies,** [illegible] **FBAR** technology.

SMR is the least patented technology and is also dominated by [illegible] activity. SMR also represent more than [illegible] portfolios.

Segments analysis

Corpus segmentation

The following part is dedicated to the analysis of **specific challenges related to acoustic wave filters**. Based on our knowledge we have chosen to [illegible] analysis on **three aspects** listed below. For each segment, the corpus has been segmented using search equations listed in the next page.

Devices

- With the increase of frequency bands, the need for complex filtering devices has become crucial. To get a better understanding of the current trends we have segmented the corpus into three main devices: **diplexers, duplexers** and **multiplexers.**

Packaging

- Devices and components downscaling is a second identified issue. Among all aspect relating to size reduction and devices integration, we have chosen to investigate the current trends of **packaging technologies** used by acoustic wave IP players, especially **Flip-Chip** Packaging, **Wafer Level** Packaging and **3D TSV** Integration.

Thermal compensation management

- **Temperature-compensated acoustic wave filters** have always been a major R&D problem since thermal drift impact the filter performances.

Segments analysis

Matrix table : Patent Assignees / Segments

Number of patent families per main patent assignees and segments

Assignees			Diplexers	Multiplexers	TC AW	Packaging	Flip Chip	3D integartion	Wafer level
MURATA									
SEIKO EPSON	137	0	0	0	8	16	4	4	0

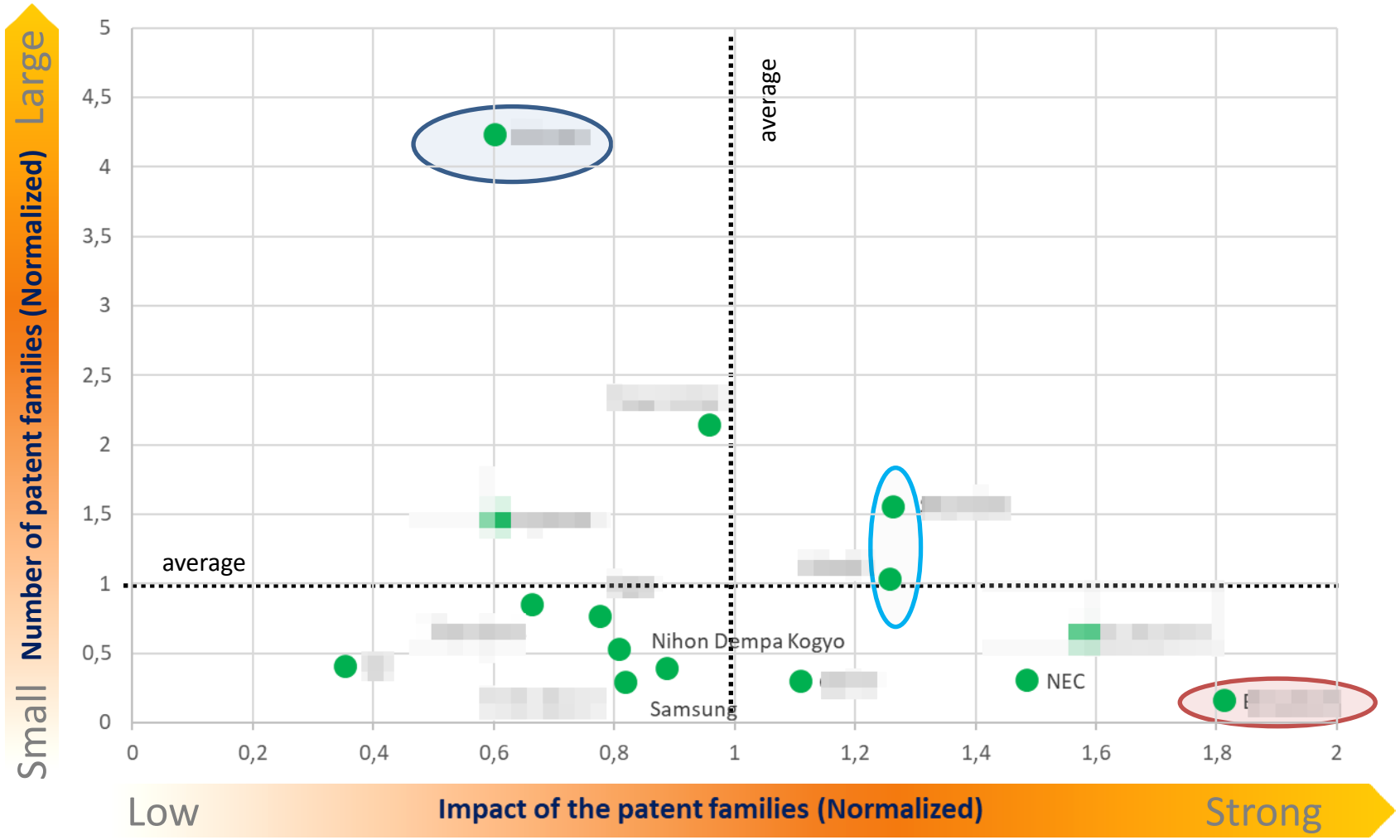
- [redacted] exhibit a large and varied patent portfolio that include almost all technologies.
- [redacted] exhibits the widest portfolio and the highest patenting activity (especially in 2014) regarding **temperature compensated** acoustic wave filters (TC AW).
- All players have developed 3D integration packaging and flip chip [redacted] are expending their patenting activity to **wafer level packaging.**

Comparative Study of IP Players

IP position of key players in the field of RF SAW filters

SAW

REPORT SAMPLE



The graph represents the relative position of each players in comparison to the average position of all players. The horizontal and vertical dot lines respectively represent the average number of patent families of the main IP players and the average impact of their patent portfolio.

With a size 4 times more important than its main competitors, [redacted] has the larger [redacted] patent portfolio.

[redacted] has [redacted] strongest portfolios. It combines a high impact* of its patent families (1,2 times more than the average) and a high number of patent families.

[redacted] the most relevant portfolio. Despite a portfolio's size 6 times lower than the average, each of its patent family is cited 1,8 times more than the average.

* The impact of a patent portfolio is measured by the number of citing patent families (self citation excluded) divided by the average citing patent families of all portfolios. A portfolio with an impact of 2 means that the portfolio is 2 times more cited than the average of the corpus.

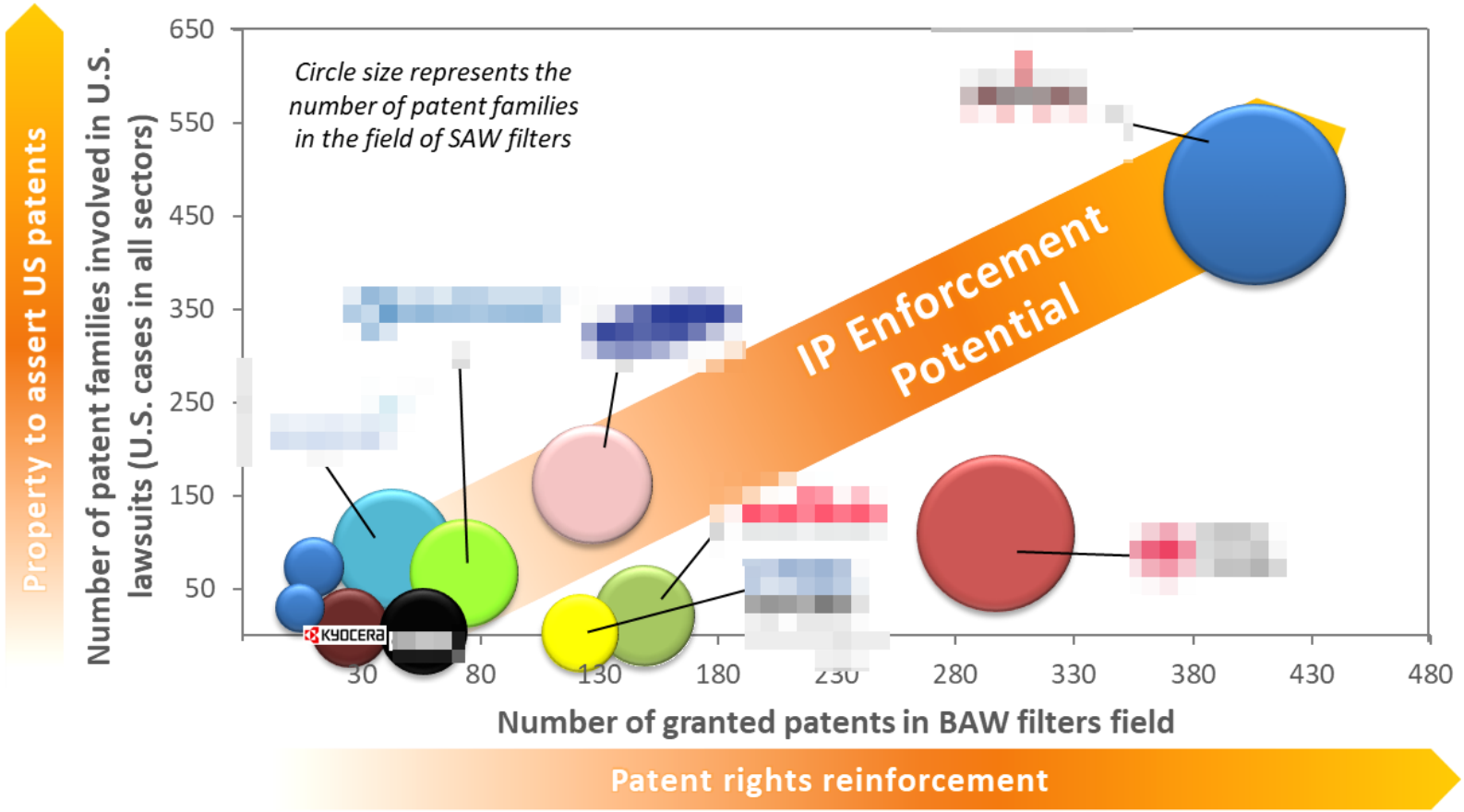
$$\text{Impact of the patent families} = \left(\frac{\textit{citation ratio of patent families}}{\textit{citation ratio over all SAW patent families}} \right)$$

Comparative Study of IP Players

Potential future plaintiffs in the filed of RF BAW filters

BAW

REPORT SAMPLE



The more the patent applicant combines a high propensity to litigate its US patents (all sectors) with a high number of granted patents on SAW filters, the more its IP enforcement potential is high in the field of SAW filters. The more the IP enforcement potential is high, the more the risk to see the patent applicant becoming a future plaintiff in the field of SAW filters is important.

[redacted] has a **high IP enforcement potential in the field of BAW filters.** Its aggressiveness and its leading position in IP landscape make it a dangerous player for competitors.

[redacted] has a **significant IP enforcement potential in the field of BAW filters.** The company combines a propensity to litigate their US patents (all sectors) with a lot of enforceable patents on BAW filters.

[redacted] exhibits a noticeable IP enforcement potential in the field of BAW filters. The company has 1[redacted] cases in US as plaintiff (all sectors) and it has currently 120+ granted patents related to BAW filters.

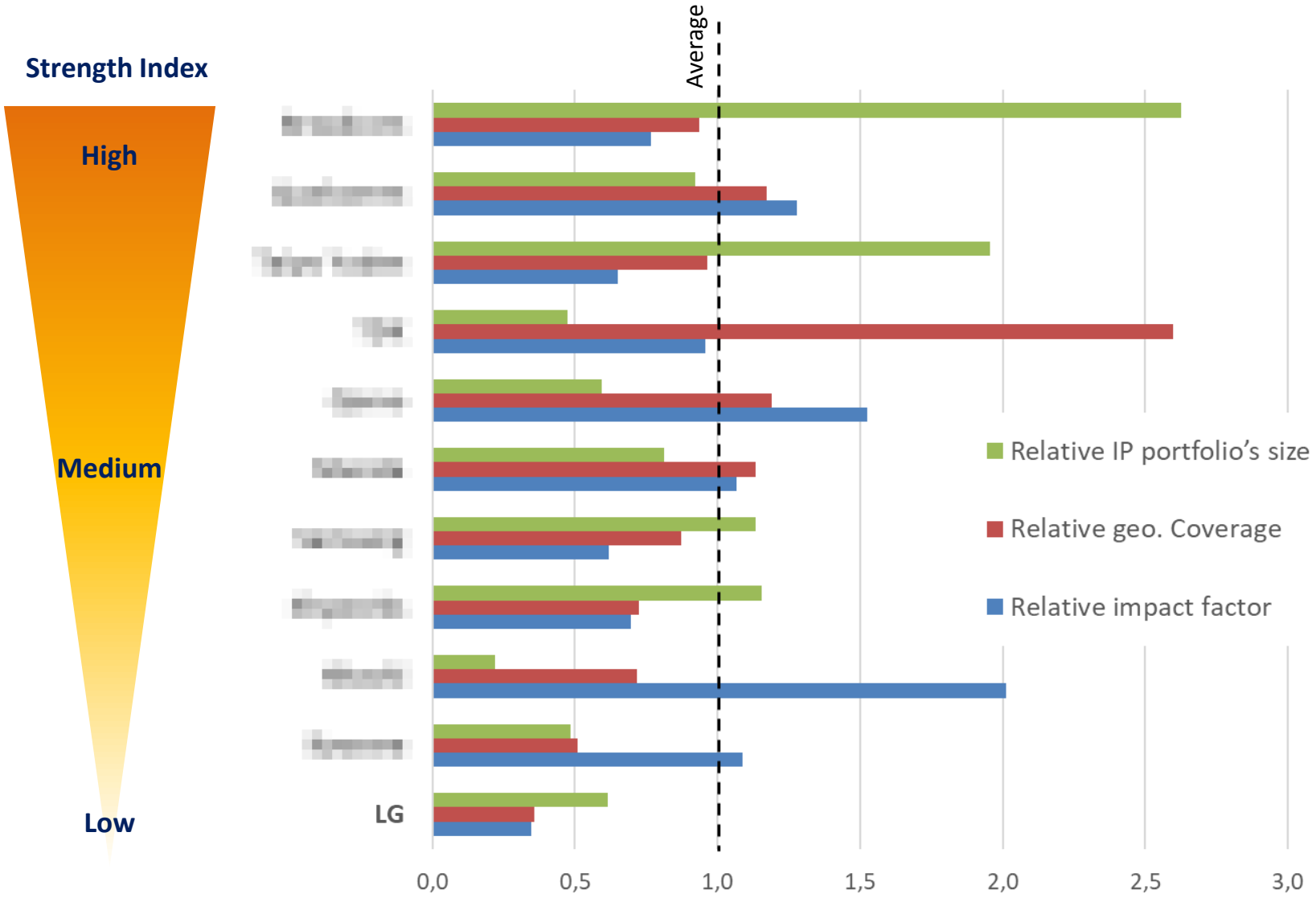
Note: Qualcomm and Apple have engaged numerous lawsuits against each other regarding their products and activities dedicated to mobile communication modules/devices and smartphones (see more).

IP players comparison

Strength index of players' portfolios related to BAW filters

BAW

REPORT SAMPLE



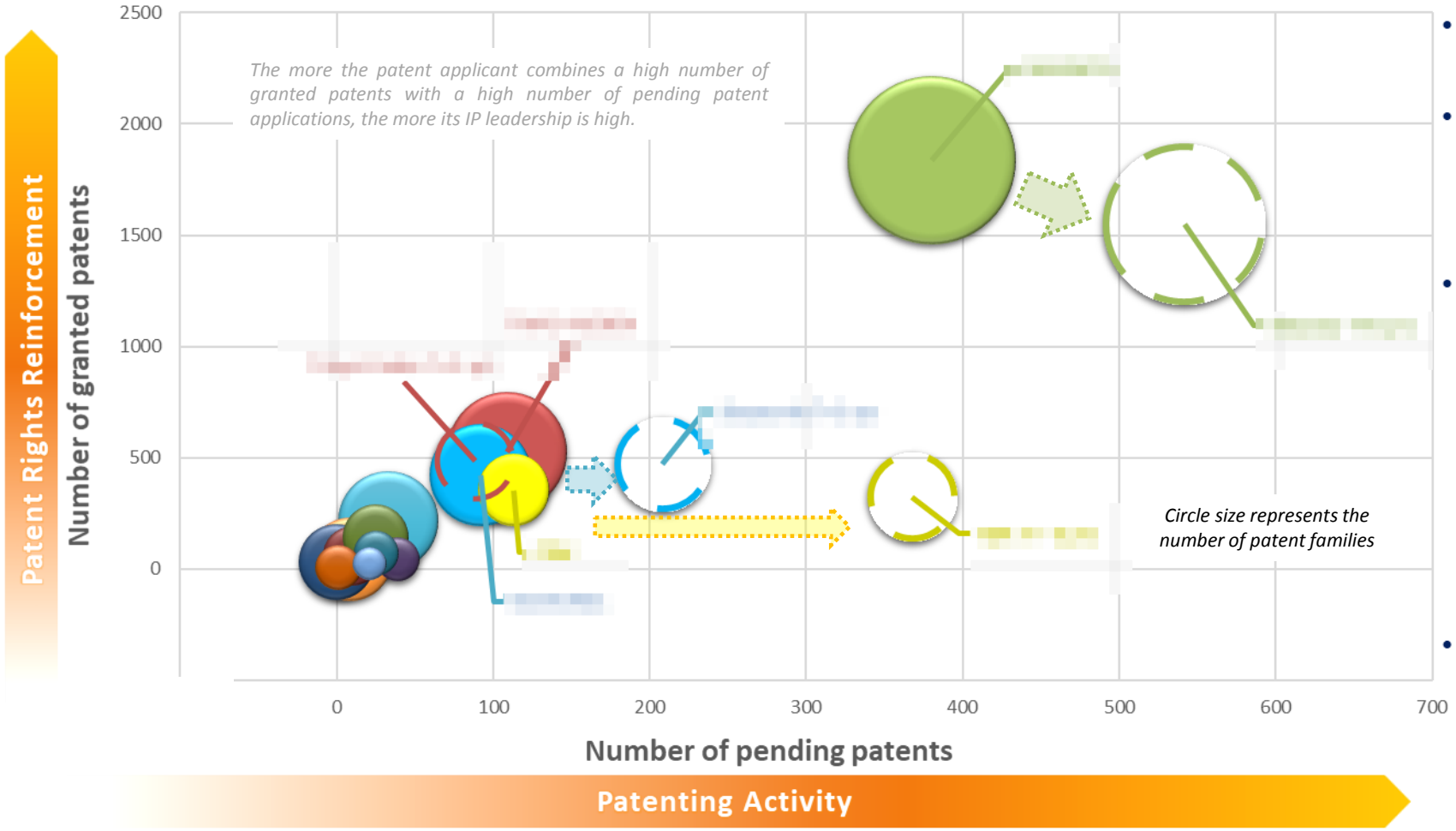
- [redacted] has the highest strength index which is due to a **number of patent families more than 2,5 time** higher than other main IP players.
- [redacted] **highest relative geo coverage** of more than 2,5 and an average impact factor. Thus, despite its low number of patent families, [redacted] the fourth strength index.
- [redacted] the **best impact factor** but suffer from its low portfolio size and geo. coverage. Furthermore, [redacted] activity related to BAW filters stopped about 10 years ago. [redacted] had been very impacting [redacted] **succeed in developing a strong IP position** from that its BAW related activity.
- [redacted] the most **balanced** strength indexes. Despite their small portfolio sizes, they have the [redacted] strength indexes respectively. **Their IP positions are thus very interesting.**

Comparative Study of IP Players

IP leadership of players at T+5 years in RF SAW filters

SAW

REPORT SAMPLE



The projection is based on a linear evolution of the patent activity of each players over the last 2 years. Thus, any change related to IP, R&D or market strategy is not taking into account in these prospective. The number of new pending patent applications corresponds to the trend of patent filings over the last 2 years. The number of granted patents results from the number of the coming expired patents and an estimation of the number of pending patents that will be granted.

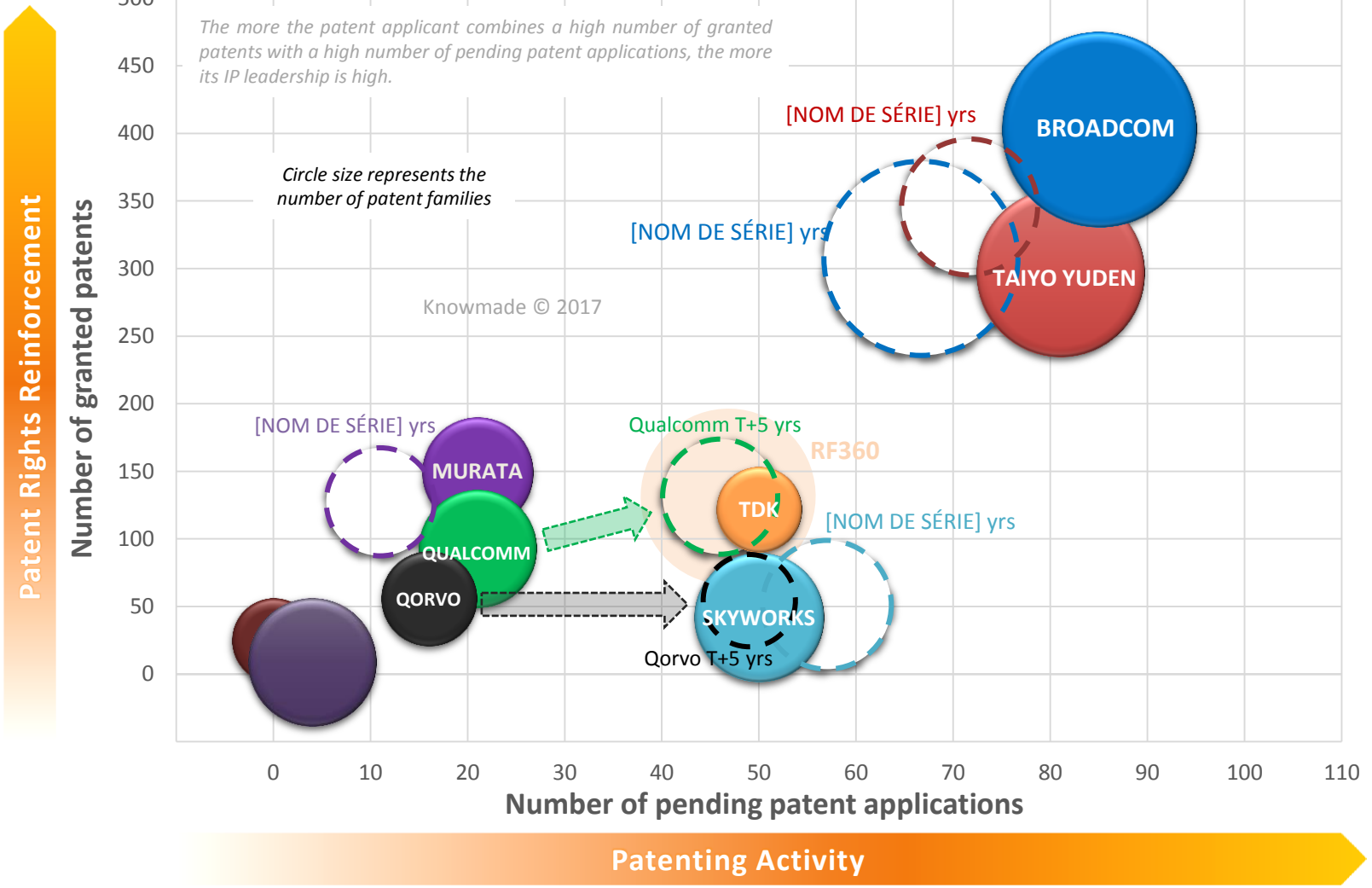
- The patent landscape of SAW [illegible] **not undergo important changes in the next 5 years.**
- [illegible] If Murata keeps its current patenting activity, we would expect a similar number of granted patents and pending patent applications in 5 years.
- [illegible] thanks to its recent increase of patenting activity. Indeed, [illegible] a **patenting activity growth of more than 30% per year** (CAGR of 31% between 2011 and 2017). However, it is important to note that [illegible] activity came after 2 years of non patenting activity and this high CAGR would probably decrease within the 5 next years reducing the gap betwee[illegible]
- With the current patenting activity [illegible] **will** [illegible] Indeed, contrary to [illegible] that will show **a small drop** of **its IP activity,** the current patenting activity of [illegible] allows it to **maintain its level of granted patents** while **increasing** the number of new **patent applications**. This trend could also be a sign of a switch of [illegible] filters in order to fulfill 5G requirements.

Comparative Study of IP Players

IP leadership of players at T+5 years in RF BAW filters

BAW

REPORT SAMPLE



The projection is based on a linear evolution of the patent activity of each players over the last 2 years. Thus, any change related to IP, R&D or market strategy is not taking into account in these projections. The number of new pending patent applications corresponds to the trend of patent filings over the last 2 years. The number of granted patents results from the number of the coming expired patents and an estimation of the number of pending patents that will be granted.

Contrary to SAW filters, **BAW** **landscape** will exhibit some **important change** the next years.

The two main IP players **XXX** and **XXX** will show a **decay** of their number of **pending patent applications** and **granted patents.**

XXX will become the **xxx** over **XXX** but will still show a lower number of patent families.

XXX and **XXX** will close the gap to **XX** and become serious **IP challengers**. The three companies will constitute **a new cluster of IP challengers**.

XXX and **XXX** portfolios will merge through their **XXX.** By combining their portfolios, they will become a new serious IP challenger for Skyworks, Broadcom and Taiyo Yuden.

IP profile of key players

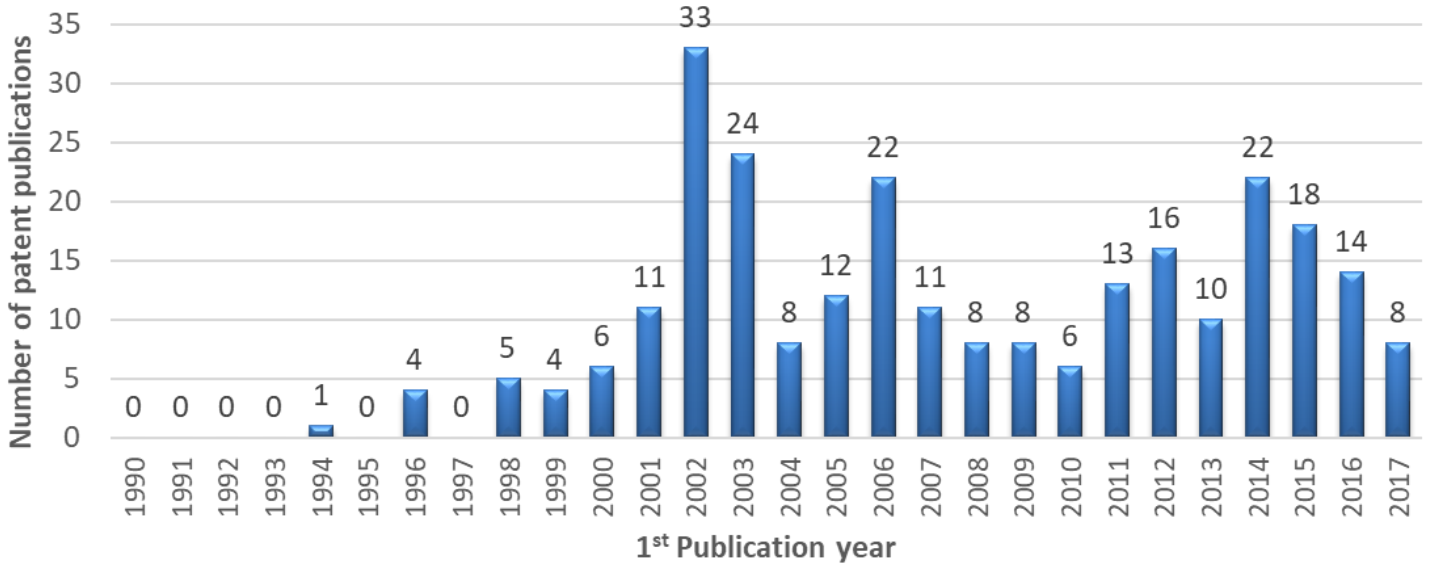
Company X: Portfolio overview

[redacted]

Includes the patents of

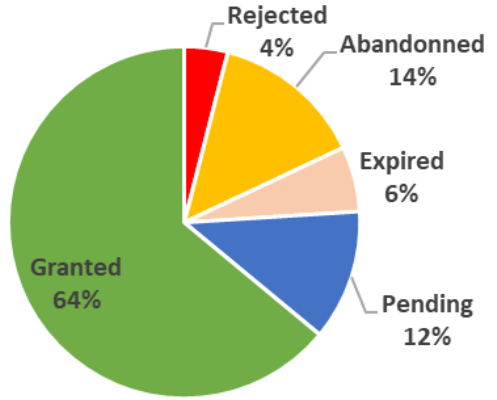
[redacted]

- *268 patent families*
- *[redacted] new patent families since 2016-01-01*

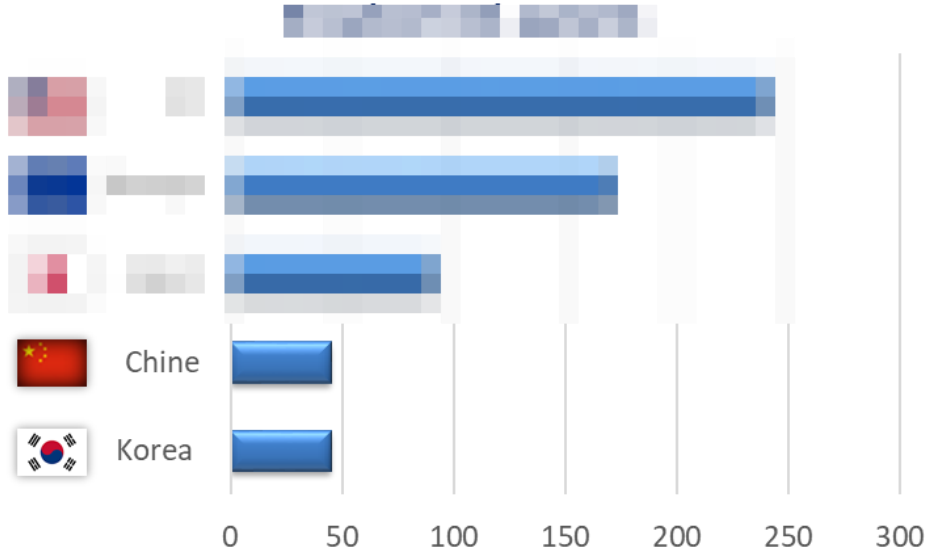


[redacted] IP leader regarding BAW related technology. As the main non Japanese IP player Broadcom focuses its patenting activity in the U.S. and Europe. Furthermore, it also appears as the main aggressive player with no less than 473 litigations.

Legal status of AW filters [redacted]



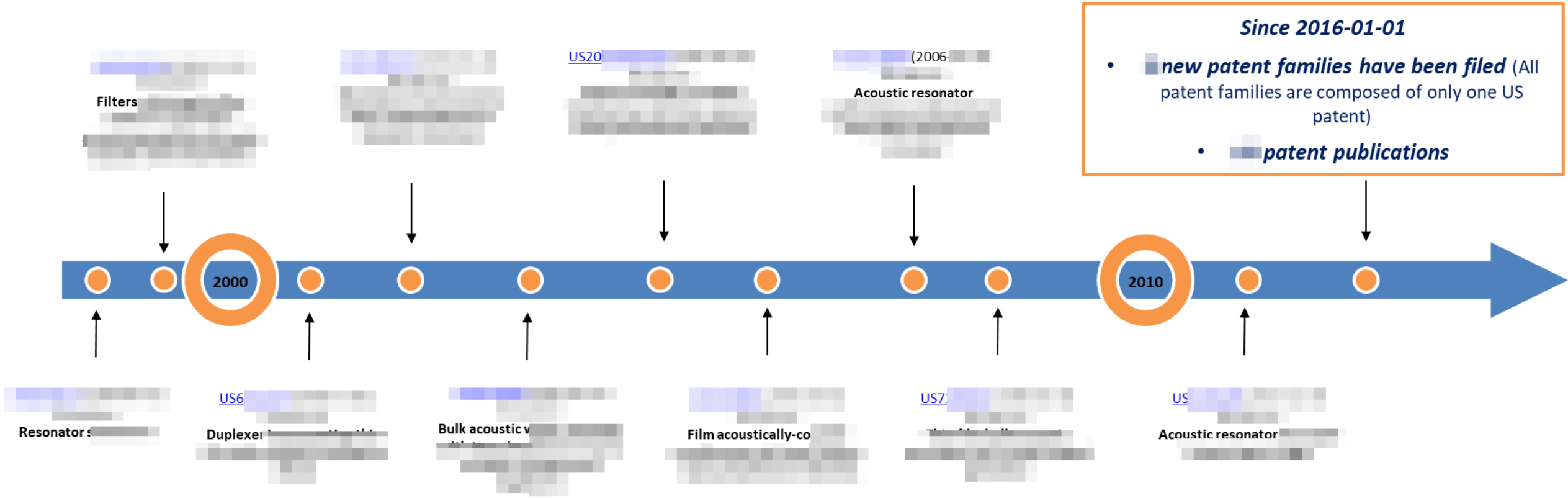
Main countries of applications of [redacted]



IP profile of key players

Company Y: key patents

The selection of **key patent families** is based on the average number of **citations** received by the family per year, the **geographical coverage** of the family (publication countries), the **legal s** the patents (granted, pending, expired, abandoned, rejected) and the patents involved in **litigation**, and it is supplemented by an expert review of **patented technologies**.
The date between brackets corresponds to the 1st publication date of the family and the patent is a representative member of this family.



IP profile of key players

Patents related to Company X's products : **FBAR filter**

System Plus Consulting has performed a reverse engineering study of [redacted]. Among the several specificities of Broadcom component we were able to identify some patents related to:

- The sealing frame and the TSV connection
- [redacted]
- [redacted]

[redacted]

- In step 114 as shown in FIG. 9, a via contact 902 is **formed on the top surface of cap wafer 202**, down via 702, **and onto via pad 403**.
- [redacted]

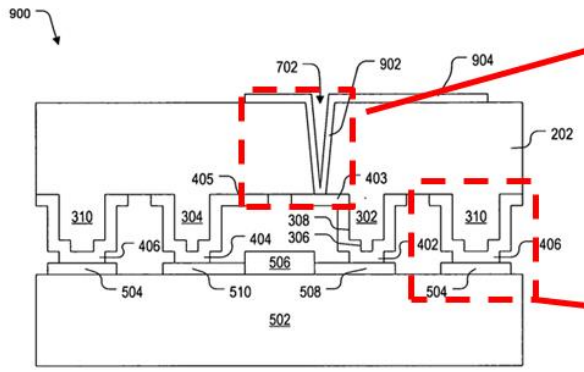
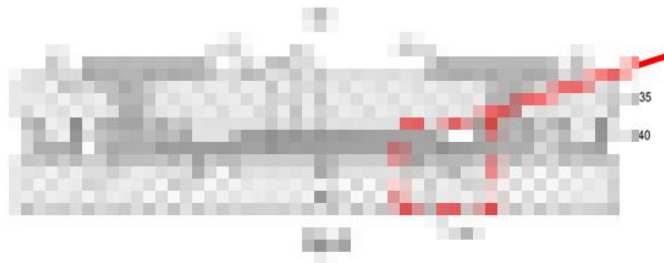
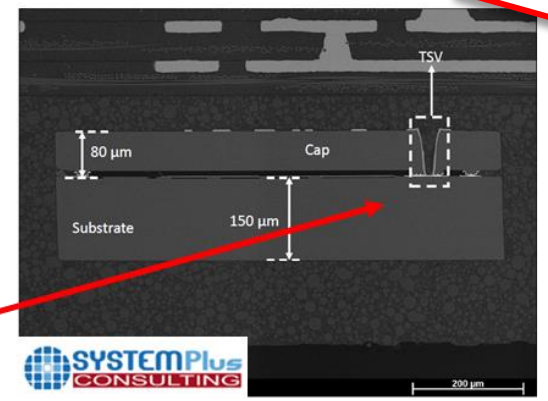


Fig. 9

US20[redacted]

- In the depicted embodiment, **trench 515** is substantially the same **depth as the cavity 510**, although in various alternative embodiments, the trench **515 may extend deeper or shallower** into the substrate 505, or may be wider or narrower





The front-end module is located on the main board of the smartphone, in which Samsung has proposed a different configuration of its LTE front-end part. [redacted] was found in all versions of the Galaxy S7. However, depending on the region, it shared the front-end with [redacted]

IP profile of key players

Summary : patenting activity of main players since 2015

Activity \ Application year	2015	2016
Packaging	Circle size represents the number of patent families	
Modules Patent families related to design of circuit, filters and front end modules	SKYWORKS	
		BROADCOM

Excel Database

with all patents analyzed in the report with technology segmentation

REPORT SAMPLE

This database allows multi-criteria searches and includes patent publication number, hyperlinks to the original documents, priority date, title, abstract, patent assignees, technological segments and legal status for each member of the patent family.

RF Acoustic Wave Filters: Patent Landscape Analysis (September 2017)

KnowMade

								TECHNOLOGY		DEVICE			CHALLENGE	
Family number (Questel-Orbit FamPat ID)	Publication numbers (all members of the family)	Title	Abstract	Original document (PDF)	Earliest priority date (yyyy-mm-)	Current patent assignee(s)	Current Legal status of the patent (Pending, Granted, Revoked, Expired, Lapsed)	SAW	BAW	Duplexers	Diplexers	Multiplexers	Thermal drift compensation	Pack
76701081	WO2016126413 JP6020780 CN106464294 US20170077896 JP2016126413W	(WO2016126413) Radio frequency module	(WO2016126413) Provided is a configuration capable of improving an attenuation characteristic of an RF signal outside a frequency band of a transmitting signal input to a transmitting terminal, and improving an isolation characteristic between a transmitting filter and a receiving filter without increasing the size of a radio	Open	2015-02-25	MURATA MANUFACTURING	(WO2016126413) PENDING (US20170077896) PENDING (JP2016126413W) GRANTED (CN106464294)	×		×				
76700211	WO2016174938 JP6024863 JP2016174938W	(WO2016174938) Ladder-type filter and duplexer	(WO2016174938) The objective of the present invention is to provide a ladder-type filter and a duplexer with which it is possible to improve out-of-band attenuation, achieve satisfactory impedance matching, and reduce insertion loss. The ladder-type filter (1) is a ladder-type filter in which a series-arm circuit configured using	Open	2015-04-30	MURATA MANUFACTURING	(WO2016174938) PENDING (JP2016174938W) GRANTED	×		×				
76700130	WO2016125720 JP6024857 JP2016125720W KR20170072351	(WO2016125720) High-frequency switch module	(WO2016125720) This high-frequency switch module (10) is provided with a switch element (20), a filter element (40), an inductor (30), and transmission conductors (901, 902). The switch element (20) is provided with a common terminal, and selectable terminals (P02, P03) connected selectively to said common terminal. The	Open	2015-02-05	MURATA MANUFACTURING	(WO2016125720) PENDING (JP2016125720W) GRANTED (KR20170072351) PENDING	×						
76699435	WO2016637181 JP6004143 JP2016637181W KR20170049572 CN106797206 DE112015004782 US20170201228	(WO2016637181) Elastic wave resonator and ladder-type filter	(WO2016637181) Provided is an elastic wave resonator which enables size reduction and low loss. An elastic wave resonator 1 has a configuration in which a plurality of divided resonators that are divided in series are provided on a piezoelectric substrate 2. The elastic wave resonator 1 is provided with first and second busbars 7, 8 a	Open	2014-10-21	MURATA MANUFACTURING	(WO2016637181) PENDING (US20170201228) PENDING (DE112015004782) PENDING (JP2016637181W)	×						
76697893	WO2003232486 DE10149542 EP1438787 US20050012568 EP1438787 DE50202400 US6975183	(EP1438787) Baw resonator	(EP1438787) A BAW resonator includes a first piezoelectric layer made of a material oriented toward a first direction, and a second piezoelectric layer made of a material oriented toward a second direction which is opposed to the first direction. The first piezoelectric layer and the second piezoelectric layer are acoustically coupled	Open	2001-10-08	AVAGO TECHNOLOGIES INFINEON TECHNOLOGIES	(WO2003232486) LAPSED (US6975183) GRANTED (DE10149542) LAPSED (EP1438787)	×						
76572189	WO2006103991 DE102004035812 JP2008507869 US20080258845 US7719388	(WO2006103991) Resonator operating with acoustic bulk waves	(WO2006103991) Disclosed is a resonator that is mounted on a substrate, operates with acoustic bulk waves, and is spaced above an acoustic mirror. According to the invention, the basic mode of the acoustic bulk wave that can be generated in the resonator is suppressed while a higher mode can be excited in parallel and be utilized for the	Open	2004-07-23	AKUCHIENGEZERUSHAFUTO EPCOS EPCOS QUALCOMM	(WO2006103991) LAPSED (US7719388) GRANTED (DE102004035812) PENDING (JP2008507869)		×	×				
76571930	WO2006048096 DE102004053319 JP2008519475 US20080136555 US7567148 JP5322087	(WO2006048096) Frequency shunt	(WO2006048096) The invention relates to a frequency shunt comprising an antenna terminal (ANT), a first signal path (S1), and a second signal path (S2). A first band pass filter (F1) is disposed in the first signal path (S1) while a second band pass filter (F2) is arranged in the second signal path (S2). An interface circuit (M1) that is provided	Open	2004-11-04	EPCOS QUALCOMM	(WO2006048096) LAPSED (US7567148) GRANTED (DE102004053319) PENDING (JP5322087)		×		×			
76571876	WO2006037787 TW200605500	(EP1763133) Balance type elastic wave	(EP1763133) The present invention provides a balanced acoustic	Open	2004-06-30	MURATA MANUFACTURING	(EP1763133) LAPSED							

ORDER FORM

RF ACOUSTIC WAVE FILTERS – Patent Landscape Analysis 2017

Ref.:KM17009

SHIP TO

Name (Mr/Ms/Dr/Pr):

_____

Job Title:

_____

Company:

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Address:

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State:

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Postcode/Zip:

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Country:

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VAT ID Number for EU members:

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Date:

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FRANCE

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IBAN: FR76 1560 7000 6360 6214 5695 126
BIC/SWIFT: CCBPFRPPNCE

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

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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.

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"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.

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2. Multi user license: the report can be used by unlimited users within the company. Subsidiaries are not included.

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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:

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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;
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- 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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Prior art
Scientific findings
Opportunities
Partners
Competitors
Newcomers
M&A targets

Patent landscape analysis
Scientific review
IP portfolio assessment
Patent valuation
Freedom-to-operate analysis
Litigation & licensing support
Patents linked to products
Technology scouting
Technology trends
Competitive IP landscape
Market trends
Reverse engineering

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Sustain competitive advantages
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Align R&D and IP with key business objectives
Strengthen IP portfolio and acquire technologies
Anticipate risks and defend core businesses
Explore new opportunities and monetize IP

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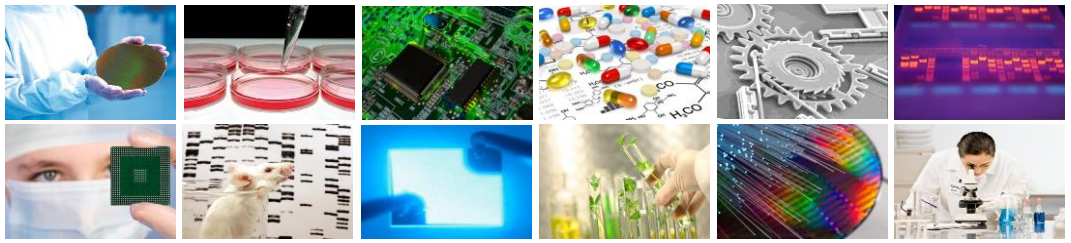

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Each year, **Knowmade** publishes a comprehensive **collection of reports** in various technology fields. These **fact-based analyses** can provide you with the reliable information you need to advance your **business** and your **competitive position**.

TYPE OF REPORT	CONTENT												
	Competitive IP landscape	IP trends	Key patents	Key IP players	IP strategy	IP collaboration network	Licensing agreements	Patent legal status	Patent Litigation	Patent database	Risk assessment	Market trends	Reverse engineering
Patent Landscape Analysis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Patent-to-Product Mapping			✓	✓	✓	✓	✓	✓	✓	✓			✓
Patent Infringement Risk Analysis			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Patent Portfolio Analysis			✓		✓	✓	✓	✓	✓	✓			
Patent Watch (monthly updated)		✓	✓	✓				✓	✓	✓			

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Report collection 2017

COMPOUND SEMICONDUCTORS
- GaN Substrate – Patent Landscape 2017*
- Patent Trolls in the Semiconductor Market – Litigation Risk and Potential Targets 2017
- GaN Technology – Top-100 IP Profiles 2016
- GaN Devices for Power Electronics – Patent Landscape 2015
- GaN-on-Silicon Substrate – Patent Landscape 2014
- GaN Substrate – Patent Landscape 2014
- FD-SOI – Patent Landscape 2014

POWER ELECTRONICS
- GaN Devices for Power Electronics – Patent Landscape 2015

RF DEVICES & TECHNOLOGIES
- RF Acoustic Wave Filters (SAW, BAW, FBAR/SMR) – Patent Landscape 2017

LED
- Phosphors and QDs for LED Applications – Patent Landscape 2015
- Nanowire LED – Patent Landscape 2014

IMAGING
- Uncooled Infrared Imaging – Patent Landscape 2017*
- Consumer Physics SCiO Molecular Sensor – Patent-to-Product Mapping 2017
- Biomedical Photoacoustic Imaging – Patent Landscape 2015
- Honeywell Microbolometer – Patent Portfolio Analysis 2015
- Capsule Endoscopy – Patent Landscape 2014

MEMORY
- 3D Monolithic Memory – Patent Landscape 2017*
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- ReRAM and Memristor Technologies – Patent Landscape 2015
- Emerging Non-Volatile Memories (eNVM) – Patent Landscape 2014

BATTERY AND ENERGY MANAGEMENT
- LiNiMnCo (NMC) Batteries – Patent Landscape 2017
- Microbattery – Patent Landscape 2016

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- Uncooled Infrared Imaging – Patent Landscape 2017*
- Pumps for Microfluidics – Patent Landscape 2017
- Knowles MEMS Microphones in Apple iPhone 7 Plus – Patent-to-Product Mapping 2017
- Microfluidic Technologies for Diagnostic Applications – Patent Landscape 2017
- Consumer Physics SCiO Molecular Sensor – Patent-to-Product Mapping 2017
- Miniaturized Gas Sensors – Patent Landscape 2016
- Microbattery – Patent Landscape 2016
- MEMS Microphone – Patent Infringement Risk Analysis 2015
- Capacitive Fingerprint Sensors – Patent Landscape 2015
- Honeywell Microbolometer – Patent Portfolio Analysis 2015
- 9-Axis MEMS IMU – Patent Infringement Risk Analysis 2014
- Emerging MEMS – Patent Landscape 2014

ADVANCED PACKAGING
- Hybrid Bonding for 3D Stack – Patent Landscape 2017*
- 3D Monolithic Memory – Patent Landscape 2017*
- Fan-Out Wafer Level Packaging – Patent Landscape 2016
- TSV Stacked Memory – Patent Landscape 2016

MEDTECH
- Pumps for Microfluidics – Patent Landscape 2017
- Microfluidic Technologies for Diagnostic Applications – Patent Landscape 2017
- 3D Cell Culture Technologies – Patent Landscape 2016
- Miniaturized Gas Sensors – Patent Landscape 2016
- Non-Invasive Glucose Monitoring – Patent Landscape 2015
- Biomedical Photoacoustic Imaging – Patent Landscape 2015
- Capsule Endoscopy – Patent Landscape 2014

** Coming soon*

Complete list of reports on www.knowmade.com

CUSTOM STUDY & CONSULTING

Tailor-made analysis to meet your needs and budgetary constraints

Prior art search

Evaluate the patentability of your invention in the course of a patent filing.
Invalidate competitor's patents in the course of patent litigation or in anticipation of one.
Make third-party observations concerning the patentability of competitor's inventions.

Patent landscape analysis

Understand the competitive environment and the technology trends from a patent perspective.
Identify key players, their IP strategy and their key patents.
Know IP collaborations, licensing agreements and litigation history.

Freedom-to-operate analysis

Assess the risks to infringe third-party patents.
Ensure that your products/processes can be safely manufactured, sold and used in specific countries without infringing patents held by others.

Litigation and licensing support

Evidence of infringement/non-infringement for offensive/defensive support.
Defend your position in licensing negotiation or patent litigation.

Patent assessment

Identify most valuable patents prior to patent acquisition/sales, licensing agreement, capital fundraising process, M&A or IP due diligence.
Estimate the financial value of your patent portfolio.

IP due diligence

Assess the patent portfolio of a company and reveal the SWOT matrix prior to patent acquisition/sale, licensing agreement or M&A.

Scientific literature analysis

Pinpoint key research findings and new emerging research fields, key laboratories and scientific experts, industrial/academic research collaborations, and identify prospective R&D partners.

Technology scouting

Identify, qualify and get access to external innovation.

Technology watch service

Follow technology trends, keep a watch on your competitors and identify new entrants, anticipate the changes, early detect business opportunities and mitigate the risks.

CUSTOM STUDY & CONSULTING

Tailor-made analysis to meet your needs and budgetary constraints

YOUR NEEDS	OUR CUSTOMIZED STUDIES									
	Prior art search	Patent landscape analysis	Freedom-to-operate analysis	Patent-to-product mapping	Litigation & Licensing support	Patent assessment	IP due diligence	Scientific literature analysis	Technology scouting	Technology watch service
Understand the competitive landscape		✓	✓				✓	✓		
Know the key players and their key patents		✓	✓				✓	✓		
Follow the technology trends and identify emerging technologies		✓						✓		✓
Track competitors, their IP activity, strategy and future intents		✓		✓				✓		✓
Know your competitors' strengths and weaknesses		✓	✓			✓	✓	✓		
Early detect business opportunities		✓						✓		✓
Evaluate the patentability of your inventions	✓									
Invalidate competitors' patents	✓				✓			✓		
Prevent registration of critical patents from competitors	✓				✓					
Identify patents used in products				✓	✓	✓	✓			
Make evidence of patent infringement			✓	✓	✓					
Evaluate the risks to infringe someone else's patents			✓	✓	✓		✓			
Mitigate the risks of patent litigation		✓	✓		✓		✓			
Defend your position in licensing negotiation or patent litigation	✓		✓	✓	✓	✓				
Reduce the risks in M&A			✓			✓	✓			
Evaluate your real patent protection					✓		✓			
Benchmark patent portfolios		✓				✓	✓			
Identify the most valuable patents and estimate their financial value				✓		✓			✓	
Monetize your patents and identify potential licensees/buyers				✓	✓	✓				
Acquire technologies or identify potential licensors		✓		✓	✓	✓		✓	✓	
Speed your R&D and enhance your innovation process		✓						✓	✓	✓
Decrease R&D and IP costs	✓		✓		✓	✓			✓	
Identify free technologies which can be used safely		✓	✓						✓	
Identify key research laboratories and potential R&D partners		✓						✓	✓	

TRAINING & WORKSHOP

Benefit from face-to-face meeting with our experts

Training

Knowmade provides guidance to companies and research laboratories seeking to gain an understanding of the issues linked with competitive intelligence, set up an internal intelligence process or improve their existing processes.

- ✓ Patent information for R&D, strategy and marketing
- ✓ Patent Intelligence: Tapping the economic potential of patent information
- ✓ Technology Intelligence and Innovation
- ✓ Setting up a strategic intelligence unit
- ✓ Intelligence process optimization

Workshop

Objective

One day face-to-face presentation of our data and analysis with Q&A session on specific questions of your choice (direct interaction with our experts at your site)

- ➢ Have the ability to ask questions or for specific analysis before the workshop
- ➢ Access to Knowmade ongoing analyses
- ➢ Direct contact with Knowmade analysts
- ➢ Open Q&A session with the key persons of your company

Content

- ✓ Presentation of updated Knowmade analyses
- ✓ Presentation of the analysis done for your company
- ✓ Executive synthesis
- ✓ Q&A session and open discussion

KnowMade
Patent & Technology Intelligence

KnowMade SARL
2405 route des Dolines
06902 Sophia Antipolis, France

www.knowmade.com
contact@knowmade.fr