

TABLE OF CONTENTS

REPORT SAMPLE	7
 200	

2

INTRODUCTION
Scope of the report
Key feature of the report
Objectives of the report

CONTEXT	
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ITROPUCTION

Market data Mergers and Acquisitions

METHODOLOGY 1	9
Patent search, selection and analysis	
Search equations	
Terminologies for patent analysis	

10

IP LANDSCAPE OVERVIEW 26

Time evolution of patent publications Main countries of filings Time evolution of publication countries Main patent assignees Legal status of patents of main IP players Publication countries of main patent assignees World mapping of patent applications Time evolution of patent assignees

COMPARATIVE STUDY OF IP PLAYERS
IP leadership
IP blocking potential
IP enforcement potential
Strength index
SEGMENT ANALYSIS

Methodology for patent categorization For each segments : Definition Segment overview Time evolution of patent publications Main patent applicants Main IP players countries of publication Key patents of the segment

KEY PATENTS92Seminal patents familiesBlocking patents familiesPromising patent families

GRANTED PATENTS NEAR EXPIRATION 129

IP PROFILE OF KEY PLAYERS

35

42

Murata, Broadcom, Qualcomm, Skyworks, Qorvo, OPPO For each player: IP dynamics Legal status of patents Countries of filings Key patents Strength and weakness of player portfolios **CONCLUSION** 168

KNOWMADE	PRESENTATION	170

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Scope of the report

- This report provides a detailed picture of the patent landscape for RF front end modules (FEM) dedicated to mobile applications.
- This report covers patents published worldwide up to September 2017. We have selected and analyzed more than 3,820 patents and patent applications
 grouped in more than 1,380 patent families relevant to the scope of this report.

Included in the report

• Patents related to RF front end modules for mobile applications and systems claiming their use such as transceivers, receivers and emitters.

Technologies: emitters, receivers, transceivers

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Technologies: MIMO, carrier aggregation, mm waves, beamforming



Not included in the report

Patents related to RF front end module components (PA, LNA, filter, switch, etc.).
Patents related to other applications (defense, medical, wireless charging, etc.) or not compatible with low cost and high-density integration requirements.

US2016094265 Title: Dielectric filter, transceiver and base station Assignee: HUAWEI



The present invention provides a dielectric filter, which resolves a problem that a solid dielectric filter has a difficulty in implementing capacitive coupling. The embodiments of the present invention are mainly used for a radio frequency front-end of a high-power wireless communications base station.

US5758287

Title: Hub and remote cellular telephone system Assignee: VERIZON

> The present invention discloses a hub and remote cellular system having RF generating equipment located at a centralized hub, and RF front end equipment located at each of a plurality of remote omnidirectional cell sites.





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loses a system

REPORT SAMPLE

4

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 (<u>get the report</u>)



"5G's Impact on the RF Front-End Industry" Yole Développement, October 2017 (<u>get the report</u>)



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)

SYSTEMPlus CONSULTING

You may also be interested in our other IP landscape analysis on RF devices for telecommunication applications:



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"RF Acoustic wave filters patent landscape 2017" Knowmade, Septembre 2017 (get the report)



Context RF frond end modules for mobile applications

REPORT J SAMPLE The **RF front end** is a generic term for all the circuitry between the antenna up to and including the mixer stage. It consists of all the components in the that process the signal at the original incoming radio frequency (RF), before it is converted to a lower intermediate frequency (IF). For most architectures, the RF front end consists of:

- A filter to reduce/remove any signals which would interfere with the desired signal. It also prevents strong out-of-band signals from saturating the input stages.
- An **RF amplifier or LNA** (low noise amplifier). Its primary responsibility is to increase the sensitivity of the receiver by amplifying weak signals without contaminating them with noise.
- A **switch module** that is used to route high frequency signals through transmission or reception paths
- A local oscillator (LO) which generates a radio frequency signal at an offset from the incoming signal, which is mixed with the incoming signal.
- The **mixer**, which mixes the incoming signal with the signal from the local oscillator to convert the signal to the intermediate frequency (IF).





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Methodology

Methodology for patent search, selection and analysis





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IP Landscape Overview

Time evolution of patent publications



1st publication year

- Patenting activity related to RF front end module (RF FEM) started around 1970 and a started around
- The patenting activity related to RF FEM has started to grow in the late 90's with the development and democratization of mobile phones. Nevertheless, we notice a flat curve between 2008 and 2012 which can be attributed to the 3G technological plateau. The upcoming 4G and 5G have revitalized the patenting activity which is oriented toward carrier aggregation, beam forming and multi input multi output inventions. This growing trend is in agreement with our conclusions of RF acoustic wave filters patent analysis (KM17009) in which we indicated that the R&D is more and more focus on integration and complex module development.

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IP Landscape Overview

Current legal status of RF FEM patents held by main applicants

Current legal status 3,820+ patents related to RF related to RF FEM 500 front end modules 450 Rejected 400 4% Patent publications Rejected Abandoned Expired Pending Granted 350 Abandoned 300 26% Granted 250 Knowmade © 2018 42% 200 150 Pending Expired 23% 100 5% 50 0 ERICSON

- RF FEM is a quite active domain regarding the IP activity. Indeed, the 65% of alive patents and only 5% of expired patents testify of the actual activity of IP players.
- Indicate the second patents. However, the recent patenting activity of second patents activity of second patents. However, the recent patenting activity of second patent applications, could modify the landscape in the coming years.
- The RF FEM patent landscape is dominated by data and a state of a state of
- We also note the patent portfolios of **Theory Heat and and granted patents**. Despite a relatively small patent portfolios, these companies's patents are **valuable**.



IP Landscape Overview

Countries of patent publications of main patent applicants

	Europe			Asia			America	Other
	Europe	China	Hong Kong	Japan	Korea	Taiwan	USA	PCT (WO)
20.01 MAN 4	49	24	4	41	19	11	74	61
	27	35	14	21	31	27	62	31
- 	10	30	0	36	7	2	39	51
- • • • • •	31	23	2	1	7	21	63	3
LG INNOTEK		•			-		1	
4464	13	12	0	3	9	1	18	13
	12	6	0	5	3	3	26	11
	1	7	0	0	36	0	13	0
SAMSUNG ELECTRONICS	1. A.	1.1			1997 - B	N		
- 100 A	3	3	0	22	3	2	8	10
TAIYO YUDEN	•	-		-	-	N	10 M	
HUAWEI	2	10 A.			-		-	
- • • • • • •	2	2	0	1	1	0	36	3
M 14 T	4	9	0	1	0	7	15	2
ZTE	-	- 22		owmade © 2		:		11
NUMBER OF A	5	3	1	4	3	1	10	9
ALC: UNKNOWN	4	5	0	3	12	0	4	1
AND AND A TRANSPORT	0	9	0	2	2	7	8	0
a transformer services	9	5	0	0	5	0	9	0

REPORT SAMPLE

RF FEM is a key component of today cell proindustry. Thus, it is normal to observe a **worldwide patent coverage** from the **main IP players**.

geographic coverage. Indeed, its patenting activity is focused on

Smaller RF FEM IP players like _____ also have a **domestic patenting activity**. In the case ______ and _____ are the case ______ are the case ____



country appears as essential for any players that want to play a major role in the 5G landscape.

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IP Landscape Overview Time evolution of RF FEM related patents of main patent applicants

Note: In this graph the bubble size represents the number of patent family, the Y-axis the main assignee and the X-axis the 1st application year of the patent family. **Patent Assignee** Knowmade © 2018 Standby 2002 2003 2004 2005 2006 2001 2008 2009 2010 , ₁999 ्र⁸⁹ , 99⁵ , 99⁵ , 99⁵ , 99⁶ , 99⁶ , 99⁶ 1st application year of the patent family result in the appearance of many other companies in the coming years. • While 📲 🔹 🖬 📲 📲 have boosted their activity in 2015. 🚛 📲 📲 📲 📲 🖬 stable IP activity since 2008 with an average of 📲 🖬 🐨 📲 • La manufa and the second to RF FEM, 1 🗰 🖿 🖛 📲 💶 = 50% of its portfolio alive and has filed 2 new patents in 2015. • Regarding the time evolution we thus have a competition between the main market players that have adopted 2 different IP strategies. 📭 📲 📲 📲 📲 📲 📲 We was a light to see by types and particular to the second State of State and State of Sta and the PANA should also be the barry of the provide generation of the barry of the provide

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Comparative Study of IP Players IP leadership of players involved in RF FEM



REPORT SAMPLE

The IP leadership analysis shows **contractions** the **current IP leader** in the RF FEM field.

less pending patent applications or The IP position of both results from their continuous patenting activity since portfolio through IP position of the in the RF FEM domain. The potential acquisition of the interval of the time of

activity related to RF FEM around 2010 and have shown the highest growth rate in these last 7 years. Their IP position is patents compared high number as the main IP challenger.

Based on the current IP activity trend and M&A, Line IP players that will trust the IP leadership in the coming years.



Comparative Study of IP Players IP blocking potential of players involved in RF FEM

600 Circle size blocking potential represents the 500 number of patent families Number of different applicants citing 400 the patent portfolio 300 STERS. 200 100 The more the number of forward citations from different patent applicants is high, the more the capability to limit the patenting activity of other firms is important. 0 Note: This graph is at patent family level. The identification of a "blocking patent" requires an in-depth specific analysis of each patent Knowmade © 2018 documents composing the patent families. 780 180 380 580 980 1180 1380

Number of forward citations (auto-citations excluded)

Their position comes from their in the field of RF FEM combined with their high technological impact. Today, they have the capability to RF FEM

AMPIF

As expected by the IP leadership analysis, because of their young portfolios.

Despite its small patent portfolio, Indeed, patents have the highest citation rate with 6.4 citations per patent on average. patents were filed **around 2005**, at the early stage of RF FEM patenting activity,



Comparative Study of IP Players IP strength index

relative strength index Number of patent families 74 67 65 The second of the second s 62 62 30 NOKIA 34 37 26 4 **1 1** 1 1 1 1 1 74 LG INNOTEK 26 16 MEDIATEK 11 11 20 HUAWEI 11 Nokia 36 THE REPORT OF A very high impact factor 10 MOTOROLA These two companies have 22 average highly 11 manufactory, a set to be the 14 A LET CAR 13 la selline a secondial a FOXCONN 80 60 20 0 0 40

portfolio, which strength index 6 times higher than the average of the top 20 IP players, is the strongest RF FEM patent portfolio. It combines

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in the state

and the second second suffer from respectively a poor geo coverage and a low prior art contribution.

TDK strength mainly comes from its collaborations with Qualcomm. Indeed, 31 of its 62 patent families have been cofiled with Qualcomm and count for more than 80% of its strength index value.

in station

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Segments analysis Corpus segmentation

REPORT SAMPIE The following part is dedicated to the analysis of specific challenges related to the development of RF FEM for 5G applications. Based on our have chosen to focus our analysis on 4 technologies listed below. These technologies can be combined in order to cover a maximum bandwidth spectrum For each segment, the corpus has been segmented using search equations listed in the next page. Each technology is then analyzed regarding the claimed architecture (transmitter, receiver, transceiver)

Carrier Aggregation

• Carrier aggregation (CA) is a method used in order to increase the transmission bandwidths. The method allows to utilize more than one carrier to transfer datas. By using several carriers, with bandwidths of 20 MHz or less, it is thus possible to increase the data spectrum up to 100 MHz.

Multi Input Multi Output (MIMO)

• MIMO is a transmission technique that uses multiple antennae to send the signal and multiple antennae to receive it. This technique is called Spatial Multiplexing. The main goal is to transmit different pieces of information on the same carrier in the same band.

Millimeter waves (mm-waves)

• Mm waves technologies tends to extend the available free spectra by increasing the working frequency above 24GHz where large band of spectrum are available. However, mm waves suffer from high propagation losses and the current hardware solutions offer poor performances.

Beam Forming

• Beam forming or other smart antenna solutions consist in enhancing the performances of the signal by combining signal from multiple antenna with different gain and directivity in order to increase the spatial selectivity.



Segments analysis Time evolution of patent applications per segments



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RF front end module for cellphones

IP activity vs technology maturity

IP activity



[1] https://semiengineering.com/inside-the-5g-smartphone/

[2] http://www.skyworksinc.com/downloads/literature/Skyworks-5G%20White-Paper.pdf



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Segments analysis Main patent applicants by segment

REPORT I SAMPLE INCOMENDATION. while the Beamforming **Carrier aggregation** MIMO **Mm Waves** supported particular han te t 4 5 1 2 oja revo **O**IIALCOMM. TRANSMITTERS HUAWEI SHAANXI FENGHUO COMMUNICATION GROUP CO.,LTD 陕西纬大通信集团有限公司 19 11 16 €. SKYWORKS RECEIVERS Infineon 49 55 11 7 SAMSUNG (intel) ELECTRONICS TRANSCEIVERS oppo ERICSSON

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Seminal patent families

Seminal patents since 1990

A seminal patent has a strong technology impact and contribution. It has the capability to limit the patenting activ tant prior art



- 1st publication year Seminal patent families **filed before 2003** are related to RF FEM and transceiver architectures that enhance performances. They especially focus on ٠ • In the second se we wilde as the second problem of the data data in the state of the second state of the second problem and the second state of the
- Between 2003 and 2011, seminal patent families have been mostly related Market Market Market Paris. During that period, the most cited patent family ٠ dedicated to **3G applications**. The most cited patent of the last 7 vears has been filed **be and the second seco** no su dan janda mi art manufacturing process. ٠
 - These inventions are identified Since 2012, as seminal patent families and show the high interest of IP players on this technological approach as well as technologies.



Blocking patent families

Blocking potential



that involve telecommunication related patents (international patent class = H04)



Blocking patents:

A blocking patent is enforceable and has the capability to limit the freedom of operation of the other firms in key countries.

The red dot indicate that member(s) of the family is or has been used in litigations. The patents are then presented in the next section of the report (here).

- Indexe a seen previously (see here) has an high number of patent families addressing MIMO communications. As seen previously (see here) has an high a second seco

IP profile of key players

Company overview

- Name: •
- Foundation:
- Size : > :
 Employees
- Website:
- Headquarter: 14 1 home arms to here. Aspendick, a to form high the high state.
- Net Income (Profit/Loss):
- Activity: The second state of the second

Company overview:

First and Philipping Space (Manager Space and Spac Space and Spac Space and S Space and Spac

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Construction of the second se second sec

IP profile of key players

RF FEM patent portfolio overview





• 20 new patent families since 2016-01-01

Time evolution of patent family applications Number of patent families 1999 2010 2013 1st application year

patenting activity related to RF FEM has started around 2010 which corresponds to the decreasing activity of filters and explains the low percentage of granted patents in the field. Regarding their geo coverage **data decreasing** activity of filters and explains the low percentage of granted patents in the field. Regarding their geo coverage **data decreasing** aglobal strategy (numerous WO applications) but also show a good development in Japan **data decreasing data decreasin**

* See our acoustic wave filters report (KM17009)







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IP profile of key players RF FEM key patents

a RF FEM IP challengers that has develop its related patent portfolio in the continuity of its R&D activity dedicated increase of patenting activity testifies of increase of patenting activity testifies of increase of patent families that are oriented toward the integration of components. The second challenge addressed by is the development of high frequency modules. Indeed, is the addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands. In addition, is addressing 5G applications is to enhance the modules and components performances in the sub 5GHz and 24GHz-60GHz bands.



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SAMOI

Excel Database

with all patents analyzed in the report with technology segmentation





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 Front End Modules for Cellphones - Patent List (January 2018)

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Questel unique family ID	Patent number	Title 🔽	Astract	Application data	Publication data	Expected expiry date	Current assigned	Inventors	Current legal status	Link to PDF	Beamforming	Carrier aggregation	мімо	T	Min waves
77852579	W02016195844	(WO2016195844) Systems, devices and	Systems, devices and methods related to	2016-04-26	2016-12-08	2036-04-26	SKYWORKS SOLUTIONS ([US])	WLOCZYSIAK STEPHANE	PENDING	<u>Open</u>		×	×		
77852579	TW201711377	(TW201711377) Systems, devices and	Systems, devices and methods related to	26/04/2016	2016-12-08	2036-04-29	SKYWORKS SOLUTIONS ([US])	WLOCZYSIAK STEPHANE	PENDING	<u>Open</u>		×	×		
77852579	SG11201703358V	(SG11201703358V) Systems, devices and	Systems, devices and methods related to	2016-04-26	2016-12-08	2036-04-26	SKYWORKS SOLUTIONS ([US])	WLOCZYSIAK STEPHANE	PENDING	Open		×	×		
77852579	CN107113050	(CN107113050) Systems, devices and	Systems, devices and methods related to	2016-04-26	2016-12-08	2036-04-26	SKYWORKS SOLUTIONS	WLOCZYSIAK STEPHANE	PENDING	<u>Open</u>		×	×		
77852579	GB201708567 GB2548043	(GB2548043) Systems,devices and	Systems, devices and methods related to	2016-04-26	2016-12-08	2036-04-26	SKYWORKS SOLUTIONS ([US])	STEPHANE RICHARD MARIE	PENDING	<u>Open</u>		×	×		
77852579	KR20180004699	(KR20180004633) Systems, devices and	다이버시티 수신기에 관련한 시스템,	2016-04-26	2016-12-08	2036-04-26	SKYWORKS SOLUTIONS	Not available	PENDING	<u>Open</u>		×	×		
77851560	US2015035637	(US20150035637) Advanced 3d	Embodiments of an apparatus that	2014-08-01	2015-02-05	2034-08-01	QORVO	MAXIM GEORGE ([US])	PENDING	Open		×	×		



ORDER FORM

RF FRONT END MODULES FOR CELLPHONES

Patent Landscape Analysis – January 2018

Ref.:KM18002

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2. MAILING OF THE PRODUCTS

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cases where a new event or access to new contradictory information would require for the analyst extra undertakes to replace the defective products as far as the supplies allow and without indemnities or The Seller may, from time to time, update these Terms and Conditions and the Buyer, is deemed to have time to compute or compare the data in order to enable the Seller to deliver a high quality Products.

conditions contained in article 3.

download or receipt of the Product.

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IBAN: : FR76 1560 7000 6360 6214 5695 126

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.

the right to invoice at the stage in progress, and to take legal action for damages.

4. LIABILITIES

Buver and the Seller. ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY Products for its business activities, shall be solely responsible for choosing the Products and for the use and OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, SHALL interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and

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

1.3 Orders are deemed to be accepted only upon written acceptance and confirmation by the Seller, within arising out of the use of or inability to use the Seller's website or the Products, or any information provided may be borne by the Seller, following this decision.

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 All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its the liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product Buyer. initially ordered.

The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including in 4.6 In the case where, after inspection, it is acknowledged that the Products contain defects, the Seller by the other Party. 2.3 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for in due time. any event as set out in article 5 below.

2.4 The mailing is operated through electronic means either by email via the sales department. If the 4.7 The deadlines that the Seller is asked to state for the mailing of the Products are given for information 9. GOVERNING LAW AND JURISDICTION Product's electronic delivery format is defective, the Seller undertakes to replace it at no charge to the only and are not guaranteed. If such deadlines are not met, it shall not lead to any damages or cancellation 9.1 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into information from the Seller. In such case only, the Buyer shall be entitled to ask for a reimbursement of its which shall have exclusive jurisdiction upon such issues.

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 3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to 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 To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this 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 accepts these conditions of sales when signing the purchase order which mentions "I hereby accept a) damages of any kind, including without limitation, incidental or consequential damages (including, but indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer not limited to, damages for loss of profits, business interruption and loss of programs or information) of such delay or cancellation. This may also apply for any other direct or indirect consequential loss that

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

use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in by or substituted with similar Products meeting the needs of the Buyer. This modification shall not lead to licensors, employees and agents. Each of them is entitled to assert and enforce those provisions against the

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

compensation of any kind for labor costs, delays, loss caused or any other reason. The replacement is accepted the latest version of these terms and conditions, provided they have been communicated to him

Buyer provided that it is informed of the defective formatting within 90 days from the date of the original of the orders, except for non-acceptable delays exceeding [4] months from the stated deadline, without in application of these Terms and Conditions shall be settled by the French Commercial Courts of Grasse,

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







www.knowmade.com contact@knowmade.fr KnowMade S.A.R.L., 2405 route des Dolines, CS 10065, 06902 Sophia Antipolis, France

KNOWMADE

Technology Intelligence and IP Strategy consulting company

Compound Semiconductors | Power & RF/microwave Electronics | LED/OLED Lighting & Display | Photonics | Memories | Solid-state Sensors, Actuators and Microsystems | Manufacturing & Advanced packaging | Batteries & Energy management | Biotechnology | Pharmaceuticals | Medical Devices | Medical Imaging | Agri-Food & Environment.

Executive team



Dr. Nicolas Baron

CEO and co-founder of Knowmade.

He leads the Physics department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis, and a Master degree in Intellectual Property Strategies and Innovation from the European Institute for Enterprise and Intellectual Property (IEEPI Strasbourg), France.



Dr. Brice Sagot

CTO 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.

Analyst team

5 full time analysts with PhD degree and in-depth knowledge in Intellectual Property and Scientific Information.

Founded in 2009 Headquartered in Sophia Antipolis FRANCE



JEI since 2013 (Innovative New Company) CIR accreditation since 2012 (Research Tax Credit)



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KNOWMADE OFFERS YOU THE CAPABILITY TO

- ✓ **Understand** your competitive environment
- ✓ **Follow** technology trends
- Identify patent/technology opportunities
- ✓ Assess patent/technology risks
- ✓ Strategize your IP and R&D
- ✓ Monetize your technologies and know-how
- ✓ Defend your business

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MEMS, Sensors & Actuators

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Make strategic decisions Sustain competitive advantages Speed R&D and enhance innovation process 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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INTELLIGENCE CYCLE

Tracking key technologies and competitors' R&D activities in order to anticipate changes, early detect business opportunities, mitigate risks, and make strategic decisions





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KnowMade

CLIENT BENEFITS

Understand your competitive environment fro and patent perspective and patent perspective and patent perspective and patent perspective and patent perspective understand technology & market from a pate Discover new markets & technology direction Understand the competitive landscape Understand the competitive landscape Know where your competition is headed Identify your current and future competitors Understand your competitors' strategic product offerings Determine your competitors' strengths and w Identify strategic partnerships Identify untapped areas and opportunities patenting activity	m technology re.ent perspective n.Speed your R&D at Sustain competitive Protect your core to .Anticipate the risk .Assess your IP por .Realize the full value .Explore new oppor .Strengthen your IP .Align your R&D and .Leverage your IP p.Identify new rever </th <th>Strategize our R&D and IP portfolio nd enhance your innovation e advantages technologies from competito s tfolio and competitive positio ue of your IP portfolio rtunities position d IP portfolio with key busine ortfolio to make strategic bu bue opportunities risks</th>	Strategize our R&D and IP portfolio nd enhance your innovation e advantages technologies from competito s tfolio and competitive positio ue of your IP portfolio rtunities position d IP portfolio with key busine ortfolio to make strategic bu bue opportunities risks
Build	Defend	Mone

an effective R&D and IP portfolio

- Strengthen your IP portfolio
- Acquire technologies and know-how
- Optimize your patent prosecution budget
- Improve your patent application process

 Protect key markets and products by leveraging your IP to address competitive

your business

- threats
- Defend your position in licensing negotiations or patent litigation

Monetize your IP portfolio

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ess objectives siness decisions

- Turn your IP portfolio into valuable asset
- Assert your patent rights
- Develop successful patent sales or licensing program
- Improve your position in licensing negotiations or patent litigation



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- With an established base of more than 100 customers worldwide, Knowmade benefits from a global perspective of innovative technologies.
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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.

IP & Technology watch service

Follow IP/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	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		V	I					V			
Know the key players and their key patents		V						V			
Follow the technology trends and identify emerging technologies		V						V		V	
Track competitors, their IP activity, strategy and future intents		V		 Image: A start of the start of				V		I	
Know your competitors' strengths and weaknesses			V			Ø		V			
Early detect business opportunities								V		Ø	
Evaluate the patentability of your inventions	V										
Invalidate competitors' patents	V				I			V			
Prevent registration of critical patents from competitors					Ø						
Identify patents used in products				 Image: A start of the start of	I	V					
Make evidence of patent infringement			I		Ø						
Evaluate the risks to infringe someone else's patents					I		 Image: A start of the start of				
Mitigate the risks of patent litigation			Ø				I				
Defend your position in licensing negotiation or patent litigation			I		Ø	Ø					
Reduce the risks in M&A			I			Ø	 Image: A set of the set of the				
Evaluate your real patent protection					Ø						
Benchmark patent portfolios		V					 Image: A set of the set of the				
Identify the most valuable patents and estimate their financial value				V		V			V		
Monetize your patents and identify potential licensees/buyers											
Acquire technologies or identify potential licensors		V			 Image: A set of the set of the			~	I		
Speed your R&D and enhance your innovation process								~		V	
Decrease R&D and IP costs	~				 Image: A start of the start of	V					
Identify free technologies which can be used safely		V									
Identify key research laboratories and potential R&D partners		~						~			



Knowmade team of experts work all year long to collect patent and scientific information, identify and analyze the trends, the challenges, the emerging technologies, the competitive environments, and turn it into results to give you a complete picture of your industry landscape.

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			Ø		V	I	V	I		V		V		
Patent-to-Product Mapping			Ø	V	Ø	Ø		V	I	V				
Patent Infringement Risk Analysis					V	I	V	I			I			
Patent Portfolio Analysis			Ø		V	I	I	I	V	V				
Patent Watch (monthly updated)			Ø											



COMPOUND SEMICONDUCTORS

- Status of the GaN IP Patent Activity 2017 + Patent Watch 2018*
- RF GaN Patent Landscape 2018*
- Power SiC Patent Landscape 2018*
- 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

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- Power SiC Patent Landscape 2018*
- Wireless Power Charging Patent Landscape 2017
- GaN Devices for Power Electronics Patent Landscape 2015

RF DEVICES & TECHNOLOGIES

- RF GaN Patent Landscape 2018*
- RF Front End Module Patent Landscape 2018*
- RF Acoustic Wave Filters Patent Landscape 2017

LED/OLED LIGHTING & DISPLAYS

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- Phosphors and QDs for LED Applications Patent Landscape 2015
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- Patent Trolls in the Semiconductor Market Litigation Risk and Potential Targets 2017
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- Microfluidic Technologies for Diagnostic Applications Patent Landscape 2017
- Consumer Physics SCiO Molecular Sensor Patent-to-Product Mapping 2017
- Miniaturized Gas Sensors Patent Landscape 2016
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- Capacitive Fingerprint Sensors Patent Landscape 2015
- Capacitive Fingerprint Sensors Patent Infringement Risk Analysis 2015
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- Emerging MEMS Patent Landscape 2014

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- Microfluidic Technologies for Diagnostic Applications Patent Landscape 2017
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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.

- \checkmark Patent information for R&D, strategy and marketing
- ✓ Patent Intelligence: Tapping the economic potential of patent information
- ✓ Technology Intelligence and Innovation
- \checkmark 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

(C)KnowMade

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







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