GaN Devices for Power Electronics
Patent Investigation
A New Type of Report Providing a Clear Link Between IP Situation and Market Evolutions

A Patent Investigation allows understanding the technology & market from a patent perspective.
• More than describing the status of the IP situation, a Patent Investigation provides a missing link between patented technological solutions and market, technological and business trends.
• In-depth technological analysis of patents leads to understanding of strategic decisions and positioning of key players within the value chain.
• By combining their technical knowledge, business understanding and patent search, Yole Développement and Knowmade are able to provide unique analysis and added value in this report.

Yole & Knowmade’s New Reports
• Essential patent data
• Patent analysis
• Technological segmentations
• Technology analysis
• Key players & key patents
• Market trends
• Market implication of IP landscape
• Full searchable patent database
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SCOPE OF THE REPORT

• This report provides a detailed picture of the patent landscape for Power Electronics based on III-nitride materials. All patents related to GaN for power applications were considered: substrates, epi-wafers, semiconductor devices, transistors, diodes, discrete components, power module, packaging, circuits and systems.

• This report covers patents published worldwide up to April 2015. We have selected and analyzed more than 4,900 patents split in more than 1,960 patent families relevant to the scope of this report.

• The patents have been manually categorized by
  ▪ Technological segment: substrates & epi-wafers, semiconductor devices, discrete components, power modules, packaging, circuits and power systems.
  ▪ Substrate for GaN: bulk, SiC, Si, Sapphire.

• Market data from Yole Développement are also provided to add some context regarding business trends and metrics.

• This report provides a clear link between the IP situation and the market evolutions.

• Note that essential patent data on GaN-on-Silicon technology have been analyzed last year in our report “GaN-on-Silicon Substrate Patent Investigation” published in April 2014 (more details).
METHODOLOGY (1/2)

• The data were extracted from the FamPat worldwide database (Questel-ORBIT) which provides 80+ million documents from 95 offices.

• The patents search was performed in April 2015, hence patents published after this date will not be available in this report.

• The patent selection was done manually.

Number of selected patents for the Power GaN Patent Investigation:

1,962 patent families comprising 4,900+ patents

• The statistical analysis was performed with Orbit IP Business Intelligence web based patent analysis software from Questel.

• The patents were manually categorized using keyword analysis of patent title, abstract and claims, in conjunction with expert review of the subject-matter of inventions.

• A patent family is a set of patents filed in multiple countries to protect a single invention by a common inventor(s). The patents were organized according to FamPat’s family rules (variation of EPO strict family http://www.epo.org/searching/essentials/patent-families/definitions.html): A Patent Family comprises patents linked by exactly same priority numbers (EPO strict family), plus comparison of priority and application numbers, specific rules by country and information gathered from other sources (national files, legal status ...).
METHODOLOGY (2/2)

Phase I

- Keywords and term-set definition
- Search equations / Search strategy

Phase II

- Patent screening
  - Fine search using IPC classes and citations analysis
  - Patent classification
    - Related
    - Relevant
    - Non relevant
  - Technological Segmentation
    - Segmentation improvement during IP Investigation

Phase III

- Patent Investigation
  - Landscape Overview
  - In-depth analysis on Key Technology Segments and Key Players
  - Patent Ranking and Key Patents analysis
  - Market Implication of IP Landscape
  - Market Trends & Forecast
PATENT SEGMENTATION (1/3)

The **1,962 patents** were manually categorized using keyword analysis of patent title, abstract and claims, in conjunction with expert review of the object of inventions.

In this report we use the following patent segmentation:

- **Technology Level**
  - Wafers
  - Semiconductor Devices
  - Components
  - Circuits & Systems

- **Substrate for GaN**
  - GaN-on-SiC
  - GaN-on-Si
  - GaN-on-Sapphire
  - GaN bulk

- **Technology Challenges**
  - Vertical Device (CAVET)
  - E-mode (N-off)
  - E/D-mode Monolithic
  - Cascode (N-off)
  - Breakdown Voltage
  - Dynamic R-on
  - Current Collapse
  - Gate Charge (Miller effect)
  - Stray Inductance
  - Chip-Scale Package
  - Thermal Issues

Substrates & Epi-wafers for power electronics, and Epitaxy, Doping, Material issues ...

Transistors (HEMT, HFET, MOSFET, JFET ...) and Diodes at the semiconductor level

Discrete components, Power modules and Packaging

Drive circuit, switching circuit, control circuit, PFC circuit ... Inverters, Converters ...

Components

Substrates & Epi-wafers for power electronics, and Epitaxy, Doping, Material issues ...
INTRODUCTION

GaN Devices in Power Application

GaN device market size split by applicative markets (M$)

Yole Développement, 2015
Studies into the suitability of the GaN material for power applications began in 2006, and coincide with the first wave of patent filings. The number of patent publications has sharply increased since 2010 with the commercialization of first Power GaN devices. Currently, the second peak of patent filings combined to the increase of granted patents is a positive indication that GaN Power market is ramping up. So far, there are only a few players selling Power GaN products (Infineon/IR, EPC, GaN Systems and Transphorm) and the GaN device market is still small, estimated at $10M in 2015. But the ramp-up will be quite impressive starting in 2016. The market will multiply by 30 from now and reach more than $300M in 2020 (Yole Développement, GaN and SiC for power electronics applications, Jul 2015).
IP OVERVIEW

Power GaN Patent Assignees

Ranking of Patent Assignees (according to their patent portfolio size)

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250+ patent applicants have filed patents on GaN Power Electronics.


Other non-profit organizations: University Tohoku, CEA, CNRS, US Navy, ETRI, Massachusetts Institute Of Technology (MIT), AIST, Fudan University, ITRI, Kyungpook National University, Nanjing University Of Aeronautics & Astronautics (Nuaa), National Chiao Tung University, Suzhou Inst. of Nano Tech. & Nano Bionics, Univ. of California, Agency for Sci. Tech. & Res. (ASTAR), California Inst. of Tech. (CalTech), Hong Kong Univ. of Sci. & Tech., Insti. of Semiconductors (Chinese Aca. Of Sci.), Inst. of Microelectronics (Chinese Aca. Of Sci.), CINES, Central Research Institute of Electric Power Industry (CRIEPI), Nagoya University ...
IP OVERVIEW

IP Collaboration Network

- Number in black on each link between patent assignees is the **number of co-assigned patent families** in the data set of the study.
- Number up right to each bubble is the number of patent families for this applicant in the data set of the study. Bubble size is proportional to the number of patent families selected for the study.
IP OVERVIEW
Power GaN Patent Assignees

- **Mitsubishi Electric**, a top Si power player already involved in SiC devices, is the top patent assignee in quantitative point of view more than 200 patent families related to the Power GaN domain, especially focused on power products including a GaN-based Fast Switching Module (FSM). Mitsubishi Electric has shown an interest in Power GaN technology quite recently, since 2010, with a strong increase of its patenting activity in this domain these last years. The company co-assigned several patents with Toshiba Mitsubishi Electric Co., a joint venture between Toshiba and Mitsubishi Electric.

- **International Rectifier (IR)**, with 120+ patents families related to Power GaN, leads the time-to-commercialization race of GaN Power devices. In 2009 the company launched its GaNpowIR™ GaN-based power device platform after five years of R&D on GaN-on-silicon epitaxial technology. In 2010 IR claimed the first commercial GaN-based integrated power stage devices (ip2010 and ip2011 family of devices). IR was acquired by **Infineon** in August 2014 (read more). This acquisition does not yet appear in patent databases. The re-assignment of patents should be expected in the next months.

- **Infineon**, as the market leader for power semiconductors, has pursued a partnership approach to accelerate their GaN development: e.g. intense collaboration with the Fraunhofer society, and involvement in two major German programs related to GaN technology—NeuLand (2010-2013) and HiPoSwitch (2011-2014). More than 60 patent families related to Power GaN have been selected for this study. Infineon acquired International rectifier in Aug. 2014 with a focus on their GaN-on-Silicon technology and intellectual property (read more). This acquisition is an important step for Infineon to bolster its position as a global market leader in power semiconductors. The combined company gains greater scope in Power GaN patent portfolio with 100+ combined patent families selected for this study. International Rectifier developed normally-off GaN HiMOS™ top gate power devices based on NMOS, with lower voltage (1200 V) products. Meanwhile, Infineon developed advanced high-stability HiMOS technology. Infineon’s product portfolio is complementary to Infineon’s with 300 V products (available). 1200 V products is in a standard configuration targeting medium power HiMOS and high current. **Infineon** recently announced a partnership with **Panasonic** for a jointly development of GaN devices based on Panasonic’s normally-off GaN-on-Silicon transistor structure integrated into Infineon’s SMD packages. In this context **Panasonic** has provided Infineon with a license of its normally-off GaN transistor technology which started in 2014. Infineon’s first products will be discrete GaN switches in SMD packages targeting high power SMPS in the PFC and main DC-DC stage.
IP OVERVIEW

Power GaN Patent Assignees

- Panasonic developed its normally-off GaN power technology (original N-off gate injection transistor GtT). In 2009, it demonstrated the first monolithic integration of a six-HEMT inverter circuit. Panasonic Electric Works merged with Panasonic in Jan 2012. For this study, we have selected 1,344 patent families related to Power GaN (Panasonic, Panasonic IP Management, Panasonic Electric Works, Panasonic expert in materials for the expansion of GaN power devices by licensing their multifunction GaN transistors out of these GaN power technology to

- Transphorm is a new GaN pure-player entrant. More than 70 patent families related to Power GaN were selected for this study. The company introduced the 600V GaN-on-SiC products (EZ-GaN™ platform) in 2011, and the 600V GaN-on-Si Diode & HEMT in 2013. Transphorm obtained in 2013 a non-exclusive worldwide patent license agreement to Cree (GaN HEMT & Schottky diode), and in 2014 an exclusive worldwide license to Furukawa Electric’s extensive GaN power device portfolio, which includes about 3,000 US issued patents and 1,111 Japanese issued patents. Transphorm also has certain rights to sublicense these patents (read more). Note that this agreement does not yet appear in patent databases. The co-assigned patent families could be revealed in the next months. As part of the IP agreement, Furukawa Electric also made a significant equity investment and obtained a minority equity stake in the company. Furukawa Electric has had research on Power GaN since the 1990s, but the company hasn’t been able yet to commercialize the technology on its own. Converting orphaned IP to revenue by patent licensing isn’t an easy road, but Furukawa Electric found a strategic partner that is well-positioned and well-funded to bring its technology to market.

- Transphorm, Fujitsu and Fujitsu Semiconductor announced in 2013 that they have reached an agreement whereby Fujitsu Semiconductor and Transphorm will integrate their gallium-nitride (GaN) power devices for power supplies businesses (read more). The three companies have also agreed that both Fujitsu and Fujitsu Semiconductor will take a minority equity position in Transphorm. Transphorm acquires Fujitsu’s GaN Power Conversion business, and the two companies announced the formation of a new company: Transphorm-Japan, a wholly-owned subsidiary of Transphorm (read more). The present report includes 110 patient families filed by Fujitsu and re-assigned to Transphorm-Japan in 2014. These patents are mainly focused on GaN technology and power supply applications. In 2017 Transphorm announced its high current boundary modulator using through its relationship with Fujitsu.

- Transphorm began a partnership with Qorvo Semiconductor in 2014 to co-develop and co-market GaN-based products and power system solutions. Let’s note the absence of Qorvo Semiconductor in the presented patent landscape, as no Power GaN patents have been identified.
# IP OVERVIEW


### Si power pure-players
- **Infineon**
- **Renesas**
- **SUMITOMO ELECTRIC**
- **MITSUBISHI ELECTRIC**
- **FUJITSU Semiconductor**
- **TOSHIBA**
- **ROHM**
- **NXP**
- **TOYOTA**
- **RFMD**
- **MOTOROLA**
- **HITACHI**
- **KOREA ELECTRONIC INVESTMENT CO.**
- **FAIRCHILD SEMICONDUCTOR**
- **SHINDENGEN**

### Si power players already involved in III-V & Compounds
- **LG Electronics**
- **SAMSUNG**
- **SHARP**
- **PANASONIC**
- **CREE**
- **CSSI**
- **DAIKIN**
- **YASKAWA**

### Semicon global players with GaN LED activity
- **LG Electronics**
- **SAMSUNG**
- **SHARP**
- **PANASONIC**
- **CREE**

### New GaN pure-player entrants
- **transphorm**
- **EPC**
- **SEUL**
- **SEOUL**

### LED pure-players
- **VisIC Technologies**

### From Si to GaN
- **Infineon** acquired **International Rectifier** (Aug. 2014).
- **Panasonic** licenses their N-off GaN transistor out to **Infineon** in 2015.
- **Transphorm** obtained in 2013 a non-exclusive worldwide patent license agreement to Cree (GaN HEMT & Schottky diode). In 2014 it obtained exclusive licensing rights to **Furukawa Electric**’s GaN patent portfolio.

### From compound semi to power GaN
- **Infineon**
- **LSI**
- **SIEMENS**
- **NXP**
- **Freescale**
- **Intel**
- **Texas Instruments**
- **Texas Instruments**
- **Texas Instruments**

### From LED & Power to GaN
- **Infineon**
- **LSI**
- **SIEMENS**
- **NXP**
- **Freescale**
- **Intel**
- **Texas Instruments**
- **Texas Instruments**
- **Texas Instruments**

### GaN from scratch
- **Fujitsu Semiconductor** and **Transphorm** collaborate (business integration of their GaN power device solutions in Nov 2013. Start of mass production of **Transphorm**’s GaN power devices in Jan 2015).
- **NXP** and **Freescale** merged in March 2015.
- **Velox Semiconductor** acquired by **Power Integrations** in 2010.

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**IP OVERVIEW**

Time Evolution of Patent Publications

Dates are defined from the earliest publication date for each patent family. Bubble size is proportional to the number of published patent families.

**Note:** The data corresponding to the year 2015 may not be complete since the patent search was done early March 2015.

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**Note:**
- Infineon acquired IR in 2014.
- Licensing agreements: Infineon/Panasonic, Transphorm/Furukawa.
- Collaborations: Transphorm/Fujitsu, Silicon Valley Bank co-assignee of Avogy’s patents.

- **The first wave** of patent publications between 2005 and 2009 is mainly due to Infineon-Infineon Corp (International Player, Power Inte-grated), and Panasonic Corp (Panasonic, Power, Electronics, Electronics, Toshiba, Kyocera).
- **Mitsubishi** and **Fujitsu** have shown an interest in Power GaN technology since 2010 with a significant increase of their patenting activity in this domain.
- The patents published in the **second period** (2010-2014) mainly originate from Infineon Technologies (Infineon, Infineon AG), Fujitsu Ltd, Transphorm USA, Avogy USA, Infineon Japan and Panasonic USA.
ANNOUNCED GAN TRANSISTOR PRODUCTS

Studies into the suitability of the GaN material for power applications began in 2006.

**First Appearance of Key Players in the Power GaN IP arena**

- **GaNpowerIR™ Gen 1.1**
  - 800 V / Si GaN FET
  - Nov. 2008
- **EPC**
  - 200 V / Si GaN Noff HEMT
  - (eGaN) Mar. 2010
- **SanKen**
  - 1260 V / Si GaN Noff FET
  - Dec. 2009
- **RENESAS**
  - 600 V / Si GaN HFET
  - May 2010
- **Microsemi**
  - 600V / SiC E-Z-GaN Transistor
  - 2011
  - (EZ-GaN™ platform)
- **transphorm**
  - 200 V / Si E-mode GaN FET
  - Mar. 2011
- **IOR**
  - 30 V / Si Point-of-Load
  - 2010
- **VisIC Technologies**
  - 600 V / Si GaN FET
  - 2012
- **FUJITSU**
  - 150 V / Si GaN HEMT
  - Jul 2013
- **FUJITSU**
  - 600 V / Si GaN Transistor test
  - 2013
- **GaN Systems**
  - 650 V / SiC GaN HEMT
  - 2012
- **transphorm**
  - 600 V / Si Diode & GaN HEMT
  - 2013
- **IOR**
  - 100 V / Si GaN FET Cascode configuration
  - 2013
  - (GaNPX™ package)
- **VisIC Technologies**
  - 650 V / Si GaN Noff MISHEMT
  - May 2015
- **transphorm**
  - 600 V / Si GaN Transistor in a TO-247 Package
  - Mar. 2015

**Commercially available**

* IR’s GaN devices are only for specific clients
IP OVERVIEW
Mapping of Patenting Activity

For each country or geographical zone:
- Number of different **patent assignees**.
- Number of **patent families** including at least one patent filed in the country.
- Number of patent families including at least one patent in a **legal status** category in corresponding country.
- Time evolution of **patent publications**.

200+ patent assignees
1160+ patent families

Current Legal Status of Patents

- USA
- Korea
- Japan
- China
- Taiwan

190+ patent assignees
1290+ patent families

Current Legal Status of Patents

Time Evolution of Patent Publications

**Note:** A patent family can include patents in different legal status and thus may appear in more than one category within the same country. For the legal status definition please refer to the Annex at the end of the report.
IP OVERVIEW
Time Evolution of Granted Patents by Country

Power GaN Granted Patent Dynamics
4,900+ patent documents
Including 1,700+ granted patents

Notes: The patent search was done in March 2015, thus the data corresponding to the year 2015 are not complete.
A lead period in patenting activity and patent grants heralds a future market domination.

The market domination of USA until 2013 is consistent with its lead in terms of granted patents from 2005 to 2010. Japan, witness of an increase of its enforceable patents since 2010, is ramping up and enlarges its market share.
IP OVERVIEW
Patent Litigations and market evolution

To this date, no litigation cases related to Power GaN domain have been filed*. But this could change.

In a patent infringement action, the potential sales volume plays a major role for assessing the damage award.

So far, the GaN device market is still at its early stage ($10M in 2015 according to Yole Développement). There are only a few players selling power GaN devices. As the GaN needs to compete with the incumbent silicon technology, the priority of GaN players is to educate the end users to adopt GaN devices. GaN players are in a cooperative mode to promote the GaN technology all together.

The GaN power industry is consolidating in preparation for significant growth, and recent movements show that the GaN industry is taking shape as mergers, acquisitions and license agreements are settled. In this context, the IP just begins to be used as leverage by companies to negotiate licensing and supply agreements (Infineon/Panasonic, Transphorm/Furukawa).

Power GaN domain emerged in terms of patents less than 20 years ago and the number of granted patents was increasing greatly only these last 5 years. According to our analysis, the Power GaN IP is mature enough. As the market ramps up (93% 2016-2020 CAGR according to Yole Développement) and more players enter into the market, there will be competition between different players in the future. When GaN players go into a competitive mode, a strict enforcement of critical patents by major Power GaN players may lead to first patent litigations in the coming years.

*IR sued EPC in 2009 for theft of trade secrets. Two companies reached settlement in 2013. The settlement will result in the payment of royalties to IR on the sale of GaN on Si based power devices from 2015-2023, subject to an offset in certain cases. The IR/EPC sue is not linked directly to IP infringement. The settlement between IR and EPC in 2013 is also a way for two companies to put the dispute behind them and continue their journey in GaN business.
TECHNOLOGY SEGMENTATION
Patent Family Split by Technology Segment

1960+ patent families on GaN power electronics

A patent family is a set of patents filed in multiple countries by a common inventor(s) to protect a single invention.

Circuits (drive circuit, switching circuit, control circuit, PFC circuit ...) and Electronic Systems (inverters, converters ...)

Components 14%

Discrete components, Power modules and Packaging

Semiconductor Devices 60%

Wafers 5%

Substrates & Epi-wafers for power electronics, and Epitaxy, Doping, Material issues ... Transistors (HEMT, HFET, MOSFET, JFET ...) and Diodes at the semiconductor level

Processed wafer

GaN-on-XX

Chips

• The number of patent applications related to GaN Power Components (discrete, module & package) and Circuits & Systems increased in a second time over the 2010-2015 period while the first Power GaN devices were commercialized. “Power Components” patents were mainly filed by [insert names] and no merchant business (merchant business).
TECHNOLOGY SEGMENTATION
Main Patent Assignees by Technology Segment

Wafers
100+ patent families
60+ patent assignees

Semiconductor Devices
1200+ patent families
220+ patent assignees

Components
280+ patent families
70+ patent assignees

Circuits & Systems
430+ patent families
120+ patent assignees

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TECHNICAL CHALLENGES
Patent Family Split by Technology Challenges

1960+ patent families on GaN power electronics

*A patent family is a set of patents filed in multiple countries by a common inventor(s) to protect a single invention.*

Note that a patent family can be found in several categories.

![Bar chart showing the number of patent families for different GaN power electronics devices and challenges](chart.png)

### Main Patent Assignees
- **Mitsubishi Electric**
- **Sumitomo Electric**
- **Toshiba**
- **Panasonic**
- **Furukawa Electric**
- **Fujitsu**
- **transphorm**

*Chart and data by Knowmade © 2015*
# TECHNICAL CHALLENGES

## GaN Power Transistor - Patent Differentiation of Key IP Players

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>OPERATING</th>
<th>PACKAGING</th>
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<td>D-mode (Normally-on)</td>
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<td>Low Stray Inductance Package</td>
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<tr>
<td>E-mode (Normally-off)</td>
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<td>Thermal Management (package, module)</td>
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<td>Cascade (N-off circuit-based approach)</td>
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<td>Chip-Scale Package</td>
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<tr>
<td>Vertical Device (CAVET)</td>
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<td>Dynamic R-on</td>
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| GaN-on-SiC              | transpherm | transpherm | Mitsubishi Electric |
| GaN-on-Si               | MITSUBISHI ELECTRIC | FURUKAWA ELECTRIC | IGR | EPC |
| GaN-on-Sapphire         | power integrations | PANASONIC | IGR | IGR |
| Bulk GaN                | Knowmade © 2015 | EVGOGY | SUMITOMO ELECTRIC |

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**TECHNICAL CHALLENGES**

Matrix  Key IP Players / Technology Challenges

<table>
<thead>
<tr>
<th>Patent Assignees</th>
<th># Patent Families</th>
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<th>OPERATING</th>
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</table>

The colored cells highlight the main features of the patent portfolio. Note that a patent can be found in several categories.
Furukawa, the top patent assignee in terms of patent filings on GaN power semiconductor devices, has continuously filed patents on this field since the early 1990s. In more recent years, companies like International Rectifier (acquired by Infineon in 2014), Panasonic, Sumitomo Electric and Toshiba have shown a steady IP interest in the GaN power semiconductor devices since 2005. Fujitsu, originally a Si Power player also involved in III-V & Compounds, is appeared lately in Transphorm patents. Transphorm and Avogy, as new GaN pure-player entrants, started their patenting activity in significant patent publications the last couple of years.

Note:
- Infineon acquired IR in 2014.
- Licensing agreements
  - Infineon/Panasonic (2015),
  - Transphorm/Furukawa (2014),
  - Transphorm/Cree (2013)
- Collaborations
  - Transphorm/Fujitsu (2013)
- Silicon Valley Bank co-assignee of Avogy’s patents

Dates are defined from the earliest publication date for each patent family. Bubble size represents the number of published patent families. The data corresponding to the year 2015 may not be complete since the patent search was done early March 2015.
SEMICONDUCTOR DEVICES
Degree of Specialization

Big companies such as Furukawa, Panasonic, Infineon, Fujitsu, Mitsubishi ... cover a wide range of technologies with their patent portfolios, thus they have a very low specialization degree in GaN power semiconductor devices. International Rectifier (IR) and Power Integrations (POWI), originally Si Power pure players, show high specialization degree. GaN Systems, and EPC stand out with a very high specialization degree, their patent portfolios are mainly dedicated to GaN power semiconductor devices. POWI and Infineon gained IP focused on GaN power semiconductor devices thanks to...
SEMICONDUCTOR DEVICES
Mapping of Main Current Patent Holders

Number of patent families* containing granted patents in the corresponding country.

* A patent family is a set of patents filed in multiple countries by a common inventor(s) to protect a single invention.

1220+ patent families on Semiconductor Devices
640+ patent families including at least one granted patent

191 patent families (83 granted)

424 patent families (42 granted)

762 patent families (429 granted)

766 patent families (296 granted)

Power Integrations

Furukawa
Sumitomo Electric
International Rectifier

Japan

Korea

Europe

China

Taiwan

USA

Velox Semiconductor 2

International Rectifier

Transphorm

Avogy

Fuji Electric

Sanken Electric

47
29
28
26

26

29

8

8

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SEMICONDUCTOR DEVICES

Power GaN IP Players

• 3220+ patents split in 1220+ patents families.
• 1540+ pending patents split in 770+ patent families, and 1210+ granted patents split in 640+ patent families.
• Few academics are active on GaN power semiconductor devices, with few patent families.

International Rectifier (IR) has currently the most important granted patents from 8 patent families. It is the main current IP holder in (8 granted patents) and as well. Infineon/IR are leading the patenting activity in Europe where together they have pending patents. Infineon shows a significant interest for with 22 pending patents.

• Fujitsu owns currently granted patents on GaN power semiconductor devices, mainly in Korea and , and it has a strong IP position in Japan. Fujitsu has strongly increased its patenting activity on GaN semiconductor devices as revealed by the number of pending patents the company has in the different offices, making Fujitsu the main patent applicant in the domain across the world with pending patent applications. This demonstrates a growing interest of Fujitsu in GaN power semiconductor devices, and it should become in all those countries in the near future.

• Transphorm has currently a granted patent portfolio focused on with a significant presence in and . With 140+ patents currently in the pipeline, Transphorm is currently the patent applicant. It is strengthening its IP position in Japan, China (31), and as well.

• Furukawa holds granted patents on GaN power semiconductor devices and is currently the main patent owners in Japan.

• Power Integrations holds enforceable patents on GaN power semiconductor devices, mainly in USA, but with a significant presence in as well.

• Asian companies have a strong IP position in USA for patents related to GaN power semiconductor devices, but they are practically non-existent in Europe.

• Samsung, Seoul Semiconductor, LG hold most of the granted patents in Korea, but Korean companies (Samsung, Seoul Semiconductor, LG) have increased their patenting activity and are currently the main patent applicants on Korean territory.
- Number in black on each link between patent assignees is the number of co-assigned patent families in the data set of the study. The minimum link size is 3 co-assigned patent families.
- Number up right to each bubble is the number of patent families for this applicant in the data set of the study. Bubble size is proportional to the number of patent families selected for the study.
### SEMICONDUCTOR DEVICES

#### Summary of Main Assignees’ Patent Portfolio

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<th>No. of patent families filed / year (average)</th>
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* A patent family is a set of patents filed in multiple countries by a common inventor(s) to protect a single invention.
GaN Devices for Power Electronics - Patent Investigation | September 2015

SEMICONDUCTOR DEVICES
Leadership of Patent Assignees

- **International Rectifier** (acquired in 2014) has patents on devices. It is enforceable and it still activity (100+ new patents).

- New challengers are becoming major forces in the IP landscape, expanding their patent portfolio with many new patent applications.

- **Sumitomo Electric**, mainly focused on vertical devices, has a noticeable patenting activity associated with already granted patents giving it a sizeable IP significance in GaN power semiconductor devices.

- **Panasonic, Furukawa** have a lesser current patenting activity but they are in the IP arena with a significant patents on GaN devices.

Notes: Infineon acquired IR in 2014; Licensing agreements Infineon/Panasonic (2015), Transphorm/Furukawa (2014), Transphorm/Cree (2013); Collaborations Transphorm/Fujitsu (2013); POWI acquired Velox in 2010.
SEMICONDUCTOR DEVICES
Strength Index of Patent Portfolios

**Portfolio Strength Index**

- **International Rectifier** and **Furukawa** hold several “seminal” patents with a significant blocking potential for Power GaN IP players. The patents of these companies receive 3 times more citations than the average of key IP players of this report. They rank respectively in terms of portfolio strength index. Their patents get almost 4 times more citations than the average of key IP players of this report. Note that the patents from **International Rectifier** receive 5 times more citations. These citations come mainly from Transphorm, Alpha & Omega, International Rectifier and Panasonic.

- **Sumitomo Electric** and **Fujitsu** have a large portfolio and thus show their large size of patent portfolio. **Sumitomo Electric** is focused on vertical devices, while **Fujitsu** started its focus on power semiconductor devices quite recently later than **Furukawa**.

In practice, only **IR**, **Transphorm**, **EPC** and **GaN Systems** have products on the market. **IR** is at the end of the GaN strength index of the market. However, the ranking of the companies is still at its early stage. Further research is needed regarding the GaN market, as most of them just began their development.
SEMICONDUCTOR DEVICES
IP Blocking Potential of Main Patent Assignees

The more the number of forward citations from different patent applicants is high, the more the capacity to hamper the other firms’ attempts to patent a related invention is important. Note, however, that the identification of a “blocking patent” requires an in-depth specific analysis of each patent documents.

- **International Rectifier** (acquired by Infineon in 2014) shows high IP blocking potential. Their patents on GaN power semiconductor devices received relative impact factors and significant citations.
- **Toshiba** and **Panasonic** show blocking potential. Toshiba’s patents on GaN devices have received significant citations, and Panasonic has increased its patenting activity on GaN power semiconductor devices recently.
- **Fujitsu** have also employed GaN technology, although not as extensively as some of the other companies mentioned.
SEMICONDUCTOR DEVICES
Potential Future Plaintiffs

- To this date, GaN domain has
- **Samsung Electronics** holds US patents, but GaN power semiconductor is the company’s key strategic patent in 2011
- **International** semiconductor patent portfolio of the company is its IP estate domain is thus acquisition of important patent
- **Fujitsu** combines its US patents portfolio
- **Furukawa** holds “seminal” patent to litigate its given to Transcend GaN patent portfolio
- **Power GaN** does not less than 20 years. The GaN power application be expected in the future

![Graph showing semiconductor devices and potential future plaintiffs](image)

Bubble size represents the number of patent families selected for the study

IP Enforcement Potential

Propensity to Litigate Patents

Number of patent families involved in U.S. lawsuits (US cases in all sectors)

Samsung Electronics

Mitsubishi Electric

Toshiba

Sharp

Velox Semiconductor

Number of granted patents

(Power GaN ‘Semiconductor Devices’)
# SEMICONDUCTOR DEVICES

## Granted Patents Near Expiration

<table>
<thead>
<tr>
<th>Title</th>
<th>Publication Number (Link to patent)</th>
<th>Current Patent Assignee(s)</th>
<th>Expected Expiration Date *</th>
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<td>Improved semiconductor device with control element and insulated gate</td>
<td><a href="#">Link</a></td>
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<td>Improved semiconductor device with control element and insulated gate</td>
<td><a href="#">Link</a></td>
<td>Banque National de Paris from 1999 (former applicant: International Rectifier)</td>
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* Expected Expiration Date is dependent on the accuracy and timeliness of the information provided by the patent offices. This indicator may change at any time without notice based on new information received from the patent offices. No decision should be made based solely on this indicators.
FOCUS ON KEY POWER GaN PLAYERS
Mapping for Patents In-Force (granted)

The size of the logo is proportional to the number of granted patents.
FOCUS ON KEY POWER GAN PLAYERS
Geographical Distribution of Granted Patents and Pending Patents

<table>
<thead>
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<th>Patent Families</th>
<th>Alive Patents</th>
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- : highest value in column
FOCUS ON KEY PLAYERS
Patent Portfolio Quantity/Quality Score*

We use Knowmade’s proprietary KQ2* framework to identify strength of patent portfolio in Power GaN domain. Figures above depict the competitive positioning of key Power GaN players, in segments “Semiconductor Devices” and “Components”. The patent assignees are compared on the basis of Quantity Score and Quality Score. We use our proprietary algorithm based on bibliographical information of patents* to calculate and rank the patent portfolios.

- The green region comprises of the assignees with the best patent portfolios, which are exemplary in terms of quantity and quality of patents. [Company A] is the only assignee lying in the green domain. [Company B] is the best patent portfolio in area of Power GaN.

- [Company C] and [Company D] are the only assignees lying in the orange region for Semiconductor Devices and Components category respectively. Their patent portfolio lacks on quality because of [reason].

- Most of the key Power GaN players form a cluster in the red region with patent portfolio lacking on both patent quantity and quality. Their patent portfolios may rise in future after successful prosecution of their pending patents and/or more citations added.

*See evaluation metrics for portfolio KQ2 score in Annex at the end of the report.
TENTATIVE ESTIMATION OF MARKET SHARE OF GaN DEVICE MAKERS

- **IR/Infineon** supplied to specific clients only. **Intellicom** has the best patent portfolio. IR/Infineon continues to be the strongest IP arm in GaN power market.

- **Transphorm** is a challenger in the Power GaN area, with the most important IP on GaN start-ups like EPC and **GaN Systems**, a partnership with **Furukawa Electric**. This puts it in a strong position to take a leading role in the GaN device market.

- **EPC** has a strong focus on low voltage (>200 V) GaN while the others more focus on 600V devices.

- **Panasonic** has devices in 2016.
**FINANCIAL INVESTMENT TO PURE GaN PLAYERS**

In 2015, around $100M in investments have been made in different GaN startups, as indicated in the following table. This financing will enable these companies to ramp up in production and expand their sales and marketing activities for their long-term growth.

Yole Développement considers that these investments reflect the confidence in the GaN device market and investors’ willingness to provide funds to accelerate production capabilities.

It is noteworthy to point out that Transphorm has received more than $220M in 9 rounds. This impressive investment may be largely related to its strong IP portfolio.

<table>
<thead>
<tr>
<th>Company name</th>
<th>Investment</th>
<th>Date</th>
<th>Venture funds</th>
<th>Total investment</th>
<th>IP Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GaN Systems</td>
<td>$20M</td>
<td>May 2015</td>
<td>Series C,</td>
<td>First round</td>
<td></td>
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<td></td>
<td>Series A &amp; B:</td>
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<td></td>
<td>Undisclosed amount</td>
<td></td>
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<tr>
<td>Exagan</td>
<td>$6.3 M (€5.7M)</td>
<td>June 2015</td>
<td>Series B,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Series A:</td>
<td></td>
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<td>Undisclosed amount</td>
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<tr>
<td>Transphorm</td>
<td>$70M</td>
<td>June 2015</td>
<td>Series A,</td>
<td>Total investment</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Series B:</td>
<td>$221.2M in 9 rounds</td>
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<td>Undisclosed amount</td>
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INTERNATIONAL RECTIFIER (IR) / INFINEON

IR acquired by Infineon in 2014

**Note:** Patent search was done in March 2015, thus the data corresponding to the year 2015 are not complete.

- **First patent applications:**
- **Oldest priority year:**
- **Patent average age:** 6 years.
- **Main patent assignees cited by IR’s patents:** Panasonic, Toshiba, Cree.
- **Main patent assignees citing IR’s patents:** Infineon, Fujitsu, Panasonic.

**IP collaboration:** Acquisition of IR in 2014. Note that this acquisition does not yet appear in patent databases. The re-assignment of patents should be reveal in the next months.

- **Main patent assignees cited by Infineon’s patents:** International Rectifier, Toshiba, Cree.
- **Main patent assignees citing Infineon’s patents:** Toshiba, National Semiconductor.
INTERNATIONAL RECTIFIER (IR) / INFINEON
IR acquired by Infineon in 2014

Power GaN Patent Portfolio’s Features

- 1350+ backward citations / 790+ forward citations
- High Strength Index
  - IP blocking potential
  - IP enforcement potential
    - No propensity to litigate patents, as for now, but a

Technology Level
- Wafers
- Semiconductor Devices
- Components
- Circuits & Systems

Substrate for GaN
- GaN-on-SiC
- GaN-on-Si
- GaN-on-Sapphire
- GaN Bulk

Technology Issues
- E-mode (N-off)
- Cascade (N-off)
- E/D-mode Monolithic Breakdown Voltage
- Current Collapse
- Dynamic R-on
- Gate Charge (Miller Effect)
- Stray Inductance Package

Semicon Devices

Components

Note that the average of main patent assignees is set at 1 and the company values are normalized by the average main patent assignees.
Integrated half-bridge circuit with low side and high side composite switches


There are disclosed herein various implementations of an integrated half-bridge circuit with low side and high side composite switches. In one exemplary implementation, such an integrated half-bridge circuit includes a III-N body including first and second III-N field-effect transistors (FETs) monolithically integrated with and situated over a first group IV FET. The integrated half-bridge circuit also includes a second group IV FET stacked over the III-N body. The first group IV FET (340a, 340b) is cascaded with the first III-N FET (330a, 330b) to provide one of the low side (320b) and the high side (320a) composite switches, and the second group IV FET (340a, 340b) is cascaded with the second III-N FET (330a, 330b) to provide the other of the low side (320b) and the high side (320a) composite switches. The first and second III-N FETs are normally ON FETs, and the low side composite switch and the high side composite switch are normally OFF switches.
Power transistor arrangement and method for manufacturing the same

Counterparts filed in Germany and China.

Various embodiments provide a power transistor arrangement. The power transistor arrangement may include a carrier; a first power transistor having a control electrode and a first power electrode and a second power electrode; and a second power transistor having a control electrode and a first power electrode and a second power electrode. The first power transistor and the second power transistor may be arranged next to each other on the carrier such that the control electrode of the first power transistor and the control electrode of the second power transistor are facing the carrier.
Noteworthy News

- **June 2015**, Transphorm raised $70M, leading to $221.2M in total (read more).
- **Mar 2015**, Transphorm announces industry’s first 600V GaN transistor in a TO-247 package (read more).
- **Mar 2015**, Transphorm and ON Semiconductor announced the start of production of co-branded GaN power devices (read more).
- **Feb 2015**, Transphorm’s key partner Yaskawa Electric launches the mass production of 4.5 kW residential PV inverters with GaN power module, based on Transphorm’s EZ-GaN™ platform (read more).
- **Jan 2015**, Transphorm and Fujitsu Semiconductor announce the start of mass production of Transphorm’s GaN power devices (read more).
- **Sept 2014**, ON Semiconductor and Transphorm partner to deliver GaN-based power system solutions with industry leading energy efficiency (read more).
- **Aug 2014**, Transphorm partners with Tata Power Solar on India’s most-efficient PV inverter. Under the partnership, Transphorm will supply GaN transistors, while Tata Power Solar will locally manufacture and market the GaN-powered solar inverters. The first PV Inverter product is scheduled to be released in early 2015 (read more).
- **May 2014**, Transphorm obtains exclusive licensing rights to Furukawa Electric’s GaN patent portfolio (read more).
- **Dec 2013**, Transphorm acquires Fujitsu’s GaN Power Conversion business, and the two companies announced the formation of a new company: Transphorm-Japan, a wholly-owned subsidiary of Transphorm (read more).
- **Nov 2013** Transphorm and Fujitsu to Integrate GaN Power Device Businesses (read more).
- **Nov 2013**, Transphorm’s 600V GaN Power Conversion Adopted by Delta Electronics (read more).
- **Aug 2013**, Cree announced that it signed a non-exclusive worldwide patent license agreement with Transphorm that provides access to Cree’s extensive family of patents related to GaN HEMT and GaN Schottky diode devices for use in the field of power conversion devices (read more).
- **Mar 2013**, Transphorm scales up to 200 mm wafers with AIX G5+ GaN-on-Si system from AIXTRON (read more).
- **Feb 2013**, Transphorm teams with Yaskawa to implement its new 600V GaN half-bridge module a in 4.5kW PV power conditioner (read more).
- **Feb 2013**, Transphorm enables the world’s first GaN-based high power converter (read more).
### Key Patents

#### III-nitride bidirectional switches

**US7875907 (2008)**

- **Key Features**
  - Matrix converter technology is enabled by these bidirectional switch designs. Matrix conversion directly converts AC to AC, thus eliminating the need for a large DC filter capacitor. The matrix converter is composed of a set of bidirectional switches, thus permitting both generation and motoring using the same set of switches. Further, the matrix converter permits an optimized power factor and harmonic content of input currents and three-level voltage switching for reduced voltage stress.
  - The switches have improved performance, e.g., lower loss, smaller size system, and fewer components over conventional devices and allow for very compact designs of high power circuits.
  - Patents filed in USA, Europe, and Japan via a PCT application.
  - Patents granted in USA and Europe.
  - 39 forward citations from Panasonic, Infineon, International Rectifier ...

- **Key Features**
  - Large source to drain barrier in the off state, low off state leakage, and low channel resistance in the access regions.
  - Patents filed in USA, China, and Taiwan via a PCT application.
  - Patents granted in USA and Taiwan.
  - More than 60 forward citations from Fujitsu, International Rectifier, Infineon, Samsung ...

- **Planar Schottky diode currents.**
  - Patents filed in USA, China, and Taiwan via a PCT application.
  - 6 granted patents (US).
  - More than 60 forward citations...
High density gallium nitride devices using island topology


A Gallium Nitride (GaN) series of devices—transistors and diodes are disclosed—that have greatly superior current handling ability per unit area than previously described GaN devices. The improvement is due to improved layout topology. The devices also include a simpler and superior flip chip connection scheme and a means to reduce the thermal resistance. A simplified fabrication process is disclosed and the layout scheme which uses island electrodes rather than finger electrodes is shown to increase the active area density by two to five times that of conventional interdigitated structures. Ultra low on resistance transistors and very low loss diodes can be built using the island topology. Specifically, the present disclosure provides a means to enhance cost/effective performance of all lateral GaN structures.
ORDER FORM
GaN Devices for Power Electronics: Patent Investigation (September 2015)

SHIP TO
Name (Mr/Ms/Dr/Pr):
______________________________________
Job Title:
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Company:
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Address:
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City:
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State:
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Postcode/Zip:
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VAT ID Number for EU members:
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Email:
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Date:
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To pay your invoice using a check, please mail your check to the following address:
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To pay your invoice using a bank money wire transfer please contact your bank to complete this process. Here is the
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Payee: KnowMade S.A.R.L.
Bank: Banque populaire St Laurent du Var CAP 3000 - Quartier du lac- 06700 St Laurent du Var
IBAN: FR76 1560 7000 6360 6214 5695 126
BIC/SWIFT: CCBPFRPPNCE
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PRODUCT ORDER
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☐ €4,990 – One user license*
For price in dollars, please use the day’s exchange rate.
For French customer, add 20% for VAT.

All reports are delivered electronically in pdf format at payment reception.
*One user license means only one person at the company can use the report. Please be aware that our publication will be watermarked on each page with the name of the recipient and of the organization (the name mentioned on the PO). This watermark will also mention that the report sharing is not allowed.

SIGNATURE
I hereby accept Knowmade’s Terms and Conditions of Sale
Terms and Conditions of Sales

Definitions

“Acceptance”: Action by which the Buyer accepts the terms and conditions of sale in their entirety. It is done by signing the purchase order which mentions “I hereby accept Knowmade’s Terms and Conditions of Sale”.

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

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

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

“License”: For the reports and databases, 2 different licenses are proposed. The buyer has to choose one license:
1. One user license: a single individual at the company can use the report.
2. Multi user license: the report can be used by unlimited users within the company. Subsidiaries are not included.

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

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

1. Scope

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

1.2 This agreement becomes valid and enforceable between the Contracting Parties after clear and non-equivocal consent by any duly authorized person representing the Buyer. For these purposes, the Buyer accepts these conditions of sales when signing the purchase order which mentions “I hereby accept Knowmade’s Terms and Conditions of Sale”. This results in acceptance by the Buyer.

1.3 Orders are deemed to be accepted only upon written acceptance and confirmation by the Seller, within [7 days] from the date of order, to be sent either by email or to the Buyer’s address. In the absence of any confirmation in writing, orders shall be deemed to have been accepted.

2. Mailing of the Products

2.1 Products are sent by email to the Buyer:
- within [1] month from the order for Products already released; or
- within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.

2.2 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer. The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including in cases where a new event or access to new contradictory information would require for the analyst extra time to compute or compare the data in order to enable the Seller to deliver a high quality Products.

2.3 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the conditions contained in article 3.

2.4 The mailing is operated through electronic means either by email via the sales department. If the Product’s electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it is informed of the defective formatting within 90 days from the date of the original dispatch 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.
Terms and Conditions of Sales

3. Price, invoicing and payment
3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to annual subscriptions. They are expressed to be inclusive of all taxes. The prices may be reevaluated from time to time. The effective price is deemed to be the one applicable at the time of the order.
3.2 Payments due by the Buyer shall be sent by cheque payable to Knowmade, PayPal or by electronic transfer to the following account:
Banque populaire St Laurent du Var CAP 3000 - Quartier du lac - 06700 St Laurent du Var
BIC or SWIFT code: CCBFRPPNCE
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 receipt 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 remain 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 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 that 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.
Terms and Conditions of Sales

6. Protection of the Seller’s IPR
6.1 All the IPR attached to the Products are and remain the property of the Seller and are protected under French and international copyright law and conventions.

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

6.3 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employees or any person to whom the Buyer has sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.4 The Buyer shall define within its company point of contact for the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

7. Termination
7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer shall indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may also apply for any other direct or indirect consequential loss that may be borne by the Seller, following this decision.

7.2 In the event of breach by one Party under these conditions or the order, the non-breaching Party may send a notification to the other by recorded delivery letter upon which, after a period of thirty (30) days without solving the problem, the non-breaching Party shall be entitled to terminate all the pending orders, without being liable for any compensation.

8. Miscellaneous
All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce those provisions against the Buyer.

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

The Seller may, from time to time, update these Terms and Conditions and the Buyer, is deemed to have accepted the latest version of these terms and conditions, provided they have been communicated to him in due time.

9. Governing law and jurisdiction
9.1 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in application of these Terms and Conditions shall be settled by the French Commercial Courts of Grasse, which shall have exclusive jurisdiction upon such issues.

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