

FD-SOI Patent Landscape

Fully Depleted Transistors on SOI Substrate

The major proponents of the FD-SOI technology have strong IP arms, but other unexpected players known as not supporting FDSOI are also present

REPORT OUTLINE

- FD-SOI.
- Patent Landscape.
- December 2014.
- PDF & Excel file.
- €3,990 (corporate license).

KEY FEATURES OF THE REPORT

The report provides **essential patent data** for FD-SOI including:

- Time evolution of patent publications and countries of patent filings.
- Current legal status of patents.
- Ranking of main patent applicants.
- Joint developments and IP collaboration network of main patent applicants.
- Segmentation by architecture (planar FD-SOI, SOI FinFET) and process level (transistor, device, circuit).
- Key patents.
- Granted patents near expiration.
- Relative strength of main companies IP portfolio.
- Matrix applicants / technology segments.
- FD-SOI IP profiles of major companies with key patents, patented technologies, partnerships, and IP strength and strategy.

The report also provides an extensive **Excel database** with all patents analyzed in the study.

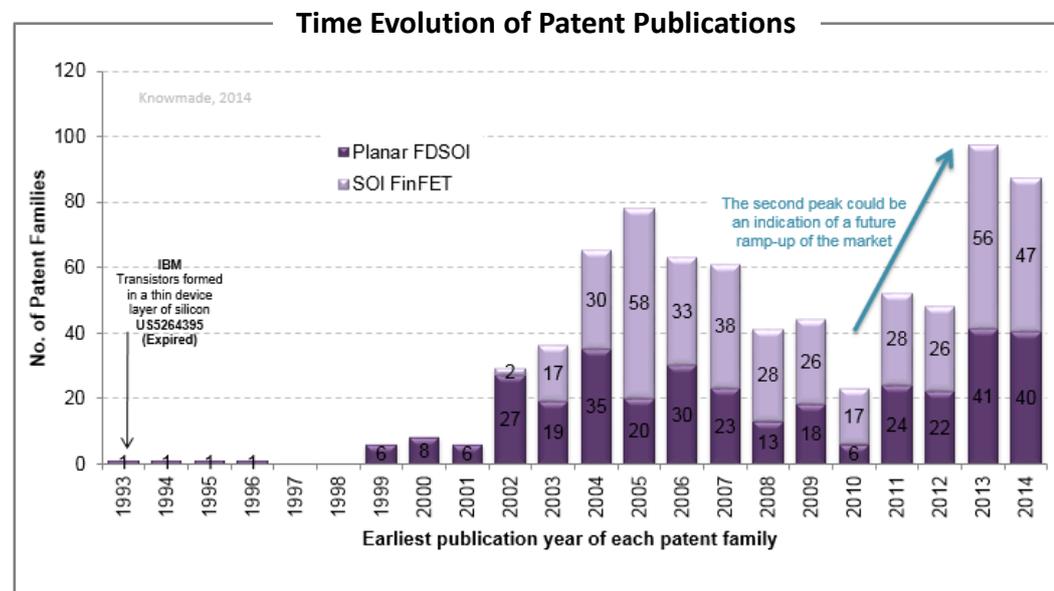
OBJECTIVE OF THE REPORT

- Provide an overview of FD-SOI technology.
- Review context for FD-SOI technology.
- Understand the patent landscape for FD-SOI.
- Identify key patents of FD-SOI technology.
- Understand trends in FD-SOI IP.
- Identify the major players in FD-SOI IP and the relative strength of their patent portfolio.
- Identify new players in FD-SOI IP.
- Identify IP collaboration networks between key players.

DESCRIBING THE IP SITUATION OF FD-SOI ARENA

To date, **FD-SOI** remains a niche market and is still trying to gain widespread adoption. But recently we observed significant moves in the arena, suggesting there is a place for **FD-SOI** in the market. Earlier this year, **Samsung** and **STMicroelectronics** signed a strategic agreement to expand 28nm **FD-SOI** technology. **GlobalFoundries**, a foundry for 28nm **FD-SOI**, plans to field a 14nm **FD-SOI** process after 2015. At the recent IEEE S3S Conference, **IBM** described an **SOI FinFET** technology at 10nm, which is said to be a more simple process than Bulk FinFET. On the Bulk FinFET front, **Intel** is shipping its 14nm FinFET technology, but with six months late due to yield issues. Other foundries are currently struggling with similar issues for their Bulk FinFETs at 16nm/14nm, and the challenges are expected to increase at 10nm and beyond. Therefore, it might be time to take a look at **IP situation of FD-SOI arena**, especially for the next stage of planar and FinFET devices.

This patent landscape focuses on fully depleted devices on SOI substrate for planar and FinFET architectures. More than **740 patent families** related to this field have been published worldwide up to October 2014. In the early 1990s, **IBM** filed first patents related to fully depleted transistors on SOI substrate. Those fundamental patents were followed by an ever increasing number of patent applications between 2000 and 2005 as more companies competed in FDSOI. After a 2005-2010 decrease period of patenting activity suggesting less room for breakthrough innovation, the patent applications are increasing again since 2010. This **second peak of patent publications** could be an indication of a **future ramp-up** of the FDSOI market.

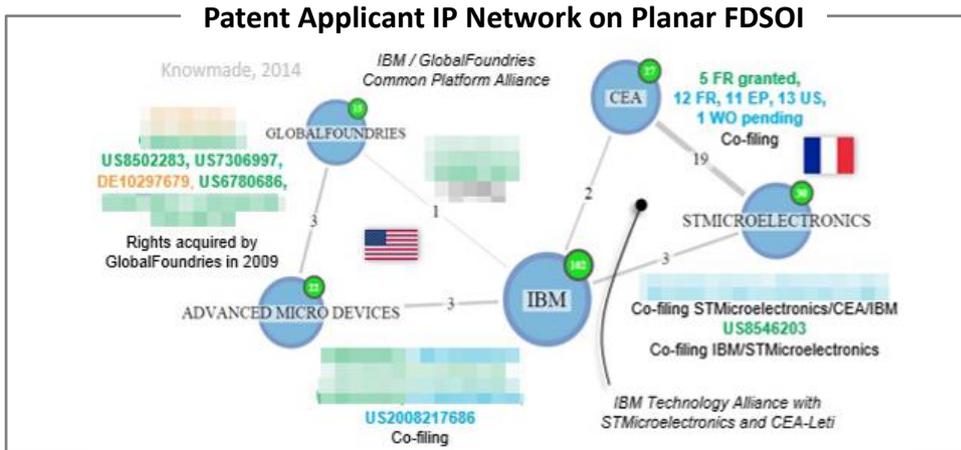


Planar FDSOI patented technologies account for more than **340 patent families** and they are monopolized by Americans (IBM, AMD, GlobalFoundries) and Europeans (STMicroelectronics, CEA-Leti). On the **SOI FinFET** (400+ patent families), we find IP players already involved in bulk FinFET technology (TSMC, Infineon, Samsung, Toshiba ...). The patent applicants are mainly **big players** already involved in microelectronic arena and there is very little room left for new IP comers. There are very few SME or startups, and the few number of academics involved in FDSOI patenting activities suggests a **mature technology**.

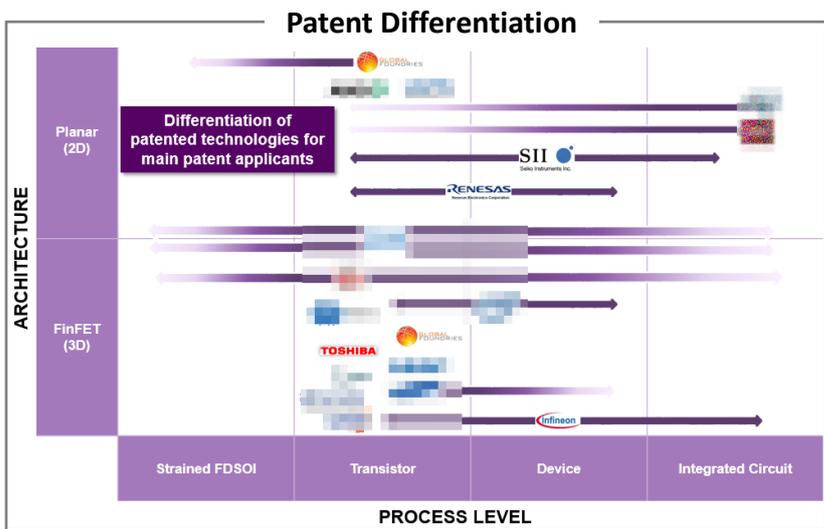
IDENTIFY KEY PLAYERS AND COLLABORATIONS

More than 30 companies/academics are involved in FDSOI technology IP. **IBM**, a major proponent of the FDSOI, is **definitively leading** this patent landscape. **STMicroelectronics**, who played a pioneering role with its partners CEA-Leti and Soitec, has a **very young**, but promising, patent portfolio. **It is interesting** to find **FDSOI patents** held by **TSMC** and **Intel**, since they are rather known as proponents of the bulk-Si technology. This may suggest they have certainly carefully looked at FDSOI as a technology option, even if so far these companies do not support FDSOI. What could be their positions whether they want to enter the FDSOI market?

The report provides a **ranking** and analysis of the **relative strength** of the top FD-SOI technology patent holders derived from their portfolio size, patent citations networks, countries of patents filings, current legal status of patents and collaborations. Through thorough analysis we have identified five major players, each of which is profiled in this report. Each profile includes a detailed portfolio summary including market news, collaborations, product, roadmap, patenting activity, patented technologies with detailed recent innovations, key patents, and partnerships.



PATENTED TECHNOLOGY AND IP STRATEGY



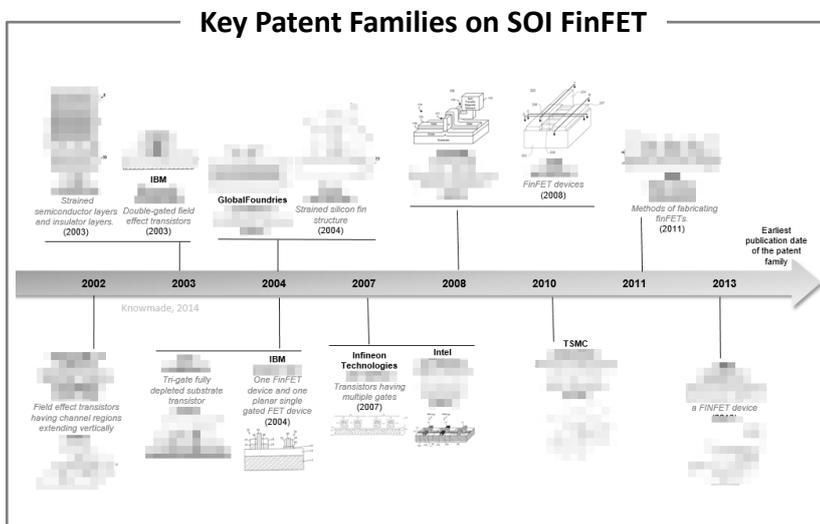
The 740+ patent families selected for this study have been **manually segmented** by architecture type (Planar FDSOI, SOI FinFET), and the dataset is organized into various technology segments that are analyzed (strained FD-SOI, transistor, device, integrated circuit). Methods for manufacturing transistor on SOI substrate represent the biggest part of patents, while recent patents seem to focus on IC level.

We observe a high number of **license agreements** and **collaborations** in FDSOI technology (IBM/ST, Samsung/ST, ST/CEA/Soitec, GF/ST ...), and for the moment there is **no patent litigation**, since the proponents of the FDSOI technology still attempt to gain its widespread adoption at 28-14nm nodes. But this could change when the FD-SOI technology will need to use FinFET-based approaches (SOI FinFET) at the 10nm node and beyond, since TSMC and Intel could enter in IP battle.

IDENTIFY KEY PATENTS

More than **50 key patents** have been identified based on several indicators, including family size, legal status, citations analysis and impact on FD-SOI technology. **Key Patents** are mainly held by **IBM** whether on Planar FDSOI or SOI FinFET. In the future, **IBM** is expected to maintain its **leadership position** in the FDSOI patent landscape, while **STMicroelectronics** and **CEA-Leti** could **become major forces** in Planar FDSOI IP. **TSMC** and **Intel** also hold some key patents that they could assert at the right time.

Our report also includes an **Excel database** containing all of the analyzed patents. This database allows for 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.



COMPANIES CITED IN THE REPORT (NON-EXHAUSTIVE)

Advanced Micro Devices, CEA-Leti, GlobalFoundries, IBM, IMEC, Infineon Technologies, Institute of Microelectronics (CAS), Intel, KAIST, Lapis Semiconductor, Micron Technology, Oki Electric Industry, Renesas Electronics, Samsung Electronics, Seiko Instruments, Sharp, SK Hynix, SMIC, Soitec, STMicroelectronics, Toshiba, TSMC, United Microelectronics Corporation...

TABLE OF CONTENT**Scope Of the Report****Rational for Choice****Key Features of the Report****Terminology for Patent Analysis****Methodology****Patent Search Strategy****Technological Segmentation**

Architecture: planar FD-SOI AND SOI FinFET

Process level: transistor, device and circuit

Executive Summary p.16**I. FD-SOI Technology Overview** p.32**II. Patent Landscape** p.38

For each architecture (planar FD-SOI and SOI FinFET):

- Time Evolution of Patent Publications
- Countries of Patent Filings
- Time Evolution by Country of Patent Filing
- Main Patent Assignees Ranking
- Main Joint Developments and Collaborations
- Time Evolution of Patent Assignees
- Countries of Patent Filings for Main Patent Assignees
- Countries of Current Main Patent Holders
- Patent Assignee IP Network
- Summary of Main Assignee Patent Portfolio
- Strength of Main Assignee Patent Portfolio

- Leadership of Patent Applicants
- IP Blocking Potential of Applicants
- Potential Future Plaintiffs
- Key Patents
- Granted Patents Near Expiration
- Matrix Patent Assignees/Technology Segment
- Patent Differentiation

III. Focus on Key Players p.79

For all of key player: last news, main collaborations and joint developments, technology choices, portfolio summary, strength/weakness, key patents.

IBM	p.80
STMicroelectronics/CEA/Soitec	P.87
Samsung	p.91
GlobalFoundries/Advanced Micro Devices (AMD)	p.94
TSMC	p.99
Intel	p.106
Micron Technology	p.111
Infineon Technologies	p.113
Renesas Electronics	p.116
Seiko Instruments	p.119
Lapis Semiconductor/Oki Semiconductor	p.120

Conclusions p.121**Annexes** p.123**AUTHORS**

Dr Audrey Bastard works for Knowmade in the field of Microelectronics and Nanotechnology. She holds a PhD in Physics from National Polytechnic Institute of Grenoble, France in collaboration with STMicroelectronics, CEA-Leti and CEMES Toulouse. She also holds a Materials Engineering Degree from the Superior Engineering School of Luminy, Marseille, France.



Dr Nicolas Baron is CEO and co-founder of Knowmade. He is leading the Microelectronics and Nanotechnology scientific and patent analysis department. He holds a PhD in Physics from the University of Nice Sophia-Antipolis, plus a University Diploma in Intellectual Property Strategy and Innovation from the European Institute for Enterprise and Intellectual Property (IEEPI Strasbourg), France.

ABOUT KNOWMADE

Knowmade is a Patent, Technology and Strategy consulting company involved in Microelectronics, Nanotechnology, Biotechnology and Life Sciences. We provide Patent Search, Patent Landscape, Patent Analysis, Scientific Landscape, State of the Art, Technology Scouting, Technology Tracking, Alerts and Updates. Our service offer consists of standard reports, custom studies & on-demand tracking, strategy consulting and training. We combine information search services, scientific expertise, powerful analytics and visualization tools, and proprietary methodologies for analyzing patents and scientific information. **Knowmade** supports research laboratories, industrial companies and investors in their business development.

ORDER FORM

FD-SOI Patent Landscape

Fully Depleted Transistors on SOI Substrate

December 2014

SHIP TO

Name (Mr/Ms/Dr/Pr):

Job Title:

Company:

Address:

City:

State:

Postcode/Zip:

Country:

VAT ID Number for EU members:

Tel:

Email:

Date:

PAYMENT METHODS

Check

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

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

Money Transfer

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

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

Paypal

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

RETURN ORDER BY

E-mail: contact@knowmade.fr

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

CONTACT

E-mail: contact@knowmade.fr

PRODUCT ORDER

- €2,990 – Single user license*
- €3,990 – Corporate license

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

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

**Single 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.*

I hereby accept Knowmade's Terms and Conditions of Sale

Signature:

TERMS AND CONDITIONS OF SALES

Definitions

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

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

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

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

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

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

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

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

1. Scope

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

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

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

2. Mailing of the Products

2.1 Products are sent by email to the Buyer:

- within [1] month from the order for Products already released; or

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

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

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

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

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

2.5 The person receiving the Products on behalf of the Buyer shall immediately verify the quality of the Products and their conformity to the order. Any claim for apparent defects or for non-conformity shall be sent in writing to the Seller within 8 days of receipt of the Products. For this purpose, the Buyer agrees to produce sufficient evidence of such defects.

2.6 No return of Products shall be accepted without prior information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information to the Seller as required under article 2.5 shall remain at the Buyer’s risk.

3. Price, invoicing and payment

3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to annual subscriptions. They are expressed to be inclusive of all taxes. The prices may be reevaluated from time to time. The effective price is deemed to be the one applicable at the time of the order.

3.2 Payments due by the Buyer shall be sent by cheque payable to Knowmade, PayPal or by electronic transfer to the following account:

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

BIC or SWIFT code: CCBPFRPPNCE

IBAN: : FR76 1560 7000 6360 6214 5695 126

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

3.3 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears based on the annual rate Refi of the «BCE» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered only after reception of the payment.

3.4 In the event of termination of the contract, or of misconduct, during the contract, the Seller will have the right to invoice at the stage in progress, and to take legal action for damages.

4. Liabilities

4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof.

4.2 The Seller shall only be liable for (i) direct and (ii) foreseeable pecuniary loss, caused by the Products or arising from a material breach of this agreement

4.3 In no event shall the Seller be liable for:

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

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

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

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

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

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

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

5. Force majeure

The Seller shall not be liable for any delay in performance directly or indirectly caused by or resulting from acts of nature, fire, flood, accident, riot, war, government intervention, embargoes, strikes, labor difficulties, equipment failure, late deliveries by suppliers or other difficulties which are beyond the control, and not the fault of the Seller.

6. Protection of the Seller's IPR

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

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:

- Information storage and retrieval systems;
- Recordings and re-transmittals over any network (including any local area network);
- use in any timesharing, service bureau, bulletin board or similar arrangement or public display;
- Posting any Product to any other online service (including bulletin boards or the Internet);
- Licensing, leasing, selling, offering for sale or assigning the Product.

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

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

7. Termination

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

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

8. Miscellaneous

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

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

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

9. Governing law and jurisdiction

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

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