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PATENT SEGMENTATION	<u>58</u>	
• For each segment:		
Key IP players, new entrants, key patents, IP dynamics		
• <u>Segments</u> : Vertical power device (vertical transistor, vertical		
diode), Normally-off (E-mode transistor, cascode topology),		

Integration (monolithic E/D-mode, SiP/SoC, power IC), GaN-on-Si, GaN-on-Sapphire, Selective area p-type doping (ion

implantation, p-GaN regrowth), Current collapse, Thermal

management, Stray inductance, EV/HEV, fast charging, wireless

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PATENT SEGMENTATION	58
• For each segment:	

GAN-ON-SILICON FOR POWER ELECTRONICS

- IP dynamics and main patent assignees
- IP leadership of patent assignees
- Key IP players, new entrants, and their key patents
- Focus on Infineon, Fuiitsu, Transphorm, Furukawa Electric, Fuii Electric, Toshiba, Panasonic, EPC, GaN Systems, Navitas, VislC, Exagan, TSMC, Intel. STMicroelectronics, CEA, imec. MIT, FMIC.

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GAN-ON-SAPPHIRE FOR POWER ELECTRONICS

- Main patent assignees
- Main patents from Power Integrations, CorEnergy, Furukawa Electric, Seoul Semiconductor, Panasonic, HRL, Powdec, Alpha & Omega, Fujitsu, Toyoda Gosei, etc.

NORMALLY OFF 95

- Leading patent assignees for cascode topology
- Leading patent assignees for E-mode transistor
- Main patent assignees by type of E-mode GaN HEMT (recessed gate, p-GaN under gate, ion implantation under gate, MIS-HFMT)
- Key IP players, new entrants, and their key patents

INTEGRATION 101

- Main patent assignees for SiP/SoC, monolithic integration and monolithic power IC.
- Key IP players, new entrantsn and their key patents
- Noticeable recent patents related to monolithically integrated E/D-mode transistors
- Monolithic power IC: focus on patents held by Navitas, Dialog, Infineon, GaN Systems, EPC, TI, etc.
- SoC with group IV and group III-nitride devices on SOI substrates

VERTICAL POWER DEVICE 121

- · Leading patent assignees for vertical GaN power transistor and vertical GaN power diode
- Key IP players, new entrants, and their key patents

- Vertical GaN power device on silicon substrate
- Selective area doping issues for vertical structure: main pate. assignees for selective ion implantation and selective p-GaN regrowth

PACKAGING 127

- Leading patent assignees for GaN power package
- Thermal management: noticeable recent patents
- Stray inductance: noticeable recent patents

CURRENT COLLAPSE 137

- Leading patent assignees for current collapse
- Main patent assignees by solution to prevent current collapse (field plate, surface passivation, holes injection)

MAIN DRIVERS FOR POWER GAN

• Power GaN patents explicitly targeting EV/HEV, fast charging and wireless charging

IP PROFILE OF KEY PLAYERS

For each player: patent portfolio overview, key patents, and recent patenting activity

40 players profiled: Infineon, Panasonic, Toshiba, Fujitsu, Transphorm, Furukawa Electric, Cree/Wolfspeed, Sanken Electric, Renesas Electronics, Texas Instruments, Toyota, ON Semiconductor, Power Integrations, Sumitomo Electric, Sharp, Fuji Electric, Rohm, Toyoda Gosei, Intel, TSMC, Seoul Semiconductor, Nexperia, EPC, GaN Systems, Nexgen, VislC, Navitas Semiconductor, Exagan, Dialog Semiconductor, CEA, STMicroelectronics, HRL, imec, Innoscience, GaNPower, Gpower, CorEnergy, FMIC, Xidian University, UESTC

CONCLUSION	278
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charging

141

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SCOPE OF THE REPORT

- This report provides a detailed picture of the patent landscape related to **GaN for Power Electronics**, covering **wafers/epiwafers** (GaN-on-SiC, GaN-on-Silcon-Silcon-Silcon-Sipphire, GaN-on-GaN, etc.), **semiconductor power devices** (HEMT, MOSFET, Schottky Barrier Diode, PN diode, planar device, vertical device, mode, E-mode, p-doping, current collapse & dynamic Ron dispersion, etc.), **integration** (System-in-Package, System-on-Chip, monolithic power IC, etc.), **circuit and operating methods** (cascode, half-bridge, IC, etc.), and **packaging** (discrete, IC, module, thermal management, stray inductance, etc.), **for all functions** (switch, converter, rectifier, inverter, etc.) and **applications** (power supply, PV, EV/HEV, UPS, LiDAR, wireless power, etc.).
- This report covers patents published worldwide up to May 2019.
- We have selected and analyzed more than **4,100 patent families** (inventions) relevant to the scope of this report.

Included

- Patents describing **GaN-based power devices** (HEMTs, MOSFETs, SBDs, PN diode, etc.) explicitly suitable for using in conversion, control and conditioning of electrical energy.
- Patents pertain to GaN-based power switch, power converter, power rectifier, power inverter, etc.
- Patents related to SiP/SoC/Power IC using GaN power devices.
- Patents related to modules/systems which explicitly use GaN-based power devices.
- Patents claiming GaN-based substrates/wafers/epiwafers with improved high-voltage characteristics and explicitly suitable for using in power electronics applications.

Excluded

- Patents describing power devices, IC, modules or systems which can use **WBG** materials (SiC, GaN, etc.) without any embodiment or preferred solution on GaN.
- Patents related to **GaN-based RF technologies and devices** which have application value in wireless communication, digital broadcasting, mobile communication base station, satellite ground station, aerospace, radar, electronic warfare equipment, military and space communication, etc.



PATENT LANDSCAPE ANALYSIS

Benefits for customer

Understanding the **competitive landscape** and **technology developments** from a **patent perspective**

- Know the key IP players, their key patents, their IP/technology strategy and their future intents
- Identify **new entrants**, their **technology** and **market areas** of interest
- Follow the technology trends and identify emerging technologies
- Benchmark patent portfolios and know competitors' strengths and weaknesses
- Identify the key patents (seminal, blocking, valuable) and the key technical solutions that address hot technical issues
- Identify free technologies which can be used safely and mitigate the risks of patent infringement
- Identify technologies to acquire and potential R&D partners



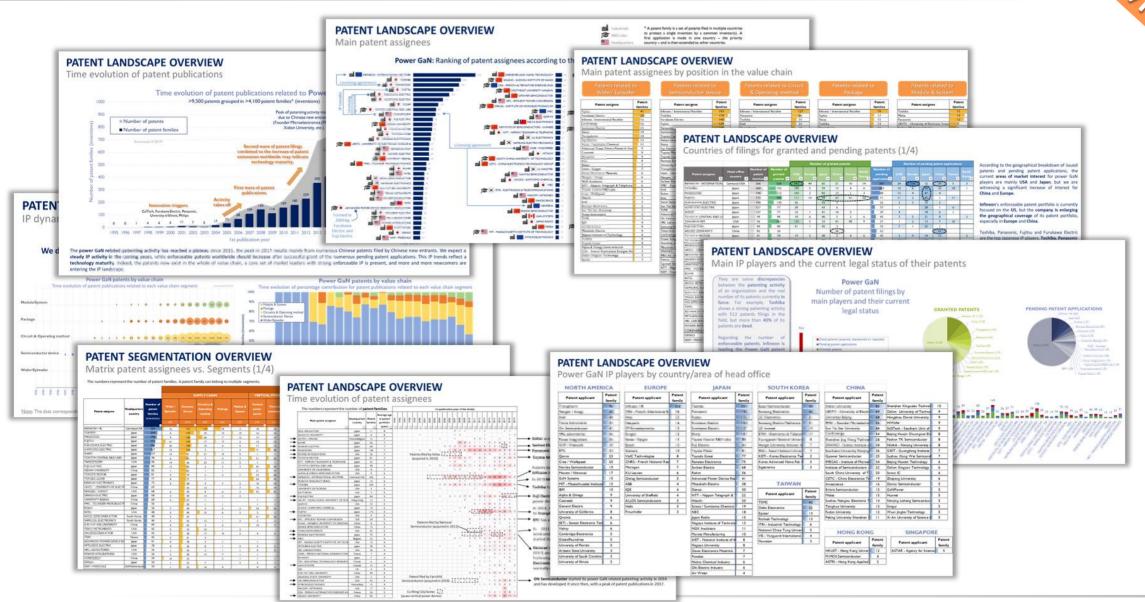
Very complementary to market research

Give an other point of view of the competitors, technologies and markets



Patent Landscape Overview

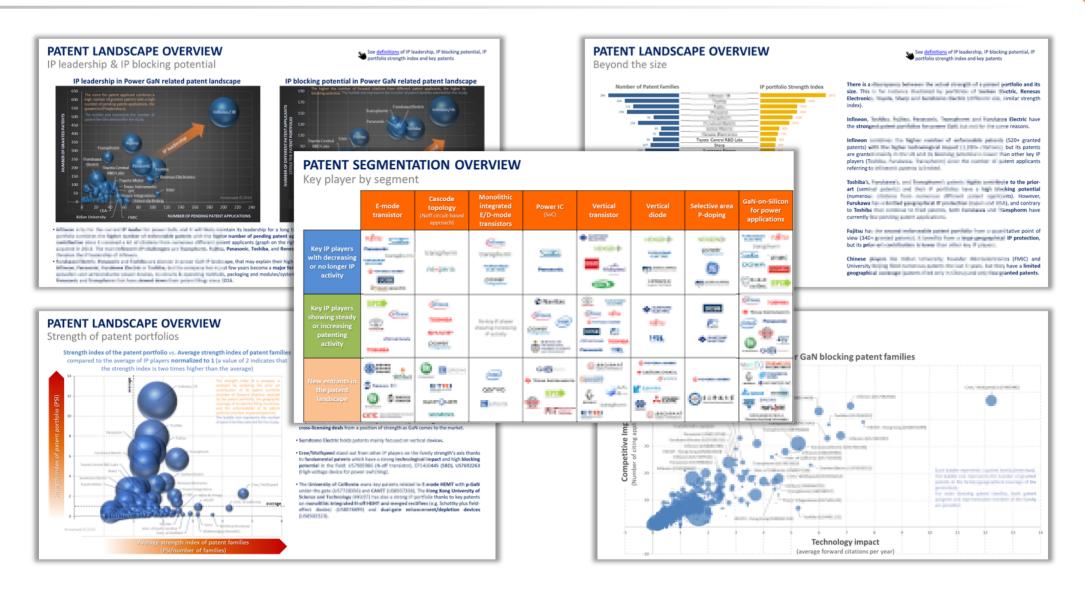
Main patent assignees, New entrants, IP dynamics, Technologies/Applications, Patent legal status, Geo coverage





IP Position of Key Players

Strength of patent portfolios, Key IP player, Blocking potential, Key patents

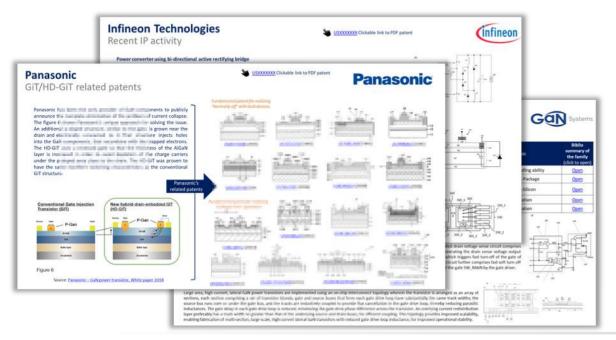


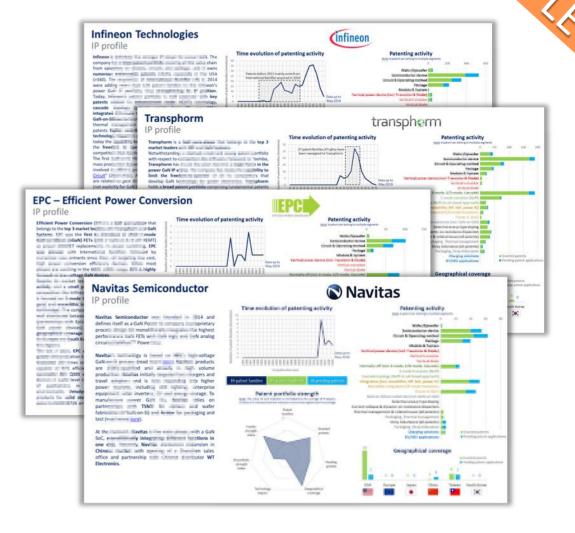


IP Profile of Key Players

IP portfolio summary, Key patents, Recent IP activity



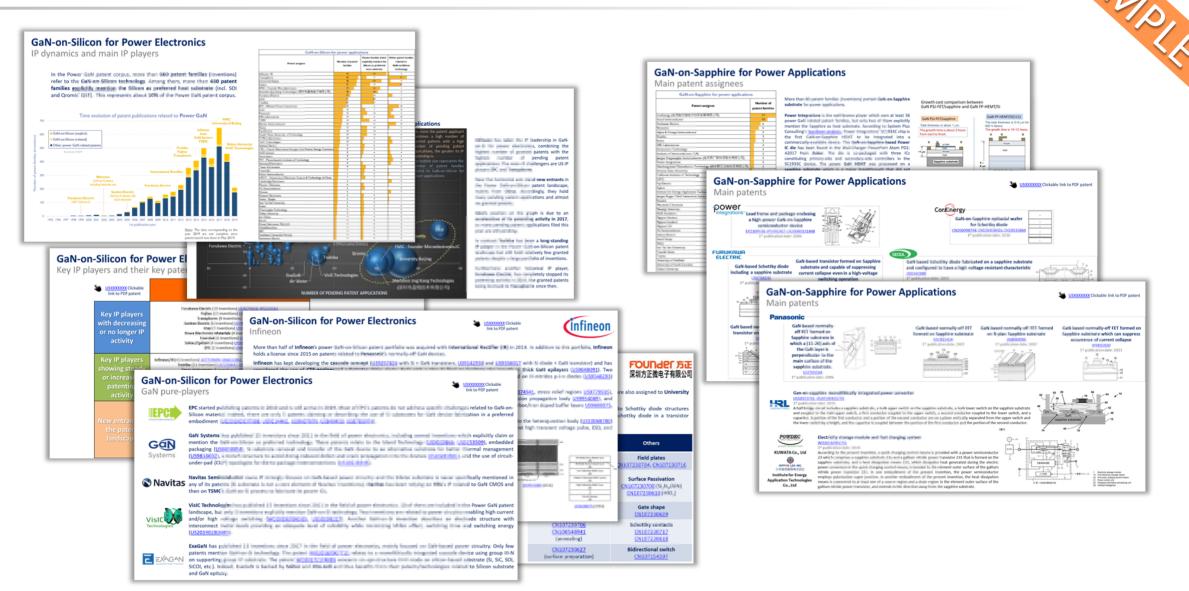






GaN-on-Silicon and GaN-on-Sapphire for Power Electronics

Key IP players, IP dynamics, Key patents





Normally-off

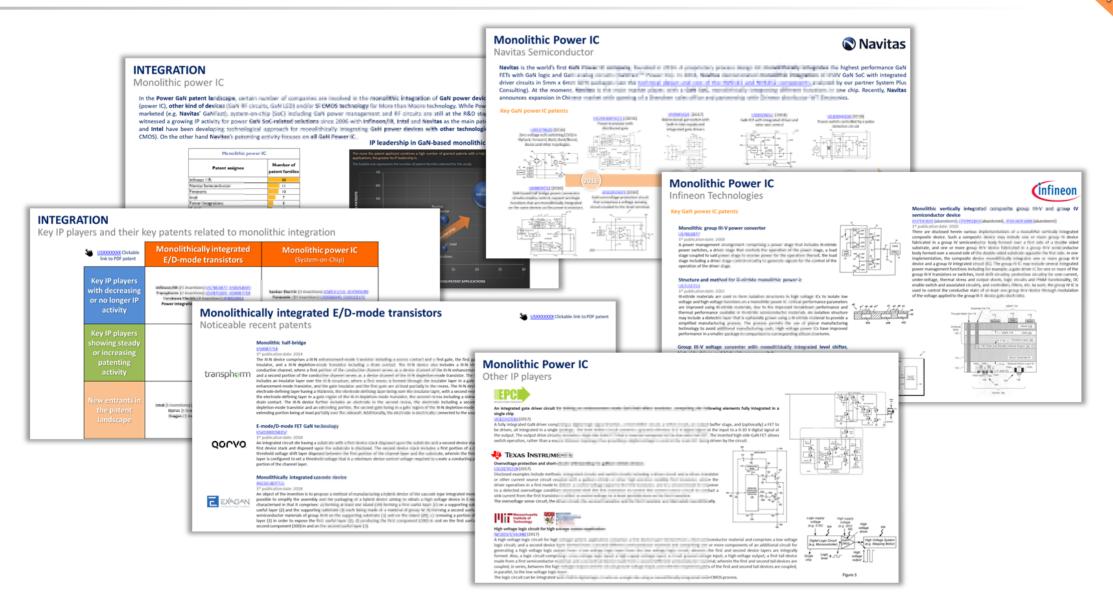
Key IP players, IP dynamics, Key patents





Integration

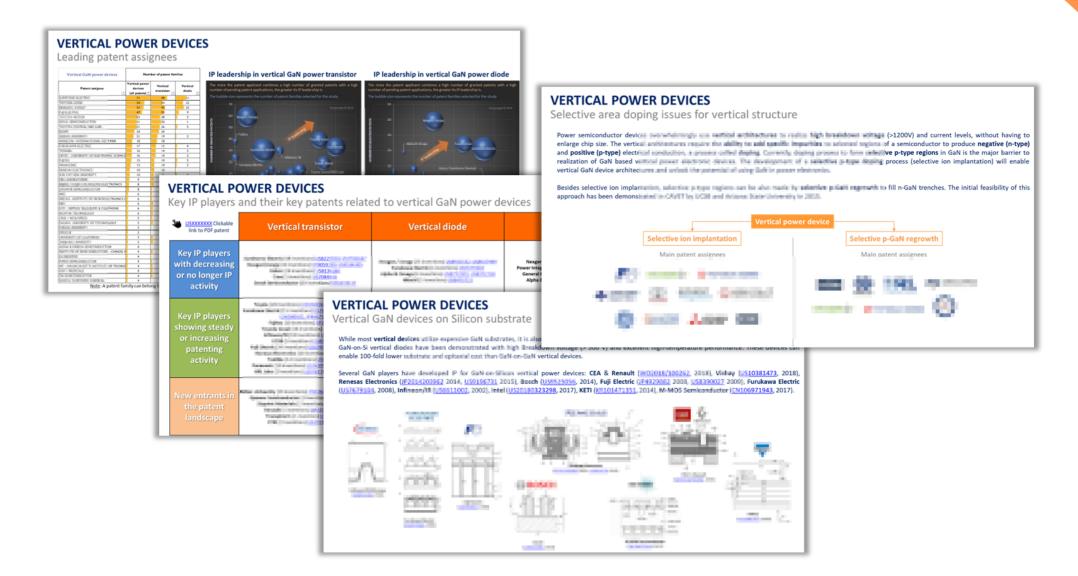
Key IP players, IP dynamics, Key patents, Recent patents





Vertical Power Devices

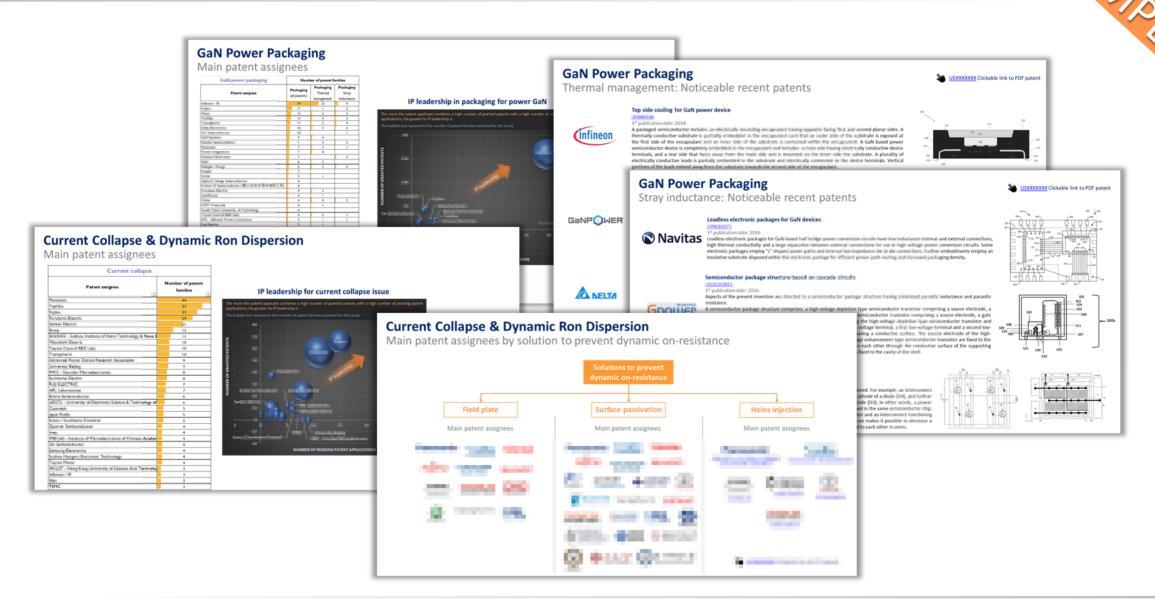
Key IP players, IP dynamics, Key patents, Recent patents





Current collapse, Thermal management, Stray inductance

Key IP players, Recent patents





EV/HEV, Charging solutions

IP players, Recent patents



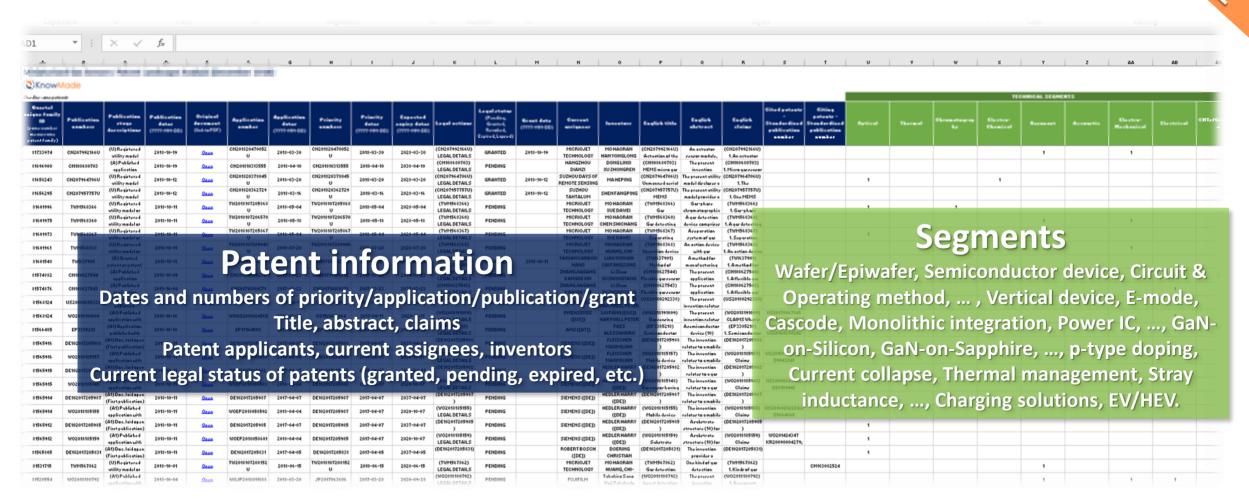




Excel file with all patents analyzed in the report

Useful patent database allows multi-criteria searches







ORDER FORM

Power GaN

Patent Landscape Analysis – November 2019

Ref.:KM19009

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Date:		

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- 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 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.
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