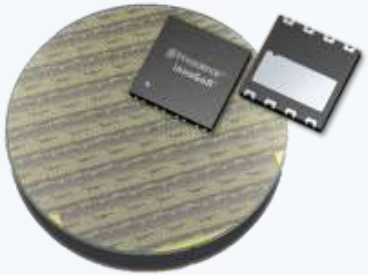
Innoscience

The largest 8-inch GaN IDM fully focused on GaN technology

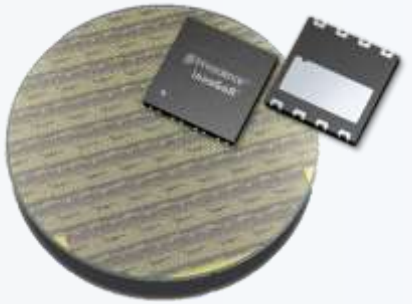


Innoscience at a glance

- We are **the largest Integrated Device Manufacturer (IDM) fully focused on GaN technology:**
  - Full manufacturing process control with the **largest dedicated 8-inch GaN-on-Si** wafers manufacturing **capacity in the world.**
  - We use advanced high-throughput brand-new 8-inch Silicon manufacturing tools (e.g ASML).

- **Highly performing and reliable normally-off/e-mode GaN devices** for a **wide range of applications and voltages (30V-150V&650V).**
  - **More than 100M devices** already **shipped and used** for several applications.

- **Ensures:**
  - Excellent performance and reliability.
  - Technical support on GaN technology.
  - **Security of supply.**
  - Large volume capabilities (10k wpm today and >70k wpm tomorrow).
  - **Competitive prices** thanks to our high-volume manufacturing lines.



Major Milestones

2015.12

Innoscience Zhuhai Founded

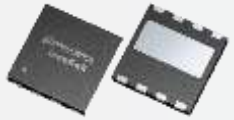
Series A

2017.11

Zhuhai fab opening

2019.08

LV and HV GaN FET Mass Production



Series B

2020.09

Largest GaN-on-Si FAB Phase 1 completed in Suzhou

Series C

2021.04

Obtaining IATF 16949:2016 Certificate for Automotive

2021.06

Innoscience Suzhou Formal mass production kick-off

2021.08

20M+ HV & LV GaN FET delivered

2021.11

Opening of European, America and Korea offices

Series D

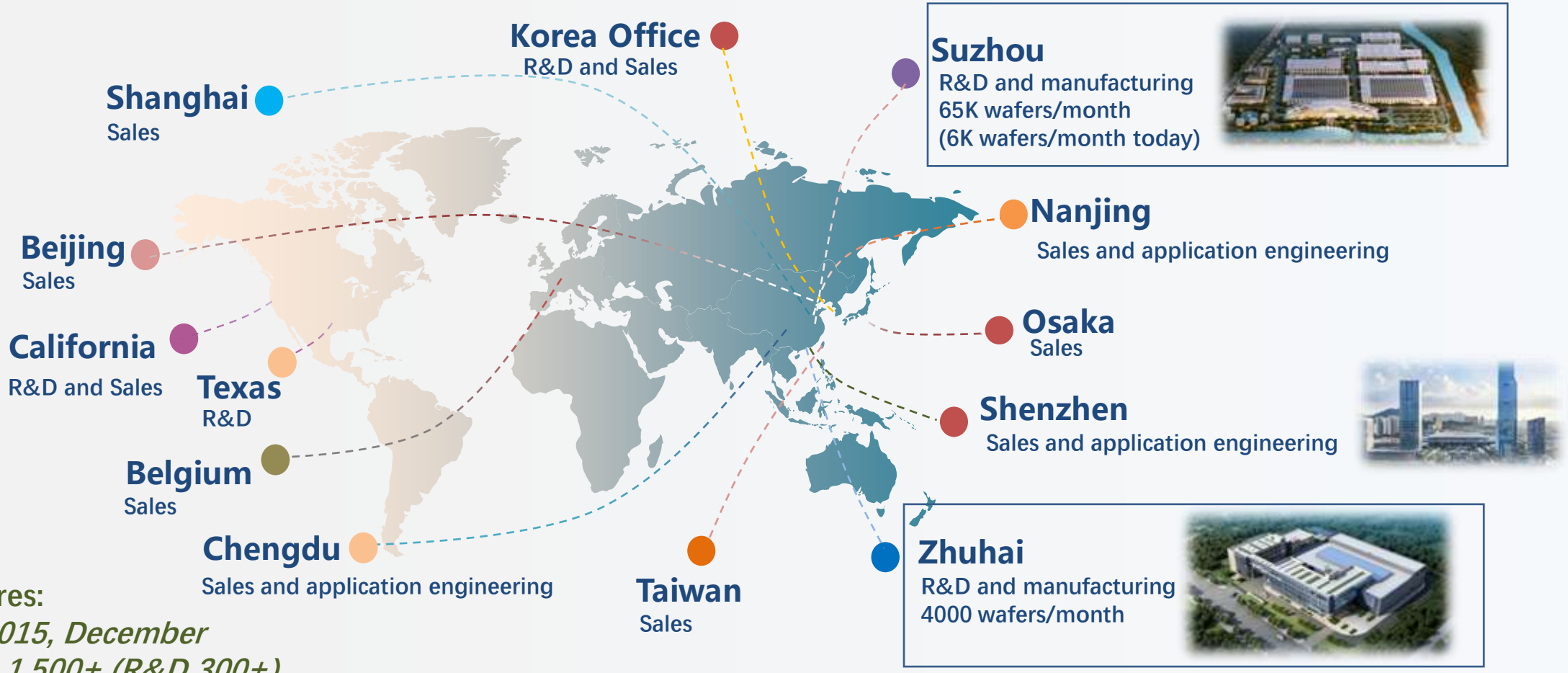
2022.07

100M HV & LV GaN FET delivered

Main Investors

招銀国际 CMB INTERNATIONAL arm SK CATL

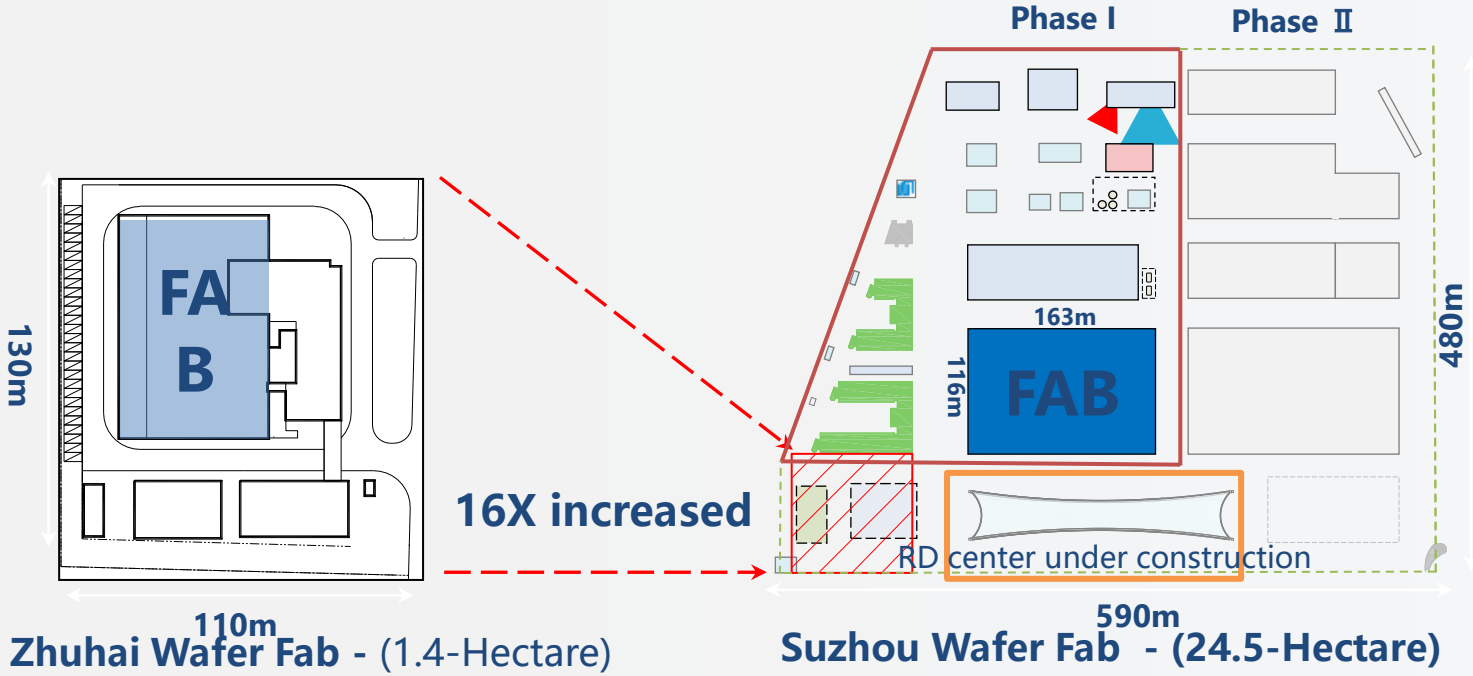
Company Overview



Facts and Figures:

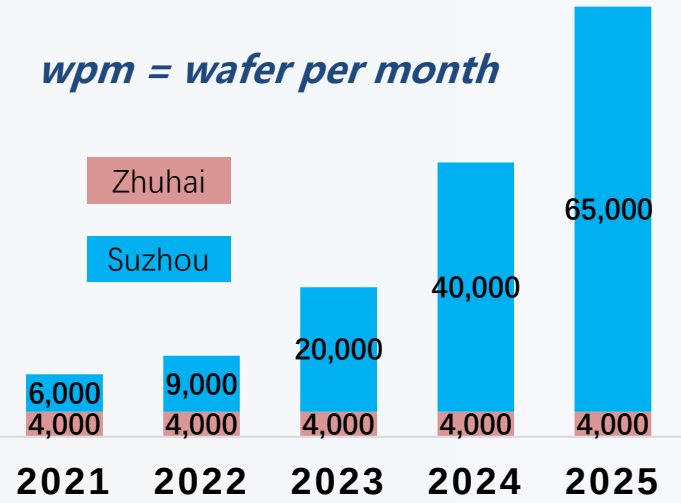
- *Founded: 2015, December*
- *Employees: 1,500+ (R&D 300+)*
- *Patents: 500+*
- *Products: 30V-650V GaN FET*
- *Technology*
  - *8-inch GaN-on-Si wafer*
  - *High throughput Silicon manufacturing lines*

Largest 8-inch fabs dedicated to GaN-on-Si technology



Zhuhai Wafer Fab - (1.4-Hectare)

Suzhou Wafer Fab - (24.5-Hectare)



Zhuhai wafer fab
R&D and manufacturing

Suzhou wafer fab
Manufacturing

Suzhou wafer fab
Today

IDM business model

- **Fast turn-around:**

From new products design to tested devices → 3 -6 months
Ready for mass production within 6 months.

- **8-inch GaN-on-Si**:

Attracting performance price/ratio.

- **Fully integrated:**

Including:

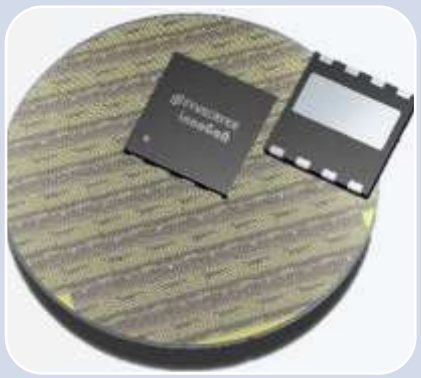
Device design.
EPI process.
Wafer process.
Failure & reliability analysis.

- **Efficient Upgrading Product**:

Supported by comprehensive failure & reliability approaches.

Market Application Analysis | Device Design | EPI Process | Wafer Process | Failure & Reliability Analysis

Key aspects of Innoscience

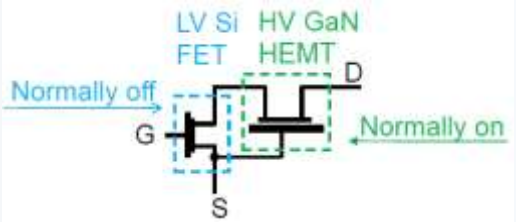
	COMMITMENT	SECURITY OF SUPPLY	ONE-STOP SHOP	LOWEST PRICE	RELIABLE DEVICES
Customer benefit					
Innoscience	**The biggest IDM fully focused and specialized in GaN**	**The biggest worldwide 8-inch dedicated GaN manufacturing capabilities**	**Wide product portfolio from 30V and up to 650V.** Design customization is also possible	**8-inch GaN tech. optimized for mass production with high throughput production lines**	**Devices passed several reliability tests and they have been used in the field without failures**

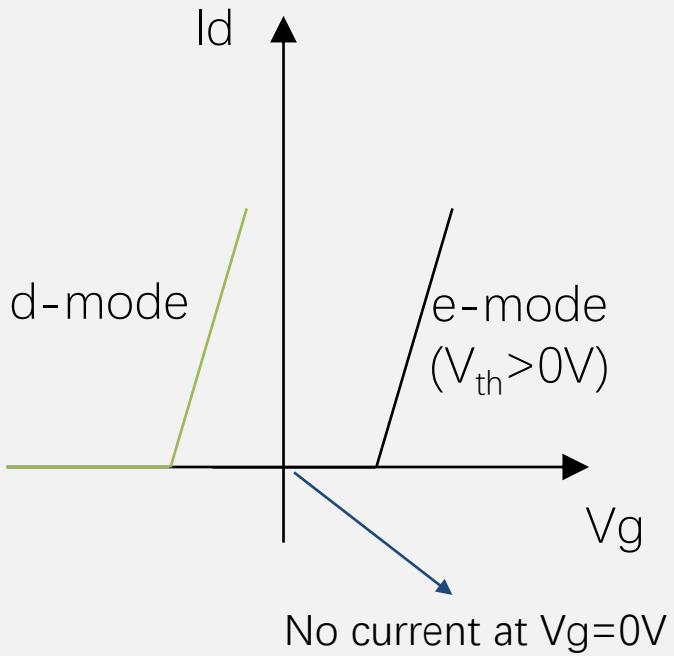
Our Technology and Advantages

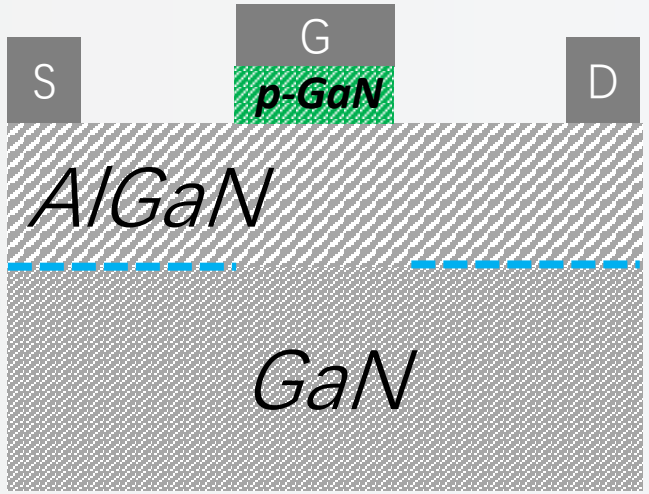
Normally-off/e-mode GaN-on-Si technology

- GaN-based devices are naturally normally-on/depletion mode (d-mode)
- **Power device market demands normally-off devices:**
  - Co-packaging of the GaN d-mode with a LV Si MOS or other Si IC
  - True normally-off/enhancement mode (e-mode) device technology
- **Innoscience device technology is normally-off/enhancement-mode (E-mode) based on p-GaN**

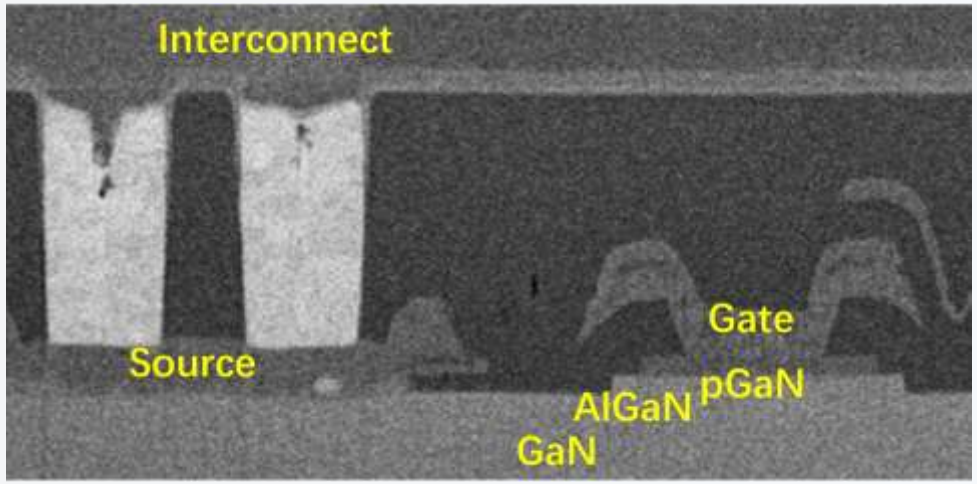
Cascode solution







A p-GaN layer below the gate lift-up the conduction band (from the Fermi level) only below the gate to realize e-mode operation.



Process capabilities: 8-inch Silicon manufacturing line

Taking advantage of high through-put Silicon wafer manufacturing technology to process GaN wafers

MOCVD
20+ Aixtron G5+C

Lithgraphy (i-line)

Implant

Thin Film & Diffusion

Dry Etch

Test & Monitor

Reliability and FA

AIXTRON

21. NOVEMBER 2018 | PRESS RELEASES

InnoScience powers GaN device development with multiple AIXTRON MOCVD systems

AIX G5+ C high-volume manufacturing platform paves way to high-performing 650V GaN-on-Si devices

Herzogenrath/Germany, November 21, 2018 – AIXTRON SE (FSE: AIXA), a worldwide leading provider of deposition equipment to the semiconductor industry, will deliver multiple AIX G5+ C MOCVD systems to Innoscience Technology Co., Ltd. (China) for the development of GaN (gallium nitride) power devices which are more and more favored over Si (silicon) power devices in various applications due to their superior performance at high frequency. All AIXTRON cluster tools will feature a 5x200 mm configuration and will be shipped until Q2/2019.

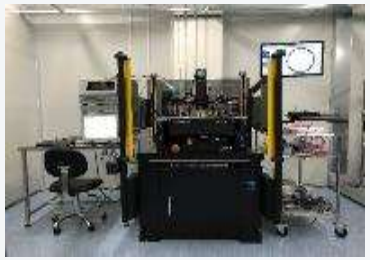
GaN power devices have very low conduction loss, switching loss and off state loss compared to the traditional Si-based power chips due to a higher breakdown strength, faster switching speed, higher thermal conductivity and lower on-resistance. GaN power devices are being used already today for applications such as efficient power supplies for PC and servers or LiDAR (Light Detection And Ranging) and wireless power transfer requiring high-speed switching higher than 1 MHz. In addition, they also

https://www.aixtron.com/en/investors/InnoScience%20powers%20GaN%20device%20development%20with%20multiple%20AIXTRON%20MOCVD%20systems_n1083

Innoscience and ASML signed collaboration agreement

January 21, 2021 – InnoScience and ASML reached a volume purchase agreement for upgraded versions of high throughput i-line and KrF TWINSCAN scanners for advanced GaN on Silicon power semiconductors

https://laoyaoba.com/n/771010



INNOGaN™ Products

GaN market & applications examples

Consumer

Mobile PC Charger



Lighter & Thinner

Industrial

Motor control Renewable


Lower switching loss & Higher efficiency

Communication

48V Bus Server


High power density & Greener

Automotive

Lidar OBC


Faster & Lower Rdson

GaN brings **efficiency** and **power density** to the next level with **optimum solution cost** !

InnoGaN™ from 30V to 650V

30W – 240V

Max 100W – 240V

5-30kW – 400V

3-30kW – 240V

30V – 150V GaN FETs

- AI and data center
- 48V mild hybrid
- Battery management
- Motor drive
- USB-PD 3.1
- Laptop battery chargers
- Wireless charging
- Lidar
- etc

Bi-Directional GaN FETs

- Load switch
- Energy storage systems
- Motor drive
- Solar inverters
- Battery chargers
- Wireless charging
- EV on-board charger
- etc

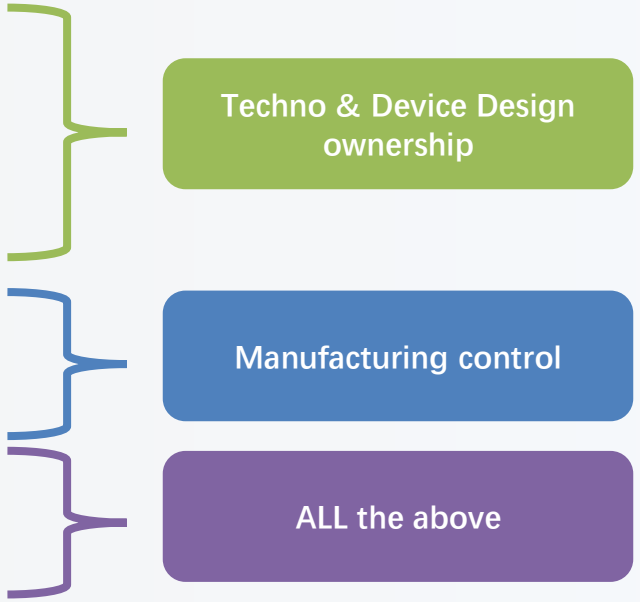
650V/700V GaN FETs

- AC/DC adapter for smart home, phone and laptops
- PC powers
- Server PSUs
- Power tools
- E-bikes
- Solar Inverters
- EV on-board chargers
- etc

How to capitalize on the big opportunity in LV GaN?

- Power supply market → great business opportunity for LV GaN

- Key enablers for GaN to enter and replace Si-MOS in LV
  - Performance optimized 30V, 40V and up to 100V devices
  - Breakthrough in reducing of IGSS and IDSS leakage
  - Innovative device concepts (bi-directional switches)
  - Cost effective manufacturing
  - High volume capacity and fast ramp-up support
  - High yield and low PPM
  - Reliability and application support



Product Roadmap – LV(30V~150V)

Products are available also as naked die (KGD wafers)

Product Name
Configuration, $R_{DS(on)}$, I_{DC}
Package

Not to scale

Updated Dec 2022

$R_{DSon,max}$

40mΩ
10mΩ
7mΩ
5mΩ
3mΩ
1mΩ

INN030W036A
Single, 3.6mΩ, TBD A
WLCSP 1.9x1.9

INN030W010A
Single, 1mΩ, TBD A
WLCSP 4.4x2.9

INN030FQ013A
Single, 1.3mΩ, 50A
FCQFN 4x5

INN040W120A
Bidirectional, 12mΩ
WLCSP1.2mmx1.7mm

INN040W080A
Bidirectional, 8mΩ
WLCSP1.7mmx1.7mm

INN040W048A
Bidirectional, 4.8mΩ, 20A
WLCSP 2.1X2.1

INN040FQ043A
Single, 4.3mΩ, 25A
FCQFN 3x4

INN040LA015A
Single, 1.5mΩ, 25A
FCLGA 4x5

INN040FQ012A
Bidirectional, 1.2mΩ,100A
FCQFN 4x6

INN100W070A
Single, 7mΩ, 29A
Solder Bar 2.5X1.5

INN100W032A
Single, 3.2mΩ, 60A
Solder Bar 3.5X2.1

INN100W027A
Single 2.7mΩ,64A
Solder Bar 4.45x2.3

INN100FQ025A
Single, 2.5mΩ, 80A
FCQFN 3X5

INN100FQ016A
Single, 1.6mΩ, 100A
FCQFN 4X6

ISG3201: HB+Driver
3.2mΩ+ 3.5mΩ, 34A
LGA 5X6.5

INN150FQ110A
Single, 11mΩ
FCQFN 3X3

INN150FQ070A
Single, 7mΩ, 48A
FCQFN 3X4

INN150LA070A
Single, 7mΩ, 28A
FCLGA 2.2X3.2

INN150FQ030A
Single, 3mΩ
(EN) FCQFN 4X6

30V	40V	100V discrete	100V integrated	150V

Production | **Sampling** | **Under development** | **Plan** | **Concept**

Note: The SPEC of product in developing or planning is subjected to be changed without notice to CTM

Product Roadmap – HV(650V)

Products are available also as naked die (KGD wafers)

Product Name
Configuration, $R_{DS(on)}$, I_{DC}
Package

Not to scale

$R_{DSon,max}$

2000 mΩ
1000mΩ
500mΩ
350mΩ
200mΩ
100mΩ
50mΩ
30mΩ

INN650N1K2A
Single, 1200mΩ, 1
WAFER

INN650N2K2A
ngle, 2200mΩ, 1.5A
WAFER

INN650N05
Single, 800mΩ, 2A
WAFER

INN650D600A
Single, 600mΩ, 5.9A
DFN 8X8

INN650DA600A
Single, 600mΩ, 5.9A
DFN 5X6

INN650DA500A
Single, 500mΩ, 7A
DFN 5X6

INN650D350A
Single, 350mΩ, 10A
DFN 8X8

INN650DA350A
Single, 350mΩ, 10A
DFN 5X6

INN650D240A
Single, 240mΩ, 12A
DFN 8X8

INN650DA240A
Single, 240mΩ, 12A
DFN 5X6

INN650D190A
Single, 190mΩ, 13A
DFN 8X8

INN650DA190A
Single, 190mΩ, 13A
DFN 5X6

INN650D140A
Single, 140mΩ, 17A
DFN 8X8

INN650DA140A
Single, 140mΩ, 17A
DFN 5X6

INN650D080BS
Single, 80mΩ, 30A
DFN 8X8

yy:
K – TO252
L – TO252slim

xx:
TH – TO220
TJ – TO220F

INN700yy800A
TO252/TO252slim

INN700yy600A
TO252/TO252slim

INN700yy480A
TO252/TO252slim

INN700xx350A
TO220/TO220F

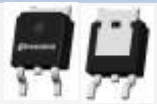
INN700yy350A
TO252/TO252slim

INN700xx240A
TO220/TO220F

INN700yy240A
TO252/TO252slim

INN700xx190A
TO220/TO220F

INN700yy190A
TO252/TO252slim



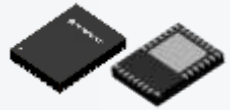
INN700xx140A
TO220/TO220F

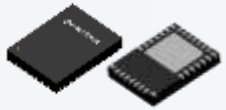
INN650T080AH
Single, 80mΩ, 30A
TOLL

INN650T050AH
Single, 50mΩ, 50A
TOLL

INN650T030AH
Single, 30mΩ, 60A
TOLL

GaN + Driver + Current Sensing

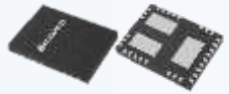




ISG6102
QFN6x8, 230mΩ

Other Rdson
currently planned

HB GaN + Driver



HB GaN + Driver
in project

650V/700V discrete *(700V version available on request)*

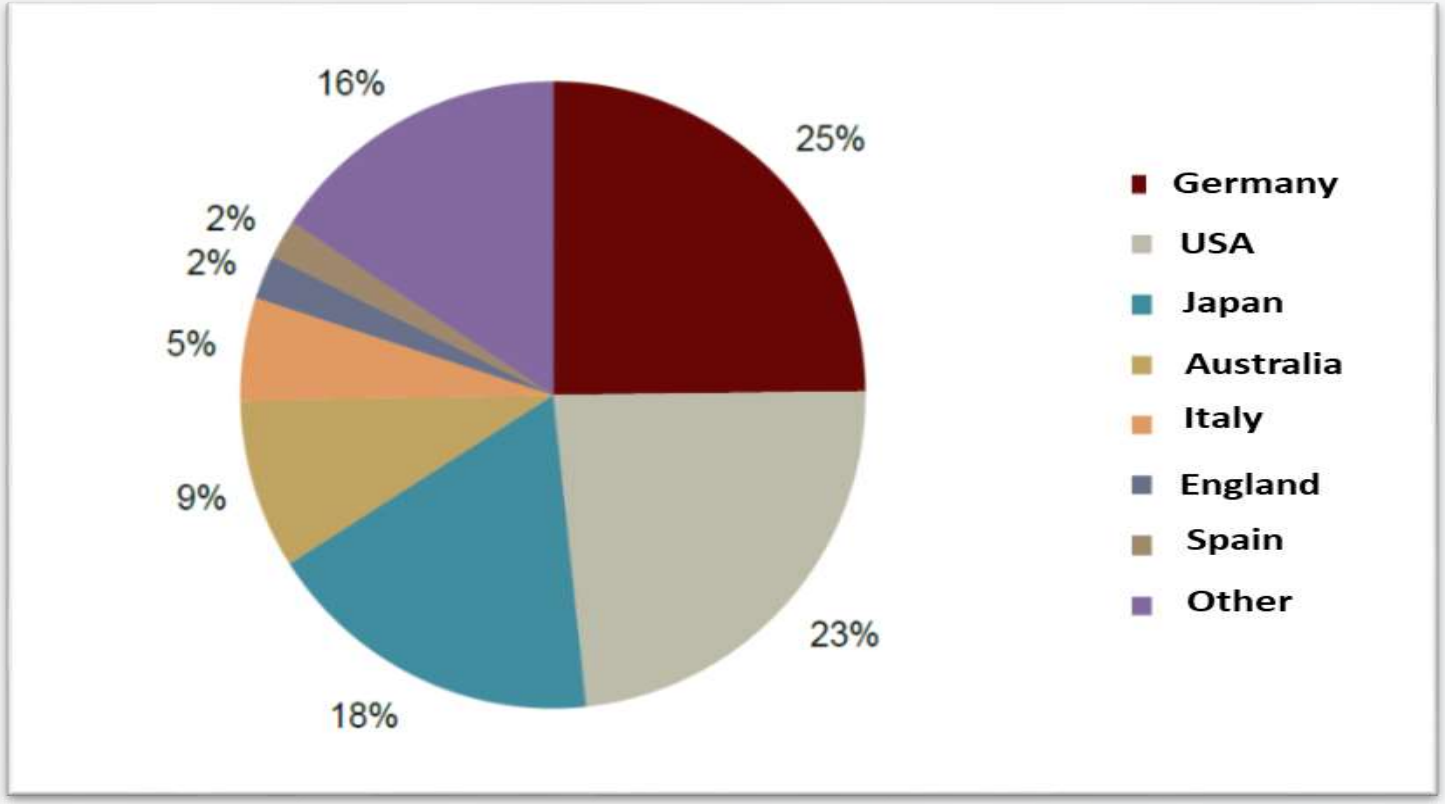
650V integrated *(700V version available on request)*

Production | **Sampling** | **Under development** | **Plan**

Note: The SPEC of product in developing or planning is subjected to be changed without notice to CTM

INNOGaN™ Applications

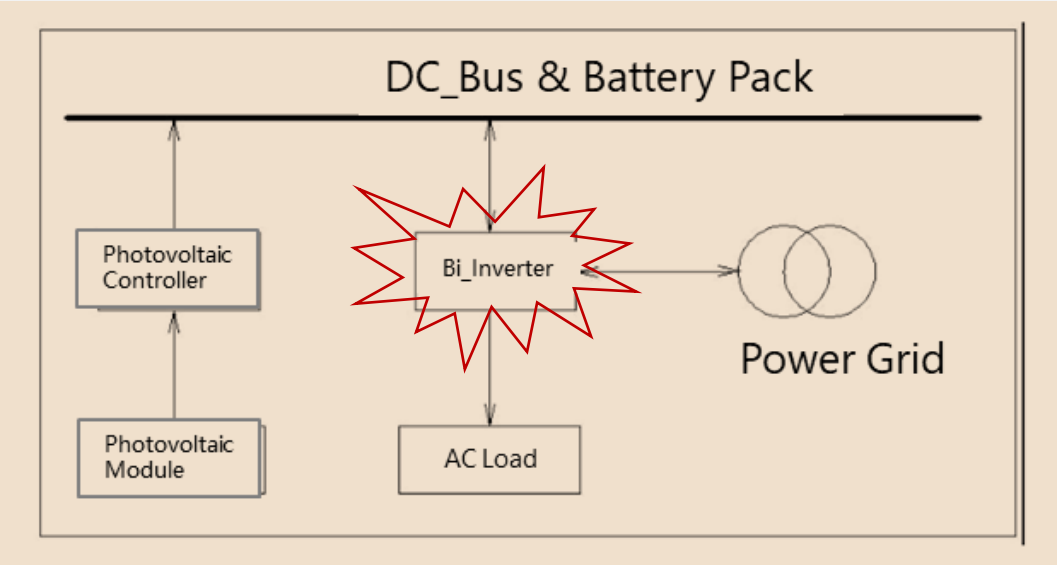
Solar: Market Trend of Home Storage Energy



- According to IHS Markit's statistics, the global new home energy storage shipments are **~4.44GWh** in 2020Y, increasing **44.2%** year on year.
- Europe, the USA, Japan & Australia are sharing **~3/4** of the global shipments.
- Germany shipments were more than 1.1GWh, No.1 in the world.
  No. 2 the USA, with over 1GWh.
  No. 3, Japan shipped nearly 800MWh.

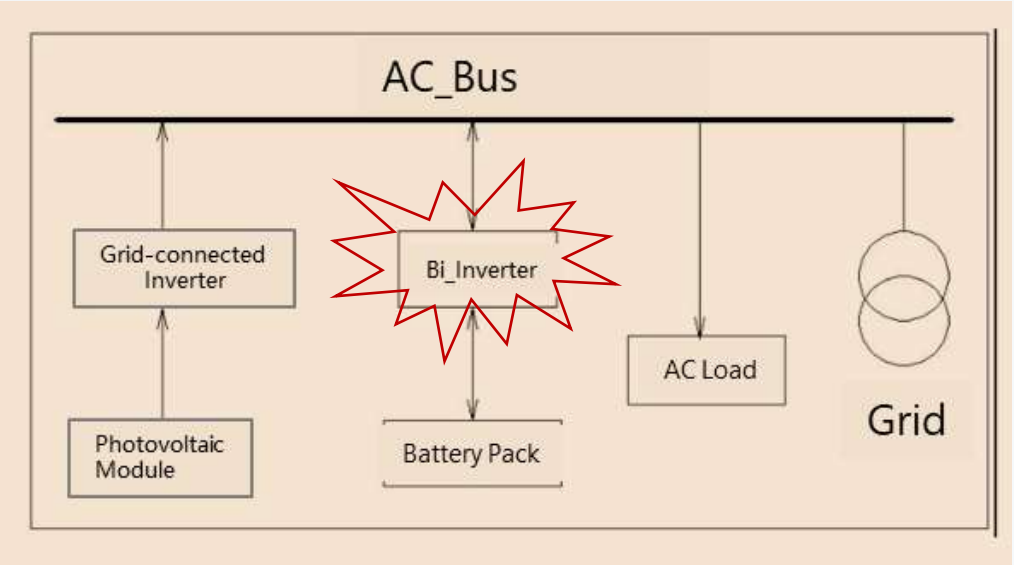
Solar: 2 Technical Routes for Home Energy Storage & Inverter Systems

DC-Coupled: Gathering point of energy is at the DC battery end



Integation → Low Cost → Storage Then using

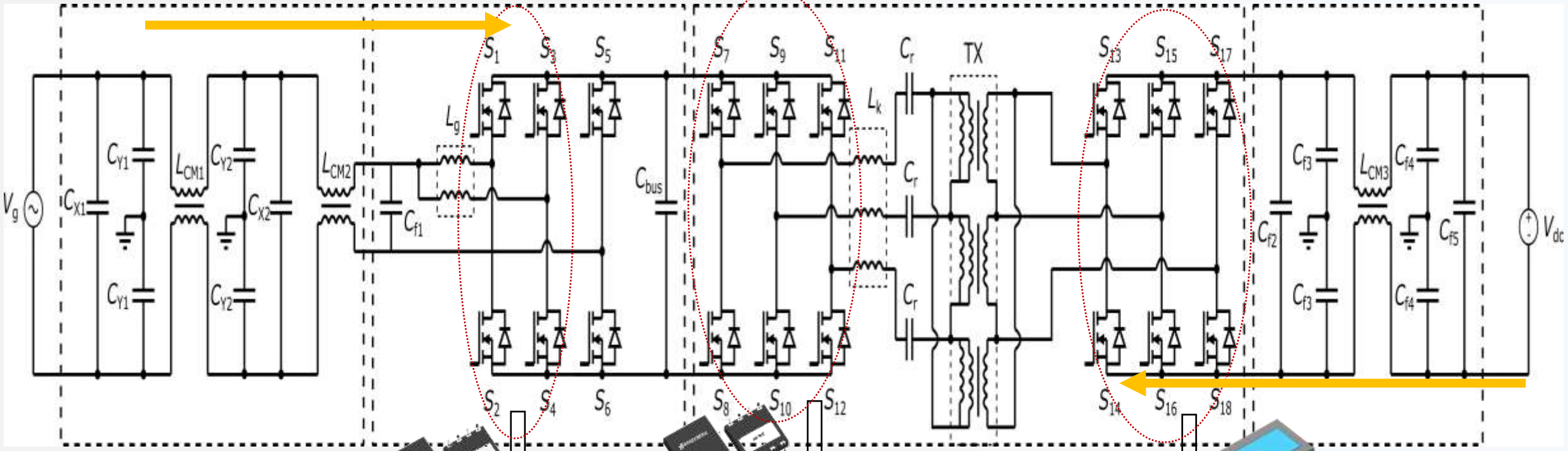
AC-Coupled: Including photovoltaic power supply system and battery power supply system; The two systems can operate independently without interference, or can be separated from the large power grid to form a microgrid system



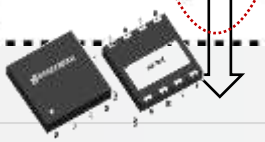
Flexible → Generation and Using Same time → Higher Power

Solar: Bidirectional Inverter Topology Structure

- Rectify Mode: **Interleaved totem-pole PFC + Step_Down LLC**
- Inverter Mode: **Interleaved inverter Bridge+ Step_Up LLC**

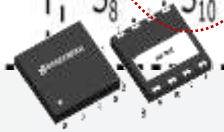


Power Rating: 1KW~5KW



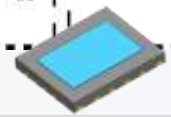
Key Parameter:

- **GaN**: INN650D080A/D030A(DFN8*8)
- **Fs:** 100KHz~500KHz



Key Parameter:

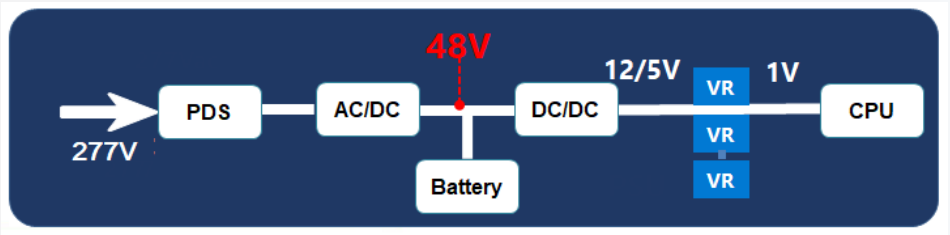
- **GaN**: INN650D080A/D150A(DFN8*8)
- **Fs:** 200KHz~300KHz



Key Parameter:

- **GaN**: INN100FQ025
- **Fs:** 200KHz~300KHz

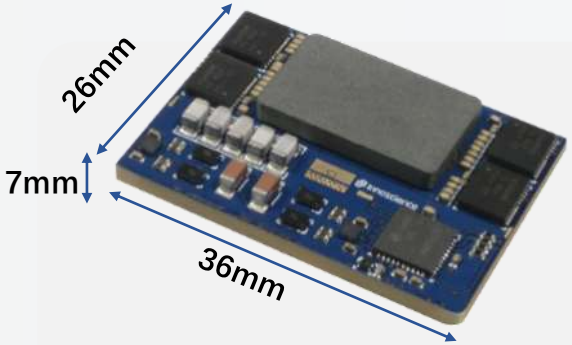
Data centers with INNOGaN™



INN100W032A (100V/3.2mohm)

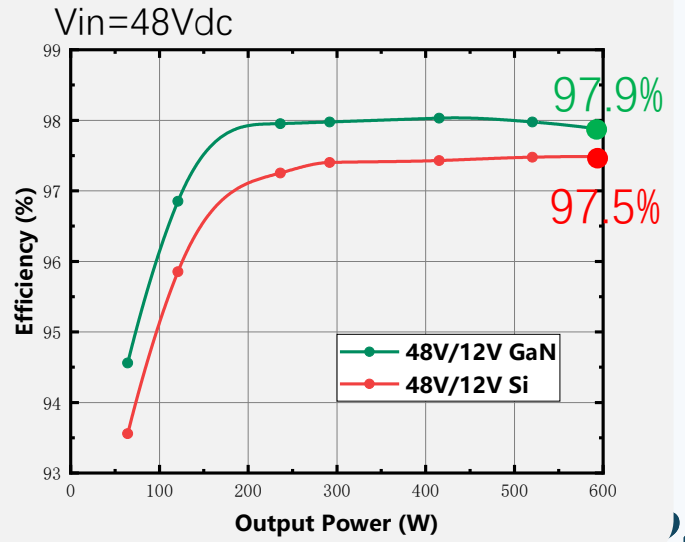
Parameter	Value
$V_{DS,Max}$	100V
$R_{DS(on),Typ}$@ 25℃	2.4mΩ
$R_{DS(on),Max}$@ 25℃	3.2mΩ
$Q_{G,\ typ}$@VDS=24V	11.37nC
Q_{OSS}@VDS=24V	54.5nC
Q_{rr}@VDS=24V	0nC
I_D @ 25℃	60A
I_{Dpulse} @ 25℃	230A

High Power Density

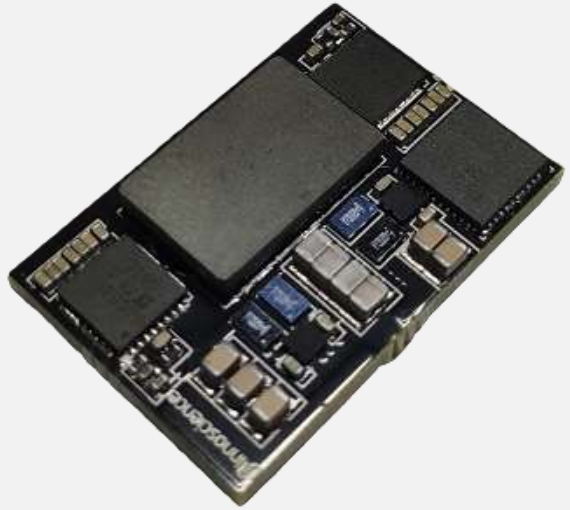


2100W/in³

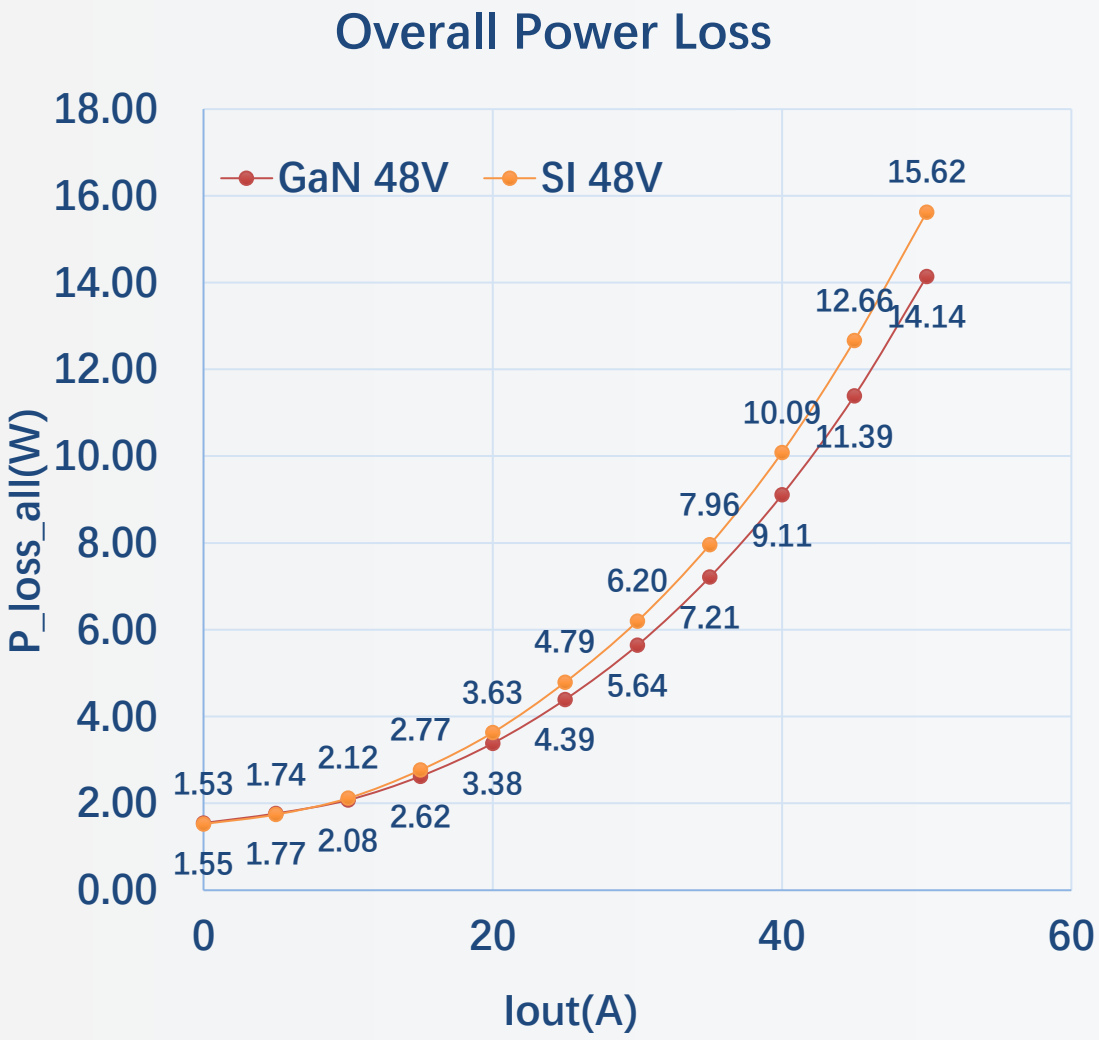
High Efficiency



Data centers: 300W DC-DC converter (48V-5V)



Parameter item	Specifications
Input voltage	36-60V
Output voltage	3.6-6V
Output Power	300W
Operating frequency	915kHz
Demo size	27mm*18mm*6mm
Power density	1700W/in^3
Efficiency	97%(peak) 95.5%（full load）



10% reduction in Power Loss

10% reduction in your energy bill

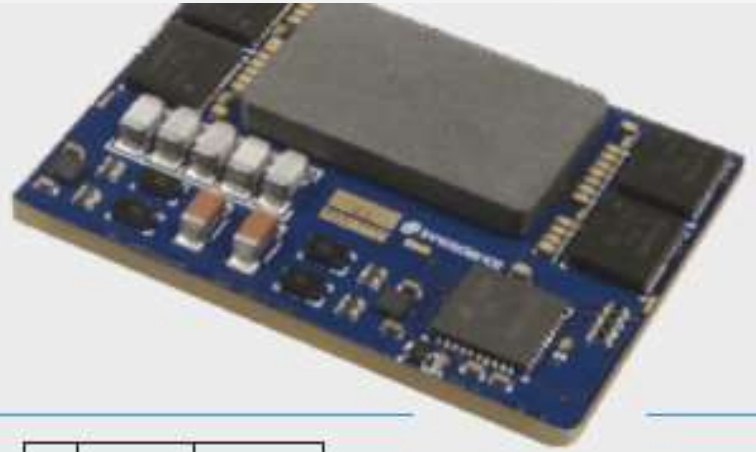
Future perspective

100 TWh saved in 2030

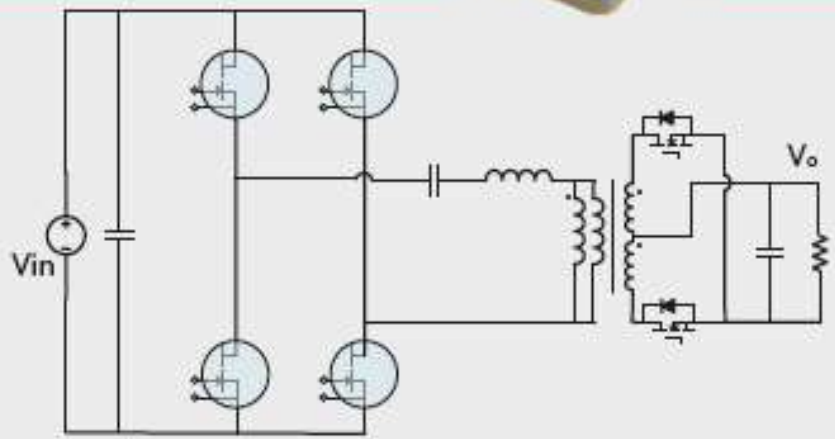
(20 nuclear reactors)

Data centers: 600W DC-DC converter (48V-12V)

Demo



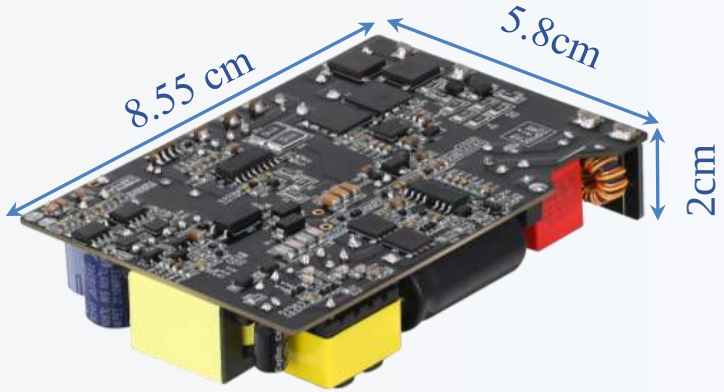
Topology



- Full Bridge LLC
- 600W DC-DC converter (48V-12V)
- Input voltage: 40V-60V
- Output voltage: 10-15V (max 60A)
- Frequency: 1000kHz
- LV (100V/7mOhm) InnoGaN
- Efficiency of 97.9% at 60V Vdc
- 36x26x7mm (PCBA)
- Power density 2100W/in^3

E.Mobility: AC/DC charger

~1/4



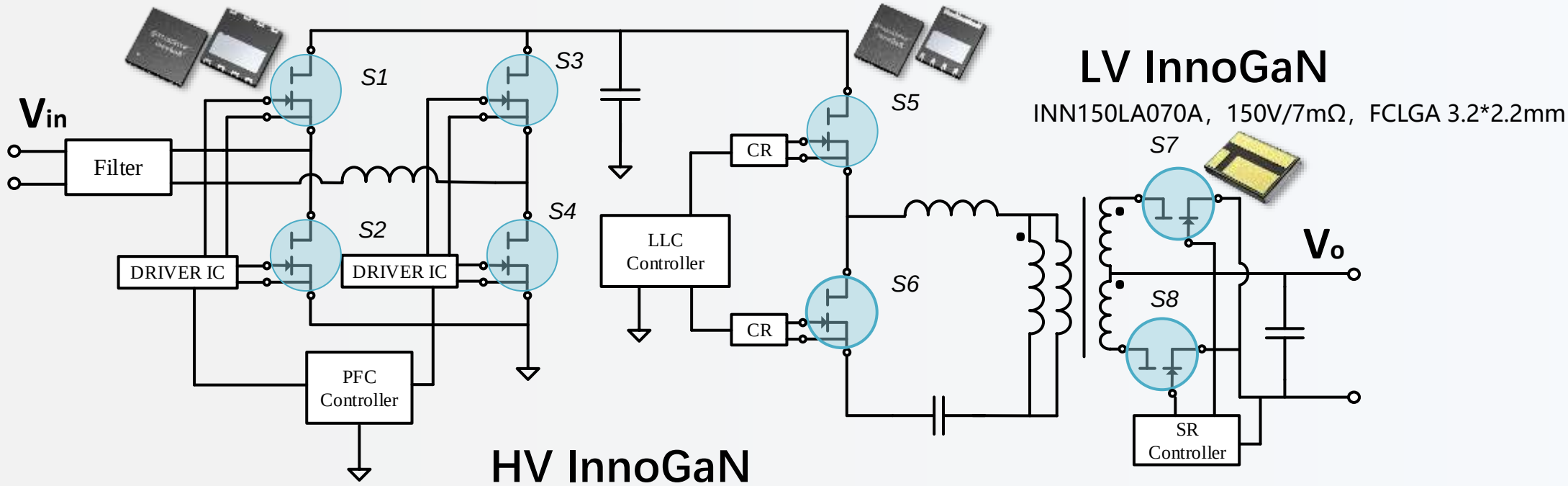
..so small that you could integrate that into the ebike frame!

Si solution

INNOGaN™ solution

240W 48V/5A Charger for e-bikes: All GaN solution

- **Topology： Bridgeless Totem Pole PFC+LLC**



Featured Innoscience Products:

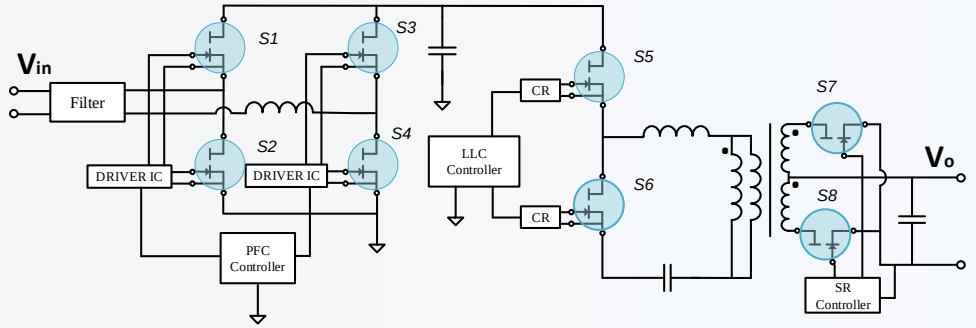
- S1/S2/S3/S4： INN650D080B, 650V /80mΩ, DFN 8x8mm
- S5/S6： INN650DA260A, 650V /260mΩ, DFN 5x6mm
- S7/S8：INN150LA070A，150V/7mΩ，FCLGA 3.2*2.2mm

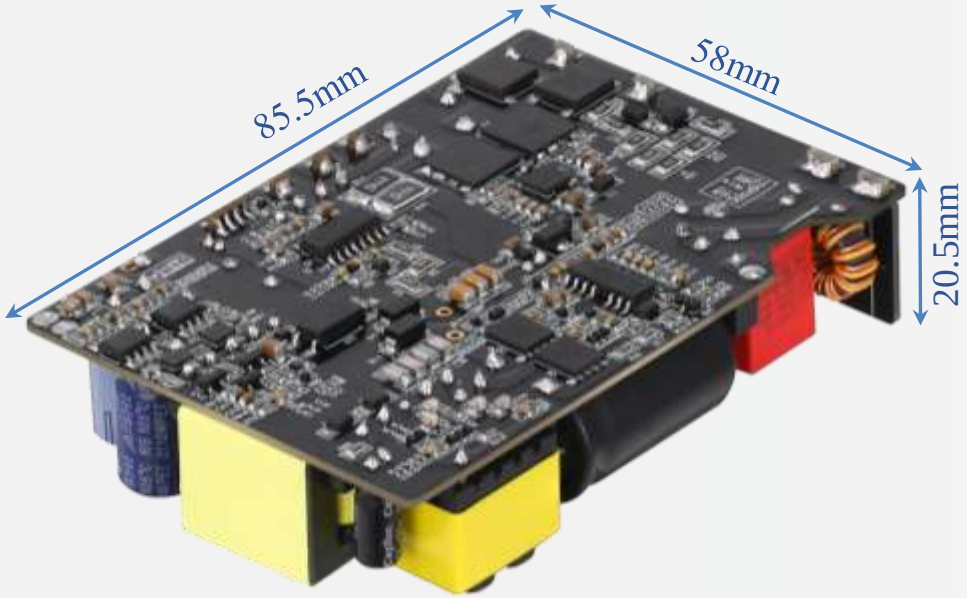
Advantage：

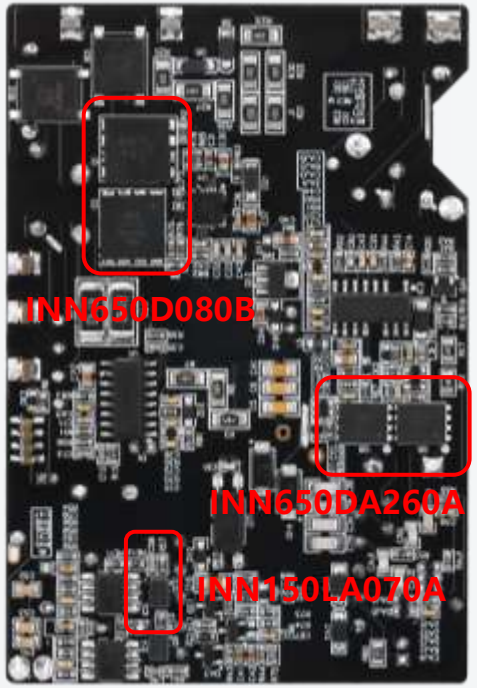
- High efficiency
- Very high power density

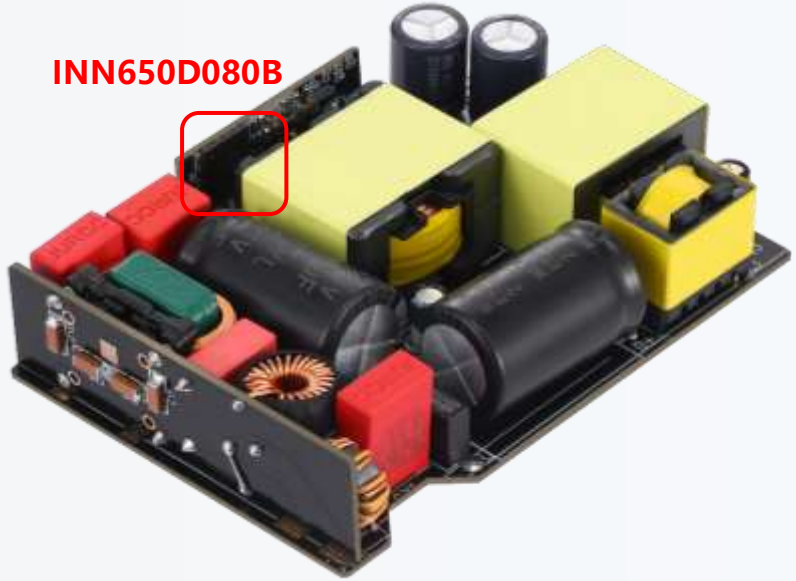
240W 48V/5A Charger for e-bikes

- PCB Size：85.5mm*58mm*20.5mm
- Power density：**38.7W/in^3**









Class-D Audio with INNOGaN™

Different applications:

- Speakers: Smart , Bluetooth, Wearable, Docking, Professional Active speakers…
- Power amplifiers
- Home cinema and multiroom systems: soundbars, theater systems
- TVs

Advantages:

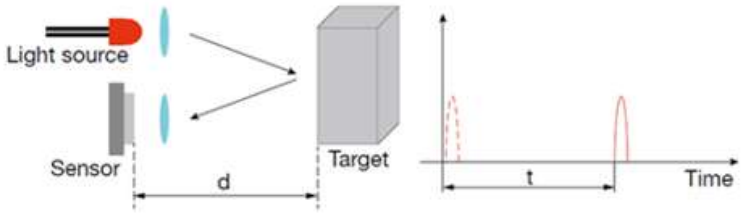
- Higher switching frequencies, lower switching losses: Reduced Power dissipation
- High audio fidelity: Better quality.
- Little or no heatsink.
- Lighter and smaller while increasing sound quality.

Products solutions:

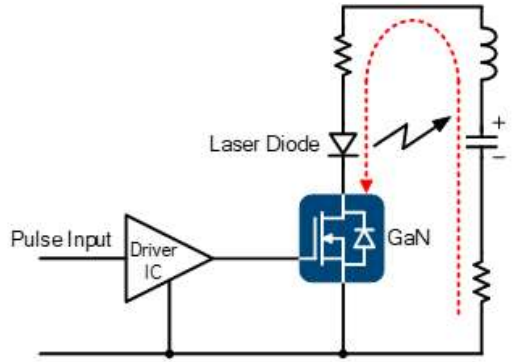
INN100W070A, INN100W032A, INN150LA070A, INNO650xxx

LiDAR with INNOGaN™

Light Detection and Ranging (LiDAR) GaN solutions are suitable as a driver element for laser switching, driving high current and extremely short pulses.



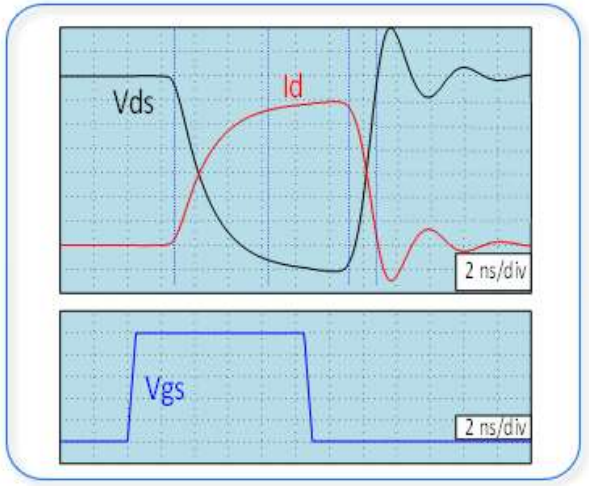
- Need high and short time current pulse
- Current Pulse Width<1ns
- Peak Current Up to 70A



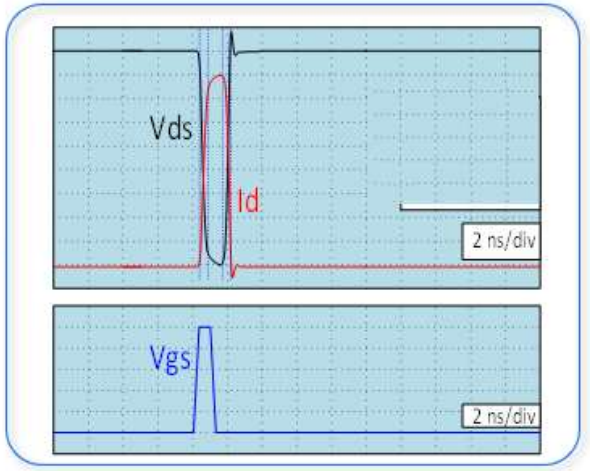
	INN100W14	BSZ146N10LS5
$Q_{G,\ typ}$	2.75nC	8nC
Q_{OSS}	13.5nC	20nC

Small Qg and Qoss makes GaN has faster switching performance

BSZ146N10LS5 (Si)

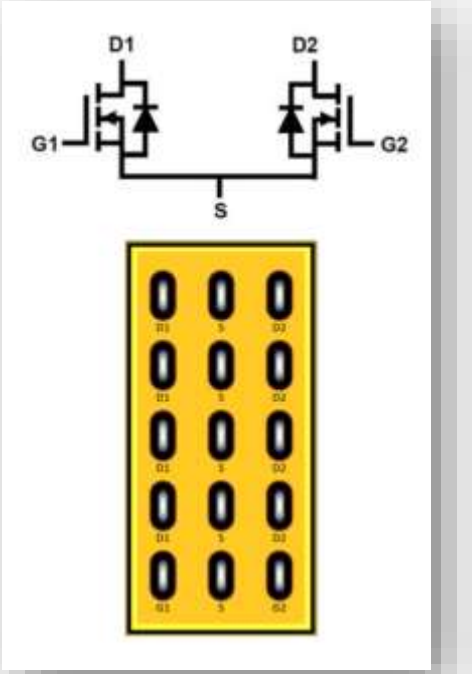


INN100W14 (GaN)

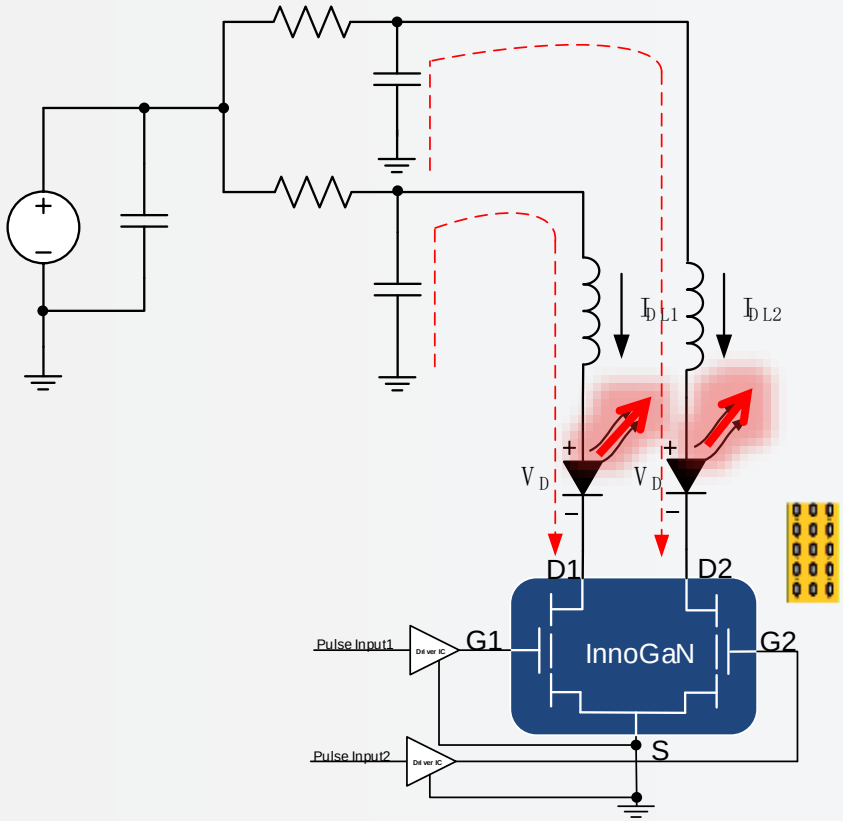


- Turn on Speed: 13X faster
- Pulse width: 5X Narrower

Why a dual/2 channels device for LiDAR applications?



100V InnoGaN
(INN100W14)



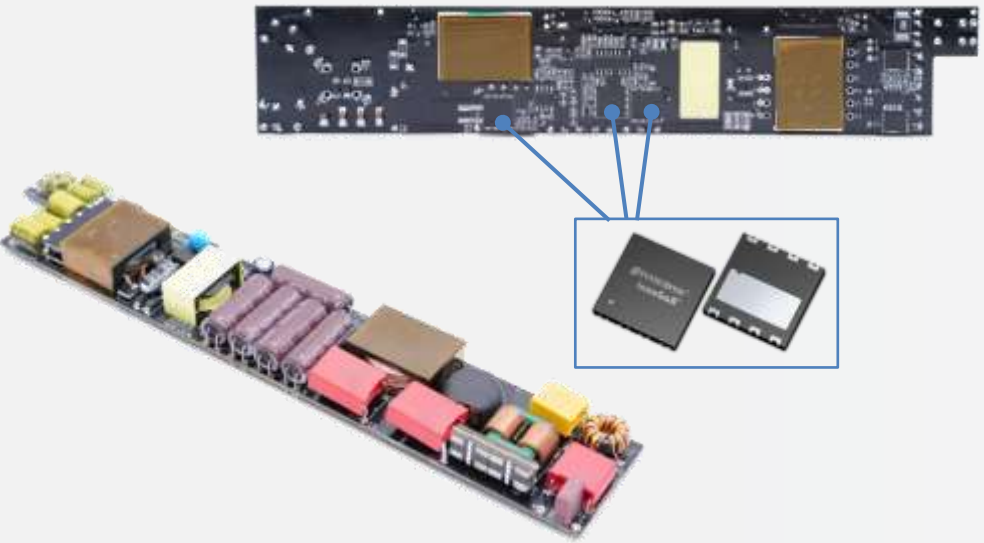
Dual InnoGaN device:

- Two InnoGaN on the same chip.
- Common source.
- One input voltage.
- Drive 2 lasers independently.

Advantages:

- **Cheaper and simpler than using 2 separated devices and associated circuits.**
- Smaller size.

LED Drivers with INNOGaN™



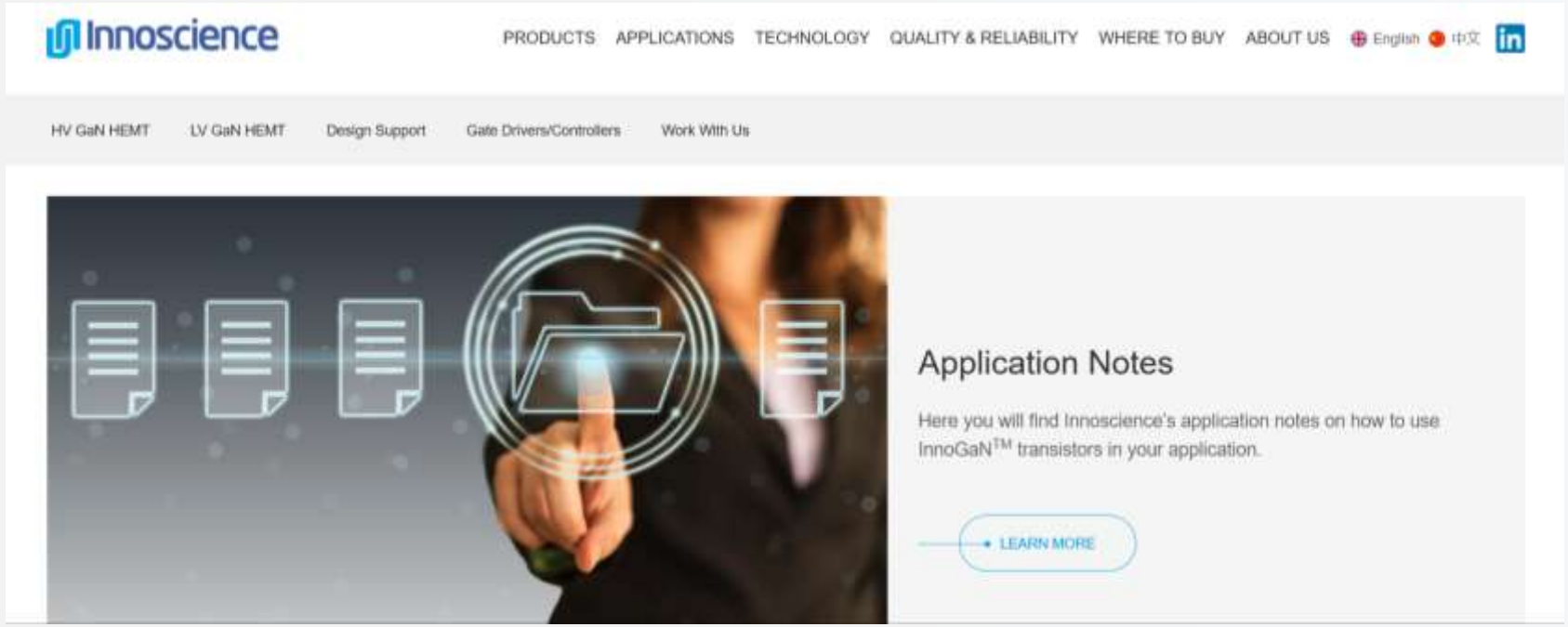
Topology	Boost PFC+LLC
Input Voltage Range	180-264Vac
Output Voltage	47~49V，CC 4.2A，TYP 48V
Efficiency	96% @230Vac & CC4.2A 48V
Size	196*35*13 mm(PCBA)
Power Density	35W/in3（PCBA）
Part Number	**INN650D150A+INN650D260A**

Si based solution
200W LED driver

InnoGaN based solution
200W LED driver

Ressources

Website Resources – Design Support / App Notes



Document	App Notes
AN001	650V InnoGaN Drive Circuit Design
AN002	Design considerations of Paralleled GaN HEMT
AN003	Double Pulse Test Evaluation Board for GaN Devices
AN004	[Sample] ApplicationNote_BiGaN with Dual Drain and Single Gate-Rev1D0

Thank you!

Looking forward to spreading GaN together!

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+33660924743

Presented by Innoscience Europe team