Price competitive GaN power devices are the technology of choice for high-efficiency, compact and cost-effective power systems

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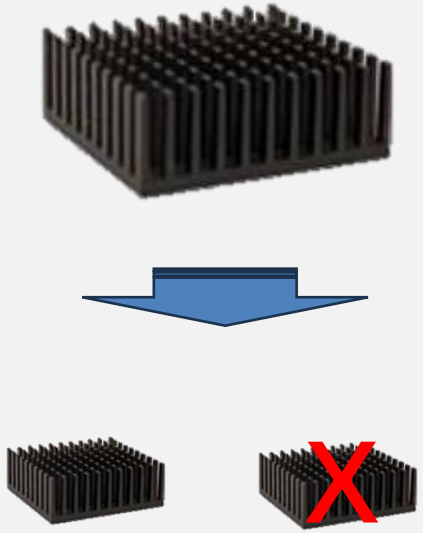
Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

GaN

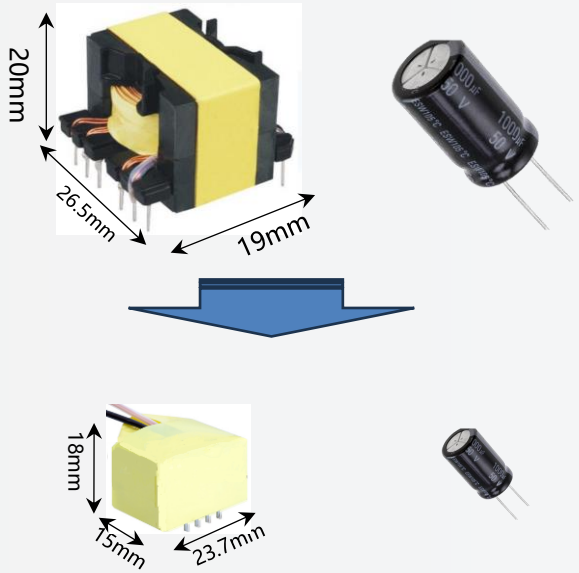
Why GaN?
GaN makes power conversion systems Lighter, Smaller, Simpler and Cheaper

High efficiency



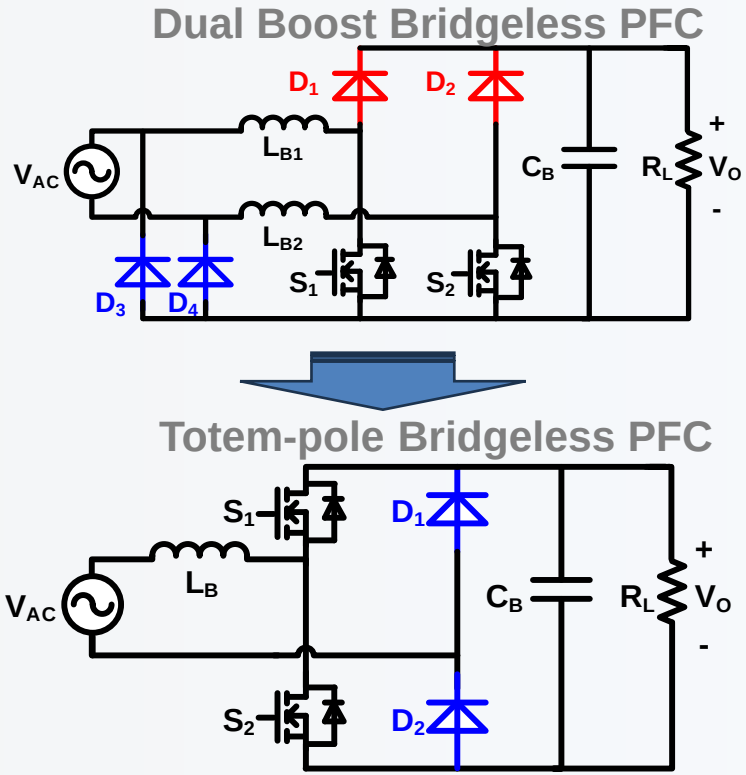
Heat sink elimination or smaller

High frequency



Size and cost reduction of the passives

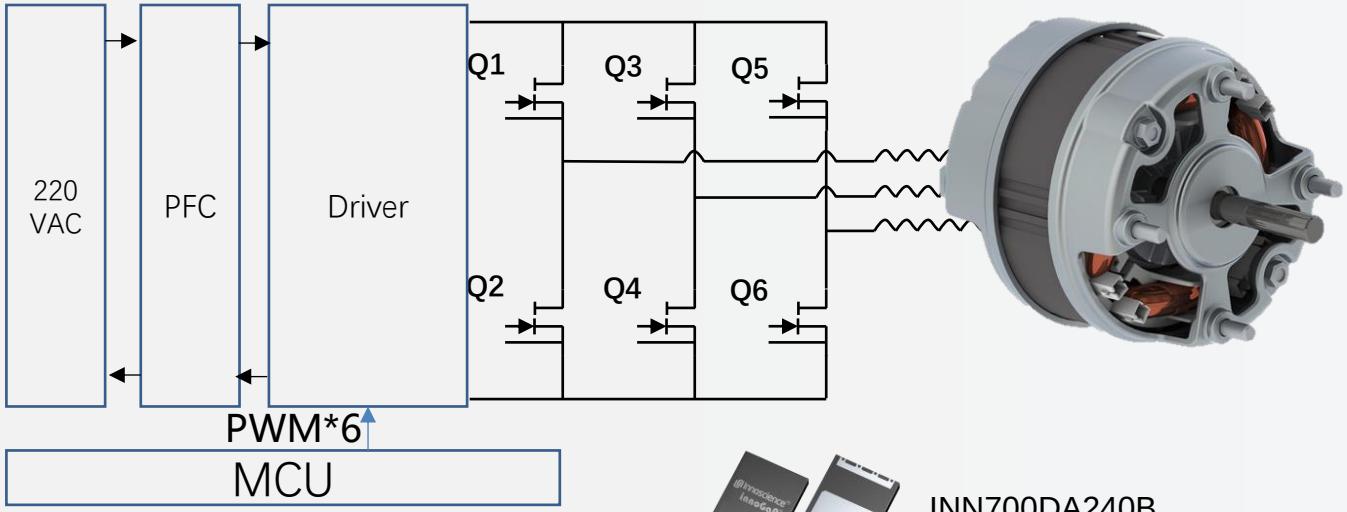
No reverse recovery



Simpler with less components (BOM)

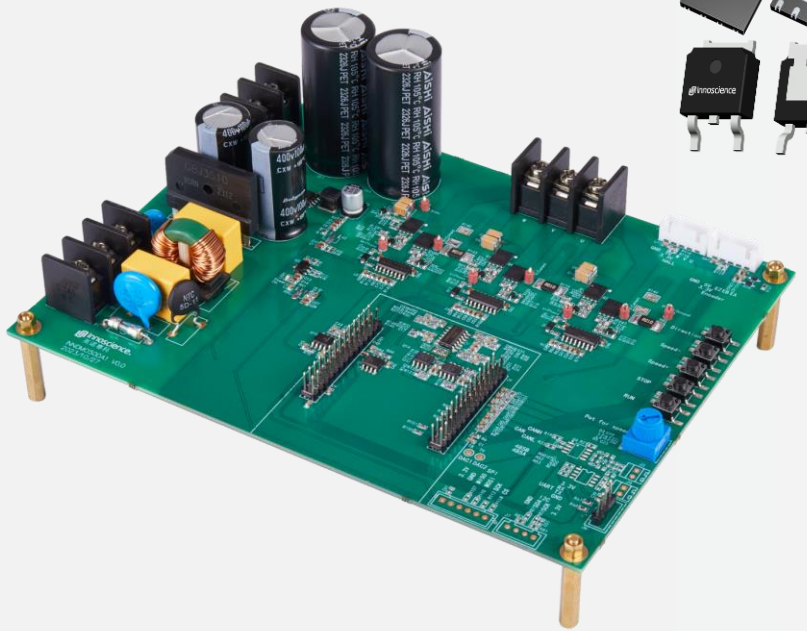
InnoGaN simplifies power electronics around us

300-500W motor drive that does not need heat sink with GaN



Motor parameters:
Rated voltage:310Vdc
Rated power:315W
Speed：1000rpm
Pole pairs：10

INN700DA240B,
700V, 240mΩ max,
DFN5x6 Package
TO252 Package

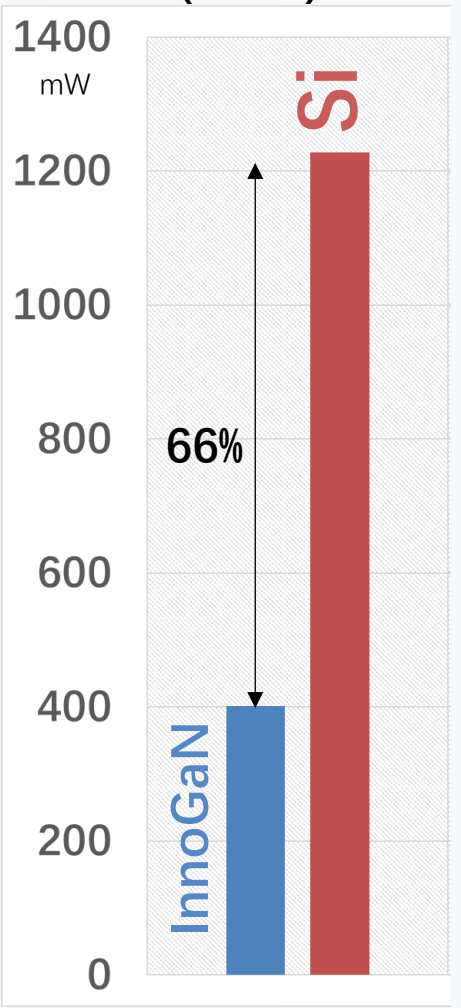


DC input：310Vdc
Rated voltage：310V
Max Rated power:500W
PWM frequency：fsw=10~50KHz
Dead time：>=100ns
Peak motor phase current：7A

InnoGaN is 15-20°C cooler than IGBT

No need of heat sink (cost saving!)

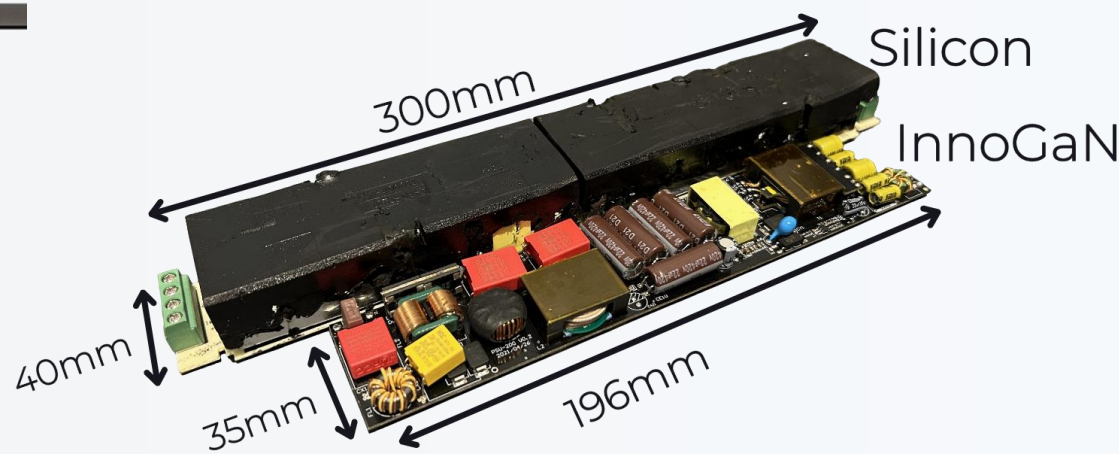
Total power loss (315W)

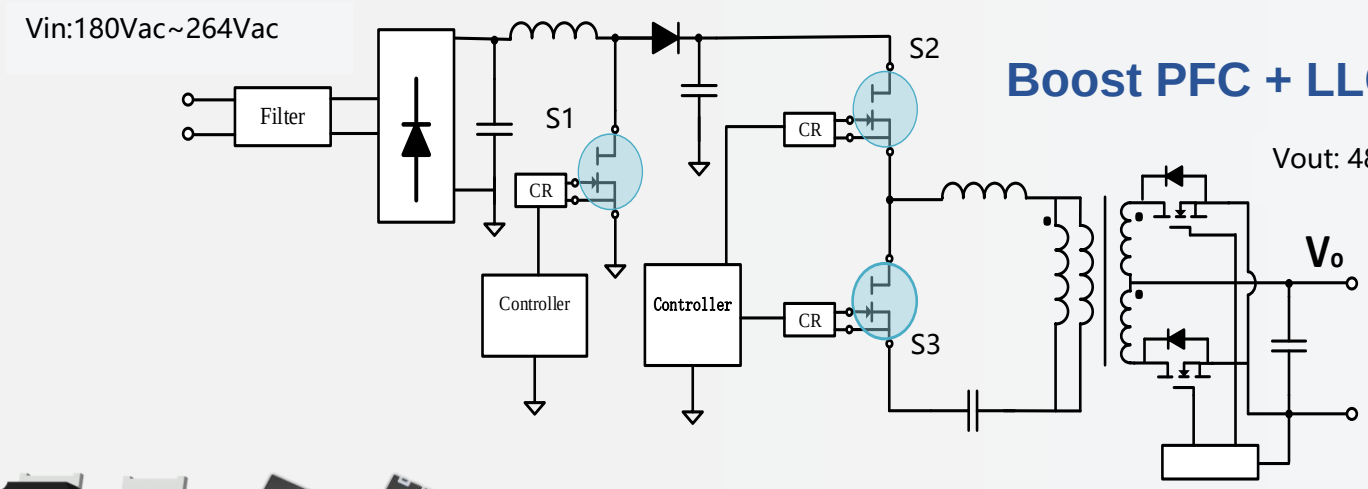


InnoGaN into LED drivers: smaller, thinner and lighter

InnoGaN LED Driver delivers

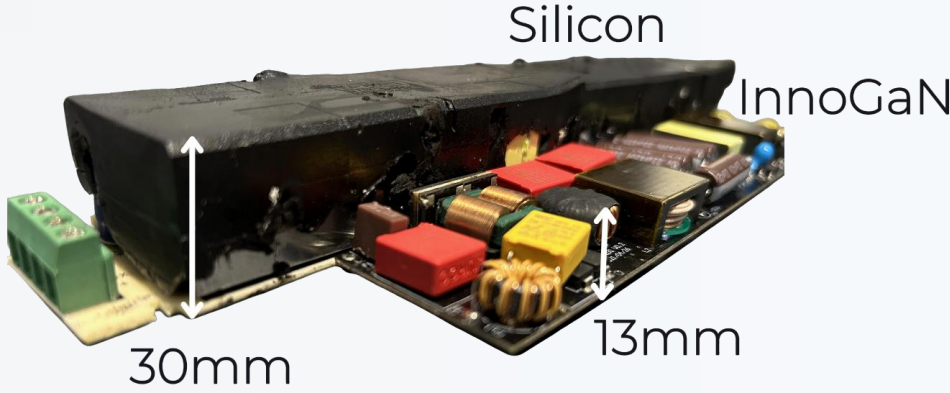
- 67% more power
  - 120W Si vs 200W InnoGaN
- 35% length reduction
- 57% height reduction

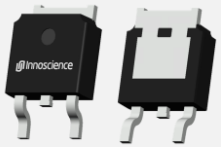


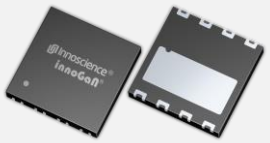


Boost PFC + LLC

Vout: 48V @200W







TO252 *DFN 8mm x 8mm*

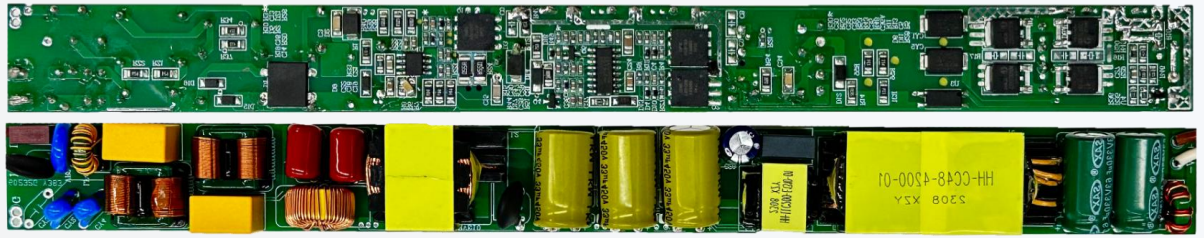
- 1x INN650D140A, 650V, 140mΩ max,
- 2x INN650D240A, 650V, 240mΩ max

Do you really need to make it thinner/smaller? Yes!

Example Silicon driver #1: too long
Driver occupies large part of the track

Example Silicon driver #2: too thick
Driver height doesn't match the track.

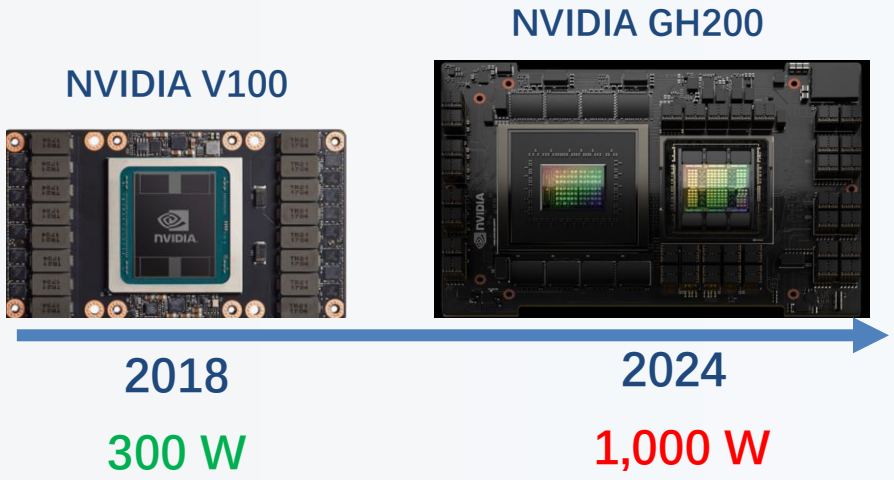
InnoGaN Solution（PFC+LLC, 200KHz) : perfect
Balance of size and shape and gain 4% in efficiency (6W saved/track)



Power Supply Unit (PSU): Key challenge

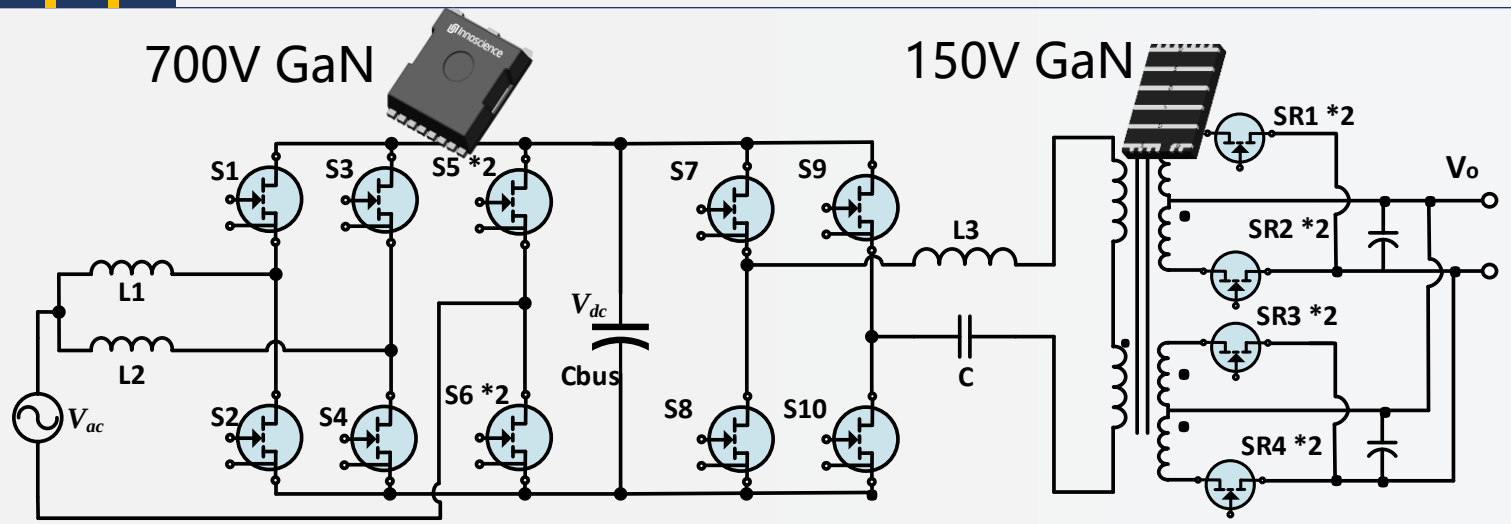
- More and more data centers (AI)
- Computational power increases → Power (Watt) per AI GPU card increases

Load	80 PLUS	Bronze	Silver	Gold	Platinum	Titanium
	Efficiency					
10%	-	-	-	-	-	90.00%
20%	80.00%	81.00%	85.00%	88.00%	90.00%	94.00%
50%	80.00%	85.00%	89.00%	92.00%	94.00%	96.00%
100%	80.00%	81.00%	85.00%	88.00%	91.00%	91.00%



With Silicon technology it is difficult to reach Titanium Plus efficiency while keeping small PSU size
This is possible with GaN power technology!

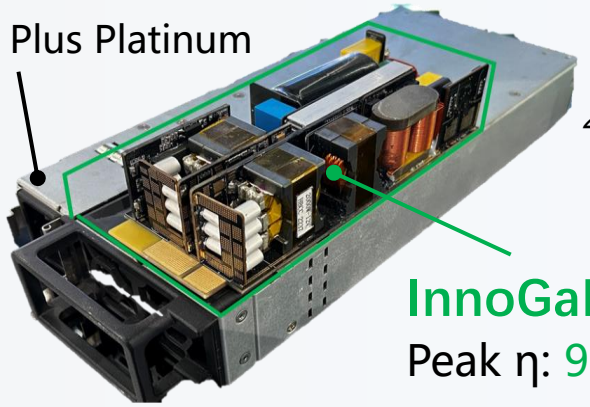
4.2kW PSU with GaN at primary and secondary side



Silicon

Peak η : 94%

80 Plus Platinum



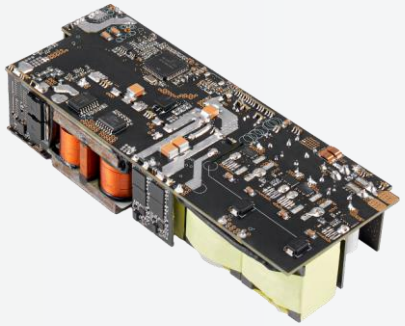
2kW PSU

InnoGaN

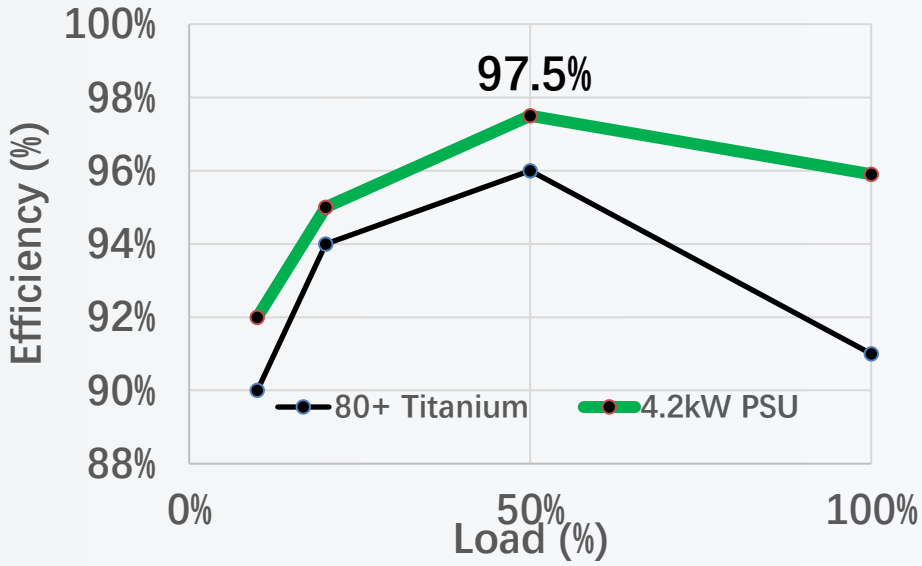
Peak η: 96.5%

80 Plus Titanium

- **Topology: Totem pole PFC + LLC**
- Output: 12V, 4.2kW
- **Size 37x69x185mm – 130 W/in³**
- **Meet 80 PLUS Titanium rating**
- InnoGaN FETs:
  - S1-S4: INN650TA050AH (650V/70mΩ, TOLL)
  - S5-S10: INN650TA030AH (650V/30mΩ, TOLL)
  - SR1-SR4: INN150FQ032A (150V/3.2mΩ, FCQFN)



4.2kW PSU



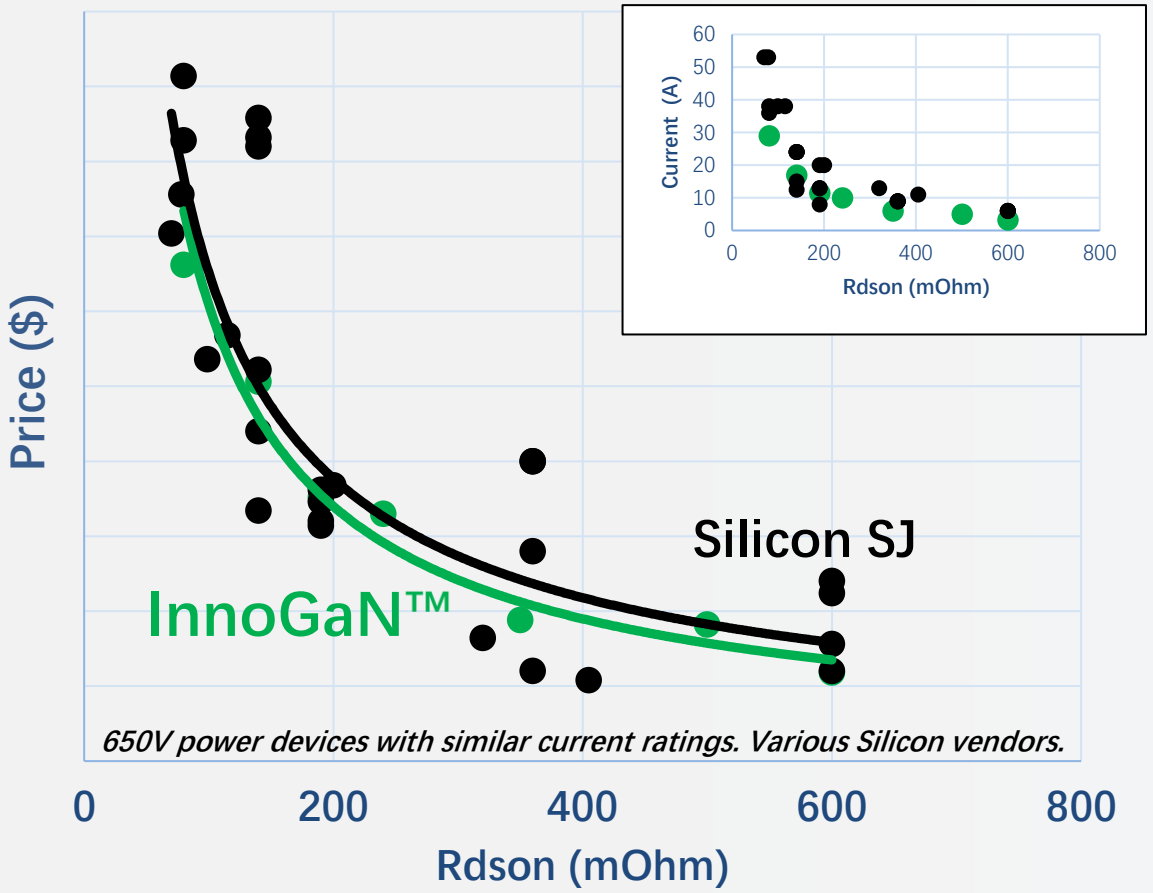
What about the price and the reliability of GaN?

- **Price perception:** GaN power devices are 2x or 3x more expensive than a Si power device.

- **Reliability perception**: GaN is a new technology, and its reliability is questionable.

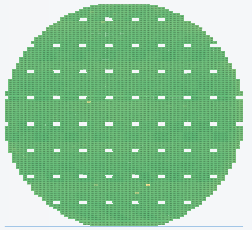
GaN vs Silicon Super Junction (SJ) price

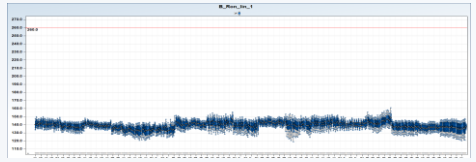
Source: www.richardsonrfpd.com and www.digikey.com



How?

- **Economy of scale & IDM**
  - Vertically integrated
  - 10k wafers/month
- **8-inch GaN-on-Si wafers**
  - ~2x dies than 6-inch
- **High Yield**





Price of InnoGaN is comparable to Si Super Junction (SJ) devices

Reliability of GaN power devices

GaN tech is not new!

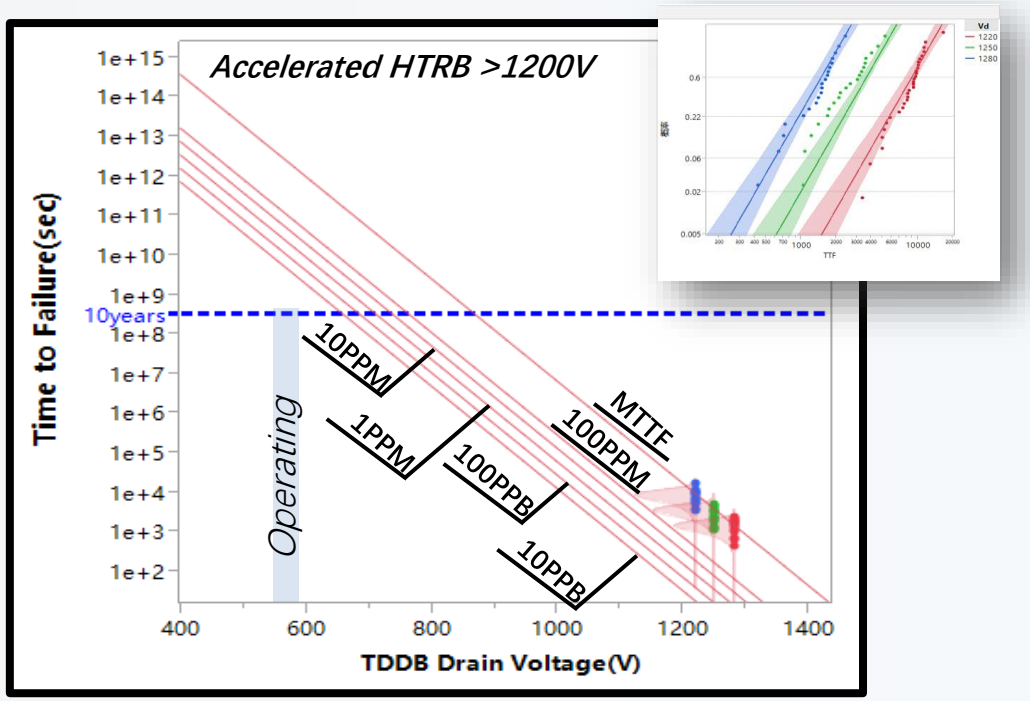
Qualification standards:

- JEDEC tests for power devices (must do).
- **JEDEC JEP180: specific for GaN**
  - Devices are stressed under switching stress (mimic real application usage)

We also do some extras:

- Test to failure and lifetime extrapolation
  - **HTGB**: beyond max gate specs
  - **HTRB**: beyond max off-state drain voltage specs

Lifetime evaluation		
Ppm/ppb	**Vop@560V,Tj150℃ (Years)**	**Vop@700V, Tj150℃ (Years)**
10ppm	1970	29
1ppm	900	14
100ppb	410	6
10ppb	**190**	**2.9**



source: JEDEC, JEDEC JEP 180 and S. Bahl, white paper, https://www.ti.com/lit/wp/snoaa68/snoaa68.pdf

What about the price and the reliability of GaN?

- ~~**Price perception:** GaN power devices are 2x or 3x more expensive than a Si power device~~

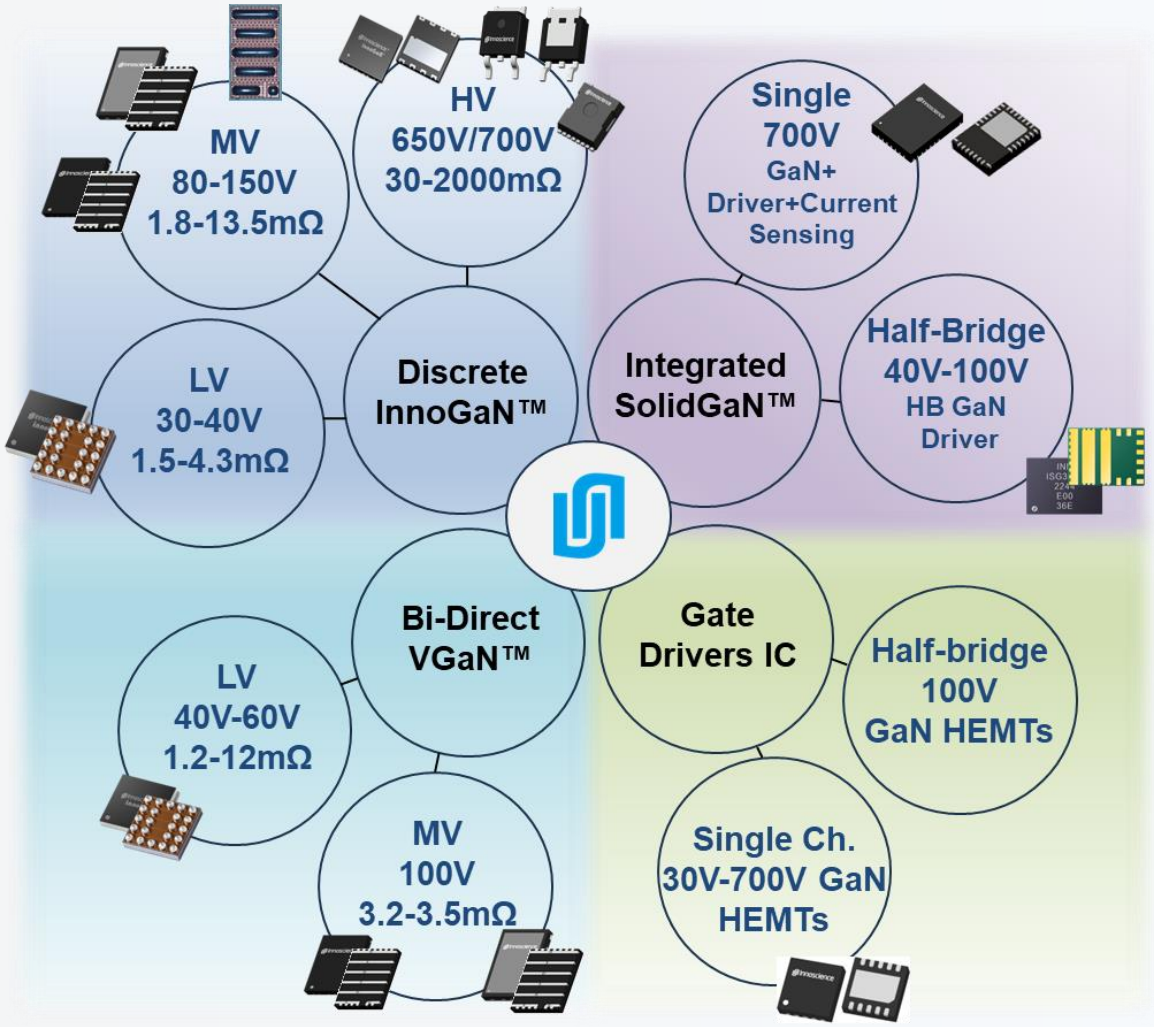
InnoGaN is price competitive with Silicon
(plus with GaN you save cost on the system solution that is also smaller and more efficient than with silicon)

- ~~**Reliability perception**: GaN is a new technology, and its reliability is questionable~~

Innoscience GaN (InnoGaN) is reliable

Conclusion

- **InnoGaN makes power conversion systems Lighter, Smaller, Simpler and Cheaper:**
  - 500W Motor Driver
  - 200W LED driver
  - 80+ Titanium PSU (50% smaller than Si)
  - …
- **Innoscience is one-stop shop for e-mode GaN devices:**
  - Wide voltage range:
    - LV (30V-40V), MV (80V-150V) and HV (650V/700V)
  - Discrete and Integrated solutions
  - Gate drivers
- **InnoGaN is price competitive with Silicon and is reliable**
- **no-brainer for today's power system solutions**



Thank you

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Innoscience: one stop shop for e-mode GaN devices

E-mode/normally-off GaN power devices

LV/MV:

- 30V-150V
- **Ron: 1.8mOhm – 14mOhm**
- WLCSP, FCQFN, EN-FCQFN, LGA
- **Discrete and HB Integrated with driver**
- **Bi-directional (40V, 100V)**

HV:

- 650V/700V
- **Ron: 30mOhm - 600mOhm**
- DFN, TO252, TO220, TOLL, TOLT
- **Discrete and Integrated with driver**

Single Channel Gate driver