GaN HEMT Device

Press Release Presentation

May 2021
ROHM Co., Ltd.
Power･Discrete business headquarter
GaN device project

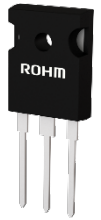
*Please note that this document is current as of the date of publication

ROHM's Approach for Power application

Provide optimal products that contribute to energy and space saving from power devices to ICs and modules

Power Devices (power semiconductors)

SiC Devices



- SiC MOSFETs
- SiC SBD (Schottky barrier diodes)

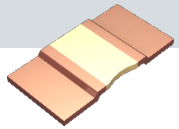
Si Devices

- IGBTs
- SJ-MOSFETs
- SBD, FRD (Fast recovery diodes)

Under Development **GaN Devices (GaN HEMT)**

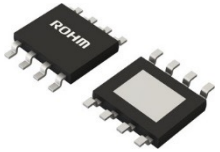
Passive Devices

- Shunt Resistors



Power ICs

Power Management ICs



- DC/DC Converter ICs
- LDOs (Low dropout)
- AC/DC converter ICs (SMPS)

Driver ICs

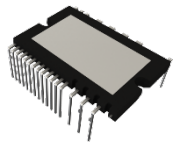
- Gate Driver ICs
- Motor Driver ICs

Standard ICs

- IPDs

Power Modules

- Full SiC Power Modules
- IPMs



We are also providing products that combine power device elements and IC technology, such as AC/DV converter ICs with built-in SiC MOSFETs.

GaN device is a device that would expand ROHM's power portfolio

What's GaN, GaN HEMT ?

GaN (Gallium Nitride)

=A type of compound semiconductor material

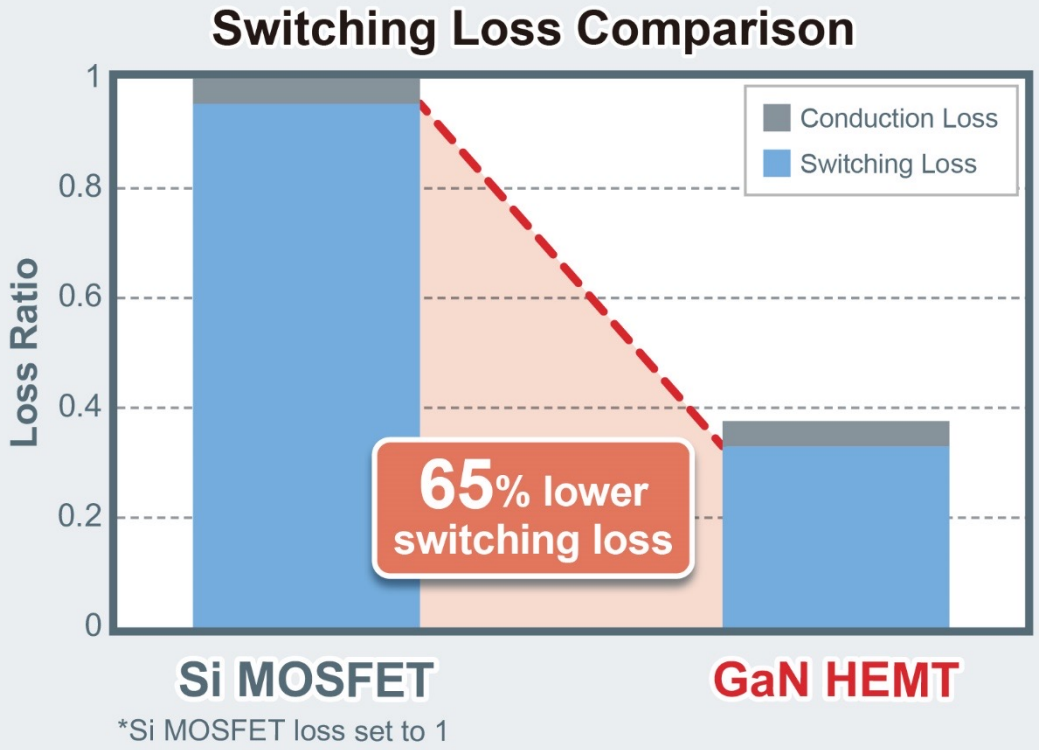
	Si	4H-SiC	GaN
Bandgap (eV)	1.12	3.2	**3.4**
Dielectric constant	11.7	9.66	8.9
Breakdown field (MV/cm)	0.3	3	**3.3**
Electron saturation velocity (10^7 cm/s)	1	2	**2.5**
Electron mobility in the bulk (cm^2/Vs)	1350	720	900
Thermal conductivity (W/cm·K)	1.5	4.5	2 to 3

- Wide band gap
- High electron saturation velocity
- Large breakdown electric field

GaN is a great potential material that could contribute further energy saving, such as SiC

HEMT (High Electron Mobility Transistor)

= A type of transistor element structure



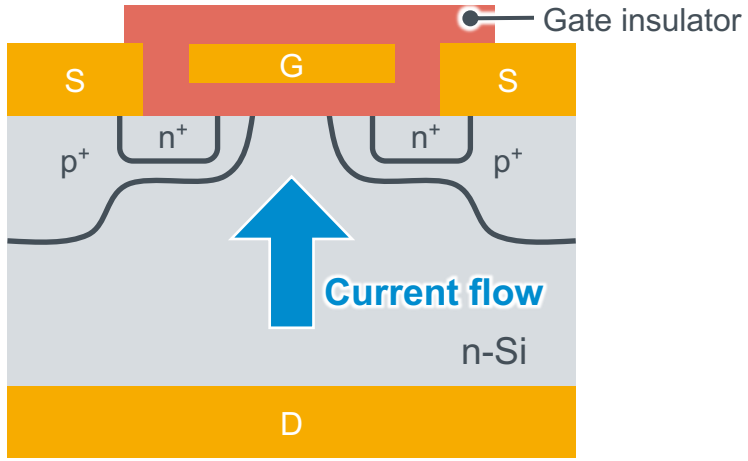
GaN HEMTs can significantly reduce switching losses compared to Si MOSFETs

Device Comparison (Comparison in the 650V band)

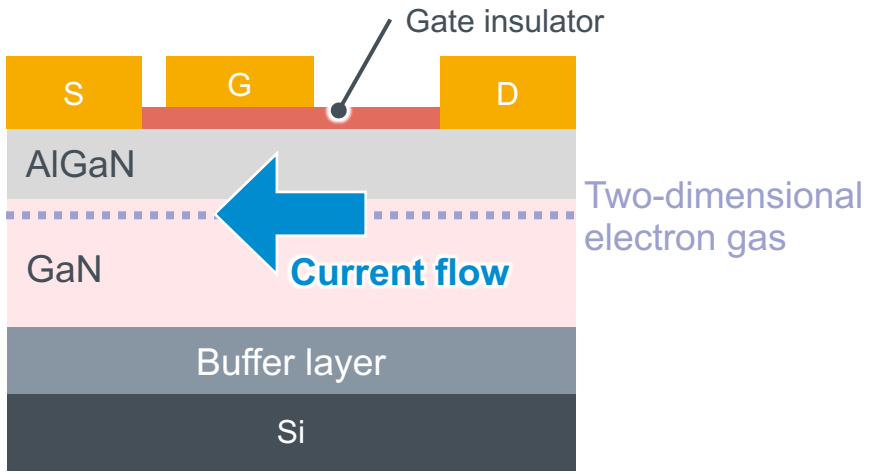
	Si SJ MOSFET	SiC MOSFET	GaN HEMT
Voltage range	500V to 1kV	600V to a few kV	**Less than 650V**
Large current	Better	Better	**Good**
High speed switching characteristic	Good	Better	**Excellent**
Ron·Qg *1	1 *2	0.63	**0.05**
Switching loss	1 *2	0.2	**0.1**

*1: index that represents switching performance. The lower the value, the better the switching performance. *2: Set Ron / Qg and switching loss of Si SJ MOSET to 1.

Si, SiC MOSFET vertical structure

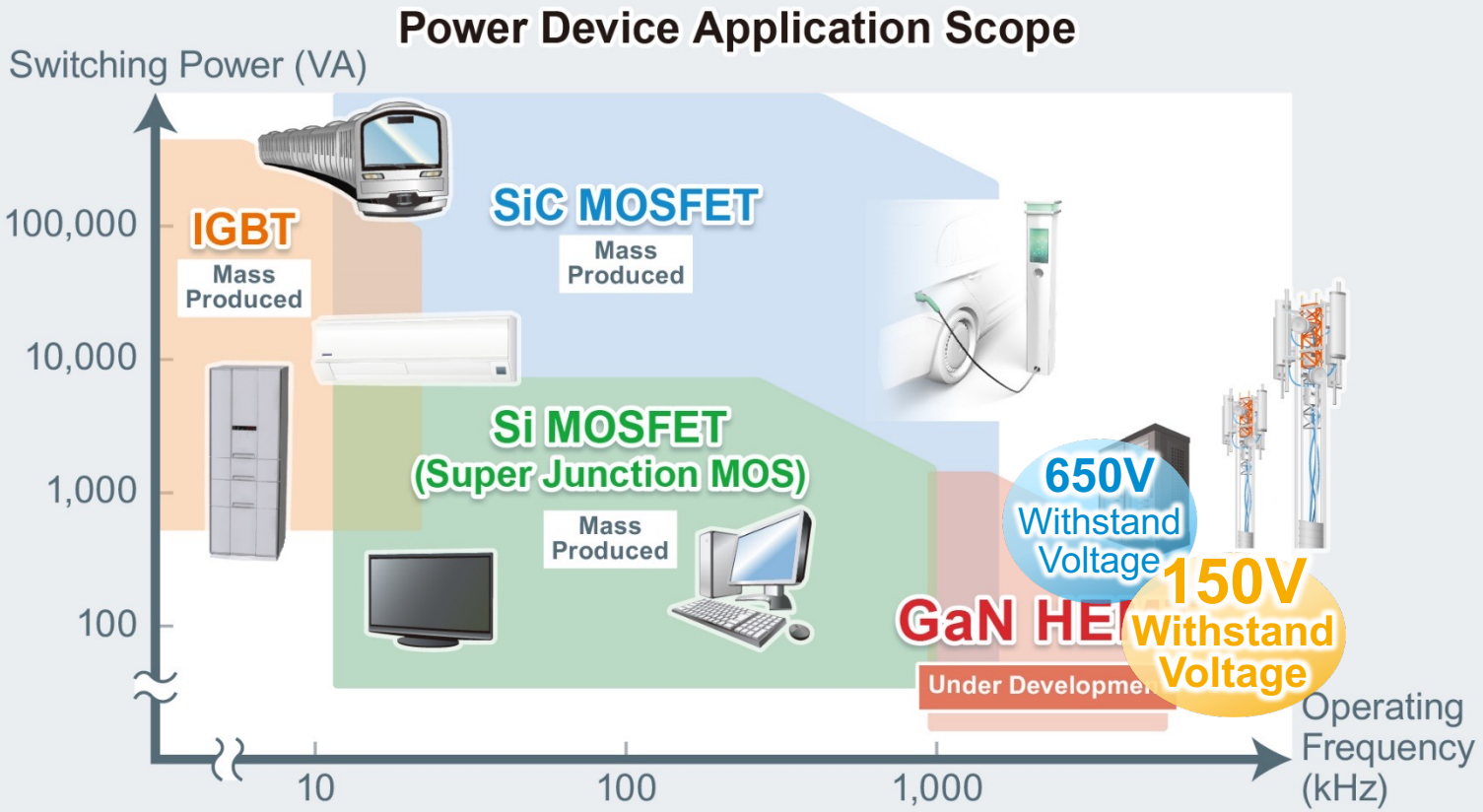


GaN HEMT lateral structure



Application range of transistor power devices

Power devices have different power (VA) and operating frequency bands, depending on the materials and device



SiC

- High Power
- High voltage (>600V)
- High frequency (20 to 200kHz)

・EV inverter, HV DC/DC, OBC
・Server primary power supply
・Solar/wind power
・Industrial power supply
・Railroad

GaN

- Middle power
- Middle voltage (100 to 600V)
- High frequency (More than 200kHz)

・Server power supply for data center
・Base station power supply
・Small AC adaptor(consumer)
・Automotive OBC, 48V DC/DC

ROHM begins development of 150V GaN device as a device to complement SiC devices

GaN HEMT is expected as a device with extremely high frequency operation in the medium voltage range

GaN device market and challenges

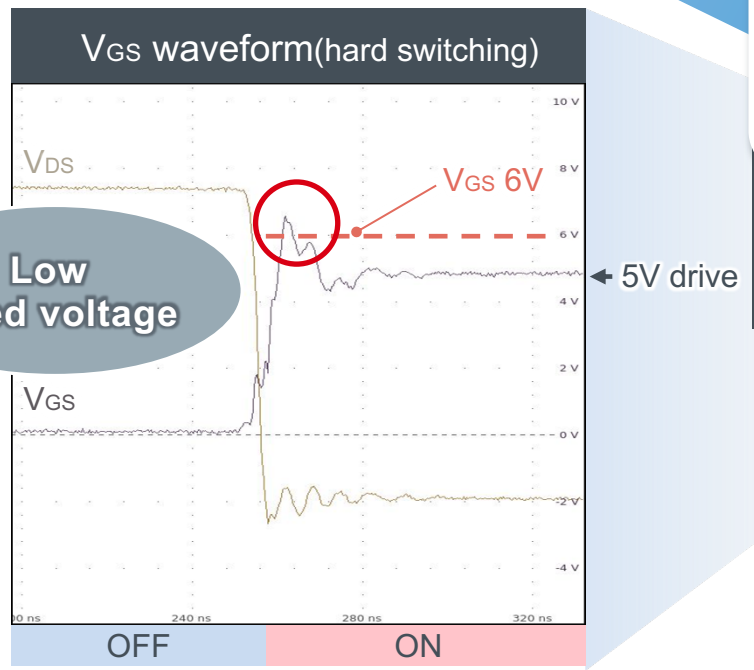
1 Start development by taking advantage of the GaN features

2 The market has started up, but issues have become apparent

Low gate-source rated voltage
Package is not user-friendly

Not user-friendly

BGA package



Low rated voltage

5V drive

3 Problem solving from the user's perspective is essential for popularization

ROHM develops technology that solves the problems and promotes the spread of GaN devices

GaN device specification

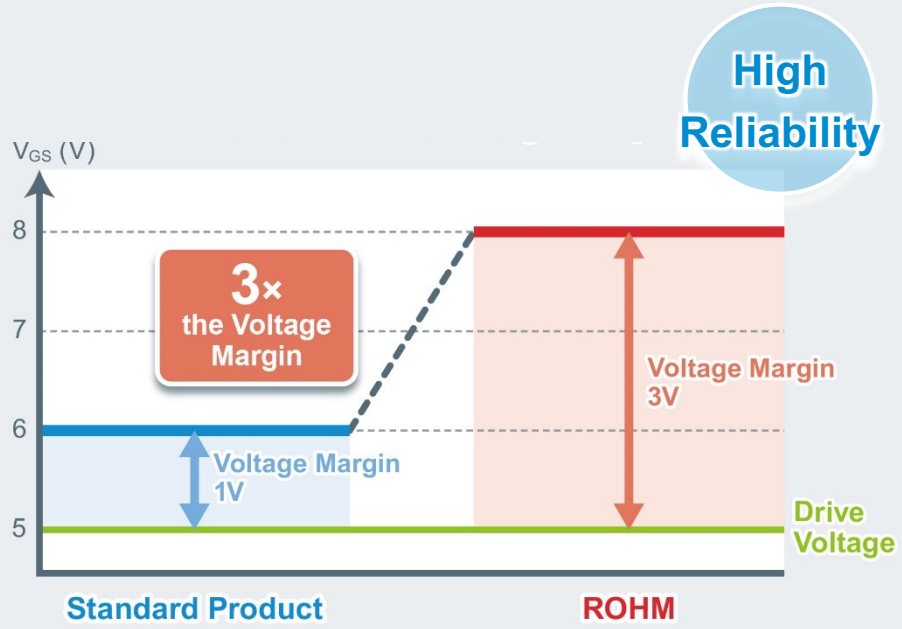
Under Development

Note: As this is a developed product, specifications are subject to change without notice.

Mainly characteristics

- Voltage (V_{DS}): 150V
- **Gate-source rated voltage: 8V**
- **Original mold package**
  - **High reliability**
  - **Good mountability**
  - **High heat dissipation**
  - Low parasitic inductance
- High speed switching (>1MHz)
- Normally-off
- Reverse recovery time 0

Rated Gate-Source Voltage Comparison



Package image

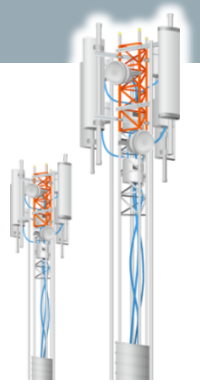
Line-up (plan)

No.	I_{DS}	$R_{DS(on)}$	Q_G
1	5A	40mΩ	2.0nC
2	15A	15mΩ	5.4nC
3	20A	7mΩ	11.5nC

Application

- **Data center, Base station (48V → 12V BUS converter)**
- **Boost converter for PA module in Base station**
- **D class audio amplifier**
- **LiDAR for industrial (LD driver)**
- **Wireless charging for portable devices**

Data center

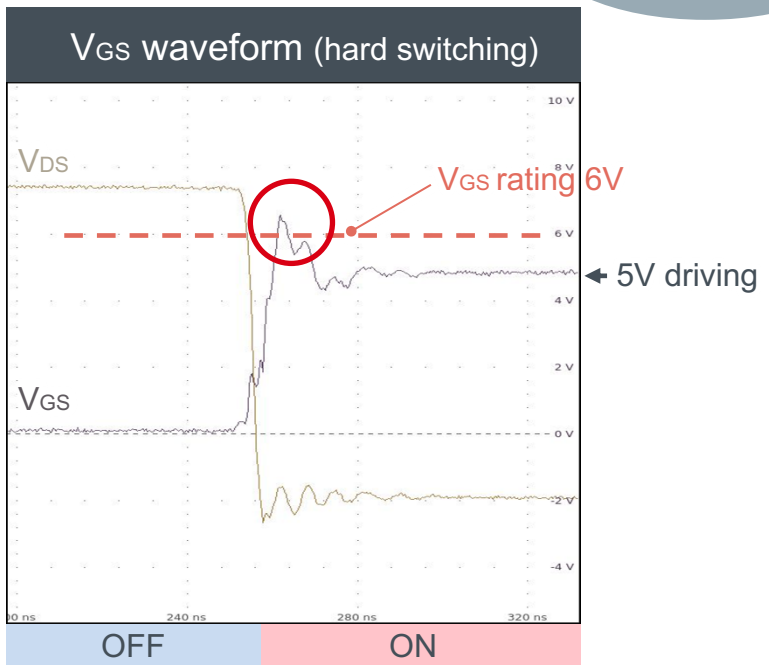


Base station

detail Gate-source rated voltage comparison

Conventional

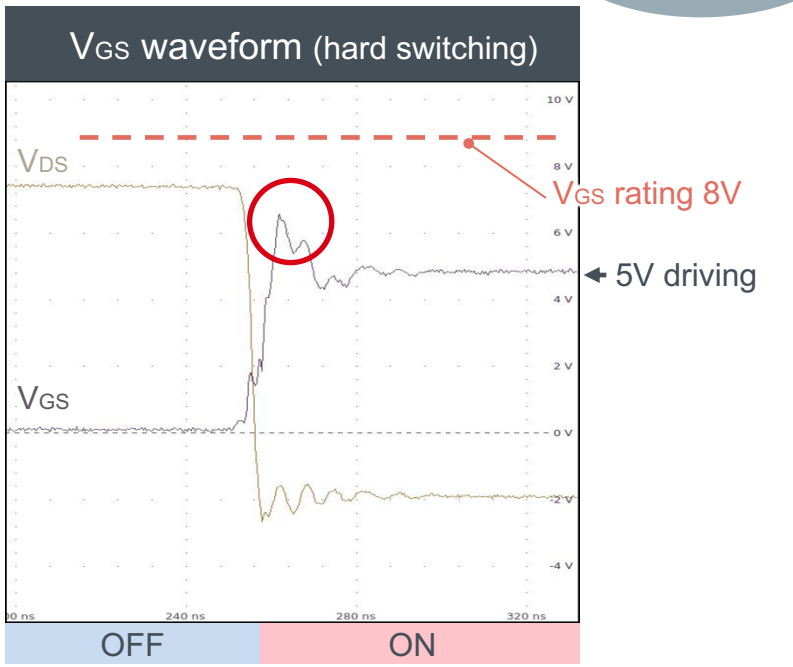
Low rated voltage



When the overshoot voltage is generated, rated voltage may be exceeded, causing problems with device reliability.

ROHM Technology

High rated voltage



Even if the overshoot voltage occurs, the margin that does not exceed rated voltage is secured to ensure reliability.

ROHM has developed 8V gate-source voltage technology that contributes to improve design margin and higher reliability

Future of GaN device development

2021

April

Announced the establishment of 8V gate-source rated voltage technology

September

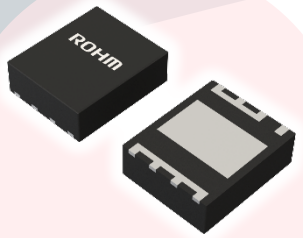
Sample product will be ready

2022

Start mass production of 150V(Gen.1st) products

2006

Started research & development of GaN devices

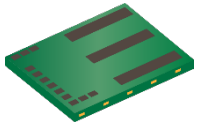


GaN Discrete

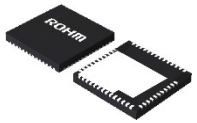
Next Gen.

Low voltage (<200V)
- **150V products** (lower $R_{on(DS)}$: Gen.2nd, Gen.3rd)
- **GaN module built-in driver IC**

High voltage (>600V)
- **650V products** (Gen.1st)
- **GaN IPM**



GaN module



GaN IPM

Plan sample in Sep. 2021 and will continue to develop next-generation products in the future

Notes

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- If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from ROHM upon request.
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