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Wafer Manufacturer Produces High-Performance SJ MOSFETs At Lower Cost

[IceMOS Technology](#), a company that has produced SOI, substrate, bonded and MEMS wafers for years, has leveraged its ability to produce deep trenches in MEMS devices to manufacture silicon superjunction (SJ) MOSFETs that are said to be highly cost competitive. According to Niall Lyne, COO and EVP Global Sales, the company holds over 75 patents for MEMS superjunction power MOSFET technology.

With its expertise in deep etching and high voltage isolation, the company has developed an SJ MOSFET process that is less costly than that which is typically used by IDMs to produce leading devices. For example, a 600-V MOSFET from a leading supplier is fabricated in 27 to 32 layers. IceMOS claims similar performance with a device fabricated in 9 layers, says Lyne. This results in significant cost savings.

The devices are said to be particularly robust too with high UIS capability and high avalanche energy as noted in Fig. 1. To illustrate, their 600-V devices can withstand 700-V transient spikes. Furthermore, the company goes beyond the usual limits in qualifying its devices.

For example, as Lyne observes, in performing HTOL, it qualifies its SJ MOSFETs to 2000 hours versus the industry standard 1000 hours. It also qualifies their SiC devices to 200°C versus the 150°C or 175°C that's common in the industry, he says.

The company's current lineup of mostly 600-V and 650-V SJ MOSFETs is listed in the table in Fig. 2 which also shows their package options. Table 1 then lists specifications for devices offered in TOLL leadless packages.

As the technology continues to evolve as shown in Fig. 3, the company's roadmap will take its SJ MOSFET devices to higher voltage ratings enabling them to compete with SiC MOSFETs.

"IceMOS is focused on both MEMS process and device physics for building power devices. Our improvements in silicon rival the improvements offered by wide bandgap devices, but with silicon's manufacturability, where at IceMOS we apply scientific principles in a disciplined engineering fashion allowing us to optimize device design for performance and center it for manufacturability and reliability," said Samuel Anderson, founder CEO.

Meanwhile, the company also has SiC MOSFETs in development which are expected to compete with existing offerings from other vendors. Their devices in development are listed in Table 2.

Although the company is well known in Asia, and also has some U.S. customers, IceMOS utilized the recent PCIM Expo to introduce its products more broadly to the European market, according to Elmar Winter, director sales EU, marketing.

IceMOS has produced a number of slides showing the positioning of their devices versus voltage, power, and frequency ranges and the popular power electronics applications within these ranges. By mapping its devices across these ranges, IceMOS aims to show design engineers that they can achieve SiC-like performance while maintaining the design-in simplicity and cost-efficiency of silicon.

For more information, see the [website](#) or contact the [company](#).

IceMOS HV SJ MOSFET ADVANTAGES

IceMOS is the first semiconductor company to successfully merge MEMS manufacturing techniques with sub-micron CMOS manufacturing to create the IceMOS MEMS Superjunction MOSFET technology platform



mSJ MOS™

Scalable high voltage Superjunction MOSFET with:

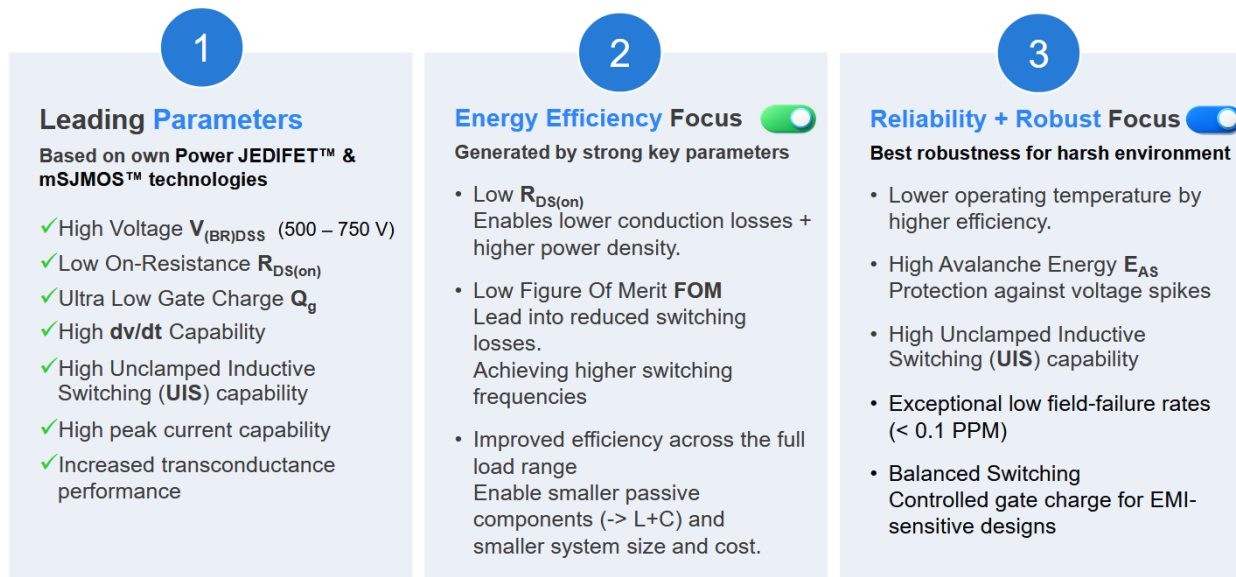
- High Drain-Source Break Down voltage $V_{(BR)DSS}$
- Low Drain-Source on resistance $R_{DS(on)}$
- High Avalanche energy, single pulse E_{AS} -> unclamped Energy
- Ultra-low gate charge Q_{GD} enables fast switching by low losses (Gen 2)
- High unclamped inductive switching (UIS) ability

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(a)



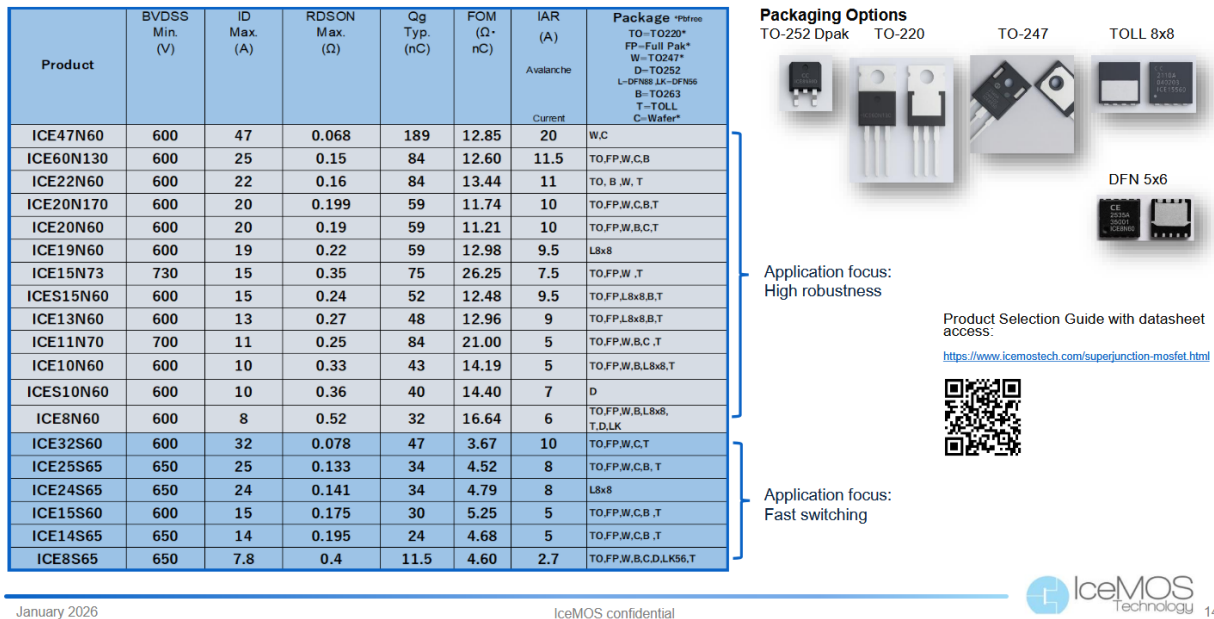
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(b)

Fig. 1. Advances in semiconductor manufacturing techniques have led to IceMOS's development of high-performance, robust superjunction silicon MOSFETs that can be manufactured at lower cost, according to the vendor (a). The chart in part b elaborates on the benefits.



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Fig. 2. IceMOS’s SJ MOSFET portfolio—key electrical specs and package options.

Table 1. Specifications for the company’s SJ MOSFETs in TOLL leadless packages.

	Design Platform	Polarity	Id (MAX)	V(BR)DSS (MIN)	Rdson (TYP)	Qg (TYP)
DFN 5x6						
ICE6N60LK	Gen 1	N	6A	600V	0.615 Ω	28 nC
ICE8N60LK	Gen 1	N	8A	600V	0.465 Ω	32 nC
ICE8S60LK	Gen 2	N	8A	600V	0.31 Ω	12.7 nC
ICE8S65LK	Gen 2	N	8A	650V	0.33 Ω	12.7 nC
DFN 8x8						
ICE6N60L	Gen 1	N	6A	600V	0.615 Ω	28 nC
ICE8N60L	Gen 1	N	8A	600V	0.465 Ω	32 nC
ICE10N60L	Gen 1	N	10A	600V	0.28 Ω	43 nC
ICE13N60L	Gen 1	N	13A	600V	0.245 Ω	48 nC
ICES15N60L	Gen 1	N	15	600V	0.21 Ω	52 nC
ICE19N60L	Gen 1	N	19A	600V	0.20 Ω	59 nC
ICE8S60L	Gen 2	N	8A	600V	0.31 Ω	12.7 nC
ICE15S60L	Gen 2	N	15A	600V	0.165 Ω	30 nC
ICE25S60L	Gen 2	N	25A	600V	0.120 Ω	34 nC
ICE8S65L	Gen 2	N	8A	650V	0.33 Ω	12.7 nC
ICE14S65L	Gen 2	N	14A	650V	0.175 Ω	24 nC
ICE24S65L	Gen 2	N	24A	650V	0.128 Ω	34 nC

	Design Platform	Polarity	Id (MAX)	V(BR)DSS (MIN)	Rdson (TYP)	Qg (TYP)
TOLL						
ICE6N60T	Gen 1	N	6A	600V	0.615 Ω	28 nC
ICE8N60T	Gen 1	N	8A	600V	0.465 Ω	32 nC
ICE10N60T	Gen 1	N	10	600V	0.28 Ω	43 nC
ICES15N60T	Gen 1	N	15	600V	0.21 Ω	52 nC
ICE13N60T	Gen 1	N	13	600V	0.245 Ω	48 nC
ICE20N60T	Gen 1	N	20A	600V	0.17 Ω	59 nC
ICE22N60T	Gen 1	N	22A	600V	0.14 Ω	72 nC
ICE15N73T	Gen 1	N	15A	730V	0.205 Ω	75 nC
ICE8S60T	Gen 2	N	8A	600V	0.31 Ω	12.7 nC
ICE15S60T	Gen 2	N	15A	600V	0.165 Ω	30 nC
ICE25S60T	Gen 2	N	26A	600V	0.120 Ω	38 nC
ICE32S60T	Gen 2	N	32A	600V	0.07 Ω	47 nC
ICE8S65T	Gen 2	N	8A	650V	0.33 Ω	12.7 nC
ICE14S65T	Gen 2	N	14A	650V	0.175 Ω	24 nC
ICE24S65T	Gen 2	N	25A	650V	0.128 Ω	34 nC



IceMOS MEMS SUPERJUNCTION FIRST'S

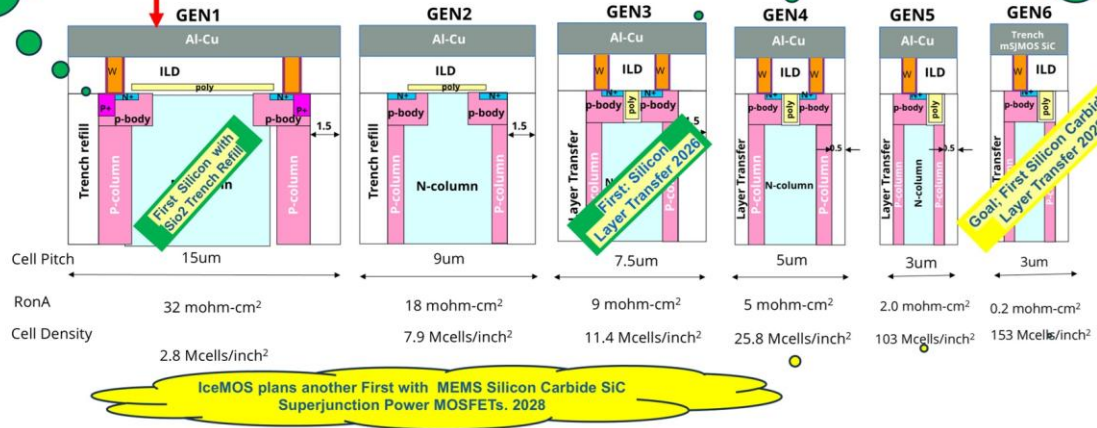
IceMOS is the first company to merge MEMS processing techniques such as DRIE and Layer Transfer to build Superjunction MOSFET structures. Our mSJ MOS™ cuts manufacturing cycle time and cost in half, while delivering improved figures of merit over the incumbent multiple-epi manufacturers.

- GEN 1 mSJ MOS™
- 1Q2022 Silicon Mass Production.
- RonA 32 mΩ-cm²
- GEN 2 mSJ MOS™
- 3Q2024 Silicon Mass Production.
- RonA 18 mΩ-cm²
- GEN 3 mSJ MOS™
- 3Q2026 Silicon Product Development.
- RonA 9.0 mΩ-cm²
- GEN 4 mSJ MOS™
- 2Q2027 Silicon Narrow P-column.
- RonA 5 mΩ-cm² *
- GEN 6 mSJ MOS-4H-SiC™
- 3Q2028 Silicon Carbide Narrow- P mSJ MOS™
- RonA 0.2 mΩ-cm² *

FIRST MEMS Superjunction SiO₂ for Trench Refill providing superior UIS. 2022

7 Million GEN1 shipped with Zero field failures 2023.

FIRST MEMS Superjunction Layer Transfer eliminating Trench Refill 2026



IceMOS plans another First with MEMS Silicon Carbide SiC Superjunction Power MOSFETs. 2028

* Estimates

IceMOS Confidential

Intellectual Property patents pending

www.icemostech.com

Fig. 3. IceMOS's mSJ MOS technology—evolution of the device structure.

Table 2. IceMOS silicon carbide MOSFET business development. Devices listed are under qualification and are currently available as engineering samples.

Part	Package	V _{DS} (V)	I _D (A)	R _{DSon} (mΩ)	Q _G (nC)	Q _{GD} (nC)	C _{OSS} (pF)	Q _{RR} (nC)
ICE166M75D	TO-252	750	12	166	11.4	2.7	25	89
ICE26M75T	TOLL	750	65	26	49	10.7	117	134
Competitor D			61	26	94	23	111	141
ICE10M75W4A ^{Auto}	TO-247-4L	750	162	9.4	223	32	420	500
ICE31M120W4	TO-247-4L	1200	55	30.4	63	21	96	217
Competitor A			56	30	63	15	116	320
ICE16M120W4	TO-247-4L	1200	110	16	279	81	213	279
Competitor B			102	20	220	63	258	225
ICE13M120W4A ^{Auto}	TO-247-4L	1200	118	12.7	210	30	225	618
ICE12M140W4A ^{Auto}	TO-247-4L	1400	124	11.8	177	47	242	368
ICE128M150W4	TO-247-4L	1500	19	128	24	8.3	27	186
ICE33M150W4	TO-247-4L	1500	56	33	90	14	86	258
ICE20M150W4	TO-247-4L	1500	86	20	103	28	129	0.57