



Littelfuse SiC MOSFETs Gate Drive Requirements

PCIM 2019
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Product Marketing Manager – SiC

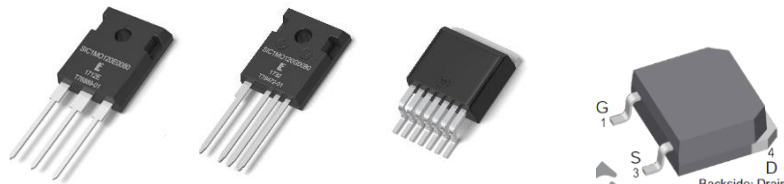


Expertise Applied | Answers Delivered

SiC MOSFET Standard Package Portfolio

In production

In qualification.



	RDSON (mΩ)	TO247-3L	TO247-4L	TO263-7L (D2PAK)	TO268-2L (D3PAK)
1200V	160	LSIC1MO120E0160	LSIC1MO120G0160 Engr. Sample available	LSIC1MO120T160 Engr. Sample available	
	120	LSIC1MO120E0120	LSIC1MO120G0120 Engr. Sample available	LSIC1MO120T120 Engr. Sample available	
	80	LSIC1MO120E0080	LSIC1MO120G0080 Engr. Sample available	LSIC1MO120T080 Engr. Sample available	
	40	LSIC1MO120E0040 Engr. Sample available	LSIC1MO120G0040 Engr. Sample available		
	25	LSIC1MO120E0025 Engr. Sample available	LSIC1MO120G0025		
1700V	750	LSIC1MO170E1000		LSIC1MO170T0750	LSIC1MO170H0750

- TO247-3L : Most common
- TO247-4L : With Kelvin connection
- TO263-7L : Surface mount with Kelvin connection
- TO268-2L : High creepage
- Other $R_{DS(on)}$ and voltages being developed
- Bare die available on request.
- Competitive performance and price with best-in-class delivery in market
- Samples available for evaluation

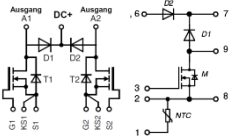
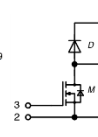
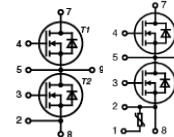
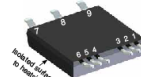
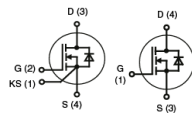
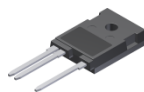
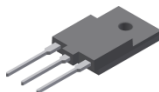
SiC MOSFET Advanced Package Portfolio

In production

In development

Planned

Idea



	RDSON (mΩ)	TO268HV (D3 HV)	T03-PFP	TO247 HV	SOT227 (MiniBloc)	SMPD (phase leg)	SMPD (boost)
900 V	10 mΩ	MCB110I900TZ			IXFN130N90SK* Sample Available	MCB110P90TLB #	
1200 V	80 mΩ	MCB25I1200TZ			IXFN27N120SK* Sample Available	MCB20P1200LB	MKH17RP650DCGLB ^{1,2}
						MCB25P1200TLB #	MCL25R1200LB
							MCL25RP1200LB ¹
	40 mΩ	MCB40I1200TZ			IXFN50N120SiC	MCB30P1200LB Sample Available	MCB30RL1200TLB ³
					IXFN50N120SK*	MCB45P1200TLB #	
	25 mΩ	MCB60I1200TZ			IXFN70N120SK*	MCB40P1200LB Sample Available	MCB60R1200TLB
1700 V	750 mΩ	LSIC1MO170H0750	MCL3I1700QN	MCL4I1700HV		MCB60P1200TLB #	
	80 mΩ						
	45 mΩ	MCB45I1700TZ			IXFN45N170SK*	MCB35P1700TLB #	MCB35R1700LB
	25 mΩ				IXFN90N170SK* Sample Available		

* Kelvin Source

Improved Rth & NTC

¹ Dual Boost

² CoolMOS + SiC Boost

³ Boost + Bypass + NTC



Expertise Applied | Answers Delivered

Littelfuse SiC MOSFETs

Gate Source and $R_{DS,ON}$ Specifications

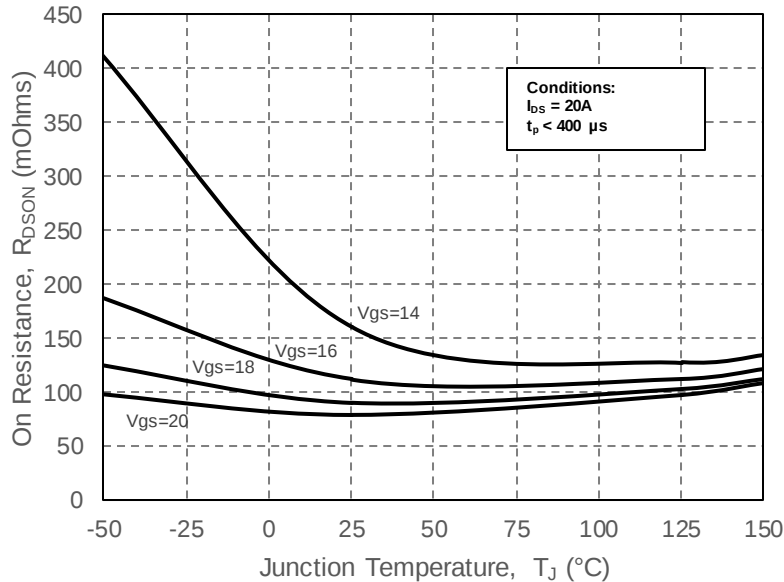
- $V_{GS,MAX}$ is the maximum voltage that can be applied on the MOSFET's gate in a steady (DC) condition
- $V_{GS,OP,TR}$ is the transient peak voltage (negative and/or positive) that can be applied repeatedly to the gate
- $V_{GS,OP}$ is what Littelfuse recommends in the application to take full advantage of its SiC MOSFETs

Characteristic	Symbol	Conditions	Value	Unit
Gate-Source Voltage	$V_{GS,MAX}$	Absolute maximum values – Steady	-6 to 22	V
	$V_{GS,OP,TR}$	Transient, < 301% duty cycle	-10 to 25	
	$V_{GS,OP}$	Recommended DC operating values	-5 to 20	

Characteristic	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Drain-Source On-State Resistance	$R_{DS,ON}$	$I_D = 2\text{ A}, V_{GS} = 20\text{ V}$	-	750	1000	m Ω
		$I_D = 2\text{ A}, V_{GS} = 20\text{ V}, T_J = 150\text{ }^\circ\text{C}$	-	1450	-	
		$I_D = 2\text{ A}, V_{GS} = 15\text{ V}$	-	1000	-	

1200V, 80 mOhm MOSFET Comparison

Rdson versus Gate Drive voltage



20V: lowest Rdson
18V: Rdson is ~5% > @ 150C



Flexible gate drive

Notes:

- Threshold voltage is high enough (typ 3V) for 0V gate drive. Good layout required
- -5V add noise margin and speed

SiC MOSFET

Solid Reliability

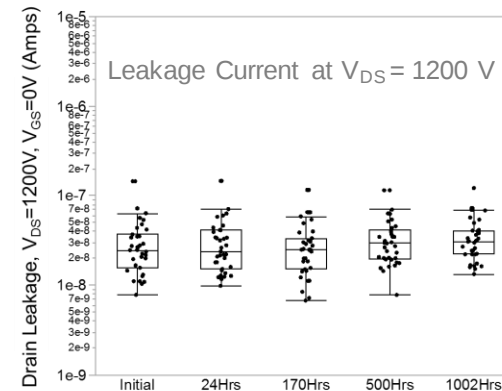
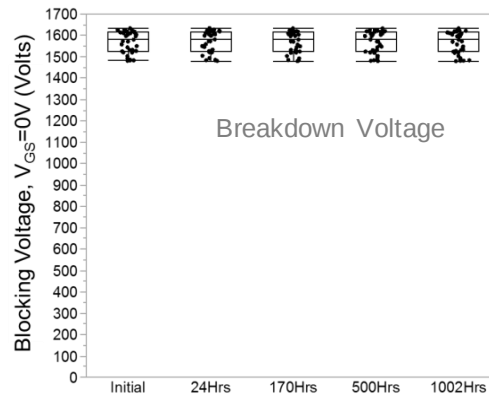
As of 2018-Sep-28

High Temperature Reverse Bias

@175°C

$V_{DS} = 960V$, $V_{GS} = 0V$

LSIC1MO120E0080

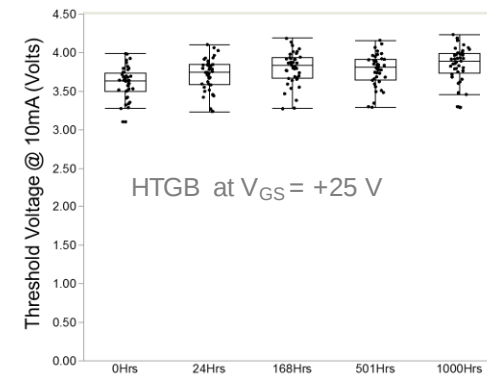
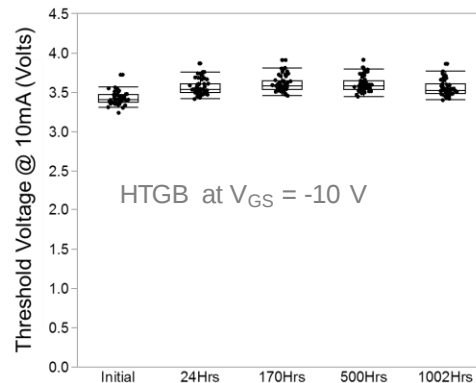


High Temperature Gate Bias

@175°C

$V_{GS} = -10V$ & $V_{GS} = +25 V$

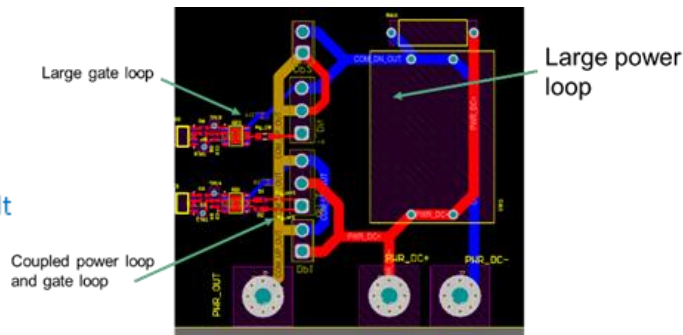
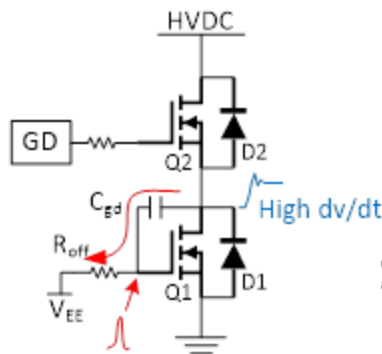
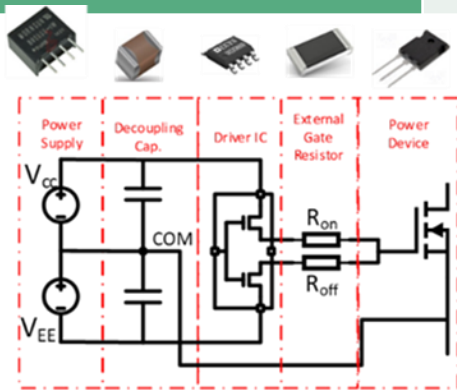
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It can operate @ 0 V....

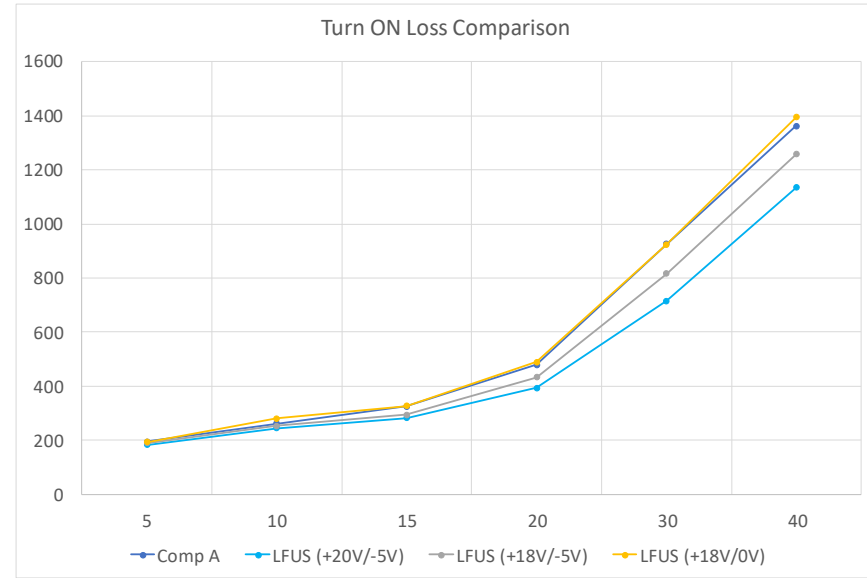
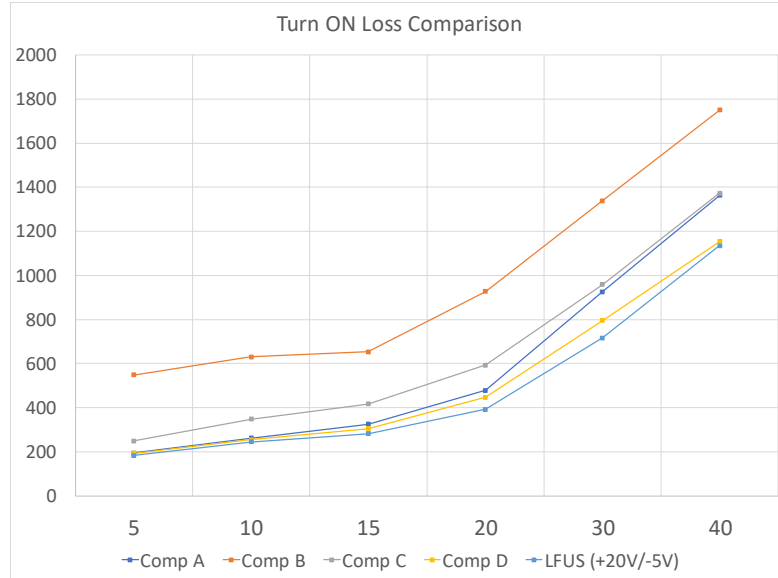
- Low gate threshold voltage ($< +1.8$ V), noise may trigger false turn-on
- High switching speed, severe EMI, pick up noise if the layout is not done properly

Characteristic	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Gate Threshold Voltage	V _{GS(TH)}	V _{DS} = V _{GS} , I _D = 10 mA	1.8	2.8	14	V
		V _{DS} = V _{GS} , I _D = 10 mA, T _J = 150 °C	-	1.9	-	



1200V, 80 mOhm MOSFET Comparison

Turn-on losses – Double Pulse Test



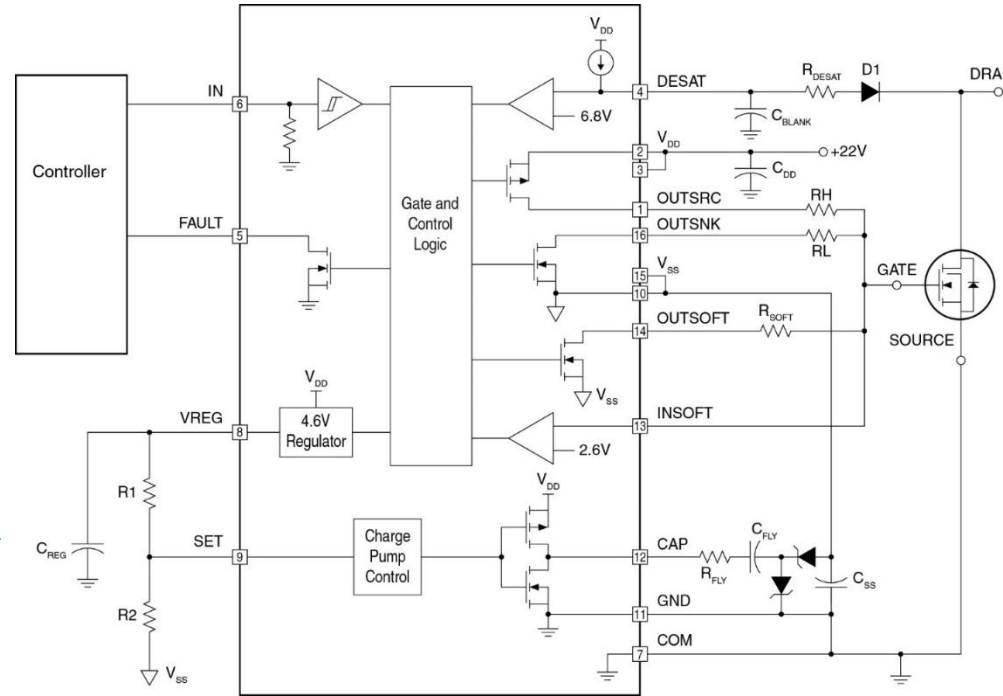
- @ recommended gate drive voltage, LFUS = lowest switching loss
- @ +18V/0V driving voltage, LFUS switching loss similar to competitor trench device

Note: 2ohms external gate resistance

SiC MOSFET & IGBT Driver

IX4351NE

- Separate 9 A Sink and Source Outputs Capable of +30 V/-10 V
- Programmable Charge Pump Regulator for **Negative Gate Drive**
- TTL/CMOS Logic Level Inputs (referenced to GND)
- Desaturation Detection with Soft Shut Down
- UVLO & TSD
- Fault Output



Samples coming!

Littelfuse SiC MOSFETs

- Comprehensive Gate Voltage specification
- Flexible gate drive
- Rugged design
- Can operate @ 0 V once thoroughly qualified in the application
- We have the drivers

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