

Silicon Carbide (SiC) Cascode JFET – EliteSiC, Power N-Channel, TO-247-4L, 750 V, 11 mohm

SiC JFET w/ Si MOSFET

UJ4SC075011K4S

Description

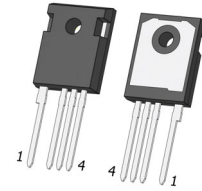
The UJ4SC075011K4S is a 750 V, 11 mΩ G4 SiC FET. It is based on a unique ‘cascode’ circuit configuration, in which a normally-on SiC JFET is co-packaged with a Si MOSFET to produce a normally-off SiC FET device. The device’s standard gate-drive characteristics allows for a true “drop-in replacement” to Si IGBTs, Si FETs, SiC MOSFETs or Si superjunction devices. Available in the TO-247-4L package, this device exhibits ultra-low gate charge and exceptional reverse recovery characteristics, making it ideal for switching inductive loads and any application requiring standard gate drive.

Features

- On-Resistance $R_{DS(on)}$: 11 mΩ (typ)
- Operating Temperature: 175 °C (Max)
- Excellent Reverse Recovery: Q_{rr} = 288 nC
- Low Body Diode V_{FSD} : 1.1 V
- Low Gate Charge : Q_G = 75 nC
- Threshold Voltage $V_{G(th)}$: 4.5 V (typ) Allowing 0 to 15 V Drive
- Low Intrinsic Capacitance
- ESD Protected: HBM Class 2
- TO-247-4L Package for Faster Switching, Clean Gate Waveforms
- This Device is Pb-Free, Halogen Free and is RoHS Compliant

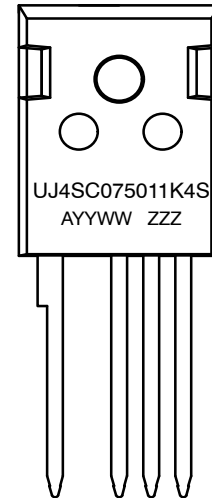
Typical Applications

- EV Charging
- PV Inverters
- Switch Mode Power Supplies
- Power Factor Correction Modules
- Motor Drives
- Induction Heating



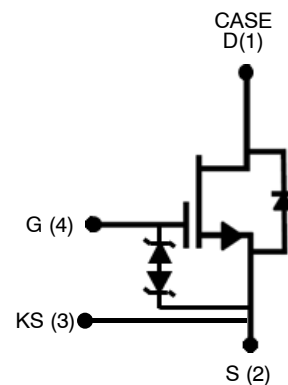
TO-247-4L
CASE 340AN

MARKING DIAGRAM



UJ4SC075011K4S = Specific Device Number
A = Assembly Location
YY = Year
WW = Work Week
ZZZ = Lot ID

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

MAXIMUM RATINGS

Symbol	Parameter	Test Conditions	Value	Unit
V_{DS}	Drain-Source Voltage		750	V
V_{GS}	Gate-Source Voltage	DC	-20 to +20	V
		AC ($f > 1$ Hz)	-25 to +25	V
I_D	Continuous Drain Current (Note 1)	$T_C = 25\text{ }^{\circ}\text{C}$	104	A
		$T_C = 100\text{ }^{\circ}\text{C}$	75	A
I_{DM}	Pulsed Drain Current (Note 2)	$T_C = 25\text{ }^{\circ}\text{C}$	300	A
E_{AS}	Single Pulsed Avalanche Energy (Note 3)	$L = 15\text{ mH}$, $I_{AS} = 4.5\text{ A}$	151	mJ
dv/dt	SiC FET dv/dt Ruggedness	$V_{DS} \leq 500\text{ V}$	100	V/ns
P_{tot}	Power Dissipation	$T_C = 25\text{ }^{\circ}\text{C}$	357	W
$T_{J,max}$	Maximum Junction Temperature		175	$^{\circ}\text{C}$
T_J , T_{STG}	Operating and Storage Temperature		-55 to 175	$^{\circ}\text{C}$
T_L	Max. Lead Temperature for Soldering, 1/8" from Case for 5 Seconds		250	$^{\circ}\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Limited by $T_{J,max}$
2. Pulse width t_p limited by $T_{J,max}$
3. Starting $T_J = 25\text{ }^{\circ}\text{C}$

THERMAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case		-	0.33	0.42	$^{\circ}\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_J = +25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
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TYPICAL PERFORMANCE – STATIC

BV_{DS}	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	750	-	-	V
I_{DSS}	Total Drain Leakage Current	$V_{DS} = 750\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	3.5	60	μA
		$V_{DS} = 750\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 175\text{ }^{\circ}\text{C}$	-	45	-	
I_{GSS}	Total Gate Leakage Current	$V_{DS} = 0\text{ V}$, $T_J = 25\text{ }^{\circ}\text{C}$ $V_{GS} = -20\text{ V} / +20\text{ V}$	-	2	± 20	μA
$R_{DS(on)}$	Drain-Source On-resistance	$V_{GS} = 12\text{ V}$, $I_D = 60\text{ A}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	11	14.2	$\text{m}\Omega$
		$T_J = 125\text{ }^{\circ}\text{C}$	-	18.4	-	
		$T_J = 175\text{ }^{\circ}\text{C}$	-	24.2	-	
$V_{G(th)}$	Gate Threshold Voltage	$V_{DS} = 5\text{ V}$, $I_D = 10\text{ mA}$	3.5	4.5	5.5	V
R_G	Gate Resistance	$f = 1\text{ MHz}$, open drain	-	2.3	-	Ω

TYPICAL PERFORMANCE – REVERSE DIODE

I_S	Diode Continuous Forward Current (Note 1)	$T_C = 25\text{ }^{\circ}\text{C}$	-	-	104	A
$I_{S,pulse}$	Diode Pulse Current (Note 2)	$T_C = 25\text{ }^{\circ}\text{C}$	-	-	300	A
V_{FSD}	Forward Voltage	$V_{GS} = 0\text{ V}$, $I_S = 30\text{ A}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	1.1	1.24	V
		$V_{GS} = 0\text{ V}$, $I_S = 30\text{ A}$, $T_J = 175\text{ }^{\circ}\text{C}$	-	1.2	-	
Q_{rr}	Reverse Recovery Charge	$V_{DS} = 400\text{ V}$, $I_S = 60\text{ A}$, $V_{GS} = 0\text{ V}$, $R_{G,EXT} = 5\text{ }\Omega$, $di/dt = 2500\text{ A}/\mu\text{s}$, $T_J = 25\text{ }^{\circ}\text{C}$	-	288	-	nC
t_{rr}	Reverse Recovery Time		-	26	-	ns

UJ4SC075011K4S

ELECTRICAL CHARACTERISTICS (T_J = +25 °C unless otherwise specified) (continued)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
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TYPICAL PERFORMANCE – REVERSE DIODE (CONTINUED)

Q _{rr}	Reverse Recovery Charge	V _{DS} = 400 V, I _S = 60 A, V _{GS} = 0 V, R _{G,EXT} = 5 Ω, di/dt = 2500 A/μs, T _J = 150 °C	–	292	–	nC
t _{rr}	Reverse Recovery Time		–	26	–	ns

TYPICAL PERFORMANCE – DYNAMIC

C _{iss}	Input Capacitance	V _{DS} = 400 V, V _{GS} = 0 V, f = 100 kHz	–	3245	–	pF
C _{oss}	Output Capacitance		–	178	–	
C _{rss}	Reverse Transfer Capacitance		–	1.2	–	
C _{oss(er)}	Effective Output Capacitance, Energy Related	V _{DS} = 0 V to 400 V, V _{GS} = 0 V	–	225	–	pF
C _{oss(tr)}	Effective Output Capacitance, Time Related		–	470	–	pF
E _{oss}	C _{oss} Stored Energy	V _{DS} = 400 V, V _{GS} = 0 V	–	18	–	μJ
Q _G	Total Gate Charge	V _{DS} = 400 V, I _D = 60 A, V _{GS} = 0 V to 15 V	–	75	–	nC
Q _{GD}	Gate-Drain Charge		–	13	–	
Q _{GS}	Gate-Source Charge		–	22	–	
t _{d(on)}	Turn-on Delay Time	Notes 4 and 5 V _{DS} = 400 V, I _D = 60 A, Gate Driver = 0 V, to +15 V, Turn-on R _{G,EXT} = 1 Ω, Turn-off R _{G,EXT} = 5 Ω, Inductive Load, FWD: same device with V _{GS} = 0 V and R _G = 5 Ω, RC snubber: R _S = 10 Ω and C _S = 400 pF, T _J = 25 °C	–	19	–	ns
t _r	Rise Time		–	26	–	
t _{d(off)}	Turn-off Delay Time		–	65	–	
t _f	Fall Time		–	9	–	
E _{ON}	Turn-on Energy Including R _S Energy	FWD: same device with V _{GS} = 0 V and R _G = 5 Ω, RC snubber: R _S = 10 Ω and C _S = 400 pF, T _J = 25 °C	–	257	–	μJ
E _{OFF}	Turn-off Energy Including R _S Energy		–	107	–	
E _{TOTAL}	Total Switching Energy		–	364	–	
E _{RS_ON}	Snubber R _S Energy During Turn-on		–	8	–	
E _{RS_OFF}	Snubber R _S Energy During Turn-off	Notes 4 and 5 V _{DS} = 400 V, I _D = 60 A, Gate Driver = 0 V, to +15 V, Turn-on R _{G,EXT} = 1 Ω, Turn-off R _{G,EXT} = 5 Ω, Inductive Load, FWD: same device with V _{GS} = 0 V and R _G = 5 Ω, RC snubber: R _S = 10 Ω and C _S = 400 pF, T _J = 150 °C	–	21	–	ns
t _{d(on)}	Turn-on Delay Time		–	19	–	
t _r	Rise Time		–	28	–	
t _{d(off)}	Turn-off Delay Time		–	73	–	
t _f	Fall Time		–	9	–	
E _{ON}	Turn-on Energy Including R _S Energy		–	320	–	μJ
E _{OFF}	Turn-off Energy Including R _S Energy		–	125	–	
E _{TOTAL}	Total Switching Energy		–	445	–	
E _{RS_ON}	Snubber R _S Energy During Turn-on		–	8	–	
E _{RS_OFF}	Snubber R _S Energy During Turn-off		–	19	–	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Measured with the switching test circuit in Figure 29.

5. In this datasheet, all the switching energies (turn-on energy, turn-off energy and total energy) presented in the tables and Figures include the device RC snubber energy losses.

TYPICAL CHARACTERISTICS

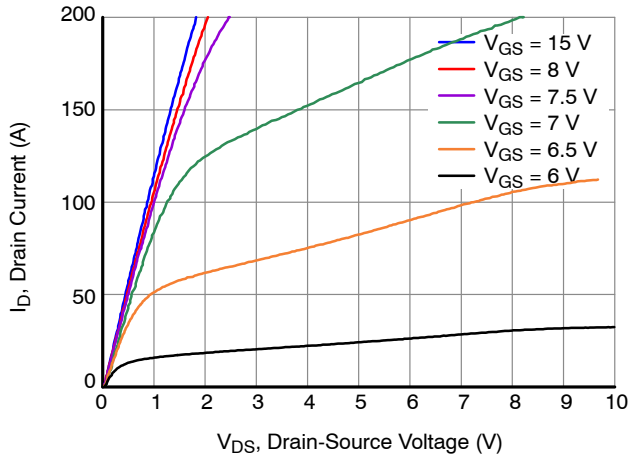


Figure 1. Typical Output Characteristics at $T_J = -55\text{ }^{\circ}\text{C}$, $t_p < 250\text{ }\mu\text{s}$

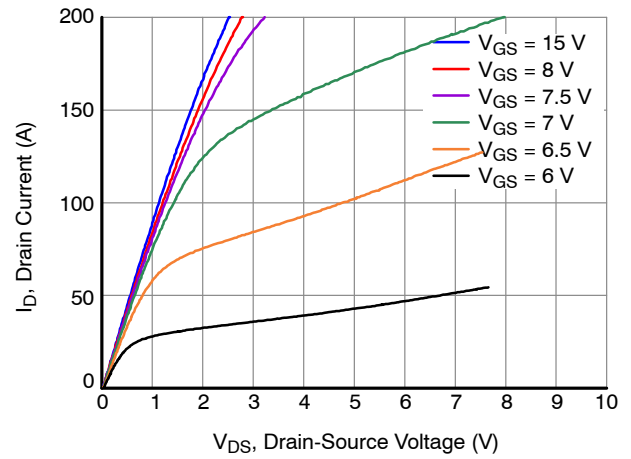


Figure 2. Typical Output Characteristics at $T_J = 25\text{ }^{\circ}\text{C}$, $t_p < 250\text{ }\mu\text{s}$

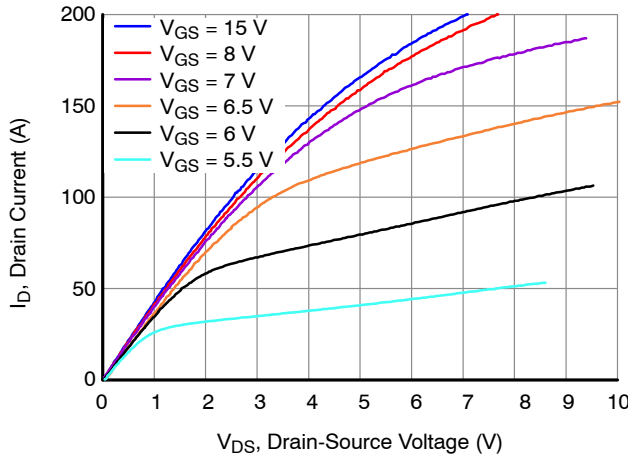


Figure 3. Typical Output Characteristics at $T_J = 175\text{ }^{\circ}\text{C}$, $t_p < 250\text{ }\mu\text{s}$

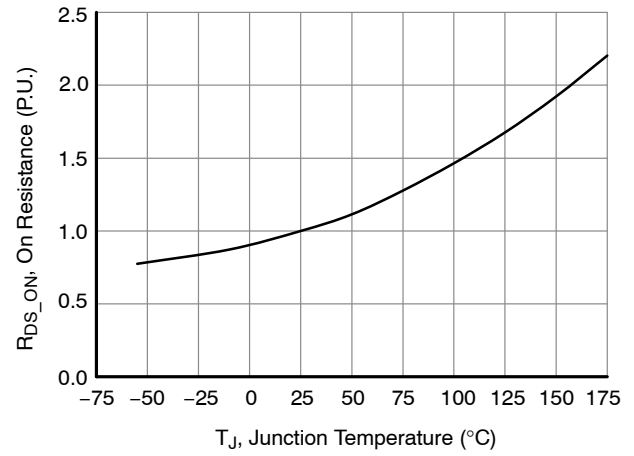


Figure 4. Normalized On-Resistance vs. Temperature at $V_{GS} = 12\text{ V}$ and $I_D = 60\text{ A}$

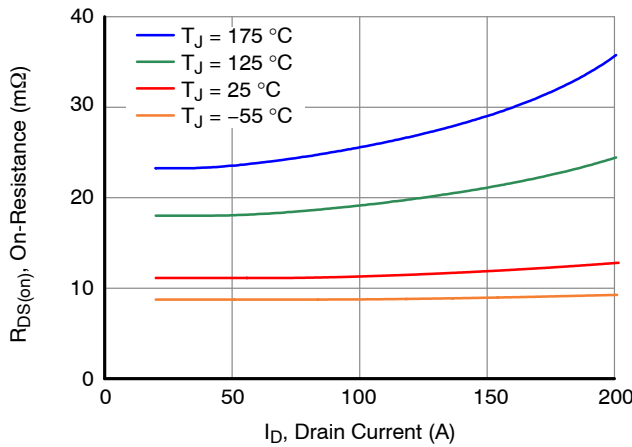


Figure 5. Typical Drain-Source On-Resistances at $V_{GS} = 12\text{ V}$

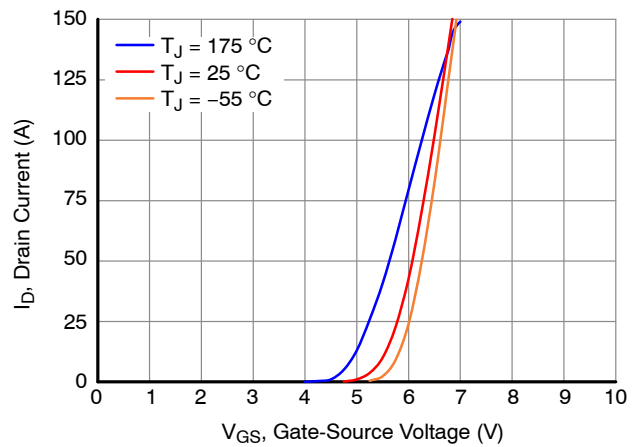


Figure 6. Typical Transfer Characteristics at $V_{DS} = 5\text{ V}$

TYPICAL CHARACTERISTICS (continued)

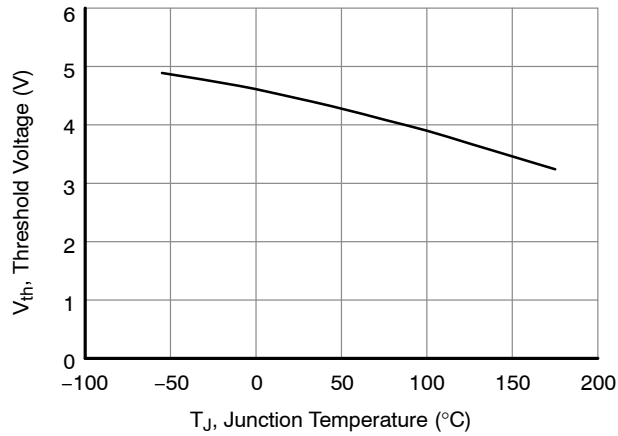


Figure 7. Threshold Voltage vs. Junction Temperature at $V_{DS} = 5\text{ V}$ and $I_D = 10\text{ mA}$

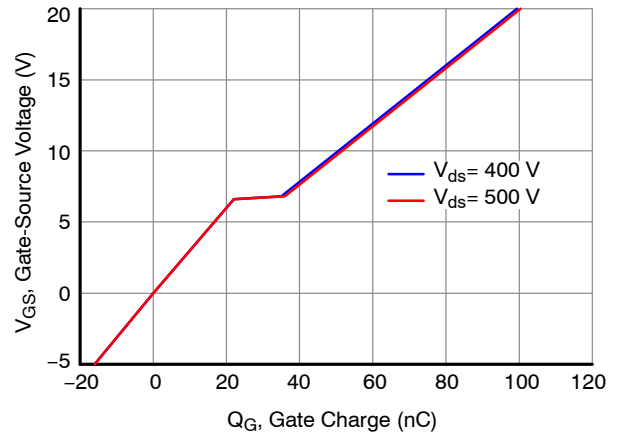


Figure 8. Typical Gate Charge at $I_D = 60\text{ A}$

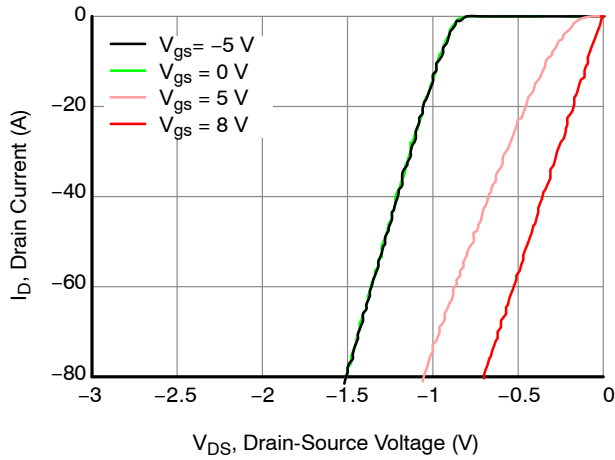


Figure 9. 3rd Quadrant Characteristics at $T_J = -55\text{ °C}$

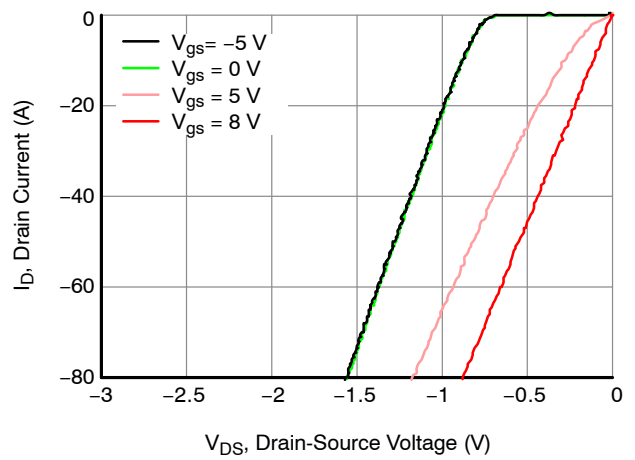


Figure 10. 3rd Quadrant Characteristics at $T_J = 25\text{ °C}$

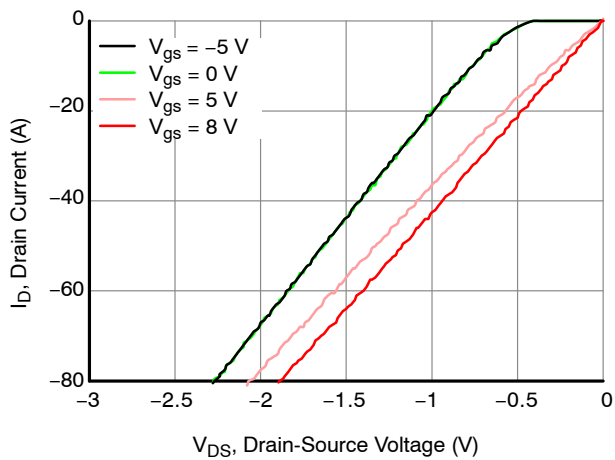


Figure 11. 3rd Quadrant Characteristics at $T_J = 175\text{ °C}$

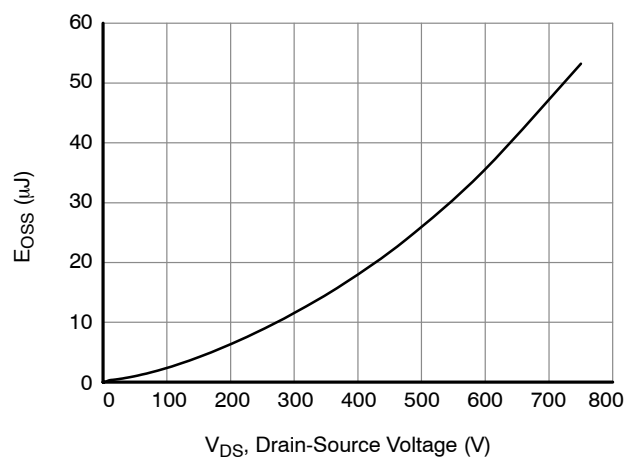


Figure 12. Typical Stored Energy in C_{OSS} at $V_{GS} = 0\text{ V}$

TYPICAL CHARACTERISTICS (continued)

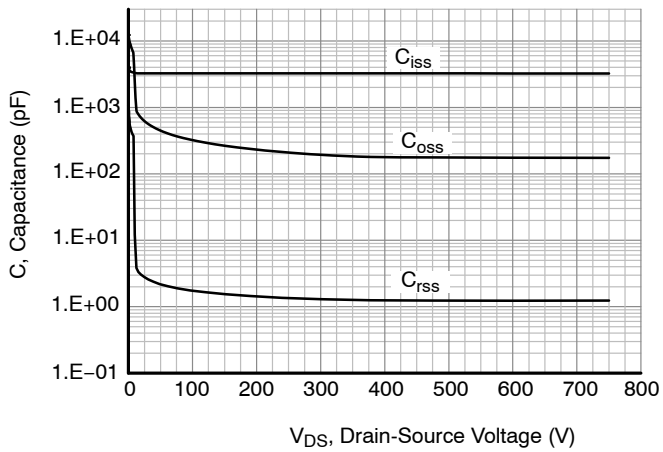


Figure 13. Typical Capacitances at $f = 100 \text{ kHz}$ and $V_{GS} = 0 \text{ V}$

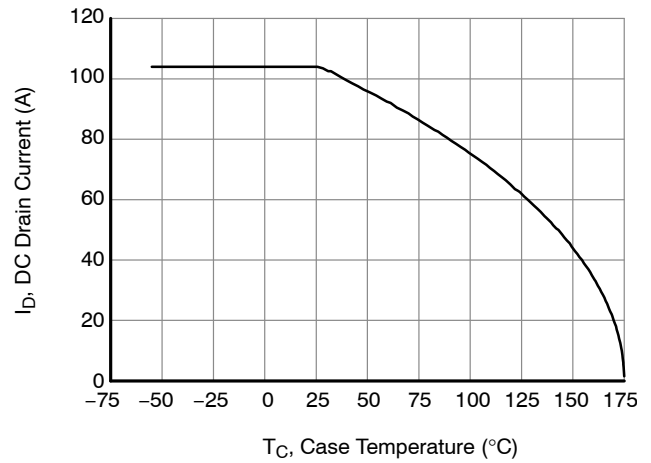


Figure 14. DC Drain Current Derating

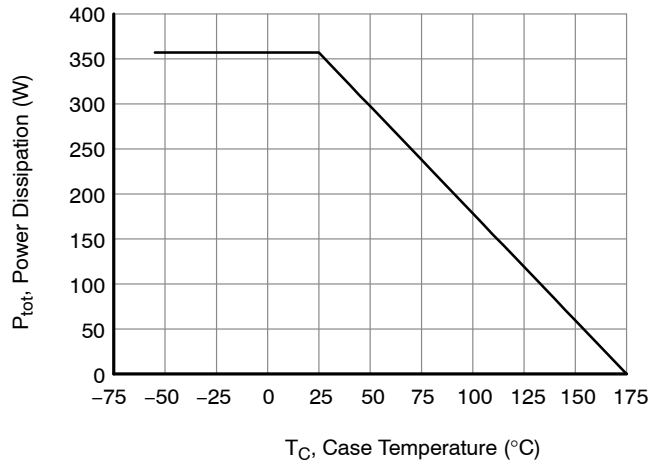


Figure 15. Total Power Dissipation

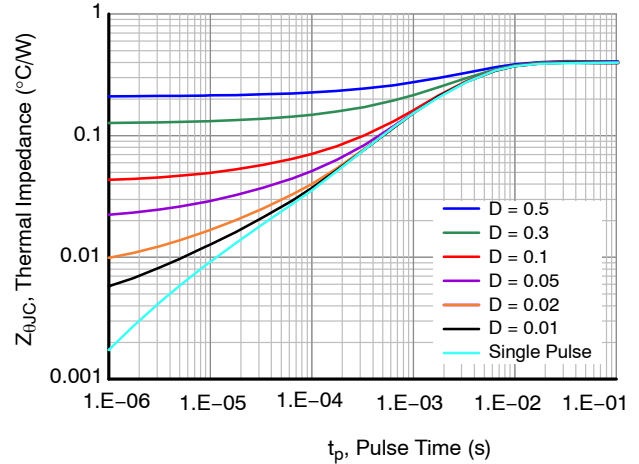


Figure 16. Maximum Transient Thermal Impedance

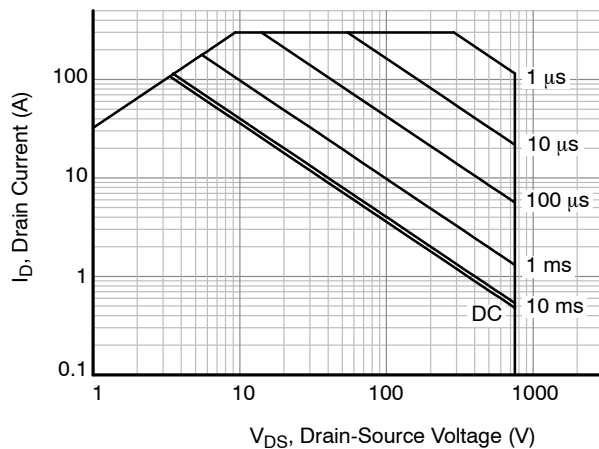


Figure 17. Safe Operation Area at $T_C = 25 \text{ °C}$, $D = 0$, Parameter t_p

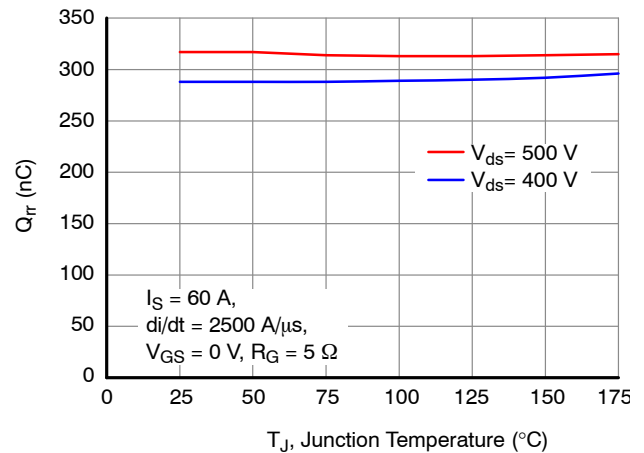


Figure 18. Reverse Recovery Charge Q_{rr} vs. Junction Temperature

TYPICAL CHARACTERISTICS (continued)

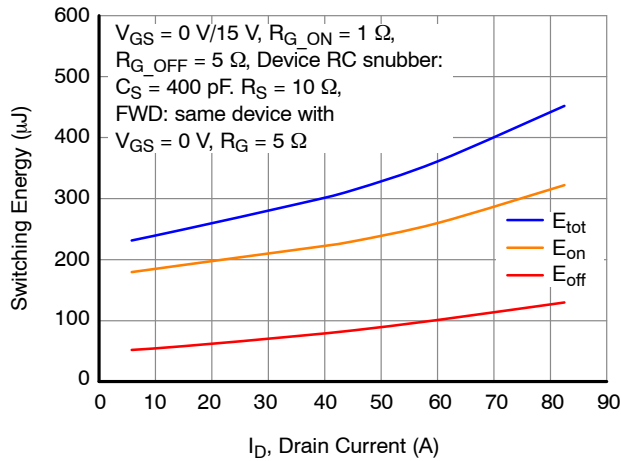


Figure 19. Clamped Inductive Switching Energy vs. Drain Current at $V_{DS} = 400$ V and $T_J = 25$ °C

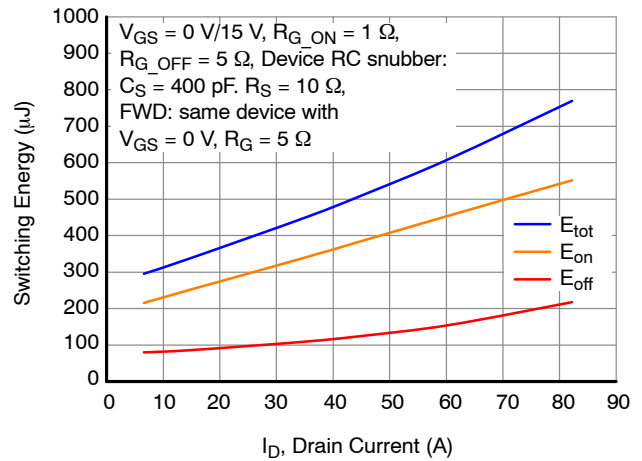


Figure 20. Clamped Inductive Switching Energy vs. Drain Current at $V_{DS} = 500$ V and $T_J = 25$ °C

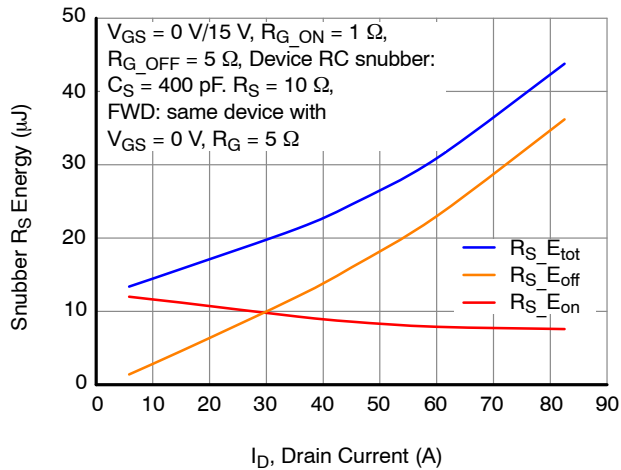


Figure 21. RC Snubber Energy Loss vs. Drain Current at $V_{DS} = 400$ V and $T_J = 25$ °C

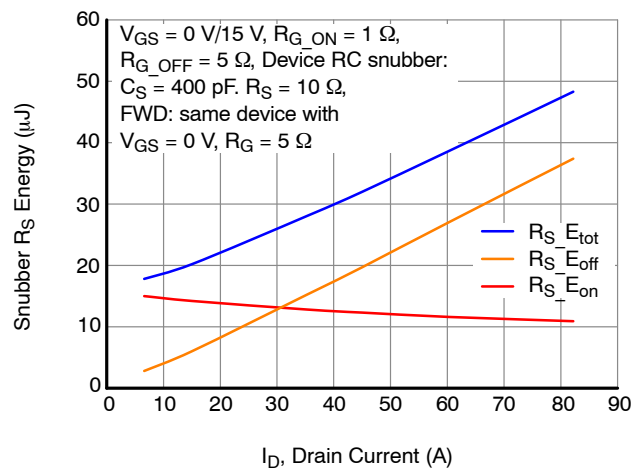


Figure 22. RC Snubber Energy Losses vs. Drain Current at $V_{DS} = 500$ V and $T_J = 25$ °C

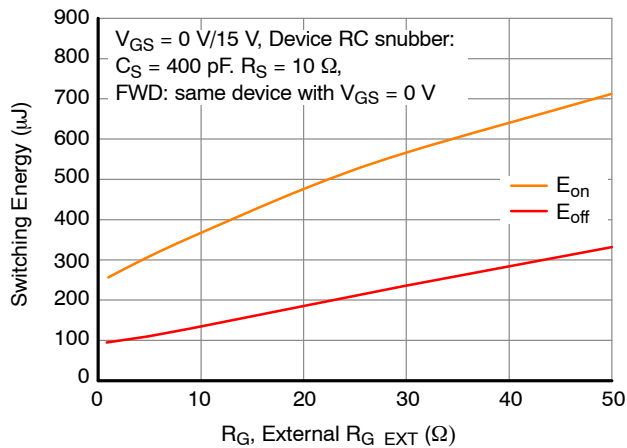


Figure 23. Clamped Inductive Switching Energies vs. R_{G_EXT} at $V_{DS} = 400$ V, $I_D = 60$ A and $T_J = 25$ °C

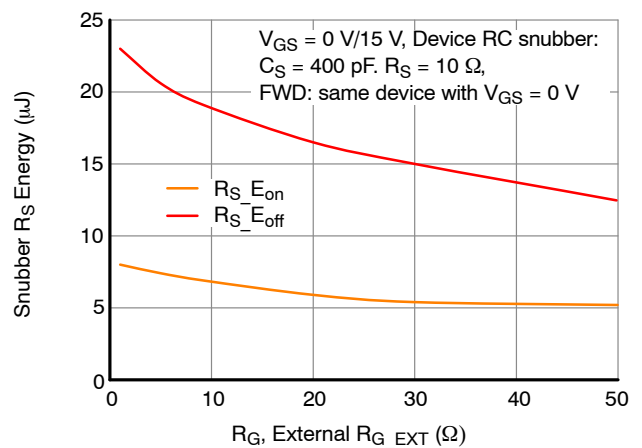


Figure 24. RC Snubber Energy Losses vs. R_{G_EXT} at $V_{DS} = 400$ V, $I_D = 60$ A and $T_J = 25$ °C

TYPICAL CHARACTERISTICS (continued)

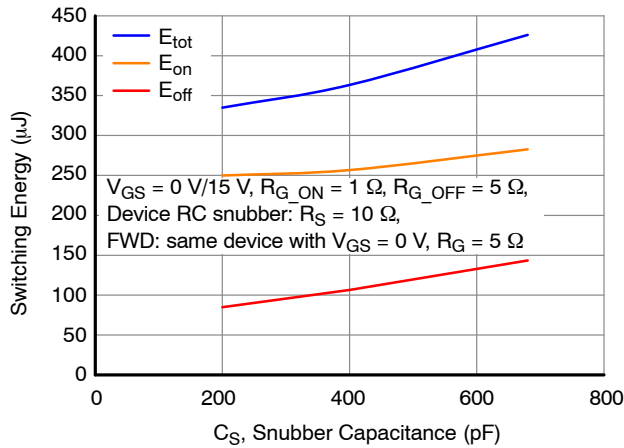


Figure 25. Clamped Inductive Switching Energies vs. Snubber Capacitance C_S at $V_{DS} = 400$ V, $I_D = 60$ A and $T_J = 25$ °C

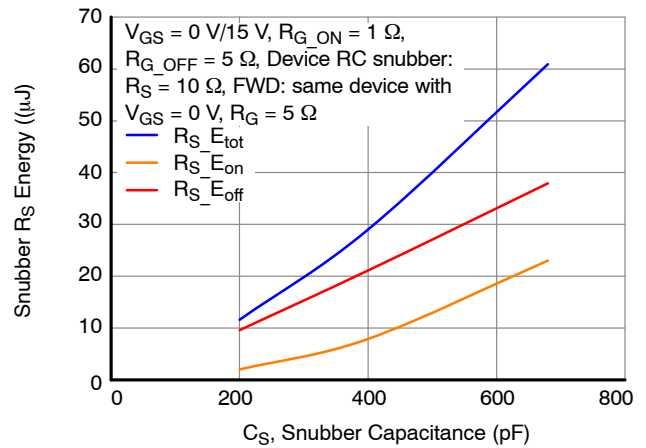


Figure 26. RC Snubber Energy Losses vs. Snubber Capacitance C_S at $V_{DS} = 400$ V, $I_D = 60$ A and $T_J = 25$ °C

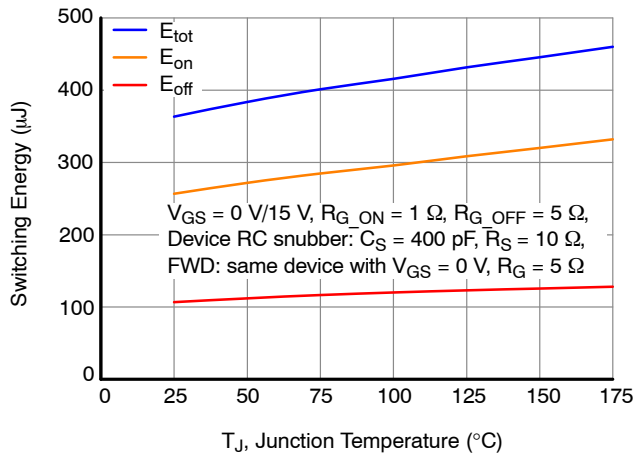


Figure 27. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS} = 400$ V and $I_D = 60$ A

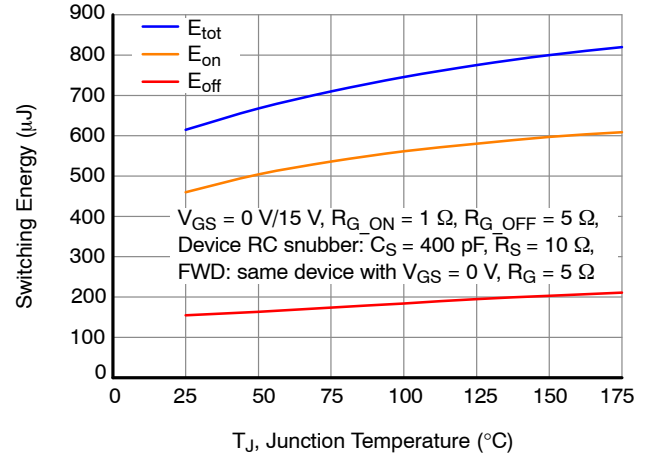


Figure 28. Clamped Inductive Switching Energy vs. Junction Temperature at $V_{DS} = 500$ V, $I_D = 60$ A

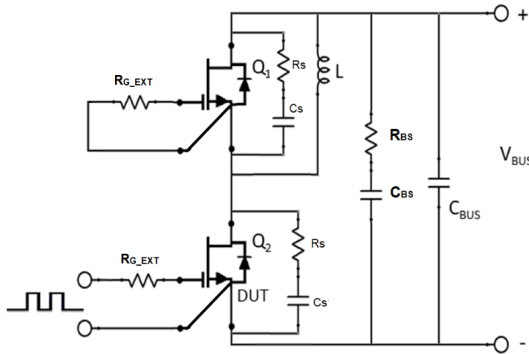


Figure 29. Schematic of the Half-Bridge Mode Switching Test Circuit. Note, a Bus RC Snubber ($R_{BS} = 1$ Ω, $C_{BS} = 100$ nF) is Used to Reduce the Power Loop High Frequency Oscillations.

APPLICATIONS INFORMATION

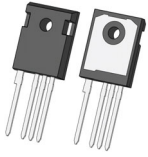
SiC FETs are enhancement-mode power switches formed by a high-voltage SiC depletion-mode JFET and a low-voltage silicon MOSFET connected in series. The silicon MOSFET serves as the control unit while the SiC JFET provides high voltage blocking in the off state. This combination of devices in a single package provides compatibility with standard gate drivers and offers superior performance in terms of low on-resistance ($R_{DS(on)}$), output capacitance (C_{oss}), gate charge (Q_G), and reverse recovery charge (Q_{rr}) leading to low conduction and switching losses.

The SiC FETs also provide excellent reverse conduction capability eliminating the need for an external anti-parallel diode.

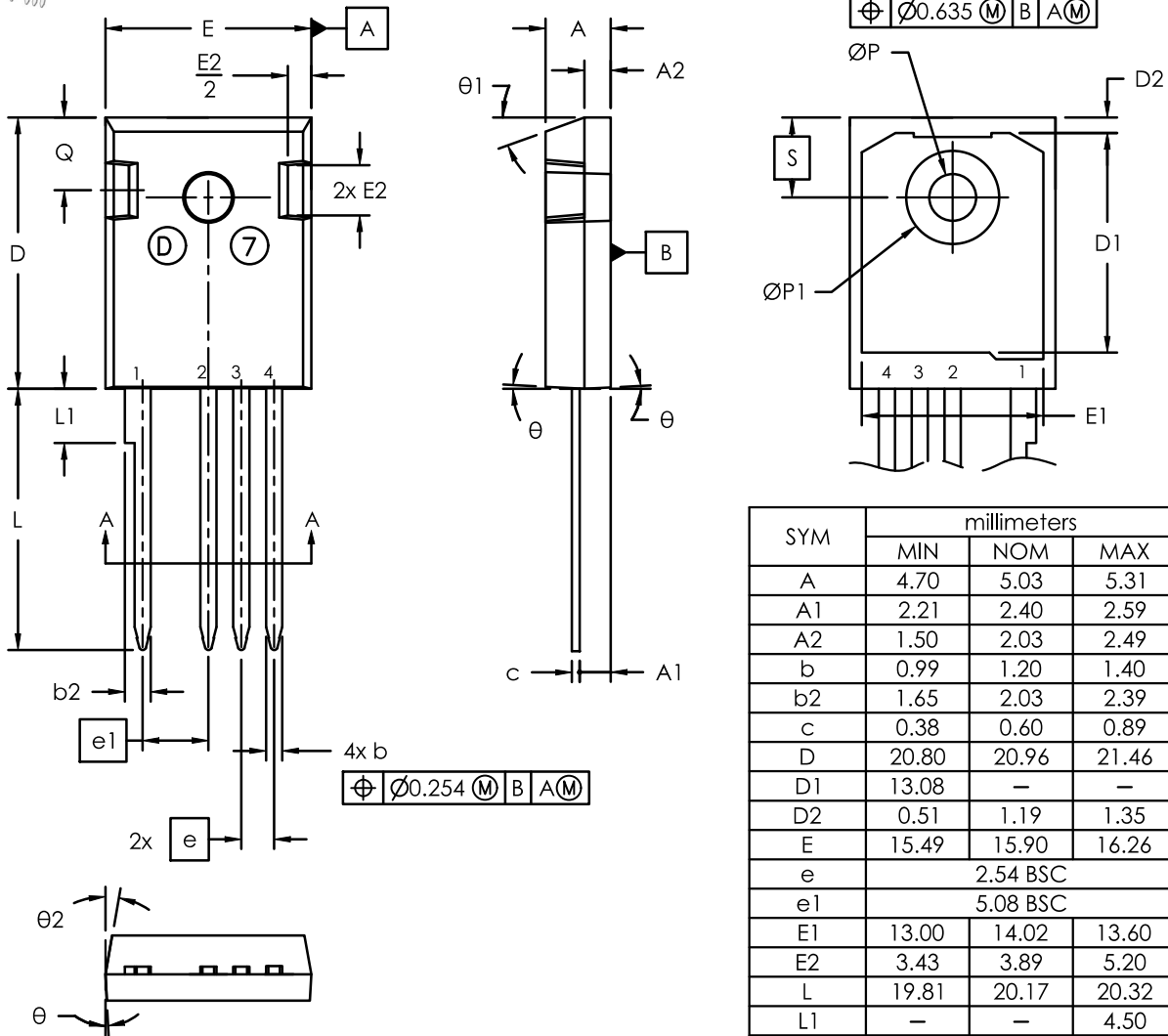
Like other high performance power switches, proper PCB layout design to minimize circuit parasitics is strongly recommended due to the high dv/dt and di/dt rates. An external gate resistor is recommended when the FET is working in the diode mode in order to achieve the optimum reverse recovery performance. For more information on SiC FET operation, see www.onsemi.com.

ORDERING INFORMATION

Part Number	Marking	Package	Shipping
UJ4SC075011K4S	UJ4SC075011K4S	TO-247-4L (Pb-Free, Halogen Free)	30 Units / Tube


TO247-4 15.90x20.96x5.03, 5.44P
CASE 340AN
ISSUE C

DATE 12 FEB 2025


NOTE:

1. Dimensioning and tolerancing as per ASME Y14.5 - 2018
2. Controlling dimension : millimeters
3. Package Outline in compliance with JEDEC standard var. AD.
4. Dimensions D & E does not include mold flash.
5. ØP to have max draft angle of 1.7° to the top with max. hole diameter of 3.91mm.
5. Through Hole diameter value = End Hole diameter
6. PCB Through Hole pattern as per IPC-2221/IPC-2222

SYM	millimeters		
	MIN	NOM	MAX
A	4.70	5.03	5.31
A1	2.21	2.40	2.59
A2	1.50	2.03	2.49
b	0.99	1.20	1.40
b2	1.65	2.03	2.39
c	0.38	0.60	0.89
D	20.80	20.96	21.46
D1	13.08	—	—
D2	0.51	1.19	1.35
E	15.49	15.90	16.26
e	2.54 BSC		
e1	5.08 BSC		
E1	13.00	14.02	13.60
E2	3.43	3.89	5.20
L	19.81	20.17	20.32
L1	—	—	4.50
ØP	3.40	3.60	3.80
ØP1	7.06	7.19	7.39
Q	5.38	5.62	6.20
S	6.17 BSC		
θ	3°		
θ1	20°		
θ2	10°		

DOCUMENT NUMBER: 98AON86067F

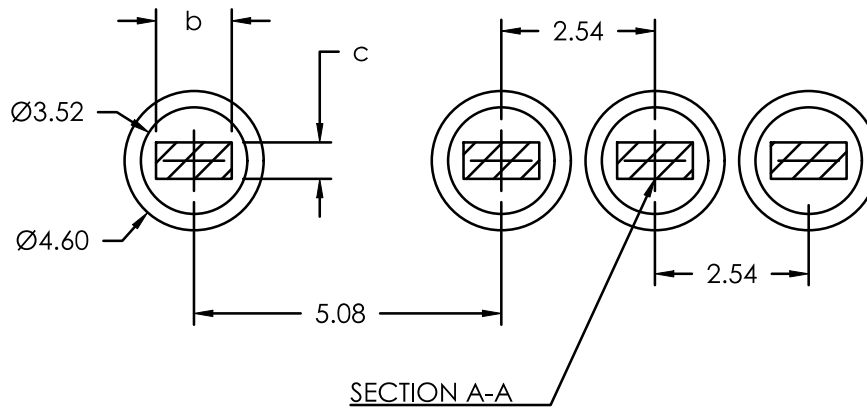
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DESCRIPTION: TO247-4 15.90x20.96x5.03, 5.44P

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RECOMMENDED PCB THROUGH HOLE



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