

**SyncFET™ – N-Channel,  
POWERTRENCH®****30 V, 21 A, 3.6 mΩ****FDS6699S****General Description**

The FDS6699S is designed to replace a single SO-8 MOSFET and Schottky diode in synchronous DC:DC power supplies. This 30 V MOSFET is designed to maximize power conversion efficiency, providing a low  $R_{DS(on)}$  and low gate charge. The FDS6699S includes an integrated Schottky diode using onsemi's monolithic SyncFET technology.

**Features**

- 21 A, 30 V
  - ◆ Max  $R_{DS(on)} = 3.6 \text{ m}\Omega$  at  $V_{GS} = 10 \text{ V}$
  - ◆ Max  $R_{DS(on)} = 4.5 \text{ m}\Omega$  at  $V_{GS} = 4.5 \text{ V}$
- Includes SyncFET Schottky Body Diode
- High Performance Trench Technology for Extremely Low  $R_{DS(on)}$  and Fast Switching
- High Power and Current Handling Capability
- 100%  $R_G$  (Gate Resistance) Tested
- These Devices are Pb-Free and are RoHS Compliant

**Applications**

- Synchronous Rectifier for DC/DC Converters
  - ◆ Notebook Vcore Low Side Switch
  - ◆ Point of Load Low Side Switch

**MOSFET MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

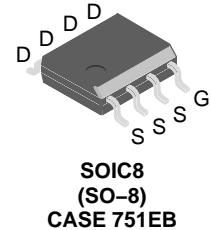
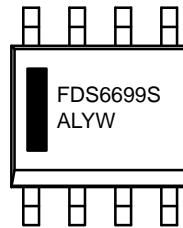
Symbol	Parameter	Ratings	Unit
$V_{DSS}$	Drain-Source Voltage	30	V
$V_{GSS}$	Gate-Source Voltage	$\pm 20$	V
$I_D$	Drain Current – Continuous (Note 1a) – Pulsed	21 105	A
$E_{AS}$	Single Pulse Avalanche Energy (Note 4)	541	mJ
$P_D$	Power Dissipation for Single Operation (Note 1a) (Note 1b) (Note 1c)	2.5 1.2 1	W
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range	-55 to +150	$^\circ\text{C}$

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.

**THERMAL CHARACTERISTICS**

Symbol	Parameter	Ratings	Unit
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	50	$^\circ\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	25	

$V_{DSS}$	$R_{DS(on)} \text{ MAX}$	$I_D$
30 V	3.6 $\text{m}\Omega$ @ 10 V	21 A
	4.5 $\text{m}\Omega$ @ 4.5 V	

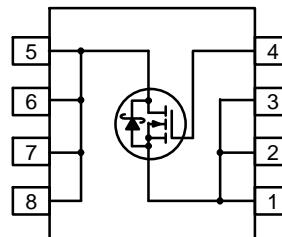
**MARKING DIAGRAM**

FDS6699S = Specific Device Code

A = Assembly Site

L = Wafer Lot Number

YW = Assembly Start Week

**PIN CONNECTIONS****ORDERING INFORMATION**

See detailed ordering and shipping information on page 5 of this data sheet.

ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
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## OFF CHARACTERISTICS

$\text{BV}_{\text{DSS}}$	Drain-Source Breakdown Voltage	$V_{\text{GS}} = 0 \text{ V}$ , $I_D = 1 \text{ mA}$	30	–	–	V
$\frac{\Delta \text{BV}_{\text{DSS}}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 1 \text{ mA}$ , Referenced to $25^\circ\text{C}$	–	28	–	$\text{mV}/^\circ\text{C}$
$I_{\text{DSS}}$	Zero Gate Voltage Drain Current	$V_{\text{DS}} = 24 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$	–	–	500	$\mu\text{A}$
$I_{\text{GSS}}$	Gate-Body Leakage	$V_{\text{GS}} = \pm 20 \text{ V}$ , $V_{\text{DS}} = 0 \text{ V}$	–	–	$\pm 100$	nA

## ON CHARACTERISTICS (Note 2)

$V_{\text{GS}(\text{th})}$	Gate Threshold Voltage	$V_{\text{DS}} = V_{\text{GS}}$ , $I_D = 1 \text{ mA}$	1	1.4	3	V
$\frac{\Delta V_{\text{GS}(\text{th})}}{\Delta T_J}$	Gate Threshold Voltage Temperature Coefficient	$I_D = 1 \text{ mA}$ , Referenced to $25^\circ\text{C}$	–	–3.2	–	$\text{mV}/^\circ\text{C}$
$R_{\text{DS}(\text{on})}$	Static Drain-Source On-Resistance	$V_{\text{GS}} = 10 \text{ V}$ , $I_D = 21 \text{ A}$ $V_{\text{GS}} = 4.5 \text{ V}$ , $I_D = 19 \text{ A}$ $V_{\text{GS}} = 10 \text{ V}$ , $I_D = 21 \text{ A}$ , $T_J = 150^\circ\text{C}$	– – –	3.0 3.6 4.6	3.6 4.5 5.6	$\text{m}\Omega$
$g_{\text{FS}}$	Forward Transconductance	$V_{\text{DS}} = 10 \text{ V}$ , $I_D = 21 \text{ A}$	–	100	–	S

## DYNAMIC CHARACTERISTICS

$C_{\text{iss}}$	Input Capacitance	$V_{\text{DS}} = 15 \text{ V}$ , $V_{\text{GS}} = 0 \text{ V}$ , $f = 1.0 \text{ MHz}$	–	3610	4800	pF
$C_{\text{oss}}$	Output Capacitance		–	1080	1435	pF
$C_{\text{rss}}$	Reverse Transfer Capacitance		–	340	680	pF
$R_G$	Gate Resistance	$V_{\text{GS}} = 15 \text{ mV}$ , $f = 1.0 \text{ MHz}$	–	1.8	–	$\Omega$

## SWITCHING CHARACTERISTICS (Note 2)

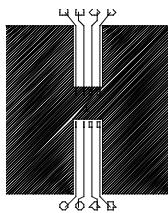
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	$V_{\text{DD}} = 15 \text{ V}$ , $I_D = 1 \text{ A}$ , $V_{\text{GS}} = 10 \text{ V}$ , $R_{\text{GEN}} = 6 \Omega$	–	11	20	ns
$t_r$	Turn-On Rise Time		–	12	22	ns
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time		–	73	117	ns
$t_f$	Turn-Off Fall Time		–	38	61	ns
$Q_{\text{g}(\text{TOT})}$	Total Gate Charge at $V_{\text{GS}} = 10 \text{ V}$	$V_{\text{DD}} = 15 \text{ V}$ , $I_D = 21 \text{ A}$	–	65	91	nC
$Q_g$	Total Gate Charge at $V_{\text{GS}} = 5 \text{ V}$		–	35	49	nC
$Q_{\text{gs}}$	Gate-Source Charge		–	9	–	nC
$Q_{\text{gd}}$	Gate-Drain Charge		–	11	–	nC

## DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

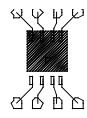
$V_{\text{SD}}$	Drain-Source Diode Forward Voltage	$V_{\text{GS}} = 0 \text{ V}$ , $I_S = 3.5 \text{ A}$ (Note 2)	–	0.36	0.7	V
$t_{\text{rr}}$	Diode Reverse Recovery Time	$I_F = 21 \text{ A}$ , $d_iF/d_t = 300 \text{ A}/\mu\text{s}$ (Note 3)	–	32	–	ns
$I_{\text{RM}}$	Diode Reverse Recovery Current		–	2.2	–	A
$Q_{\text{rr}}$	Diode Reverse Recovery Charge		–	35	–	nC

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.

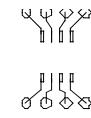
1.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.



- a. 50°C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper.



- b. 105°C/W when mounted on a .04 in<sup>2</sup> pad of 2 oz copper.



- c. 125°C/W when mounted on a minimum pad.

Scale 1:1 on letter size paper

2. Pulse Test: Pulse Width < 300  $\mu\text{s}$ , Duty Cycle < 2.0%
3. See "SyncFET Schottky Body Diode Characteristics" below.
4.  $E_{\text{AS}}$  of 541 mJ is based on starting  $T_J = 25^\circ\text{C}$ ,  $L = 3 \text{ mH}$ ,  $I_{\text{AS}} = 19 \text{ A}$ ,  $V_{\text{DD}} = 30 \text{ V}$ ,  $V_{\text{GS}} = 10 \text{ V}$ . 100% test at  $L = 1 \text{ mH}$ ,  $I_{\text{AS}} = 25 \text{ A}$ .

## TYPICAL CHARACTERISTICS

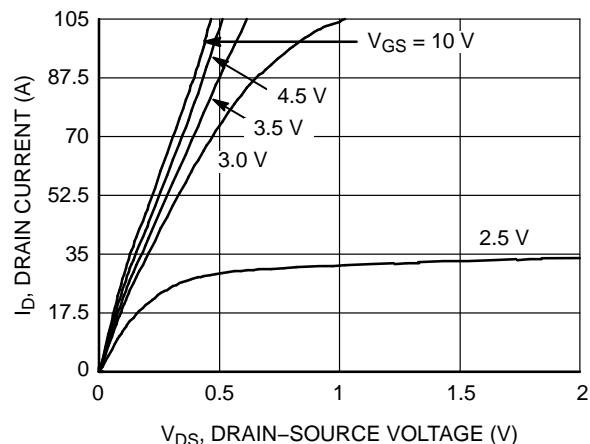


Figure 1. On-Region Characteristics

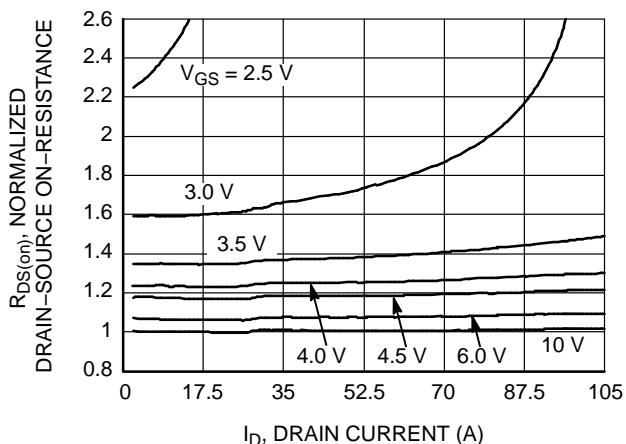


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

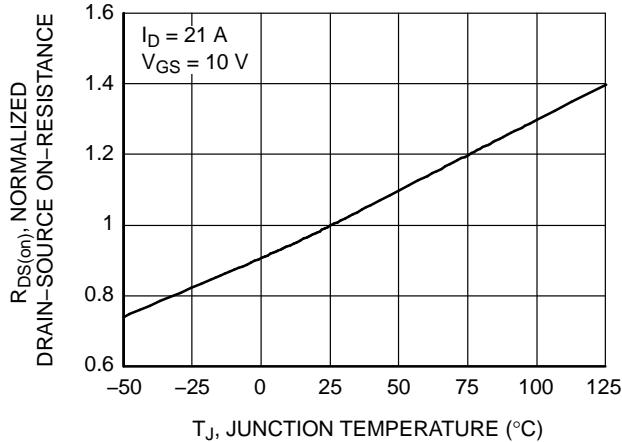


Figure 3. On-Resistance Variation with Junction Temperature

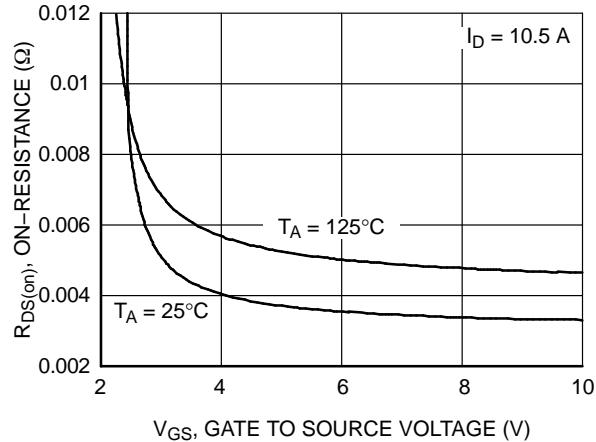


Figure 4. On-Resistance Variation with Gate-to-Source Voltage

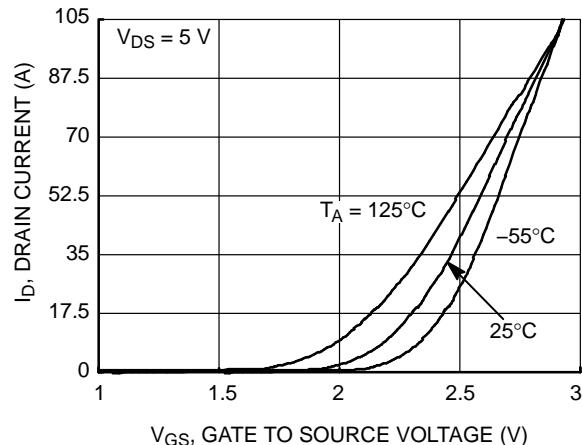


Figure 5. Transfer Characteristics

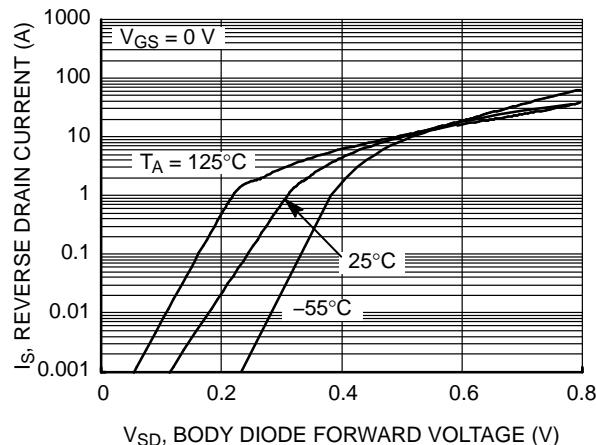


Figure 6. Body Diode Forward Voltage Variation with Source Current and Temperature

## TYPICAL CHARACTERISTICS (CONTINUED)

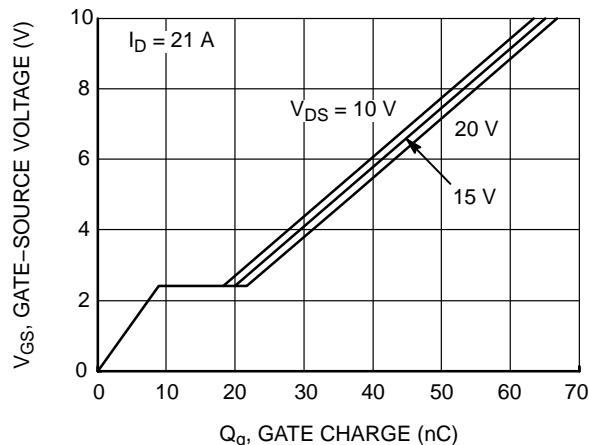


Figure 7. Gate Charge Characteristics

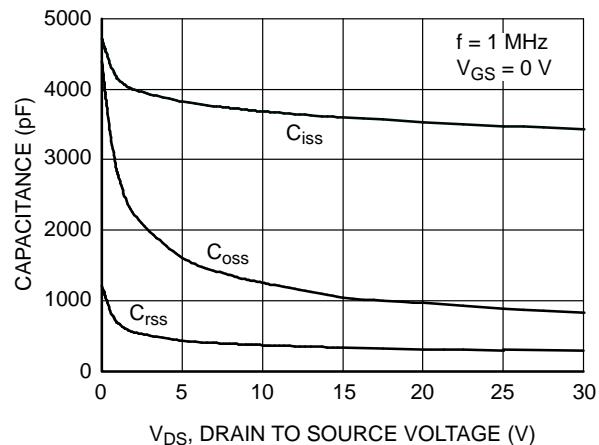


Figure 8. Capacitance Characteristics

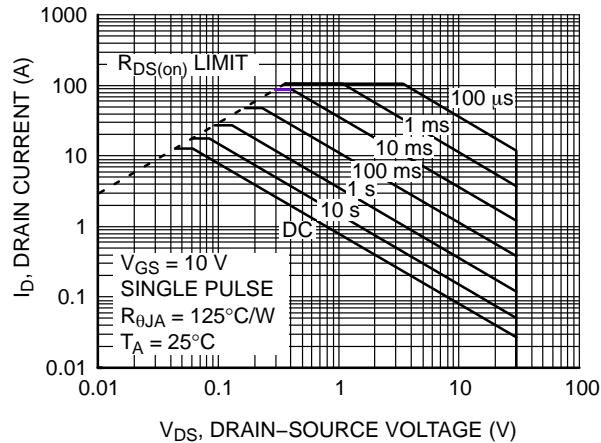


Figure 9. Maximum Safe Operating Area

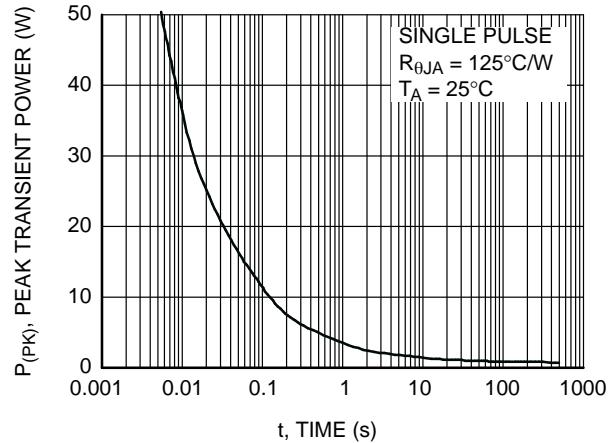


Figure 10. Single Pulse Maximum Power Dissipation

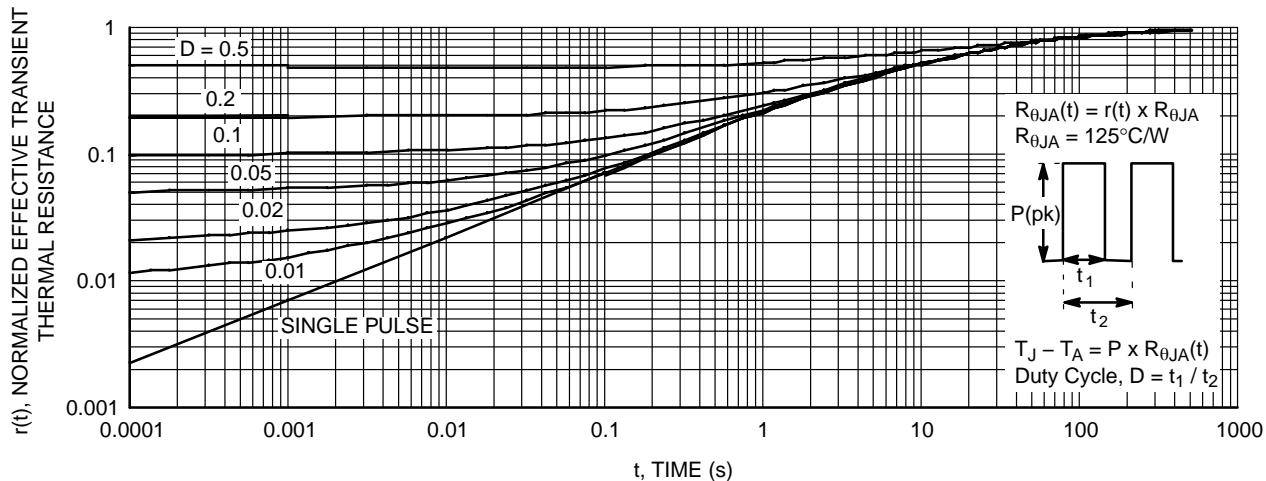


Figure 11. Transient Thermal Response Curve

(Thermal characterization performed using the conditions described in Note 1c.  
Transient thermal response will change depending on the circuit board design.)

## TYPICAL CHARACTERISTICS (CONTINUED)

## SyncFET Schottky Body Diode Characteristics

onsemi's SyncFET process embeds a Schottky diode in parallel with POWERTRENCH MOSFET. This diode exhibits similar characteristics to a discrete external Schottky diode in parallel with a MOSFET. Figure 12 shows the reverse recovery characteristic of the FDS6699S.

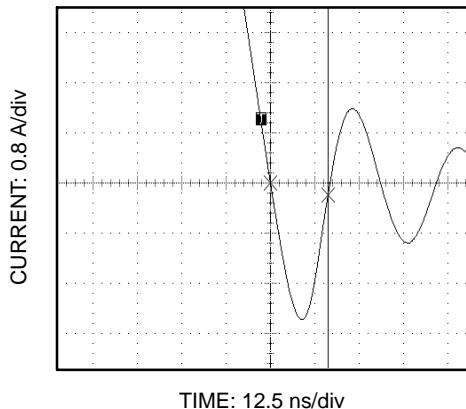


Figure 12. FDS6699S SyncFET Body Diode Reverse Recovery Characteristics

Schottky barrier diodes exhibit significant leakage at high temperature and high reverse voltage. This will increase the power in the device.

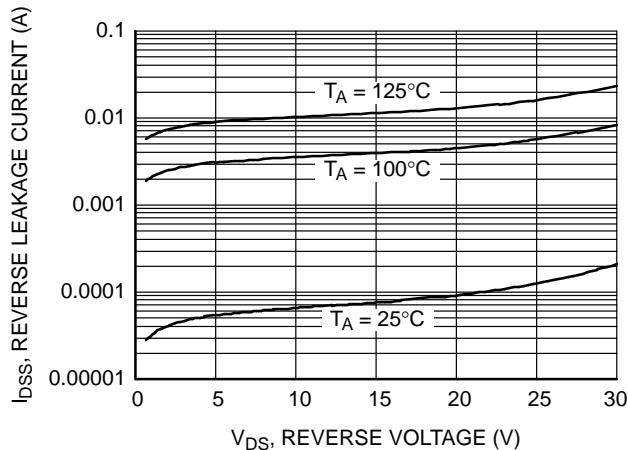


Figure 13. SyncFET Body Diode Reverse Leakage vs. Drain-Source Voltage and Temperature

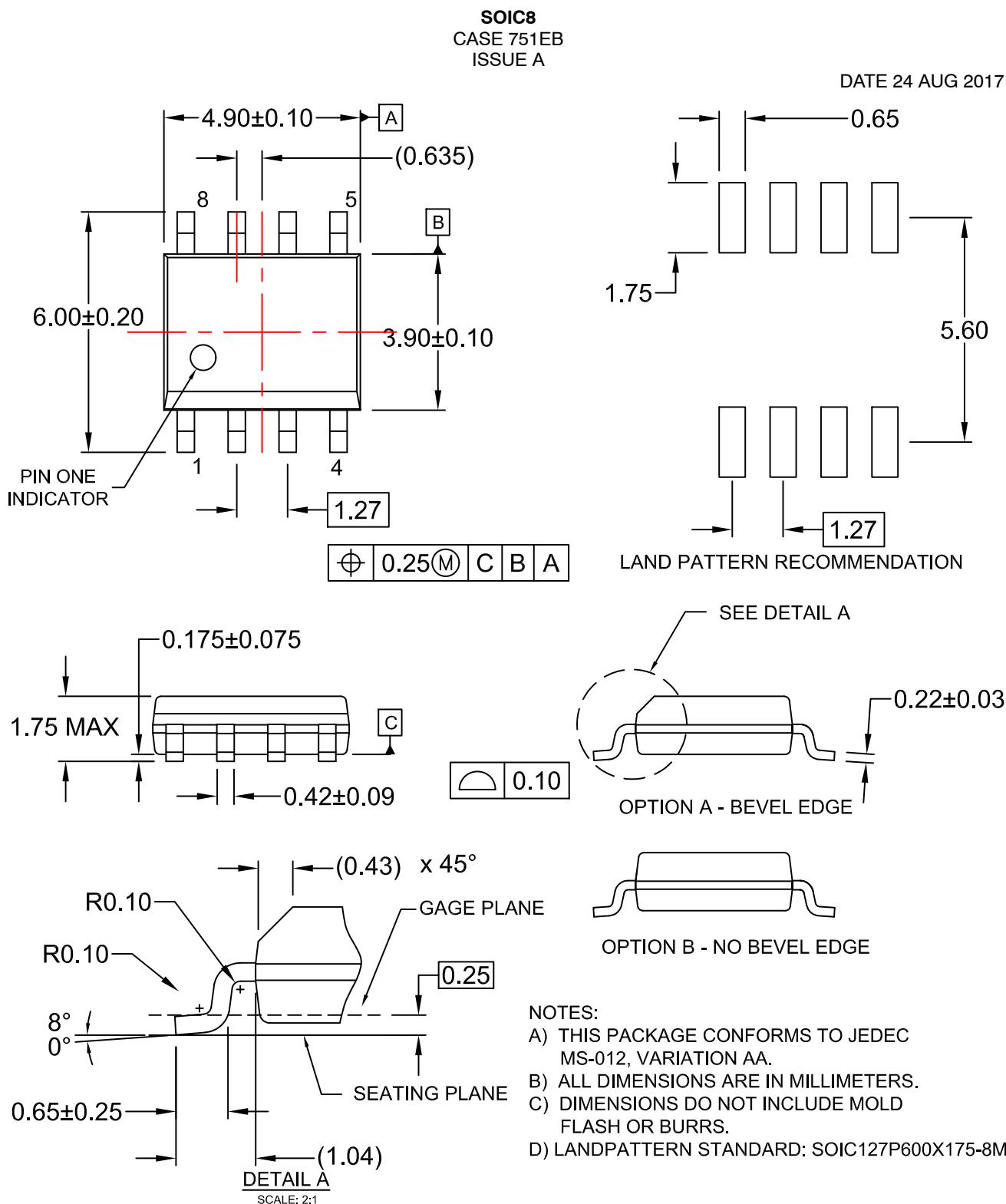
## PACKAGE MARKING AND ORDERING INFORMATION

Device	Device Marking	Package Type	Reel Size	Tape Width	Shipping <sup>†</sup>
FDS6699S	FDS6699S	SOIC8 (SO-8) (Pb-Free, Halide Free)	13"	12 mm	2500 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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