

CSD13385F5 12-V N-Channel FemtoFET™ MOSFET

1 Features

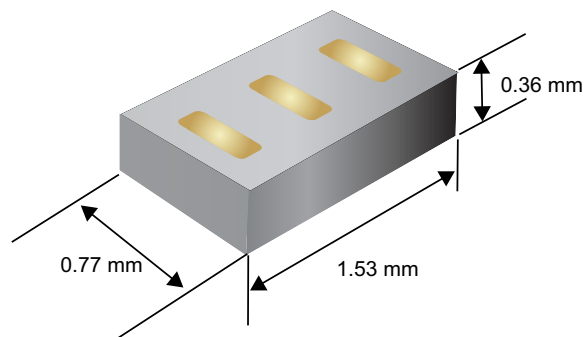
- Low on resistance
- Low Q_g and Q_{gd}
- Ultra-small footprint
 - 1.53 mm × 0.77 mm
- Low profile
 - 0.36-mm height
- Integrated ESD protection diode
 - Rated > 4-kV HBM
 - Rated > 2-kV CDM
- Lead and halogen free
- RoHS compliant

2 Applications

- Optimized for industrial load switch applications
- Optimized for general purpose switching applications

3 Description

This 12-V, 15-mΩ, N-Channel FemtoFET™ MOSFET technology is designed and optimized to minimize the footprint in many handheld and mobile applications. This technology is capable of replacing standard small signal MOSFETs while providing a significant reduction in footprint size.



Typical Part Dimensions

Product Summary

$T_A = 25^\circ\text{C}$		TYPICAL VALUE	UNIT
V_{DS}	Drain-to-Source Voltage	12	V
Q_g	Gate Charge Total (4.5 V)	3.9	nC
Q_{gd}	Gate Charge Gate-to-Drain	0.39	nC
$R_{DS(on)}$	Drain-to-Source On Resistance	$V_{GS} = 1.8\text{ V}$	26
		$V_{GS} = 2.5\text{ V}$	18
		$V_{GS} = 4.5\text{ V}$	15
$V_{GS(th)}$	Threshold Voltage	0.8	V

Device Information⁽¹⁾

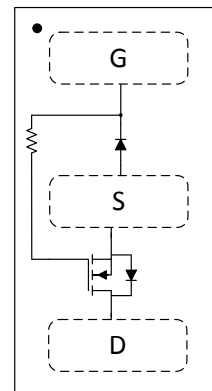
DEVICE	QTY	MEDIA	PACKAGE	SHIP
CSD13385F5	3000	7-Inch Reel	Femto	Tape and Reel
CSD13385F5T	250		1.53-mm × 0.77-mm SMD Lead Less	Reel

- (1) For all available packages, see the orderable addendum at the end of the data sheet.

Absolute Maximum Ratings

$T_A = 25^\circ\text{C}$		VALUE	UNIT
V_{DS}	Drain-to-Source Voltage	12	V
V_{GS}	Gate-to-Source Voltage	8	V
I_D	Continuous Drain Current ⁽¹⁾	4.3	A
	Continuous Drain Current ⁽²⁾	7.1	
I_{DM}	Pulsed Drain Current ^{(1) (3)}	41	A
P_D	Power Dissipation ⁽¹⁾	0.5	W
	Power Dissipation ⁽²⁾	1.4	
$V_{(ESD)}$	Human-Body Model (HBM)	4	kV
	Charged-Device Model (CDM)	2	
T_J, T_{stg}	Operating Junction, Storage Temperature	–55 to 150	$^\circ\text{C}$

- (1) Min Cu, typical $R_{\theta JA} = 245^\circ\text{C/W}$.
 (2) Max Cu, typical $R_{\theta JA} = 90^\circ\text{C/W}$.
 (3) Pulse duration $\leq 100\ \mu\text{s}$, duty cycle $\leq 1\%$.



Top View



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (May 2017) to Revision B (February 2022)	Page
• Changed ultra-low profile bullet from 0.35 mm to 0.36 mm in height.....	1
• Updated ultra-low profile image height from 0.35 mm to 0.36 mm.....	1
• Changed ultra-low profile image height from 0.35 mm to 0.36 mm.....	8
• Added FemtoFET Surface Mount Guide note.....	9

Changes from Revision * (October 2016) to Revision A (May 2017)	Page
• Changed I_{DSS} and I_{GSS} unit value from μA to nA in the <i>Electrical Characteristics</i> table.	3

5 Specifications

5.1 Electrical Characteristics

$T_A = 25^\circ\text{C}$ (unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
STATIC CHARACTERISTICS						
BV_{DSS}	Drain-to-source voltage	$V_{GS} = 0\text{ V}, I_{DS} = 250\ \mu\text{A}$	12			V
I_{DSS}	Drain-to-source leakage current	$V_{GS} = 0\text{ V}, V_{DS} = 9.6\text{ V}$			50	nA
I_{GSS}	Gate-to-source leakage current	$V_{DS} = 0\text{ V}, V_{GS} = 8\text{ V}$			25	nA
$V_{GS(th)}$	Gate-to-source threshold voltage	$V_{DS} = V_{GS}, I_{DS} = 250\ \mu\text{A}$	0.5	0.8	1.2	V
$R_{DS(on)}$	Drain-to-source on resistance	$V_{GS} = 1.8\text{ V}, I_{DS} = 0.1\text{ A}$		26	50	m Ω
		$V_{GS} = 2.5\text{ V}, I_{DS} = 0.9\text{ A}$		18	23	
		$V_{GS} = 4.5\text{ V}, I_{DS} = 0.9\text{ A}$		15	19	
g_{fs}	Transconductance	$V_{DS} = 1.2\text{ V}, I_{DS} = 0.9\text{ A}$		11.3		S
DYNAMIC CHARACTERISTICS						
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}, V_{DS} = 6\text{ V}, f = 1\text{ MHz}$		519	674	pF
C_{oss}	Output capacitance			305	396	pF
C_{riss}	Reverse transfer capacitance			29	38	pF
R_G	Series gate resistance			20		Ω
Q_g	Gate charge total (4.5 V)	$V_{DS} = 6\text{ V}, I_{DS} = 0.9\text{ A}$		3.9	5.0	nC
Q_{gd}	Gate charge gate-to-drain			0.39		nC
Q_{gs}	Gate charge gate-to-source			0.74		nC
$Q_{g(th)}$	Gate charge at V_{th}			0.46		nC
Q_{oss}	Output charge		$V_{DS} = 6\text{ V}, V_{GS} = 0\text{ V}$		2.5	
$t_{d(on)}$	Turnon delay time	$V_{DS} = 6\text{ V}, V_{GS} = 4.5\text{ V}, I_{DS} = 0.9\text{ A}, R_G = 2\ \Omega$		7		ns
t_r	Rise time			10		ns
$t_{d(off)}$	Turnoff delay time			33		ns
t_f	Fall time			10		ns
DIODE CHARACTERISTICS						
V_{SD}	Diode forward voltage	$I_{SD} = 0.9\text{ A}, V_{GS} = 0\text{ V}$		0.67	1.0	V

5.2 Thermal Information

$T_A = 25^\circ\text{C}$ (unless otherwise stated)

THERMAL METRIC		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance ⁽¹⁾		90		$^\circ\text{C/W}$
	Junction-to-ambient thermal resistance ⁽²⁾		245		

- (1) Device mounted on FR4 material with 1-in² (6.45-cm²), 2-oz (0.071-mm) thick Cu.
(2) Device mounted on FR4 material with minimum Cu mounting area.

5.3 Typical MOSFET Characteristics

$T_A = 25^\circ\text{C}$ (unless otherwise stated)

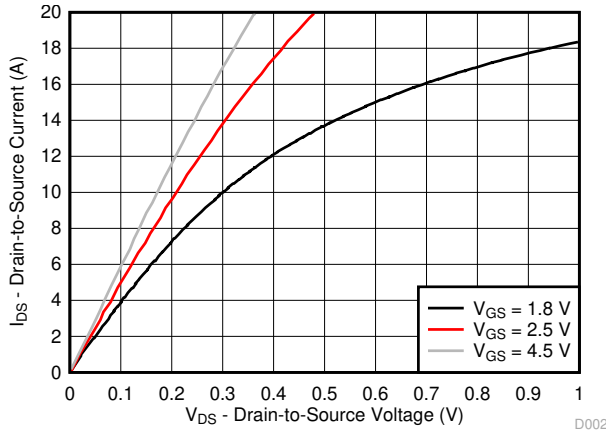


Figure 5-1. Saturation Characteristics

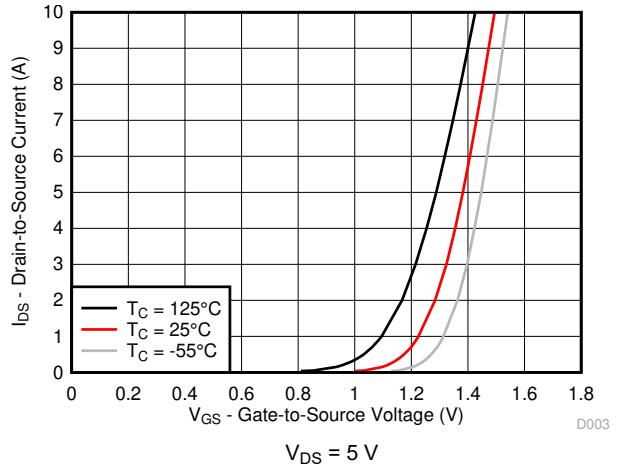


Figure 5-2. Transfer Characteristics

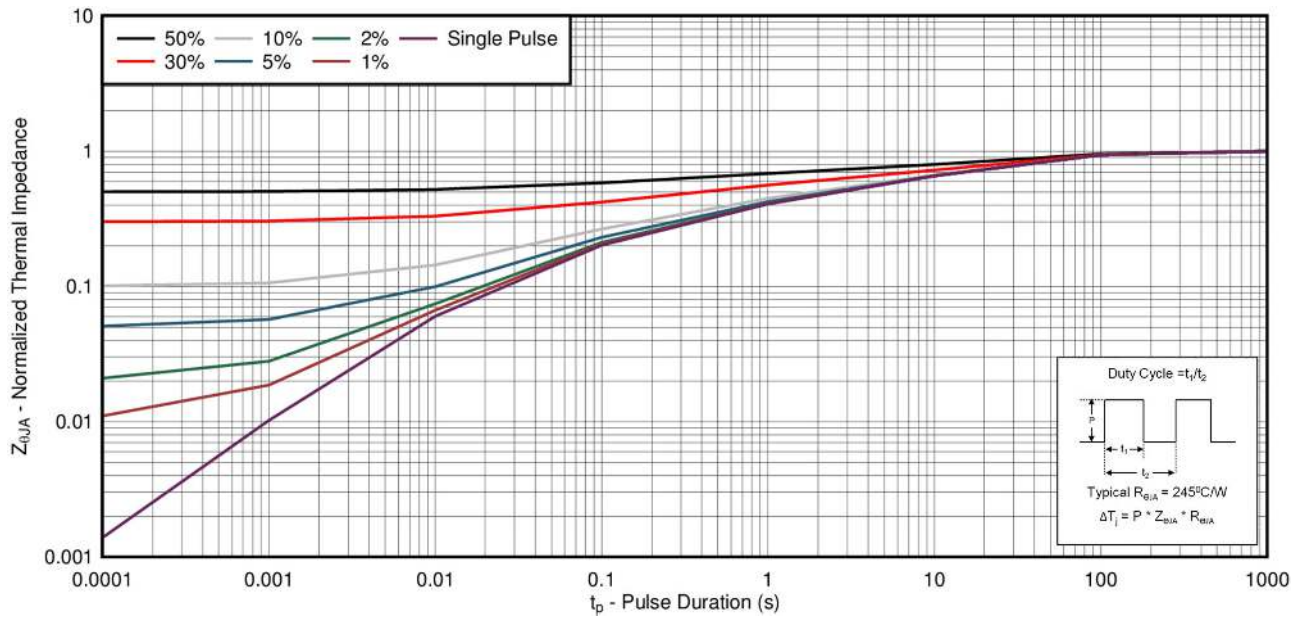


Figure 5-3. Transient Thermal Impedance

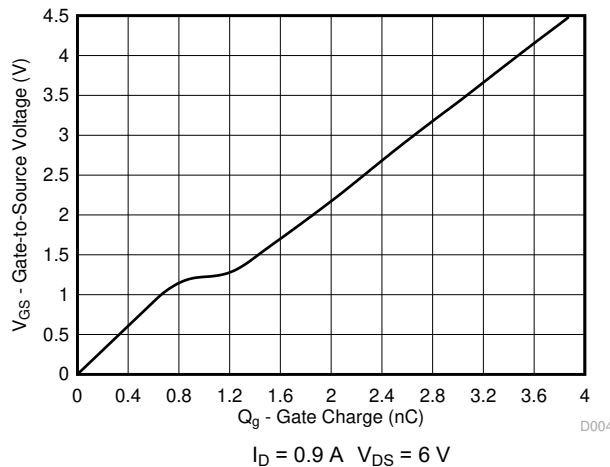


Figure 5-4. Gate Charge

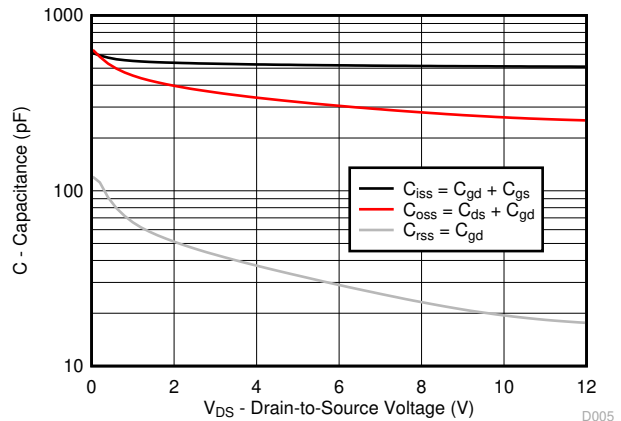


Figure 5-5. Capacitance

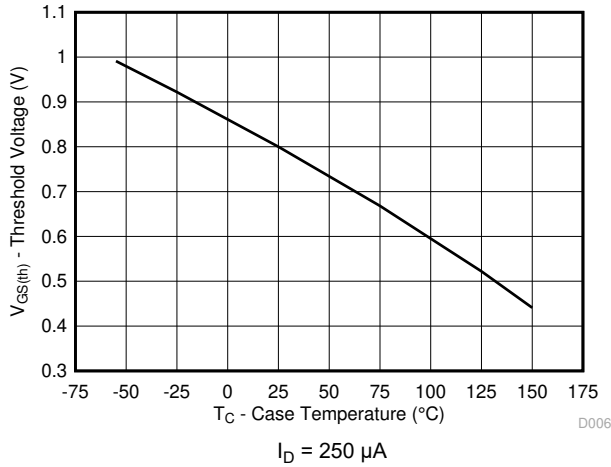


Figure 5-6. Threshold Voltage vs Temperature

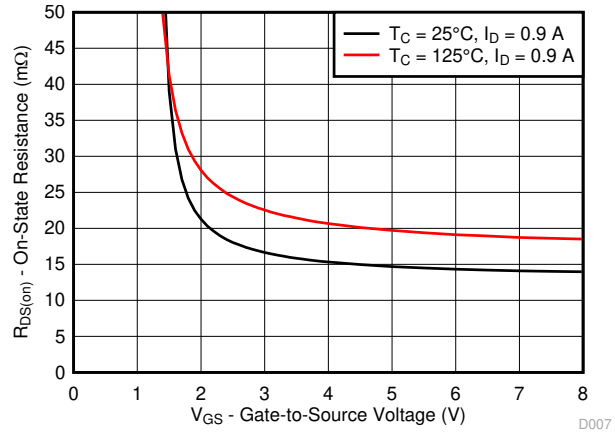


Figure 5-7. On-State Resistance vs Gate-to-Source Voltage

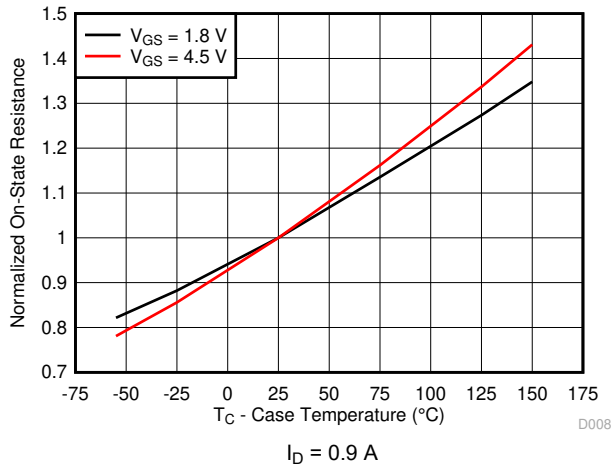


Figure 5-8. Normalized On-State Resistance vs Temperature

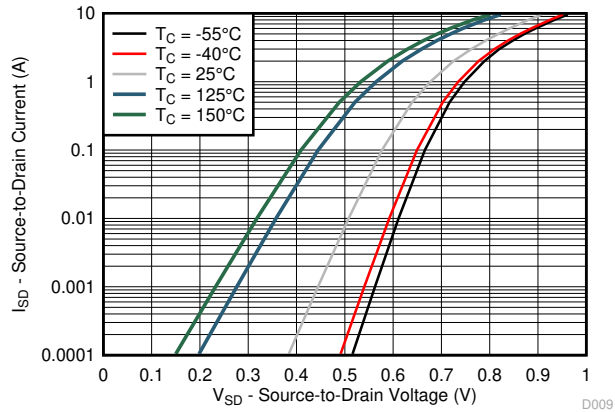


Figure 5-9. Typical Diode Forward Voltage

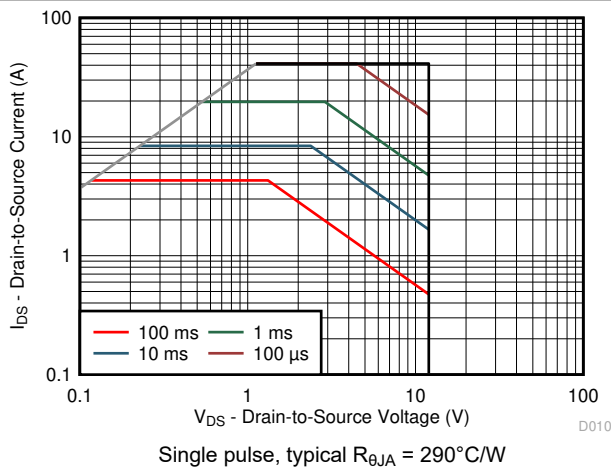


Figure 5-10. Maximum Safe Operating Area (SOA)

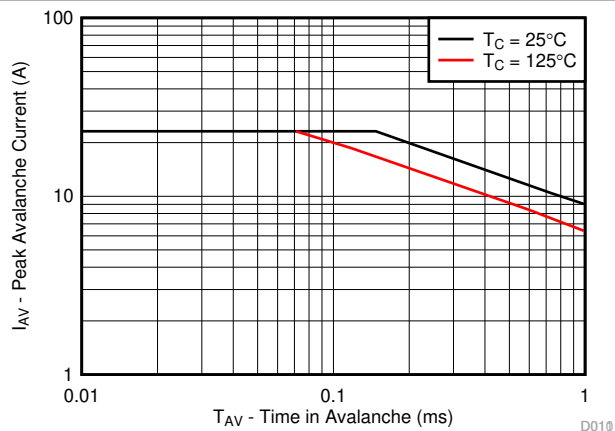


Figure 5-11. Single Pulse Unclamped Inductive Switching

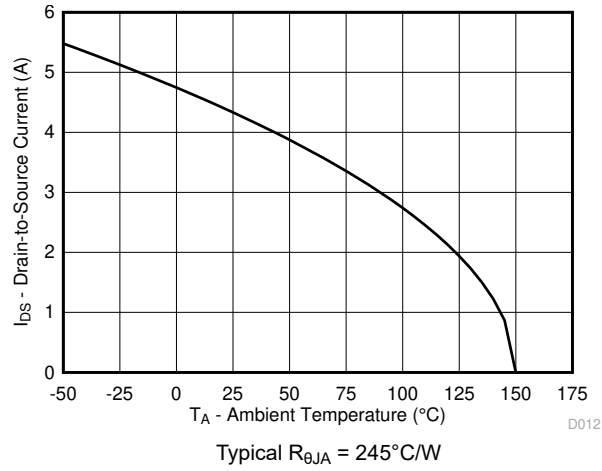


Figure 5-12. Maximum Drain Current vs Temperature

6 Device and Documentation Support

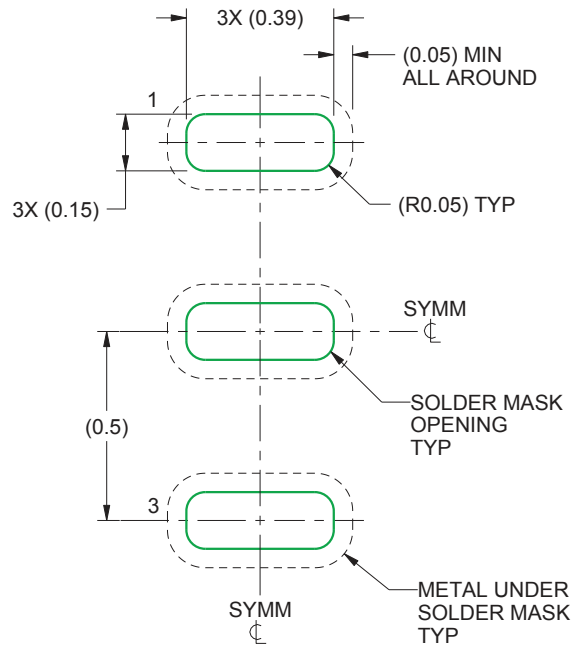
6.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

6.2 Trademarks

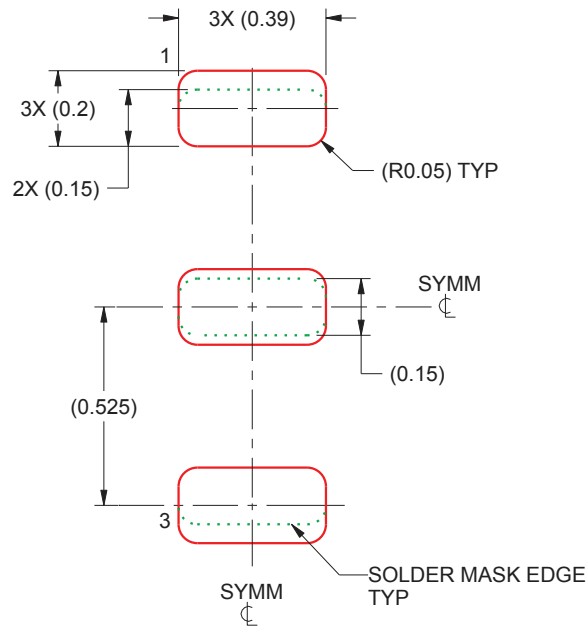
FemtoFET™ is a trademark of Texas Instruments.
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7.2 Recommended Minimum PCB Layout



- A. All dimensions are in millimeters.
- B. For more information, see [FemtoFET Surface Mount Guide](#) (SLRA003D).

7.3 Recommended Stencil Pattern



- A. All dimensions are in millimeters.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CSD13385F5	ACTIVE	PICOSTAR	YJK	3	3000	RoHS & Green	NIAU	Level-1-260C-UNLIM	-55 to 150	4V	Samples
CSD13385F5T	ACTIVE	PICOSTAR	YJK	3	250	RoHS & Green	NIAU	Level-1-260C-UNLIM	-55 to 150	4V	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

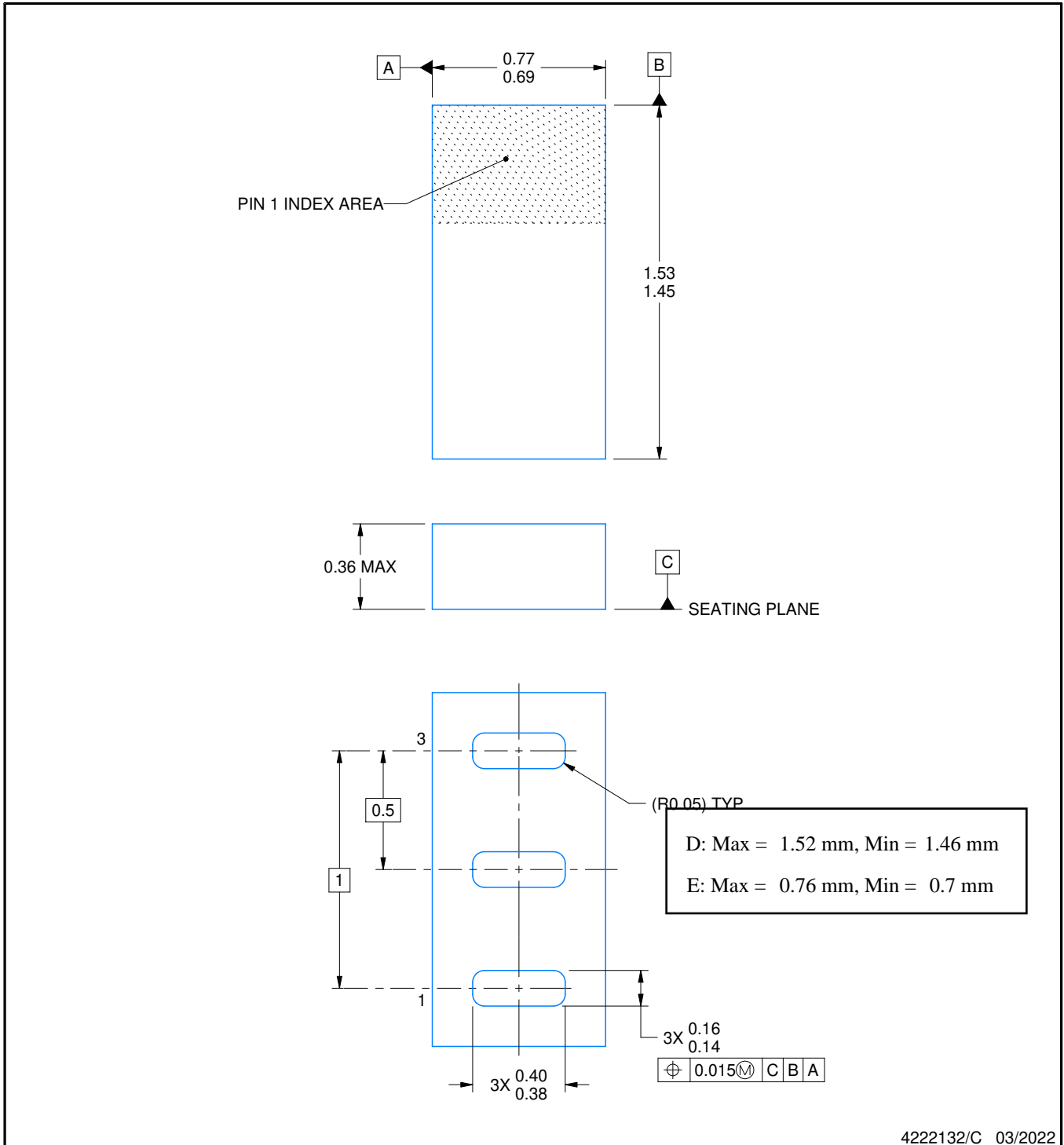

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CSD13385F5	PICOST AR	YJK	3	3000	180.0	8.4	0.92	1.68	0.42	4.0	8.0	Q1
CSD13385F5	PICOST AR	YJK	3	3000	178.0	8.4	0.92	1.68	0.42	4.0	8.0	Q1
CSD13385F5T	PICOST AR	YJK	3	250	178.0	8.4	0.92	1.68	0.42	4.0	8.0	Q1
CSD13385F5T	PICOST AR	YJK	3	250	180.0	8.4	0.92	1.68	0.42	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CSD13385F5	PICOSTAR	YJK	3	3000	182.0	182.0	20.0
CSD13385F5	PICOSTAR	YJK	3	3000	220.0	220.0	35.0
CSD13385F5T	PICOSTAR	YJK	3	250	220.0	220.0	35.0
CSD13385F5T	PICOSTAR	YJK	3	250	182.0	182.0	20.0

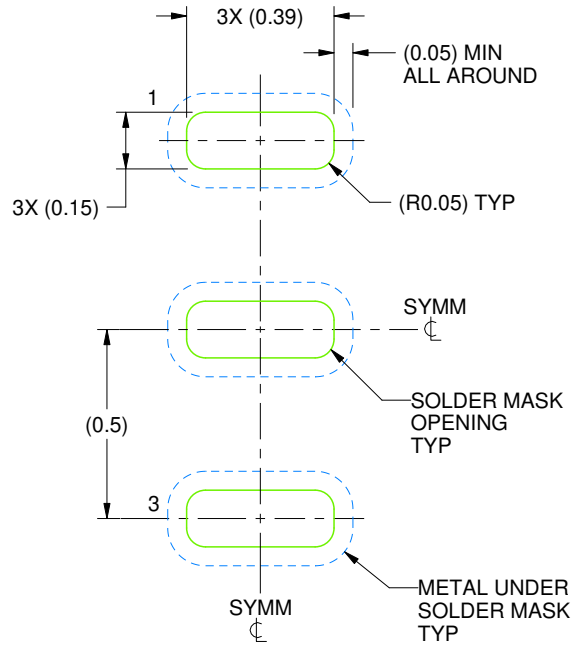


4222132/C 03/2022

NOTES:

PicoStar is a trademark of Texas Instruments.

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M
2. This drawing is subject to change without notice.
3. This package is a Pb-free bump design. Bump finish may vary. To determine the exact finish, refer to the device datasheet or contact a local TI representative.



LAND PATTERN EXAMPLE
SOLDER MASK DEFINED
SCALE:50X

NOTES: (continued)

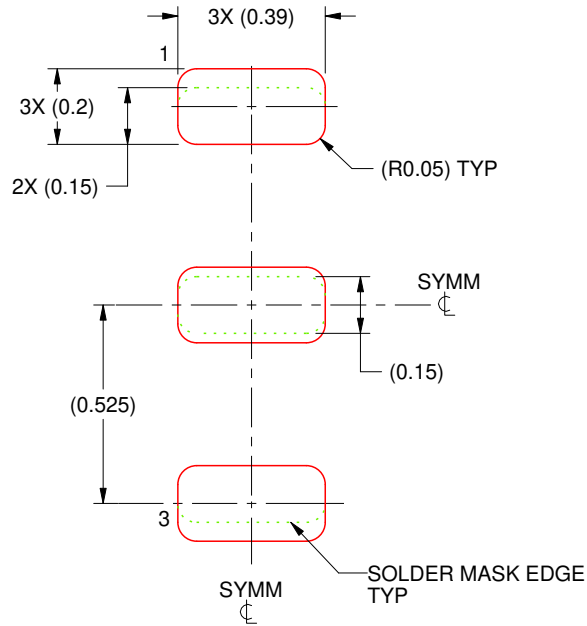
4. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).

EXAMPLE STENCIL DESIGN

YJK0003A

PicoStar™ - 0.36 mm max height

PicoStar™



SOLDER PASTE EXAMPLE
BASED ON 0.075 - 0.1 mm THICK STENCIL
SCALE:50X

4222132/C 03/2022

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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