

CSD23381F4 12-V P-Channel FemtoFET™ MOSFET

1 Features

- Ultra-low on-resistance
- Ultra-low Q_g and Q_{gd}
- High operating drain current
- Ultra-small footprint (0402 case size)
 - 1.0 mm × 0.6 mm
- Ultra-low profile
 - Maximum height: 0.36 mm
- Integrated ESD protection diode
 - Rated > 4-kV HBM
 - Rated > 2-kV CDM
- Lead and halogen free
- RoHS compliant

2 Applications

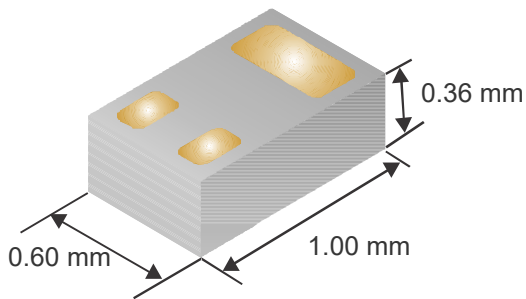
- Optimized for load switch applications
- Optimized for general purpose switching applications
- Battery applications
- Handheld and mobile applications

3 Description

This 150 mΩ, 12 V P-Channel FemtoFET™ MOSFET 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 at least a 60% reduction in footprint size.

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)	1140		pC
Q_{gd}	Gate charge gate-to-drain	190		pC
$R_{DS(on)}$	Drain-to-source on-resistance	$V_{GS} = -1.8\text{ V}$	480	mΩ
		$V_{GS} = -2.5\text{ V}$	250	mΩ
		$V_{GS} = -4.5\text{ V}$	150	mΩ



Typical Device Dimensions

Product Summary (continued)

$T_A = 25^\circ\text{C}$		TYPICAL VALUE	UNIT
$V_{GS(th)}$	Threshold voltage	-0.95	V

Ordering Information

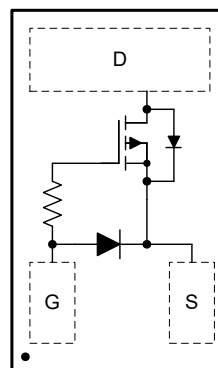
Device ⁽¹⁾	Qty	Media	Package	Ship
CSD23381F4	3000	7-inch reel	Femto(0402) 1.0-mm × 0.6-mm	Tape and reel
CSD23381F4T	250		Land Grid Array (LGA)	

- (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⁾	-2.3	A
I_{DM}	Pulsed drain current ⁽²⁾	-9	A
I_G	Continuous gate clamp current	-35	mA
	Pulsed gate clamp current ⁽²⁾	-350	
P_D	Power dissipation ⁽¹⁾	500	mW
$V_{(ESD)}$	Human body model (HBM)	4	kV
	Charged device model (CDM)	2	kV
T_J, T_{stg}	Operating junction and storage temperature range	-55 to 150	°C

- (1) Typical $R_{\theta JA} = 85^\circ\text{C/W}$ on 1-inch² (6.45 cm²), 2-oz. (0.071-mm thick) Cu pad on a 0.06-inch (1.52 mm) thick FR4 PCB.
 (2) Pulse duration $\leq 300\ \mu\text{s}$, duty cycle $\leq 2\%$



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 F (October 2021) to Revision G (January 2022) Page

- Changed Maximum height from "0.35 mm" to "0.36 mm" in *Features* 1
- Changed height dimension from "0.35 mm" to "0.36 mm" in *Typical Device Dimensions* 1
- Changed maximum height dimension from "0.35 mm" to "0.36 mm" in *Mechanical Dimensions* 7

Changes from Revision E (May 2015) to Revision F (October 2021) Page

- Added footnote with link to support document..... 8

Changes from Revision D (September 2014) to Revision E (May 2015) Page

- Corrected typo for I_{DSS} Test Condition 3
- Corrected typo for I_{GSS} Test Condition 3

5 Specifications

5.1 Electrical Characteristics

(T_A = 25°C unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
STATIC CHARACTERISTICS						
B _V DSS	Drain-to-Source Voltage	V _{GS} = 0 V, I _{DS} = -250 μA	-12			V
I _{DSS}	Drain-to-Source Leakage Current	V _{GS} = 0 V, V _{DS} = -9.6 V			-100	nA
I _{GSS}	Gate-to-Source Leakage Current	V _{DS} = 0 V, V _{GS} = -8 V			-50	nA
V _{GS(th)}	Gate-to-Source Threshold Voltage	V _{DS} = V _{GS} , I _{DS} = -250 μA	-0.7	-0.95	-1.20	V
R _{DS(on)}	Drain-to-Source On-Resistance	V _{GS} = -1.8 V, I _{DS} = -0.1 A		480	970	mΩ
		V _{GS} = -2.5 V, I _{DS} = -0.5 A		250	300	mΩ
		V _{GS} = -4.5 V, I _{DS} = -0.5 A		150	175	mΩ
g _{fs}	Transconductance	V _{DS} = -6 V, I _{DS} = -0.5 A		2		S
DYNAMIC CHARACTERISTICS						
C _{iss}	Input Capacitance	V _{GS} = 0 V, V _{DS} = -6 V, f = 1 MHz		236		pF
C _{oss}	Output Capacitance			98		pF
C _{rss}	Reverse Transfer Capacitance			6.9		pF
R _G	Series Gate Resistance			20		Ω
Q _g	Gate Charge Total (4.5 V)	V _{DS} = -6 V, I _{DS} = -0.5 A		1140		pC
Q _{gd}	Gate Charge Gate-to-Drain			190		pC
Q _{gs}	Gate Charge Gate-to-Source			300		pC
Q _{g(th)}	Gate Charge at V _{th}			145		pC
Q _{oss}	Output Charge	V _{DS} = -6 V, V _{GS} = 0 V		1290		pC
t _{d(on)}	Turn On Delay Time	V _{DS} = -6 V, V _{GS} = -4.5 V, I _{DS} = -0.5 A, R _G = 2 Ω		4.5		ns
t _r	Rise Time			3.9		ns
t _{d(off)}	Turn Off Delay Time			18		ns
t _f	Fall Time			7		ns
DIODE CHARACTERISTICS						
V _{SD}	Diode Forward Voltage	I _{SD} = -0.5 A, V _{GS} = 0 V		-0.75		V
Q _{rr}	Reverse Recovery Charge	V _{DS} = -10 V, I _F = -0.5 A, di/dt = 100 A/μs		1260		pC
t _{rr}	Reverse Recovery Time			7.9		ns

5.2 Thermal Information

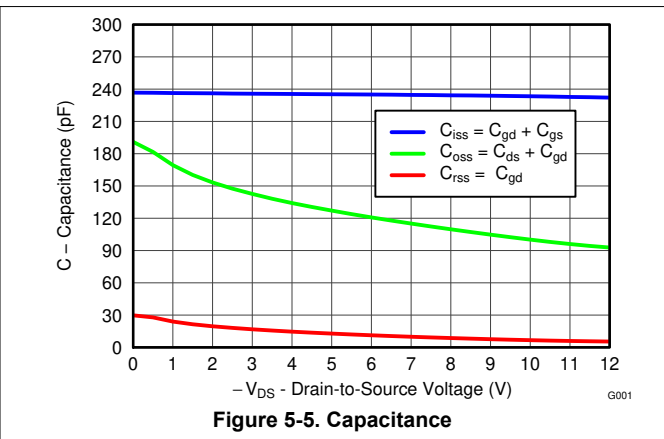
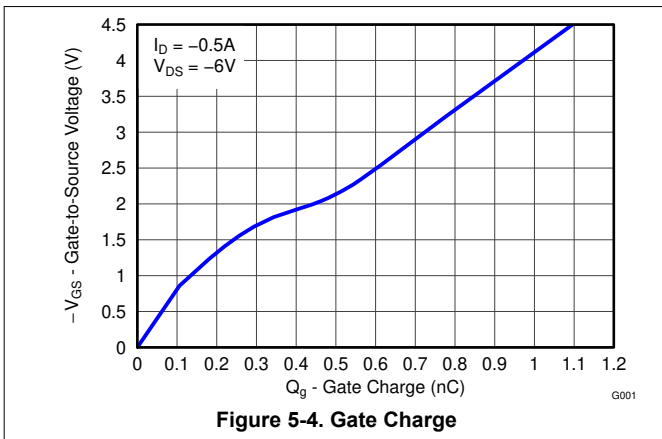
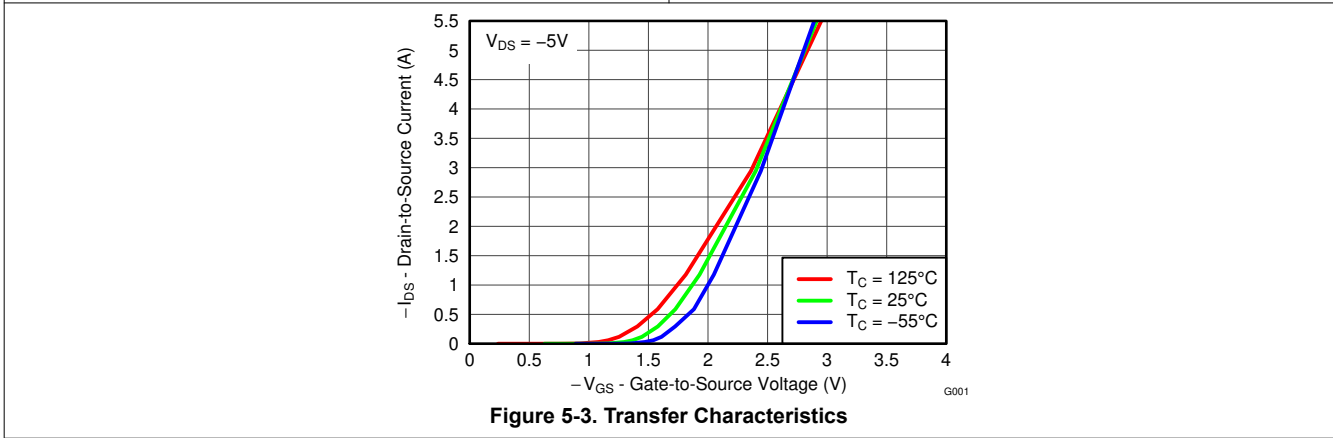
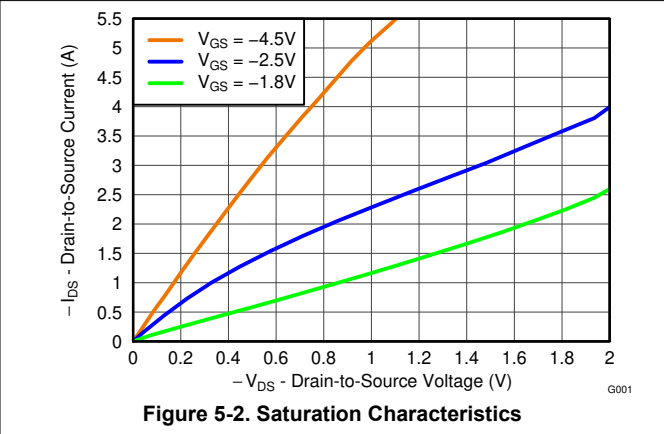
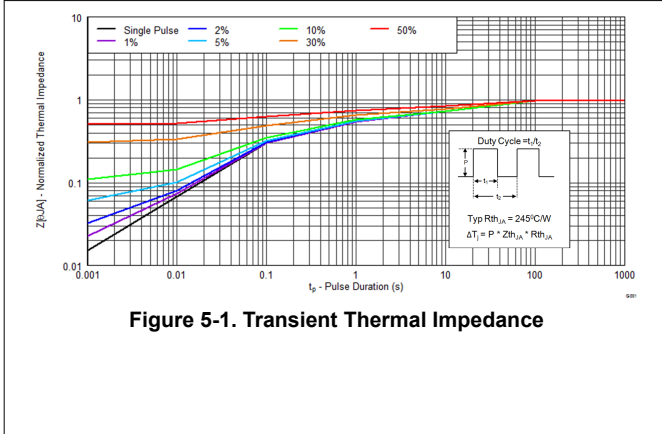
(T_A = 25°C unless otherwise stated)

THERMAL METRIC		TYPICAL VALUES	UNIT
R _{θJA}	Junction-to-Ambient Thermal Resistance ⁽¹⁾	85	°C/W
	Junction-to-Ambient Thermal Resistance ⁽²⁾	245	

- (1) Device mounted on FR4 material with 1-inch² (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)



5.3 Typical MOSFET Characteristics (continued)

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

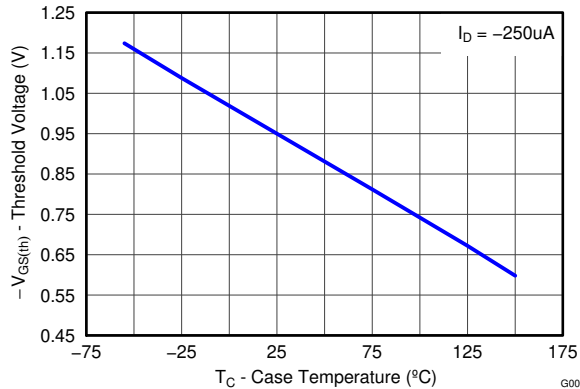


Figure 5-6. Threshold Voltage vs Temperature

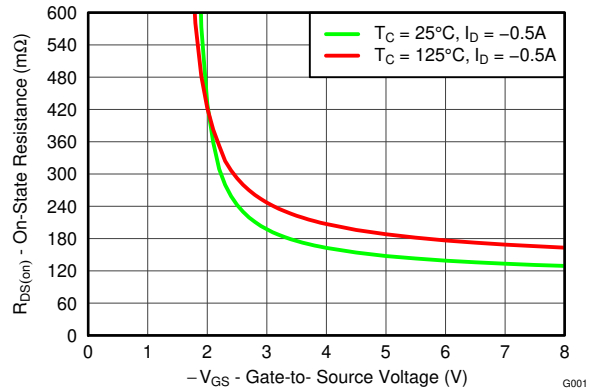


Figure 5-7. On-State Resistance vs Gate-to-Source Voltage

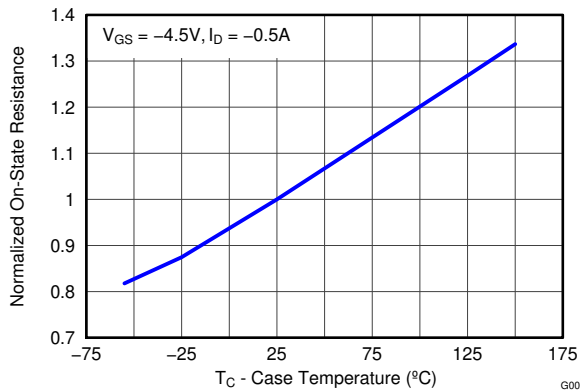


Figure 5-8. Normalized On-State Resistance vs Temperature

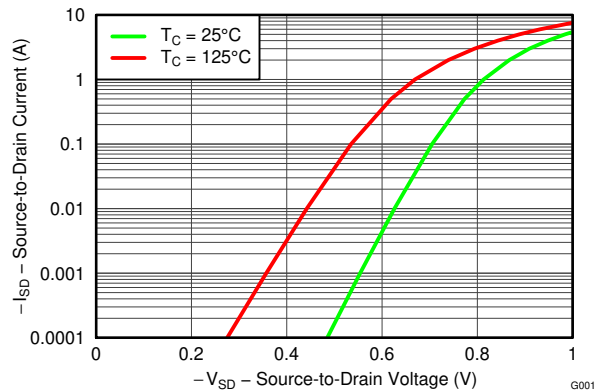


Figure 5-9. Typical Diode Forward Voltage

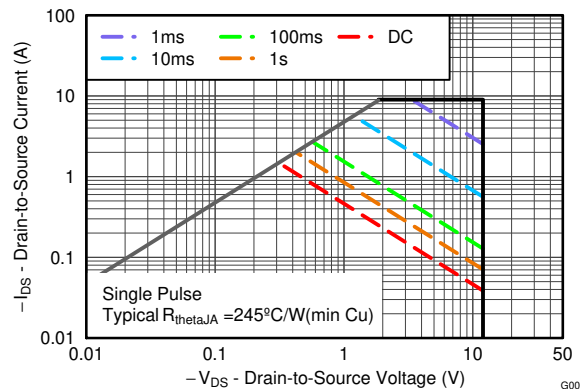


Figure 5-10. Maximum Safe Operating Area

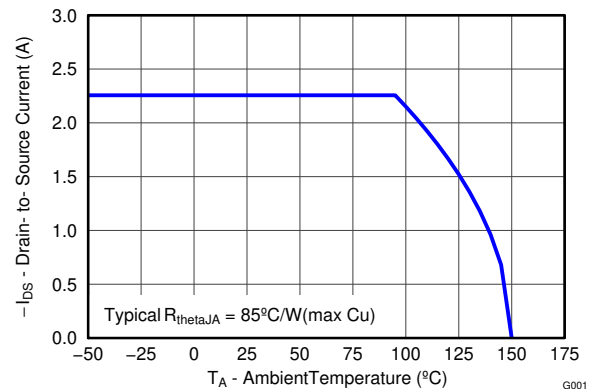


Figure 5-11. Maximum Drain Current vs Temperature

6 Device and Documentation Support

6.1 Trademarks

FemtoFET™ is a trademark of Texas Instruments.
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6.2 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

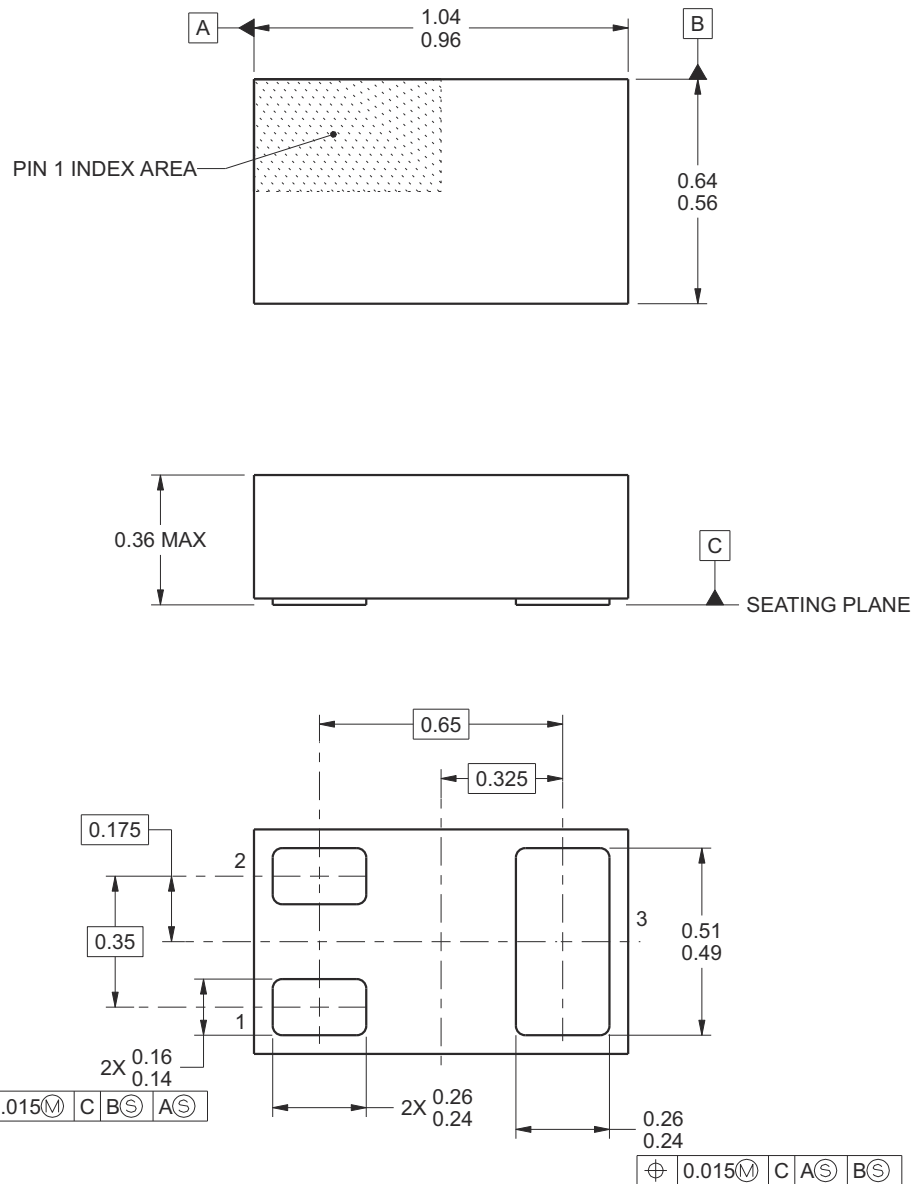
6.3 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

7 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

7.1 Mechanical Dimensions

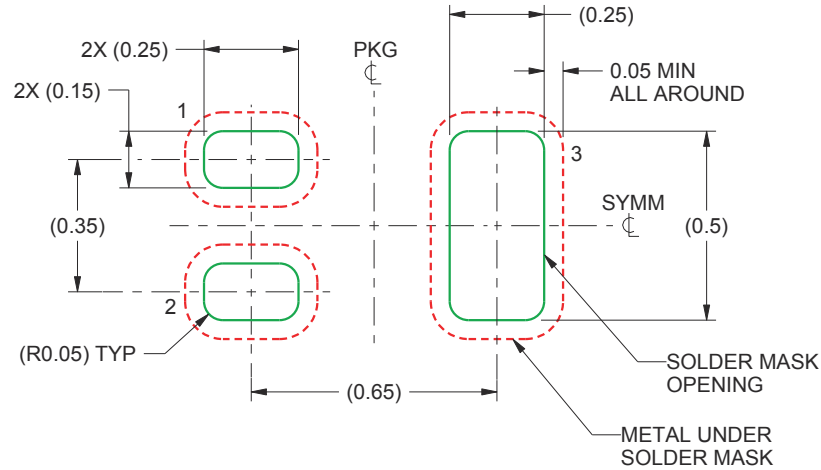


- A. All linear dimensions are in millimeters (dimensions and tolerancing per AME T14.5M-1994).
- B. This drawing is subject to change without notice.
- C. This package is a PB free solder land design.

Pin Configuration

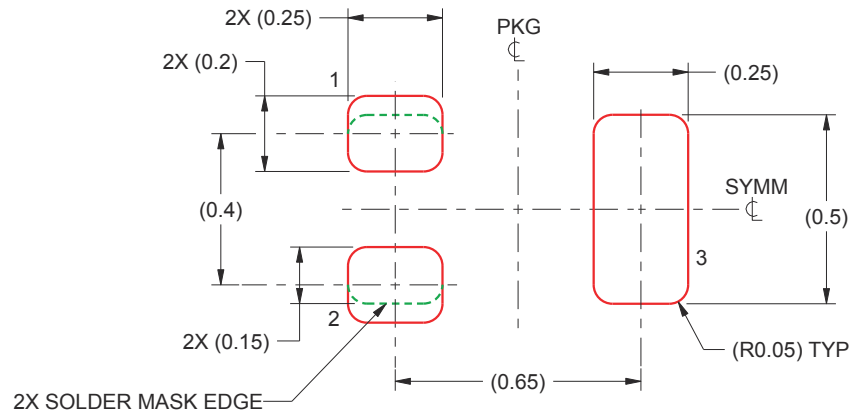
Position	Designation
Pin 1	Gate
Pin 2	Source
Pin 3	Drain

7.2 Recommended Minimum PCB Layout



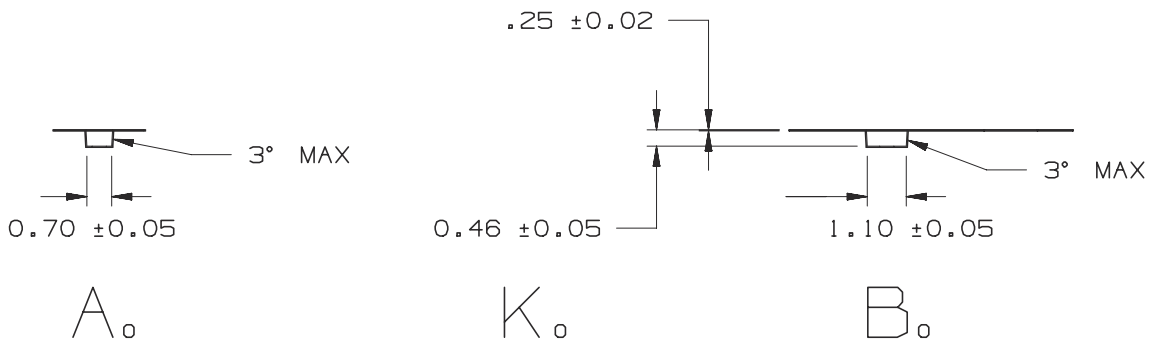
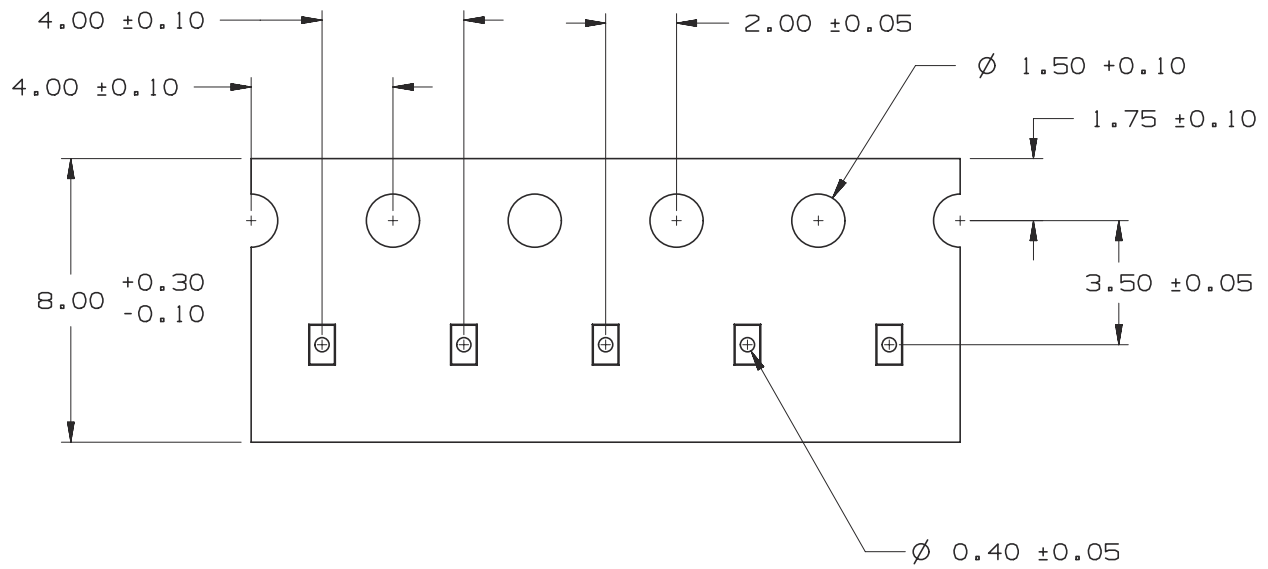
- A. All dimensions are in millimeters.
- B. For more information, see [FemtoFET Surface Mount Guide \(SLRA003D\)](#).

7.3 Recommended Stencil Pattern



- A. All dimensions are in millimeters.

7.4 CSD23381F4 Embossed Carrier Tape Dimensions



A. Pin 1 is oriented in the top-right quadrant of the tape enclosure (quadrant 2), closest to the carrier tape sprocket holes.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
CSD23381F4	Active	Production	PICOSTAR (YJC) 3	3000 LARGE T&R	Yes	NIAU	Level-1-260C-UNLIM	-55 to 150	DS
CSD23381F4.B	Active	Production	PICOSTAR (YJC) 3	3000 LARGE T&R	Yes	NIAU	Level-1-260C-UNLIM	-55 to 150	DS
CSD23381F4T	Active	Production	PICOSTAR (YJC) 3	250 SMALL T&R	Yes	NIAU	Level-1-260C-UNLIM	-55 to 150	DS
CSD23381F4T.B	Active	Production	PICOSTAR (YJC) 3	250 SMALL T&R	Yes	NIAU	Level-1-260C-UNLIM	-55 to 150	DS

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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
CSD23381F4	PICOSTAR	YJC	3	3000	180.0	8.4	0.7	1.1	0.46	4.0	8.0	Q2
CSD23381F4T	PICOSTAR	YJC	3	250	180.0	8.4	0.7	1.1	0.46	4.0	8.0	Q2

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CSD23381F4	PICOSTAR	YJC	3	3000	182.0	182.0	20.0
CSD23381F4T	PICOSTAR	YJC	3	250	182.0	182.0	20.0

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