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
  - 0.35 mm Max Height
- Integrated ESD Protection Diode
  - Rated >4 kV HBM
  - Rated >2 kV CDM
- Lead and Halogen Free
- RoHS Compliant

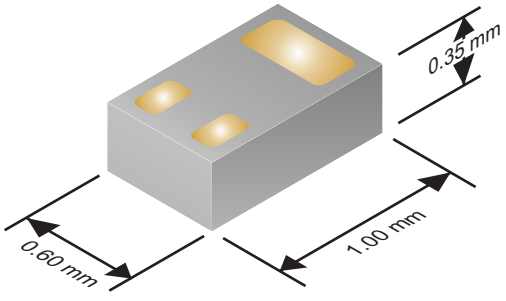
2 Applications

- 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.

Typical Part Dimensions



Product Summary

T_A = 25°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 V	480	mΩ
		V_{GS} = –2.5 V	250	mΩ
		V_{GS} = –4.5 V	150	mΩ
$V_{GS(th)}$	Threshold Voltage	–0.95		V

Ordering Information(1)

Device	Qty	Media	Package	Ship
CSD23381F4	3000	7-Inch Reel	Femto(0402) 1.0 mm x 0.6 mm Land Grid Array (LGA)	Tape and Reel
CSD23381F4T	250			

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

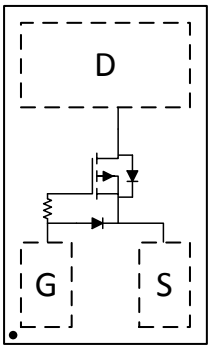
Absolute Maximum Ratings

T_A = 25°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°C/W on 1 inch^2 (6.45 cm^2), 2 oz. (0.071 mm thick) Cu pad on a 0.06 inch (1.52 mm) thick FR4 PCB.

(2) Pulse duration ≤300 µs, duty cycle ≤2%

Top View



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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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 D (September 2014) to Revision E — **Page**

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

Changes from Revision C (July 2014) to Revision D — **Page**

- Corrected timing V_{DS} to read –6 V ... 3

Changes from Revision B (February 2014) to Revision C — **Page**

- Corrected capacitance units to read pF in Figure 5 ... 5

Changes from Revision A (January 2014) to Revision B — **Page**

- Updated lead and halogen free in features ... 1
- Added I_G parameter ... 1
- Lowered I_{DSS} limit ... 3
- Lowered I_{GSS} limit ... 3

Changes from Original (October 2013) to Revision A — **Page**

- Added small reel info ... 1

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5 Specifications

5.1 Electrical Characteristics

(T_A = 25°C unless otherwise stated)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
STATIC CHARACTERISTICS						
BV_{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
$R_{\theta JA}$	Junction-to-Ambient Thermal Resistance(1)	85	°C/W
	Junction-to-Ambient Thermal Resistance(2)	245	

(1) Device mounted on FR4 material with 1 inch^2 (6.45 cm^2), 2 oz. (0.071 mm thick) Cu.
(2) Device mounted on FR4 material with minimum Cu mounting area.

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5.3 Typical MOSFET Characteristics

(T_A = 25°C unless otherwise stated)

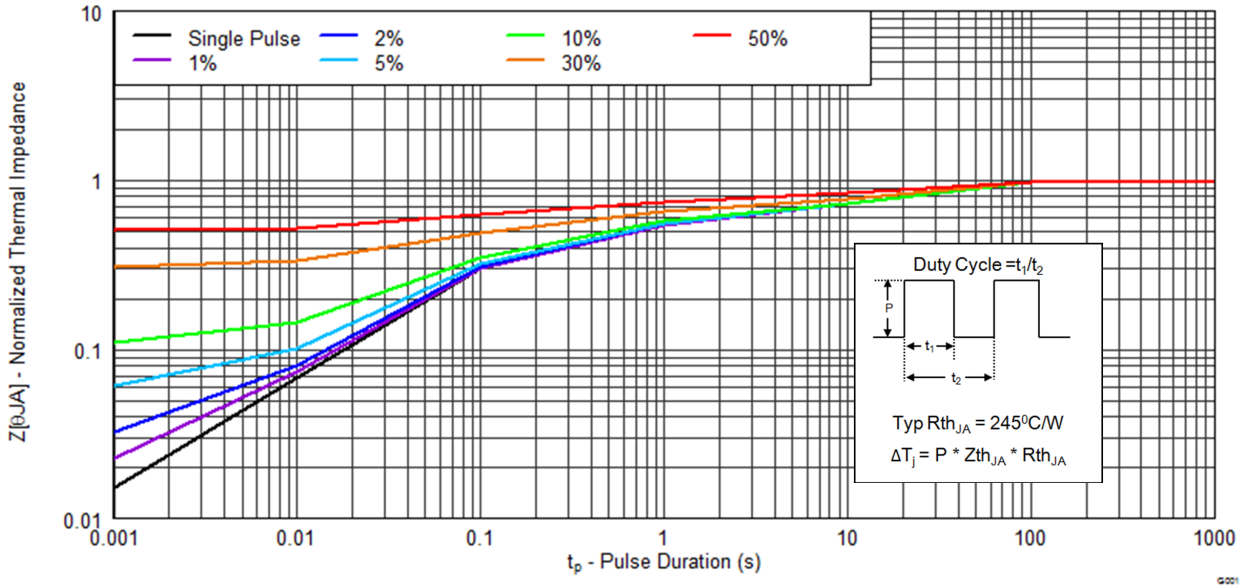


Figure 1. Transient Thermal Impedance

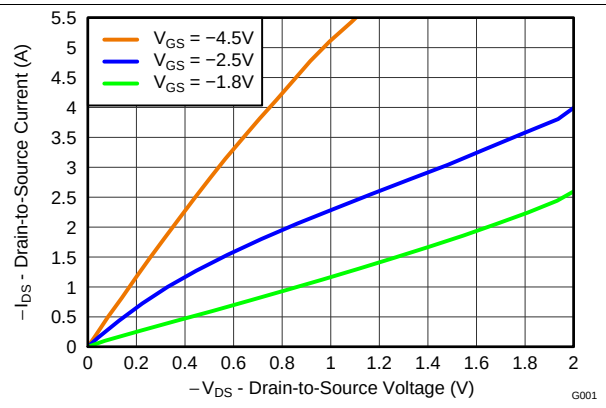


Figure 2. Saturation Characteristics

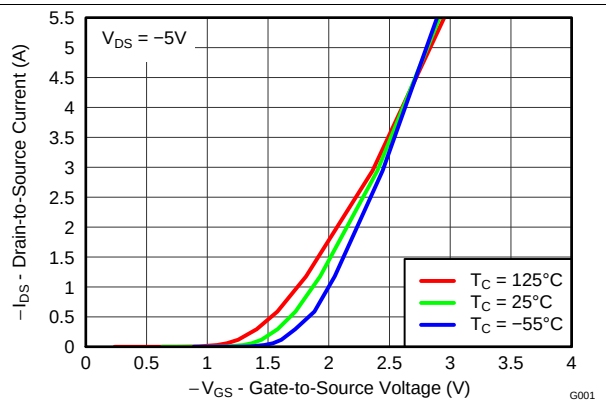


Figure 3. Transfer Characteristics

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Typical MOSFET Characteristics (continued)

(T_A = 25°C unless otherwise stated)

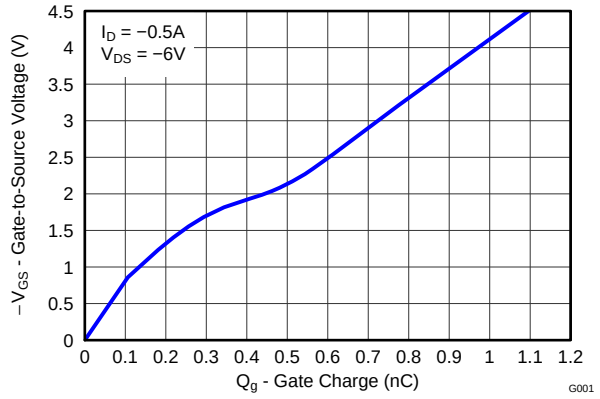


Figure 4. Gate Charge

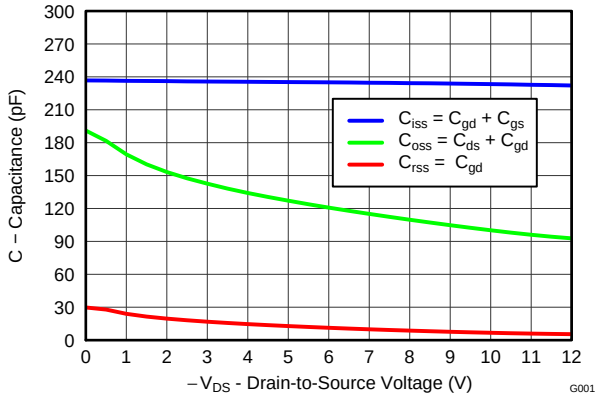


Figure 5. Capacitance

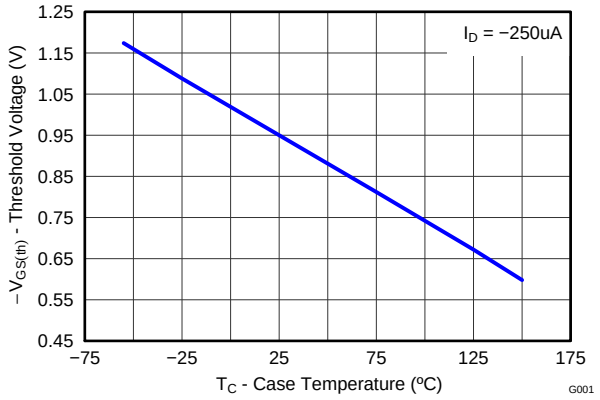


Figure 6. Threshold Voltage vs Temperature

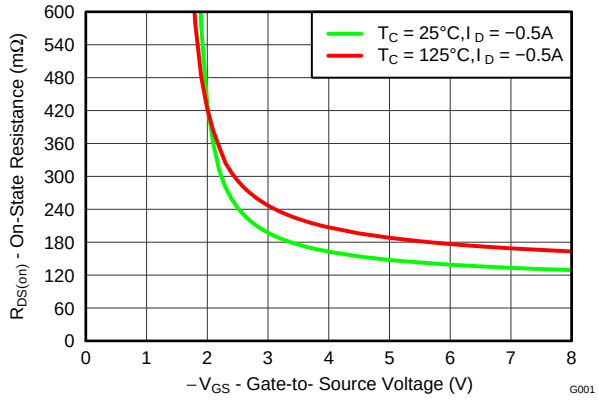


Figure 7. On-State Resistance vs Gate-to-Source Voltage

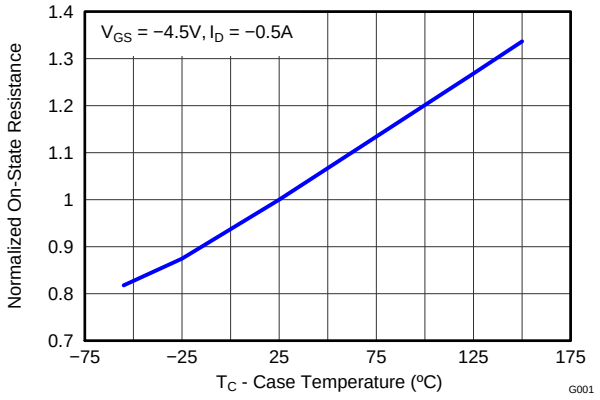


Figure 8. Normalized On-State Resistance vs Temperature

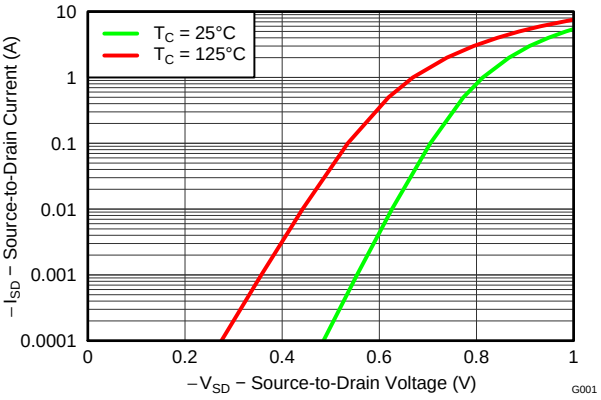


Figure 9. Typical Diode Forward Voltage

Typical MOSFET Characteristics (continued)

(T_A = 25°C unless otherwise stated)

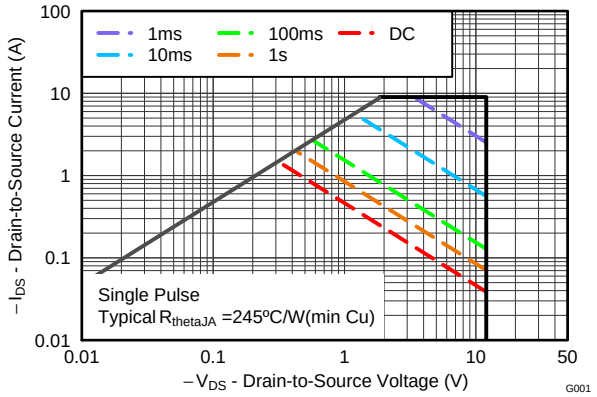


Figure 10. Maximum Safe Operating Area

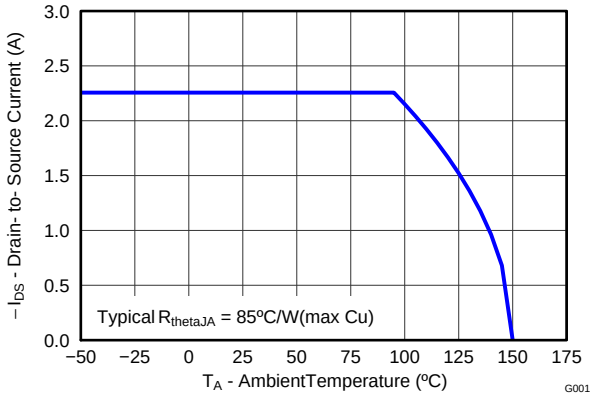


Figure 11. Maximum Drain Current vs Temperature

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6 Device and Documentation Support

6.1 Trademarks

FemtoFET is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

6.2 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

6.3 Glossary

SLYZ022 — *TI Glossary*.

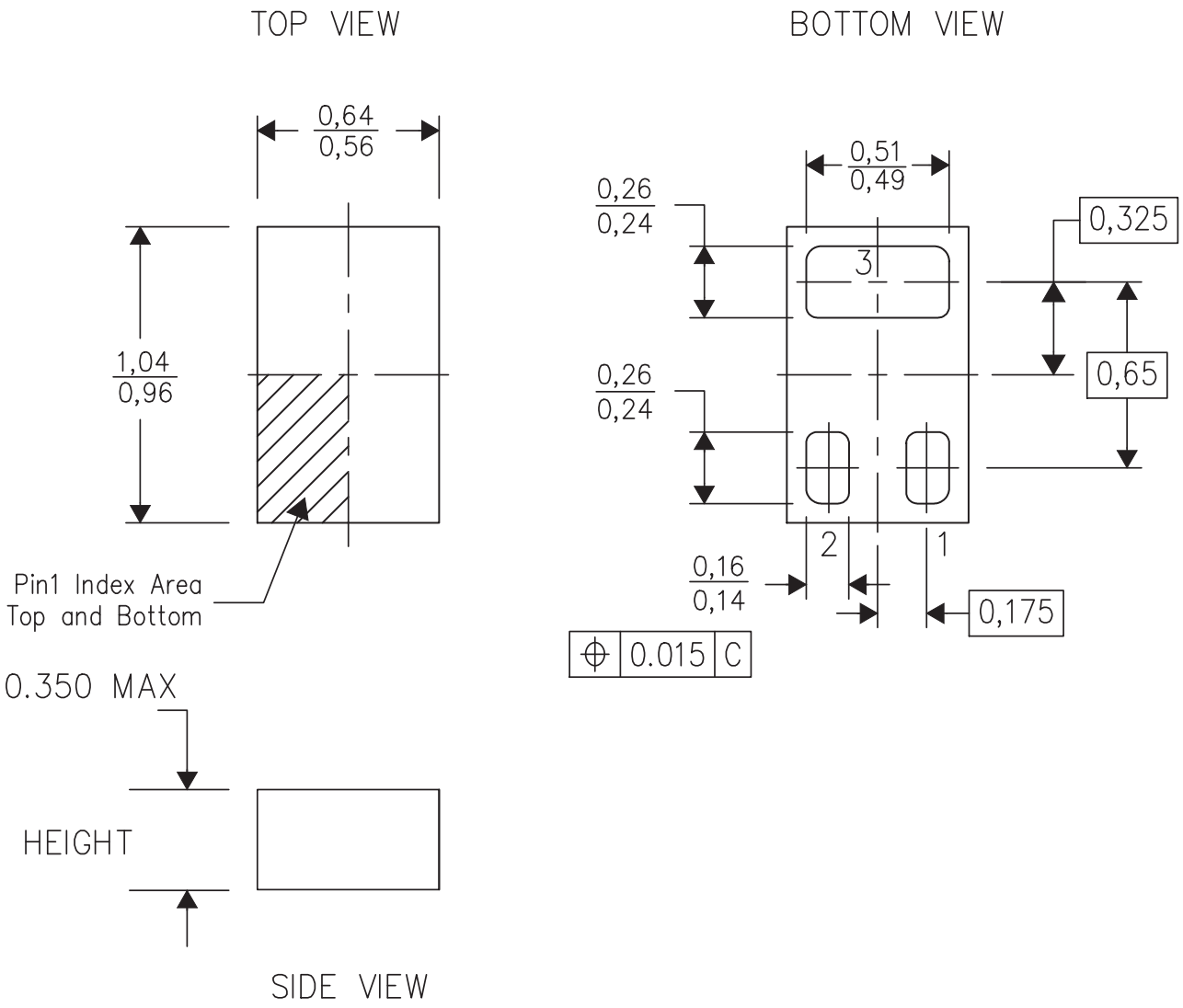
This glossary lists and explains terms, acronyms, and definitions.

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7 Mechanical Data

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



(1) All linear dimensions are in millimeters (dimensions and tolerancing per AME T14.5M-1994).

(2) This drawing is subject to change without notice.

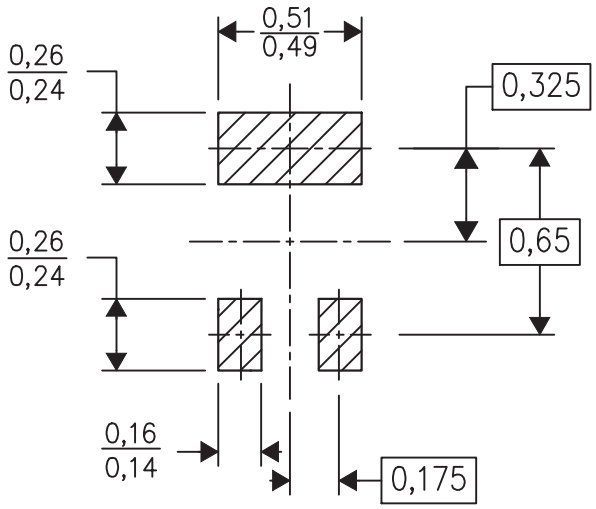
(3) This package is a PB free solder land design.

Pin Configuration

Position	Designation
Pin 1	Gate
Pin 2	Source
Pin 3	Drain

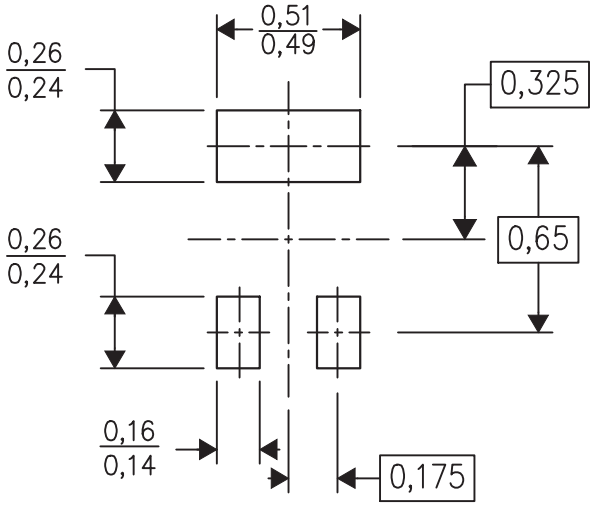
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7.2 Recommended Minimum PCB Layout



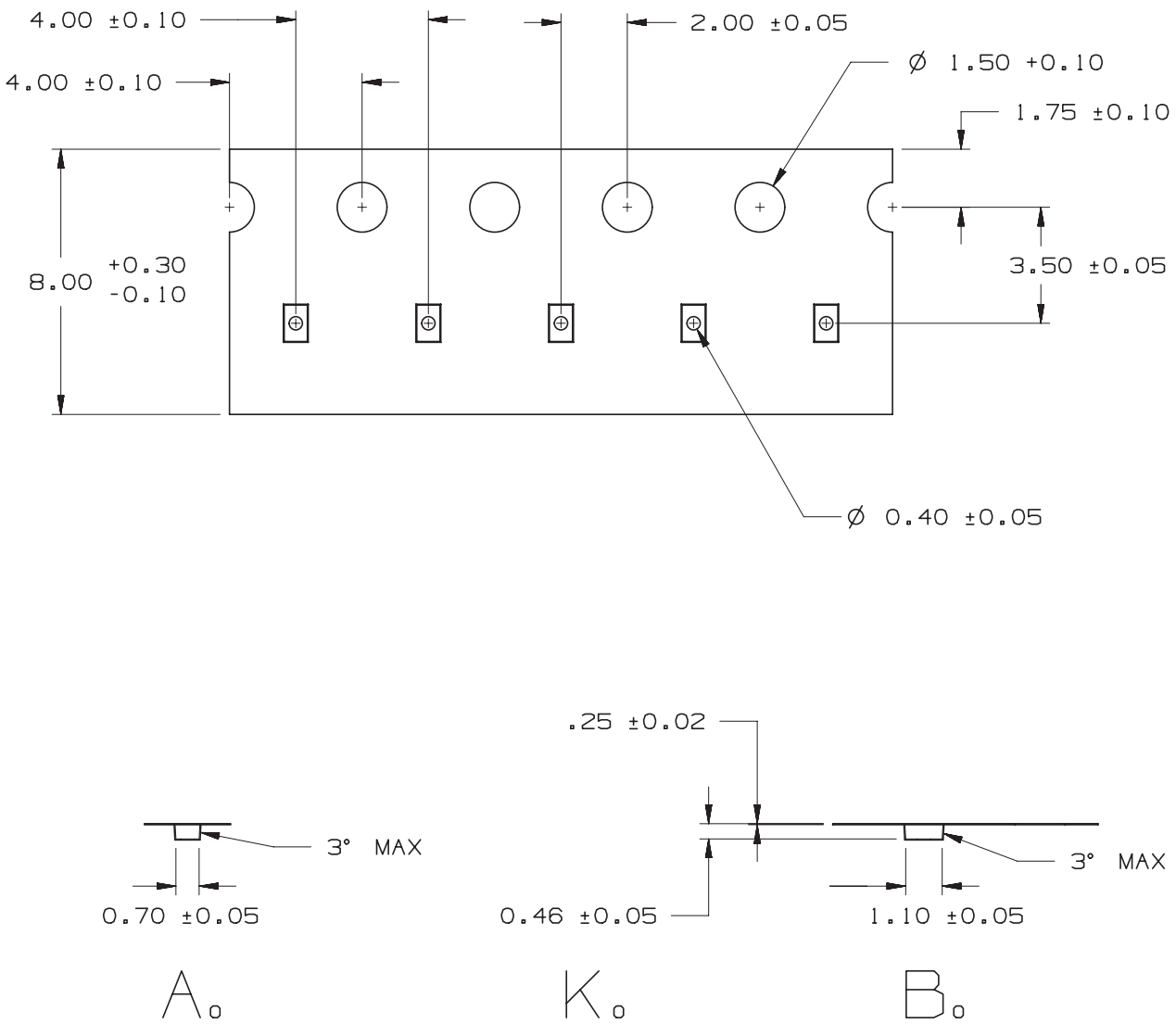
(1) All dimensions are in millimeters.

7.3 Recommended Stencil Pattern



(1) All dimensions are in millimeters.

7.4 CSD23381F4 Embossed Carrier Tape Dimensions



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

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CSD23381F4	ACTIVE	PICOSTAR	YJC	3	3000	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	-55 to 150	DS	Samples
CSD23381F4T	ACTIVE	PICOSTAR	YJC	3	250	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	-55 to 150	DS	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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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