CSD13385F5 12-V N-Channel FemtoFET™ MOSFET

1 Features
- Low On Resistance
- Low Qg and Qgd
- Ultra-Small Footprint
  - 1.53 mm × 0.77 mm
- Low Profile
  - 0.35-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.

Product Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ta = 25°C</th>
<th>Typical Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS (Drain-to-Source Voltage)</td>
<td>12</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Qg (Gate Charge Total (4.5 V))</td>
<td>3.9</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>Qgd (Gate Charge Gate-to-Drain)</td>
<td>0.39</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>RDS(on) (Drain-to-Source On Resistance)</td>
<td>VGS = 1.8 V 26</td>
<td>mΩ</td>
<td></td>
</tr>
<tr>
<td>VGS(th) (Threshold Voltage)</td>
<td>0.8</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

Device Information

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>QTY</th>
<th>MEDIA</th>
<th>PACKAGE</th>
<th>SHIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD13385F5</td>
<td>3000</td>
<td>7-Inch Reel</td>
<td>Femto 1.53-mm × 0.77-mm SMD Lead Less</td>
<td>Tape and Reel</td>
</tr>
<tr>
<td>CSD13385FST</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ta = 25°C</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDS (Drain-to-Source Voltage)</td>
<td>12</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VGS (Gate-to-Source Voltage)</td>
<td>8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>ID (Continuous Drain Current)</td>
<td>4.3</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>IDM (Continuous Drain Current)</td>
<td>7.1</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>IP (Pulsed Drain Current)</td>
<td>41</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>PO (Power Dissipation)</td>
<td>0.5</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>VESSD (Human-Body Model (HBM))</td>
<td>4</td>
<td>kV</td>
<td></td>
</tr>
<tr>
<td>VESD (Charged-Device Model (CDM))</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TJ (Operating Junction)</td>
<td>-55 to 150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Tstg (Storage Temperature)</td>
<td>-55 to 150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

(1) Min Cu, typical RθJA = 245°C/W.
(2) Max Cu, typical RθJA = 90°C/W.
(3) Pulse duration ≤ 100 μs, duty cycle ≤ 1%.

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

Changes from Original (October 2016) to Revision A

- Changed Idss and Igss unit value from µA to nA in the Electrical Characteristics table. ................................................................. 3
# 5 Specifications

## 5.1 Electrical Characteristics

\( T_A = 25^\circ C \) (unless otherwise stated)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STATIC CHARACTERISTICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( BV_{DSS} )</td>
<td>Drain-to-source voltage</td>
<td>12</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( I_{DSS} )</td>
<td>Drain-to-source leakage current</td>
<td>50</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>( I_{GSS} )</td>
<td>Gate-to-source leakage current</td>
<td>25</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>( V_{GS(th)} )</td>
<td>Gate-to-source threshold voltage</td>
<td>0.5</td>
<td>0.8</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>( R_{DS(on)} )</td>
<td>Drain-to-source on resistance</td>
<td>26</td>
<td>50</td>
<td></td>
<td>m\Omega</td>
</tr>
<tr>
<td>( g_f )</td>
<td>Transconductance</td>
<td>11.3</td>
<td></td>
<td></td>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>DYNAMIC CHARACTERISTICS</strong></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_{iss} )</td>
<td>Input capacitance</td>
<td>519</td>
<td>674</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>( C_{oss} )</td>
<td>Output capacitance</td>
<td>305</td>
<td>396</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>( C_{rss} )</td>
<td>Reverse transfer capacitance</td>
<td>29</td>
<td>38</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>( R_G )</td>
<td>Series gate resistance</td>
<td>20</td>
<td></td>
<td></td>
<td>\Omega</td>
</tr>
<tr>
<td>( Q_G )</td>
<td>Gate charge total (4.5 V)</td>
<td>3.9</td>
<td>5.0</td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>( Q_{gd} )</td>
<td>Gate charge gate-to-drain</td>
<td>0.39</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>( Q_{gs} )</td>
<td>Gate charge gate-to-source</td>
<td>0.74</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>( Q_{g(th)} )</td>
<td>Gate charge at ( V_{th} )</td>
<td>0.46</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>( Q_{oss} )</td>
<td>Output charge</td>
<td>2.5</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>( t_{d(on)} )</td>
<td>Turnon delay time</td>
<td>7</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>( t_r )</td>
<td>Rise time</td>
<td>10</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>( t_{d(off)} )</td>
<td>Turnoff delay time</td>
<td>33</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>( t_f )</td>
<td>Fall time</td>
<td>10</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>DIODE CHARACTERISTICS</strong></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{SD} )</td>
<td>Diode forward voltage</td>
<td>0.67</td>
<td>1.0</td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

## 5.2 Thermal Information

\( T_A = 25^\circ C \) (unless otherwise stated)

<table>
<thead>
<tr>
<th>THERMAL METRIC</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_{JA} )</td>
<td>90</td>
<td></td>
<td></td>
<td>^C/W</td>
</tr>
</tbody>
</table>

(1) Device mounted on FR4 material with 1-in\(^2\) (6.45-cm\(^2\)), 2-oz (0.071-mm) thick Cu.

(2) Device mounted on FR4 material with minimum Cu mounting area.
5.3 Typical MOSFET Characteristics

\( T_A = 25^\circ C \) (unless otherwise stated)

![Figure 1. Transient Thermal Impedance](image1)

- 50%
- 10%
- 2%
- Single Pulse
- 30%
- 5%
- 1%

\( V_{GS} = 1.8 \) V
\( V_{GS} = 2.5 \) V
\( V_{GS} = 4.5 \) V

![Figure 2. Saturation Characteristics](image2)

![Figure 3. Transfer Characteristics](image3)

\( V_{DS} = 5 \) V

Product Folder Links: CSD13385F5
Typical MOSFET Characteristics (continued)

$T_A = 25^\circ C$ (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)

![Typical MOSFET Characteristics](image)

Figure 10. Maximum Safe Operating Area (SOA)

Figure 11. Single Pulse Unclamped Inductive Switching

Figure 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 Community Resources

The following links connect to TI community resources. Linked contents are provided “AS IS” by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI’s views; see TI’s Terms of Use.

**TI E2E™ Online Community** TI's Engineer-to-Engineer (E2E) Community. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** TI's Design Support Quickly find helpful E2E forums along with design support tools and contact information for technical support.

6.3 Trademarks

FemtoFET, E2E are trademarks of Texas Instruments. All other trademarks are the property of their respective owners.

6.4 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.

6.5 Glossary

SLYZ022 — *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

Table 1. Pin Configuration

<table>
<thead>
<tr>
<th>POSITION</th>
<th>DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1</td>
<td>Gate</td>
</tr>
<tr>
<td>Pin 2</td>
<td>Source</td>
</tr>
<tr>
<td>Pin 3</td>
<td>Drain</td>
</tr>
</tbody>
</table>
7.2 Recommended Minimum PCB Layout

(1) All dimensions are in millimeters.

7.3 Recommended Stencil Pattern

(1) All dimensions are in millimeters.
# PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead finish/ Ball material</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD13385F5</td>
<td>ACTIVE</td>
<td>PICOSTAR</td>
<td>YJK</td>
<td>3</td>
<td>3000</td>
<td>RoHS &amp; Green</td>
<td>Call TI</td>
<td>Level-1-260C-UNLIM</td>
<td>-55 to 150</td>
<td>4V</td>
<td></td>
</tr>
<tr>
<td>CSD13385F5T</td>
<td>ACTIVE</td>
<td>PICOSTAR</td>
<td>YJK</td>
<td>3</td>
<td>250</td>
<td>RoHS &amp; Green</td>
<td>Call TI</td>
<td>Level-1-260C-UNLIM</td>
<td>-55 to 150</td>
<td>4V</td>
<td></td>
</tr>
</tbody>
</table>

(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

### REEL DIMENSIONS

- **Reel Diameter**

### TAPE DIMENSIONS

<table>
<thead>
<tr>
<th>A0</th>
<th>Dimension designed to accommodate the component width</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0</td>
<td>Dimension designed to accommodate the component length</td>
</tr>
<tr>
<td>K0</td>
<td>Dimension designed to accommodate the component thickness</td>
</tr>
<tr>
<td>W</td>
<td>Overall width of the carrier tape</td>
</tr>
<tr>
<td>P1</td>
<td>Pitch between successive cavity centers</td>
</tr>
</tbody>
</table>

### PACKAGE MATERIALS INFORMATION

**CSD13385F5**

- **Type**: PICOST
- **Drawing**: YJK
- **Pins**: 3
- **SPQ**: 3000
- **Reel Diameter (mm)**: 178.0
- **Reel Width W1 (mm)**: 8.4
- **A0 (mm)**: 0.92
- **B0 (mm)**: 1.68
- **K0 (mm)**: 0.42
- **P1 (mm)**: 4.0
- **W (mm)**: 8.0
- **Pin1 Quadrant**: Q1

**CSD13385F5**

- **Type**: PICOST
- **Drawing**: YJK
- **Pins**: 3
- **SPQ**: 3000
- **Reel Diameter (mm)**: 180.0
- **Reel Width W1 (mm)**: 8.4
- **A0 (mm)**: 0.92
- **B0 (mm)**: 1.68
- **K0 (mm)**: 0.42
- **P1 (mm)**: 4.0
- **W (mm)**: 8.0
- **Pin1 Quadrant**: Q1

**CSD13385F5T**

- **Type**: PICOST
- **Drawing**: YJK
- **Pins**: 3
- **SPQ**: 250
- **Reel Diameter (mm)**: 180.0
- **Reel Width W1 (mm)**: 8.4
- **A0 (mm)**: 0.92
- **B0 (mm)**: 1.68
- **K0 (mm)**: 0.42
- **P1 (mm)**: 4.0
- **W (mm)**: 8.0
- **Pin1 Quadrant**: Q1

**CSD13385F5T**

- **Type**: PICOST
- **Drawing**: YJK
- **Pins**: 3
- **SPQ**: 250
- **Reel Diameter (mm)**: 178.0
- **Reel Width W1 (mm)**: 8.4
- **A0 (mm)**: 0.92
- **B0 (mm)**: 1.68
- **K0 (mm)**: 0.42
- **P1 (mm)**: 4.0
- **W (mm)**: 8.0
- **Pin1 Quadrant**: Q1

*All dimensions are nominal.*
<table>
<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSD13385F5</td>
<td>PICOSTAR</td>
<td>YJK</td>
<td>3</td>
<td>3000</td>
<td>220.0</td>
<td>220.0</td>
<td>35.0</td>
</tr>
<tr>
<td>CSD13385F5</td>
<td>PICOSTAR</td>
<td>YJK</td>
<td>3</td>
<td>3000</td>
<td>182.0</td>
<td>182.0</td>
<td>20.0</td>
</tr>
<tr>
<td>CSD13385F5T</td>
<td>PICOSTAR</td>
<td>YJK</td>
<td>3</td>
<td>250</td>
<td>182.0</td>
<td>182.0</td>
<td>20.0</td>
</tr>
<tr>
<td>CSD13385F5T</td>
<td>PICOSTAR</td>
<td>YJK</td>
<td>3</td>
<td>250</td>
<td>220.0</td>
<td>220.0</td>
<td>35.0</td>
</tr>
</tbody>
</table>

*All dimensions are nominal.
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