**FEATURES**
- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET® Power MOSFETs
- 2000 V ESD Protection
- Very Small Footprint
- High-Side Switching
- Low On-Resistance:
  - N-Channel, 0.7 \( \Omega \)
  - P-Channel, 1.2 \( \Omega \)
- Low Threshold: ± 0.8 V (Typ.)
- Fast Switching Speed: 14 ns
- 1.8 V Operation
- Compliant to RoHS Directive 2002/95/EC

**BENEFITS**
- Ease in Driving Switches
- Low Offset (Error) Voltage
- Low-Voltage Operation
- High-Speed Circuits
- Low Battery Voltage Operation

**APPLICATIONS**
- Replace Digital Transistor, Level-Shifter
- Battery Operated Systems
- Power Supply Converter Circuits

**PRODUCT SUMMARY**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain-Source Voltage</td>
<td>V_{DS}</td>
<td>V</td>
</tr>
<tr>
<td>Gate-Source Voltage</td>
<td>V_{GS}</td>
<td>± 6 V</td>
</tr>
<tr>
<td>Continuous Drain Current (T_{J} = 150 °C)(^a)</td>
<td>I_{D}</td>
<td>mA</td>
</tr>
<tr>
<td>Continuous Source Current (Diode Conduction)(^a)</td>
<td>I_{S}</td>
<td>mA</td>
</tr>
<tr>
<td>Maximum Power Dissipation(^a)</td>
<td>P_{D}</td>
<td>mW</td>
</tr>
<tr>
<td>Operating Junction and Storage Temperature Range</td>
<td>T_{J}, T_{stg}</td>
<td>°C</td>
</tr>
<tr>
<td>Gate-Source ESD Rating (HBM, Method 3015)</td>
<td>ESD</td>
<td>V</td>
</tr>
</tbody>
</table>

**SC-89**

**REFERENCES**

Notes:
- Surface mounted on FR4 board.
- Pulse width limited by maximum junction temperature.

Ordering Information: Si1016X-T1-GE3 (Lead (Pb)-free and Halogen-free)
# SPECIFICATIONS (T<sub>J</sub> = 25 °C, unless otherwise noted)

## Static

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Gate Threshold Voltage</td>
<td>V&lt;sub&gt;GS(th)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = V&lt;sub&gt;GS&lt;/sub&gt;, I&lt;sub&gt;D&lt;/sub&gt; = 250 µA</td>
<td>N-Ch</td>
<td>0.45</td>
<td>1</td>
<td>V</td>
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<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = V&lt;sub&gt;GS&lt;/sub&gt;, I&lt;sub&gt;D&lt;/sub&gt; = - 250 µA</td>
<td>P-Ch</td>
<td>- 0.45</td>
<td>- 1</td>
<td></td>
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<tr>
<td>Gate Body Leakage</td>
<td>I&lt;sub&gt;GSS&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 0 V, V&lt;sub&gt;GS&lt;/sub&gt; ≤ 4.5 V</td>
<td>N-Ch</td>
<td>± 0.5</td>
<td>± 1.0</td>
<td>µA</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>P-Ch</td>
<td>± 1.0</td>
<td>± 2.0</td>
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<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>I&lt;sub&gt;DS&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 16 V, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V</td>
<td>N-Ch</td>
<td>0.3</td>
<td>100</td>
<td>nA</td>
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<td></td>
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<td></td>
<td>P-Ch</td>
<td>0.3</td>
<td>- 100</td>
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<td>V&lt;sub&gt;DS&lt;/sub&gt; = 16 V, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V, T&lt;sub&gt;J&lt;/sub&gt; = 85 °C</td>
<td>N-Ch</td>
<td>5</td>
<td></td>
<td>µA</td>
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<td></td>
<td>P-Ch</td>
<td>- 5</td>
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<tr>
<td>On State Drain Current</td>
<td>I&lt;sub&gt;D(on)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 5 V, V&lt;sub&gt;GS&lt;/sub&gt; = 4.5 V</td>
<td>N-Ch</td>
<td>700</td>
<td></td>
<td>mA</td>
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<td></td>
<td>P-Ch</td>
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<tr>
<td>Drain-Source On-State Resistance</td>
<td>R&lt;sub&gt;DS(on)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 4.5 V, I&lt;sub&gt;D&lt;/sub&gt; = 600 mA</td>
<td>N-Ch</td>
<td>0.41</td>
<td>0.70</td>
<td>Ω</td>
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<td>P-Ch</td>
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<td>V&lt;sub&gt;GS&lt;/sub&gt; = 2.5 V, I&lt;sub&gt;D&lt;/sub&gt; = 500 mA</td>
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<td>P-Ch</td>
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<td>1.6</td>
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<td>V&lt;sub&gt;GS&lt;/sub&gt; = 1.8 V, I&lt;sub&gt;D&lt;/sub&gt; = 350 mA</td>
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<td></td>
<td>P-Ch</td>
<td>1.80</td>
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<td>Forward Transconductance</td>
<td>g&lt;sub&gt;FS&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 10 V, I&lt;sub&gt;D&lt;/sub&gt; = 400 mA</td>
<td>N-Ch</td>
<td>1.0</td>
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<td>P-Ch</td>
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<tr>
<td>Diode Forward Voltage</td>
<td>V&lt;sub&gt;SD&lt;/sub&gt;</td>
<td>I&lt;sub&gt;DS&lt;/sub&gt; = 150 mA, V&lt;sub&gt;GS&lt;/sub&gt; = 0 V</td>
<td>N-Ch</td>
<td>0.8</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P-Ch</td>
<td>- 0.8</td>
<td>- 1.2</td>
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## Dynamic

<table>
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<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>N-Ch</th>
<th>P-Ch</th>
<th>Unit</th>
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<tr>
<td>Total Gate Charge</td>
<td>Q&lt;sub&gt;G&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 10 V, V&lt;sub&gt;GS&lt;/sub&gt; = 4.5 V, I&lt;sub&gt;D&lt;/sub&gt; = 250 mA</td>
<td>750</td>
<td></td>
<td>pC</td>
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<td>V&lt;sub&gt;DS&lt;/sub&gt; = - 10 V, V&lt;sub&gt;GS&lt;/sub&gt; = - 4.5 V, I&lt;sub&gt;D&lt;/sub&gt; = - 250 mA</td>
<td>1500</td>
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<td>Gate-Source Charge</td>
<td>Q&lt;sub&gt;GS&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DS&lt;/sub&gt; = 10 V, V&lt;sub&gt;GS&lt;/sub&gt; = 4.5 V, I&lt;sub&gt;D&lt;/sub&gt; = 250 mA</td>
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<td>V&lt;sub&gt;DS&lt;/sub&gt; = - 10 V, V&lt;sub&gt;GS&lt;/sub&gt; = - 4.5 V, I&lt;sub&gt;D&lt;/sub&gt; = - 250 mA</td>
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<td></td>
<td>Gate-Drain Charge</td>
<td>Q&lt;sub&gt;GD&lt;/sub&gt;</td>
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<tr>
<td></td>
<td>Turn-On Time</td>
<td>t&lt;sub&gt;ON&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 10 V, R&lt;sub&gt;L&lt;/sub&gt; = 47 Ω</td>
<td>5</td>
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<tr>
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<td></td>
<td>I&lt;sub&gt;D&lt;/sub&gt; = 200 mA, V&lt;sub&gt;GEN&lt;/sub&gt; = 4.5 V, R&lt;sub&gt;G&lt;/sub&gt; = 10 Ω</td>
<td>5</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Turn-Off Time</td>
<td>t&lt;sub&gt;OFF&lt;/sub&gt;</td>
<td>V&lt;sub&gt;DD&lt;/sub&gt; = 10 V, R&lt;sub&gt;L&lt;/sub&gt; = 47 Ω</td>
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<tr>
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<td></td>
<td>I&lt;sub&gt;D&lt;/sub&gt; = 200 mA, V&lt;sub&gt;GEN&lt;/sub&gt; = 4.5 V, R&lt;sub&gt;G&lt;/sub&gt; = 10 Ω</td>
<td>35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- a. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %.
- b. Guaranteed by design, not subject to production testing.

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
**N-CHANNEL TYPICAL CHARACTERISTICS** (\(T_A = 25 \, ^\circ\mathrm{C}\), unless otherwise noted)

**Output Characteristics**

- **On-Resistance vs. Drain Current**
  - \(V_GS = 5 \, \text{V through } 1.8 \, \text{V}\)

**Transfer Characteristics**

- **Capacitance**
  - \(V_GS = 1.8 \, \text{V}\) 
  - \(V_GS = 2.5 \, \text{V}\) 
  - \(V_GS = 4.5 \, \text{V}\)

- **On-Resistance vs. Junction Temperature**
  - \(T_J = -55 \, \text{°C}\) 
  - \(25 \, \text{°C}\) 
  - \(125 \, \text{°C}\)

**Gate Charge**

- \(V_GS = 10 \, \text{V}\) 
  - \(I_D = 250 \, \text{mA}\)

**On-Resistance vs. Junction Temperature**

- \(V_GS = 4.5 \, \text{V}\) 
  - \(I_D = 350 \, \text{mA}\) 
- \(V_GS = 1.8 \, \text{V}\) 
  - \(I_D = 150 \, \text{mA}\)
**N-CHANNEL TYPICAL CHARACTERISTICS**  \( T_A = 25 \, ^\circ C \), unless otherwise noted

- **Source-Drain Diode Forward Voltage**
  - Graph showing source-drain voltage \( V_{SD} \) vs. source current \( I_S \) for different temperature levels: \( T_J = 125 \, ^\circ C \), \( T_J = 25 \, ^\circ C \), and \( T_J = 50 \, ^\circ C \).

- **On-Resistance vs. Gate-to-Source Voltage**
  - Graph showing on-resistance \( R_{D\,on} \) vs. gate-to-source voltage \( V_{GS} \) for different currents: \( I_D = 350 \, mA \) and \( I_D = 200 \, mA \).

- **Threshold Voltage Variance vs. Temperature**
  - Graph showing threshold voltage variance \( V_{GS\,(th)} \) vs. temperature \( T_J \) with \( I_D = 0.25 \, mA \).

- **BVGS vs. Temperature**
  - Graph showing gate-to-source breakdown voltage \( BV_{GSS} \) vs. temperature \( T_J \).
**P-CHANNEL TYPICAL CHARACTERISTICS** (\(T_A = 25 \, ^\circ\text{C}\), unless otherwise noted)

### Output Characteristics

**On-Resistance vs. Drain Current**

- **\(V_{DS}\) - Drain-to-Source Voltage (V)**
- **\(I_D\) - Drain Current (A)**
- **\(V_{GS}\) = 5 V thru 3 V**
- **\(2.5\) V**
- **\(2\) V**
- **\(1.8\) V**

### Transfer Characteristics

**Capacitance**

- **\(V_{GS}\) - Gate-to-Source Voltage (V)**
- **\(C\) - Capacitance (pF)**
- **\(V_{GS} = 0\) V**
- **\(f = 1\) MHz**
- **\(V_{GS} = 4.5\) V**
- **\(ID = 350\) mA**

### Gate Charge

- **\(V_{DS}\) - Gate-to-Source Voltage (V)**
- **\(Q_g\) - Total Gate Charge (nC)**
- **\(V_{DS} = 10\) V**
- **\(ID = 250\) mA**

### On-Resistance vs. Junction Temperature

- **\(R_{DS(on)}\) - On-Resistance (Ω)**
- **\(V_{GS} = 1.8\) V**
- **\(ID = 150\) mA**
- **\(V_{GS} = 4.5\) V**
- **\(ID = 350\) mA**
- **\(V_{GS} = 1.8\) V**
- **\(ID = 150\) mA**
**Si1016X**

**Vishay Siliconix**

**P-CHANNEL TYPICAL CHARACTERISTICS** (*T_A = 25 °C*, unless otherwise noted)

![Diagrams showing typical characteristics of Si1016X](image)

- **Source-Drain Diode Forward Voltage**
- **Threshold Voltage Variance vs. Temperature**
- **On-Resistance vs. Gate-to-Source Voltage**
- **I_GS vs. Temperature**
- **BV_GSS vs. Temperature**

**Notes:**
- **VSD** - Source-to-Drain Voltage (V)
- **IGSS** - (µA)
- **VGS** - Gate-to-Source Voltage (V)
- **ID** = 350 mA
- **ID** = 200 mA
- **I_D** = 0.25 mA
- **I_D** = 0.1 mA
- **VGS** = 4.5 V
- **V_J** = 125 °C
- **V_J** = 25 °C
- **V_J** = -55 °C
**N- OR P-CHANNEL TYPICAL CHARACTERISTICS**  
($T_A = 25 \, ^\circ\text{C}$, unless otherwise noted)

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SC-89 6-Leads (SOT-563F)

**Notes**

1. Dimensions in millimeters.

- Dimension D does not include mold flash, protrusions or gate burrs. Mold flush, protrusions or gate burrs shall not exceed 0.15 mm per dimension E1 does not include interlead flash or protrusion, interlead flash or protrusion shall not exceed 0.15 mm per side.

- Dimensions D and E1 are determined at the outmost extremes of the plastic body exclusive of mold flash, the bar burrs, gate burrs and interlead flash, but including any mismatch between the top and the bottom of the plastic body.

- Datums A, B and D to be determined 0.10 mm from the lead tip.

- Terminal numbers are shown for reference only.

- These dimensions apply to the flat section of the lead between 0.08 mm and 0.15 mm from the lead tip.

**Table:**

<table>
<thead>
<tr>
<th>DIM.</th>
<th>MIN.</th>
<th>NOM.</th>
<th>MAX.</th>
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<tr>
<td>A</td>
<td>0.56</td>
<td>0.58</td>
<td>0.60</td>
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<tr>
<td>A1</td>
<td>0</td>
<td>0.02</td>
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<tr>
<td>b</td>
<td>0.15</td>
<td>0.22</td>
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<tr>
<td>c</td>
<td>0.10</td>
<td>0.14</td>
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<tr>
<td>D</td>
<td>1.50</td>
<td>1.60</td>
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<td>E1</td>
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<tr>
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C14-0439-Rev. C, 11-Aug-14
DWG: 5880
RECOMMENDED MINIMUM PADS FOR SC-89: 6-Lead

Recommended Minimum Pads
Dimensions in Inches/(mm)
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