Trends driving change in power management

**Power density** – Integrating active and passive components to safely and reliably achieve size-reduction goals

**Low Iq** – Extending battery and shelf life enables more functionality, improved lifetime and reduced system cost

**Low noise** – Reducing or shifting noise simplifies the power chain and improves reliability for precision analog applications

**Isolation** – Enabling the highest working voltage and highest reliability in high-voltage and safety-critical applications

**Low EMI** – Minimizing interference with other system components and simplify the engineer’s design and qualification processes
### Key features of an isolated gate driver

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest working voltage</td>
<td>Improves system reliability and device lifetime</td>
</tr>
<tr>
<td>High drive strength</td>
<td>Allows for faster propagation delays and rise/fall times</td>
</tr>
<tr>
<td>High immunity</td>
<td>Best-in-class surge protection of 12.8kV and noise immunity greater than 100V/ns</td>
</tr>
<tr>
<td>Higher power density</td>
<td>Enabling smaller, more robust solutions</td>
</tr>
</tbody>
</table>

# Si vs. SiC power solutions

## Key differences

<table>
<thead>
<tr>
<th>Circuit Symbol</th>
<th>Si-MOSFET</th>
<th>Si-IGBT</th>
<th>SiC-MOSFET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Rating</td>
<td>20-650V</td>
<td>≥650V</td>
<td>≥650V</td>
</tr>
<tr>
<td>$f_{sw}$</td>
<td>Medium-High ($&gt;20$kHz)</td>
<td>Low-Medium ($5-20$kHz)</td>
<td>High ($&gt;50$kHz)</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>0–15V (20V)</td>
<td>-10–15V (10–20V)</td>
<td>-5–20V (25–30V)</td>
</tr>
<tr>
<td><strong>Typical Applications</strong></td>
<td>Power supplies – server, datacom, telecom, factory automation, offboard/onboard chargers, solar u-inverters and string inverters</td>
<td>Motor drives (AC machines), UPS, solar central and string power inverters, HEV/EV traction inverters</td>
<td>PFC – Power supplies, solar inverters, DC/DC for EV/HEV and traction inverters for EV, motor drives, railways</td>
</tr>
<tr>
<td><strong>Power Level</strong></td>
<td>&lt;3kW</td>
<td>&gt;3kW</td>
<td>&gt;5kW</td>
</tr>
</tbody>
</table>

The need for advanced performance + reliability

TI has introduced the first isolated gate drivers with integrated sensing for IGBTs and SiC MOSFETs to save energy and protect high-voltage systems.
Benefits of the UCC217xx family

Enhanced system performance
High peak drive strength of ±10 A maximize switching behavior and reduce losses, while 200 ns of overcurrent detection enables fast system protection.

Strengthened system-level reliability
Extends insulation barrier lifetimes with capacitive isolation technology and industry-leading reinforced isolation ratings with surge immunity up to 12.8 kV.

Reduced system size
Eliminate external components with integrated buffers and sensors while providing accurate temperature, current or voltage sensing, with an isolated analog-to-pulse-width modulation sensor.

View the UCC21750 datasheet
The UCC217xx family of devices provides advanced monitoring and protection while improving total system efficiency in automotive and industrial applications.

- **Traction inverters and onboard chargers** (Automotive)
- **Solar inverters** (Industrial)
- **Motor drives** (Industrial)
UCC217xx: solve your system challenges in motor drives

**Design challenge** | **TI isolated driver value**
---|---
**Improve operation in noisy and harsh environments?** | • Higher CMTI rating

**How to improve efficiency?** | • High drive strength (10A)

**How to improve power density?** | • High drive strength with integrated buffer
|  | • Integrated isolated analog sensor

**How to increase reliability in power stage?** | • Best in-class overcurrent and short circuit protection
|  | • UVLO and active miller clamp

**UCC217xx family of drivers**

| UCC21710-Q1 | UCC21750 | UCC21732-Q1 |

For details please click on the individual device hyperlinks.
Isolation in grid infrastructure: solar string inverters

- High working voltage
  - Increasing bus voltages (1500V)
- High creepage and clearance
  - High altitude operation
- Pollution (dust & moisture)
Evaluate your design today

UCC21750 evaluation board available now: http://www.ti.com/tool/UCC21750QDWEVM-025

• 10-A peak, split output drive current with programmable drive voltages
• Two 5.7-kVrms reinforced isolated channels to support up to 1700 V input rail
• Short circuit protection with soft turn OFF and Miller clamp with internal FET

Available for US$99.
The need for high efficiency and high power density

• TI has recently released an isolated dual-channel gate driver, UCC21530 with 4-A source and 6-A sink peak current.

• It is designed to drive IGBTs and SiC MOSFETs up to 5-MHz with best-in-class propagation delay and pulse-width distortion.
Unique footprint of UCC21530

<table>
<thead>
<tr>
<th>Standard</th>
<th>PCB coating applied?</th>
<th>Working voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC-60950</td>
<td>Yes</td>
<td>1740 Vpk (Table 2Q)</td>
</tr>
<tr>
<td>IEC-60950</td>
<td>No</td>
<td>650 Vrms (Table 2N)</td>
</tr>
<tr>
<td>IPC-2221</td>
<td>Yes</td>
<td>1320 Vpk (Table 6-1)</td>
</tr>
<tr>
<td>IPC-2221</td>
<td>No</td>
<td>660 Vpk (Table 6-1)</td>
</tr>
</tbody>
</table>

[Product Details + Datasheet]
WHY 12V UVLO is **Critical** for SiC MOSFETs & IGBTs !!

- UVLO is referenced to VSSA
- For SiC MOSFET / IGBT, VSSA can be a negative voltage (e.g., VDDA=+20V, VSSA=-5V)
- Low VDDA would result in low $V_{GS}$, which would cause:
  - High Conduction Loss of power switch
  - Power switch would get heated up !!
  - Reduced switch lifetime & system reliability !!
TIDM-1000
Vienna Rectifier-Based Three Phase Power Factor Correction Reference Design

Design Features
- 3-Phase Input 208 V-L 60 Hz, Output 600-V DC Nominal, 1.2 KW
- 3-Phase Input 400 V-L 50 Hz, Output 700-V DC Nominal, 2.4 KW
- 50kHz Pulse Width Modulation (PWM) Switching
- >98% Peak Efficiency
- <2% Total Harmonic Distortion (THD) at Full Load and Low Line
- powerSUITE Support for Easy Adaptation of the Design for User Requirement
- Software Frequency Response Analyzer (SFRA) and Compensation Designer for Ease of Tuning of Control Loops

Applications
- EV Charging (piles) stations
- Telecom Rectifier
- Drives, Welding, and Other Industrial

Tools & Resources
- TIDM-1000 Tools Folder
- Test Data/Design Guide
- Design Files: Schematics, BOM and BOM Analysis, Design Files
- Key TI Devices: UCC21520, AMC1301, DCH010505S, OPA320, TMS320F28377D

Available on ti.com

[TIDM-1000](https://www.ti.com/tool/TIDM1000)
TI’s capacitive isolation technology

Silicon dioxide (SiO₂) offers the highest dielectric strength in the industry.

<table>
<thead>
<tr>
<th>Insulator Materials</th>
<th>Dielectric Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>~1 Vrms/μm</td>
</tr>
<tr>
<td>Epoxies</td>
<td>~20 Vrms/μm</td>
</tr>
<tr>
<td>Silica filled Mold Compounds</td>
<td>~100 Vrms/μm</td>
</tr>
<tr>
<td>Polyimide</td>
<td>~300 Vrms/μm</td>
</tr>
<tr>
<td>SiO₂</td>
<td>~500 Vrms/μm</td>
</tr>
</tbody>
</table>

For details: please go to http://www.ti.com/isolation/overview.html

TI’s reinforced isolators use a logic input and output buffer separated by a double capacitive SiO₂ insulation barrier.
Summary

• Power density and isolation: key trends driving change in power management

• Key features of an isolated gate driver:
  - Highest working voltage
  - High drive strength
  - High immunity
  - Higher power density

• Isolated gate driver solutions for industrial applications
  - UCC217xx
  - UCC21530

For more details, please go to ti.com under Applications & designs

• TI’s capacitive isolation technology
Discover more about isolation and SiC/IGBT gate drivers

Watch the video series:

• How High Voltage Isolation technology works?
• Build your expertise with TI Precision Labs - Isolation
• Enabling high voltage signal isolation quality and reliability

Additional reliability and isolation resources:

• High-voltage reinforced isolation: Definitions and test methodologies
• High-voltage isolation quality and reliability for AMC130x
• Understanding isolation terminology and relevance
• Impact of an Isolated Gate driver
• Silicon carbide gate drivers – a disruptive technology in power electronics