

Welcome!

Texas Instruments New Product Update

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New Product Update: Low Side Gate Drivers

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September 23 2021

Agenda

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Gate Drivers are Everywhere ...

Power
Supplies



Wireless
Infrastructure



Factory
Automation



Grid
Infrastructure



Motor Drives

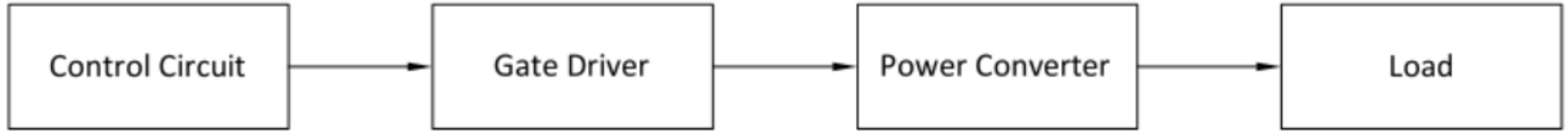


Automotive
& Transport



... and many more !!

What is a Gate Driver?



- Gate drivers live in between the controller and the switch of the power converter
- The gate driver amplifies the control signal to turn the switch on and off
- The type of gate driver used will vary depending on the switch, power topology, and application

Gate Drivers **Power Switches**

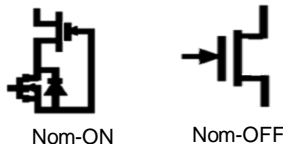
MOSFETs



60V, 100V, 200V, 600V, etc.
4V, 5V, 8V Typical UVLOs

- High frequency
- Long duty cycles
- Low voltage applications
- Most common
- Most cost-efficient

GaN FETs



100V, 300V, 600V
Requires Precise 5V drive

- Lower gate capacitance for higher switching frequencies when compared to traditional MOSFETs
- Smaller footprint, higher efficiency
- Lower $R_{DS(on)}$

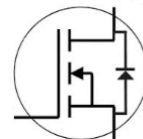
IGBTs



1200V – 1700V
8V, 12V Typical UVLOs

- Low frequency
- Short duty cycle
- Narrow/small line or load variations
- High voltage applications

SiC FETs

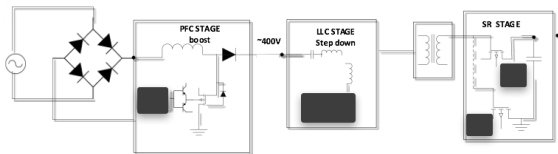


1200V – 1700V
12V or higher Typical UVLOs

- Lower weight
- Better performance over temperature
- Lower gate charge
- Improved reverse recovery
- High voltage applications

Gate Drivers Application Topologies

AC/DC

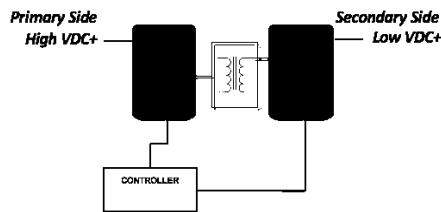


PFC (Power Factor Correction) Power Conditioning

Applications:

- Merchant Network & Server PSU
- 5G/Telecom Power Supply
- EV On-board Charger
- HVAC
- EV Charging Station
- Aircraft Electrical Power
- Wall Charger & Adaptor
- UPS

DC/DC

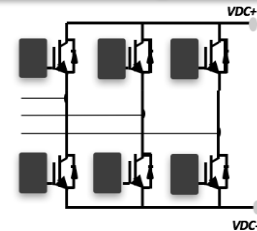


DC-to-DC Power Conversion Synchronous Rectification

Applications:

- 5G/Telecom Power Supply
- EV On-board Charger & DC-DC
- Solar MPPT Boost Stage
- Merchant Network & Server PSU
- Automotive Body Electronics
- Aircraft Electrical Power
- UPS
- EV Charging Station

DC/AC (Inverter)



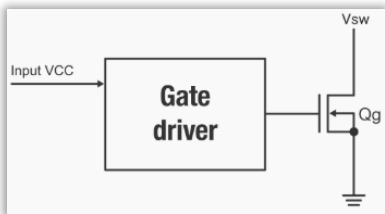
Inverter Motor Drive

Applications:

- HEV/EV: 48V Traction/Aux Motor Inverter
- Stepper Drives
- Battery Powered Appliances
- Personal Transport (e-scooters, e-bikes)
- Solar Micro inverters
- Aircraft Electrical Power and Motor Control

Gate Drivers Configurations

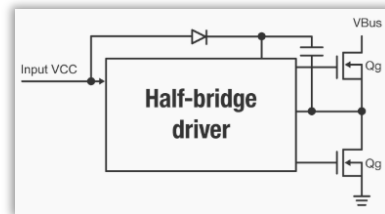
Low-side



Power switch is referenced to ground

- Single or dual channel options for driving 1 or more switches
- High drive strength and fast switching characteristics increases efficiency and reduces switching losses
- Negative voltage handling protects inputs and outputs from transients

Half-Bridge



Two switches, one referenced to ground, other referenced to the switch node

- Bootstrap diode used to generate the bias for the high-side switch
- Integrated bootstrap diode reduces customer BOM count
- Interlock functionality protects from shoot-through
- High drive strength and fast switching characteristics increases efficiency and reduces switching losses

Low-Side Gate Driver Roadmap & Portfolio



		Channels						
		1 Channel				2 Channel		
Low Side Drivers	Output Current (A)							
	> 4A	<p>UCC27322</p> <ul style="list-style-type: none"> • 15V, 9A • t_p 25ns • Enable Pin • WSON 8, SOIC 8 	<p>LMG1020</p> <ul style="list-style-type: none"> • 5V, 7A/5A • t_p 2.5ns • 1ns min input pulse • Over temperature Protection • WCSP 0.8 x 1.2 	<p>UCC27611</p> <ul style="list-style-type: none"> • 5V, 6A • t_p 14ns • 5-V Regulated Output • 1-Ω Pullup, 0.35-Ω Pulldown • SON 2x2 • SON 2x2mm 	<p>LMG1025-Q1</p> <ul style="list-style-type: none"> • 5V, 7A/5A • t_p 2.9ns • 1.25ns min input pulse 	<p>UCC27614</p> <ul style="list-style-type: none"> • 30V, 10A/10A • 4V UVLO • -10V on inputs • 2x2mm package • SON 8, SOIC 8 	<p>UCC27624</p> <ul style="list-style-type: none"> • 30V, 5A/5A • 4V UVLO • -10V on inputs • P2P w/ 324, 424, 524 • SOIC 8, MSOP 8 	<p>UCC2752x/A</p> <ul style="list-style-type: none"> • 18V, 5A/5A • t_p 13ns • Negative voltage tolerance • Enable Pins • 1-ns channel-channel matching • SOIC 8, SON 8
	≤ 4A	<p>UCC2753x</p> <ul style="list-style-type: none"> • 35V, 2.5A/2.5-5A • t_p 15ns • Negative voltage tolerance • Multiple input and output structures • SOT23 5, SOIC 8 	<p>UCC27511/2</p> <ul style="list-style-type: none"> • 18V, 4A/4-8A • t_p 12ns • CMOS/TTL • Asymmetric Drive & Split output • Negative Voltage Tolerance • SOT23 6, SON 6 	<p>UCC27516/7A</p> <ul style="list-style-type: none"> • 18V, 4A/4A • t_p 12ns • CMOS/TTL • Negative Voltage Tolerance • SOT23 5, SON 6 	<p>JUST APL'd!</p>		<p>UCC2732x</p> <ul style="list-style-type: none"> • 16V, 4A • t_p 35ns • SOIC 8, SON 8 	<p>UCC2742x</p> <ul style="list-style-type: none"> • 16V, 4A • t_p 25ns • Enable Pins • Negative Voltage Handling • SOIC 8, SON 8

Gate Driver **Key Characteristics**

Negative Input / Output Voltage Capability

Negative voltages result from parasitic inductances caused by switching transitions, leakage or even poor layout. A gate driver's ability to survive negative voltages is critical for a robust, reliable solution. High immunity to ground noise

Wide VDD Range

Flexibility to use the same driver with different operating voltages and different types of power switches.
Robustness in noisy environments or when using low-quality power supplies
Supports split-rail systems, such as driving IGBTs/SiC-FETs with both positive and negative supplies.

Peak Drive Current

Higher gate charge power FETs require stronger driver meaning higher peak drive current out of the driver to fully turn-on the FET.

Propagation Delay

Supports higher frequency, reduces reverse recovery losses
Fast turn-on propagation delays enables quicker switching on of a FET, minimizing the conduction time of the body diode and thus minimizing losses (improves efficiency)

UCC27614/-Q1

Sampling

+10-A/-10-A, 30-V, single channel LS driver with improved transient protection

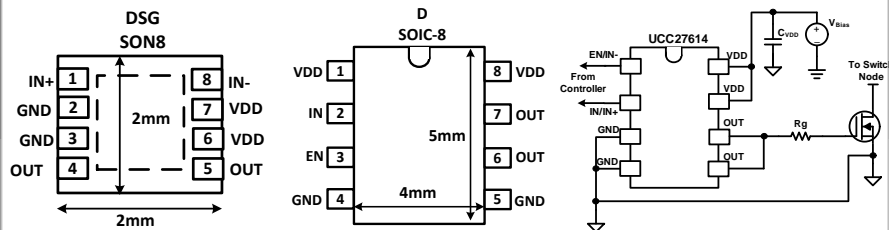
Features

- V_{DD} recommended operating range 4.5 to 26-V, 30-V (abs max)
- Switching Parameters
 - 27-ns Max Propagation Delay
 - 7-ns Typ Rise and 5-ns Typ Fall Time With 1.8-nF Load
 - 15-ns input pulse width can produce output pulse
- Robustness Parameters
 - Abs. Max Negative Voltage Handling -10 V on inputs
 - Abs. Max Negative Transient Handling -2 V on output
 - Abs. Max 10-A Reverse Current Protection on the output
 - Abs. Max V_{DD} Voltage 30-V
- +10-A peak source & -10-A peak sink output drive currents
- 4-V Under Voltage Lockout (UVLO)
- Enable function (pin can be floated)
- 2mm x 2mm SON package
- Industry standard SOIC package, p2p to UCC27322
- Operating range from -40 to 150°C

Benefits

🚗 : AEC-Q100

- Small package enable high-density
- High peak current enables fast switching and thus lower switching losses
- 26V bias improves system robustness in applications where there is high bias supply noise
- Negative input voltage allows direct use with gate drive transformers
- UVLO allows low bias voltage operation to optimize design at different operating modes in high efficiency applications
- Low propagation delay reduces dead-time requirements and thus improves efficiency in high power applications
- Enable functionality allows added control flexibility.



UCC27624/-Q1

Sampling

+5-A/-5-A, 30-V, dual channel LS driver with improved transient protection

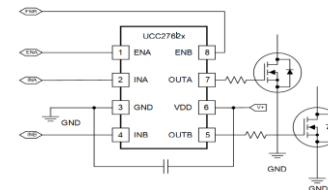
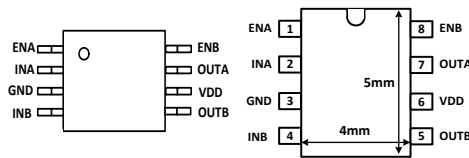
Features

- V_{DD} recommended operating range 4.5 to 26-V, 30-V (abs max)
- Switching Parameters
 - 27-ns Max Propagation Delay
 - 9-ns Typ Rise and 5-ns Typ Fall Time With 1.8-nF Load
 - 2-ns Max Delay Matching
 - 15-ns input pulse width can produce output pulse
- Robustness Parameters
 - Abs. Max Negative Voltage Handling -10 V on inputs
 - Abs. Max Negative Transient Handling -6 V on output
 - Abs. Max 5-A Reverse Current Protection on the output
 - Abs. Max V_{DD} Voltage 30-V
- +5-A peak source & -5-A peak sink output drive currents
- 4-V Under Voltage Lockout (UVLO)
- Enable function (pins can be floated)
- Industry standard SOIC and SSOP packages
 - P2P with UCC27524, UCC27424, UCC27324
- Operating range from -40 to 150°C

Benefits

 : AEC-Q100

- High peak current for fast switching and thus lower switching losses
- Low minimum pulse width and low pulse width distortion enables precise MOSFET driving in very high switching frequency applications
- Low propagation delay reduces dead-time requirements and thus improves efficiency in high power applications
- Low delay matching allows paralleling the outputs as well as use in multi-phase applications
- Negative voltage capability offers compatibility with gate drive transformers, reduces external clamp circuitry, increases overall robustness
- UVLO allows low bias voltage operation to optimize design at different operating modes in high efficiency applications
- Pin to pin compatibility to legacy device eliminates board redesigns



Why is drive strength important?

Drive strength (I_{PEAK}) minimizes switching losses

High current low-side drivers:

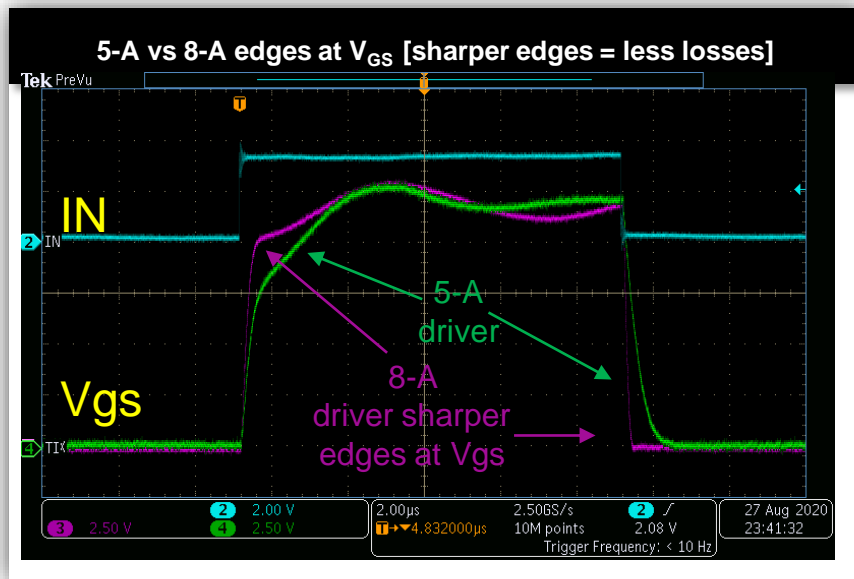
- UCC27614: 10 A/10 A
- UCC27624: 5 A/5 A

Higher drive current =
Fast V_{GS} rise and fall times ($t_{ON/OFF}$) =
lower MOSFET switching losses

$$P_{sw} = V_{DS} \times I_D \times F_{SW} \times \frac{Q_g}{I_{gate}}$$

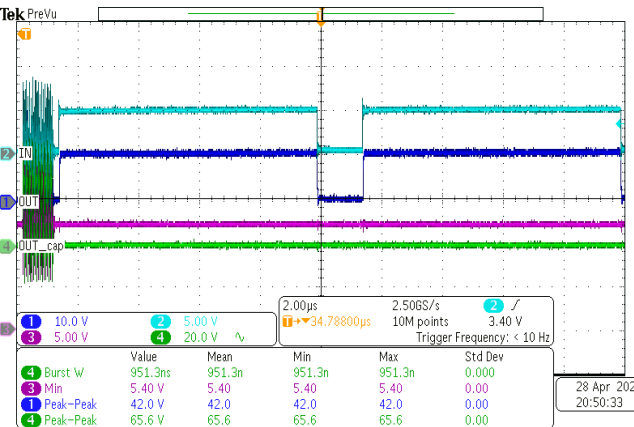
$$\frac{Q_g}{I_{gate}} = T_{on/off}$$

$$I_{peak} = C_{gs} \times \frac{dV_{GS}}{dt_{on/off}}$$

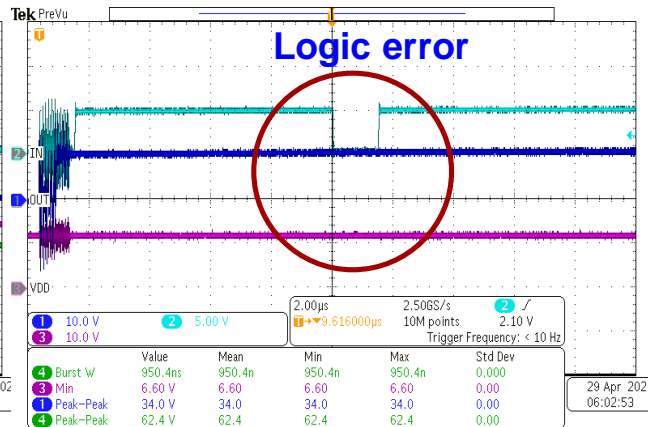


High frequency noise on the output

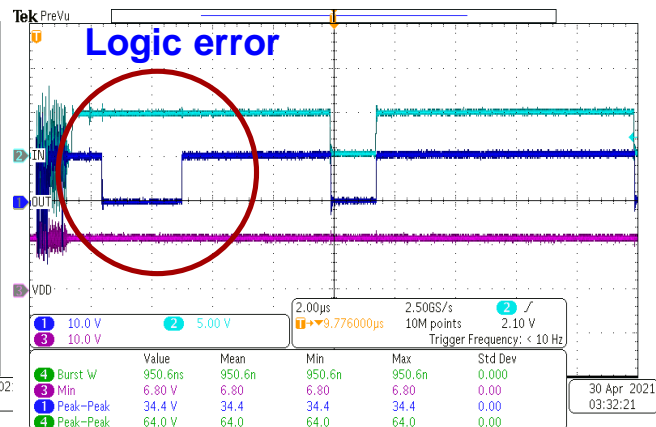
UCC276x4's 30V VDD and reverse current handling allow the part to withstand high-frequency noise and transients at the output pins regardless of input state.



UCC27624 (LS)



Comp 1

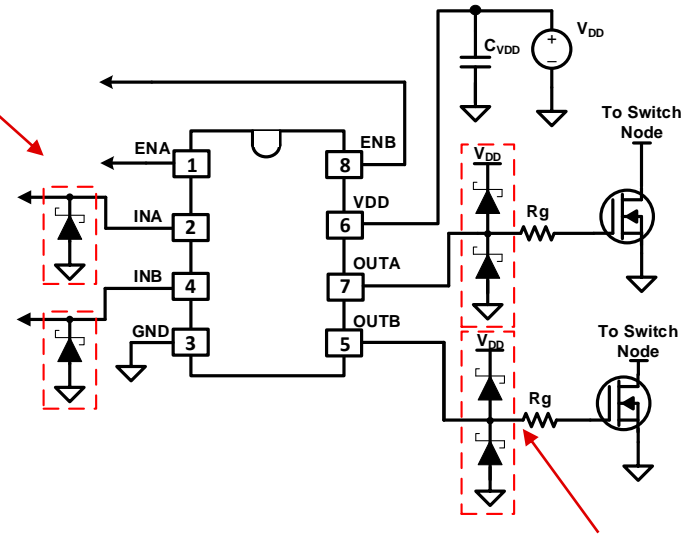


Comp 2

VDD = 12 V, INA = 0 V, 1000 ns noise on OUT

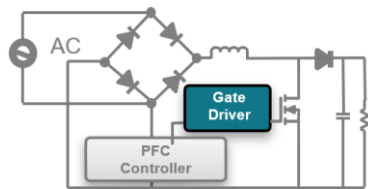
Robust features to achieve cost savings

- The -10V negative voltage handling on the UCC27614 and UCC27624 (LS) provides inherent protection against noise and transients allowing for the elimination of clamp diodes on the input channel.
- UCC27614/24 30-V VDD max supply voltage and 5-A reverse current handling allow for the elimination of 2 clamp diodes per output channel in applications where transients on the output are common.
- Saving up to 6 external diodes allows for savings of up to \$0.12 in a system!



UCC276x4 Target Application Topologies

Conventional PFC



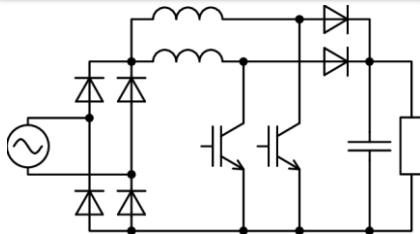
Hero Device:

- [UCC27614](#) – Single Channel Driver

Key Features:

- 30V VDD to handle noise and transients
- 10A drive strength to reduce switching losses
- Low propagation delay to enable higher frequencies
- Small 2mm x 2mm package to save space

Interleaved PFC

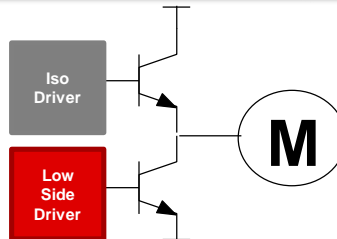


- **Hero Device:**
- [UCC27624](#) – Dual Channel Driver

Key Features:

- 1ns typical delay matching to ensure correct timing
- 30V VDD to handle noise and transients
- 5A drive strength to reduce switching losses
- Low propagation delay to enable higher frequency operation

AC Motor



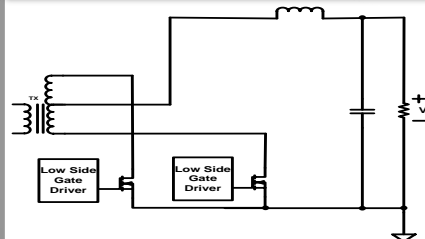
Hero Device:

- [UCC27614](#) – Single Channel Driver

Key Features:

- 10A drive strength to reduce switching losses
- Small 2mm x 2mm package to save space
- Negative voltage handling for inductive spikes
- Reverse current handling on outputs to protect against transients

Synchronous Rectifier



Hero Device:

- [UCC27624](#) – Dual Channel Driver

Key Features:

- -10V voltage handling for noise and transients
- 5A drive strength to reduce switching losses
- Low propagation delay to enable higher frequencies
- 1ns typical delay matching to ensure correct timing

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