

Part 2: What motor driver should I use?

- The H-Bridge & construction
- How to select a motor driver
- Motor driver with integrated FET versus gate driver

THE ART OF Driving Motors

A **WEBINAR SERIES** BY TEXAS INSTRUMENTS

Matt Hein
Innocent Irakoze

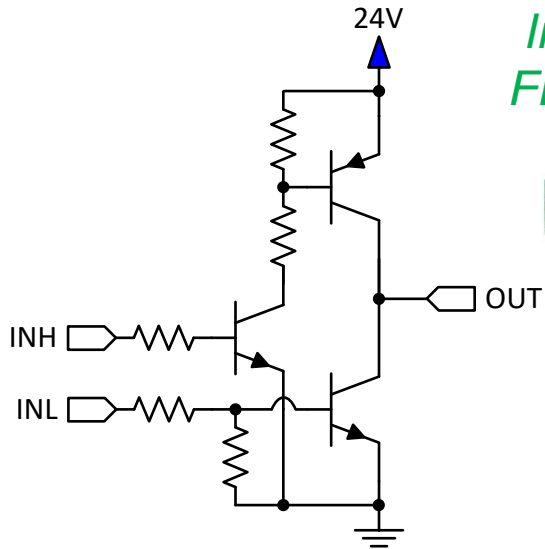
Date: Nov 6th, 2018

The H-bridge: discrete 1/2-H

Blog: [Not so risky business: discrete vs. integrated](#)

ti.com/motordrivers
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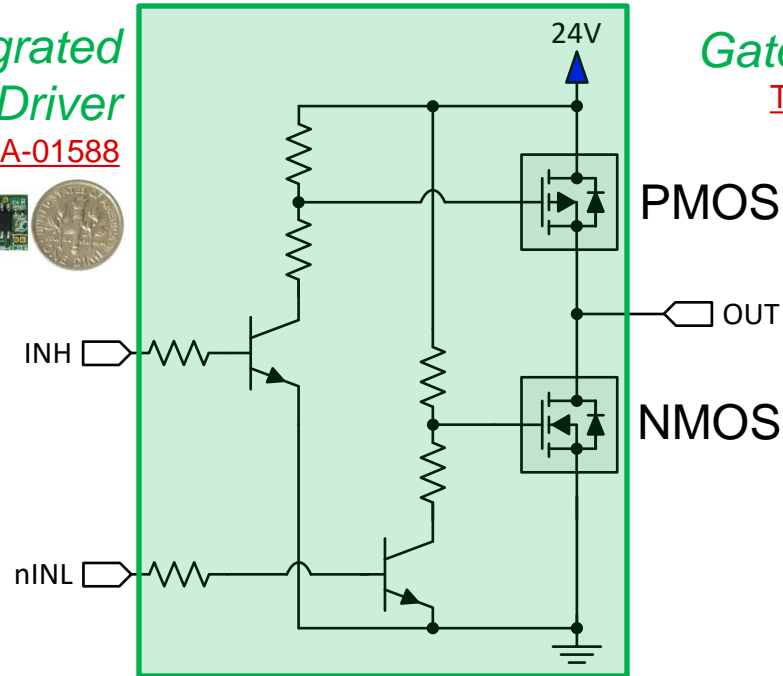
BJT Circuit



*Integrated
FET Driver*
[TIDA-01588](#)



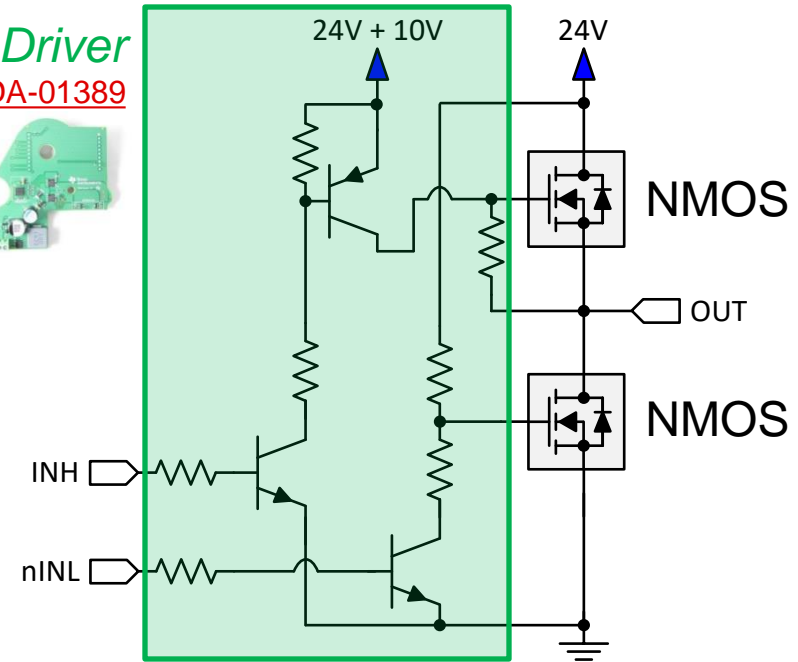
NMOS & PMOS



Gate Driver
[TIDA-01389](#)



NMOS & NMOS



Low voltage BJTs are much less efficient than MOSFETs

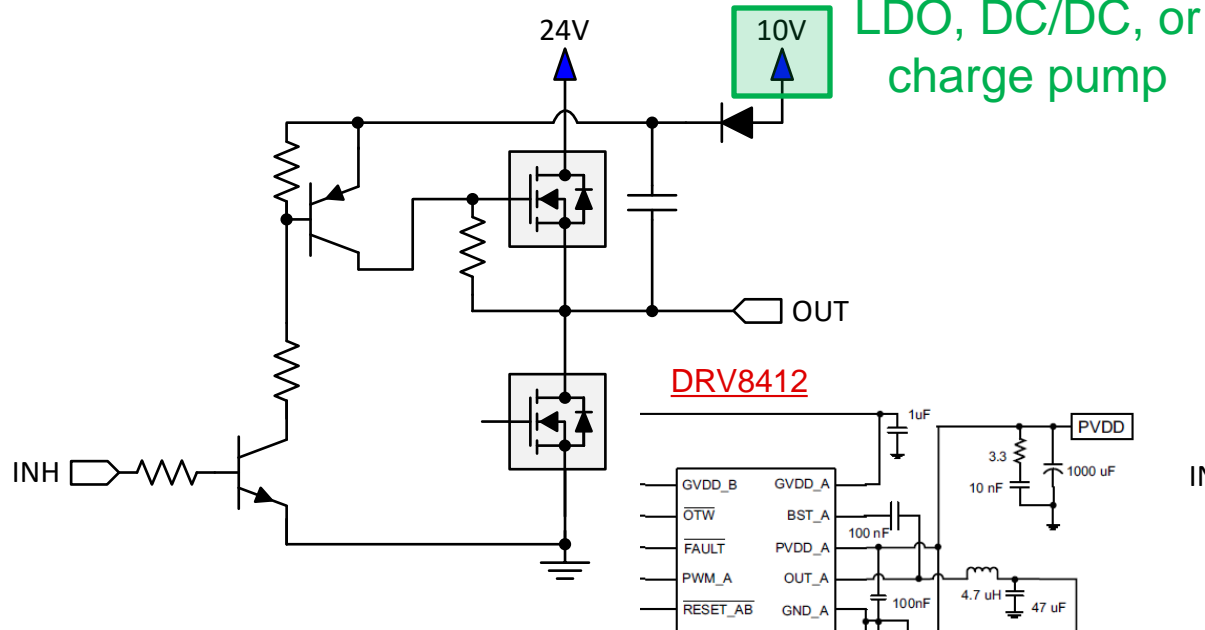
PMOS MOSFETs are 2.5 ~ 3.0x larger than NMOS MOSFETs

Where do we get this extra supply from?

The H-bridge: charge pump and bootstrap

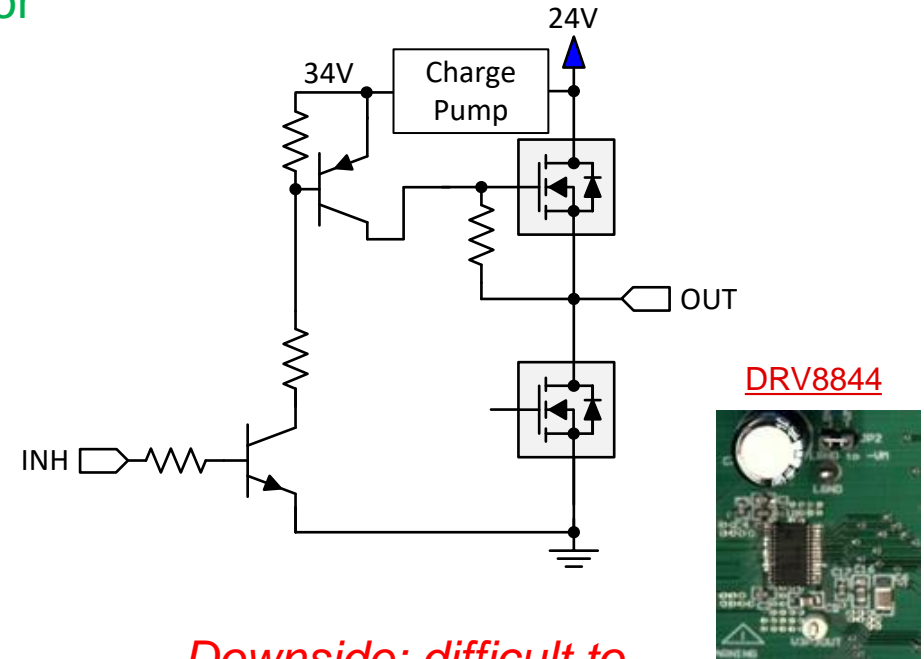
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Bootstrap Circuit



Downside: can't support 100% duty cycle, need extra supply

Charge Pump Circuit

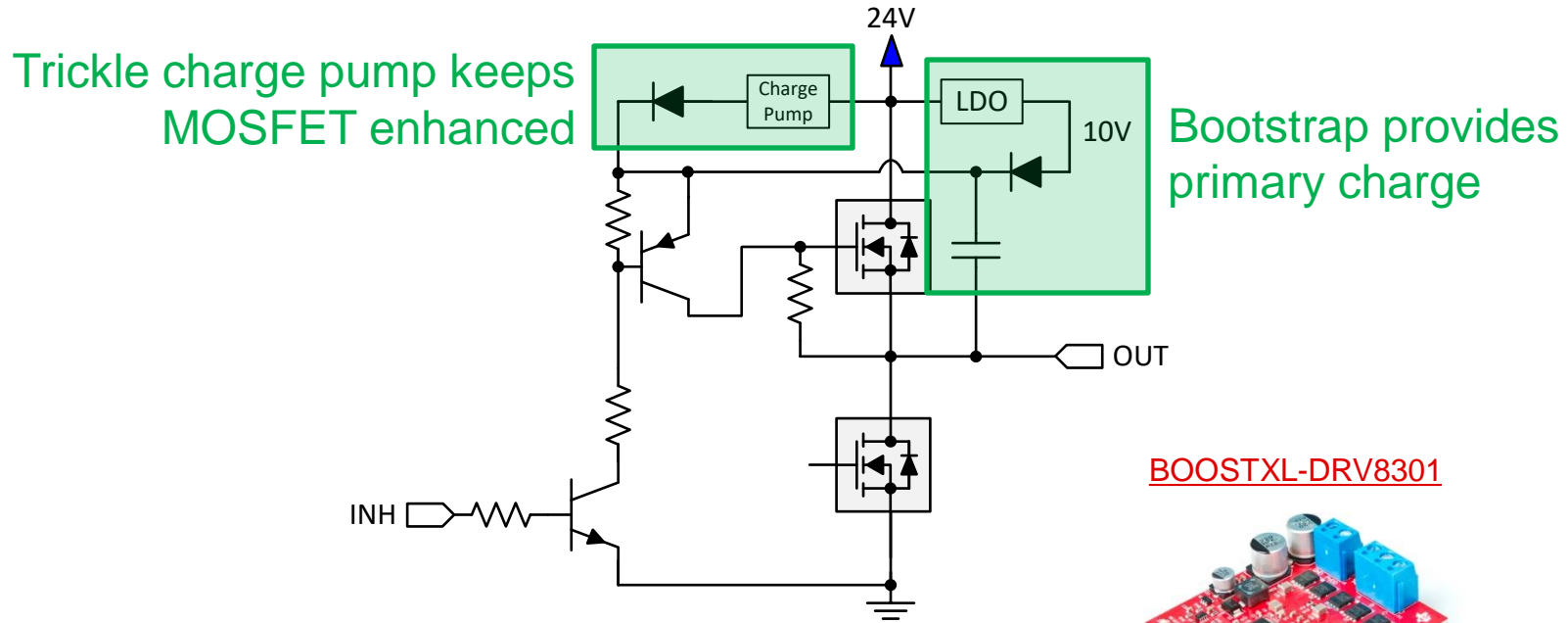


Downside: difficult to implement in discrete, lower efficiency

The H-bridge: charge pump and bootstrap

[ti.com/motordrivers](https://www.ti.com/motordrivers)
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Bootstrap Circuit with Trickle Charge Pump



[BOOSTXL-DRV8301](#)

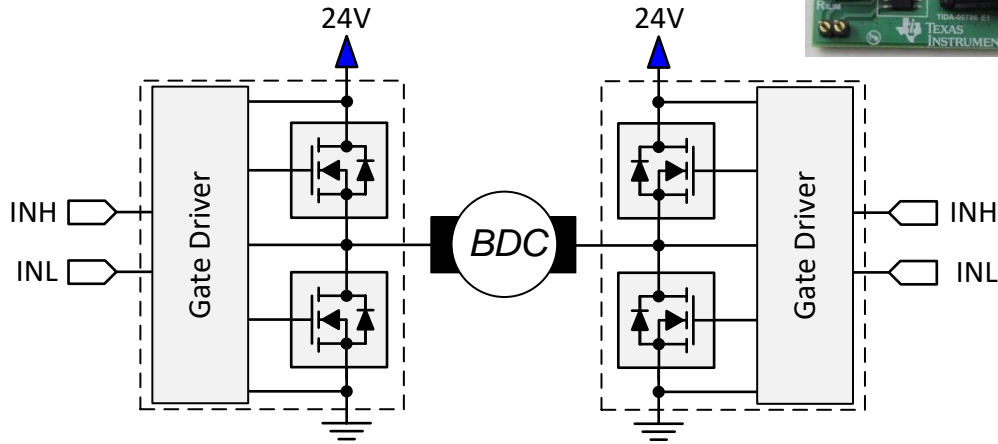


*Downside: complexity,
can only implement in
an integrated circuit*

The H-bridge: motor types

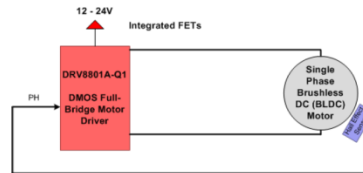
Brushed-DC

TIDA-00786



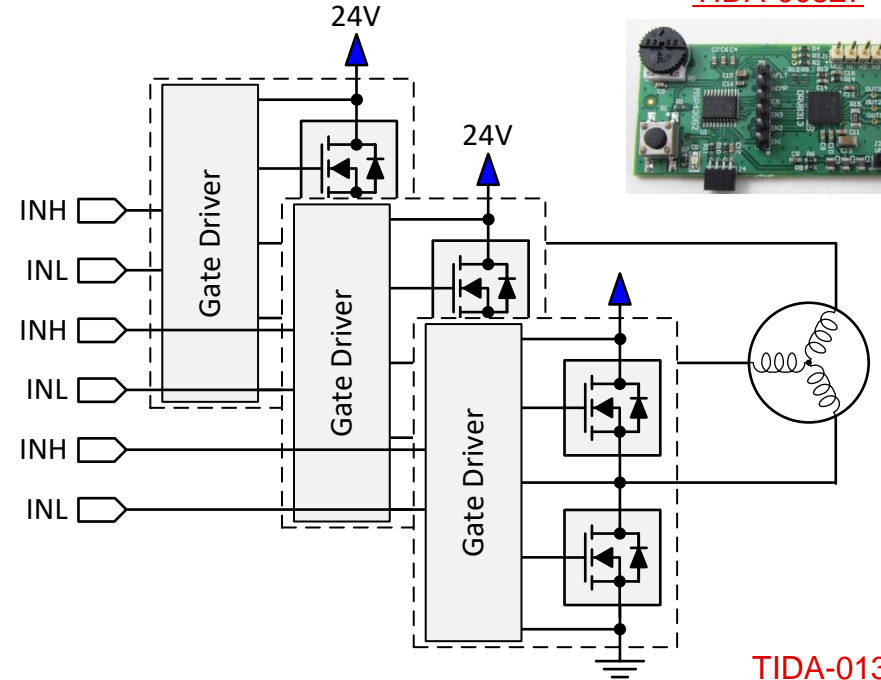
+ single-phase Brushless-DC

TIDA-00875



Brushless-DC

TIDA-00827



+ three-phase stepper motor

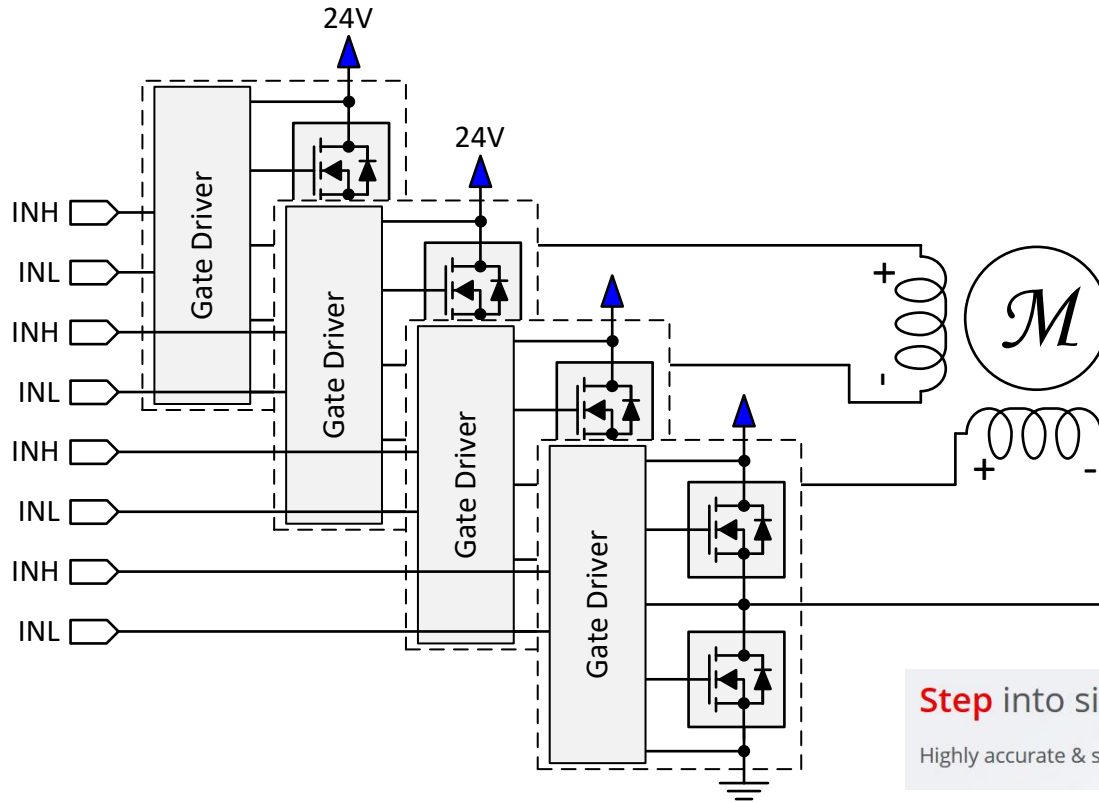
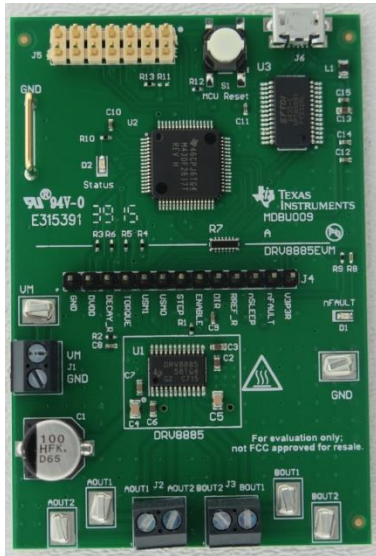
TIDA-01362



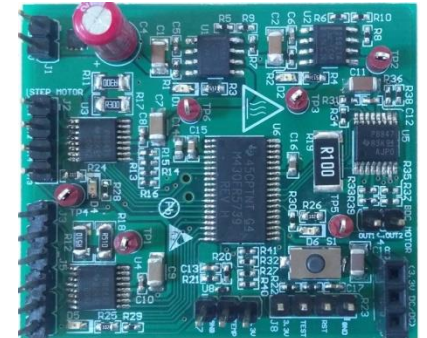
The H-bridge: motor types

Stepper motor

TIDA-00867



TIDA-010004



Step into simple speed and position control

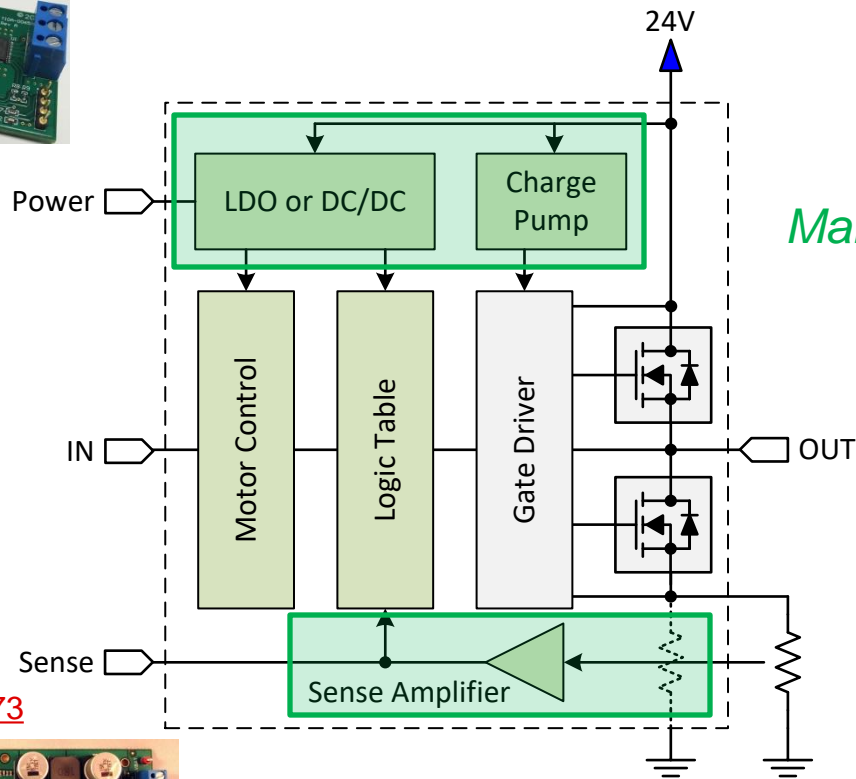
Highly accurate & smooth motion that is easy to design

The H-bridge: peripheral circuits

TIDA-00656



Integrated FET

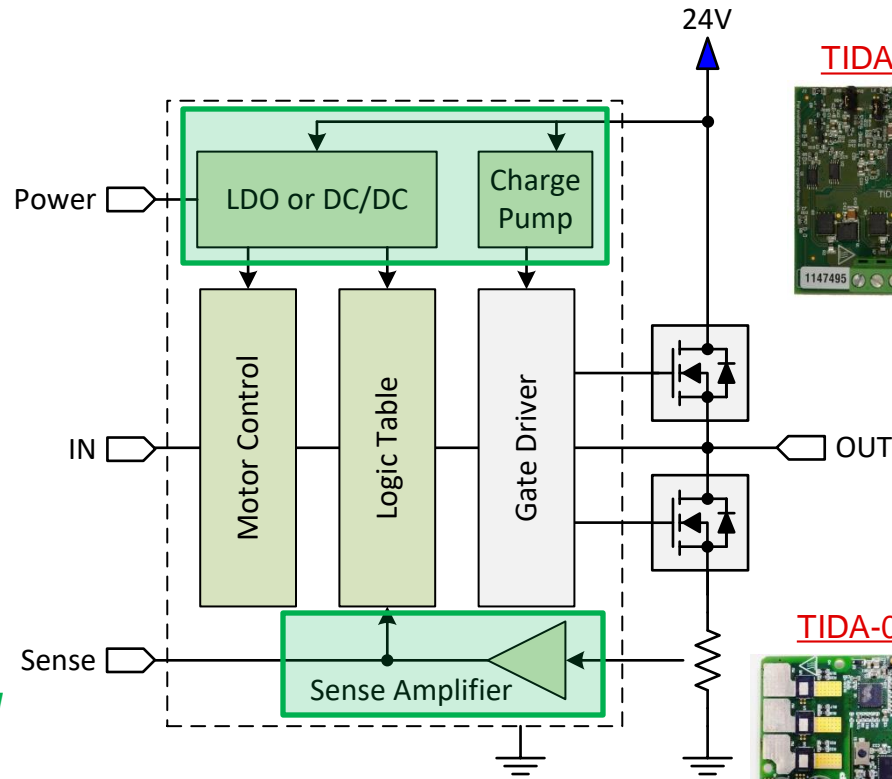


DRV8873



Power Management

Gate Driver



TIDA-01629



Current Sensing

TIDA-01516

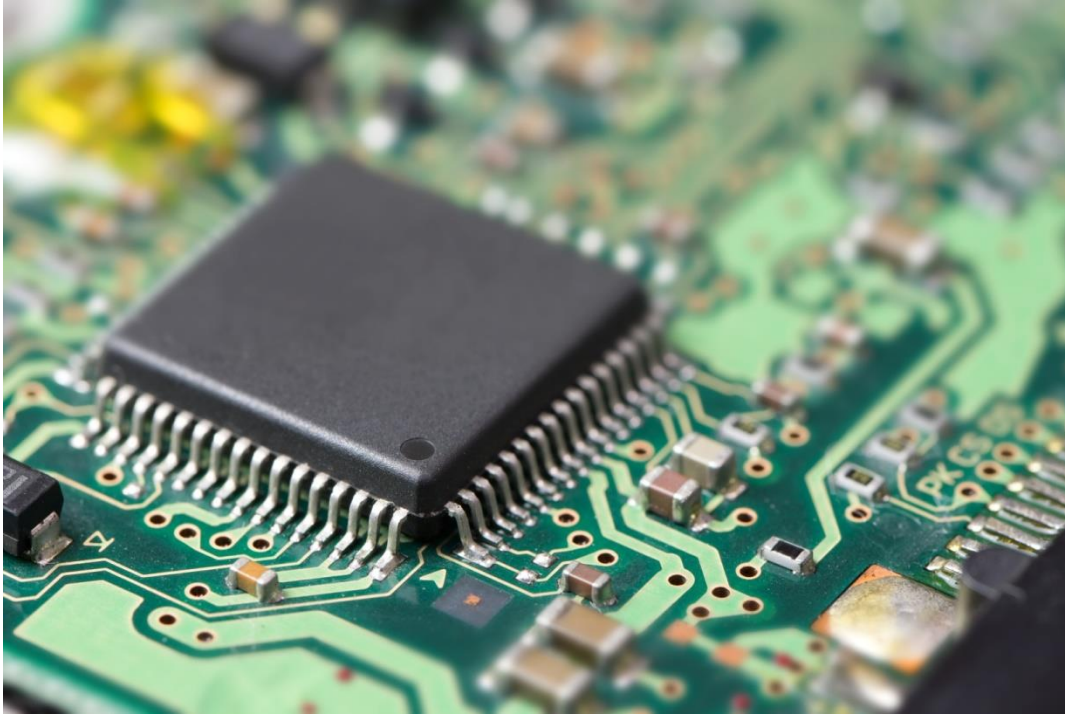


Motor drivers

Driving innovation

Smarter, safer, smaller motor drive solutions

ti.com/motordrivers



Reduce

- Cost
- Debugging time

Increase

- System efficiency
- Motor drive smoothness
- Performance

Selection: motor type

Brushed-DC motor

Pros

- Cost
- Easy to drive

Cons

- Maintenance
- EMI

Applications

- [Automatic gates](#)
- [Electronic door locks](#)
- [Home robots](#)
- [Automotive body motors](#)
- [Shut off valves](#)



Stepper DC motor

Pros

- Cost
- Simple control interface

Cons

- Noise & resonance
- High Heat & inefficiency

Applications

- [Security cameras](#)
- [Printers](#)
- [Refrigerator](#)
- [EPOS and banking automation](#)
- [Adaptive headlights in cars](#)



Brushless-DC motor

Pros

- Operational life & reliability
- Low EMI & efficiency

Cons

- Complex drive design
- Cost

Applications

- [Power & garden tools](#)
- [Appliance pumps and fans](#)
- [Cordless vacuum cleaners](#)
- [E-bikes](#)
- [Automotive powertrain & safety motors](#)



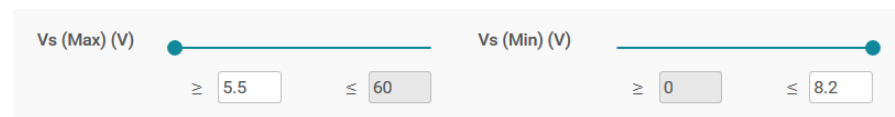
Selection: ratings

- Qualification & ratings
 - Catalog (commercial & industrial) – [Brushed-DC](#), [Stepper](#), [Brushless-DC](#)
 - [AEC-Q100](#) (Automotive) – [Brushed](#), [Brushless-DC](#)
 - [EP](#) (Enhanced products)
 - [QMLQ, QMLV, QMLV-RHA](#) (Military & Space)
- Operating Temperature Range:
 - -40 C to 85°C (Catalog)
 - -40 C to 125°C (Catalog, AEC-Q100)
 - -40 C to 150°C (AEC-Q100) – [DRV8305-Q1](#)
 - -55 C to 125°C (EP, QMLQ, QMLV)



Selection: voltage

- The supply voltage applied to the motor
- Commonly called V_s , V_M , $PVDD$, V_{BB} , V_{BAT}
- *Examples:* 24 V from wall outlet, 6-cell lithium-ion battery, 2x AAA alkaline battery
- Typical supply variation: $24V \pm 10\%$, 14 - 21V
- Additional supply variation caused by motor
 - Motor inrush current (supply droop)
 - Motor coasting (supply pump)
- Determine minimum and maximum voltage range acceptable for your system



Selection: current



- Current relates to the motor power
- *Peak current*: maximum possible current when driving the motor
 - If current lasts longer than tens of milliseconds, it is probably closer to an RMS current
- *RMS, average or continuous current*: typical current in the motor
 - Relates to thermal performance
- High power systems – *use a gate driver*

Motor Driver Topologies

Gate Driver

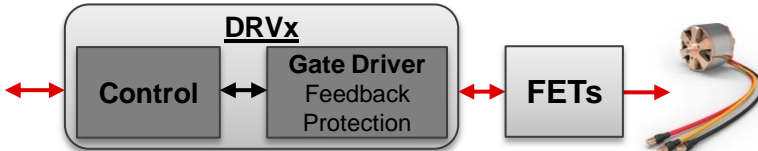
- Scalable/Higher Currents
- High Control Flexibility
- Reduced Board Space
- Full Protection



[DRV8703-Q1](#)

Control + Gate Driver

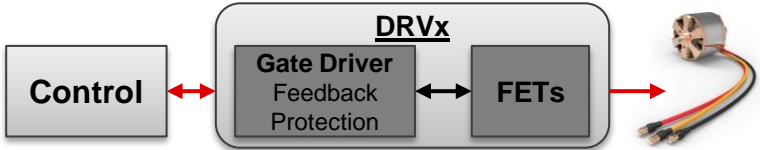
- Scalable/Higher Currents
- High Control Flexibility
- Reduced Board Space
- Full Protection



[DRV8306](#)

Integrated FET

- Small Board Space
- Easy to Design
- Excellent Performance
- Full Protection and Optimization



[DRV8847](#)

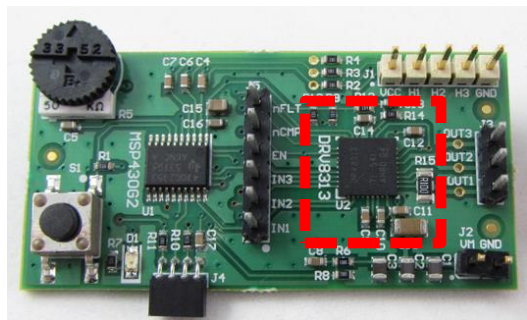
Full Integration

- Smallest Board Space
- Single Chip Solution
- Excellent Performance
- Full Protection and Optimization



[DRV10987](#)

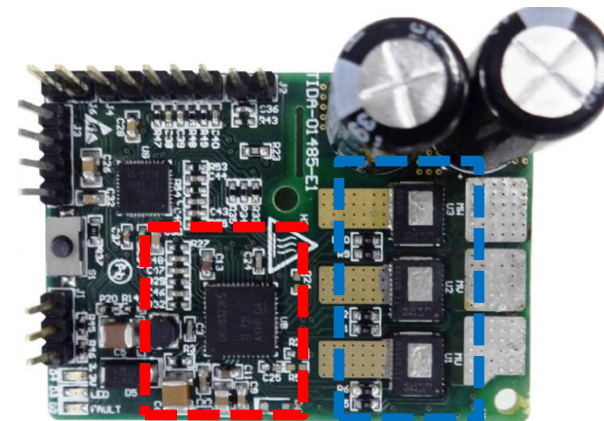
Selection: integrated driver vs gate driver



TIDA-00827



TIDA-01496



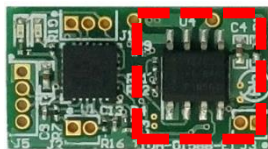
TIDA-01485

- Integrated driver: MOSFETs are included
 - Low to mid-power applications
 - Easy schematic & schematic
 - Simple system design
 - *Parameters:* Peak Current & $R_{DS(ON)}$

- Gate driver: MOSFETs required outside
 - Can support high power
 - Better thermal performance
 - Selectable & scalable power
 - *Parameters:* Gate Drive Current

Selection: integrated driver vs gate driver

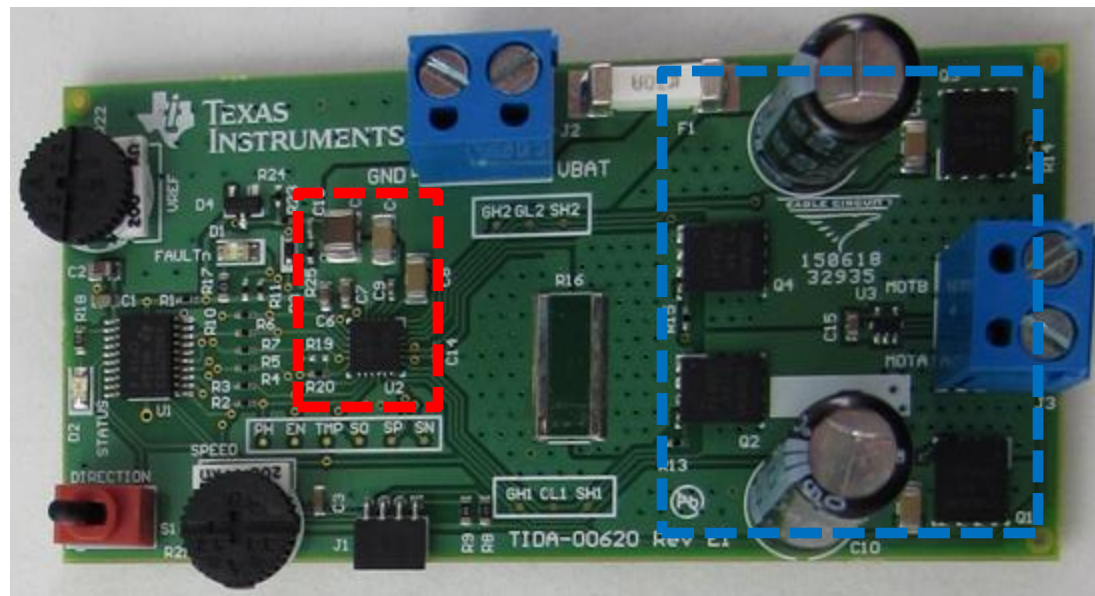
- Integrated driver: MOSFETs are included



[TIDA-01588](#)

Brushed-DC motor Driver
[DRV8870](#), 3.6-A peak

- Gate driver: MOSFETs required outside



[TIDA-00620](#)

Brushed-DC motor driver
[DRV8701](#) & [CSD18540Q5B](#),
27-A rms

Selection: integrated driver vs gate driver

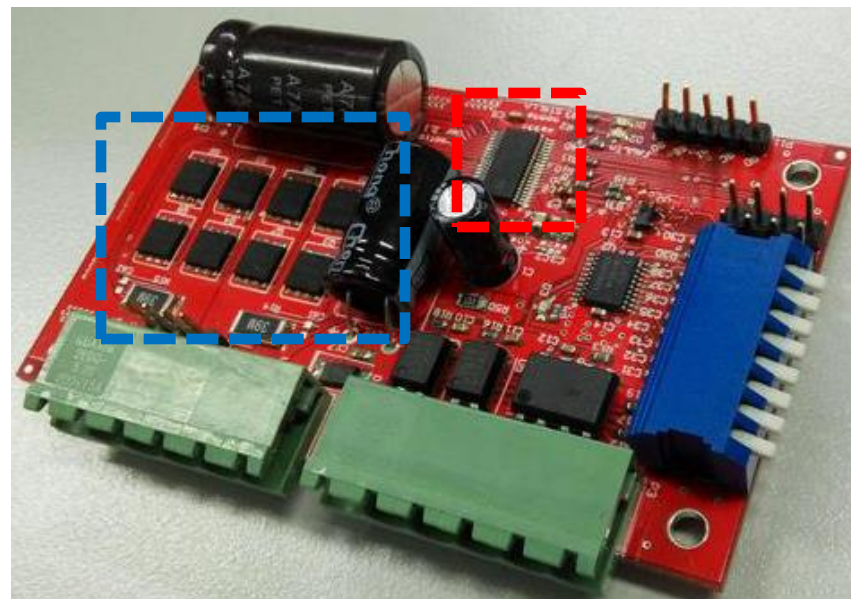
- Integrated driver: MOSFETs are included



[DRV8886ATEVM](#)

Stepper motor driver
[DRV8886AT](#), 1.4-A rms

- Gate driver: MOSFETs required outside



[TIDA-00736](#)

Stepper motor driver
[DRV8711](#) & [CSD18531Q5A](#),
4.0-A rms

Thank you

THE ART OF

Driving
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