Welcome!
Texas Instruments New Product Update

- This webinar will be recorded and available at www.ti.com/npu
- Phone lines will be muted
- Please post questions in the chat or contact your sales person or field applications engineer

New Product Update:
Isolated power products for high voltage applications

Jake Boydston

October 7th, 2021

Agenda

- Brief overview of high voltage product types for isolated power
- Trade-offs of common architectures in 3-phase inverter systems
- System benefits of newest products
  - Fixed-frequency PWMs
  - Flyback controllers
  - UCC25800-Q1 low cost transformer driver
  - UCC14240-Q1 dual output DC/DC module

Decades of power

Texas Instruments

National Semiconductor

UNITRODE

3 = 1

10k+

CUSTOMERS

35+

YEARS

Shipping controllers

2+

BILLION UNITS

Products shipped

10+

TOPOLOGIES

Transforming every watt

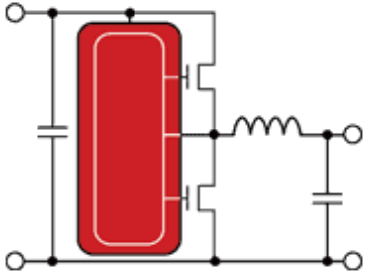
300+

PRODUCTS

AC/DC, isolated, DC/DC, digital

Isolated DC/DC product types

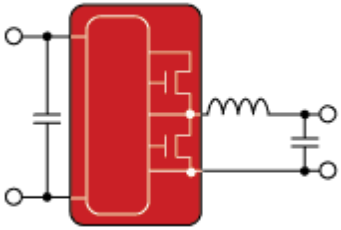
Controllers



External FETs
External magnetics

Typical use cases:
- DC/DC conversions > 10 W
- Any voltage input

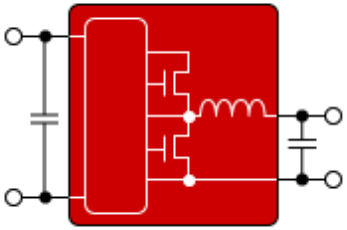
Converters



Integrated FETs
External magnetics

Typical use cases:
- DC/DC conversions < 10 W
- Mid-voltage input < 65 V

Modules

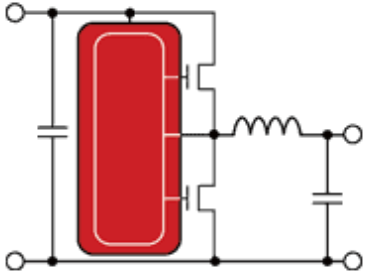


Integrated FETs
Integrated magnetics

Typical use cases:
- DC/DC conversions < 2 W
- Low-voltage input < 30 V

Isolated DC/DC product benefits

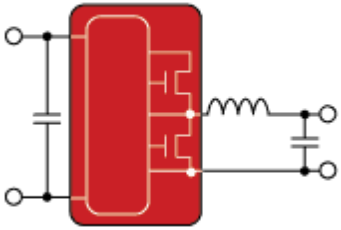
Controllers



External FETs
External magnetics

Benefits:
- Higher power level
- Multiple outputs
- Multiple topologies

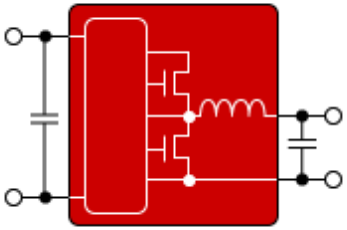
Converters



Integrated FETs
External magnetics

Benefits:
- Superior EMC performance
- Off-the-shelf transformer options
- Low cost solution

Modules

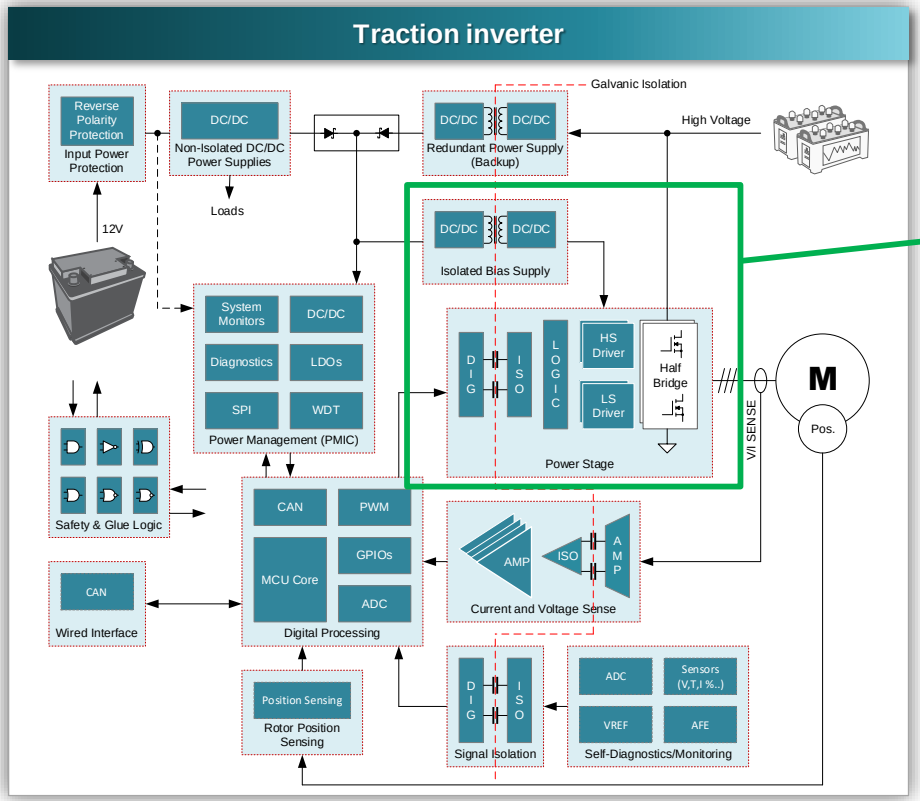


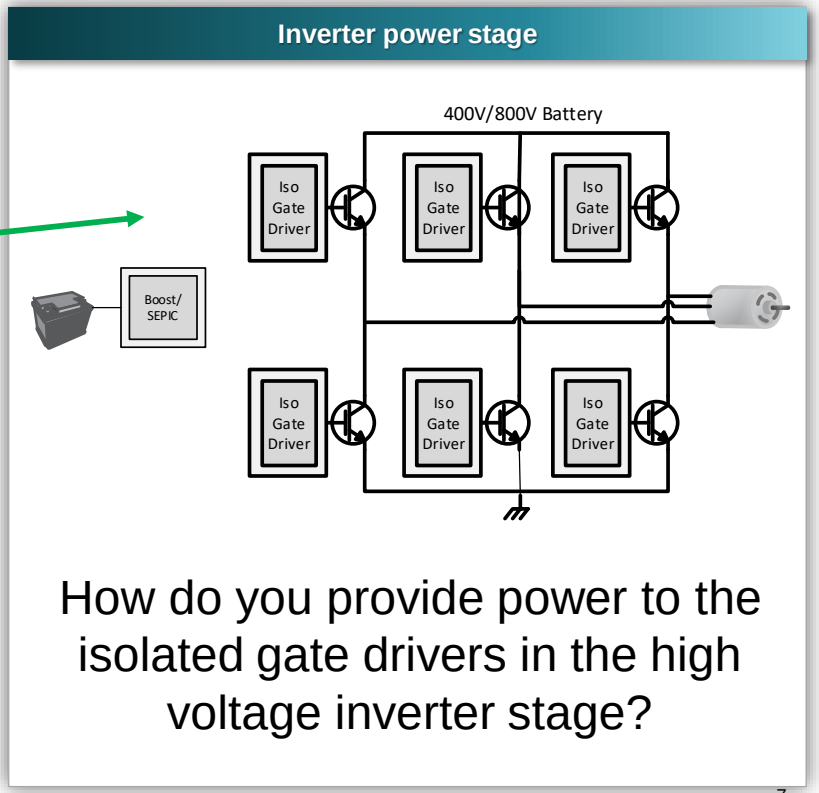
Integrated FETs
Integrated magnetics

Benefits:
- Single IC solution
- Integrated protections
- Highest performance

Most flexibility ⟷ **Highest integration**

3-phase traction inverter example

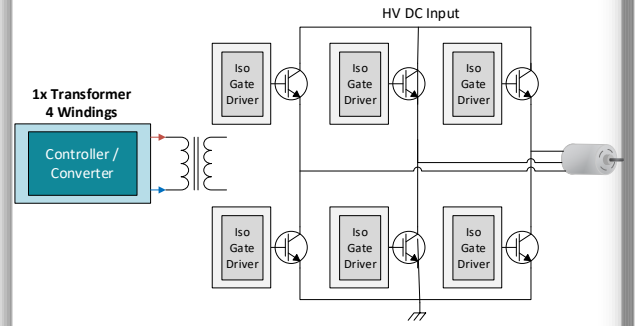




How do you provide power to the isolated gate drivers in the high voltage inverter stage?

Isolated bias architectures comparison

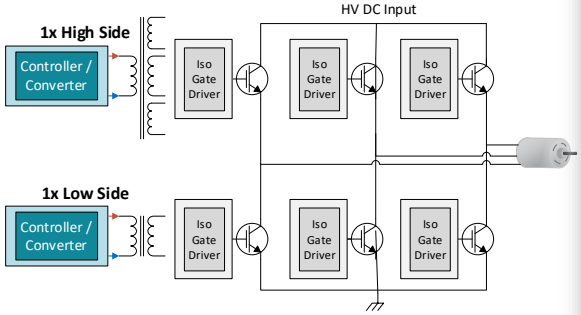
Centralized



Why choose centralized?

- EMI is not an issue
- Low F_{SW}, dV/dt (e.g. IGBT)
- Low BOM count
- Lowest total cost

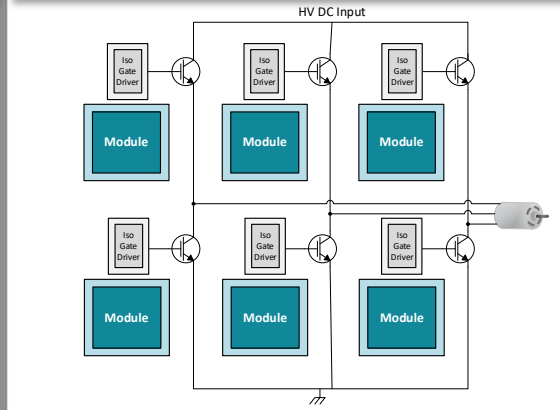
Semi-distributed



Why choose semi-distributed?

- Optimize EMI performance
- Increased F_{SW}, dV/dt (e.g. SiC, GaN)
- Medium BOM count
- Low cost is still a priority
- Reduce risk of total failure

Distributed

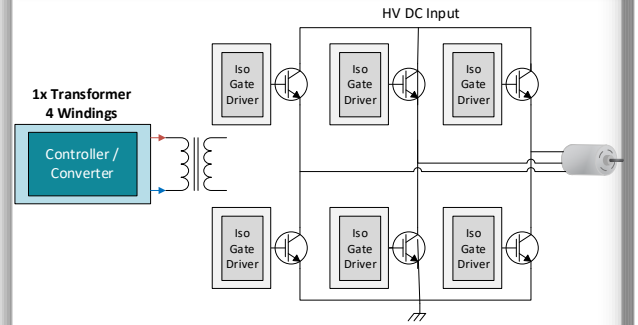


Why choose distributed?

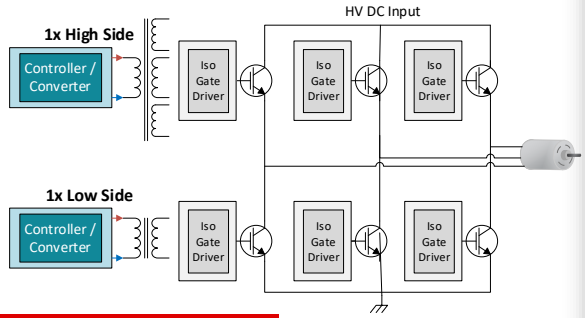
- Optimize EMI performance
- High F_{SW}, dV/dt (e.g. SiC, GaN)
- Low BOM count
- Power density is a priority
- Lowest risk of total failure

Isolated bias architectures comparison

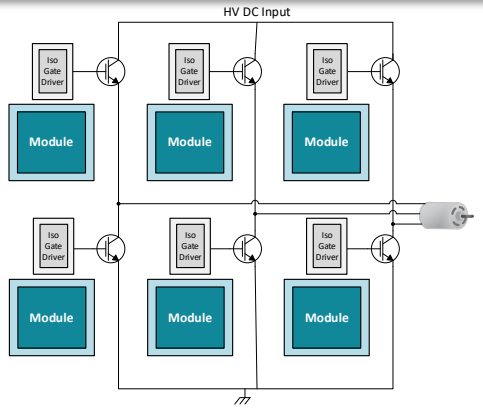
Centralized



Semi-distributed



Distributed



Controllers

Converters

Modules

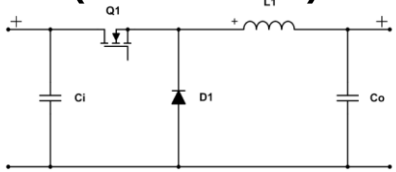
High performance, not cost!

Controllers overview
PWMs & Flybacks

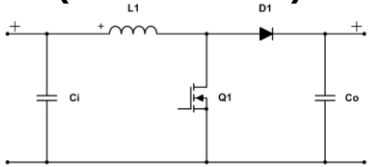
Single-ended PWM products

Examples

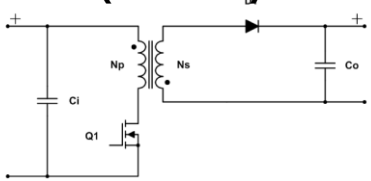
Buck (Non-isolated)



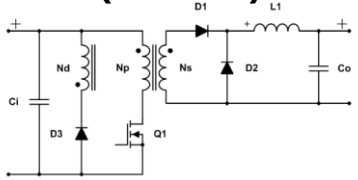
Boost (Non-isolated)



Flyback (Isolated)



Forward (Isolated)



Typically used for systems <200 W
One PWM controller can be used for all of these topologies!

Hero product	UC2842/3/4/5 TL2842/3/4/5	UCC28C40/1/2/3/4/5	UCC2800/1/2/3/4/5
Value proposition	Lowest cost IC High gate drive voltage	Highest performance High efficiency	Most integrated features: Soft-start, gate clamp, hiccup
Use case	Wide range	>400-V HV systems	<400-V LV systems

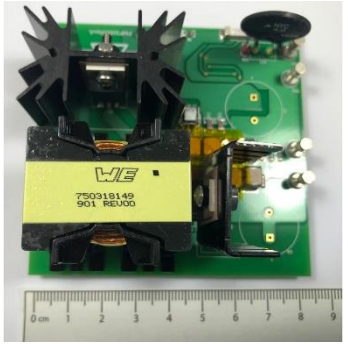
UCC28C4X/UCC38C4X: reference designs

Used for many topologies:

Topology	Reference Design
Buck	PMP10783 PMP10833
Boost	PMP30653
Flyback	PMP1941 PMP6716 PMP6811
Flybuck	PMP10834
SEPIC	PMP5353

PMP30653: 200-V at 400-mA LED lighting from a 24-V input

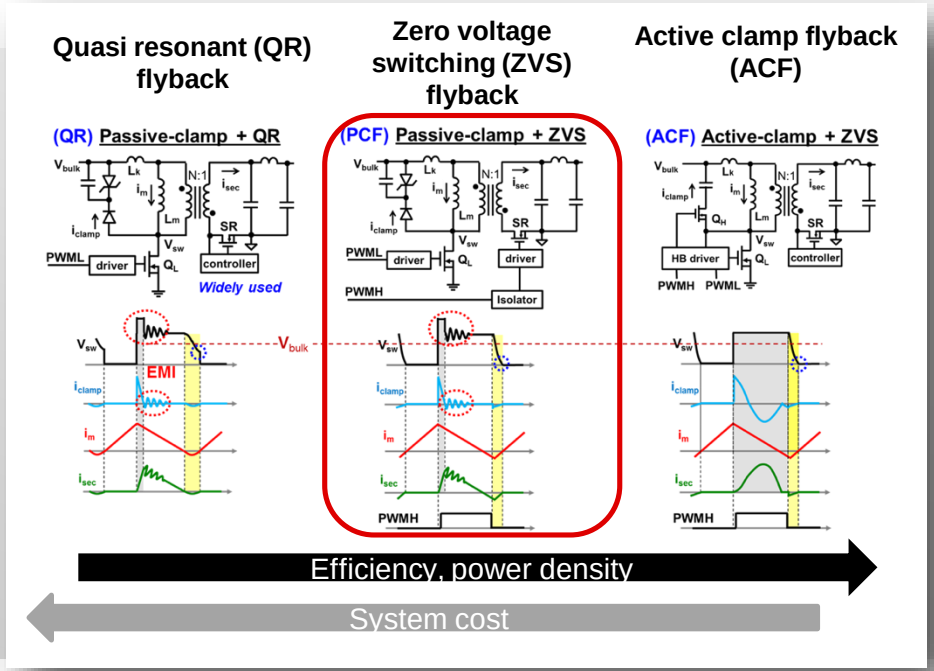
- provides a cost effective and precise constant-current regulation
- open LED protector circuitry provides overvoltage protection



Visit https://www.ti.com/reference-designs/ before you begin your next design!

Flyback controllers for 65-W applications

Parameter	UCC28600	UCC28781	UCC28782	UNITS
Control Method	QR	ZVS	ACF	-
Solution Standby Power	35	36	55	mW
Full-load efficiency 15V@ 115VAC	87.1	93.5	94.2	%
Full-load efficiency 15V@ 230VAC	87.9	93.2	93.7	%
Solution volume	274.2	59.4	35.5	cc
Energy Density	0.24	1.08	1.83	W/cc



Converter overview
UCC25800-Q1

UCC25800-Q1

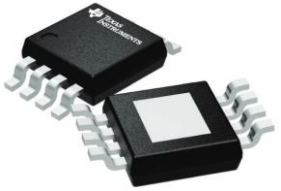
Low cost transformer driver with high performance

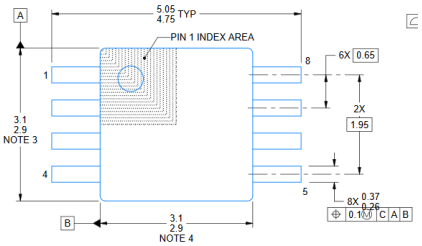
Features

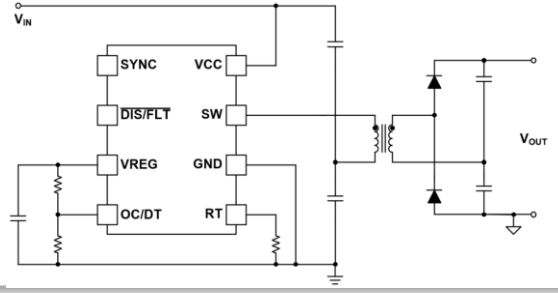
- **Operation from 9V to 34V (40V Abs Max)**
- **6W from 24V input, Up to 10W from 34V input**
- Integrated half-bridge MOSFETs
- Programmable fixed switching frequency up to 1.2MHz
  - 1.2MHz default, resistor settable 100kHz – 1MHz
  - Frequency accuracy +/-6% maximum over temperature
  - External SYNC function
- **Drive multiple transformers with one UCC25800-Q1**
- Automatic dead time adjustment with programmable maximum
- Integrated soft-start
- Disable pin with fault code output
- Two-level over current protection
  - Programmable via external resistor
  - UCC25800A-Q1 is auto retry after over current
  - UCC25800L-Q1 is latch after over current
- Over Temperature Protection
  - 160°C Junction
  - 20°C Hysteresis
- AEC Q100 Qualified

Benefits

- Low common mode noise due to minimal interwinding capacitance in transformer
- Simple design, highly integrated, no bootstrap capacitor
- High switching frequency for smaller size and more robustness





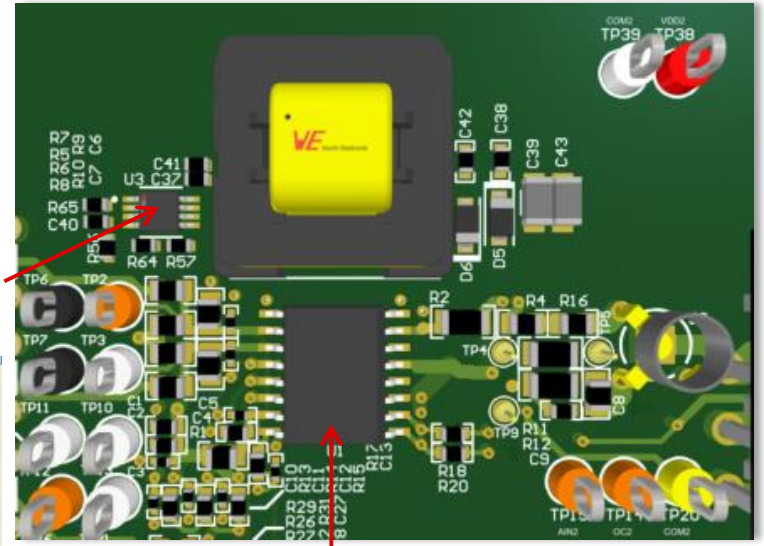


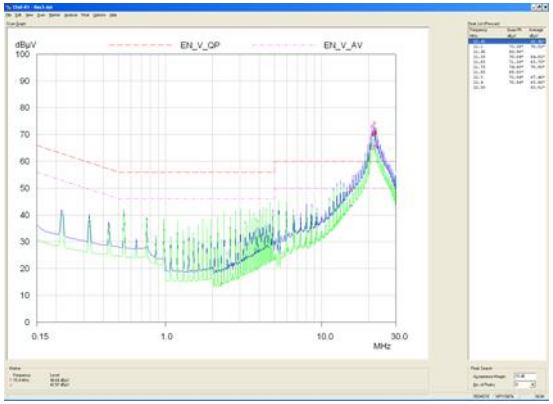
Link to Datasheet Link to EVM Samples Available

TEXAS INSTRUMENTS

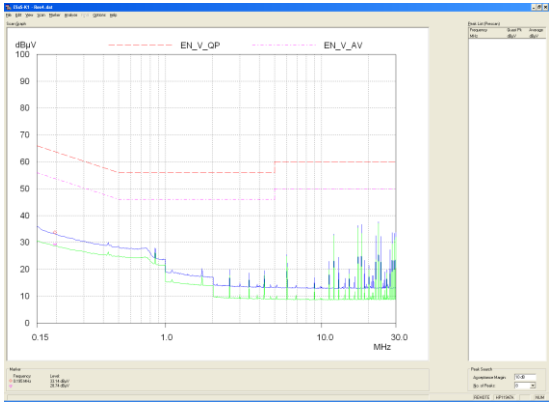
UCC25800-Q1: LLC converter EMI benefits

- Open loop controller with secondary side resonance for tighter regulation
- Lowest Cpri-sec capacitance <2 pF and resonant switching for extremely low CM noise solution
- High CMTI for fast edge rate switching



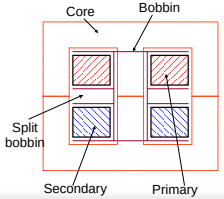
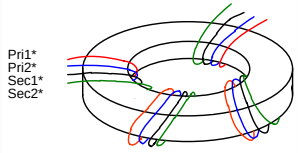
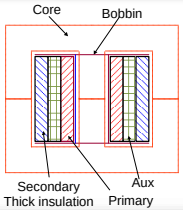
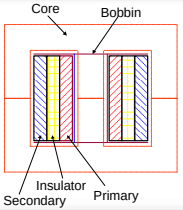
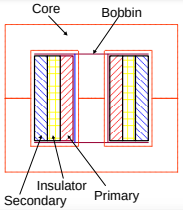


Flyback converter



LLC converter

Transformers for isolated bias supply

	LLC Transformer UCC25800-Q1	Push-Pull Transformer	Three-winding Flyback	Two-winding PSR	Half-Bridge
					
$C_{Pri-Sec}$	**<2pF**	~10pF	~20pF	~20pF	~20pF
CMTI	**>150V/ns**	Worse than LLC	Worse than LLC	Much worse than LLC	Much worse than LLC
Cost	**1X**	>1.15	>1.3X	>1.18X	>1.18X
EMI	**Best**	Good	Poor	Poor	Poor
Size	13.36mmX10.16mmX8.64mm	**8.3mmX12.6mmX4.1mm**	13.4mmX11.9mmX8.4mm	9.3mmX10.2mmX10.6mm	9.3mmX10.2mmX10.6mm
Regulation	Good	Good	Better	**Best**	Good

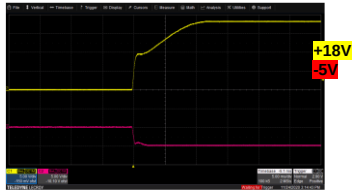
Link to Application Note

UCC25800-Q1 EVM measurement data

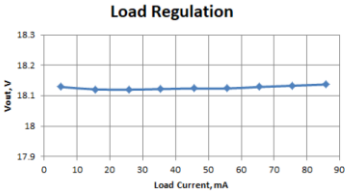
UCC25800-Q1 EVM with LM5156 re-regulator

PARAMETER	SPECIFICATIONS
Input voltage range	6 V – 26 V
Output voltage and current	+18 V / -5 V
Switching frequency	2.2 MHz and 500 kHz
Isolation	Yes, 2500 VAC (1 sec)
Topology	SEPIC + Open loop LLC transformer driver

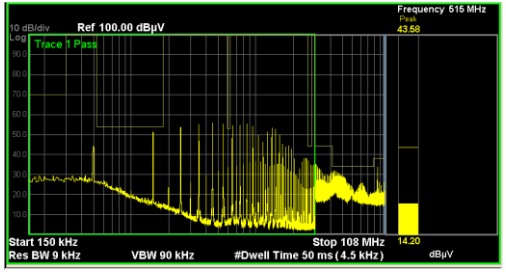
Predictable startup of +/- rails



1% load regulation



Surpasses CISPR 25 class 5 EMI standard



Pass - LLC Board Only with Filter

Module overview
UCC14240-Q1

Isolated DC/DC module with integrated transformer

Technology shift for isolated gate driver bias supplies

Decades of **bulky transformers** …

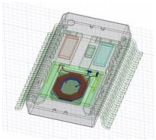
- Bulky – prone to vibrations
- High radiated EMI
- Large footprint & height
- Difficult to design

Push-pull

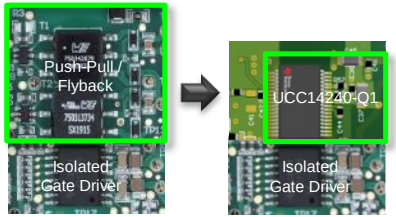
Flyback

Introducing the **UCC14240-Q1**

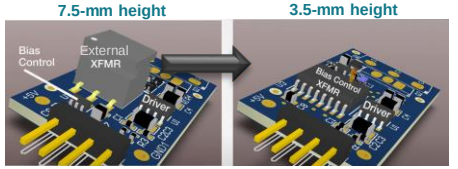
- 1.5-W high-efficiency isolated DC/DC power supply
- Industry's smallest, most accurate & easiest-to-use
- Proprietary integrated transformer technology
- No bulky, noisy transformers



2X smaller PCB area, lower BoM



2X lower height



UCC14240-Q1 basic isolation

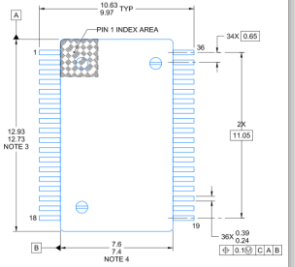
3.55mm Height Dual Output Gate Drive Bias w/ Integrated XFMR

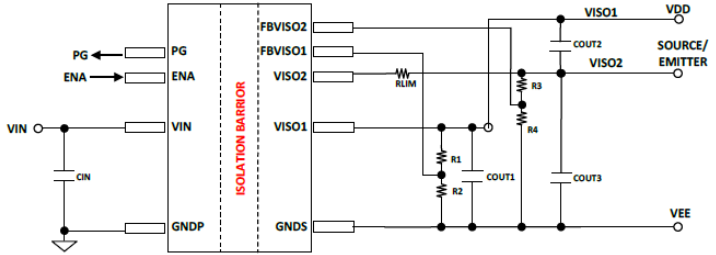
Features

- Isolated power module with integrated transformer
- **3.55-mm height**,12.8 mm x 10.3 mm with leads (8 mm creepage)
- **1.5W output power at Ta = 105°C**
- Input voltage range
  - 24-V nominal
  - 21 V – 27 V, 32 V Abs,max
- Dual adjustable output voltages
  - VISO1 to GNDS range 18 V to 25 V
  - VISO2 to GNDS range 2.5 V to VISO1
  - **Both ≤ 1.3% accuracy -40°C to 150°C**
- 3.5pF primary-to-secondary capacitance with low emissions
- Wide temperature range:
  - Tj: -40 to 150°C
  - Ta: -40 to 125°C
- **UVLO, OVLO, PG, soft-start, short-circuit, power-limit, and over temperature protection, CMTI > 150k V/us**
- 3rd party certified basic isolation
  - 3k Vrms (60s)
  - 1.2 kVpk working
  - 5k-V surge
- AEC-Q100 auto grade

Benefits

- Integrated solution enables smaller BOM, reduced board space and helps with easier system certification
- High accuracy to reduce size of IGBTs / SiC switches
- Soft start enables minimal overshoot current,
- Low EMI, high CMTI, high isolation voltage



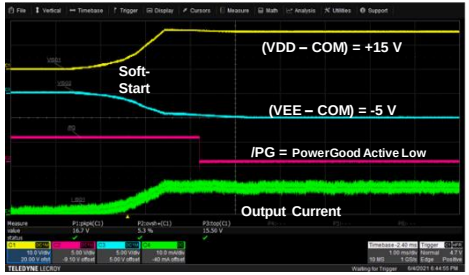


Link to Datasheet Link to EVM Order Now

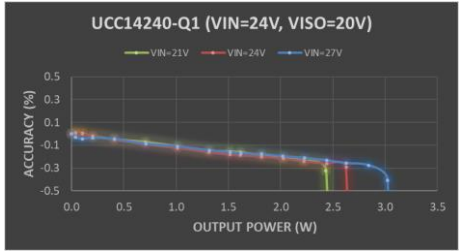
Texas Instruments

UCC14240-Q1 measurement data

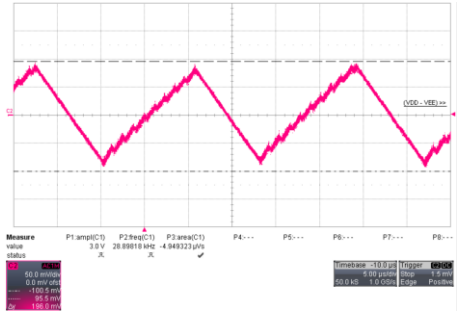
Soft startup of +/- rails



< 1% load regulation

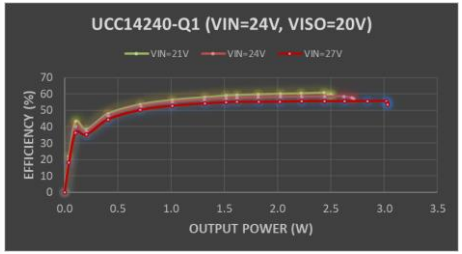


Burst mode control

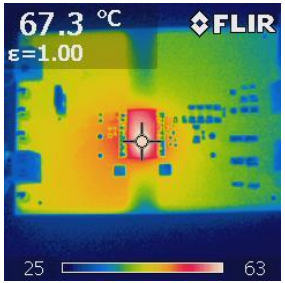


Smallest solution

60% peak efficiency



2-W out @ 25degC T_A

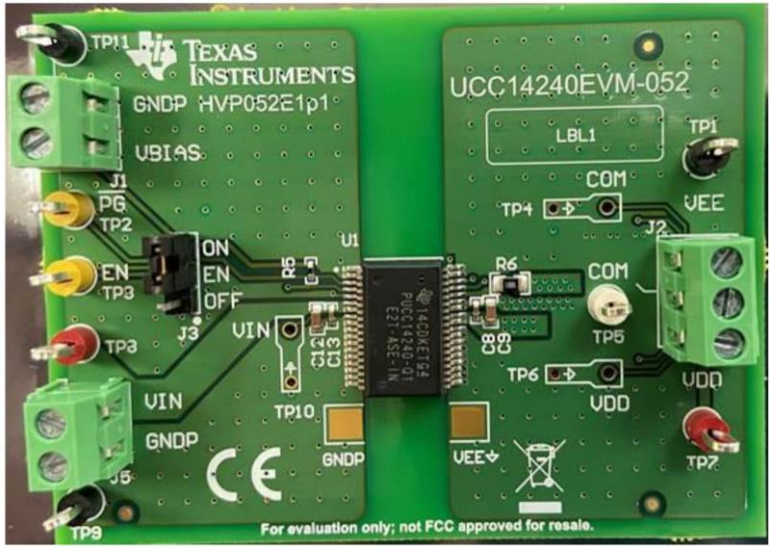


ΔT=42.3°C

UCC14240-Q1

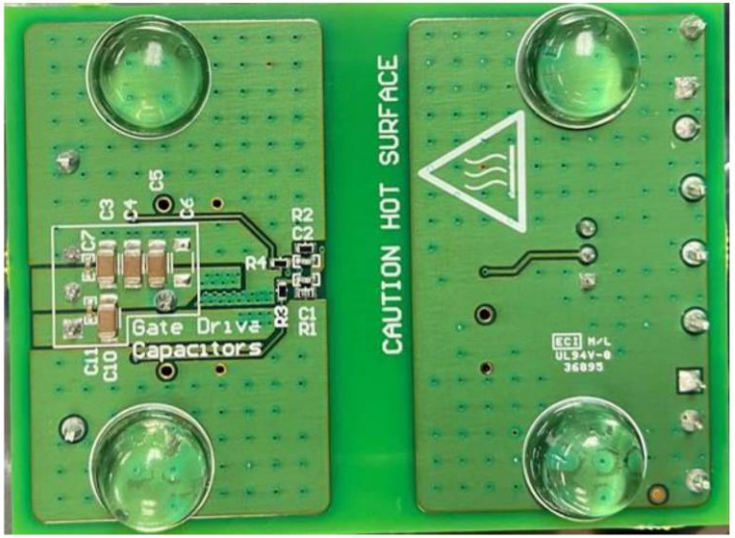
Simple & small BOM and layout

EVM top



EVM bottom

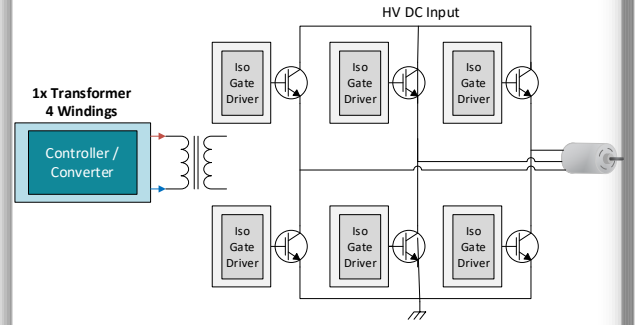
Flipped



Link to Datasheet Link to EVM Order Now

Isolated DC/DC summary

Centralized

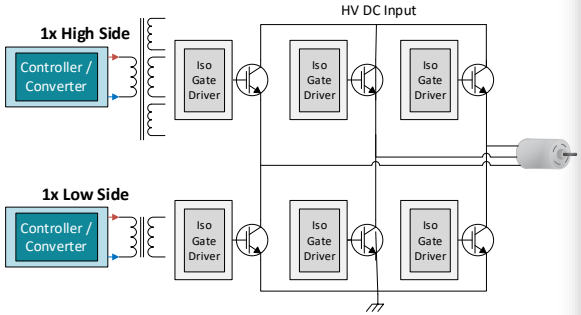


Why choose centralized?

- EMI is not an issue
- Low F_{SW}, dV/dt (e.g. IGBT)
- Low BOM count
- Lowest total cost

➢ **PWMs & flyback controllers**

Semi-Distributed

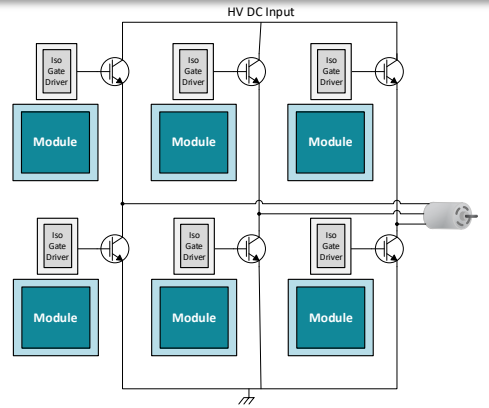


Why choose semi-distributed?

- Optimize EMI performance
- Increased F_{SW}, dV/dt (e.g. SiC, GaN)
- Medium BOM count
- Low cost is still a priority
- Reduce risk of total failure

➢ **UCC25800-Q1 converter**

Distributed



Why choose distributed?

- Optimize EMI performance
- High F_{SW}, dV/dt (e.g. SiC, GaN)
- Low BOM count
- Power density is a priority
- Lowest risk of total failure

➢ **UCC14240-Q1 module**

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For more information on the New Product Update series, calendar and archived recordings

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