驱动SiC和GaN功率器件的Broadcom光耦

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2021年7月29日

议程 – 驱动SiC和GaN功率器件的Broadcom光耦

- 简介： Broadcom光耦
- SiC（碳化硅）和GaN（氮化镓）功率开关——特性和优势
- Infineon CoolSiC™ EasyDUAL 模块驱动板
- Wolfspeed WolfPACK™ SiC模块驱动板
- STM SiC 功率 MOSFET 半桥评估板
- Nexperia GaN FET半桥评估板
- 更多SiC和GaN参考设计
- 问&答

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Broadcom光耦里程碑：50 年制造经验

Agilent Technologies

AVAGO TECHNOLOGIES

BROADCOM

Isolation Products Milestones

1968 HP commercialized GaAsP LEDs

1970 HP introduced Optocouplers

1989 HS CMOS & Widebody Optocouplers (HCNW)

1992 Flagship Gate Drive Optocoupler HCPL-3120

1993 Optically Isolated Current Sensor HCPL-7800

1997 First Smart Gate Drive Optocoupler HCPL-316J

1999 Agilent spun off

2000 3.3V/5V Optocouplers

2004 Multi-Channel Bi-Directional Optocouplers (ACSL)

2005 First Automotive Grade Optocoupler R²Coupler™ (ACPL-xxxT)

2008 Avago spun off

FROST & SULLIVAN

Global Optocouplers Company of the Year

2010 Ultra-Low Power Optocoupler

2012 Optically Isolated Voltage Sensor

2014 15mm Wide Optocouplers (ACNT)

2015 >40M R²Couplers™ Shipped

2016 Broadcom merged with Avago

2016 11mm Wide Optocouplers (ACNU)

2017 50mV Sigma Delta Modulator (ACPL-C799)

2018 1500V 8mm Wide SSR (ASSR-601J)

2018 20Mhz Int. Clk 200mV Sigma Delta Modulator (ACPL-C740)

Beyond 2021 *More Functions Better Performance*

New Platform 600V CTI, Double Mold

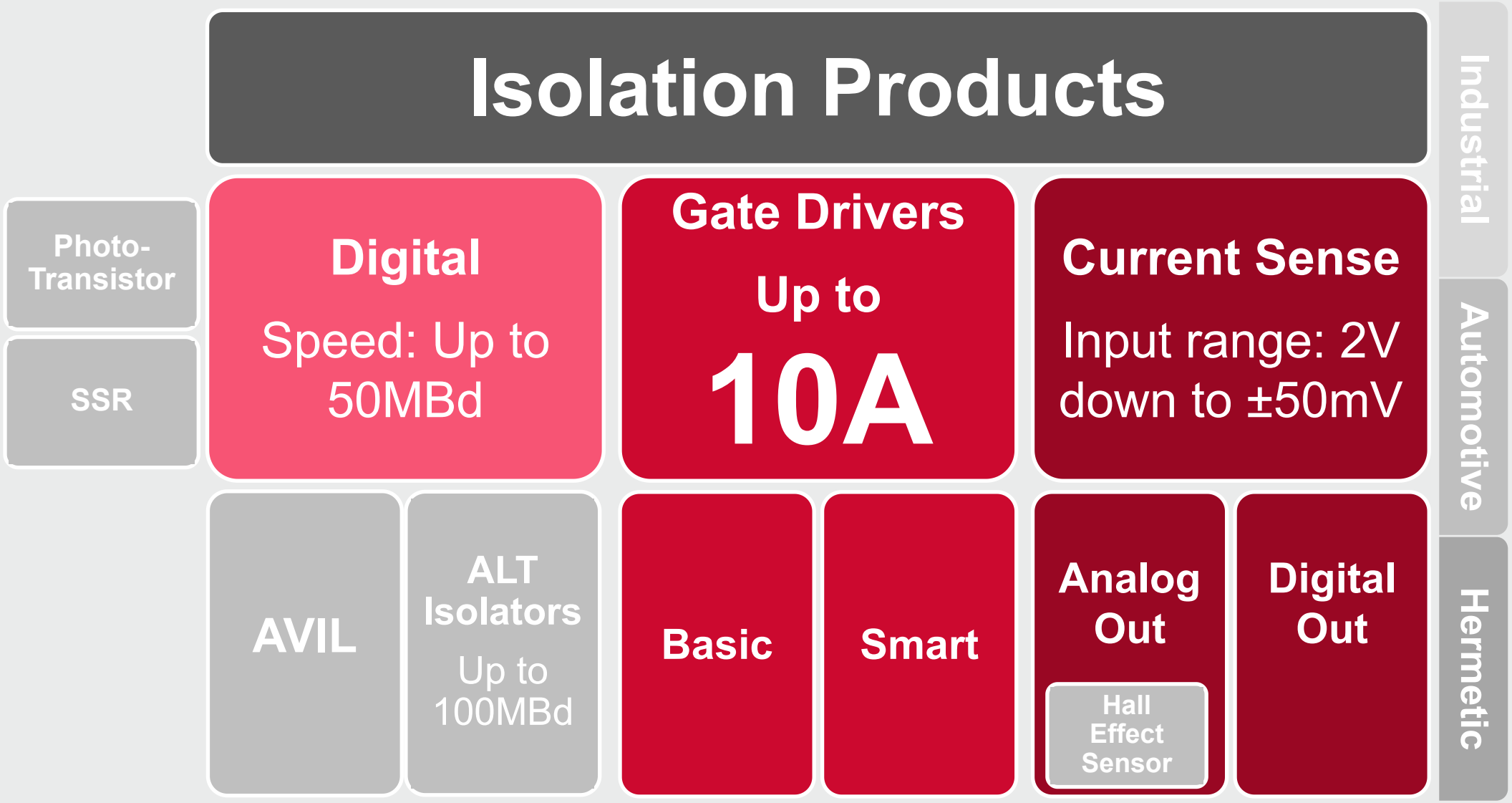
New Package SO12/24/30

GO with OPTO! BROADCOM® OPTOCOUPLERS

50 YEARS

BROADCOM

Broadcom隔离产品概述



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10A

Scan for Reference Design Details

门极驱动光耦

ACFL-3161
Single-CHANNEL
(newly released)

ACFJ-3262
DUAL-CHANNEL
(coming soon)

ACPL-355JC
SMART with PROTECTION
(coming soon)

5 经测试和验证的参考设计





for Leading SiC & GaN Power Switches

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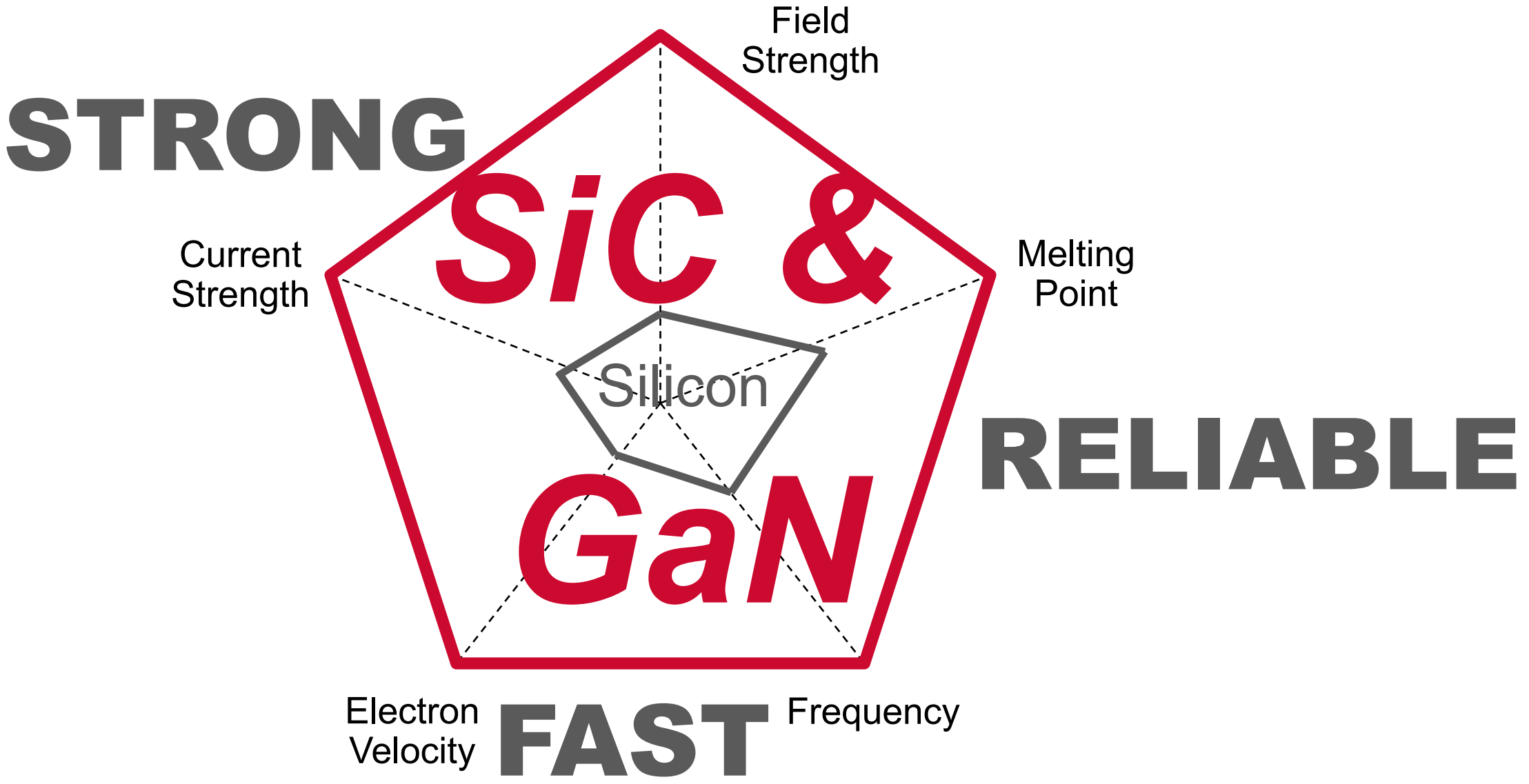
SiC和GaN功率开关——特性和优势



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SiC和GaN功率开关——特性和优势

SMALLER
CHEAPER
EFFICIENT

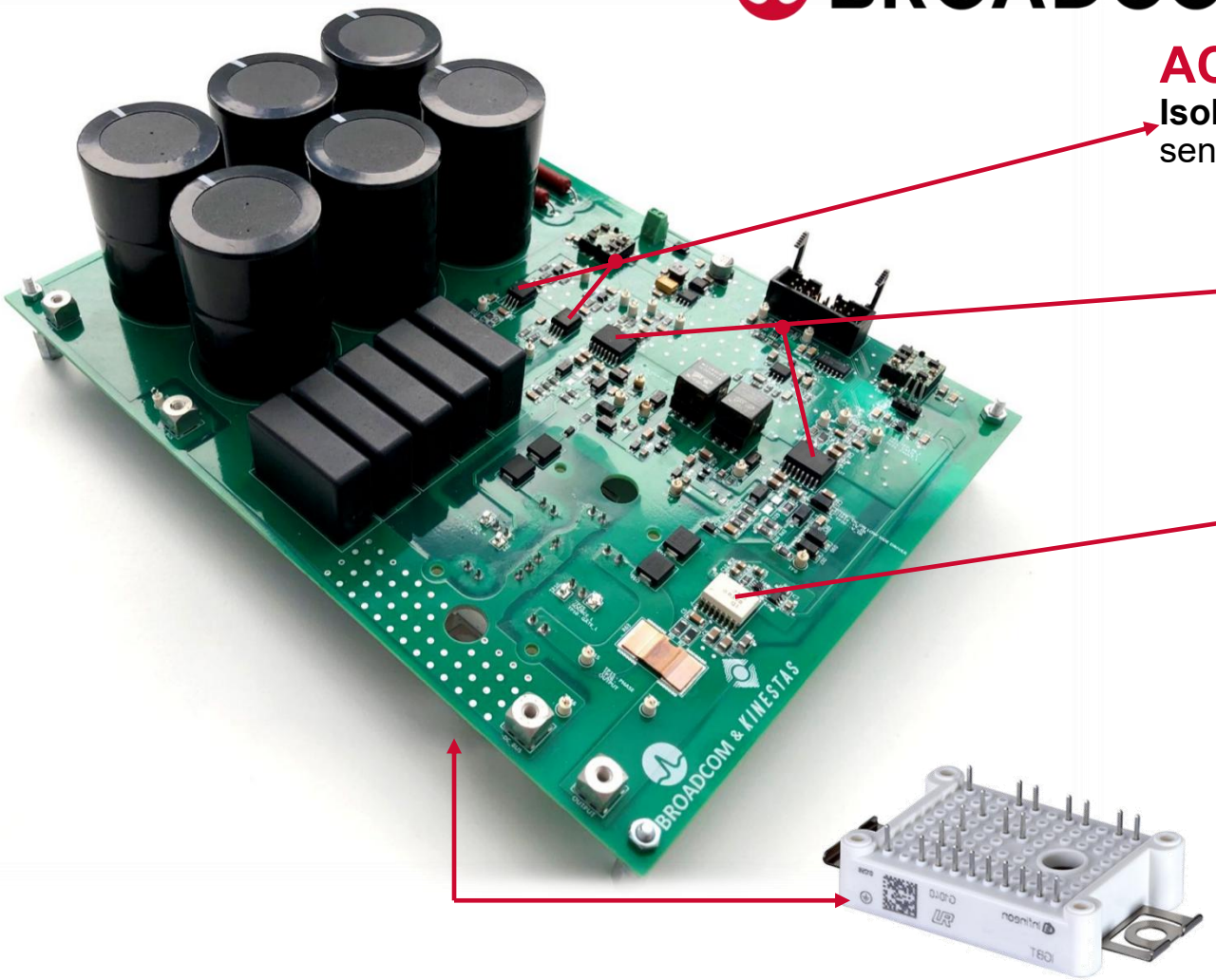
SiC & GaN

Silicon

BROADCOM

Infineon CoolSiC™ EasyDUAL 模块驱动板

BROADCOM®



ACPL-C87B

Isolated Voltage Sensor for IGBT thermistor sensing and BUS voltage sensing

ACPL-355JC

10A Gate Drive Optocouplers with Short Circuit Protection

ACPL-736J

±50mV external clocked Isolated Sigma-Delta Modulator for current sensing

Infineon

FF23MR12W1M1_B11
FF11MR12W1M1_B11

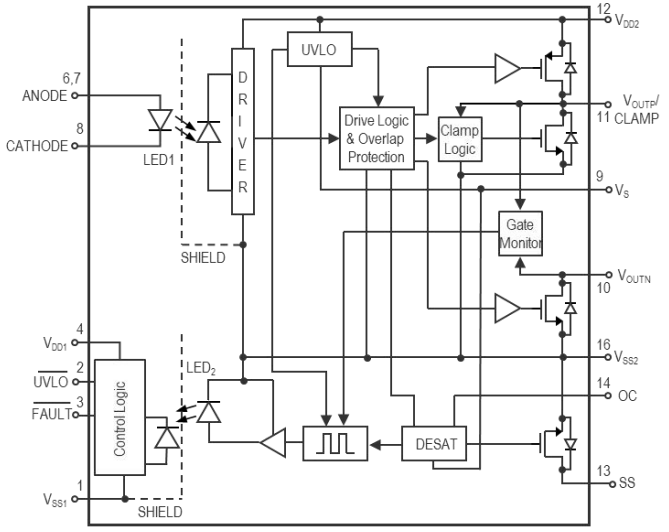
EasyDUAL CoolSiC ™ Module
1200V 50-100A

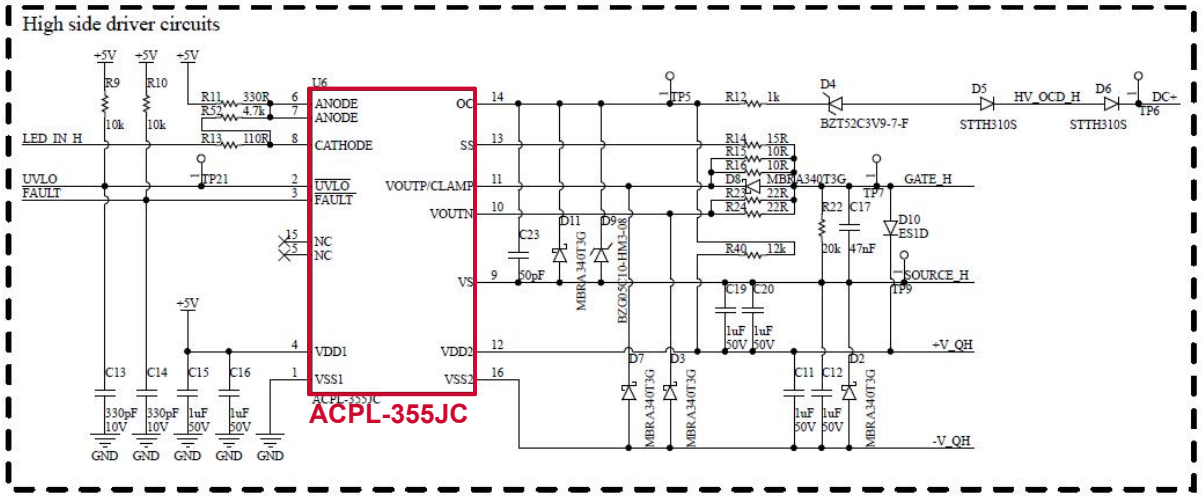
BROADCOM®

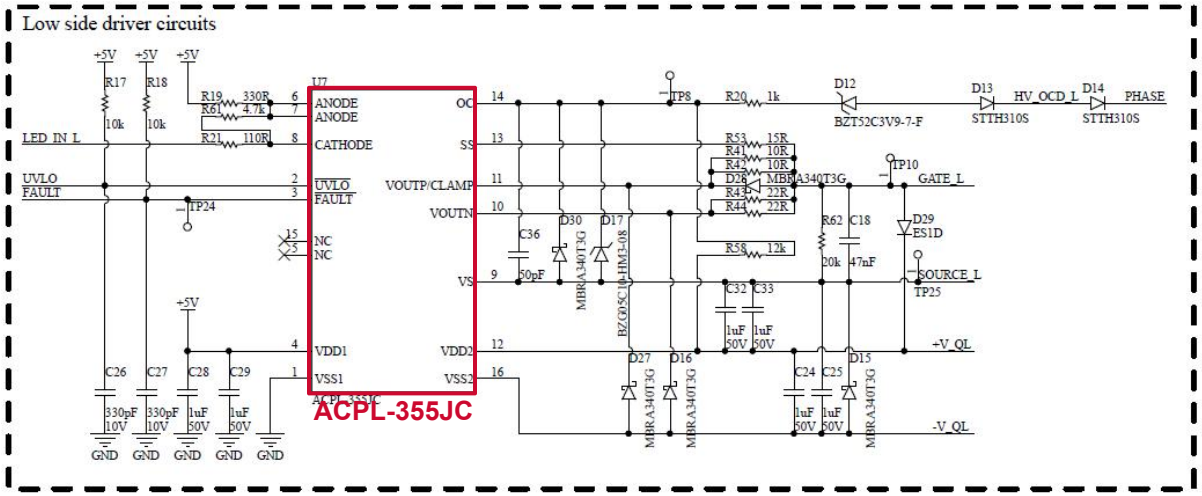
Infineon CoolSiC™ 驱动板– ACPL-355JC智能门极驱动器

Features

- **10A** peak output current
- **V_{IORM}=2262V_{PEAK}** working voltage
- **CTI > 600V**, **Material Group I** Package
- Short Circuit Protection with Feedback
- Noise Immunity, dv/dt > **100kV/µs**







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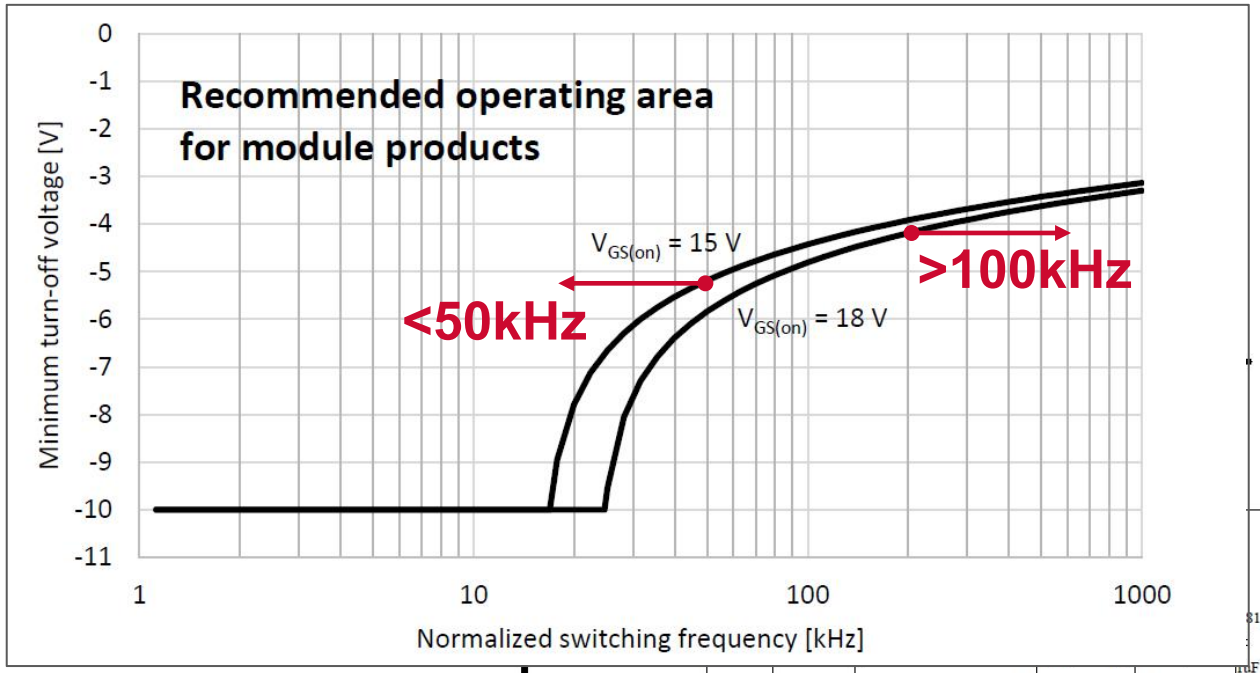
Infineon CoolSiC™ 驱动板–门极驱动电源



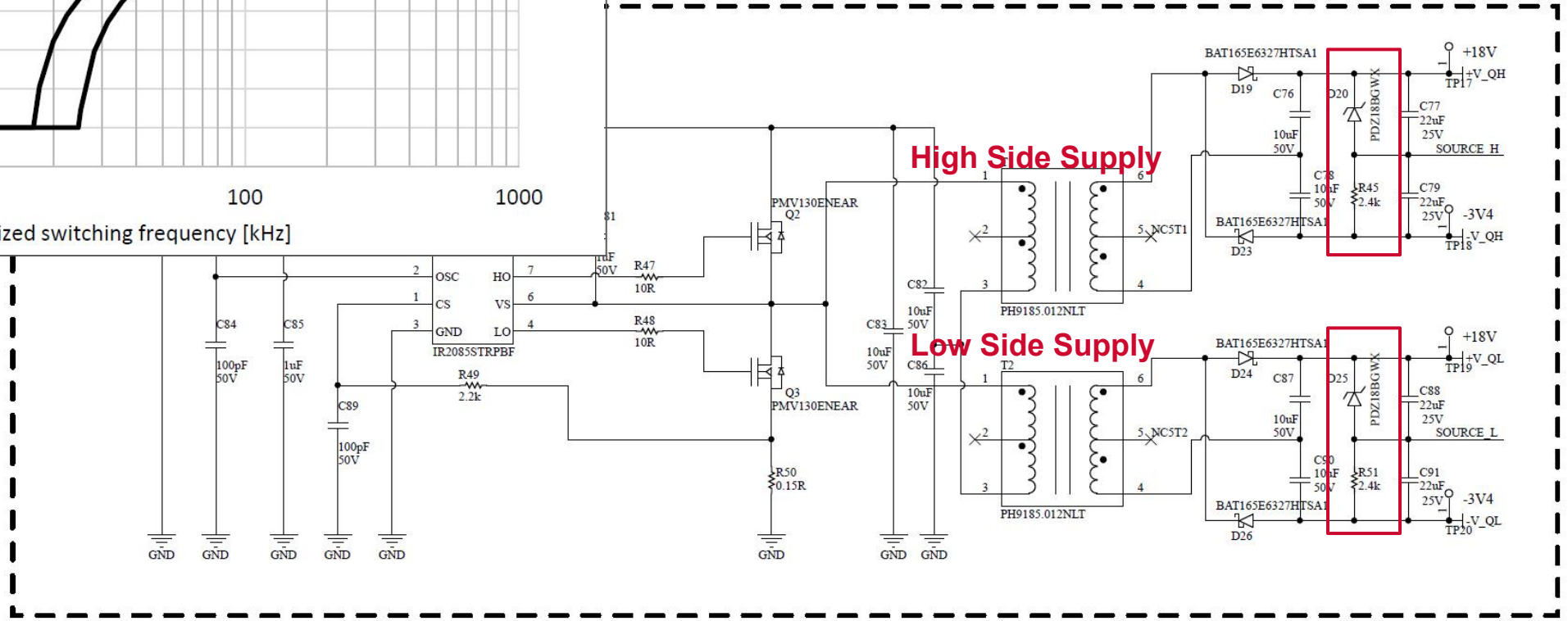
AN2018-09

Total Supply Rail = 21V

Configurable Gate Drive Supply

High Freq =18V/-3.4V

Low Freq = 15V/-6V



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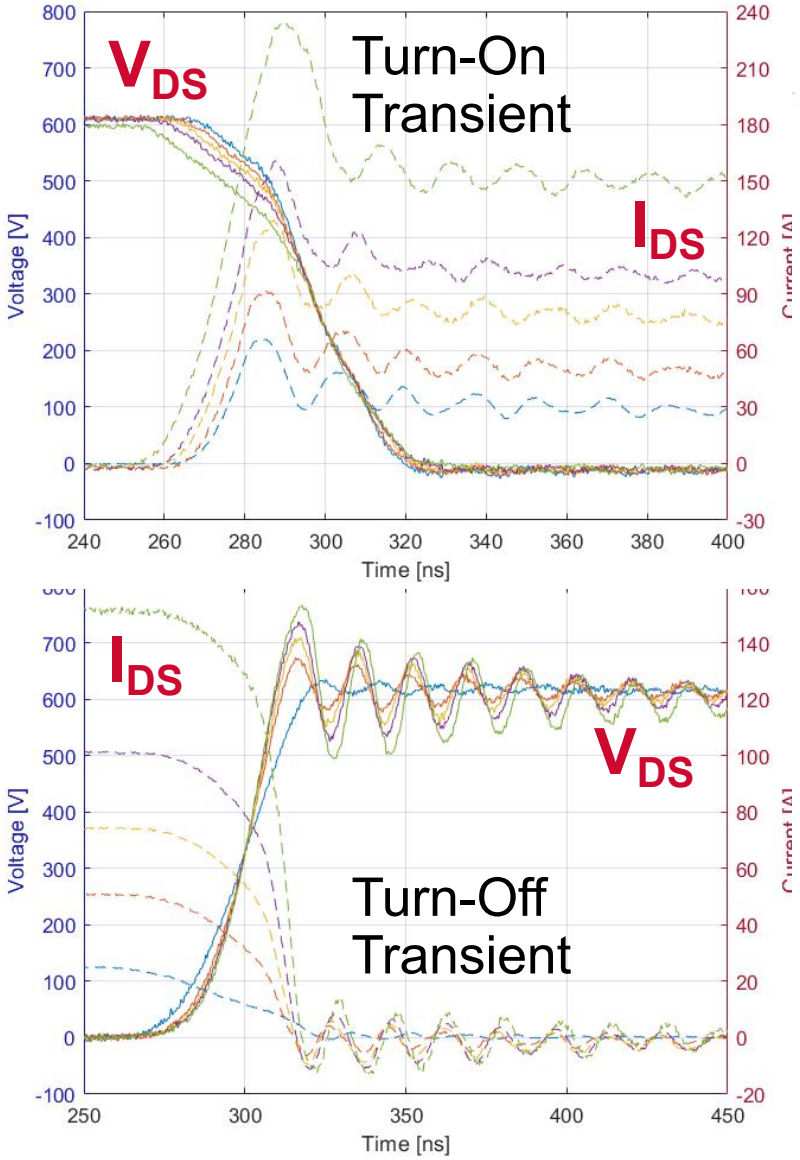
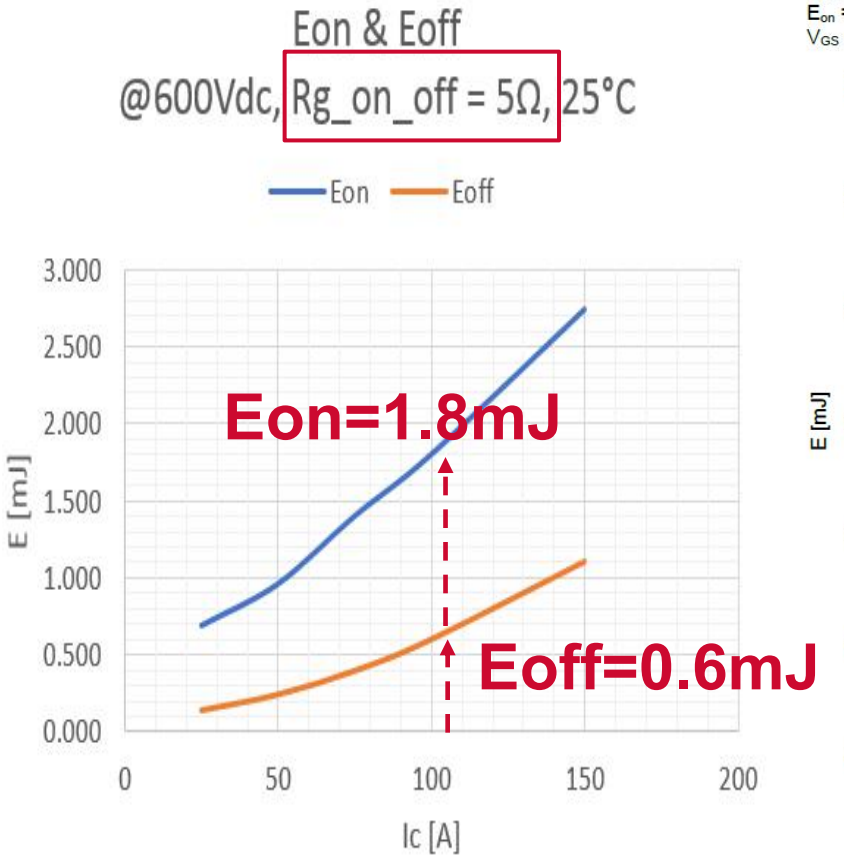
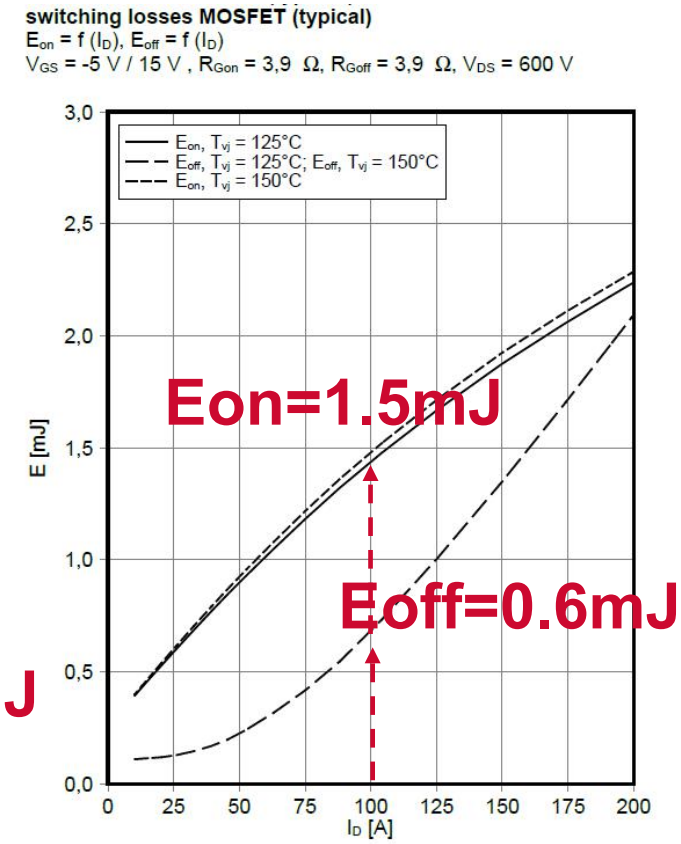
Infineon CoolSiC™ 驱动板– SiC开关性能



Board Measurements



SiC Datasheet



FF11MR12W1M1_B11
Datasheet 1200V/100A

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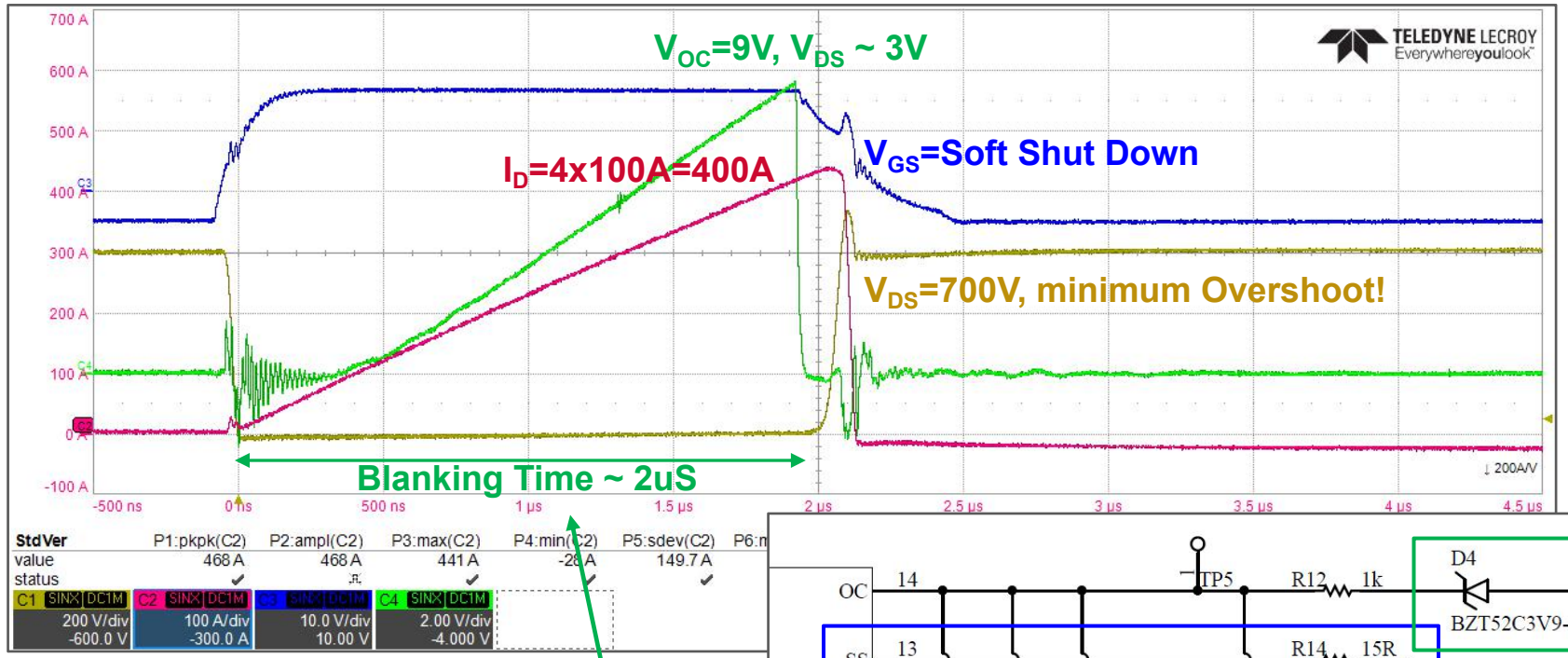
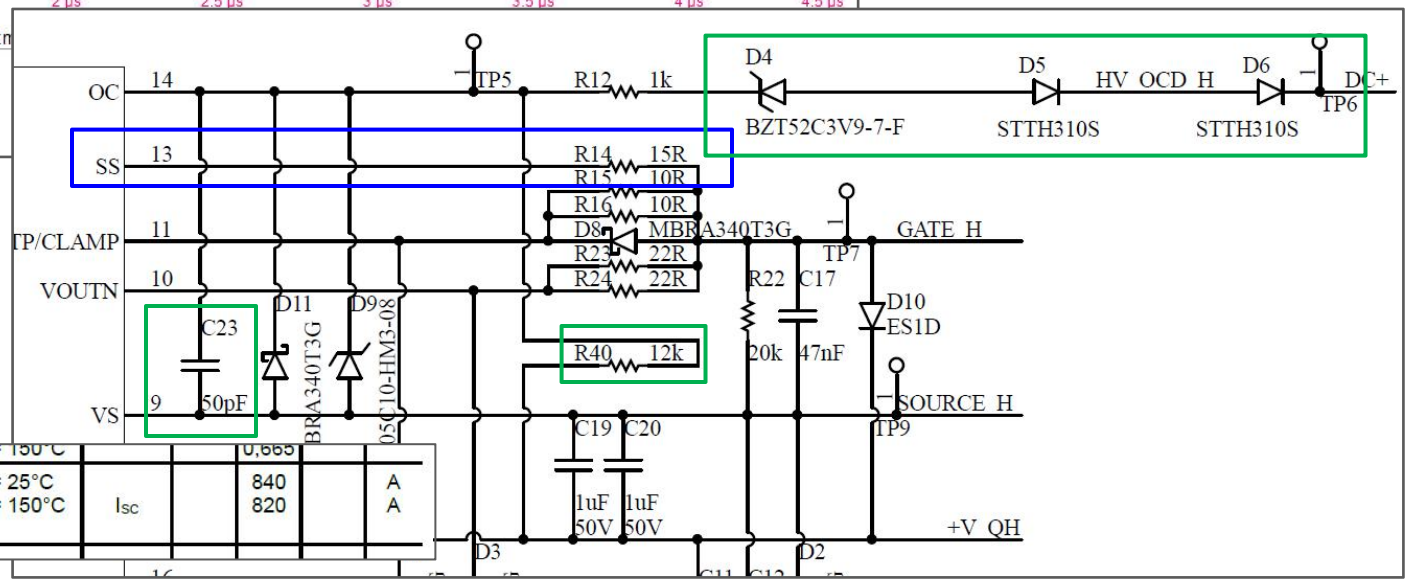
Infineon CoolSiC™ 驱动板– SiC 短路测试





FF11MR12W1M1_B11

Datasheet 1200V/100A

Kurzschlußverhalten SC data	V_{GS} = -5 V / 15 V, V_{DD} = 800 V V_{DSmax} = V_{DSS} -L_{sDS} ·di/dt R_G = 10,0 Ω	$t_P \leq 2$ µs, T_{vj} = 25°C $t_P \leq 2$ µs, T_{vj} = 150°C	I_{SC}		840 820	A A

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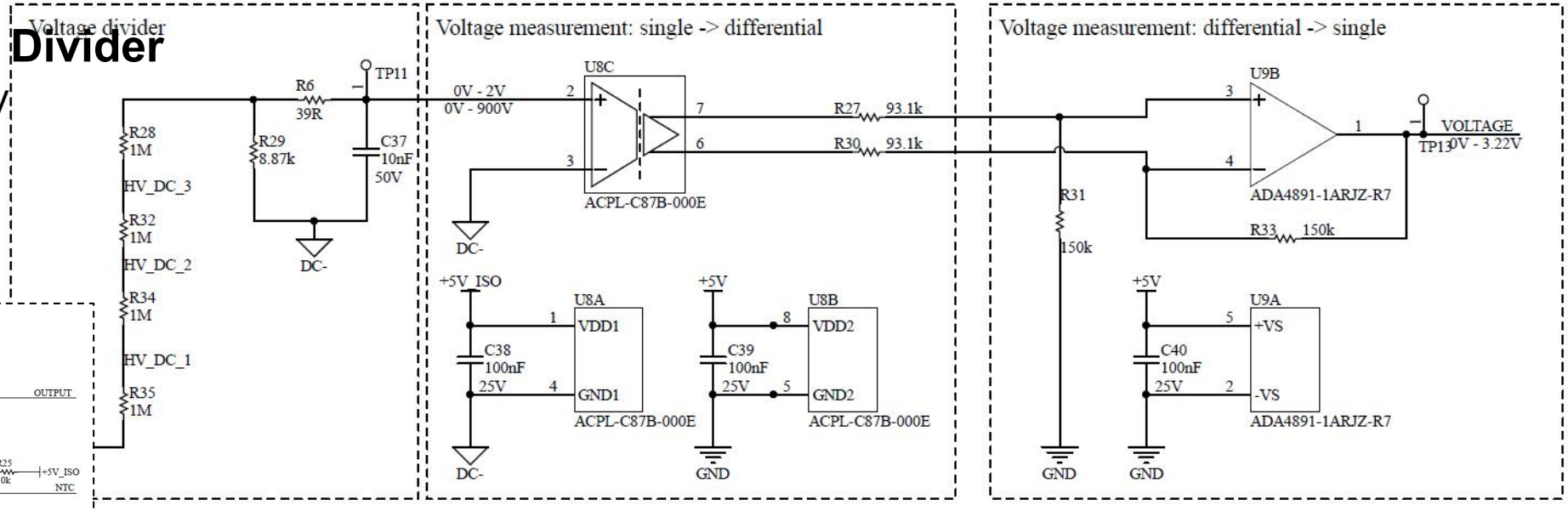
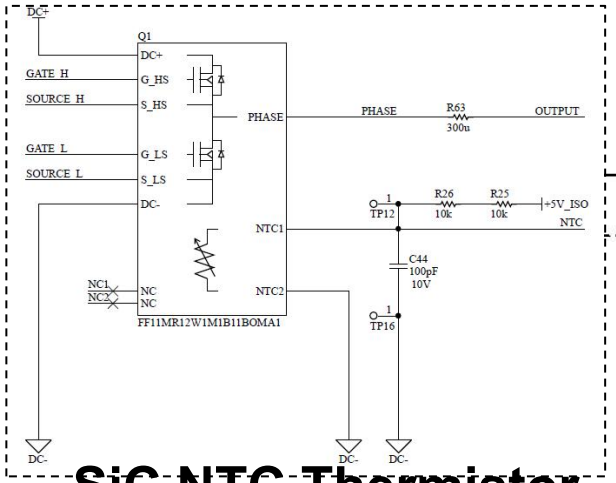
Infineon CoolSiC™ 驱动板 – 隔离DC BUS电压感测

BUS Voltage Divider

Scale 900V to 2V





SiC NTC Thermistor Voltage Divider

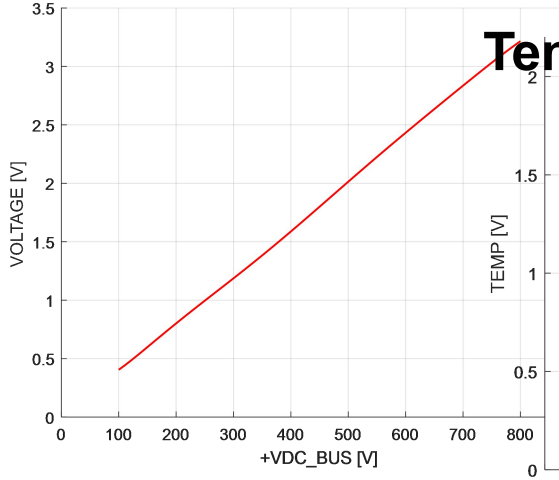
0°C to 140°C

2V to 0.05V

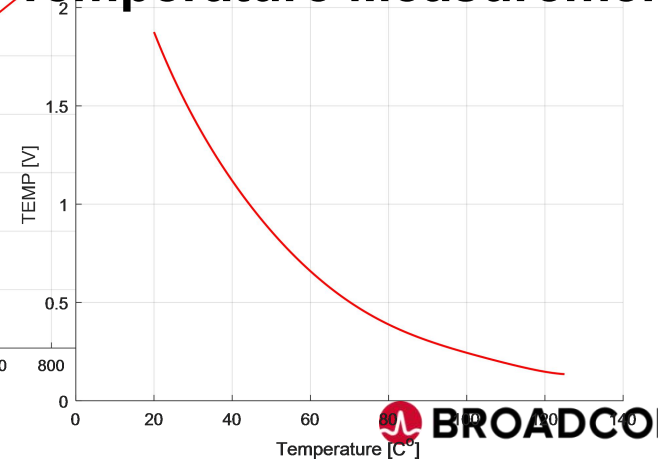
ACPL-C87B

- Linear input range : **0 - 2V**
- High input impedance : **1GΩ**
- Unity gain, differential output
- Gain accuracy: ±0.5%
- Gain Drift : -35ppm/°C
- Supply Voltage V_{DD2}: 3 to 5.5V
- Nonlinearity : 0.1% max

DC Bus Voltage Measurements



Temperature Measurements



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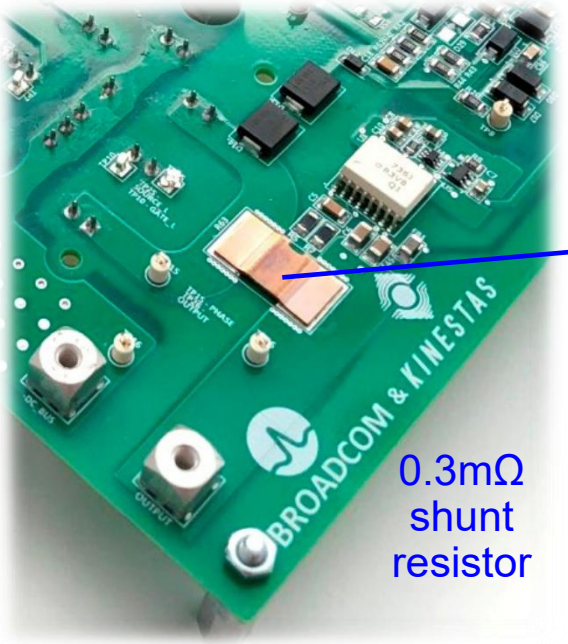
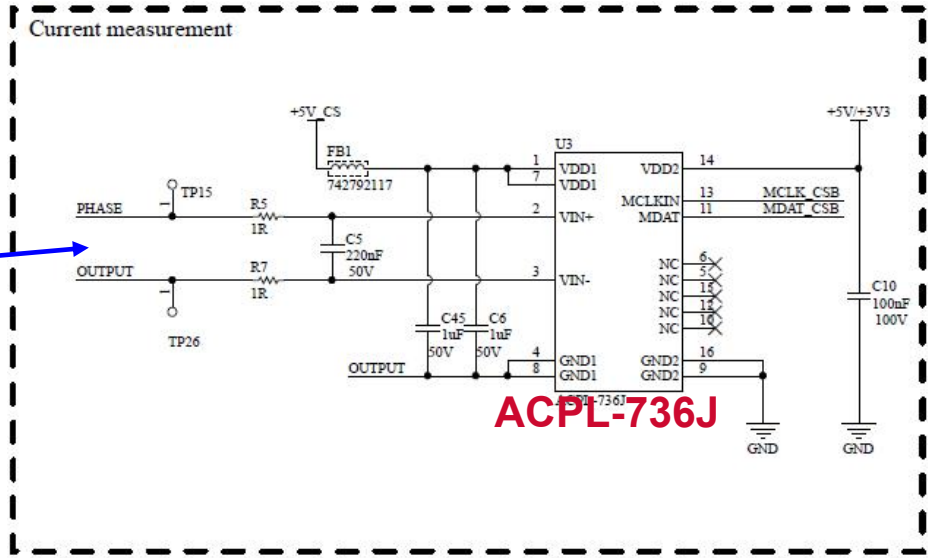
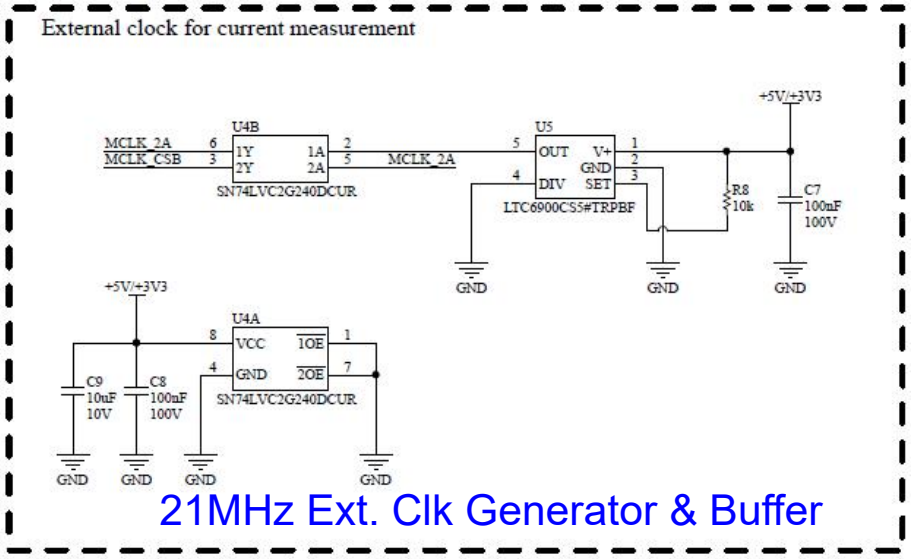
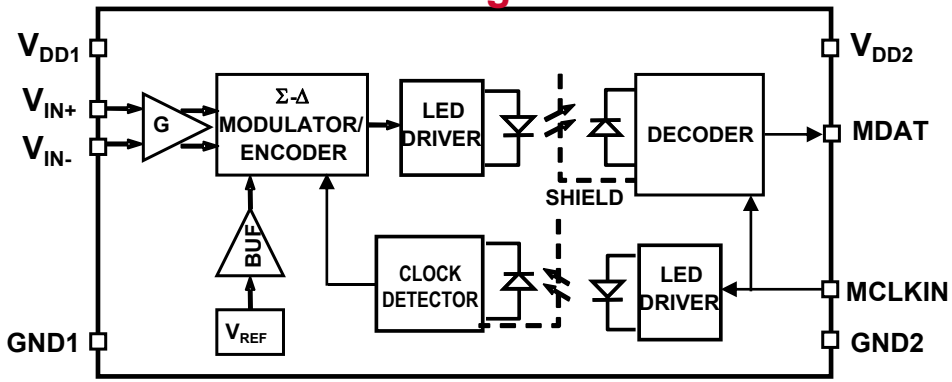
Infineon CoolSiC™ 驱动板– ACPL-736J电流感测







ACPL-736J ±50mV Sigma-Delta Modulator



Samples Available Now!

Features

- **±50 mV** linear range
- **5 to 21MHz** external clock input range
- **1-bit, second-order** sigma-delta modulator
- **16 bits resolution** no missing codes
- **80dB typ SNR**, 78dB typ. SNDR
- <1.0µV/°C maximum offset drift
- ±1% maximum gain error

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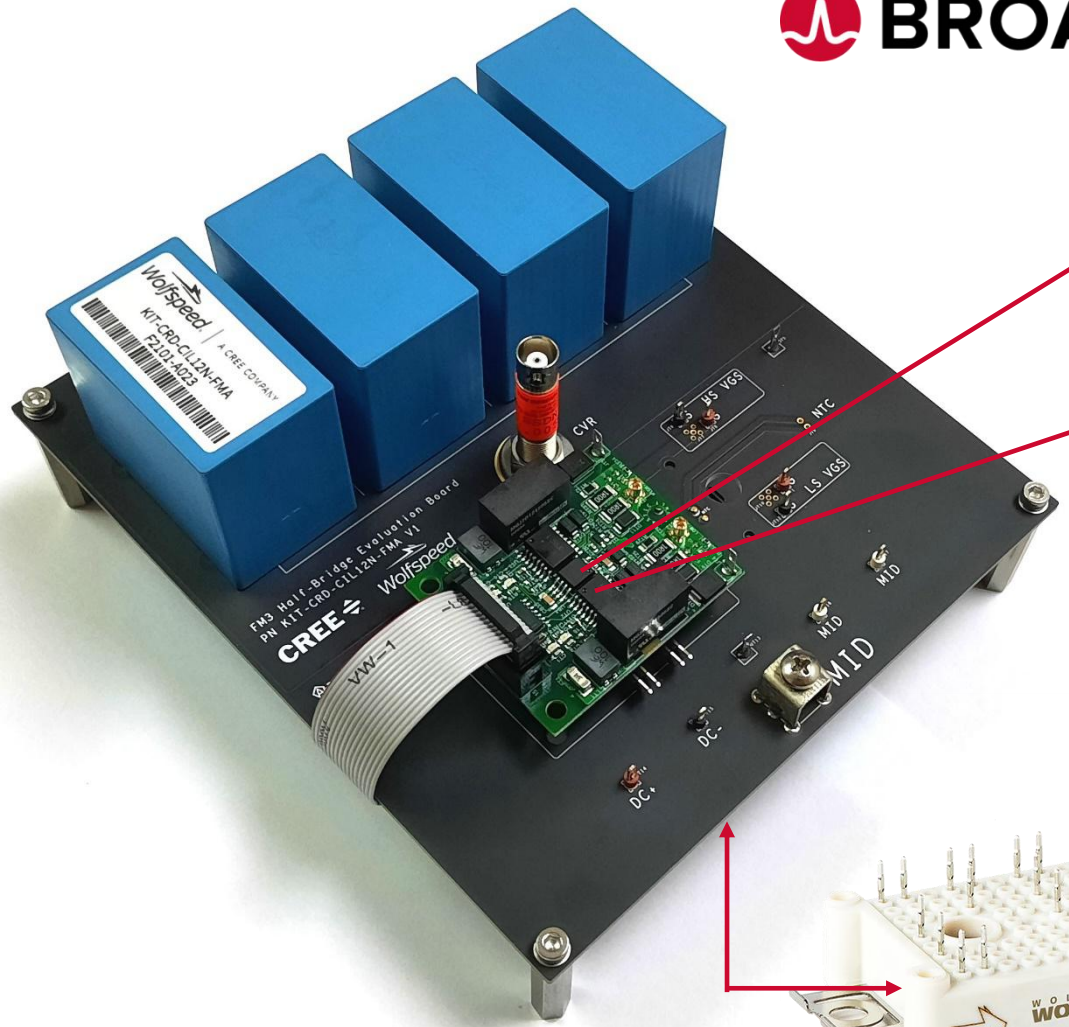
CREE Wolfspeed WolfPACK™ 半桥模块驱动板

BROADCOM®



ACPL-C87B

Isolated Voltage Sensor for IGBT thermistor sensing and BUS voltage sensing

ACPL-355JC

10A Gate Drive Optocouplers with Short Circuit Protection

Wolfspeed®

CAB011M12FM3

CAB016M12FM3

Wolfspeed wolfPACK™ Module

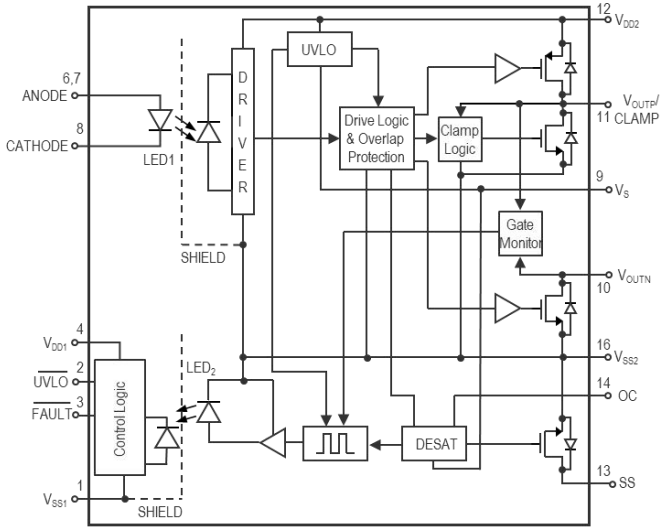
1200V 78-105A

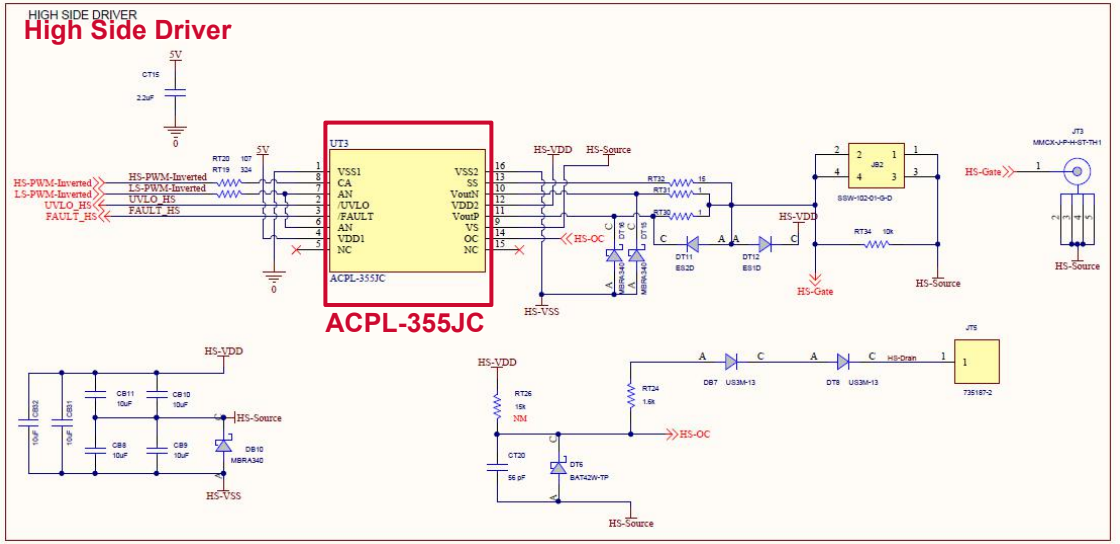
BROADCOM®

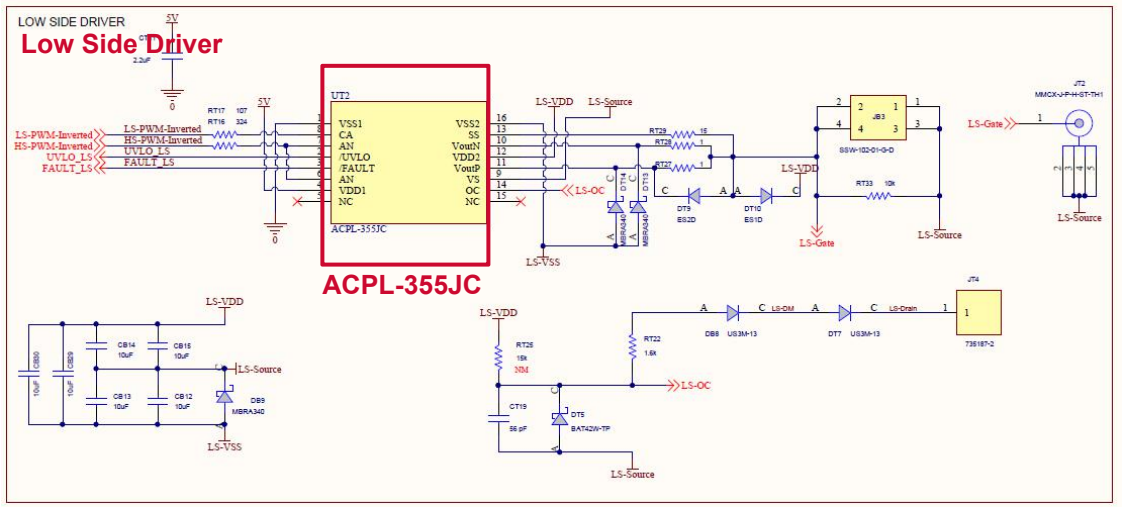
Wolfspeed WolfPACK™ 驱动板– ACPL-355JC 智能门极驱动器

Features

- **10A** peak output current
- **V_{IORM}=2262V_{PEAK}** working voltage
- **CTI > 600V**, **Material Group I** Package
- Short Circuit Protection with Feedback
- Noise Immunity, dv/dt > **100kV/µs**







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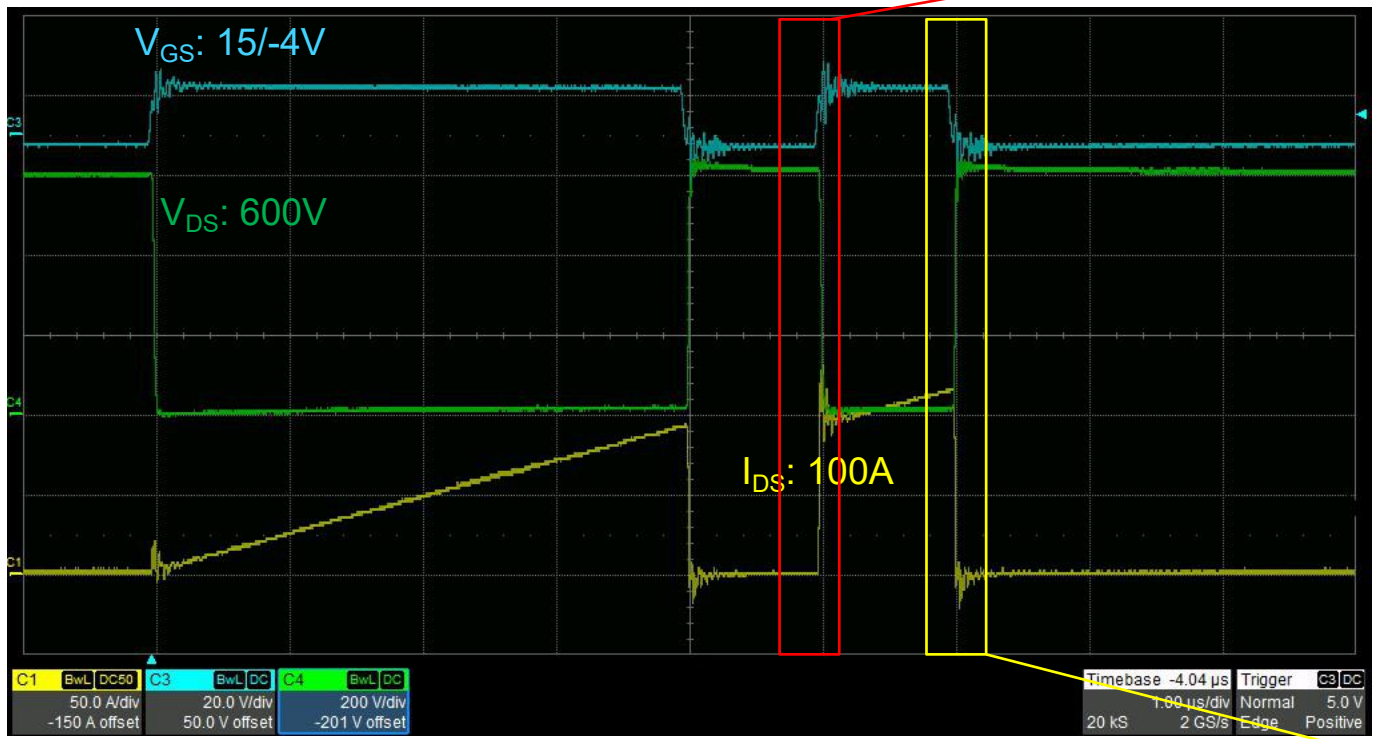
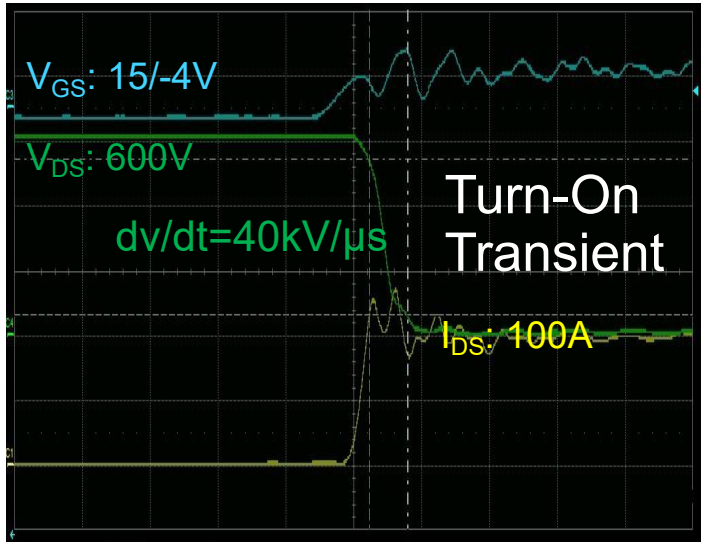
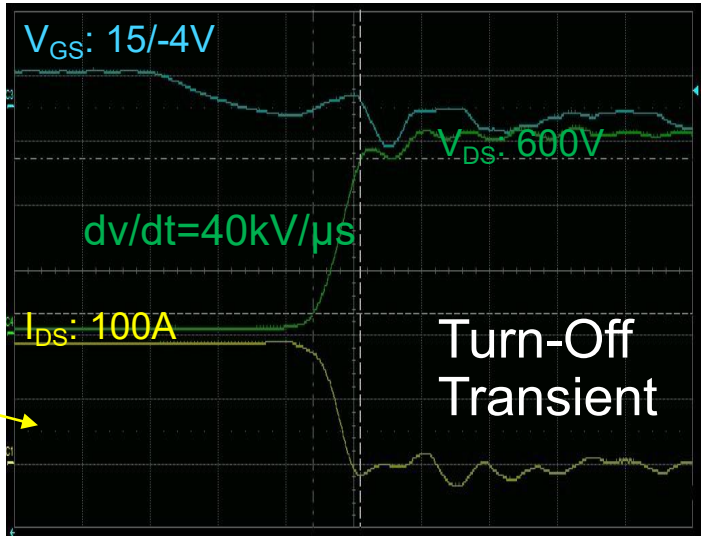
Wolfspeed WolfPACK™ 驱动板 – SiC开关性能

Double Pulse Test







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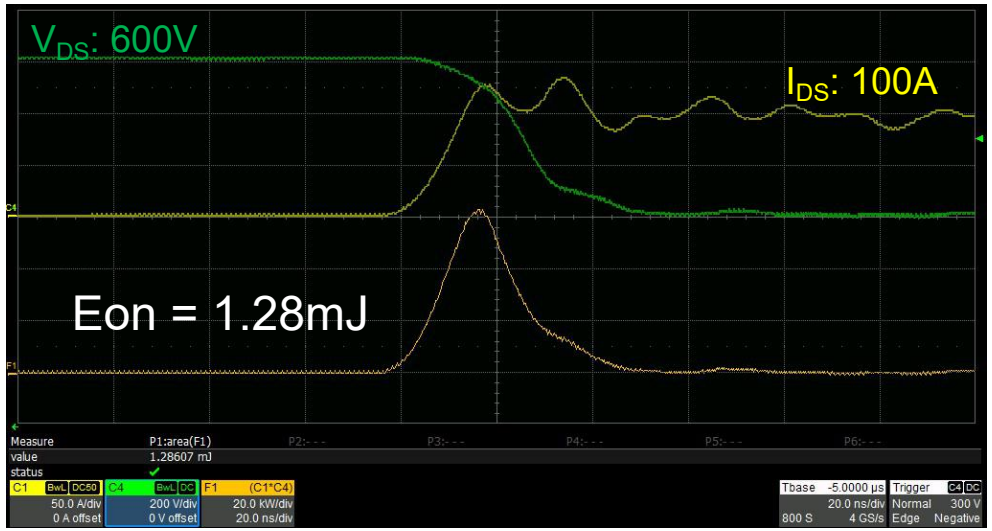
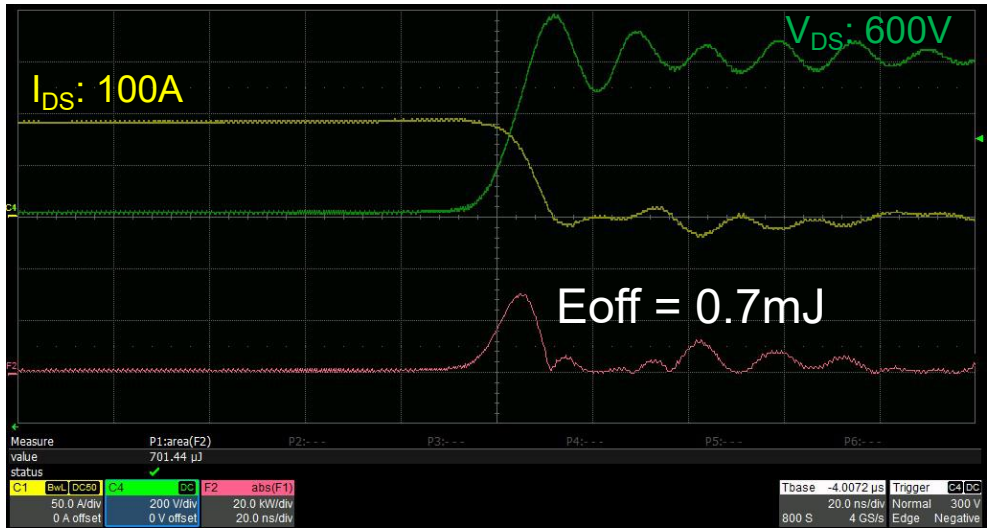
Wolfspeed WolfPACK™ 驱动板 – SiC开关性能





SiC Datasheet

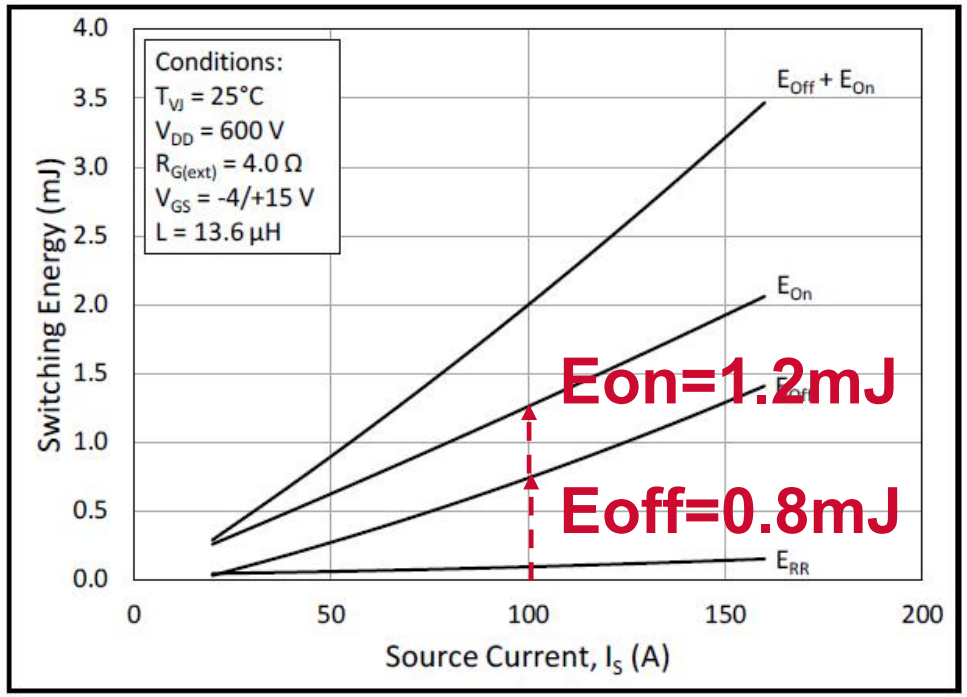


Figure 11. Switching Energy vs. Drain Current (V_{DS} = 600 V)

CAB016M12FM3

Datasheet 1200V/78A

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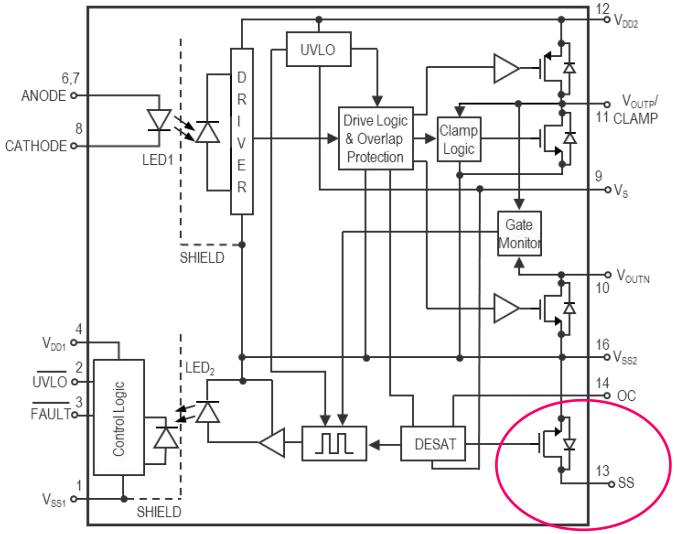
Wolfspeed WolfPACK™ 驱动板– SiC 短路测试

ACPL-355JC



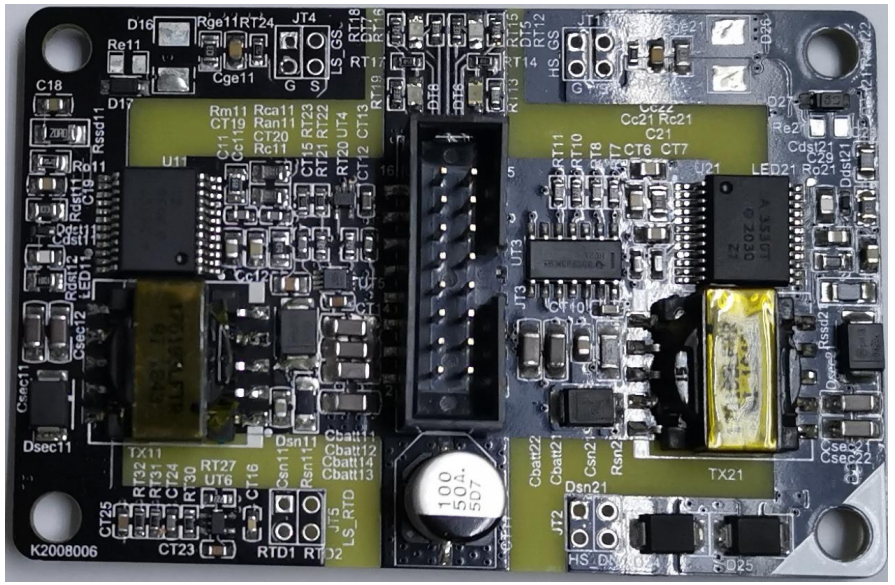
软关断引脚

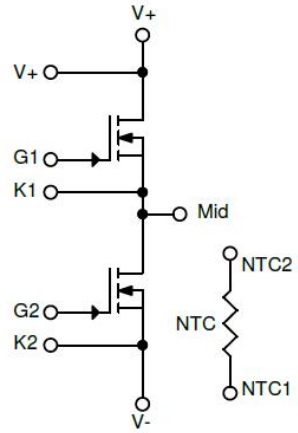
BROADCOM

Wolfspeed XM3 驱动板 – ACFJ-3530 智能门极驱动器

- CREE CAB450M12XM3
- 1200V, 450A all-Silicon Carbide
- Conduction optimized, half-bridge module
- Dual channel isolated gate driver IC (ACFJ-3530) with integrated flyback DC/DC PWM controller plus:
  - +16~18V regulated positive supply;
  - Programmable –5.1V supply up to -8V;
  - DC/DC power can be sized up to 4W;
  - Supply output overload protection;
  - Supply output short circuit protection;
  - SiC desaturation short circuit sensing with soft shutdown and fault feedback;
  - Under-voltage lockout protection (UVLO) and feedback.

驱动板详情请另行查询。





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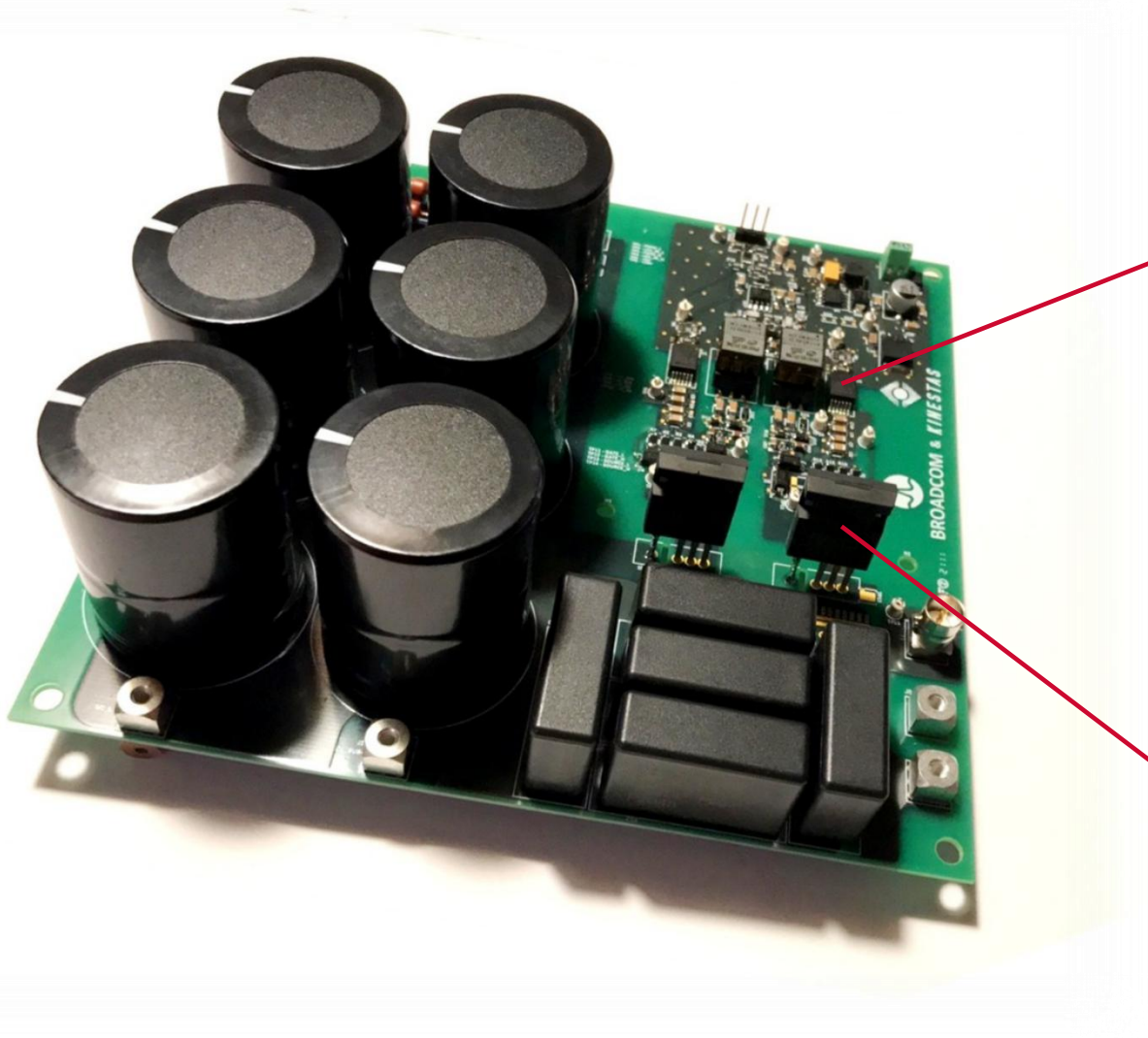
STM SiC Power MOSFET –半桥评估板



BROADCOM®

ACFL-3161

10A Single Channel
Gate Drive Optocouplers

life.augmented

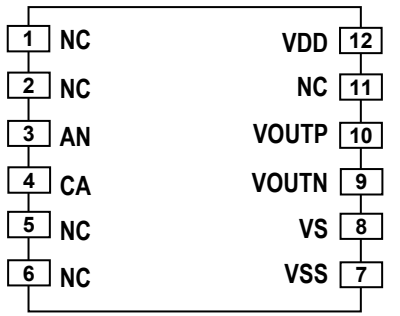
SCTWA70N120G2V4

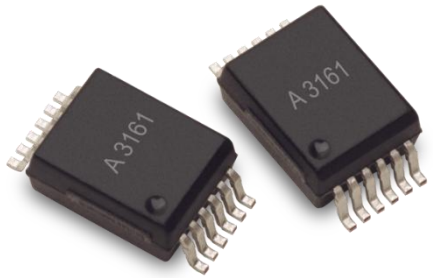
1200V, 90A, 21mΩ SiC MOSFET

STM SiC MOSFET 评估板– ACFL-3161基础门极驱动器

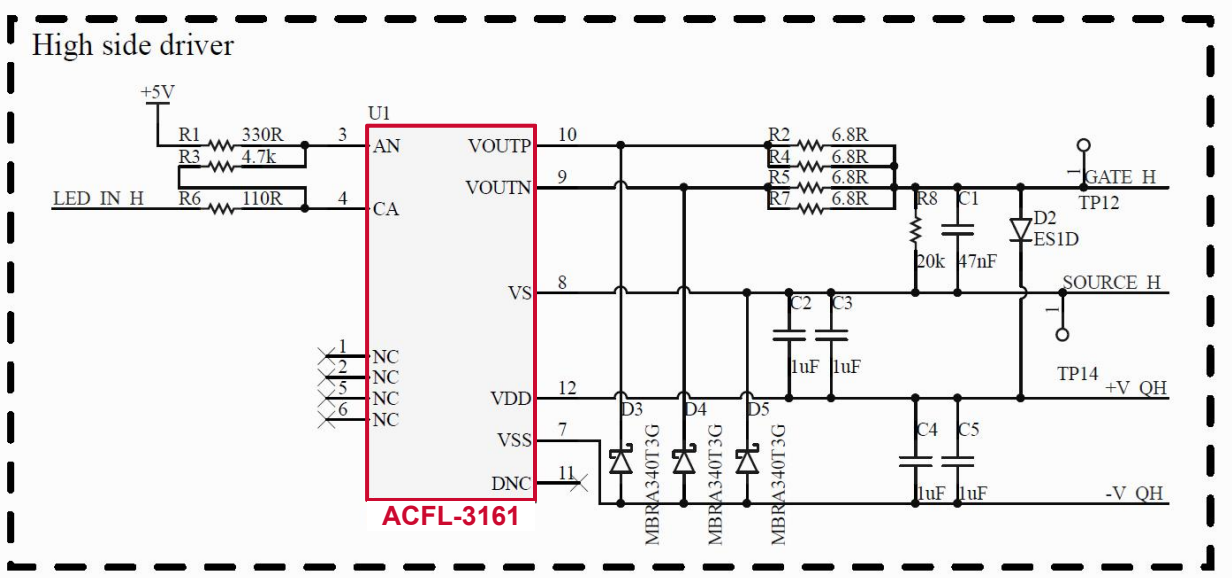
Features

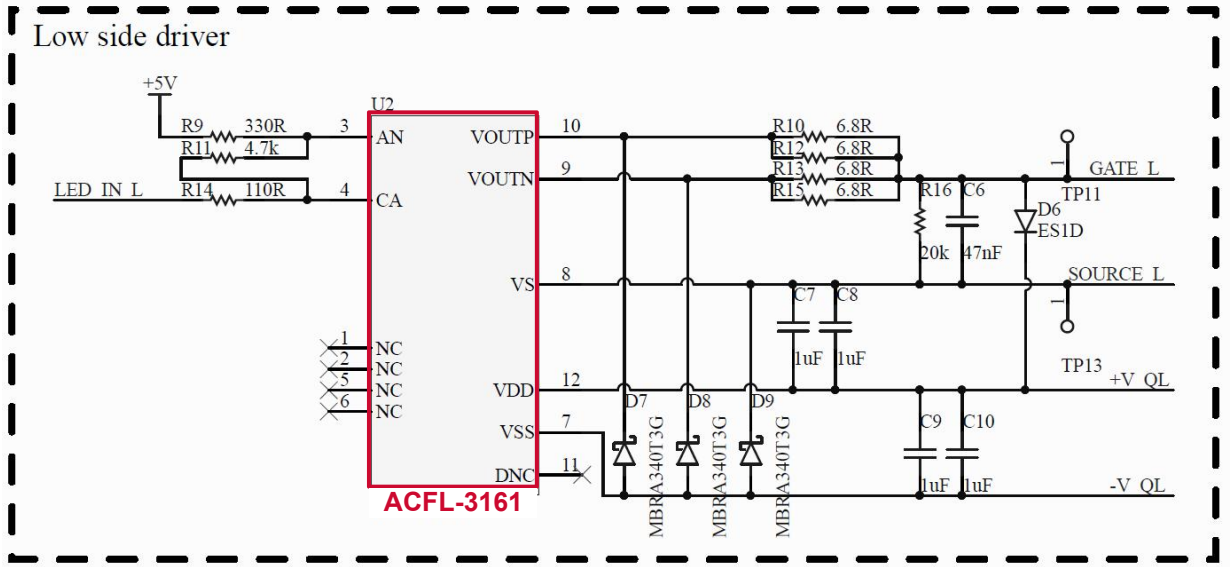
- **10A** peak output current
- Less than **95ns** propagation delay
- Noise Immunity, dv/dt > **100kV/µs**
- Safety Approval
  - UL Recognized 5000 V_{RMS} for 1min.
  - CSA
  - IEC/EN/DIN EN 60747-5-5 V_{IORM} = 1230 V_{PEAK}





Released!





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STM SiC MOSFET 评估板–电源和门极驱动设计

SCTWA70N120G2V4
Datasheet

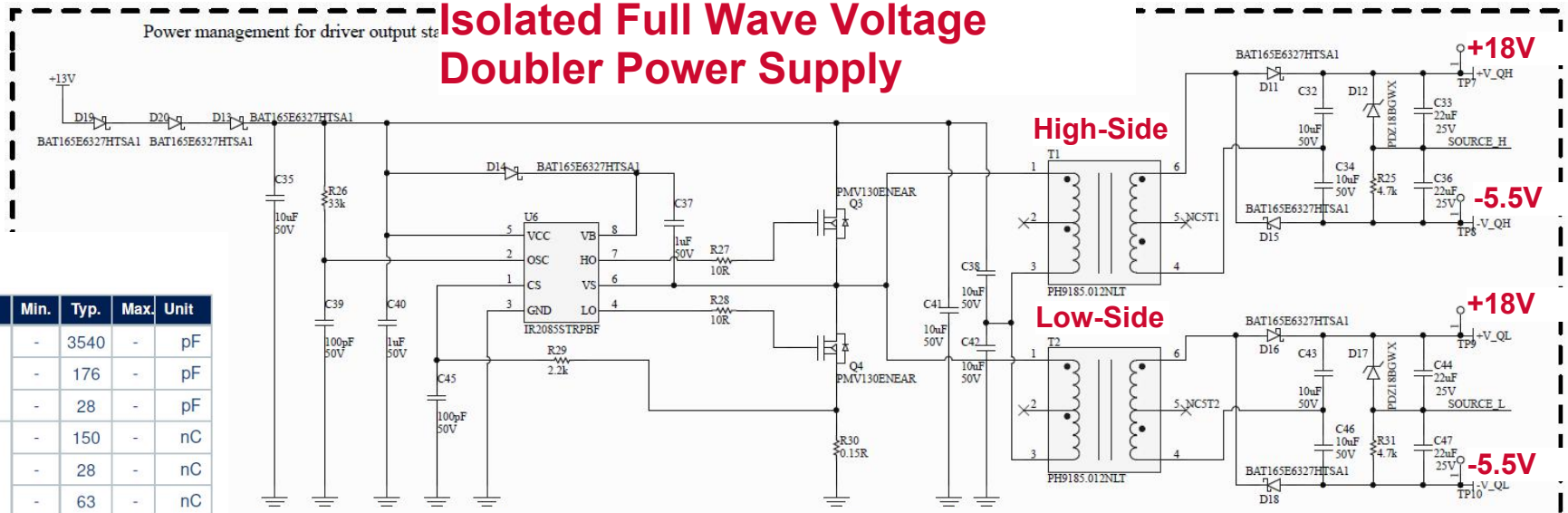
Table 4. **Dynamic**

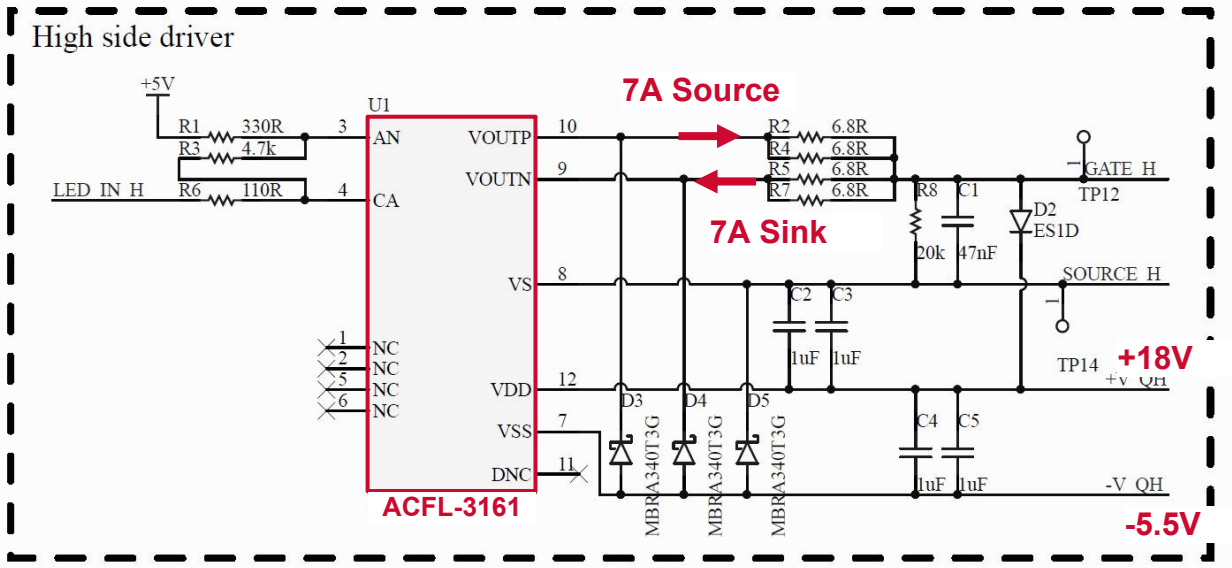
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 800 V, f = 1 MHz, V_{GS} = 0 V	-	3540	-	pF
C_{oss}	Output capacitance		-	176	-	pF
C_{rss}	Reverse transfer capacitance		-	28	-	pF
Q_g	Total gate charge	V_{DD} = 400, I_D = 50 A, V_{GS} = -5 to 18 V	-	150	-	nC
Q_{gs}	Gate-source charge		-	28	-	nC
Q_{gd}	Gate-drain charge		-	63	-	nC
R_G	Intrinsic gate resistance	f = 1 MHz, I_D = 0 A	-	1	-	Ω

Table 5. **Switching energy**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{ON}	Turn-on switching energy	V_{DD} = 800, I_D = 50 A, R_G = 3.4 Ω, V_{GS} = -5 to 18 V	-	895	-	µJ
E_{OFF}	Turn-off switching energy		-	332	-	µJ

Isolated Full Wave Voltage Doubler Power Supply





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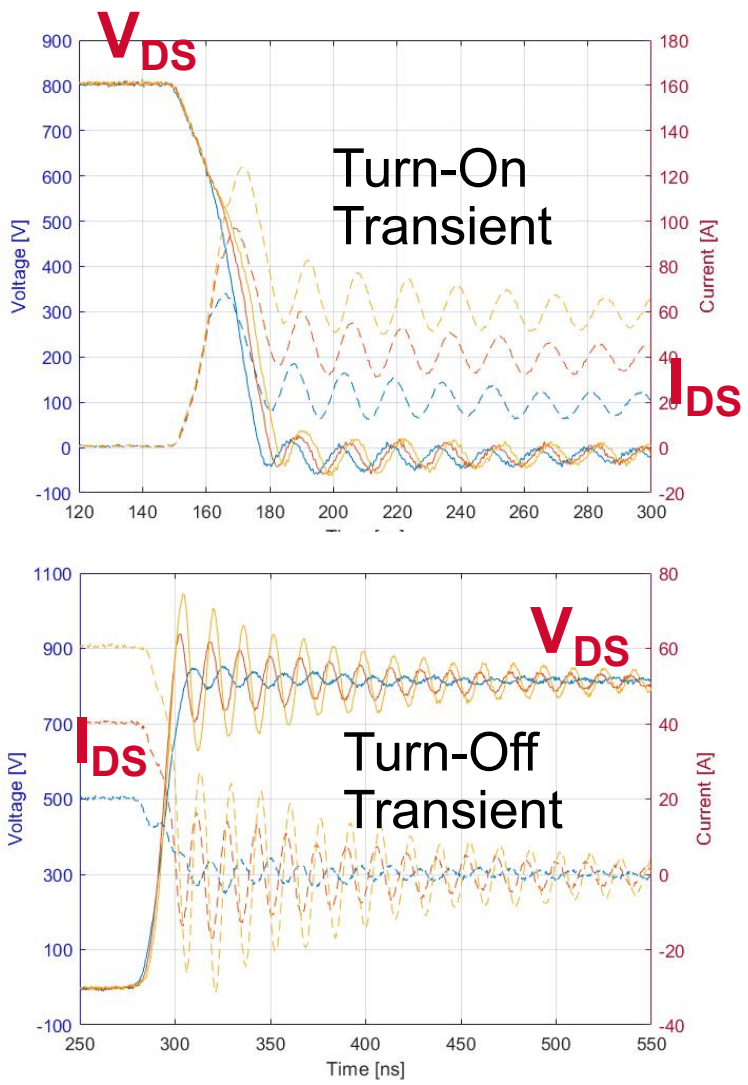
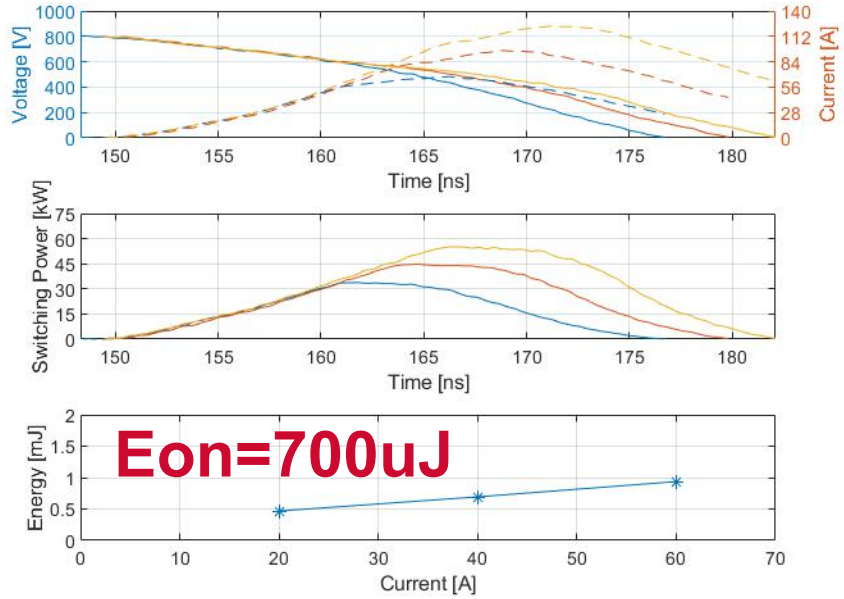
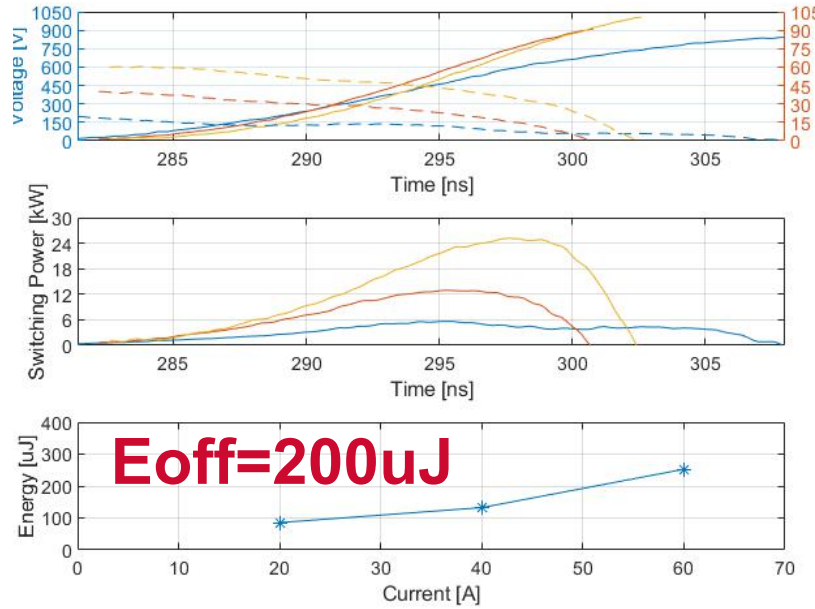
STM SiC MOSFET评估板– SiC开关性能







SCTWA70N120G2V4

Datasheet

Table 5. **Switching energy**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
E_{ON}	Turn-on switching energy	V_{DD} = 800, I_D = 50 A R_G = 3.4 Ω V_{GS} = -5 to 18 V	-	895	-	µJ
E_{OFF}	Turn-off switching energy		-	332	-	µJ

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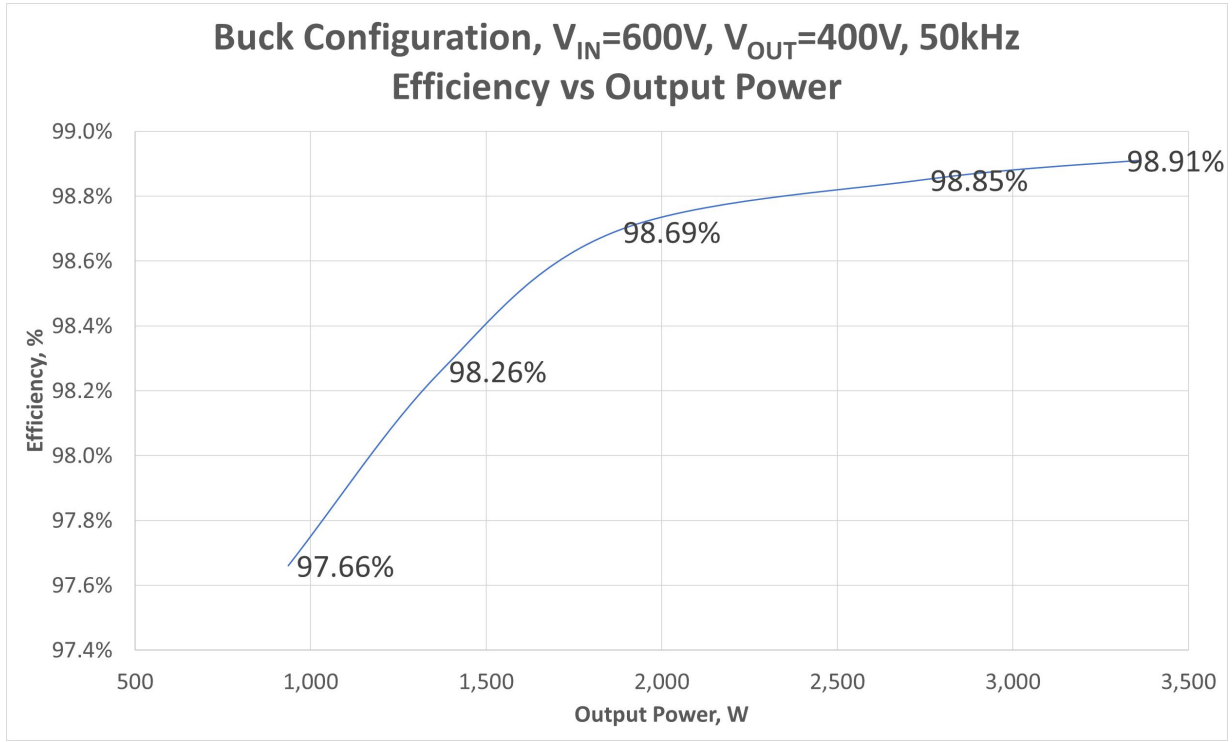
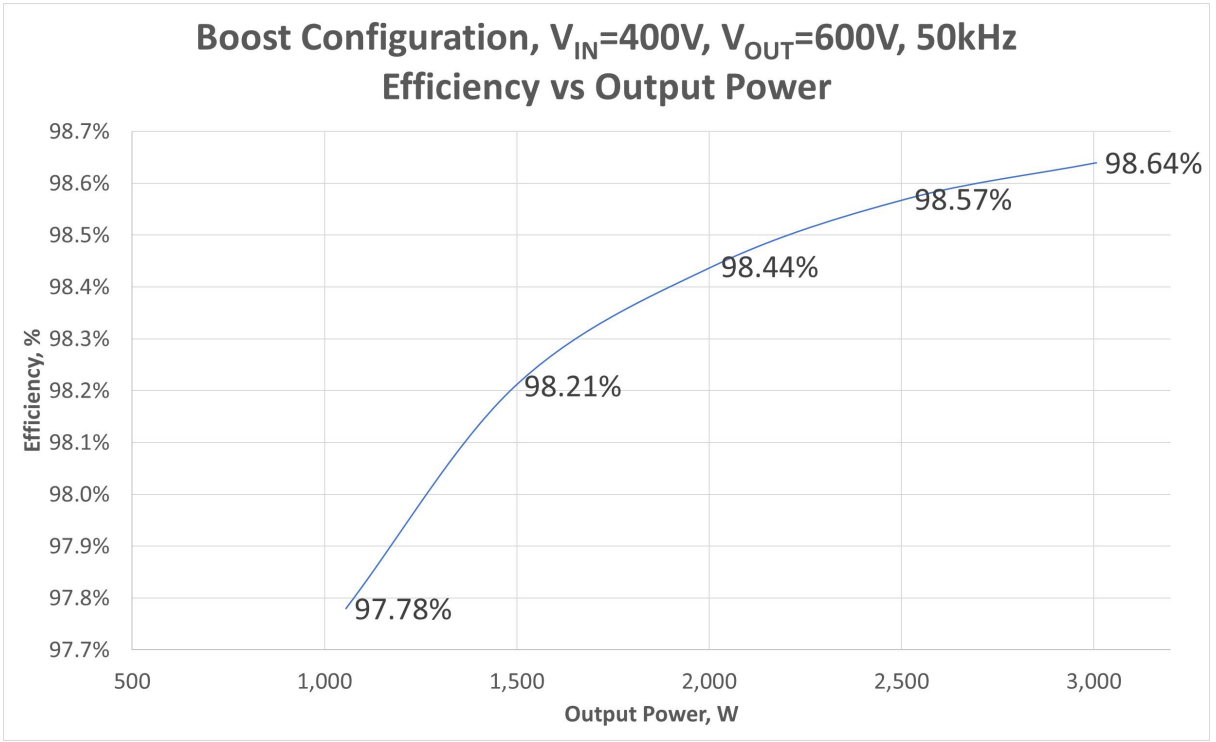
STM SiC MOSFET 评估板–效率性能





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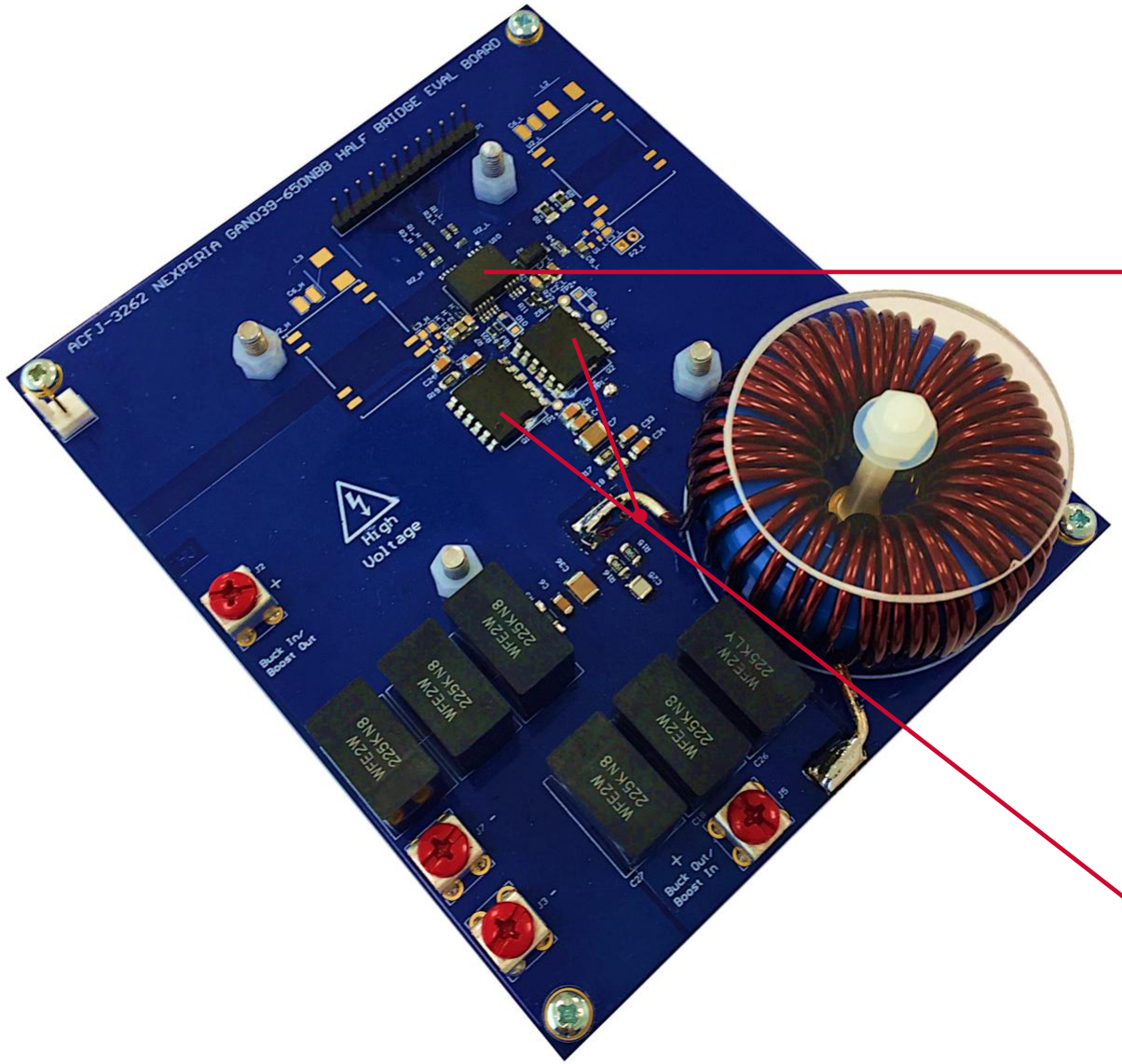
Nexperia GaN FET – 半桥评估板



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ACFJ-3262

10A Dual Channel Gate Drive Optocouplers

nexperia

GAN039-650NBB

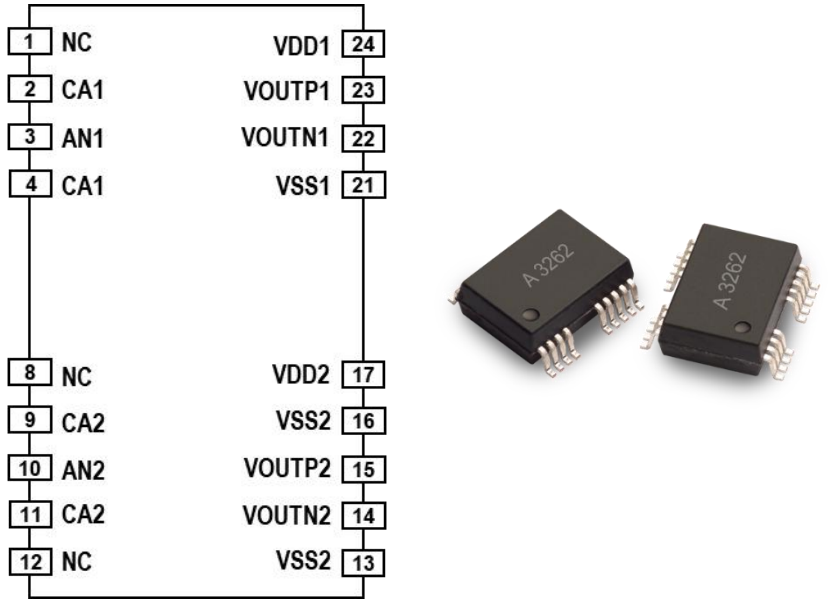
650V 33mΩ GaN FET

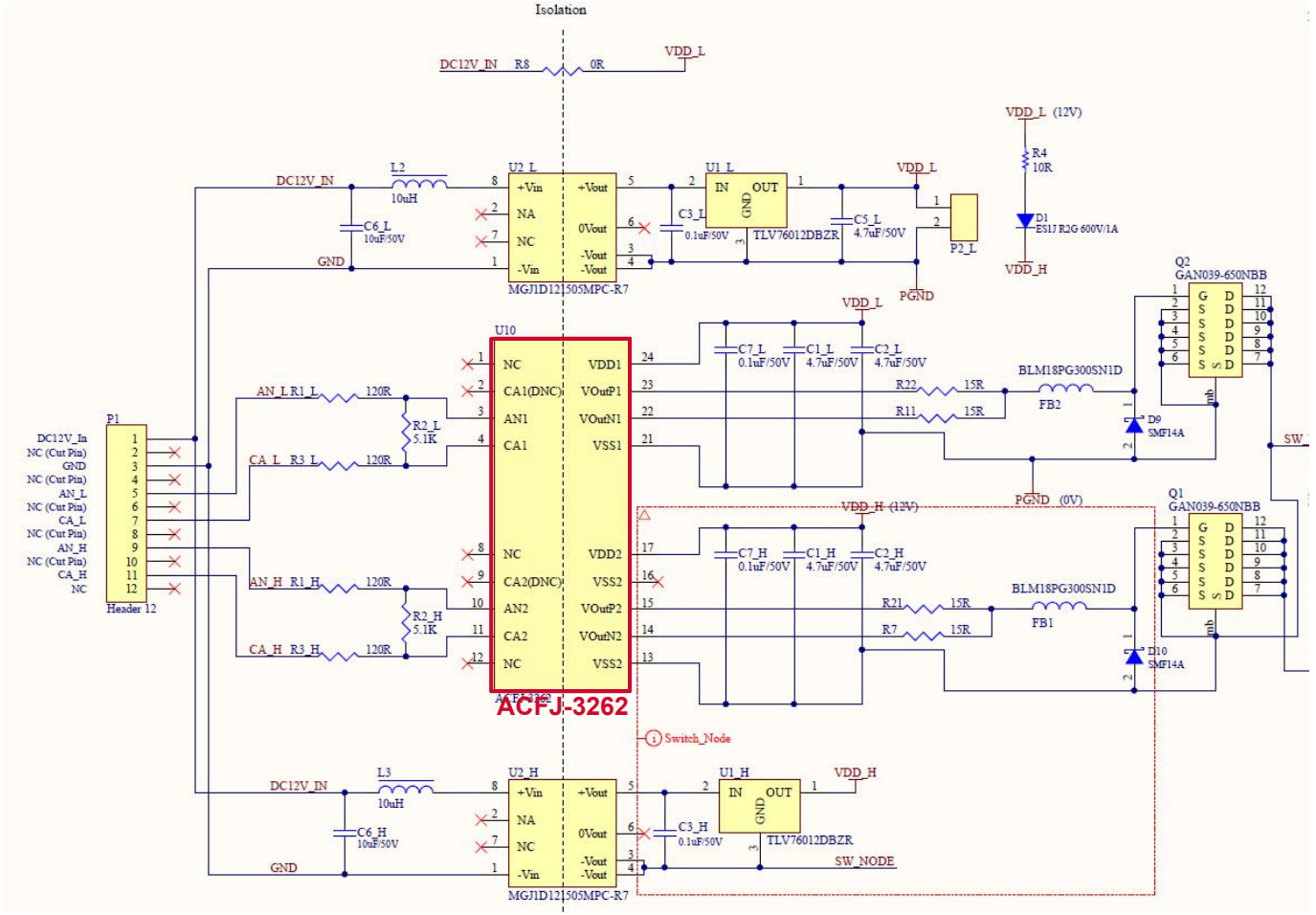
BROADCOM®

Nexperia GaN FET评估板– ACFJ-3262

Features

- **10A** peak output current
- 8.6V UVLO for **10-25V** supply range
- Less than **100ns** propagation delay
- Noise Immunity, dv/dt > **100kV/µs**





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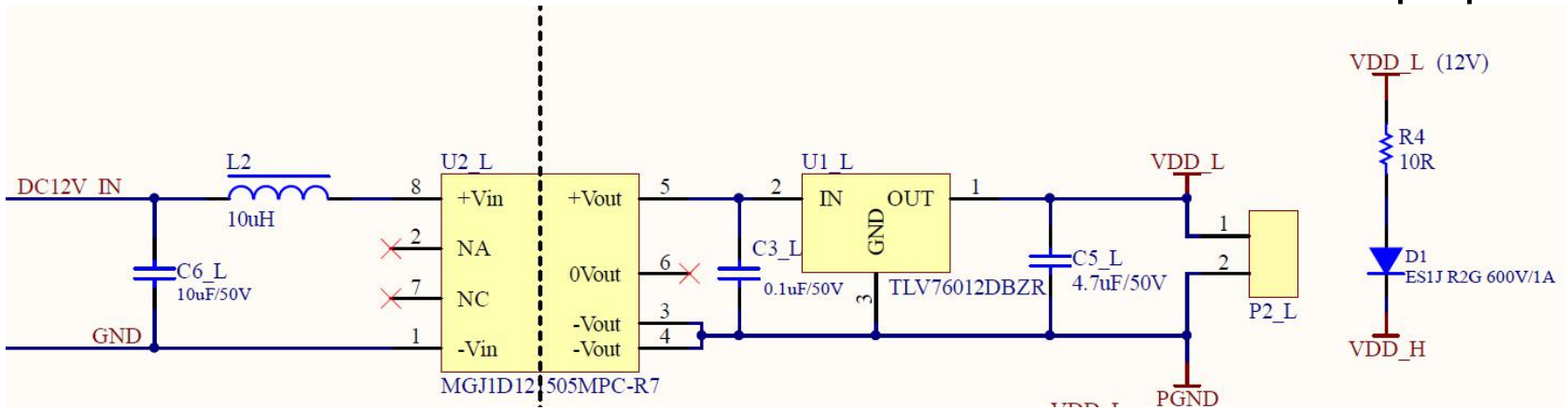
Nexperia GaN FET评估板– 门极驱动电源

12V/12V Isolated DC-DC Converter & Bootstrap options



GAN039-650NBB

650 V, 33 mOhm Gallium Nitride (GaN) FET in a CCPAK1212 package

31 July 2020 — Objective data sheet

1. General description

The GAN039-650NBB is a 650 V, 33 mΩ Gallium Nitride (GaN) FET in a CCPAK1212 package. It is a normally-off device that combines Nexperia's latest high-voltage GaN HEMT H2 technology and low-voltage silicon MOSFET technologies — offering superior reliability and performance.

2. Features and benefits

- Simplified driver design as standard level MOSFET gate drivers can be used:
  - 0 V to 12 V drive voltage
  - Gate threshold voltage V_{GSth} of 4 V
- Robust gate oxide with ±20 V V_{GS} rating

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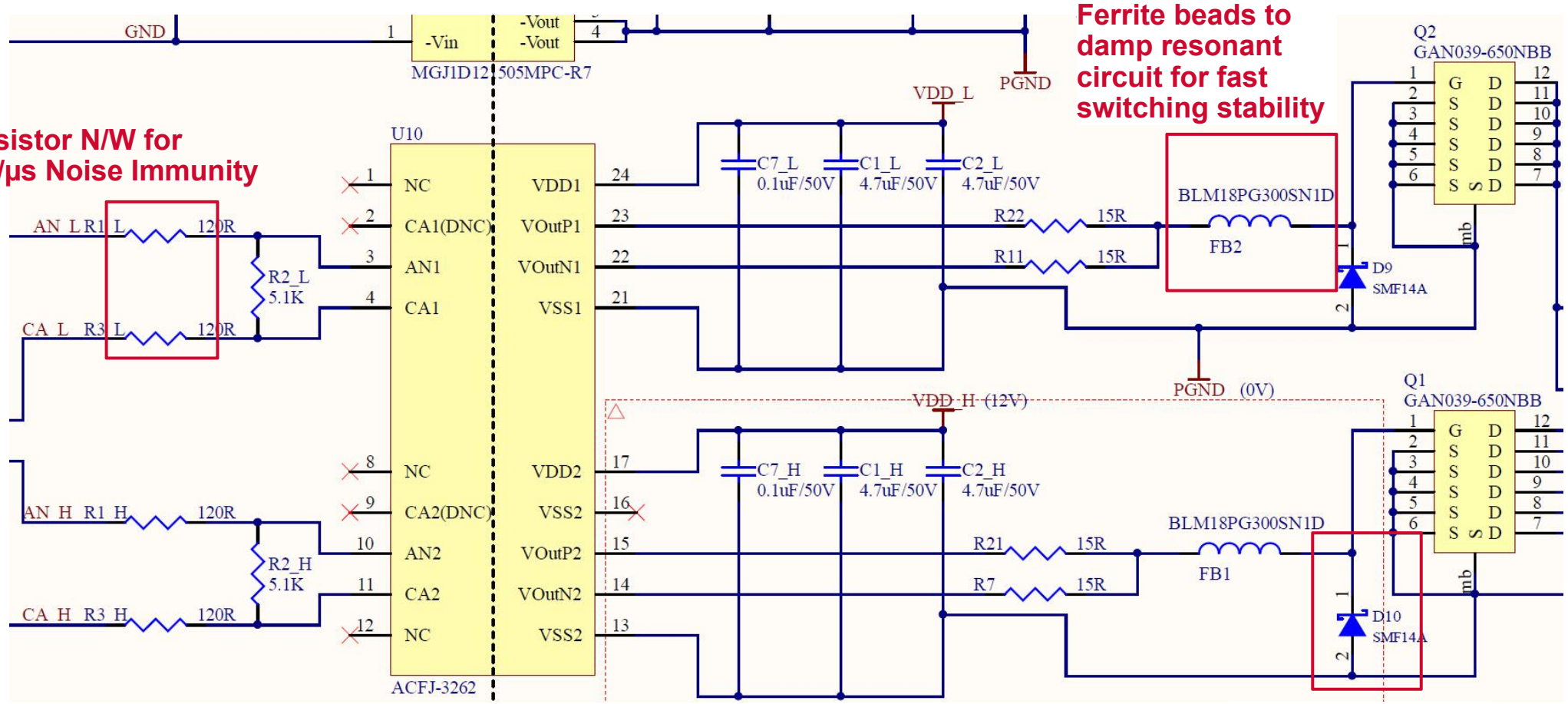
Nexperia GaN FET评估板– 门极驱动器设计



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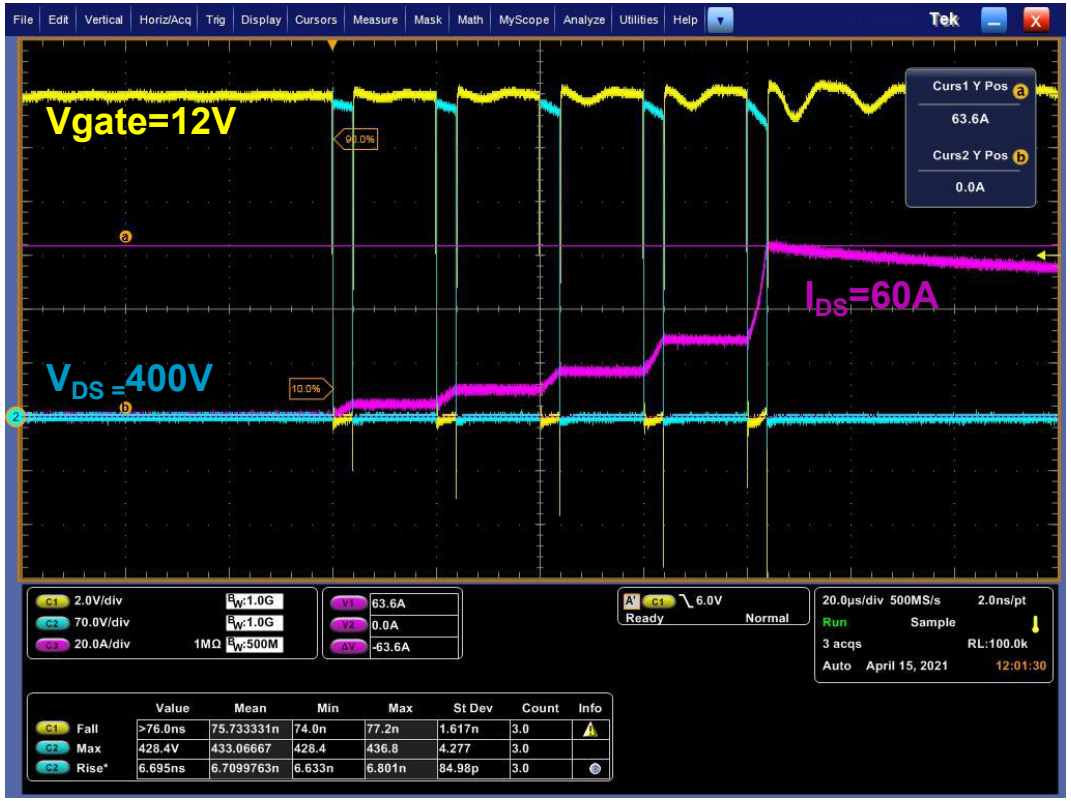
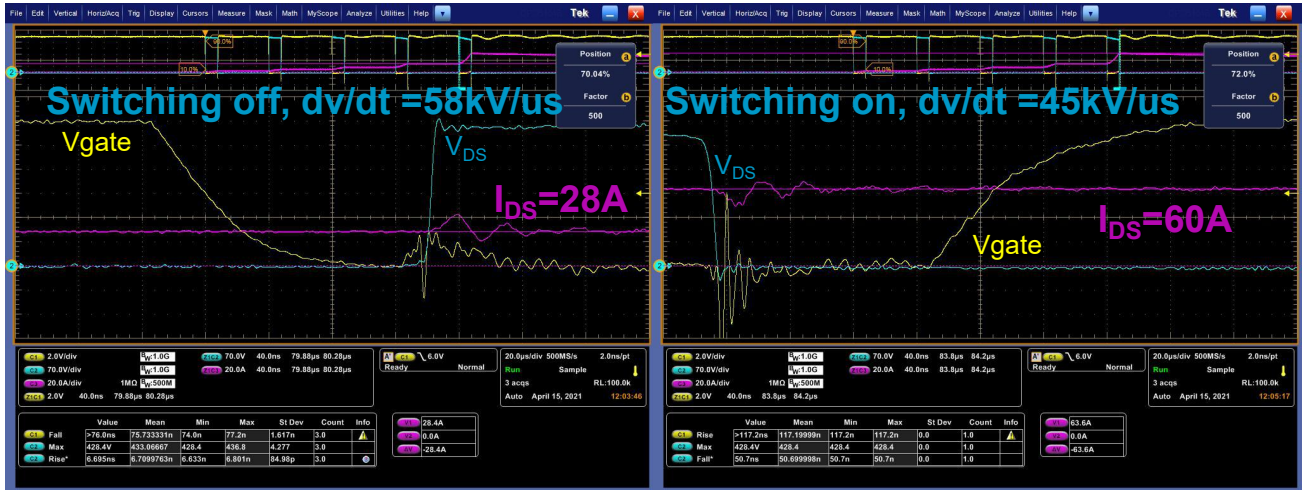
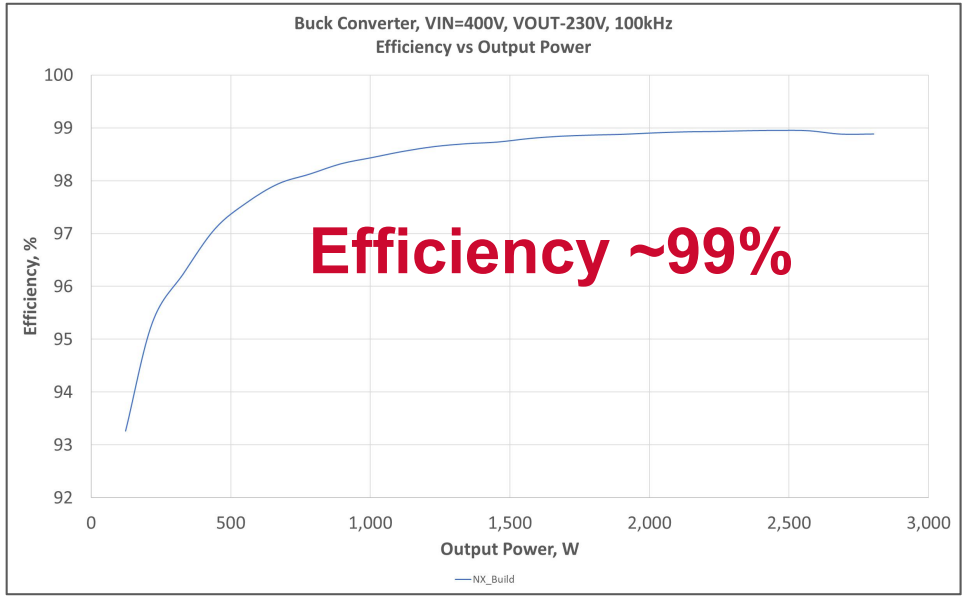
Nexperia GaN FET评估板 – 开关性能

Double Pulse Tests







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5

参考设计

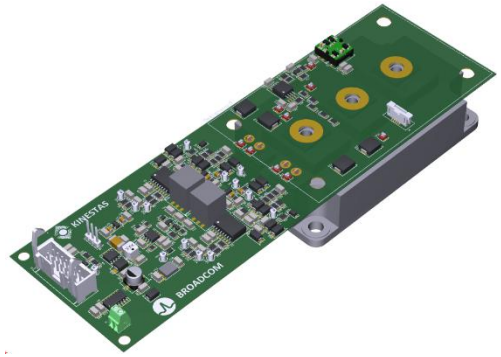
Scan for Reference Design Details

Infineon CoolSiC™

Easy1B Module

STM STSiC

TO-247 Discrete

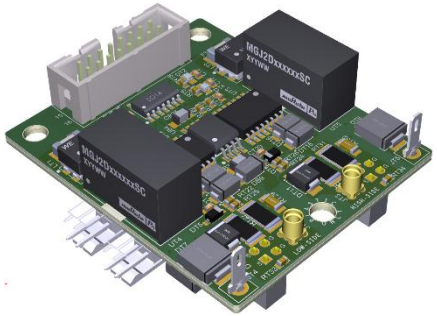


Infineon CoolSiC™

62mm Module

Nexperia GaN FET

CCPAK1212 Discrete



Wolfspeed SiC

WolfPACK™ Module

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