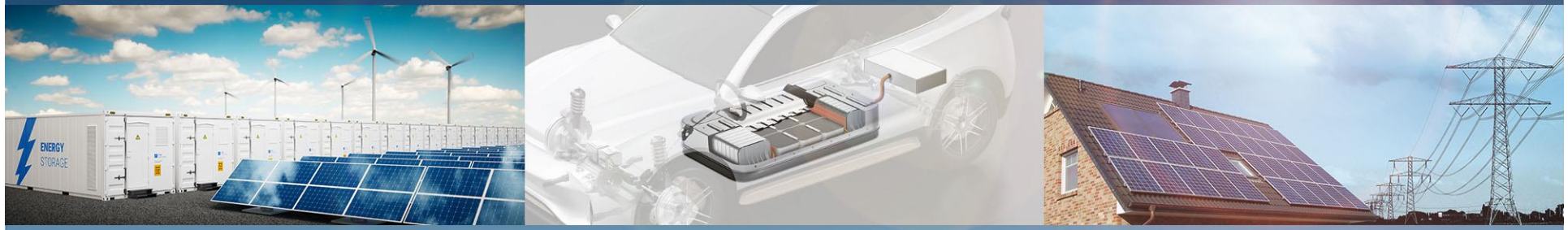
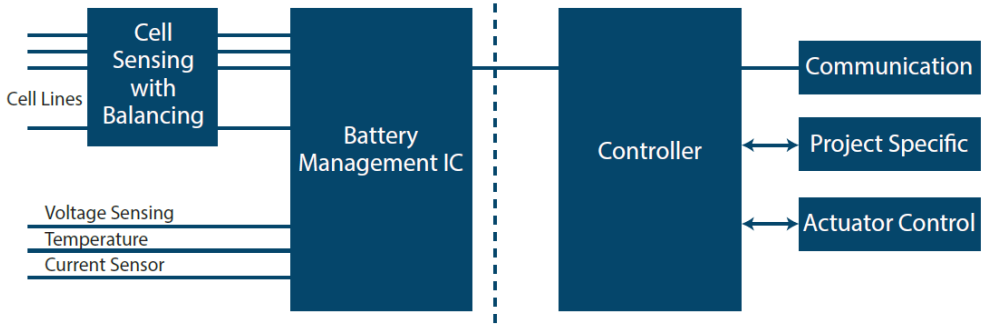
Bourns电池管理系统(BMS) 整体解决方案



BOURNS®

Outline

- Bourns公司介绍
- Bourns 针对 BMS系统的整体解决方案
  - BMS整体方案概况
  - 针对BMS的磁性器件解决方案
  - 针对BMS的电路保护器件解决方案
  - 针对BMS的电流采样器件解决方案
- Q & A



Bourns 公司介绍

- 全球知名的电子元器件研发&生产供应商。提供电路调节/电路保护/Sensing的整体解决方案。
- 公司成立于1947年，由Marlan and Rosemary Bourns创立。
- 总部在Riverside, CA
- 在全球拥有16个电子产品制造中心，员工约5700人
- 所有的制造中心都通过了ISO 9001和/或IATF/TS16949认证

Bourns公司宗旨

成为客户所信赖的首选电子器件及方案解决供应商

全球化生产


Chihuahua, Mexico


Bedford, UK


BOURNS
Osaka, Japan


Suzhou, China


Tijuana, Mexico


Ajka, Hungary


Okayama, Japan


Xiamen, China


Heredia, Costa Rica


BOURNS
Žužemberk, Slovenia


Shiga, Japan


Xiang'an, China


BOURNS
Logan UT, U.S.A.


BOURNS
Linkou, Taiwan


Fukui, Japan


Dongguan, China

汽车组件应用

Comfort & Positioning
Window Lifts, Seat Positioning

Instrumentation, Infotainment & Telematics
Dashboards, GPS, In-Car Cameras, In-Car Televisions

Vehicle Lighting
HID, LED

Vehicle Networks
CAN, Flexray, Ethernet, LIN

Electrification of Powertrain
BMS, Fuel Pumps, Start Stop Module, High Power DC/DC Convertors, Battery Chargers

Bourns Value Proposition

- AEC-Q200 qualification – PPTC, Inductors, Transformer, CMC, Solenoid, PFC, Wireless coil, Magnetic, Power Resistors, ESD, Sensors & Controls
- TS 16949 quality system
- Application test lab

Bourns 主要产品介绍

(1) Circuit Conditioning

- ***Current and Voltage Management***
  - **Trimpot® Trimming Potentiometer**
  - Precision Potentiometers
  - Chip Resistors
  - Inductors and Transformer
  - Precision Resistors
  - Resistor Networks (Thick Film/Thin Film
  - Switches
- ***Current Sensing***
  - **CSR: Current Sense Resis**
- ***Digital Signal Management***
  - Chip Diodes
- ***Filtering***
  - Power Chokes
  - Transformers
- ***Interconnect***
  - Connectors
  - Metal Contacts

(2) Motion Control Sensing

- ***Measurement***
  - CSR : Current Sense Resistors
  - Single- and Multiturn Rotary Contacting Position Sensors
  - Single- and Multiturn Rotary Non-Contacting Position Sensors
- ***Control***
  - Single- and Multitur ols
  - Contacting Encoder
  - Optical Encoders
  - Magnetic Encoders

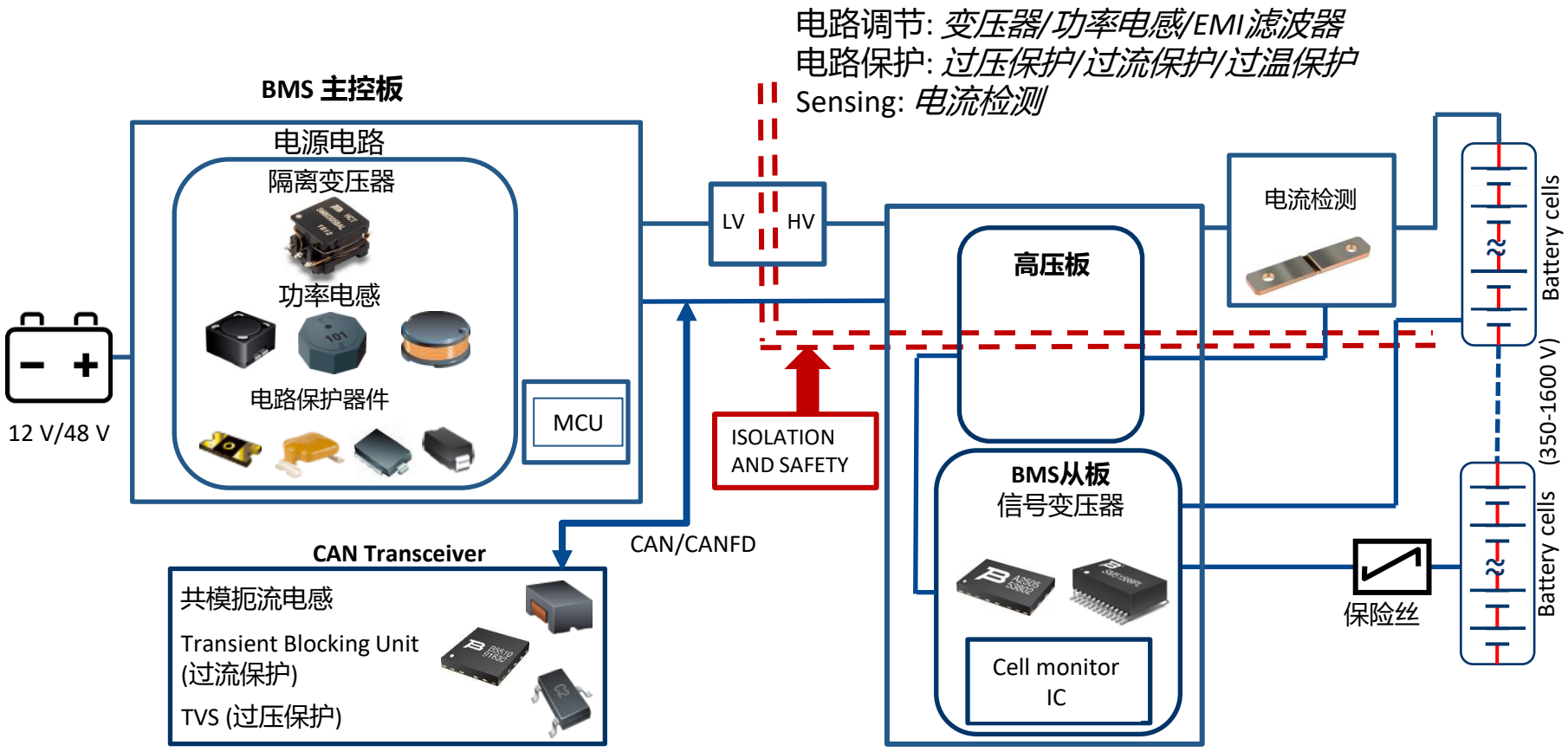
(3) Circuit Protection

- ***Innovative Offerings***
  - TBU® High-Speed Protectors
  - TCS™ High Speed Transient Current Suppressors
  - FLAT™ GDT Surge Arrestors
- ***OCP : Overcurrent Protection Devices***
  - Multifuse® Polymer PTC Resettable Fu
  - Ceramic PTC Resettable Fuses
  - Telecom Fuses – Telefuse™ Products
  - Thin Film Chip Fuses – SinglFuse™ Pro
- ***OVP: Overvoltage Protection Devices***
  - TISP® Thyristor Surge Protectors®
  - Gas Discharge Tubes – GDT
  - Integrated TVS Diode Arrays
  - TVS Diodes and Diode Arrays
  - ChipGuard® ESD Suppressors
  - Metal Oxide Varistors – MOVs
- ***Overtemperature Protection Devices***
  - *Mini-Breakers (Miniature Thermal Cut-Off Device*
  - *Polymeric Temperature Cutoff (PTCO)*
- ***SPDs : Surge Protective Devices***
  - AC Line Protection
  - DC Line Protection
  - Coax and Data Line Protection
- ***LED Shunt Protectors – LSPs***

Outline

- Bourns公司介绍
- Bourns 针对 BMS系统的整体解决方案
  - BMS整体方案概况
  - 针对BMS的磁性器件解决方案
  - 针对BMS的电路保护器件解决方案
  - 针对BMS的电流采样器件解决方案
- Q & A

Bourns针对BMS系统整体方案概况



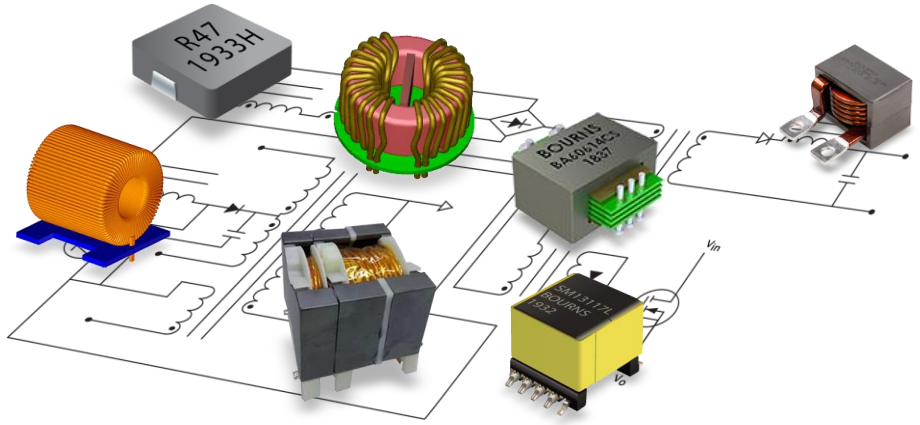
Outline

- Bourns公司介绍
- Bourns 针对 BMS系统的整体解决方案
  - BMS整体方案概况
  - 针对BMS的磁性器件解决方案
  - 针对BMS的电路保护器件解决方案
  - 针对BMS的电流采样器件解决方案
- Q & A

电源/信号磁性器件的设计难点

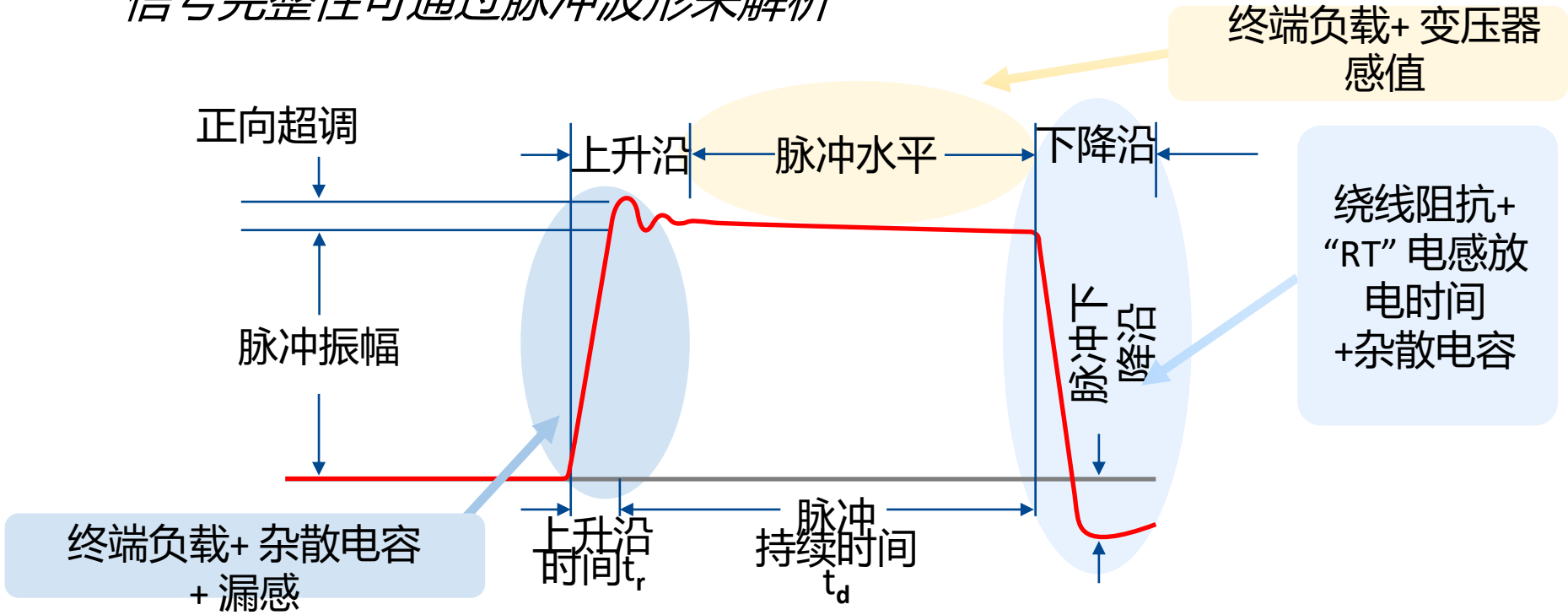
成功要素

- 维持信号完整性
- 兼顾元器件的尺寸和损耗
- 满足隔离以及EMC/EMI需求
- 选择合适的拓扑结构



隔离变压器方案–保持信号完整性

信号完整性可通过脉冲波形来解析



寄生参数: 寄生电容vs. 漏感

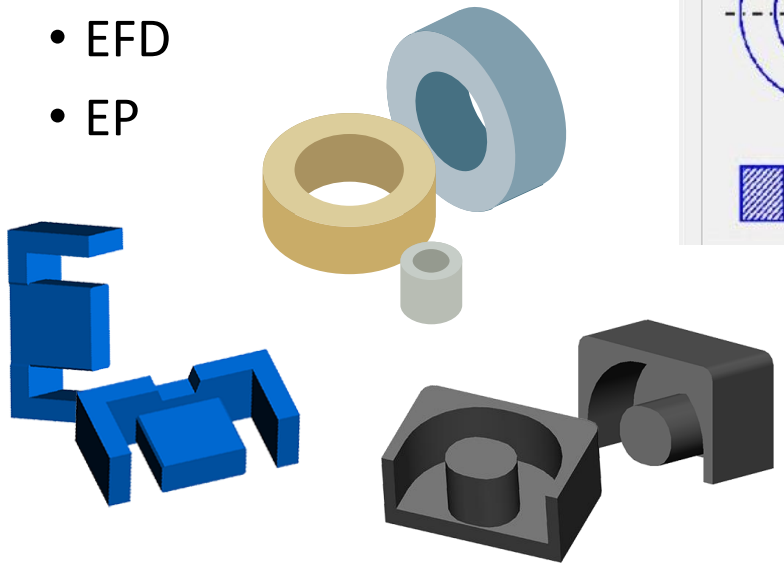
- 降低匝数–降低杂散电容 (更高的谐振点)
- 增加原副边距离– 降低绕线间电容
- 增加绕线股数–增加绕线间电容
- 屏蔽线–降低绕线间电容

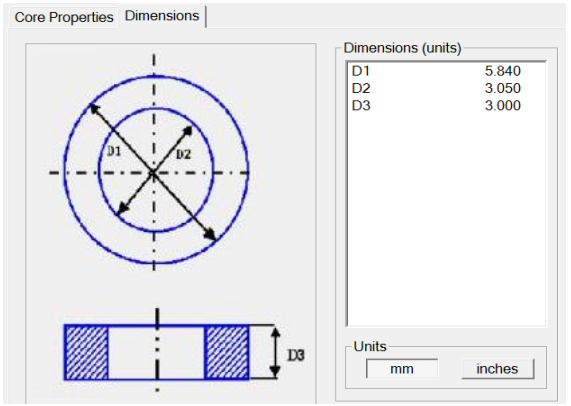
- 降低匝数– 降低漏感
- 降低原副边距离–降低漏感
- 增加绕线股数–降低漏感
- 屏蔽线– 增加漏感

- *安规性能在变压器产品中扮演了重要角色*
- *基本来说，为了改善 EMC/EMI 特性意味着更多的成本投入 (如增加屏蔽)*
- *寄生参数对损耗影响不大(铁损和铜损)*
- *需要综合考虑各种参数*

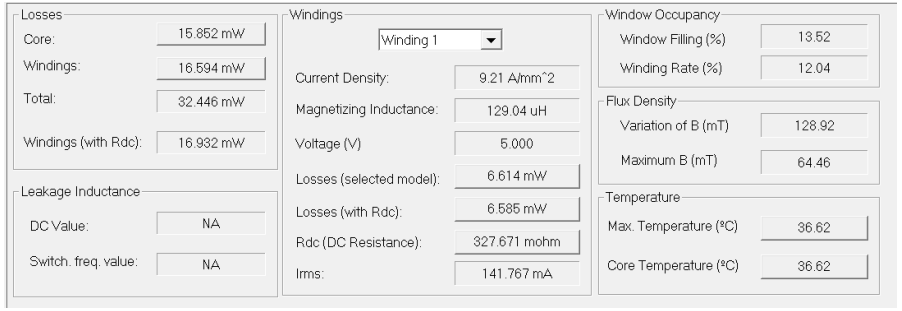
降低损耗以及尺寸

- T-环磁芯
- 铁氧体
- EFD
- EP





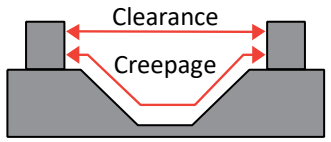
Part Number	#	Turns Ratio (Np : Ns)	Temp. at 350mA (°C)	Room Temp. (°C)
HCTSM80809AAL	1	8 : 9	35.2	20.4
HCTSM80809AAL	2	8: 9	36.3	19.8
HCTSM80803AAL	1	8 : 3	32	22.8
HCTSM80803AAL	2	8 : 3	32.1	23.6
HCTSM81017CAL	1	10 : 17	44.5	21.1
HCTSM81017CAL	2	10 : 17	44.7	21.3
HCTSM80305BAL	1	3 : 5	41	19.9
HCTSM80305BAL	2	3 : 5	41.6	19.9
HCTSM80304BAL	1	3 : 4	34.8	19.7
HCTSM80304BAL	2	3 : 4	32	19.8
HCTSM80201AAL	1	2:1	30	21.2
HCTSM80201AAL	2	2:1	31	21.1
HCTSM80403AAL	1	4:3	32	20.8
HCTSM80403AAL	2	4:3	33	20.6
HCTSM80102AAL	1	1:2	52.3	20
HCTSM80102AAL	2	1:2	52.1	20
HCTSM80308BAL	1	3:8	59	19.7
HCTSM80308BAL	2	3:8	61.5	19.8
HCTSM80910BAL	1	9:10	35.1	19.8
HCTSM80910BAL	2	9:10	33.8	19.8



BMS的高压绝缘

需要满足下列参数的合适变压器

- 最高工作电压
- 过压类型 / Hi-Pot 测试
- 满足特定标准
- 满足特定绝缘等级(功能绝缘, 基本绝缘, 双重绝缘, 加强绝缘)
- 工作条件:
  - *海拔高度*
  - *污染等级*
  - 特殊要求，如局部放电等 (用于判定绝缘系统的长期可靠性)



Peak working voltage

Overvoltage category

Altitude (above sea level)

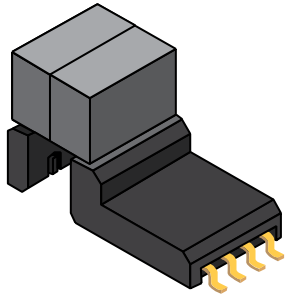
Level of insulation

Standards:
IEC 62368
IEC 60664
IEC 61558

满足安全距离的方式

增加物理间距

Red line shows creepage



Extended tooling for bobbin height

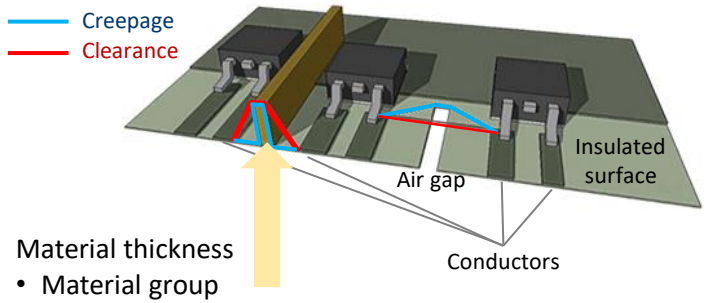
增加绕线绝缘层

- 三层绝缘线/ 完全绝缘线(FIW)
- 次级绕组: 完全绝缘线(FIW6)

漆包线+ 3层绝缘

Tape
- Polyester (PET)
- Epoxy film
- Polyimide
- Kynar

密封结构

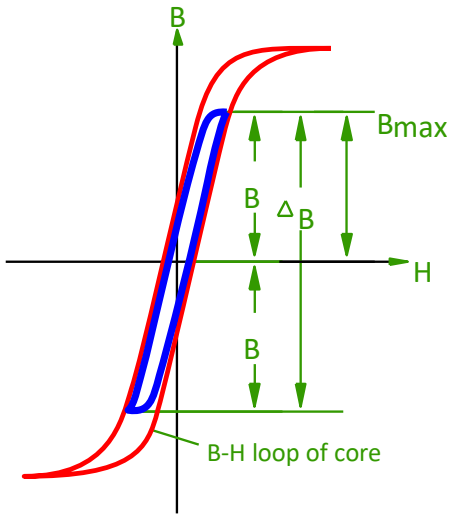


Material thickness
- Material group
- Comparative Tracking Index (CTI)

选择合适的拓扑结构

推挽式

- 变压器方案 (bipolar)

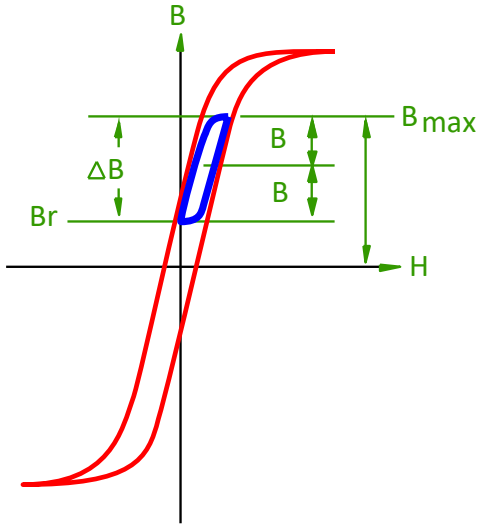


磁性器件的设计要素

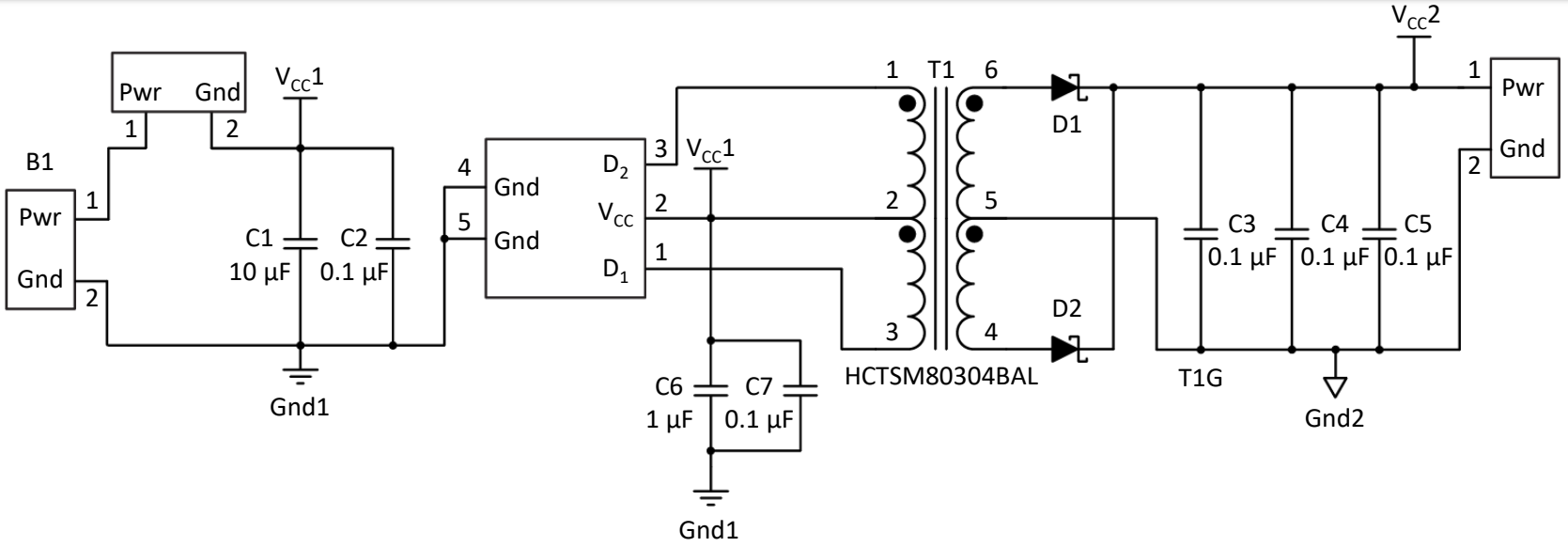
+	材料利用率	−
N/A	磁通量	N/A
+	EMI 性能	−
+	变压器尺寸	N/A
+	漏感	−
+	磁芯气隙	−
−	开关频率	+
	电压范围	
−	内部绕线	+
−	杂散电容	−
−	安全性	−

反激式

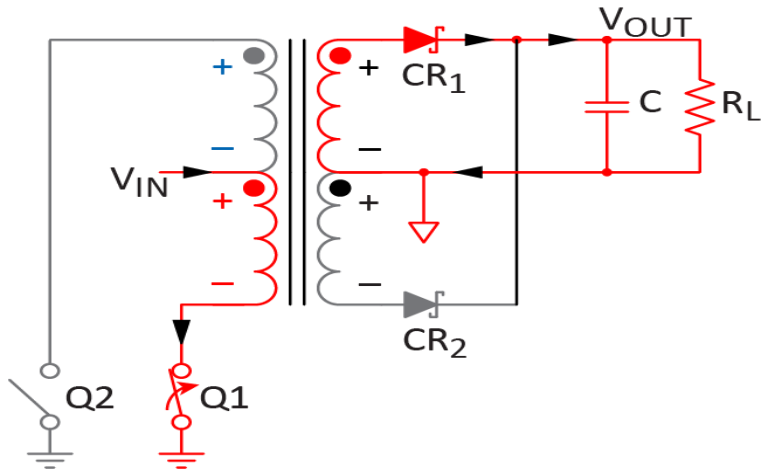
- 功率电感或变压器方案 (unipolar)

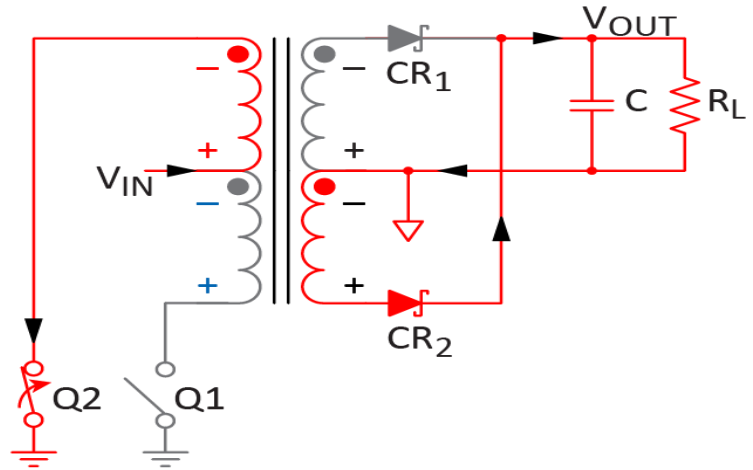


SN6501/6505 推挽式拓扑结构



开关管的整个开关周期内均有电流通过





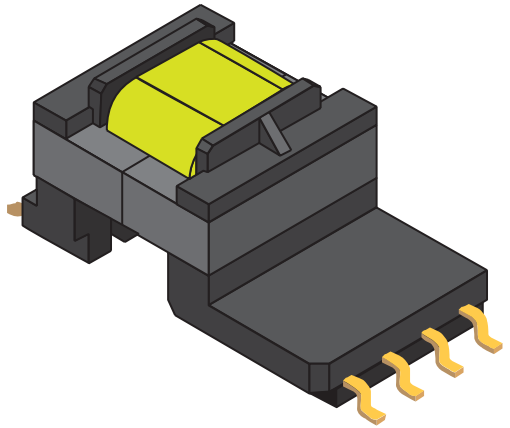
推挽式变压器- 更小的封装尺寸

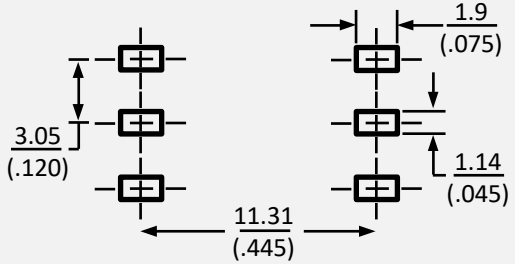
磁芯不需要开气隙– 更小的尺寸

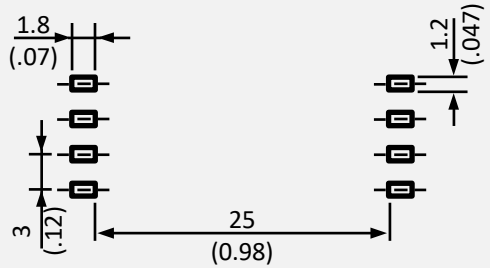
- 同样的爬电距离8mm的条件下，

Bourns的HCT系列变压器和传统的磁芯方案尺寸对比

Sugar Cube

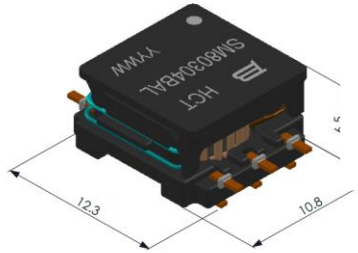


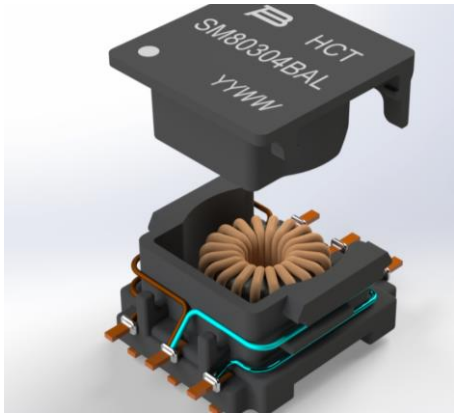


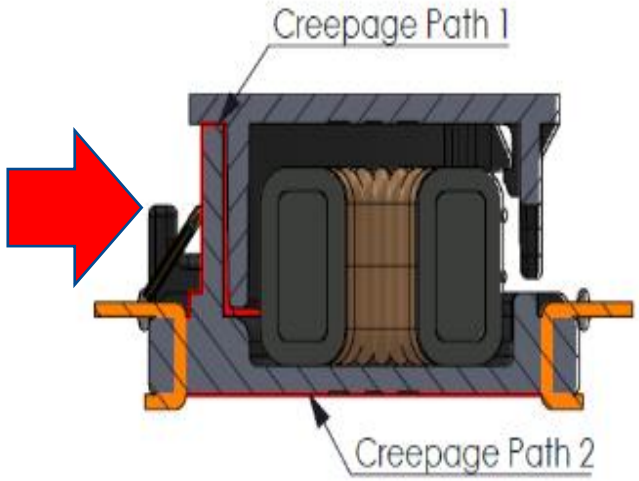


HCT 系列推挽式变压器介绍

- 低高度化(6.5 mm) **以及8~9.2mm的电气间距和爬电距离**
- 满足IEC 60950-1, IEC 62368-1， IEC 60664-1
- **加强绝缘，额定电压800VAC**
- **耐压4.2k VAC for 1 minute**
- **专门针对 TI SN6501, SN6505B-Q1 and SN6505D-Q1 开发**
- AEC-Q200 Compliant
- RoHS compliant
- Halogen free
- 工作温度范围::–40 °C to +125 °C
- 3.3 – 5 V input, 3.3 – 15 V output
- 最高350 mA output







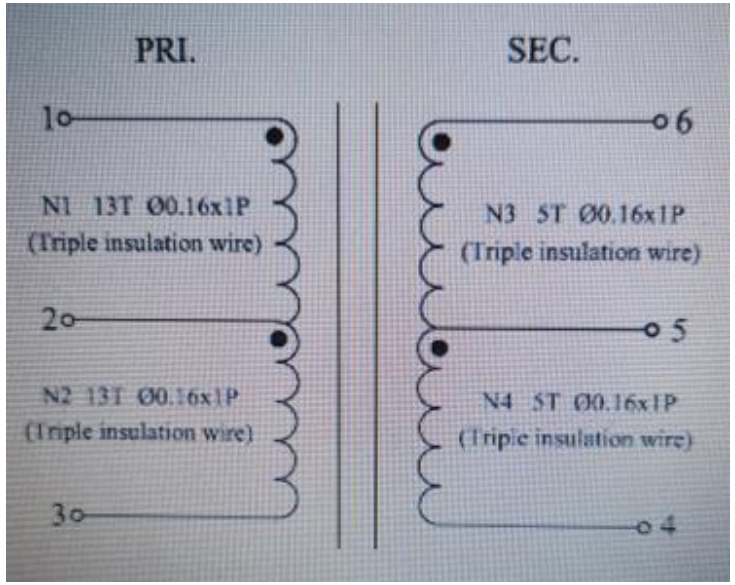
Innovative Design for High Creepage

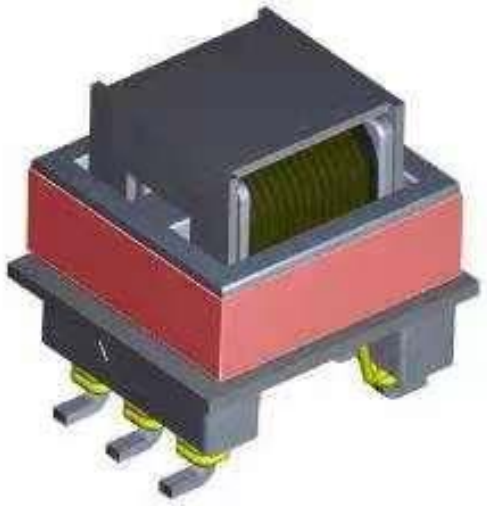
Bourns® Model HCT 系列变压器特点及同业对比

- 全系列为车规品，工厂满足IATF 16949 认证
- 提供多种匝数比供选择(1:1 to 1:2.7)
- 其高压隔离性能能够满足各种特殊安规需求
- 可以在原有基础上进行进一步定制化支持
- TI SN6501Q1验证通过并且为参考设计
- 紧凑尺寸

	Bourns® HCT Series	Competitor 1	Competitor 2
Hi Pot Capability acc. DS	4.2kV @ 60s	5.0kV @ 60s	4.0kVAC
Hi Pot Capability tested	up to <7.5kV	up to <7.5kV	up to <6kV
DCR	++	+	0
Thermal Derating	+	0	0
Size	0	+	+
Pri / Sec Wire Grade	TIW/ FIW	TIW / FIW	FIW/ FIW
Working Voltage for Reinforced Isolation	800VAC	250VAC/400VAC	300VAC
Available Turns Ratios	11	7	9
Creepage Distance	>8mm	>8mm	7mm

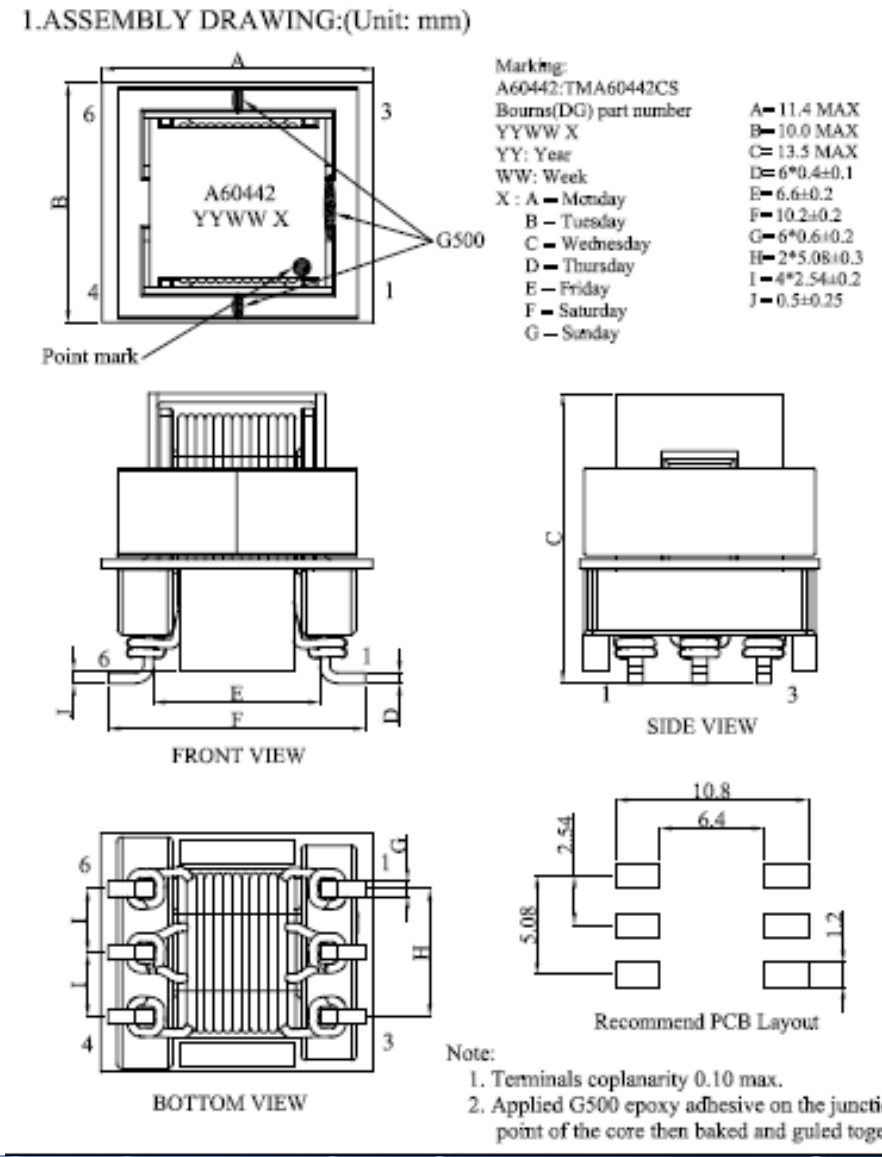
Tesla#6415推挽式变压器 for 1.5KV Hi-Pot
（Primary/Secondary功能绝缘）



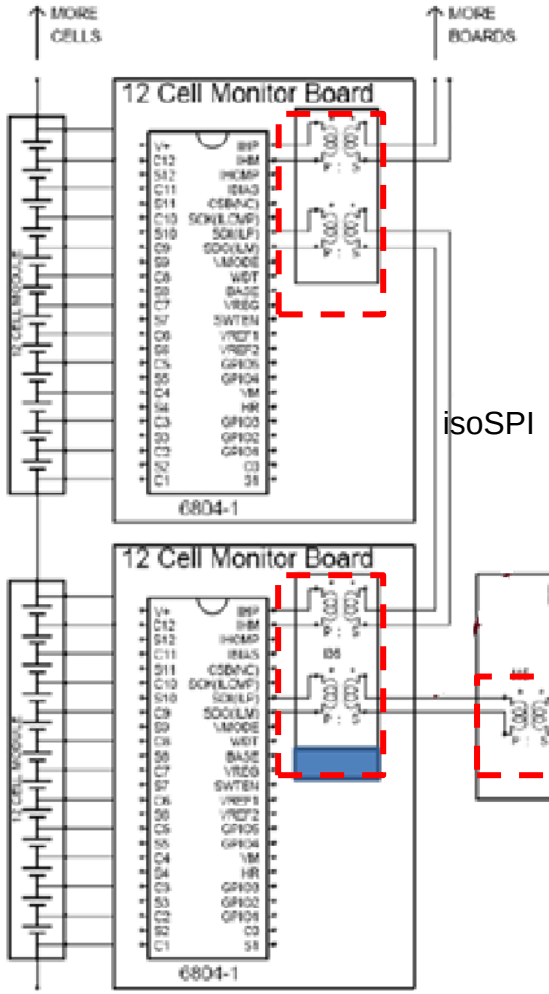


匝数比 - 1：1：1.3：1.3
替换 WE 760390014

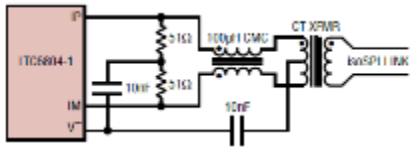
长宽高 - 11.4*10*12mm



Bourns 菊花链变压器方案

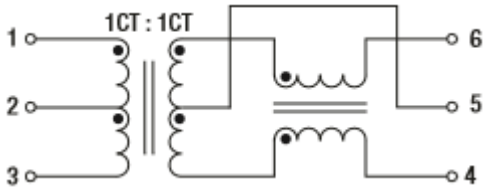


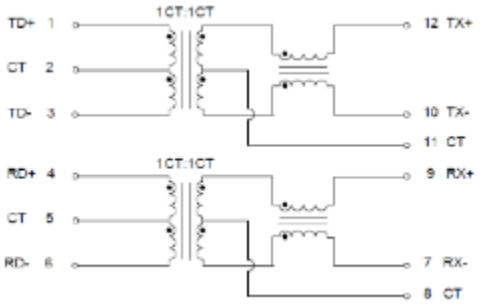
- 菊花链信号传输方案是BMS电池采样的主流通信方案
- 信号制式主要为SPI,UART & isoSPI
- Bourns的信号变压器主要针对 Linear 的LTC68XX系列，NXP的MC33771C 以及 MAXIM的 MAX17823/17853 设计;
- BMS菊花链信号变压器的设计：
  - 1:1 变压器用于传输差分信号
  - 内置共模扼流线圈来降低EMI噪声



Single ch

Dual ch



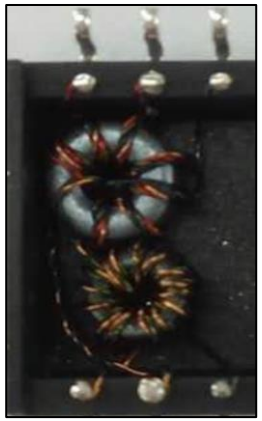


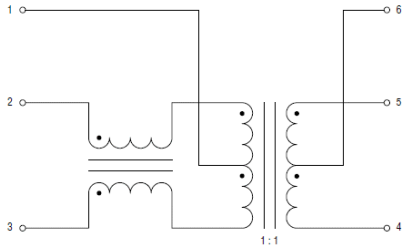
https://www.bourns.com/docs/product-datasheets/sm91501al.pdf?sfvrsn=15427df6_3

https://www.bourns.com/docs/product-datasheets/sm91502al.pdf?sfvrsn=10427df6_7

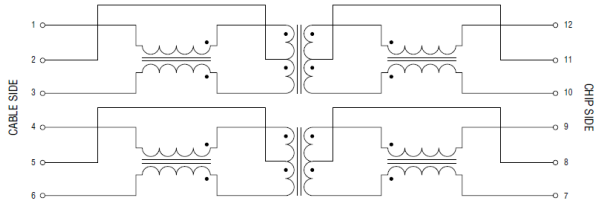
Bourns 菊花链变压器方案

- **变压器部分:** 提供高压隔离以及瞬态电流保护 / 传输菊花链差分信号
- **共模扼流线圈(CMC):** 用于EMI噪声抑制



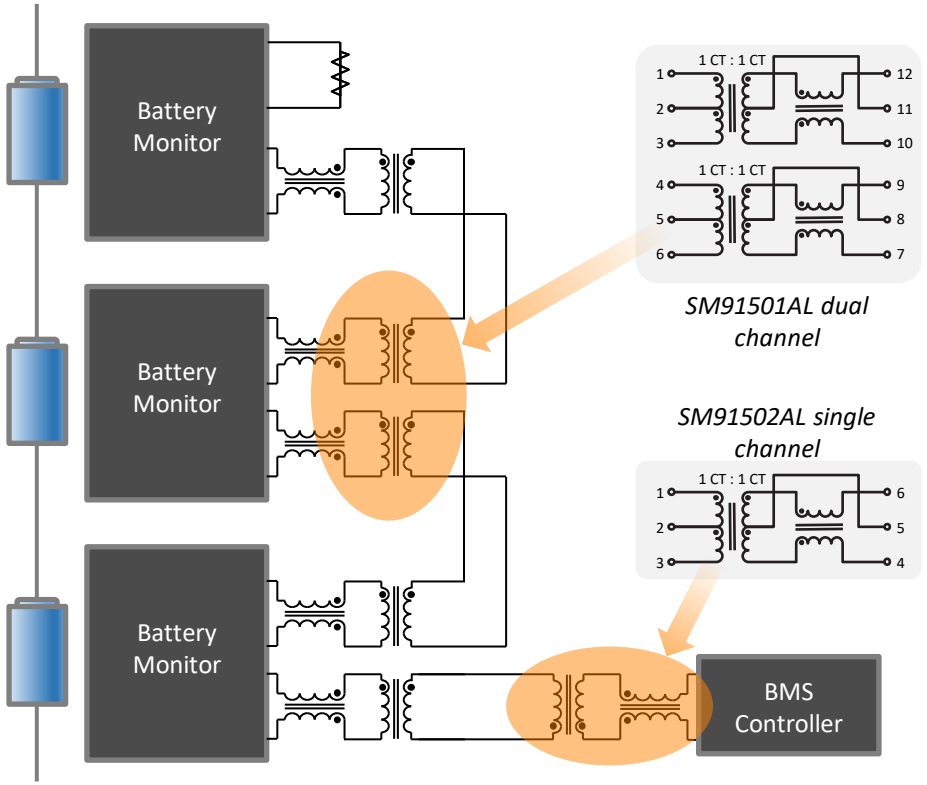


Single Channel with integrated Common Mode Choke



Two Channels with two integrated Common Mode Chokes per channel (chip side and cable side CMCs)

Bourns 菊花链变压器方案



SM91501AL 双通道变压器

- 变压器+共模电感
- 温度范围: –40 °C to +125 °C
- 感值: 150 µH ~ 450 µH
- 功能绝缘
- 额定电压: 1600 VDC
- Hi-Pot: 4300 VDC or 3100 VAC
- 双通道
- AEC-Q200 compliant

SM91502AL 单通道变压器

- 变压器+共模电感
- 温度范围: –40 °C to +125 °C
- 感值: 150 µH ~ 450 µH
- 功能绝缘
- 额定电压: 1600 VDC
- Hi-Pot: 4300 VDC or 3100 VAC
- 单通道
- AEC-Q200 compliant

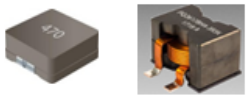
Bourns的SM91502AL和SM91501AL均在LINEAR， NXP的方案上验证通过

Daisy Chain transformer Family

Bourns #	Chipset	Cross/Des	Voltage/ Isolation	Creepage (mm)	Hi-PoT Isolation	Center Tap	Choke	Operation Temp
SM91071/072AL	LTC6804	HM1188NL/ Halo TG110-AEX50N5LF	100Vdc/ Function	3	1500Vrms	Yes	Yes	-40~85° C
SM91501AL	NXP3371 LTC6811&12&13	HM2102NL HMU2102NL	1600Vdc Max /Function	>10	4300Vdc	Yes	Yes	-40~125° C
SM91502AL	NXP3371 LTC6811&12&13	HM2103NL/ HMU2103NL	1000Vdc Max /Function	>5	3200Vdc	Yes	Yes	-40~125° C
SM91505AL	Intersil	package same 501/ 300uHmin	1000Vdc Max /Function	>5	3200Vdc	Yes	Yes	-40~125° C
SM91506AL	NXP/LTC	same to 501	1600Vdc Max /Function	>12	3100Vrms	Yes	Yes	-40~125° C
SM91507AL	Maxim17823	HM1237NL	600Vdc Max /Function		2500Vrms	Yes	Yes	-40~125° C
SM91508AL	Maxim	HM1238NL	1000Vdc Max /Function		4300Vdc	Yes	Yes	-40~125° C
SM91509AL	TI BQ79606	same layout 501/600uHmin	1000Vdc Max /Function		4300Vdc	Yes	Yes	-40~125° C
SM91510AL	Maxim	500uH/HM1236NL/4mm	600Vdc Max /Function	>7	3200Vdc	Yes	Yes	-40~125° C
SM91511AL	Stmicro	Stmicro						-40~125° C
SM91512AL	NXP/LTC	HMU2104NL/CBM5D33	1000Vdc Max /Function	>5	3200Vdc	Yes	No	-40~125° C
SM91513AL 4Pin	NXP/LTC	HMU1229NL/SUMIDA ESMIT-4180	1000Vdc Max /Function	>5	3200Vdc	Yes	No	-40~125° C
SM91514AL	NXP/LTC	HMU2103ANL	1000Vdc Max /Function	>5	3200Vdc	Yes	Yes	-40~125° C
SM91516AL 4pin	NXP/LTC	ESMIT-4187	1000Vdc Max /Function	>5	3200Vdc	Yes	No	-40~125° C
SM91519AL	NXP/LTC	HMU21xxNL	1700Vdc Max /Reinformeced	>22	5000Vdc	Yes	Yes	-40~125° C
SM13105AL	NXP/LTC	HM2110ZNL	1600Vdc Max Reinforced	>22	4300Vdc	Yes	Yes	-40~125° C

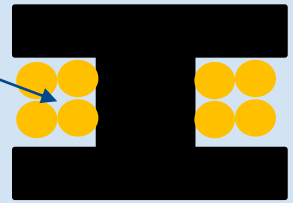
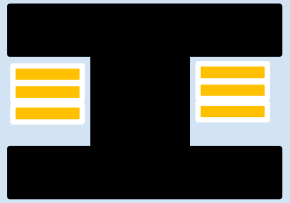
Bourns功率电感介绍

>超过150种标准品功率电感产品

Inductor Model	SDE / SDR Non Shielded	SRN Semi Shielded	SRR / SRU Shielded	SRP / PQ High Current Shielded
Appearance				
Construction				• Molding - SRP • Ferrite - PQ 
Features	• Ferrite core • Low cost • High saturation current	• Ferrite core • Semi-Shielded with epoxy resin • Lower radiation than non-shielded • Lower cost than shielded	• Ferrite core • Shielded • Low radiation • Low DCR	• Alloy powder core -SRP • Ferrite - PQ • Shielded • Low radiation • Low DCR • High rated current
Models Available	26	22	70	40 (37 + 3)
Footprint	3x2.8 to 22x15 mm	2x1.6 to 10x9.8 mm	2.8x2.8 to 18.3x14 mm	2x1.6 to 23.5x22 / 27.9x19.8 mm
Height	2.7 to 7.8 mm	0.8 to 6 mm	1 to 10 mm	0.95 to 13 / 16 to 19mm
Inductance	0.68 to 15,000 µH	0.24 to 470 µH	0.47 to 15,000 µH	0.1 to 100 µH / 1 to 33µH
Rated Current	0.02 to 16 A	0.20 to 12 A	0.02 to 20 A	1 to 70A / 28 to 30A

https://www.bourns.com/products/magnetic-products/power-inductors-aec-q200-compliant
https://www.bourns.com/docs/technical-documents/technical-library/automotive/publications/bourns-automotive-compliant-selection-guide-brochure.pdf?sfvrsn=5f2646f6_18

大电流一体成型功率电感(扁平线绕线工艺)

SRP series *SRP为Bourns的一体成型电感料号	SRP_A/TA series	SRP_CA/FA series
绕线类型	Wasted area  圆线	 扁平线
额定电流	Normal	Higher
Rdc	Normal	Lower
Size	Normal	Smaller

大电流一体成型功率电感(扁平线绕线工艺)

Comparison data with the competitor

SRP series	SRP6060FA-220M	Competitor
Inductance	22uH	22uH
Core Material	Metal Alloy	Metal Alloy
Wire Type	Flat Wire	Normal
Size	Max 6.8*6.6*6.0mm	Max 11.2*10.3*4.0mm
Rated current (Irms)	5.0A	3.8A
Rdc	60.5mΩ	70mΩ

同样的磁芯材料条件下，Bourns的扁平线功率电感能达到更低的RDC以及更高的额定电流.

仿真支持

Bourns能够提供在各种拓扑/工作条件下的功率电感损耗仿真。

BOURNS®

Data area | Chart

Choose Calculator Type: Buck

Applications: Automotive

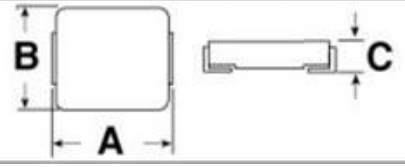
Series: SRP-FA

Family/Case Size: SRP6060FA

Part Number: SRP6060FA-4R7M

Calculation

Inputs					Outputs		
Frequency =	400000			Hz	Inductance	4.7	µH
Current =	3			Amps	25º C DC Res	14.4	mOhms
Volts In =	12			Volts	Isat	10.5	Amps
Volts Out =	4.6			Volts	I(Heat)	11	Amps
Bpk	349.2			G	Imax	3.75	Amps
A	1.72	Inch	6.80	mm	Imin	2.24	Amps
B	1.67	Inch	6.60	mm	Iripple	1.50	Amps
C	1.52	Inch	6.00	mm	Iin		Amps
Dimention					Duty	38.3	%
					Pcore	0.094	Watts
					Pdc	0.129	Watts
					Ptot	0.224	Watts



Bourns功率电感选型指南

1.	2.		3.	4.	5.		6.	7.
Bourns Part Number	Inductance @ 100 KHz / 1 V		Q (Min.) @100 KHz / 1 V	SRF (MHz) Typ.	DCR (mΩ) Typ.	DCR (mΩ) Max.	Irms (A)	Isat (A)
	L (μH)	Tol. (%)						
SRP1038A-R20M	0.20	20	10	155	0.66	0.95	35	70

1. Bourns 料号;

2. Inductance @ 100kHz/1V;

3. Q值:
品质因数;
Q=2Πf*L/R; Higher Q value means lower loss.

4. SRF: 自谐振频率:
作为EMI滤波电感用时, SRF 尽量选择靠近噪声频段;
作为功率电感时r, SRF 尽量远离开关频率.

5. DCR: DC直流阻抗;

6. Irms温升电流: 引起40C自温升时的电流，Irms应大于实际最大常态工作电流

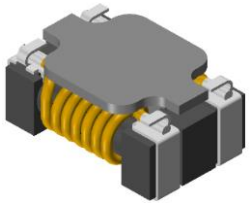
7. Isat: 饱和电流：感值跌落20 or 30 %时的电流 ; Isat应大于实际最大常态工作电流+1/2纹波电流

Magnetic products (Power inductor)

- Bourns SMD Power Inductors cross to major inductor suppliers

Bourns	Vishay	Würth	Coilcraft	TDK	Chilisin	Cooper Bussman (Eaton)	Murata	Panasonic	Sumida	Delta Elect.	Taiyo Yuden
SRP series	IHLP	7443	MLC, XPL, XAL XFL, XTL, XEL	RLF,SPM	MHC,MHCC ,BMQA,BM CA	HCM,HCMA		ETQ	CDEP	HAU,HAL, HAH	MAM K MAKK
SRN series	IFSC	7440405XXXX		VLS	BWVF,BWV C		LQH6PP LQH_	ELL5PR		SIG	NR/N RS MDKK
SRF series	ICM	74476XXXX 74423xxxx 732xxxxx 7447XXXXX	HQ PDF DRQ HP	ACT,ACM, B82787C	BWCU	DRQ	DLW	EXC			CM01 U
SDR(SDE) series	IDCP,IDC	7445xxxxx	DO	VLP	SSL0,BPSL	LD1,4C,UP,U PS			CD,CDR	SISH,SI	
SRU series	IDCS	744066XXXX 744045XXX	LPS/DR/DO	VLF /B82477R4	BPSC	DR			CDRH	SIL,SIQ	
SRR Series	IDCS	74477XXXX	DS/DT MSS LPO LPS	SLF,VLCF CLF	SCDS	SD,DR	LQH_ MBH_	ELLCTP	CDRH	SIL,SIQ	NS

SRF7038A系列电源线用共模电感介绍

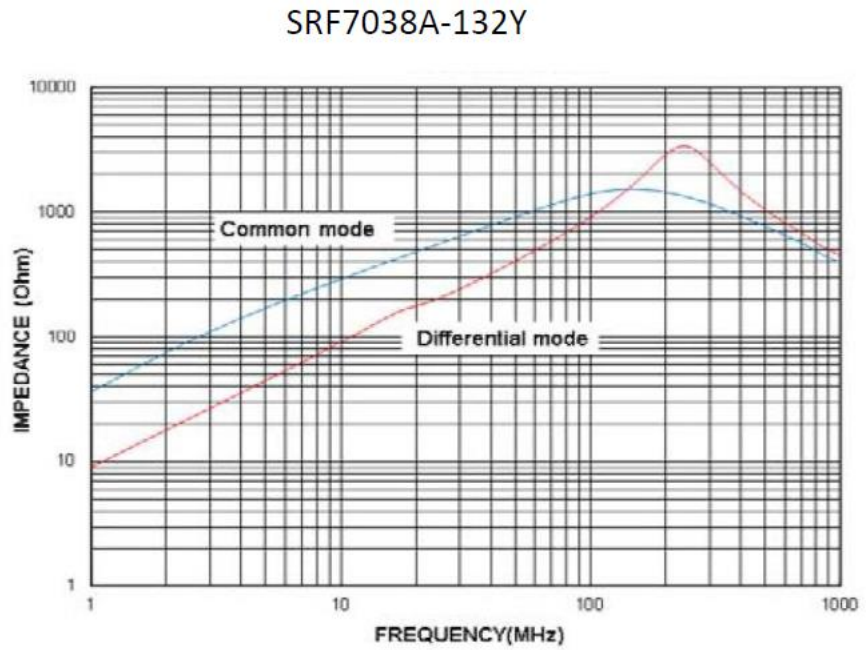


SRF7038A series

- **特点：**
  - 大电流 （额定电流3A-15A），能满足大部分BMS电源的电流要求；
  - 高阻抗（最高共模阻抗1300Ω@100MHz），帮助解决日益严格的EMI静噪要求
- **应用范围：**

  输入/输出电源线
- **尺寸：**

  7.0×6.0×3.8



较高的共模/差模阻抗，对解决电源线EMI噪声有非常大的帮助

Magnetic products (CMC for power line)

Comparison with competitor's

7*6mm size

Bourns SRF7038A-701Y	TDK ACM70V-701-2P
Rated current 4A	Rated current 4A
Common mode impedance 700ohm @ 100MHz	Common mode impedance 700ohm @ 100MHz
Cost Low	Cost High

12*11mm size

Bourns SRF1206A-701Y	TDK ACM12V-701-2P
Rated current 8A	Rated current 8A
Common mode impedance 700ohm @ 100MHz	Common mode impedance 700ohm @ 100MHz
Cost Low	Cost High

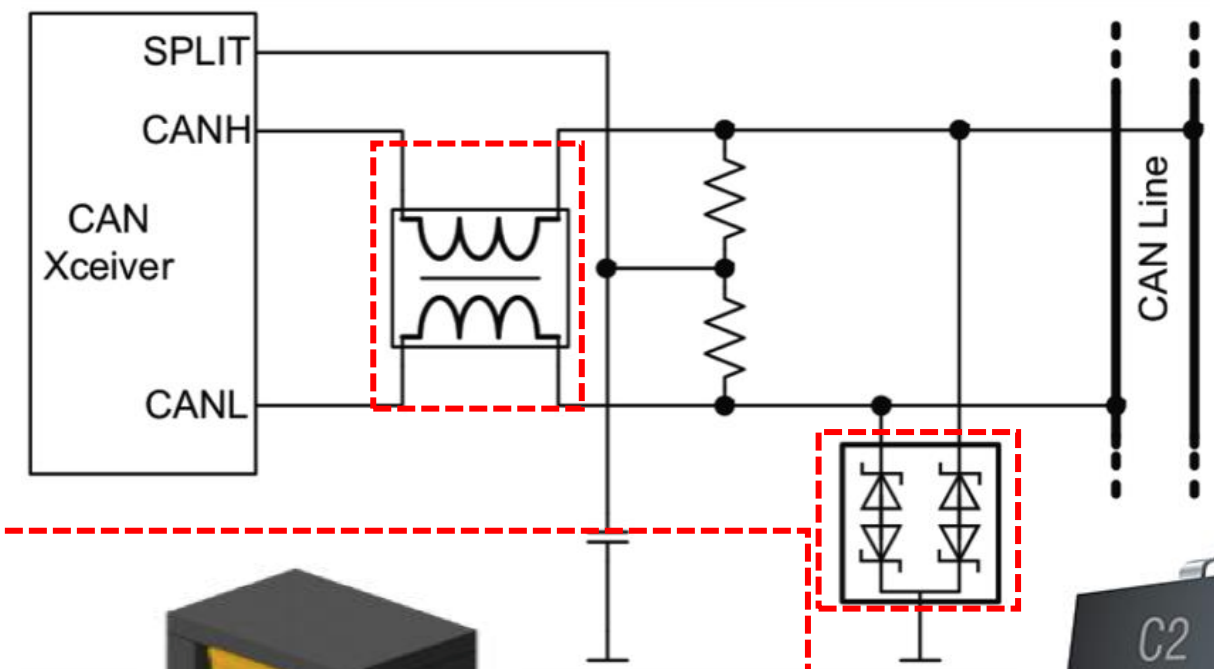
9*6.5mm size

Bourns SRF9045A-701Y	TDK ACM90V-701-2P
Rated current 5A	Rated current 5A
Common mode impedance 700ohm @ 100MHz	Common mode impedance 700ohm @ 100MHz
Cost Low	Cost High

12*11mm size

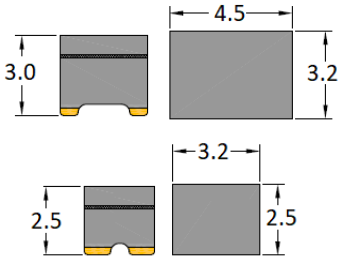
Bourns SRF1206A-102Y	TDK ACM12V-701-2P
Rated current 6A	Rated current 8A
Common mode impedance 1000ohm @ 100MHz	Common mode impedance 700ohm @ 100MHz
Cost Low	Cost High

CANBUS/CANFD接口整体方案（共模扼流电感+TVS）



Common Mode Choke (CMC)

- SRF4530A
- SRF3225TAC
- SRF3225TAFD



TVS Diode

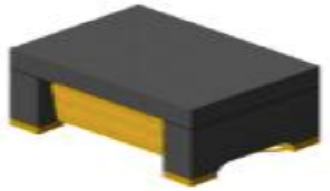
- CDSOT23-T24CAN

CANBUS/CANFD接口整体方案（共模扼流电感+TVS）

CANBUS （速率小于1Mbps）：
Bourns共模电感，满足IEC62228-3 Class1：
SRF4530A-510Y：
尺寸：4.5*3.2*3.0mm
感值：51uH
SRF3225TAC-510Y：
尺寸：3.2*2.5*2.0mm
感值：51uH

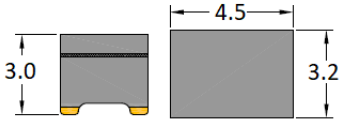
CANFD （速率2Mbps）：
Bourns共模电感,满足IEC62228-3 Class2：
SRF3225TAC-101Y：
尺寸：3.2*2.5*2.0mm
感值：100uH

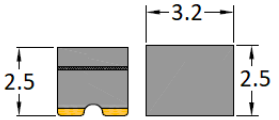
CANFD （速率5Mbps）：
Bourns共模电感,满足IEC62228-3 Class3：
SRF3225TAFD-101Y：
尺寸：3.2*2.5*2.0mm
感值：100uH



Common Mode Choke (CMC)

- SRF4530A
- SRF3225TAC
- SRF3225TAFD





Magnetic products (CMC for Canbus/CanFD)

Parameter comparison (51uH for Canbus)

4530 size

Bourns SRF4530A-510Y	TDK ACT45B-510-2P	Murata DLW43SH510XK2
Temperature 150C	Temperature 150C	Temperature 125C
Rated current 230mA	Rated current 200mA	Rated current 230mA
Cost Low	Cost High	Cost Mid

3225 size

Bourns SRF3225TAC-510Y	TDK ACT1210-510-2P	Murata DLW32SH510XK2
Temperature 150C	Temperature 150C	Temperature 125C
Rated current 200mA	Rated current 200mA	Rated current 200mA
Cost Low	Cost High	Cost Mid

Magnetic products (CMC for Canbus/CanFD)

Parameter comparison (100uH for CanFD)

4530 size

Bourns SRF4530A-101Y	TDK ACT45B-101-2P	Murata DLW43SH101XK2
Temperature 150C	Temperature 150C	Temperature 125C
Rated current 200mA	Rated current 150mA	Rated current 200mA
Cost Low	Cost High	Cost Mid

3225 size

Bourns SRF3225TAC-101Y	TDK ACT1210-101-2P	Murata DLW432SH101XK2
Temperature 150C	Temperature 150C	Temperature 125C
Rated current 150mA	Rated current 150mA	Rated current 150mA
Cost Low	Cost High	Cost Mid

Outline

- Bourns公司介绍
- Bourns 针对 BMS系统的整体解决方案
  - BMS整体方案概况
  - 针对BMS的磁性器件解决方案
  - 针对BMS的电路保护器件解决方案
  - 针对BMS的电流采样器件解决方案
- Q & A

CDSOT23-T24CAN-Q – TVS for CAN & CAN FD

CDSOT23-T24CAN-Q

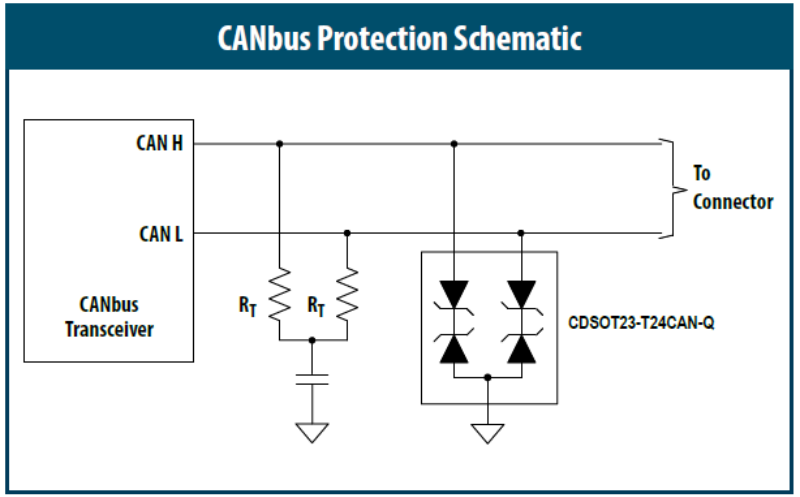
特性

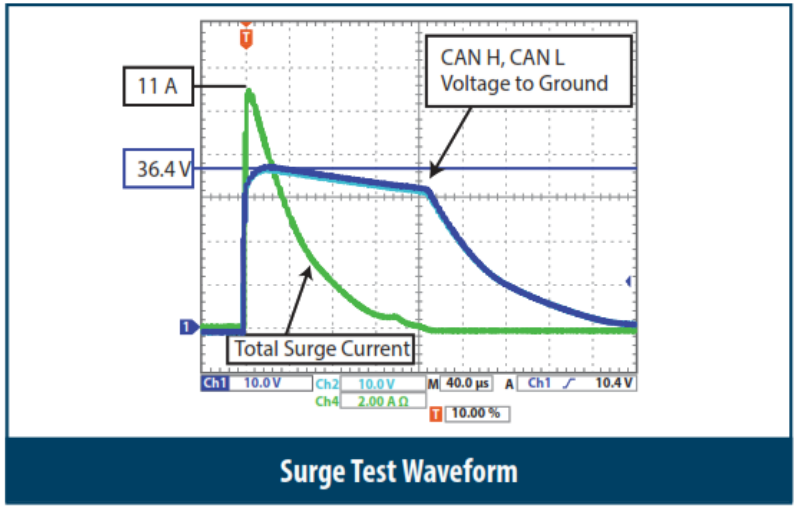
- IEC 61000-4-2 30 kV ESD
- IEC 61000-4-5 (Level 1, CWG 1.2/50) 500 V Surge
- V_{BR} 26.2V compatible with transceivers with internal circuitry for 24V power supply miswiring
- AECQ101 complaint

应用

- 高速CAN通信
- LED headlamp control
- BMS
- Infotainment
- ADAS
- DCDC

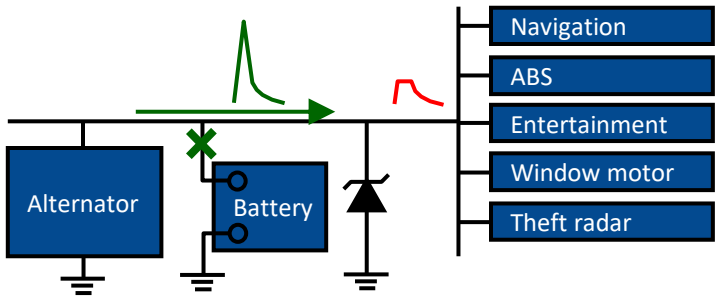
****Both are AECQ Compliant**

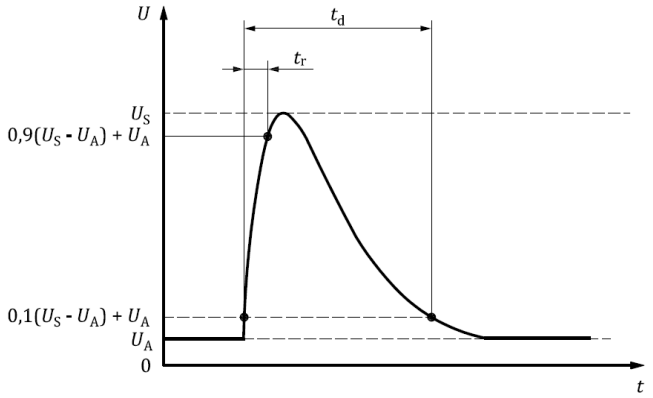




Load Dump抛负载测试

- 正常工作的汽车交流电机/蓄电池等突然切断负载，而对许多其它电器造成的电压冲击。
- 一些应用并没有外挂交流电机 (诸如EV, industrial BMS), 但长时间的冲击电压仍旧存在。
  - “长时间” ~ 0.5 sec vs “短时间 ~ 1 usec
  - 负载变化
  - 具有危险性
- 目前为止，ISO 16750-2是主流的抛负载测试标准 。





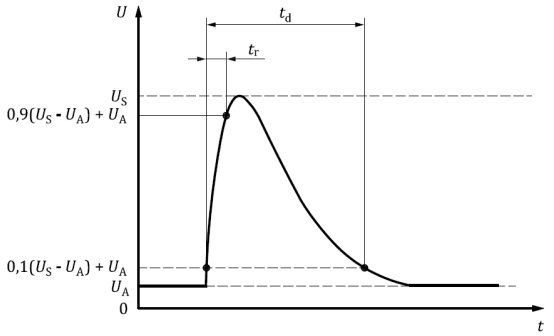
ISO 16750-2 抛负载测试条件

测试中我们关注以下三个变量：

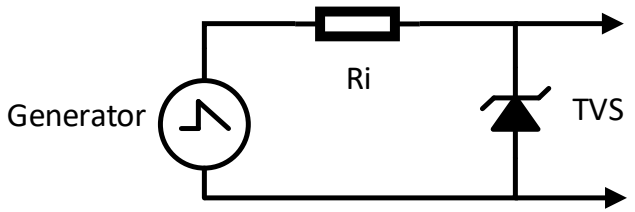
- U_S = 最大电压
- R_i = Generator的固有内阻值
- t_d = 脉冲持续时间

通过测试的难点为：

- U_S = Big
- R_i = Small
- t_d = Long



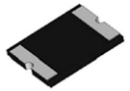
(Old)



(New)

Standard	ISO 7637-2	ISO 16750-2
Parameter	24 V system	24 V system
U_s	123 V to 174 V	**151 V to 202 V**
R_i	1 Ω to 8 Ω	1 Ω to 8 Ω
t_d	100 ms to 350 ms	100 ms to 350 ms
t_r	10 / +0 / –5 ms	10 / +0 / –5 ms
Pulse	1 pulse	**10 pulses 1 pulse/min.**

Bourns® SM8Sxxxx-Q 系列TVS介绍

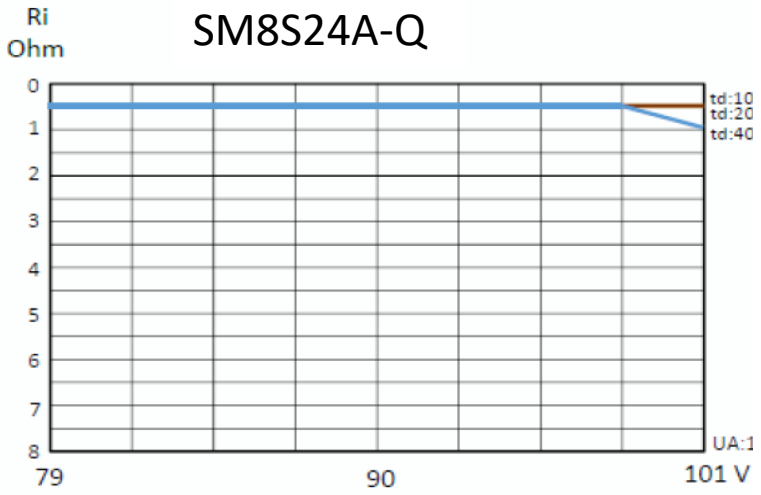
Feature	SM8Sxxx-Q	SM8SFxxx-Q
单向	✓	✓
双向	✓	✓
封装尺寸 (W x L x H mm)	 15.5 x 10 x 4.85	 10.5 x 8.1 x 1.3
额定电压(V @ 10 µA)	16 V -> 43 V	24 V -> 36 V
钳位电压@ I_{max}	26 V @ 254 A to 69.4 V @ 95 A	38.9 V @ 180 A to 58.1 V @ 120 A
工作温度范围	–55 °C to +175 °C	–55 °C to +175 °C
P_{max} (W)	6.6 kW (10/1000 µs) 8 W (infinite heatsink)	7 kW (10/1000 µs), 5 W (infinite heatsink)
AEC-Q101 compliant	✓	✓
Compliant to RoHS Directive 2015/863, Mar 31, 2015 and Annex	✓	✓

SM8Sxx-Q – ISO 16750-2 抛负载测试表现

SM8S24A-Q

12 V

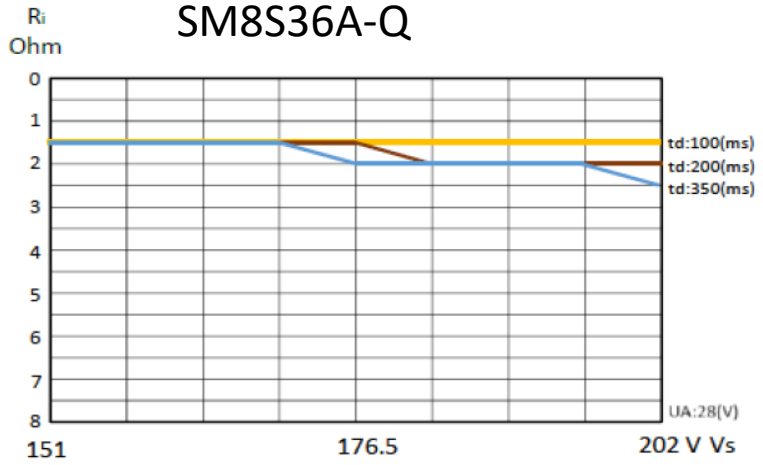
ISO 16750-2 test A (10 pulse)



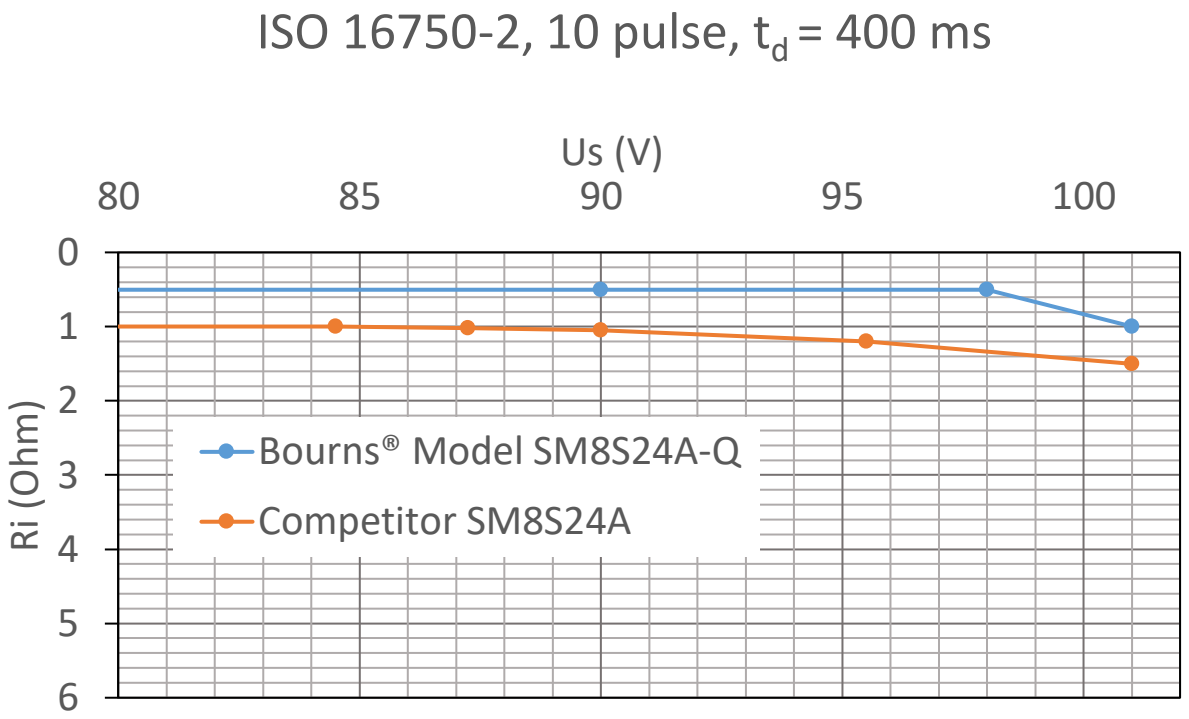
SM8S36A-Q

24 V

ISO 16750-2 test A (10 pulse)



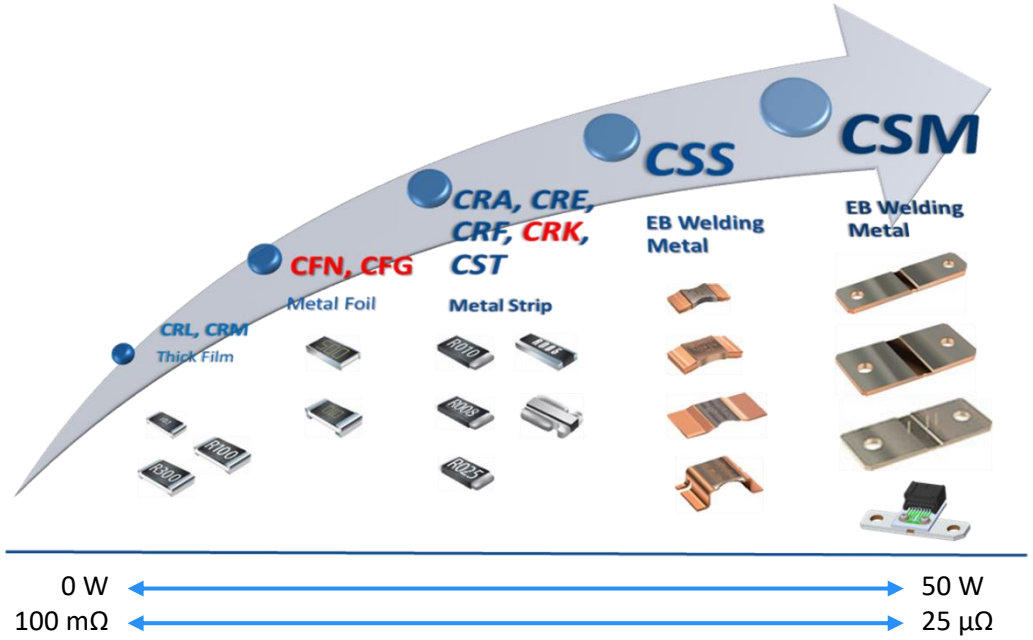
12 V 系统抛负载测试对比



Outline

- Bourns公司介绍
- Bourns 针对 BMS系统的整体解决方案
  - BMS整体方案概况
  - 针对BMS的磁性器件解决方案
  - 针对BMS的电路保护器件解决方案
  - 针对BMS的电流采样器件解决方案
- Q & A

Bourns 标准品采样电阻/分流器介绍

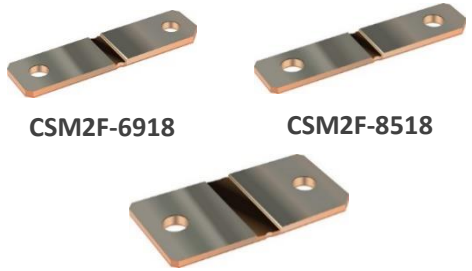


CSM	
Construction	EB welded Mn/Cu alloy
Low resistance	0.025 µΩ to 200 µΩ
High power rating	1 to 50 W
Low TCR	±150 ppm/°C

- **AEC-Q200 compliant**
- **Custom capability**
- Excellent long term stability
- Low inductance
- Low thermal EMF

Bourns 标准品采样电阻/分流器介绍

- High Accuracy
- Range of Zero Amperes to 500/1000 Amperes
- Bus Bar Type Resistor with Tin Plating and or Attachment Screws
- Low Temperature Drift



CSM2F-6918　　CSM2F-8518

CSM2F-7036

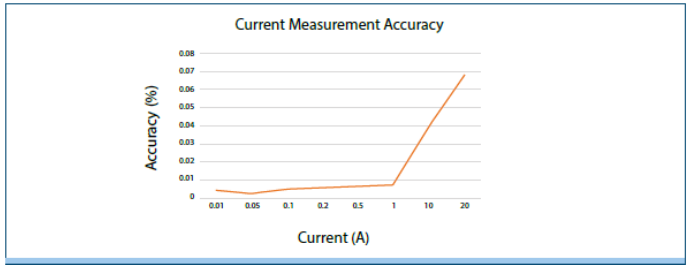


Figure 5. | *Accuracy of Bourns® Model CSM2F-8518 Shunt with Current Sense Module*

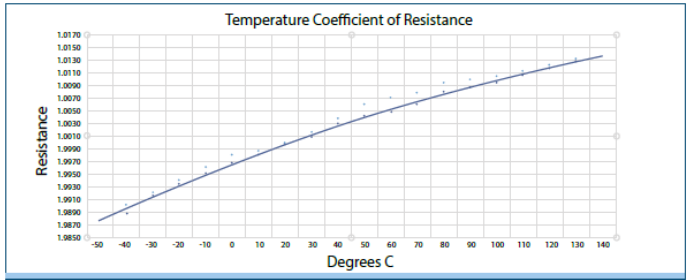


Figure 6. | *Data from Look Up Table Showing Resistance Drift with Temperature*

Bourns 标准品采样电阻/分流器介绍

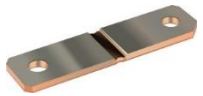
	CSS	CSM
Construction	EB welded Mn/Cu alloy	
Low Resistance	0,1 to 5 mOhms	0,05 to 5 mOhms
High power rating	1 to15 W	1 to 50 W
Low TCR	±75 to 150 ppm/°C	±150 ppm/°C

2512

CSS2H-3920

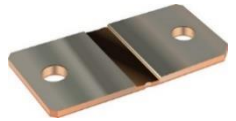
CSS2H-5930

CSS4J-4026



CSM2F-6918

CSM2F-8518



CSM2F-7036

AEC-Q200 compliant
Custom capability
Excellent long term stability
Low inductance
Low thermal EMF

Applications:
- Current sensing
- Battery Management Systems
- Power modules/motor controllers
- Frequency converters

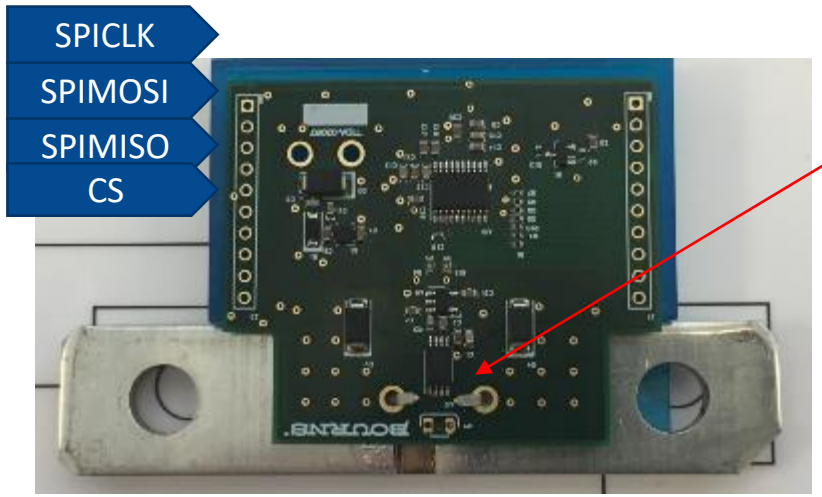
https://bourns.com/products/fixed-resistors/current-sense-resistors

Bourns 定制分流器方案

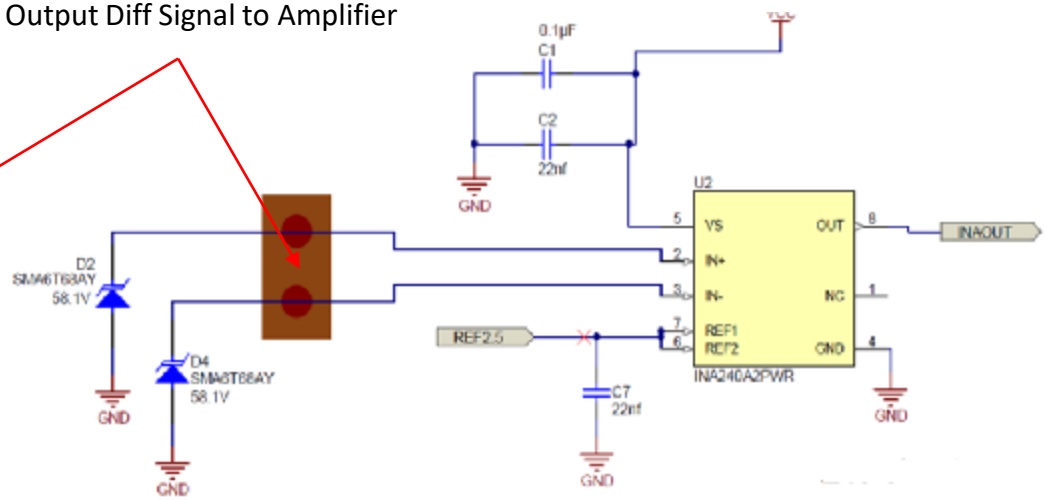
- Complete stamping tool design
- Offers Module services
- Capability to offer different shapes, hole locations, and sensing pins.

Resistor (Current sensing)

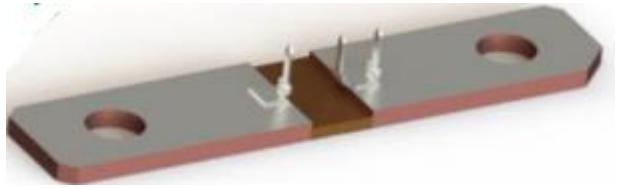
- For zero to 800 Amps
- Shunt P/N CSM2F-8518 Shunt from Bourns and INA240 CS Amp (TI)
- ADS1259-Q1 Sigma Delta



Pins Welded to Shunt provide
Output Diff Signal to Amplifier



- Bourns Shunt Resistor CSM2F-8518
  - Tin Plated Copper Terminals
  - 50µΩ or 100µΩ Resistance Values
  - CM2F-8518 is rated to 50% Full Power (25 Watts) at 125°
    - The Copper will heat up to 125°C at room Temperature at 50%
    - Continuous Current 500A
    - Pulsed Current 1000 A (30 minutes on/off)



Thank you!

BOURNS®

APPENDIX

Isolated Power Conversion Drivers Maintaining Signal Integrity

No core saturation – think energy, not power

$$B_m = \frac{V \cdot 10^8}{K_f N A_C f}$$ Where $$B_m \propto \frac{V}{f}$$ $$T = \frac{1}{f}$$

Rewrite Faraday's Law formula as: $$B_m = \frac{V \cdot T \cdot 10^8}{K_f N A_C}$$

$$V \cdot T = \frac{B_m \cdot K_f \cdot N \cdot A_c}{10^8}$$ or $$I(AC) \cdot AL = \frac{B_m \cdot 10 \cdot A_c}{N}$$

Where AL = nH/Turn^2

$$V \cdot T < \frac{B_m \cdot K_f \cdot N \cdot A_c}{10^8}$$ or $$I(AC) \cdot AL < \frac{B_m \cdot 10 \cdot A_c}{N}$$

No Core Saturation!

Bm = Operating Flux Density
V = Voltage
Kf = Scaling factor depending on waveform
N = Turns

Ac = Core Area
f = frequency
T = time
AL = inductance factor (nH/T2)

Dielectric Withstand Voltage

What is it?

Maximum voltage that a transformer can withstand without breaking down. In other words, it's the voltage beyond which isolation components in the transformer will operate.

What isolation components?

- Wire insulations
- Bobbin molding materials
- Varnish
- Tape and/or tubing
- Air (what's that you say???)

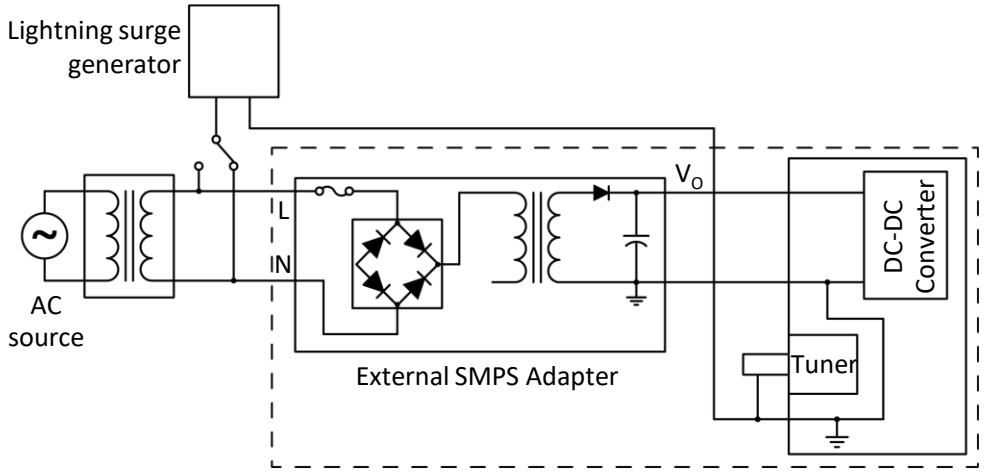
  Safety distances (i.e. creepage and clearance)

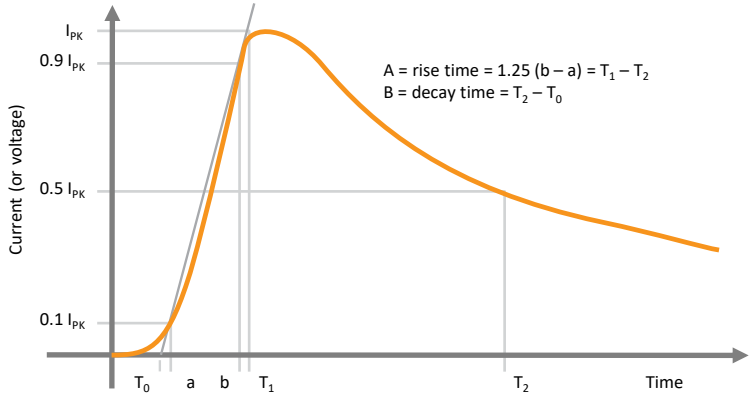
Why is it important?

To qualify a transformer's ability to operate safely during rated electrical conditions.

Surge/Impulse/Lightning Testing

- Short duration pulse instead of constant voltage, like dielectric testing
- Typically higher voltage pulses than for dielectric testing
- Typically to JEC (210.212), NEBS (GR1089) or IEC (61000) standards





Partial Discharge Testing

When partial discharge is initiated, high frequency transient current pulses will appear and persist for nanoseconds to a microsecond, then disappear and reappear repeatedly as the voltage sine wave goes through the zero crossing. The PD happens near the peak voltage, both positive and negative. PD pulses are easy to measure using the HFCT method. The HFCT is a "high frequency" current transducer which is clamped around the case ground of the component being tested.

- This means ARCING on a material level; NOT the transformer or component

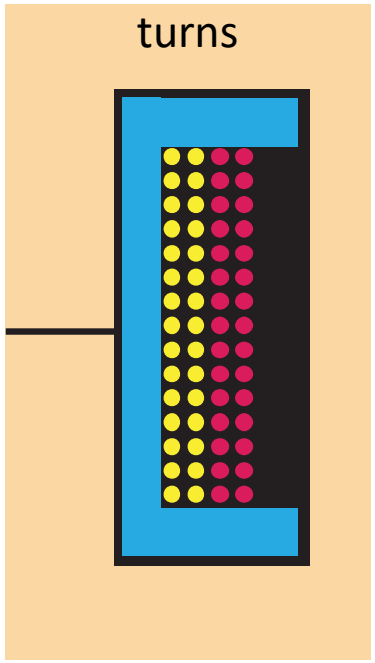
Partial discharges within an insulating material are usually initiated within gas-filled voids within the dielectric. Because the dielectric constant of the void is considerably less than the surrounding dielectric, the electric field across the void is significantly higher than that across an equivalent distance of dielectric. If the voltage stress across the void is increased above the corona inception voltage (CIV) for the gas within the void, PD activity will start within the void.

- This means a HOLE that causes arcing within said material.

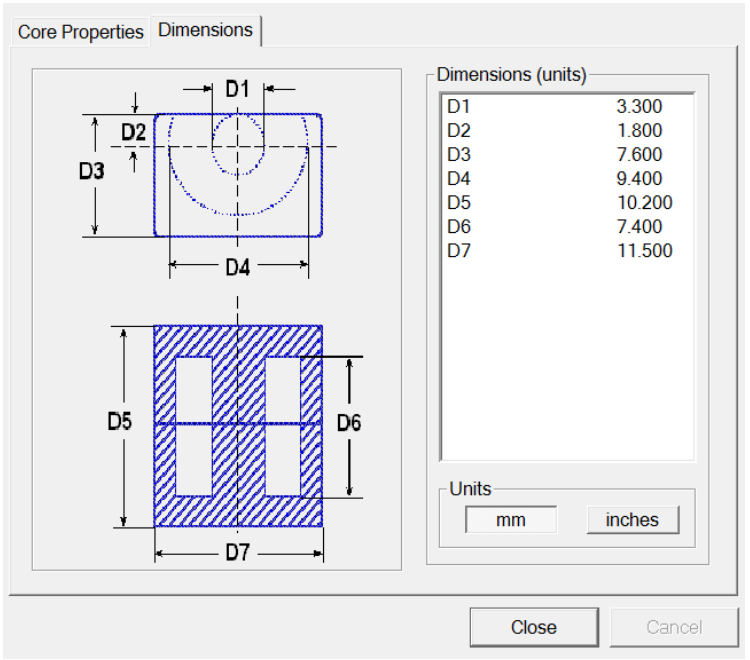
Energy Storage - Other Topology (Flyback)

Ep7 split core

40 turns



EP10



Energy Storage - Other Topology (Flyback)

$$n\,i\,\phi = (R_c + R_g)$$

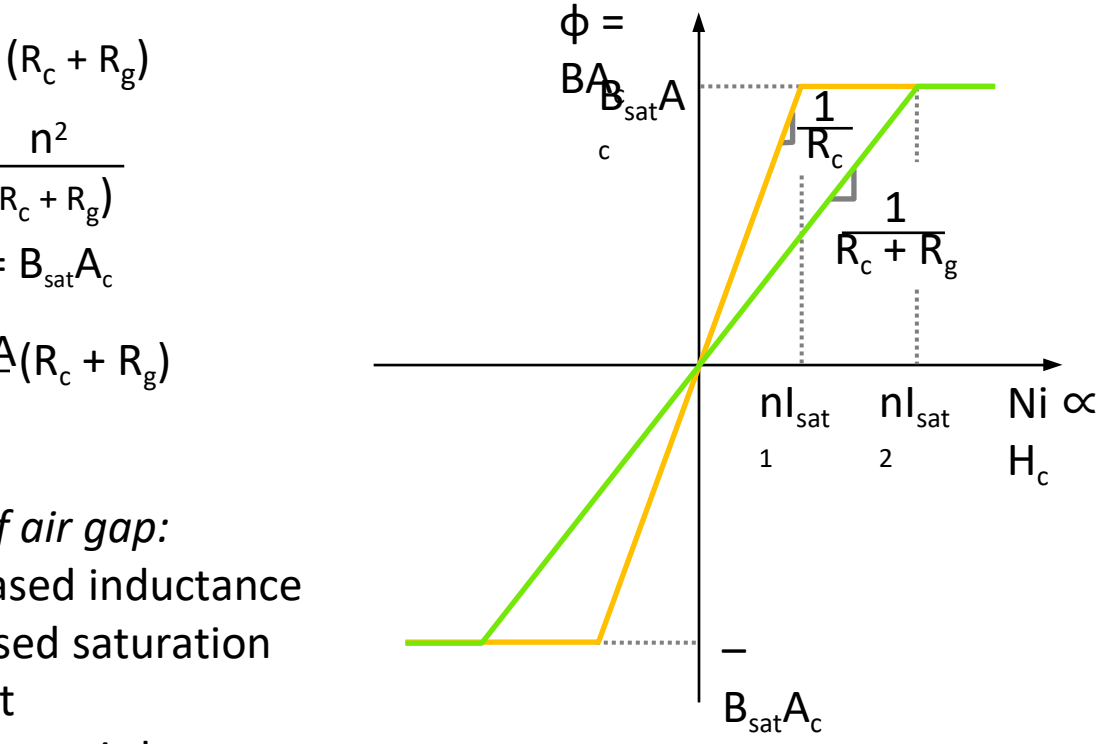
$$L = \frac{n^2}{(R_c + R_g)}$$

$$\phi_{sat} = B_{sat}A_c$$

$$I_{sat} = \frac{B_{sat}A_c}{n}(R_c + R_g)$$

Effect of air gap:

- Decreased inductance
- Increased saturation current
- Inductance is less dependent on core permeability

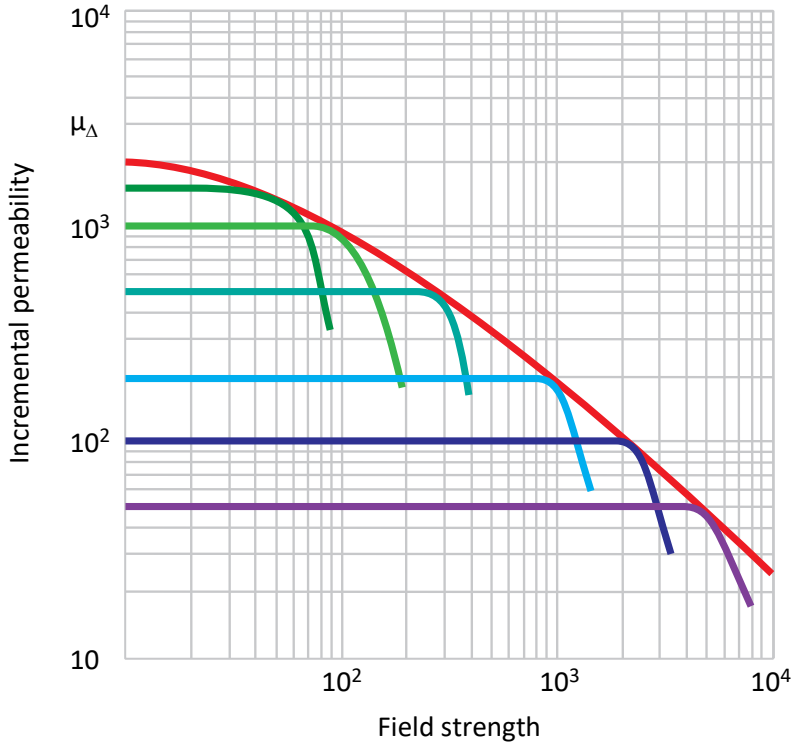


Effects of Gapping a Core

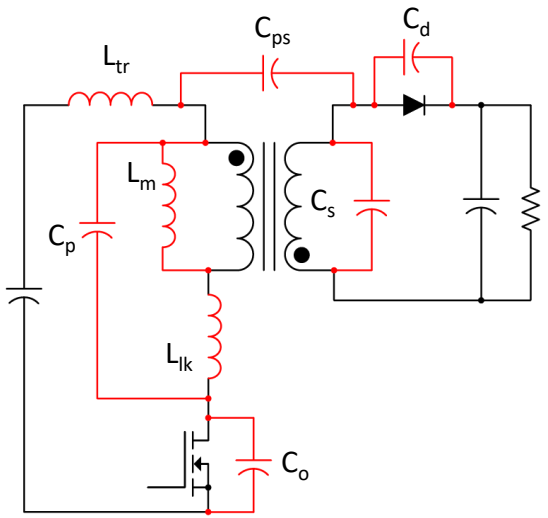
Core Gapping

- Increases DC current handling
  - More inductance per DC current till roll off point (red line)
- Reduces the amount of inductance per wire turn

Effective permeability µe plot

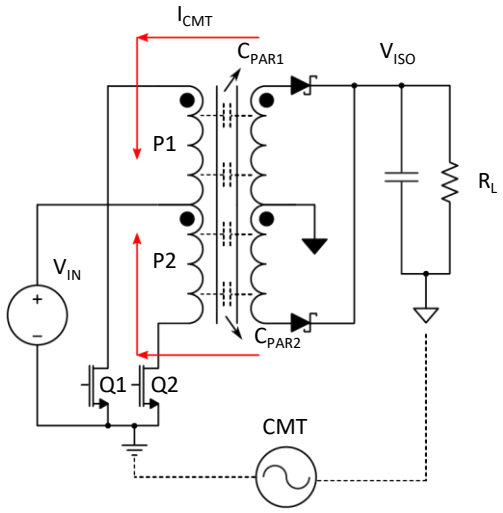


Parasitic Components Affecting EMI



Sources of parasitics that cause ringing

- Leakage inductance Llk
- Distributed Capacitance Cp, Cs, Cd
- FET junction (output) capacitance Co



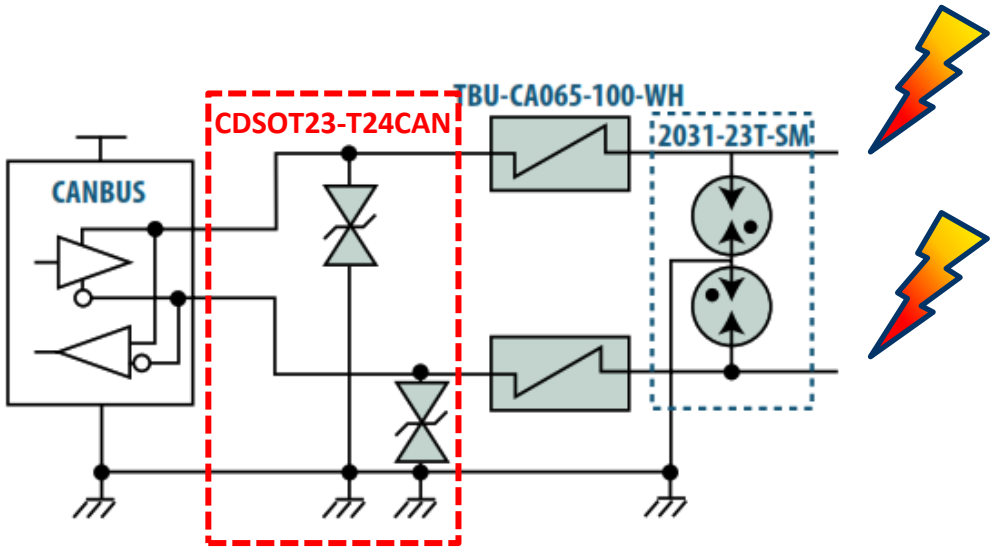
Source of EMI translation path

- Interwinding capacitance (Cps)
- Determines Y-Cap sizing

Protection for Exposed CAN bus Ports

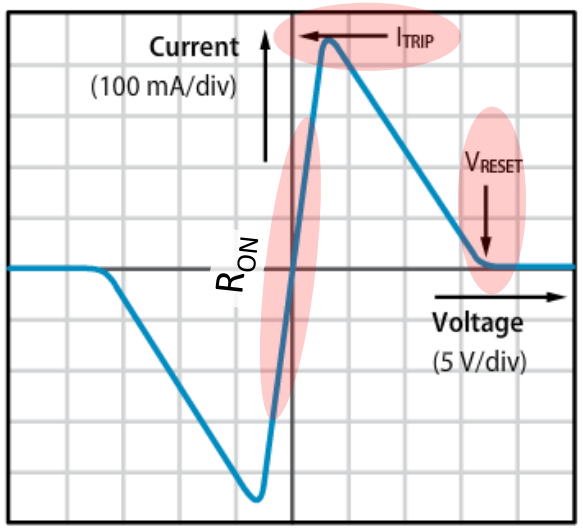
When extra robustness is required

1. TVS protects circuits
2. TBU protects TVS
3. GDT protects TBU



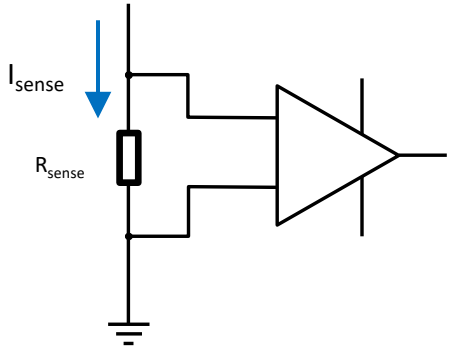
Overcurrent Protector - Transient Blocking Unit (TBU® HSP)

- Provides current protection by becoming an open circuit
- Three parameters describe the IV curve of the Bourns® TBU® HSP
  1. ON resistance
  2. I_{TRIP}
  3. V_{RESET}
- A family of parts is available to allow optimal designs

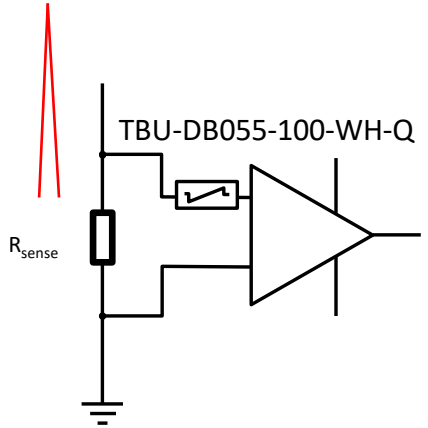


BMS Applications – Sensor Protection

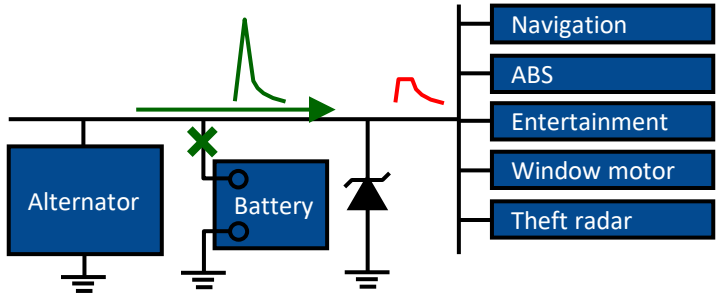
- Battery pack maintenance and monitoring requires a sensing circuit

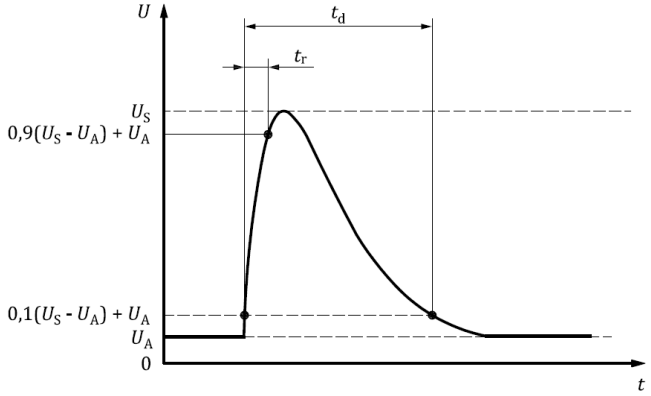


- During a fault condition (e.g., battery puncture), the current can dramatically and rapidly increase, overloading the sensing circuit unless protected



Load Dump Standard





	(Old)	(New)
Standard	ISO 7637-2	ISO 16750-2
Parameter	24 V system	24 V system
U_s	123 V to 174 V	**151 V to 202 V**
R_i	1 Ω to 8 Ω	1 Ω to 8 Ω
t_d	100 ms to 350 ms	100 ms to 350 ms
t_r	10 / +0 / –5 ms	10 / +0 / –5 ms
Pulse	1 pulse	**10 pulses 1 pulse/min.**

Shunts in BMS

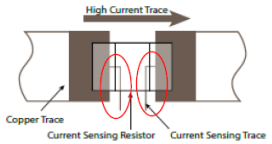
Superior Current Measurement Performances

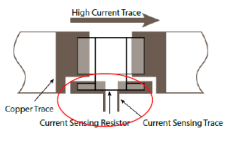
BOURNS®

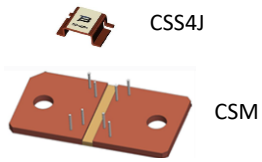
Designing a Shunt Circuit for BMS

Optimizing PCB design/Kelvin connection

- Voltage drop at SMT shunt resistor is a combination of shunt resistance plus lead and solder joint resistance.
  - Measurement resistance value different than shunt value
  - TCR of leads and copper traces are high compared to shunt TCR



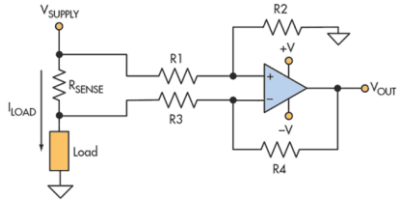




Choosing the best ohmic value

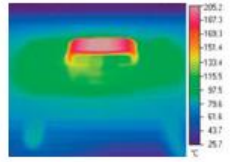
- Trade-off between resolution and power losses

- Shunt voltage to be compatible with ADC input
- Typical: 25 µΩ – 100 mΩ, voltage drop 10 mV – 130 mV



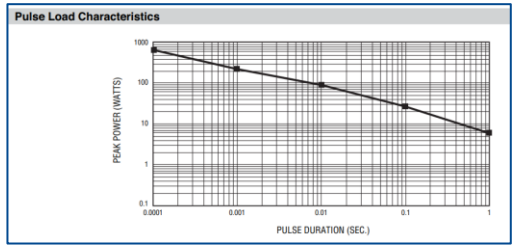
Power rating

- Continuous current $P = R \times I^2$
- Consider overload – peak current / duration
- Working temperature (derating)
- Function of PCB layouts/thermal substrate



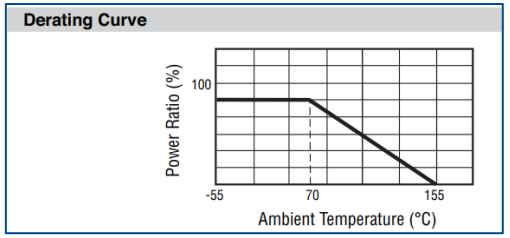
Current surges

- Surges can arise momentarily as a result of inrush conditions



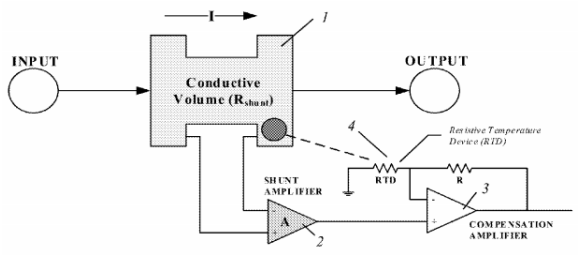
Temperature derating

- As with any resistor, if the ambient temperature is higher than the rated temperature, power derating must be applied, and this is generally indicated in graphical form on the data sheet.
- Typical operating temperature:
  –55 °C to +170 °C

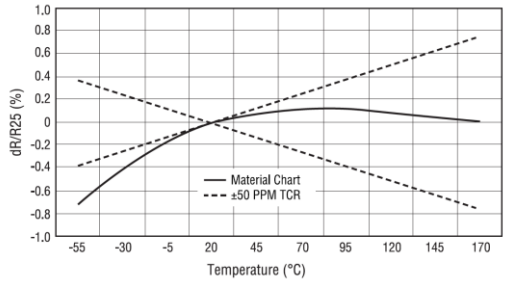


Designing a Shunt Circuit for BMS

Temperature Compensation



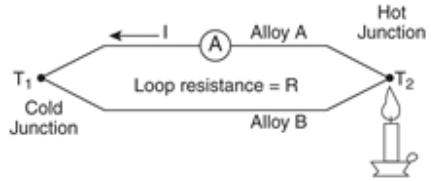
Shunt accuracy is limited by resistance drift. 50 PPM temperature drift over 100 °C results in an output drift of 0.5 %. Higher accuracy requires active temperature compensation.



TCR curve of Bourns® Model CSS4J-4026R current sense resistor

Thermal EMF

Thermoelectric voltage effect: the junction between a metallic R element and a metal termination acts as a thermocouple, generating a V proportional to T across it.



A thermal EMF is a very small voltage in the microvolt range (µV) which is produced due to temperature variations across the resistor. Thermal EMF is an important consideration in the low ohmic value resistors used in DC circuits as it adds offset error.

In the CSM2F-7036 series data sheet, the thermal EMF value s specified as follows:

Characteristic	Model CSM2F-7036 Series
Thermal EMF (µV/K)	< 0.25 for 50 MicroOhms

For instance, considering two different temperature conditions, 20 °C and 70 °C:

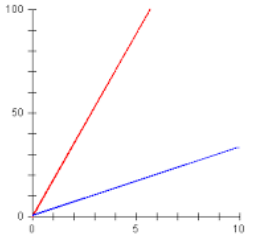
- 0.25 µV/K x 50K = 12.5 µV
- 12.5 µV / 50 µΩ = 250 mA

This is the difference in current measurement due to thermal EMF.

Current Measurement in BMS

- Current measurement functions:
  - Overload protection & safety
  - Battery State of Charge (SOC) measurement
  - Optimized operation for long cycle life of batteries

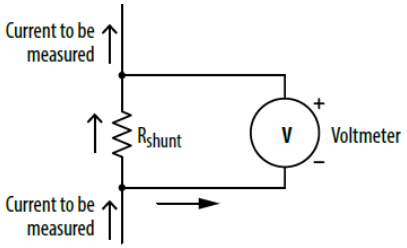
- Current measurement requirements:
  - Accuracy from low to high currents (mA to kA)
  - Stability and linearity over entire battery life
  - Stability and linearity over full temperature range
  - Robustness against mechanical stress, external magnetic fields



- Shunt resistors, in combination with latest signal conditioning solutions, are best in class for BMS requirements.

Shunt Current Measurement

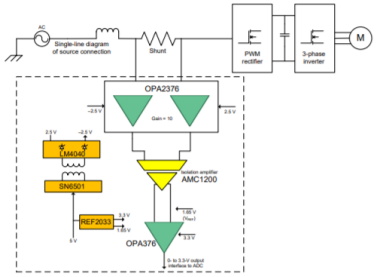
Non-Isolated measurement

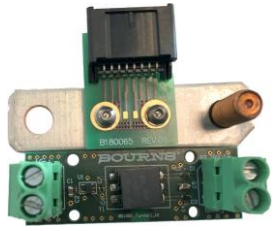


Advantages
- DC & AC measurement
- Good linearity and low drift over temperature and time
- Low cost
- High overload resistance
- Not sensitive to external magnetic field
- Good accuracy over full current range

Disadvantages
- No isolation
- Power losses

Isolated measurement





Advantages
- DC & AC measurement
- Good linearity and low drift over temperature and time
- High overload resistance
- Not sensitive to external magnetic field
- Good accuracy over full current range
- Isolation

Disadvantages
- Power losses
- More complex