BOURNS®

Automotive Application Note

Overview

- Founded in 1947, Bourns, Inc. is a leading provider of components and solutions for Motion Control, Circuit Protection and Circuit Conditioning
- Privately held company headquartered in Riverside, California
- Approximately 5,300 employees with 14 worldwide manufacturing centers for electronic products
- All manufacturing centers are ISO 9001 and/or TS16949 certified

General Information

1947: founded by Marlan & Rosemary Bourns
privately held company
HQ in Riverside, CA

1980: start of supplying automotive solutions

2004: Acquisition of Ruf

2005: Formation of
Automotive Division

2006: Acquisition of SSI

15 Acquisitions since 2000

Joslyn GDT Division
March 2001

Microelectronic Modules Corporation
December 2003

RUF Automotive Group
December 2004

J.W. Miller Magnetics Business
May 2006

pPTCs of Therm-O-Disc
July 2006

TBUs of Fultec Semiconductor
October 2008

Jensen Devices' GDTs
June 2012

Power Innovations, Ltd.
May 2000

Telecom Protection Products from TI
January 2003

MMC's Switch Power Products
February 2004

Tyco/Meggitt's Fuel Cards
February 2005

Automotive Controls Division of SSI
June 2006

Protection Products from Emerson
January 2008

Protection Products of Corning
June 2009

Komatsulite
December 2014

Global Manufacturing

ISO 9001, ISO 14001 and ISO/TS 16949 certified.

Major Customers

Customer	OEM Customer
GM Chassis & GM Powertrain	General Motors (GM)
Ford	Ford
Continental	Chrysler, VW, Audi, BMW
ZFLS	GM, VW, BMW
Hyundai Mobis	Hyundai, Kia
American Axle	GM
TRW	GM, Ford
Timken	Chrysler, GM, Ford
Delphi	GM
Pierburg	Opel, Fiat
Bosch	Honda, GM, Opel, Fiat, DCX, Nissan, Volvo

Customer	OEM Customer
Magneti Marelli	Opel, Fiat, PSA, Audi, Harley Davidson
Arvin Meritor	Various Heavy Truck
Knorr Bremse	Various Heavy Truck
Valeo	Mercedes
Mando	GM
Williams Controls	Volvo, Hyundai, CAT
Visteon	Ford, Jaguar, Mazda
Borg Warner	Ford, DCX
Dura	GM, Chrysler
Hella	GM, Ford, Audi, Nissan, Kia
ASMO	Nissan, HY, Toyota, VW

Automotive Sensor Applications

Fuel Management

Fuel Level, Throttle Position & Electronic Throttle Control, Accelerator and Brake Pedal

Steering and Stability Control

Angle, Torque, Motor Position, Chassis

Speed Sensors

Wheel, Transmission

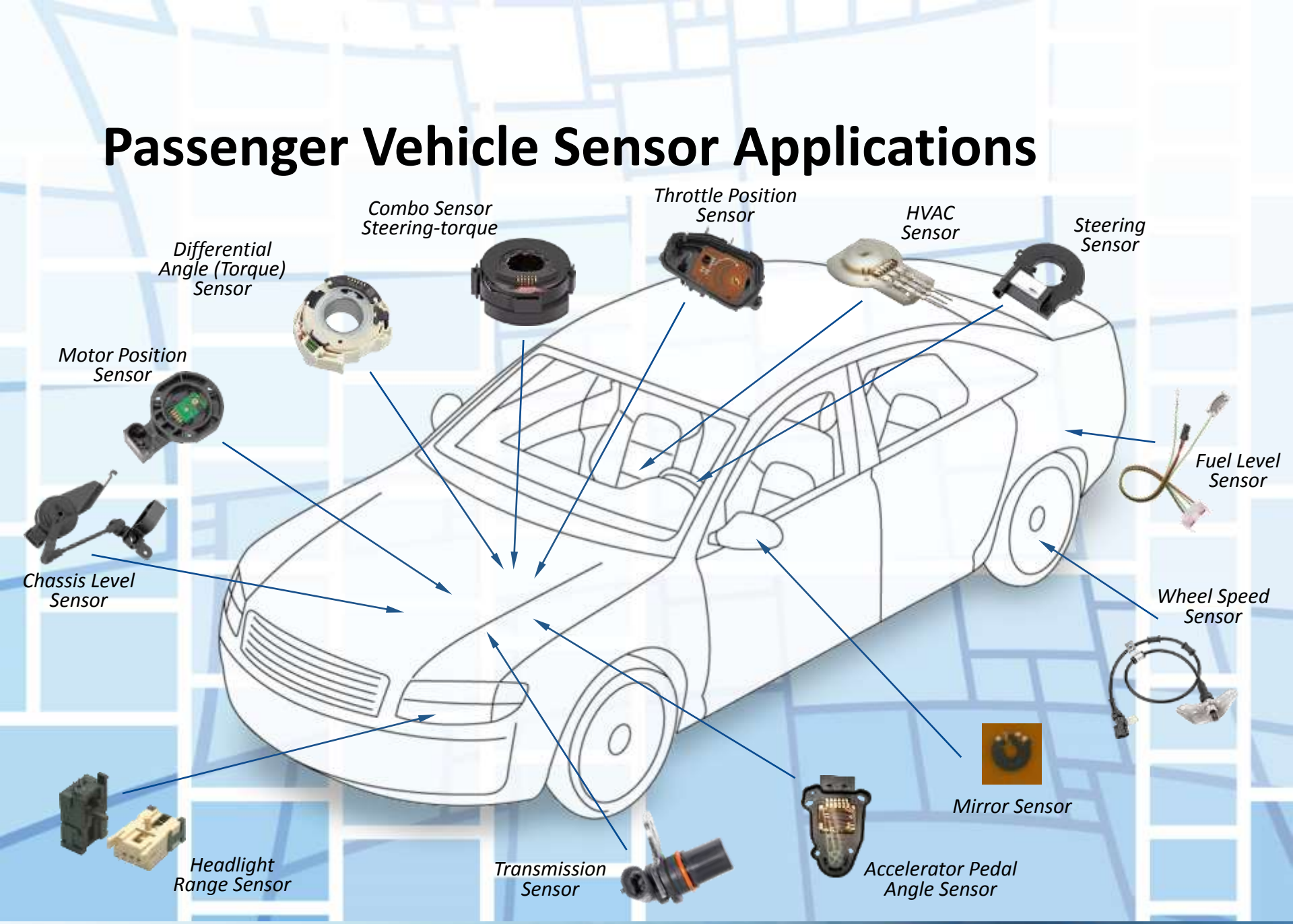
Other Angle and Position Sensors

HVAC, Air Flaps, Temperature Control, Mirrors

Bourns Value Proposition

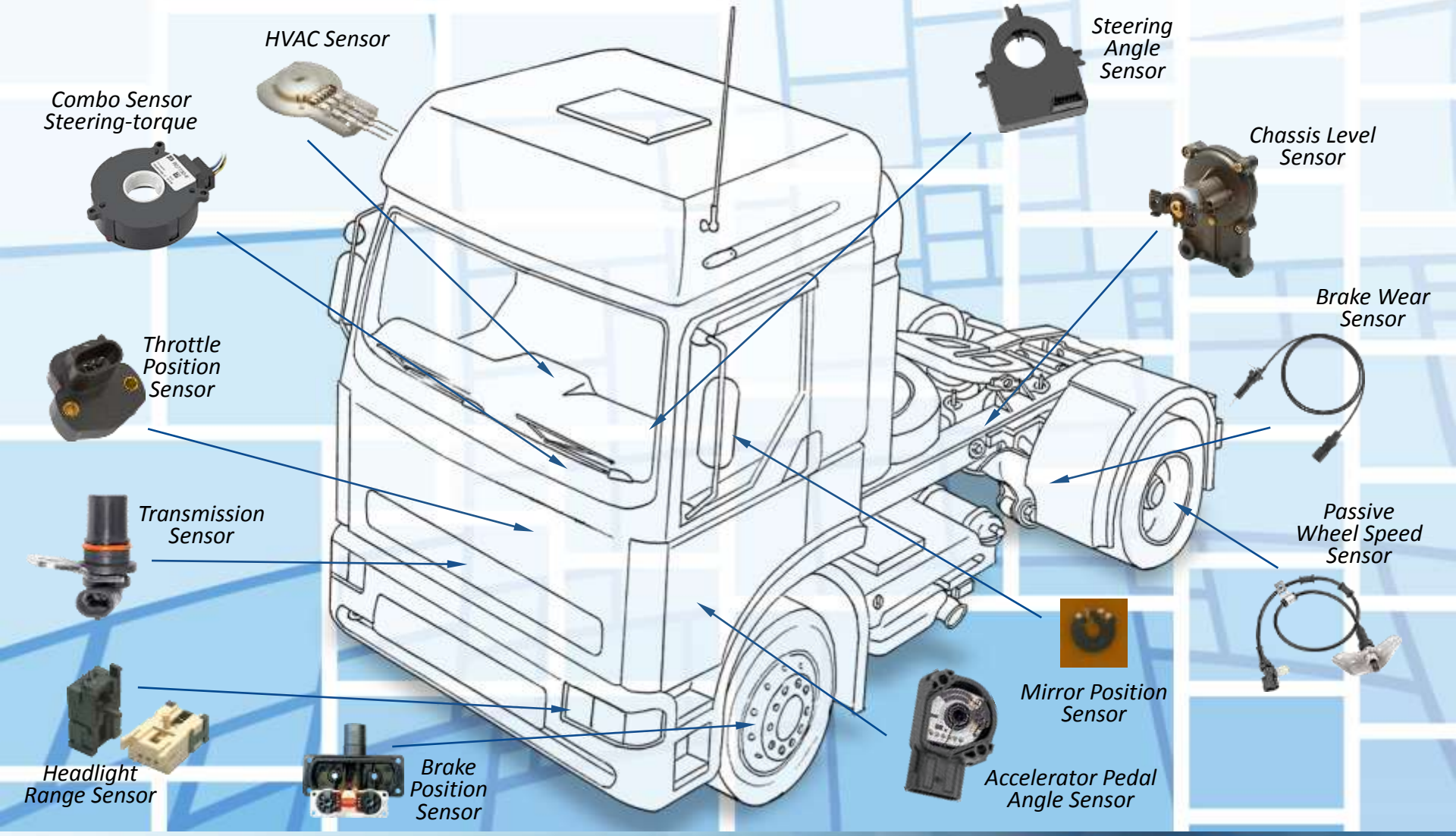
- Contacting and non-contacting solutions
- Travel, angle and linear measurement
- Worldwide engineering support capabilities
- ISO 26262 compliant, all manufacturing sites are TS 16949 certified
- In-house design, toolmaking, screen-printing, cermet firing & injection molding
- Development of proprietary resistive ink

Passenger Vehicle Sensor Applications



BOURNS®

Commercial Vehicle Sensor Applications



BOURNS®

Automotive Component Applications

Comfort & Positioning
Window Lifts, Seat Positioning

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

Vehicle Lighting
HID, LED

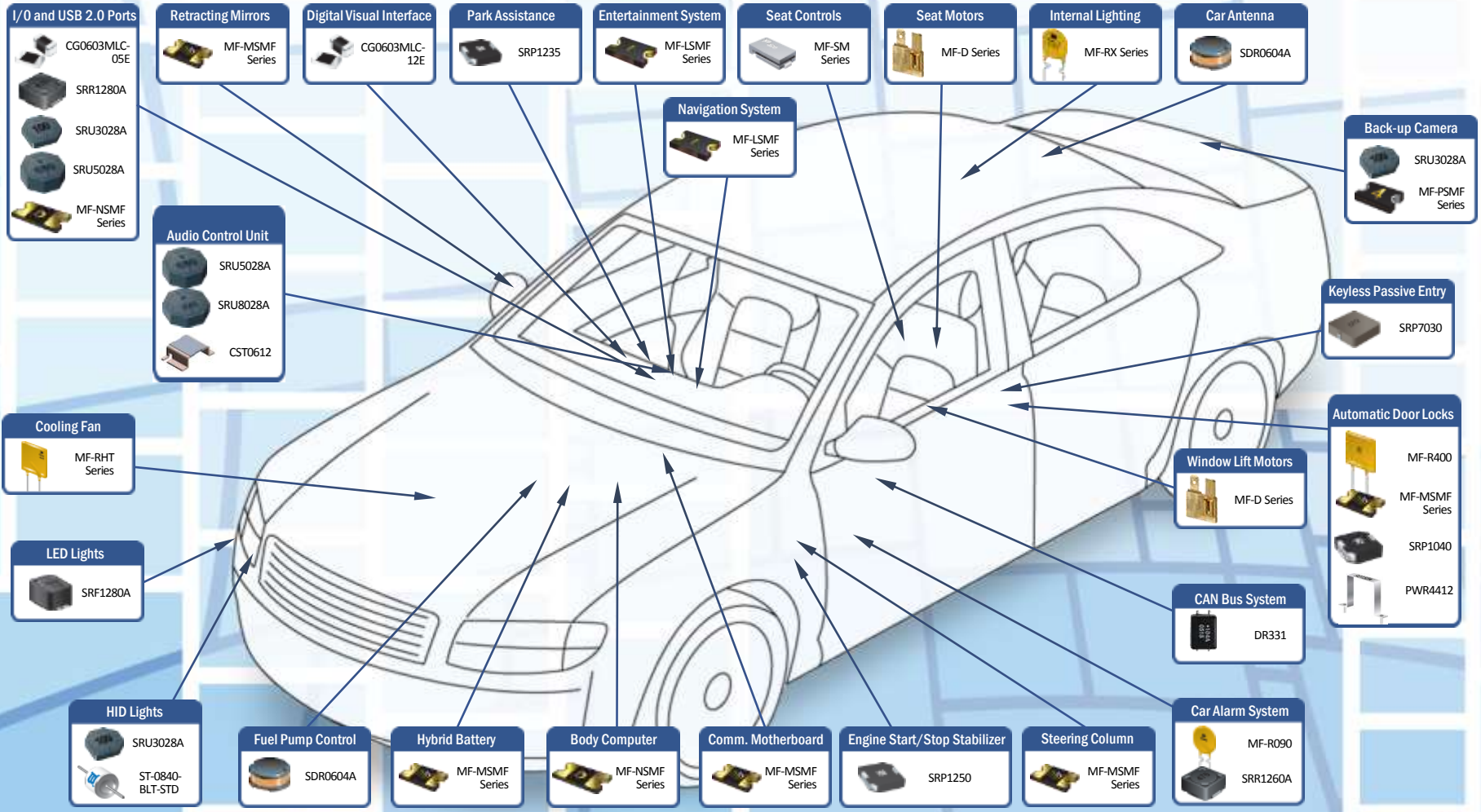
Vehicle Networks
CAN, Flexray, Ethernet, LIN

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

Bourns Value Proposition

- AEC-Q200 qualification – PPTC, inductors, resistors & MLVs
- TS16949 quality system
- Application test lab

Board Level Components for Automotive Applications

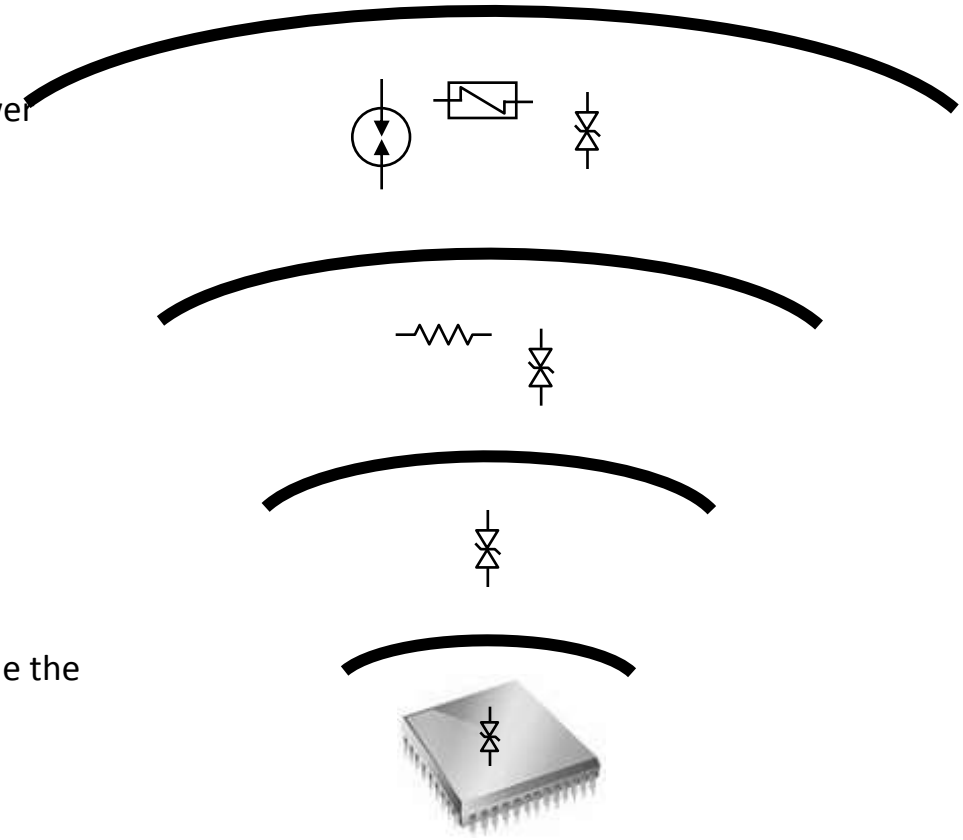


BOURNS®

Levels of Protection

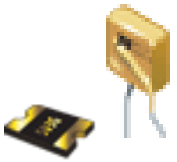
- The TBU solution provides a higher level of protection

- High Energy Surge Protection
  - Provides resistibility against lightning and power induced faults
- Moderate Energy Surge Protection
  - Typically need to add components to increase energy resistibility
- Low Energy Surge Protection
  - Basic ESD protection if IC structures are not adequate
- Protected IC
  - Sometimes contains sufficient protection inside the chip for low energy surges



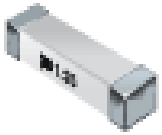
Bourns® Protection Device

Multifuse®



CPTC

Telefuse™



SinglFuse™

Over Current Protection

Over Voltage Protection

Magnetics

LSP

TCO

LPM

TBU™

TCS™

MOV

GDT

TISP®

TVS

Chip Guard®

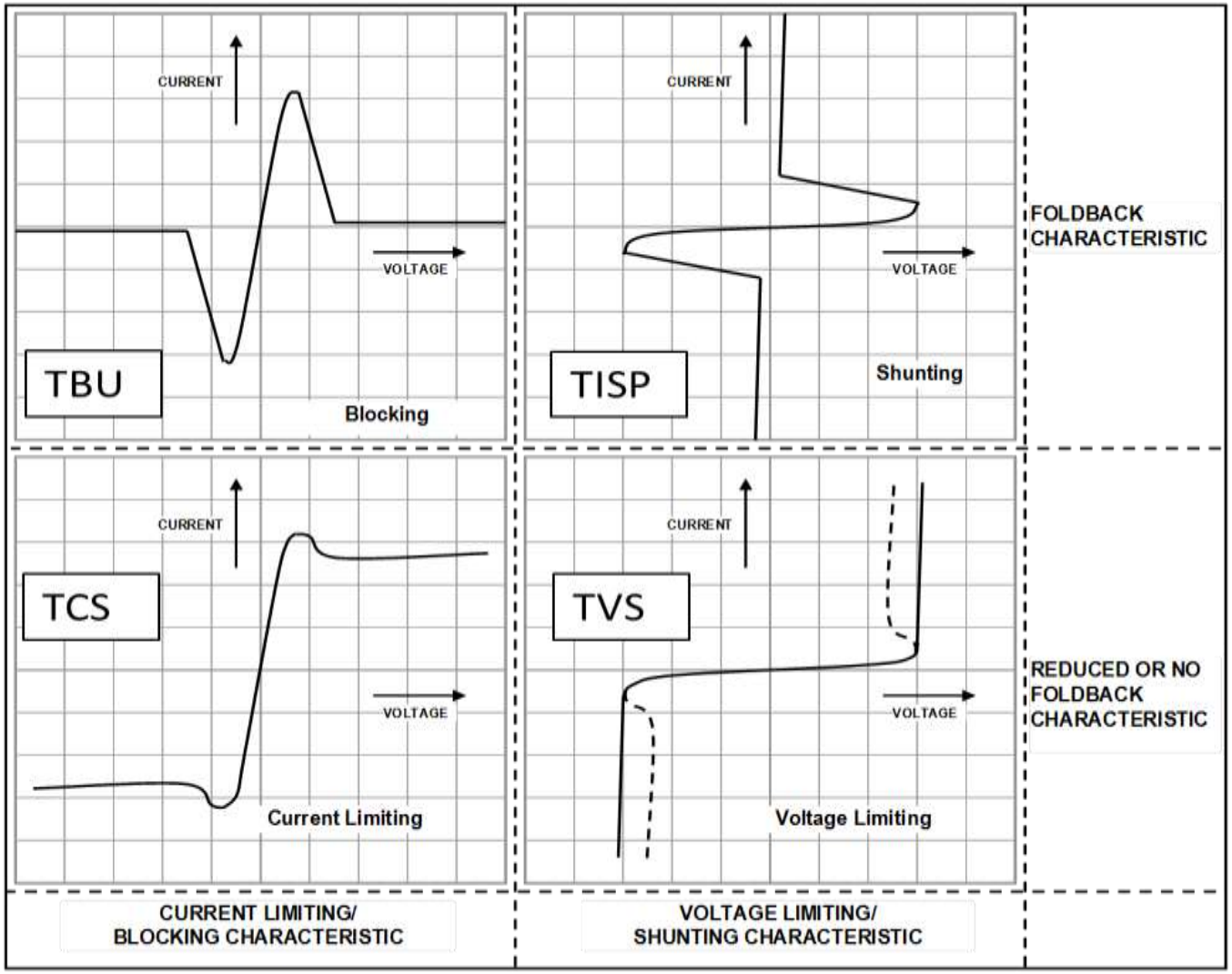
Automotive Electronics

- Electronic content in automotive applications continues to increase (6 % per year) (SAE)
- 30-45 ECUs per vehicle (IHS Global Insight (2009))
- Expect 70 ECUs by 2020 (IHS Global Insight (2009)
- Safety (ISO262262), Electrification, Infotainment Systems, Connectivity Driving Forces

Automotive Design Challenges

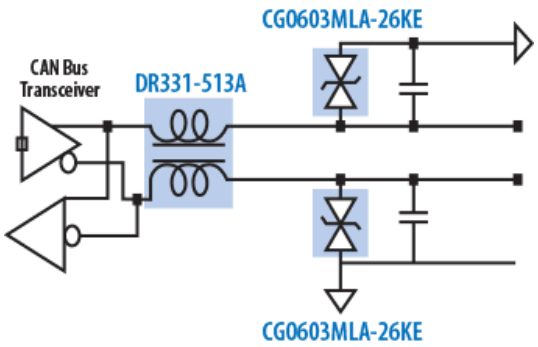
- Overcurrent / short circuit protection of chipset
- Circuit conditioning of power supply
- Transients according ISO 7637
- Automotive environment testing
- PPAP level 3 submission
- TS16949 Qualification

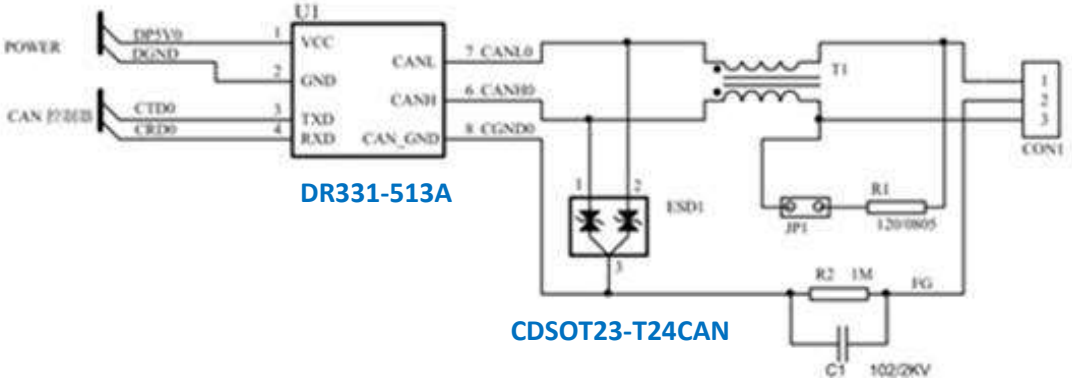
General Characteristics of the Device Types



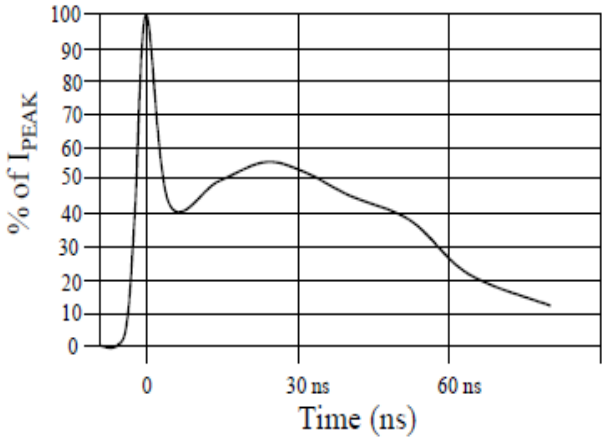
Canbus Connectivity Applications

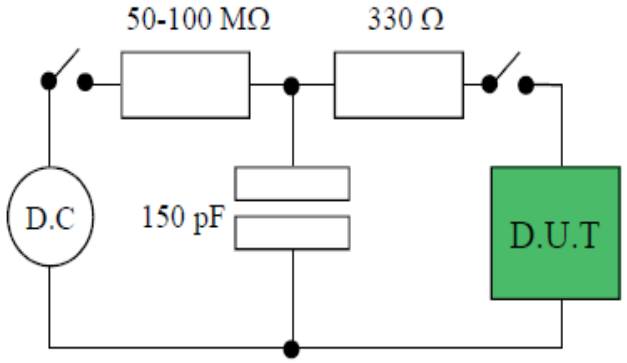
- Solution: CDSOT23-T24CA(NUP2105)+ DR331 (Common choke)
- Reduce Stress on CANbus Phy
- Transients clamped by Automotive Approved ESD or TVS Array
- See the app note on DR331 at: http://www.ti.com/lit/an/slla271/slla271.pdf





IEC 61000-4-2 HBM ESD Transient Model



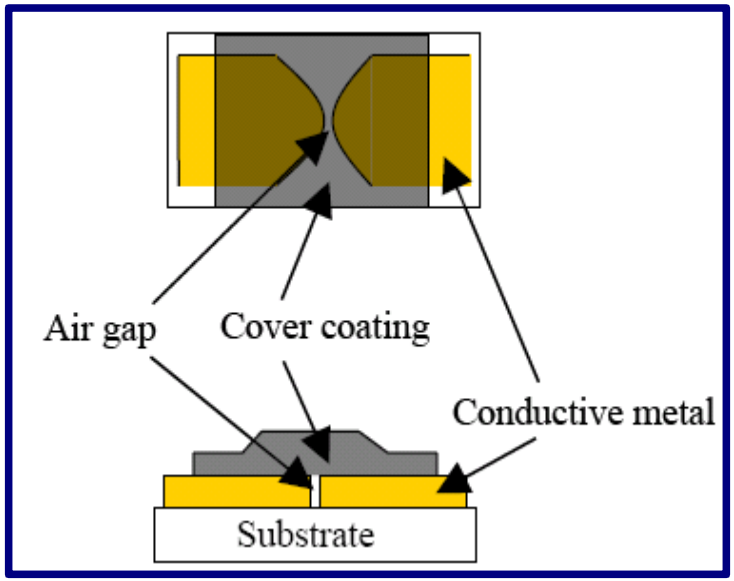


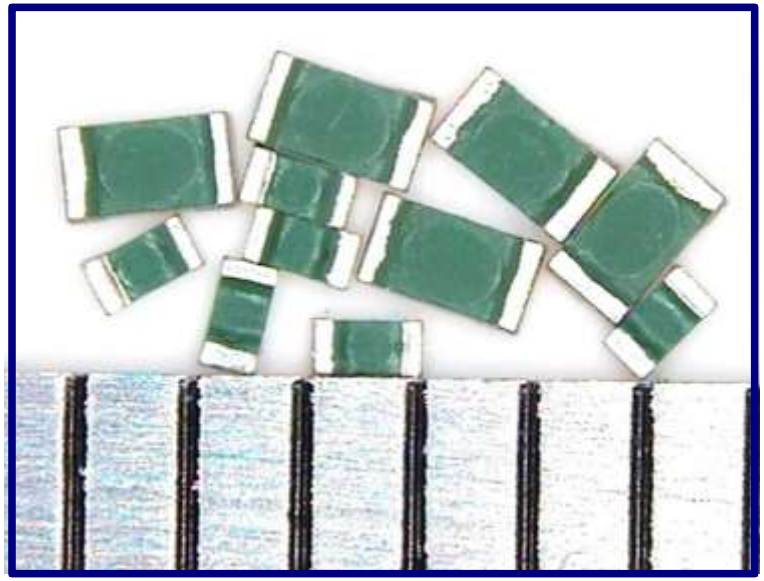
IEC 61000-4-2 Standard	Contact Voltage (kV)	Air Discharge Voltage (kV)	Peak Contact Current (A)	Contact Current @ 30 ns (A)	Contact Current @ 60 ns (A)
Level 1	2	2	7.5	4	2
Level 2	4	4	15	8	4
Level 3	6	8	22.5	12	6
Level 4	8	15	30	16	8

Bourns Automotive Approved ESD Protectors

Part Number	Working Voltage (V)	ESD Rating	BreakDown Voltage	Capacitance	Clamping Voltage(V)
CG0603MLC-05E	5	8KV Contact, 15KV Air	250V	0.5pF	25
CG0603MLC-12E	12	8KV Contact, 15KV Air	250V	0.5pF	25
CGA0402MLC-05E	5	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0402MLC-12E	12	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0402MLC-24E	24	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0603MLC-05E	5	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0603MLC-12E	12	8KV Contact, 15KV Air	300V	0.2pF	30
CGA0603MLC-24E	24	8KV Contact, 15KV Air	300V	0.05pF	30

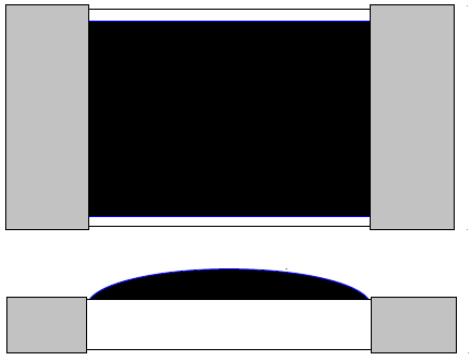
ChipGuard® ESD Suppressor Product
Using Air Gap

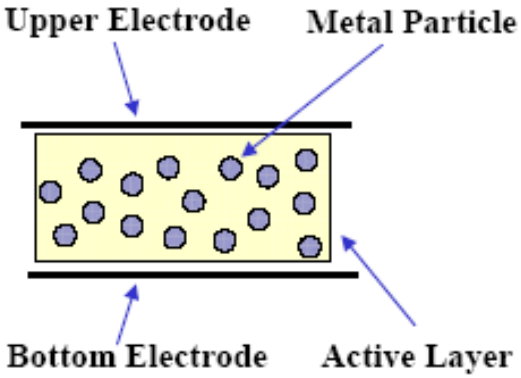




- Air Gap technology fabricated in surface mount devices (SMD, 0603 / 0402 chip type)
- Designed by air space discharge technology; provides bidirectional protection

ChipGuard® ESD Suppressor Product
Using Polymer

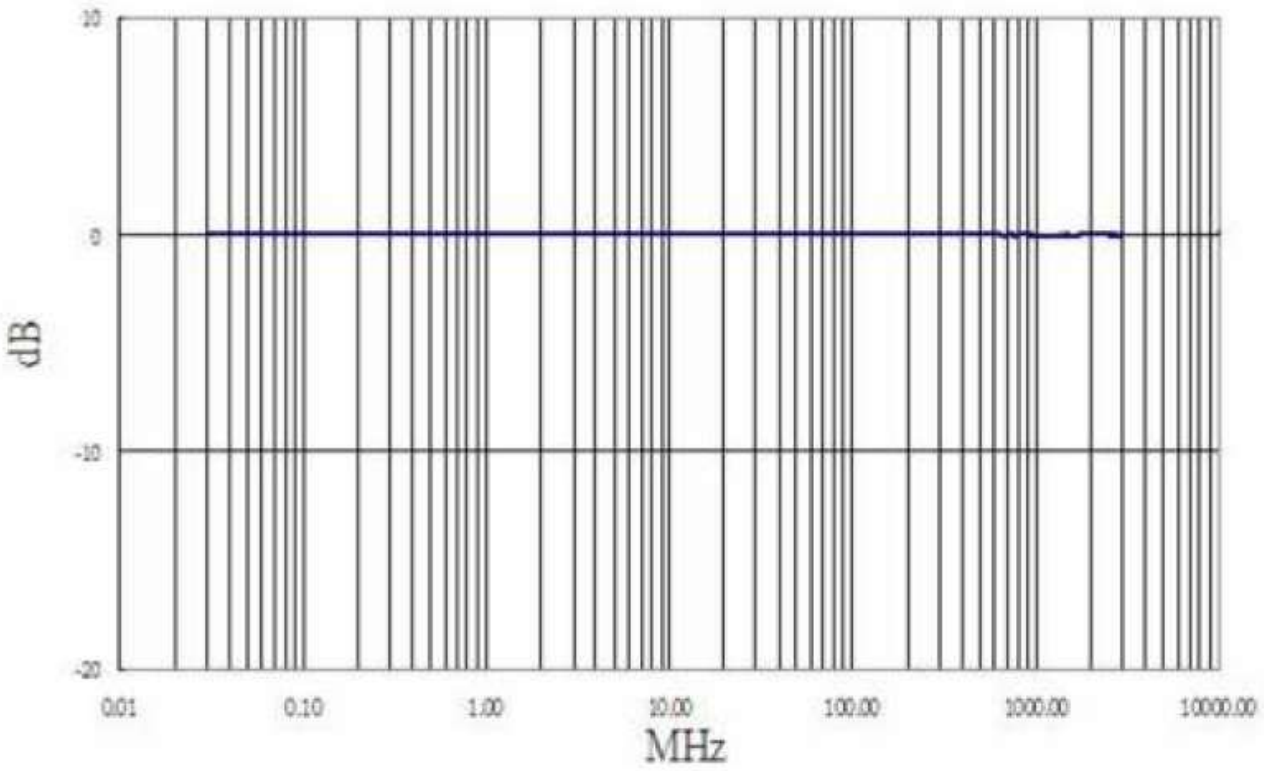




- Polymer technology fabricated in surface mount devices (SMD, 1206 / 0603 chip type)
- Polymer technology provides bidirectional protection

Bourns® ChipGuard® ESD Suppressor Products

CG0603MLC-05E Frequency Response



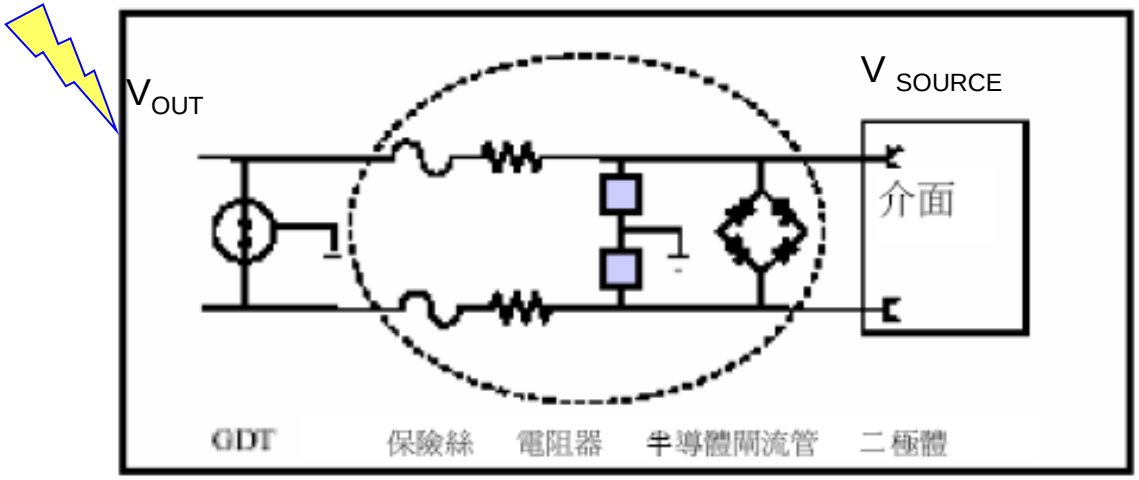
Bourns® ChipGuard® ESD Suppressor Products

CGxxxxMLC-xxLE and CGxxxxMLU-xxE series.

- Features
  - MLC Low capacitance of 0.5 pF max.
  - MLU Ultra Low capacitance of 0.05 pF max.
  - Operates from -40C to +125C.
  - IEC 61000-4-2 level 4 ESD specifications.
  - Guaranteed minimum 1000 ESD repetitions at 8 kV contact &15 kV air discharge tests.
  - Excellent clamp voltages under 8 kV tests.
  - Response time of less than 1 ns.
- Applications:
    - High speed data / communication ports
      - USB 2.0
      - USB 3.0
      - HDMI 1.4
    - Mobile phone antenna protection

Conventional Protection Solution

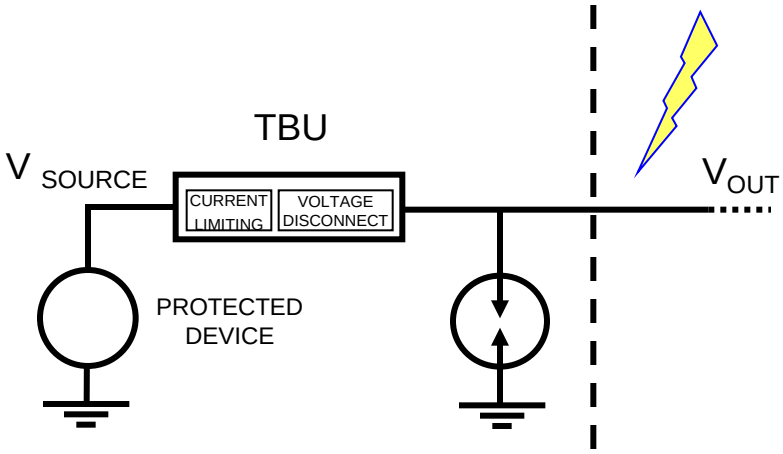
Lightning test circuit

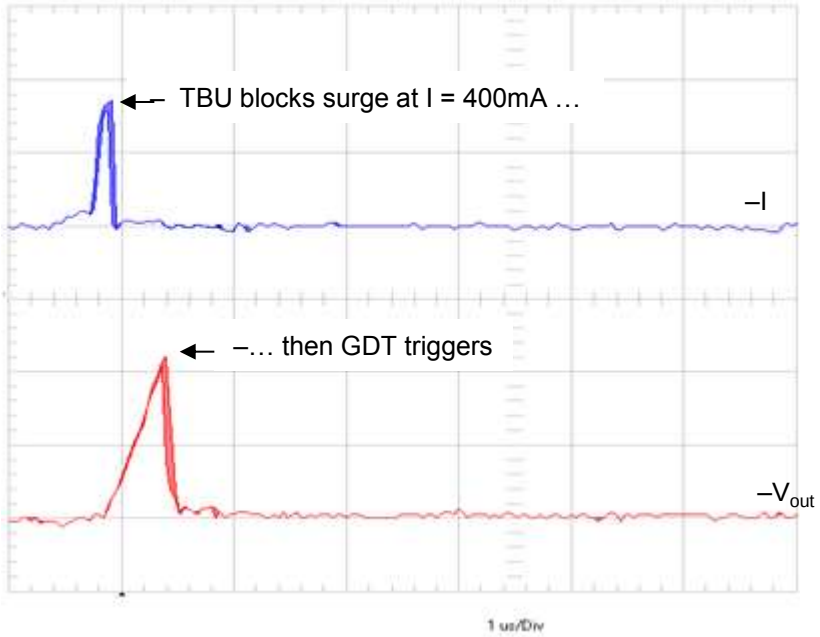


- Circled parts indicating the secondary protection and the Coordinating impedances.

Example: OVP Coordination using a TBU™ device

Lightning test circuit

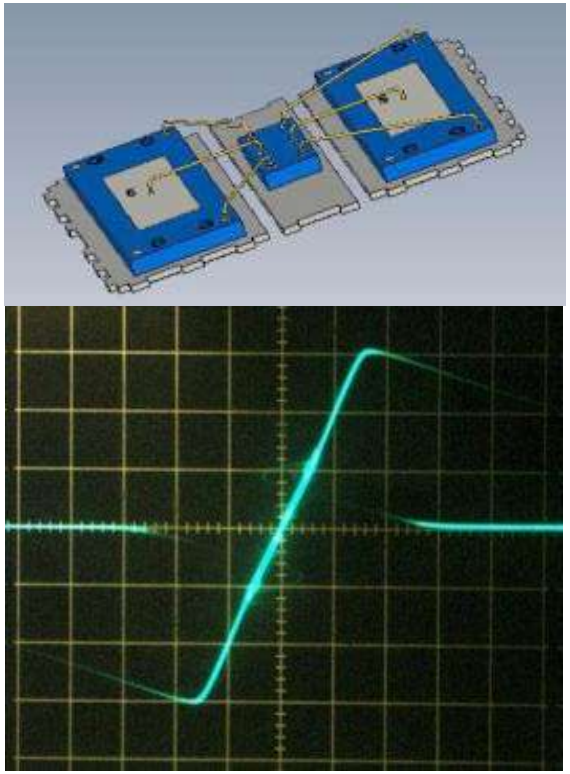


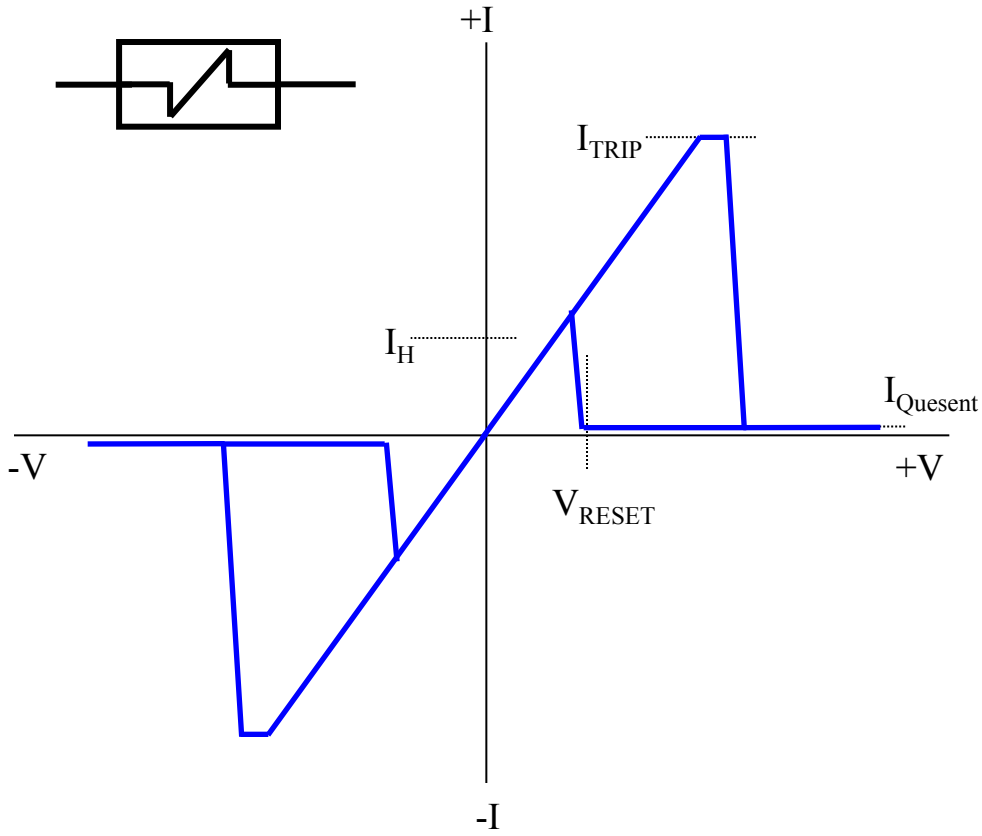


Surge 5000V, 1/50 μsec

I-V Characteristic of a TBU™ device

- Below trigger threshold, TBU device acts like a resistor
- Above trigger threshold, TBU acts like a ~1mA current source



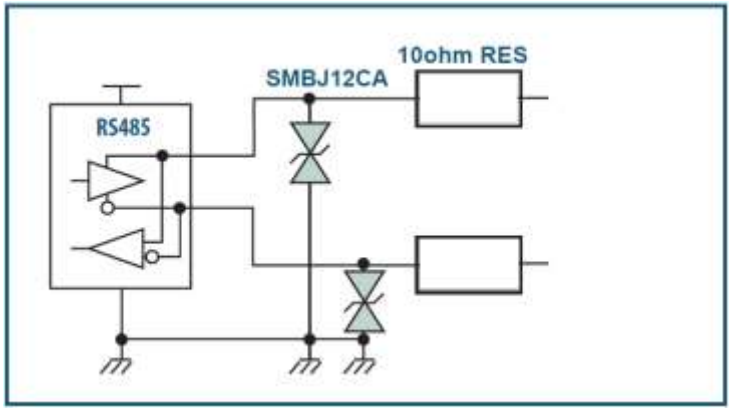


Operating temperature range: -40 to +125° C

TBU Advantages & Benefits

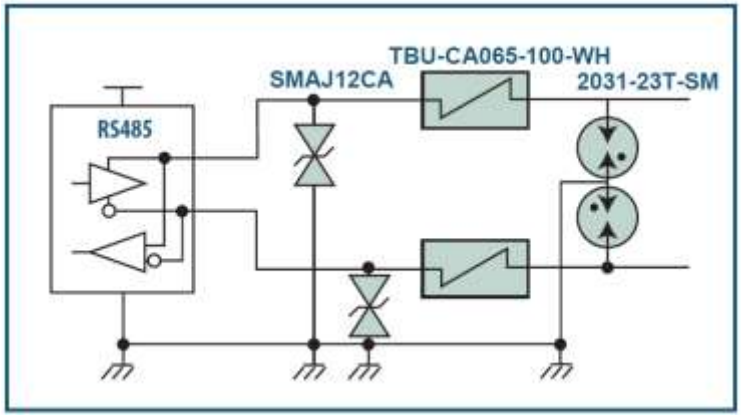
Example: RS485 Port Protection

TVS/Resistor Solution



- Limited Surge Protection
- No AC/DC Power Cross protection
- Non-Resettable
- Fulfills lower tier of protection envelope

TBU solution



- High energy surge protection
- AC/DC Power cross protection
- Resettable solution
- Works irrespective of surge duration or rate-of-repetition
- No let-thru energy to sensitive chipsets
- Wide operational bandwidth

RS-485 Port Protection Evaluation Board For TBU Solution

Figure 1: RS-485 Evaluation Board Schematic

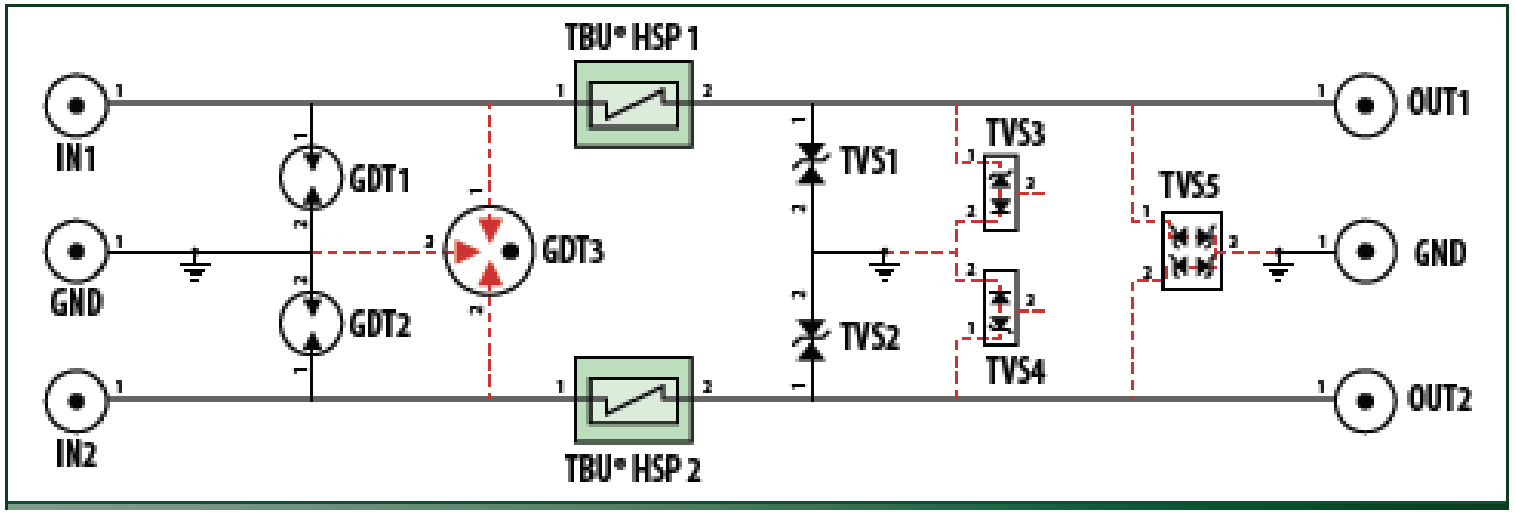


Figure 2: RS-485 Evaluation Board 1

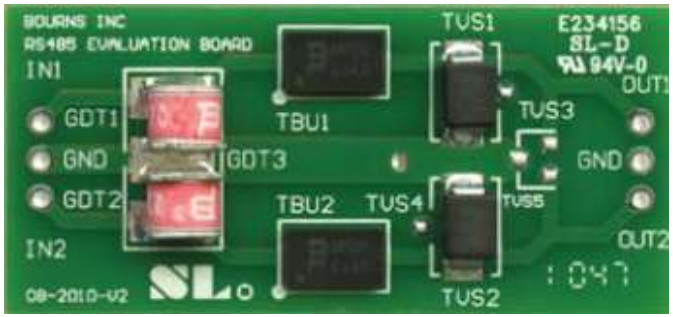
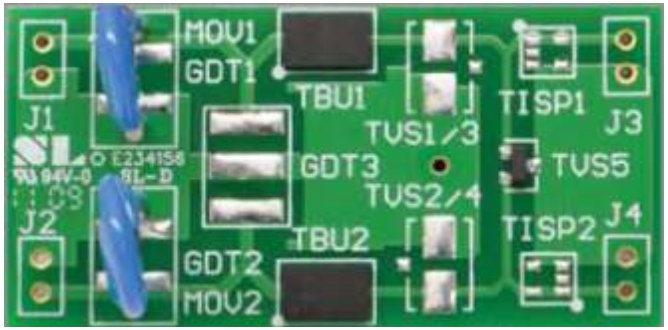
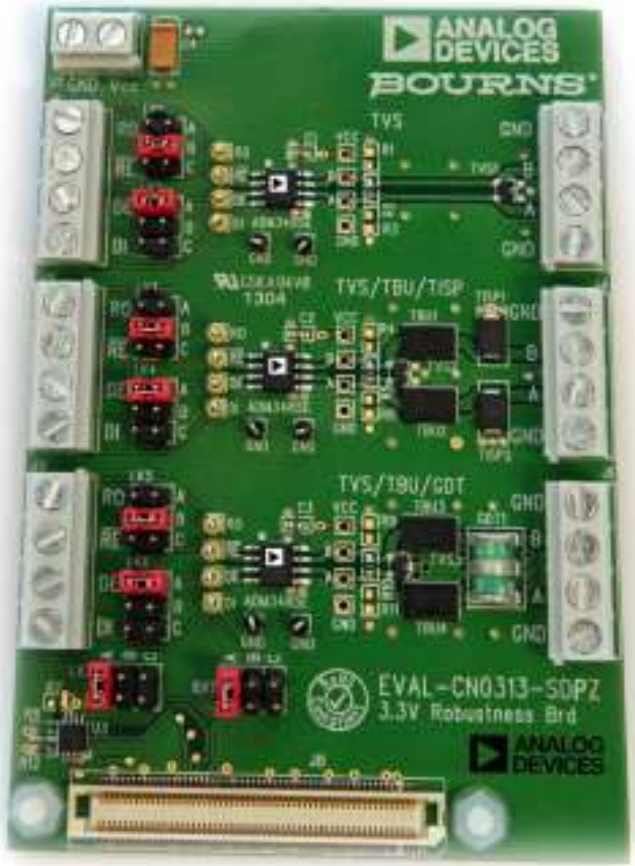


Figure 3: RS-485 Evaluation Board 2



ADI RS-485 Evaluation Board



Features:

- Cost-efficient, three panel board
- Tests circuits at the beginning of the design cycle
- Use of schematics and layout as a starting point in your design
- Certified to protect ADI's ADM3485E, 3.3 V RS-485 transceiver for:
  - 6 kV, 4 kV and 1 kV Surge (IEC 61000-4-5)
  - 15 kV Air Discharge ESD (IEC 61000-4-2)
  - 2 kV EFT and 8 kV Contact (IEC 61000-4-4)
- The ezLINX™ iCoupler® Isolated Interface Development Environment

For more information:

- Visit http://www.bourns.com/adi_board
- Register to watch the webcast, Safeguarding RS485 Communication Networks from Harmful EMC Events, on March 27, 2013

The evaluation boards are now available through select authorized distributors of Bourns and ADI.

Should you have any questions or need additional information, please contact Bourns Customer Service/Inside Sales or ADI Technical Support.

LVDS Protection

- TBU devices have been evaluated and recommended by National Semiconductor for LVDS applications
- Tested to 3 Gbps up to 100 meters

National Semiconductor
The Right & Sound of Information

www.national.com

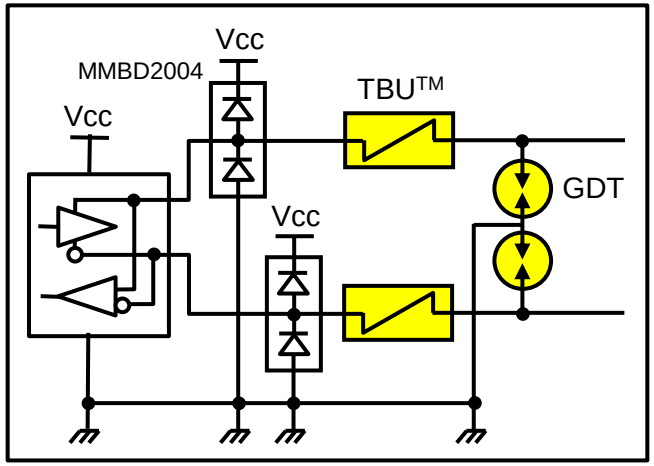
Signal Integrity Evaluation of Bourns Lightning Protection Solutions

Bourns lightning protection solutions suitable for National Semiconductor's high speed interface devices consist of gas discharge tubes (GDT) and transient blocking unit (TBU™) protectors. Table 1 summarizes common lightning protection standards in the industry and Bourns devices suitable for each of the standards.

	GR-1089 Intra-B	GR-1089 Intra-B Enhanced	IEC61000-4-5 Class 0-3	IEC61000-4-5 Class 4-5	ITU-T K.21
Lightning	800V/100A Diff 1500V/100A Com	5000V/500A	2000V/48A	4000V/95A	6000V/150A
Power Cross	120V	230V	-	-	230V
TBU	C650	C850	C650	C850	C850
GDT	G5500AS	G5200AS	G5500AS	G5200AS	G5200AS
Resistance	10Ω	14Ω	10Ω	14Ω	14Ω
Capacitance	1 pF	1 pF	1 pF	1 pF	1 pF

Table 1. Common Lightning Protection Standards and Recommended Bourns Solutions

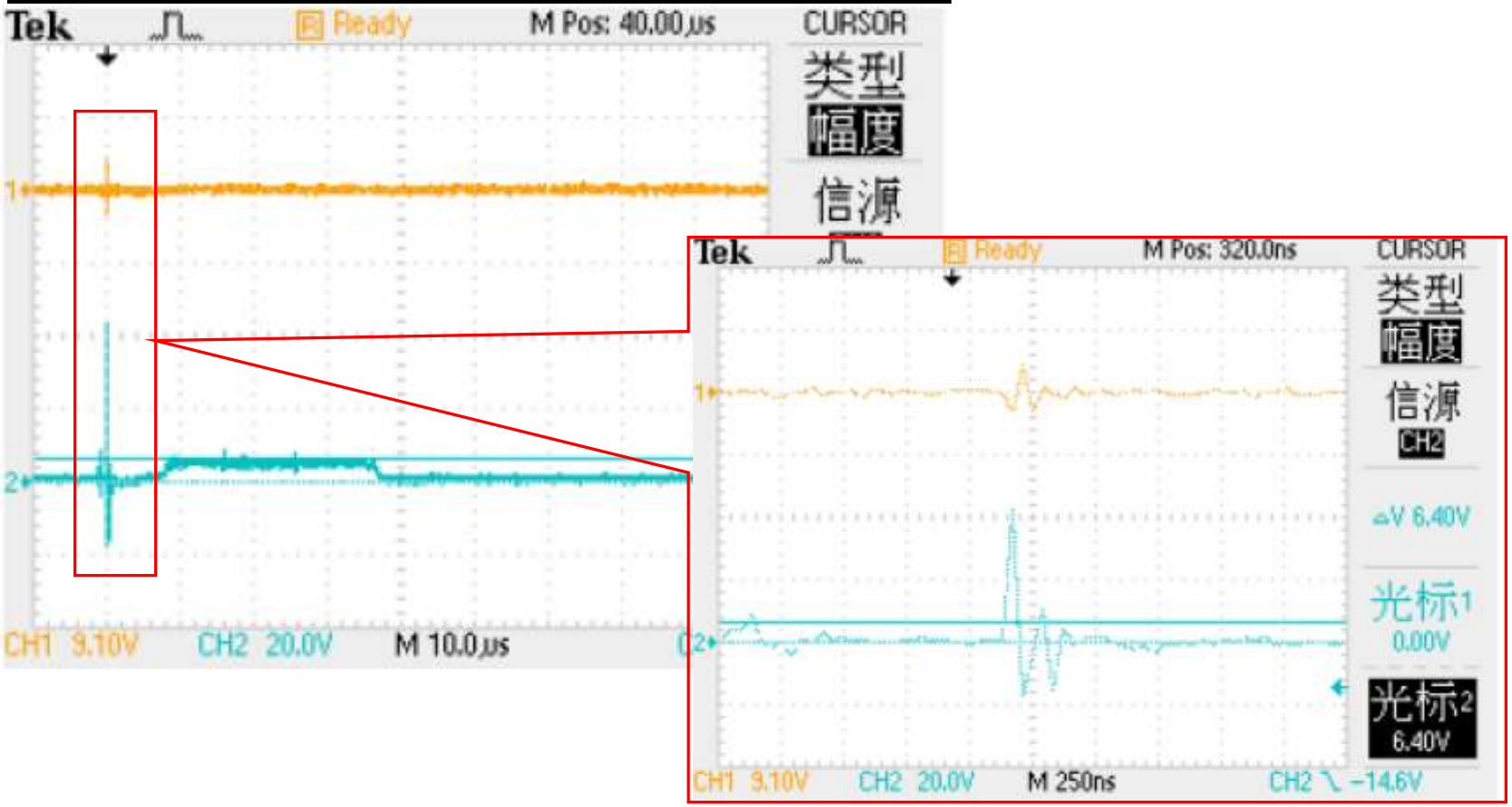
Excerpt from National Semiconductor white paper



- TBU and GDT device selection are per the required protection level

TBU-CA Solution for RS485

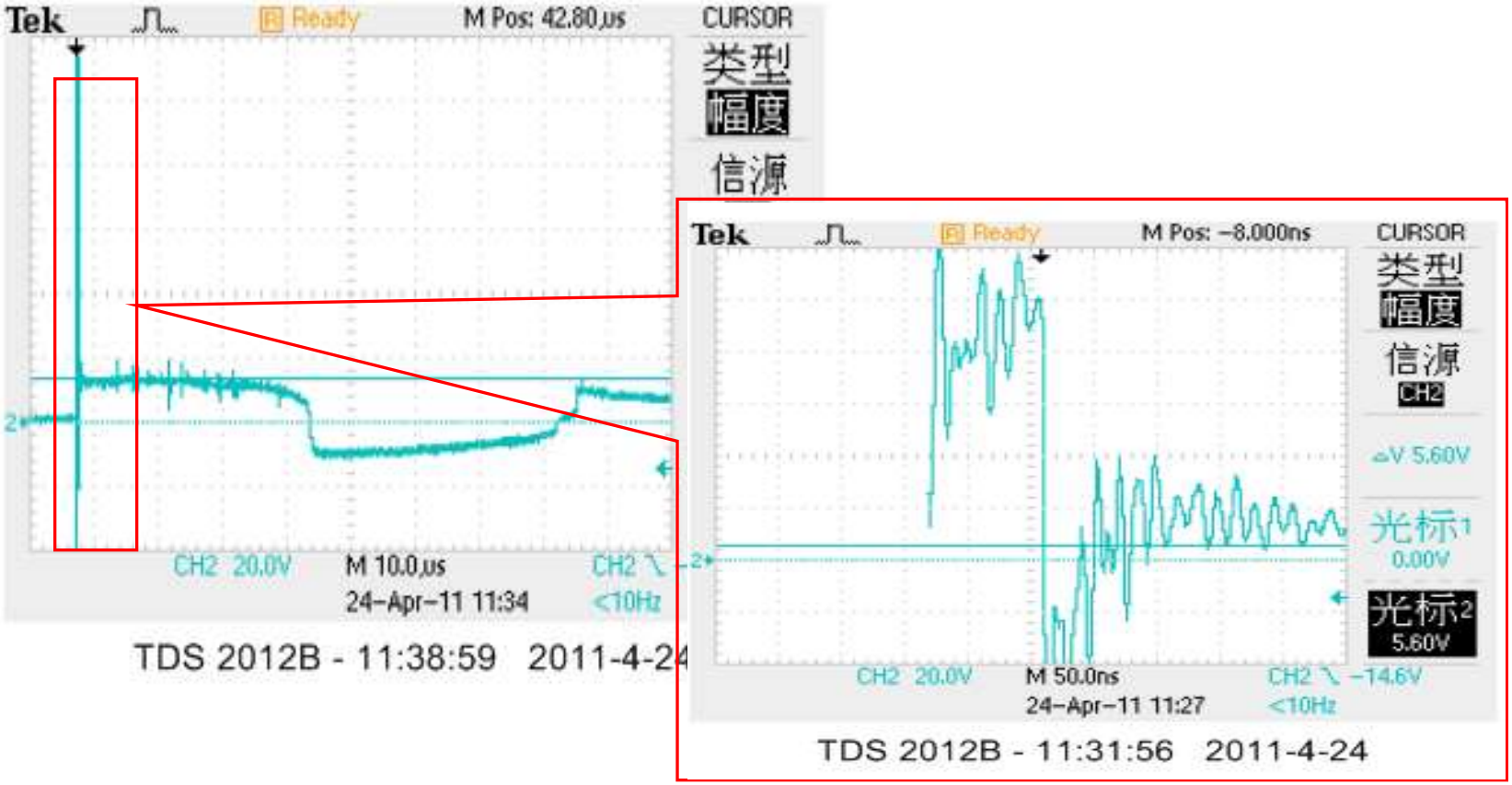
Lightning: 8/20μs,20kV, 10kA



Conventional Vedio Protection Solution

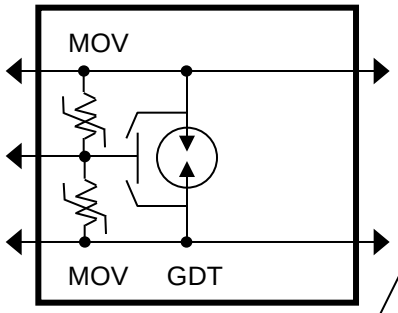
(GDT+PR+TVS)

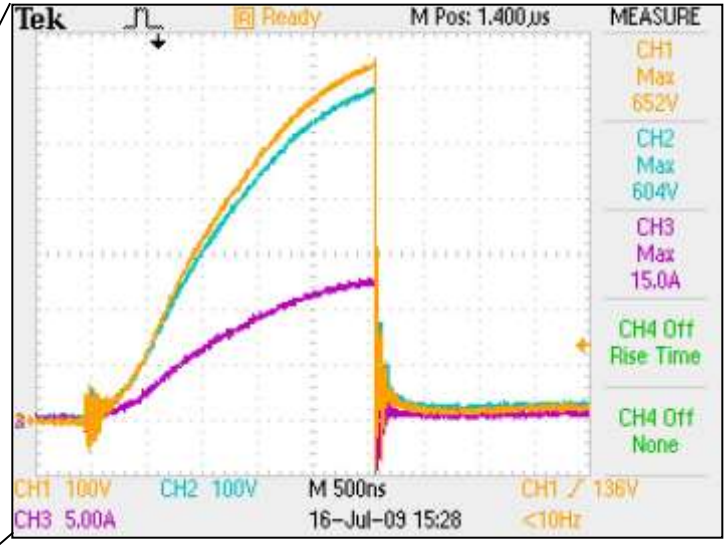
Lightning: 8/20μs,20kV, 10kA



Leading Technology-Integrated MDF Modules

2410





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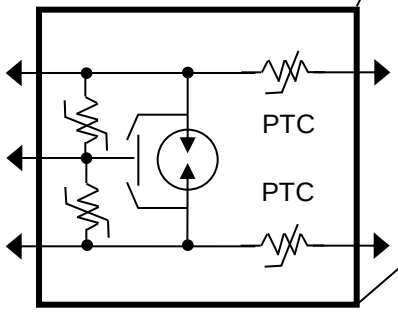

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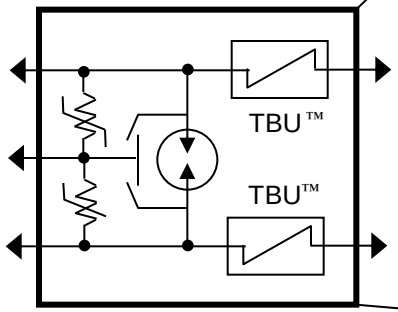
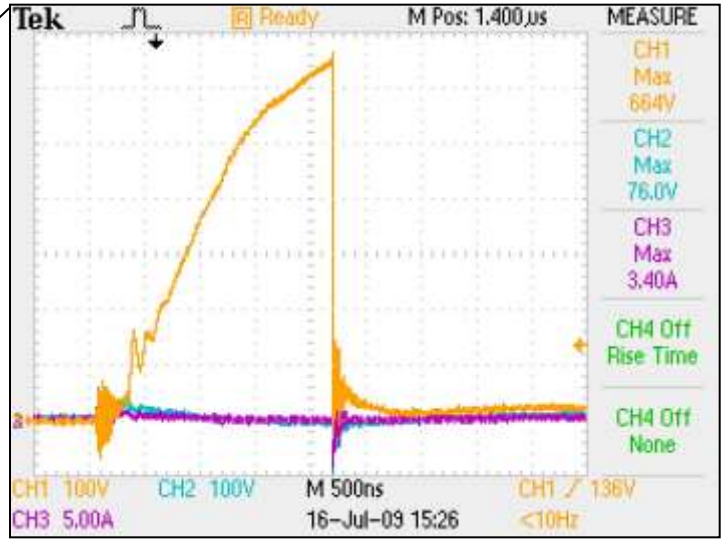
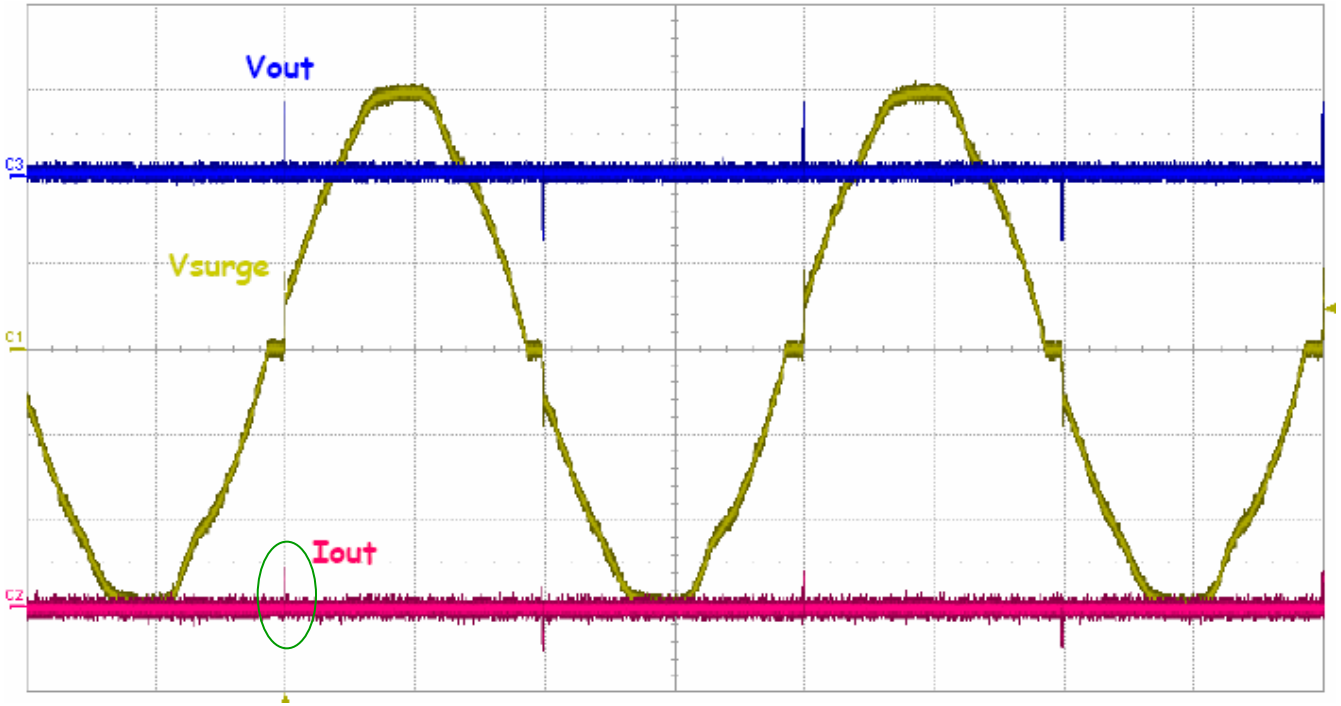




AC Power Cross using a TBU™ device

- During power cross, the TBU device turns on and off every cycle:
  - 440VRMS into 10ohm load using C850-260-WH



V_{SURGE}	: 100V/div	5ms/div
I_{OUT}	: 1A/div	5ms/div
V_{OUT}	: 5V/div	5ms/div

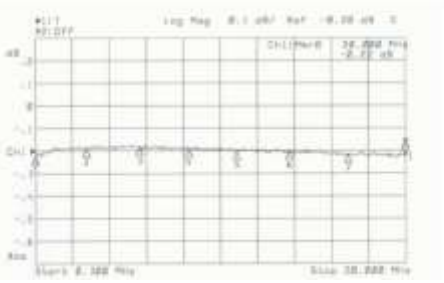
Vout determined by the load resistance and TBU trip current:

Vout = Iout * Rload

Bandwidth using a TBU™ device

- Insertion Loss of two C850-260-WH TBU devices in a 50ohm LVDS test circuit
  - -3dB at ~3GHz

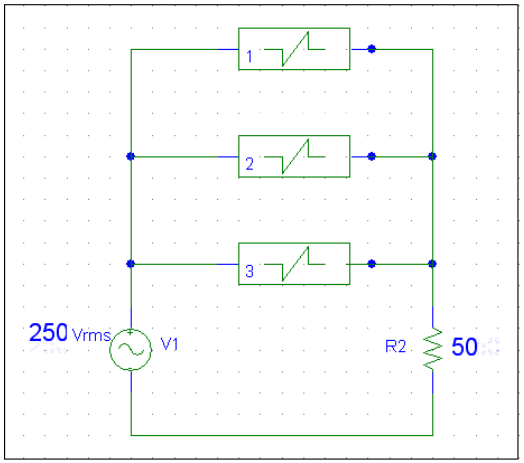
传输特性图（T=25℃，0.3-20MHz）

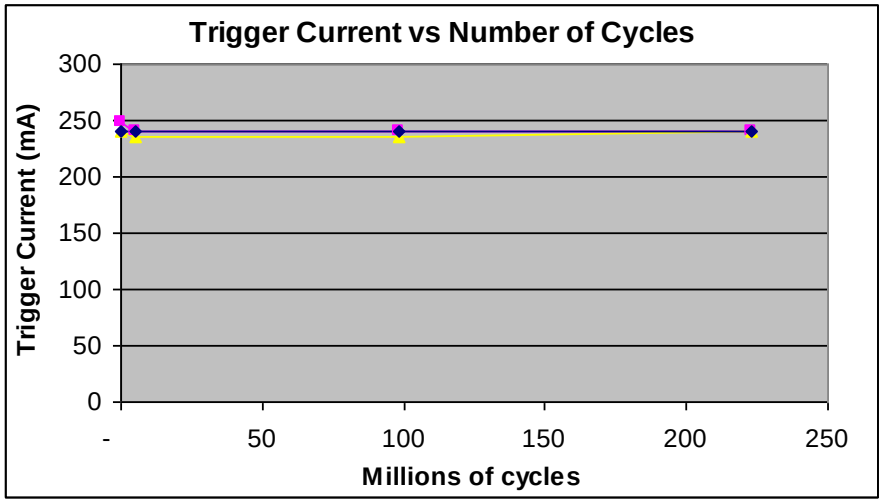


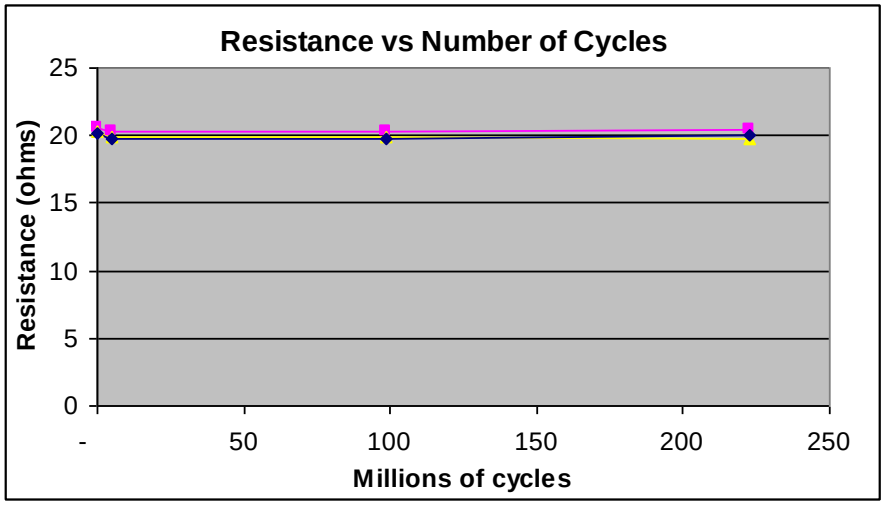
TBU Has Exceptional Stability

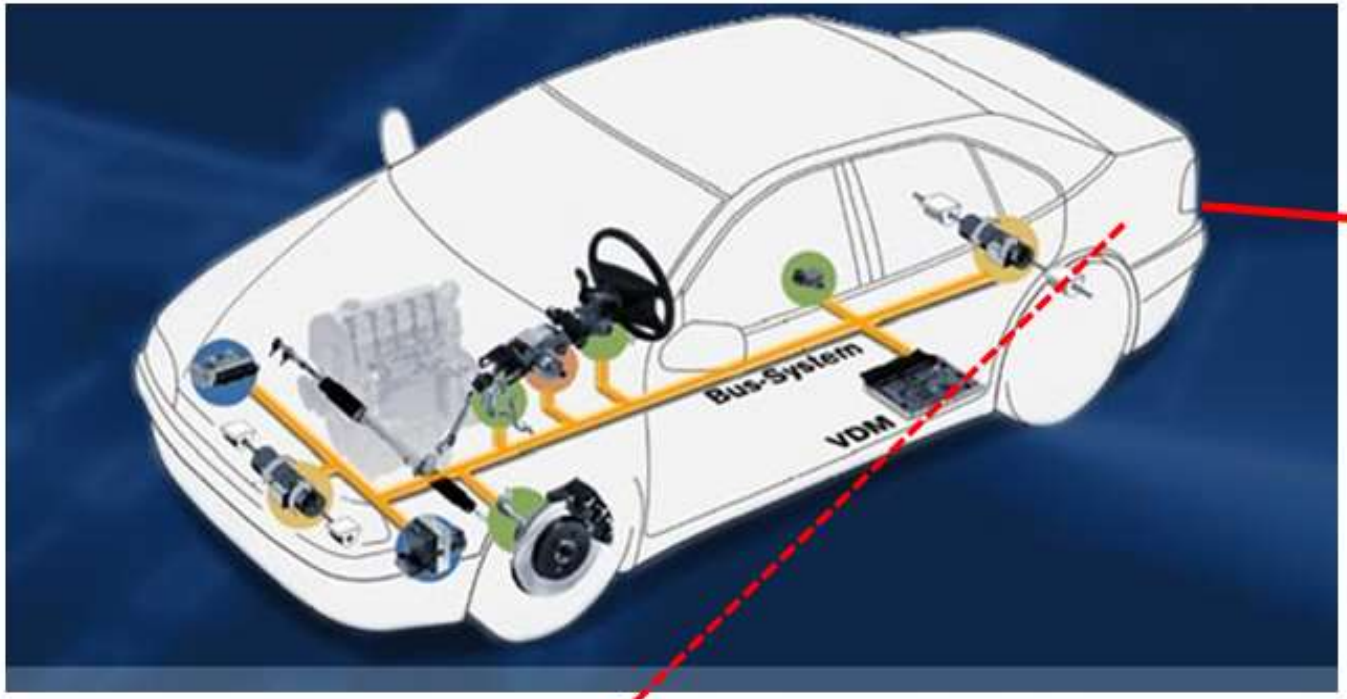
Fault cycle test results (UL1434)

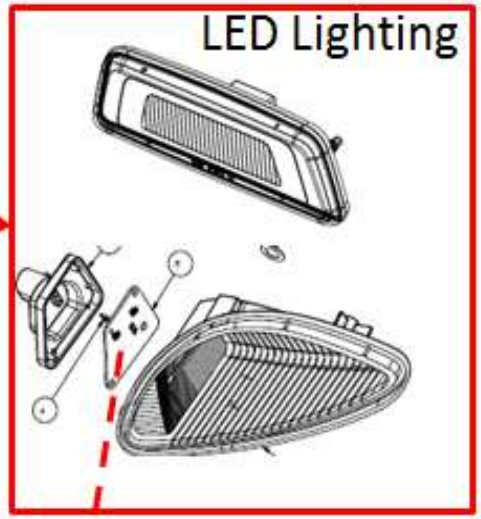
- 250V_{ac}, ~4A fault current, 85° C;
- TBU remains <u>unchanged</u> after 200M cycles

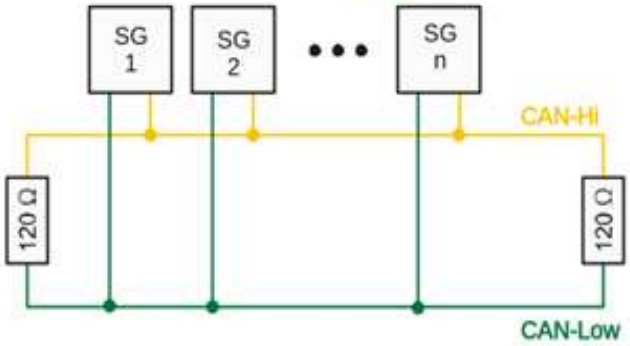






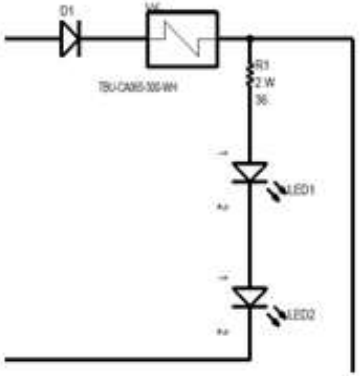






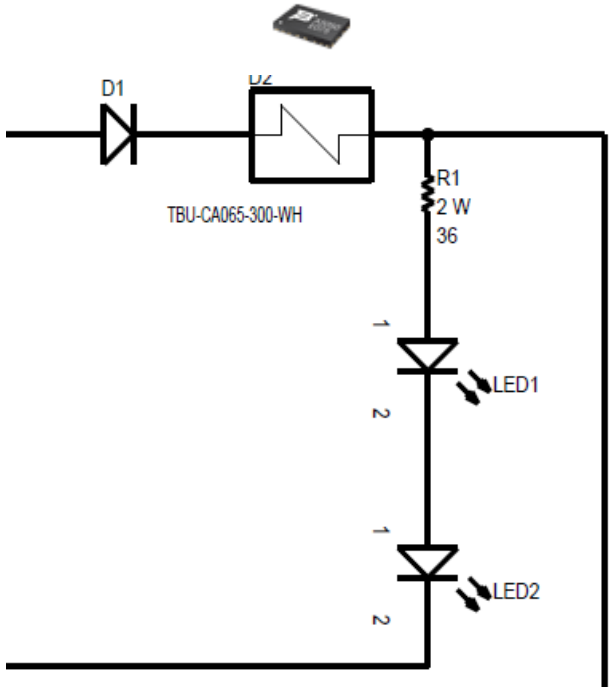
Communication by CANBUS

TBU Series



General circuit protection solution of CANBUS in Automotive LED lighting:

- Single Fuse + TVS
- TBU + MLV



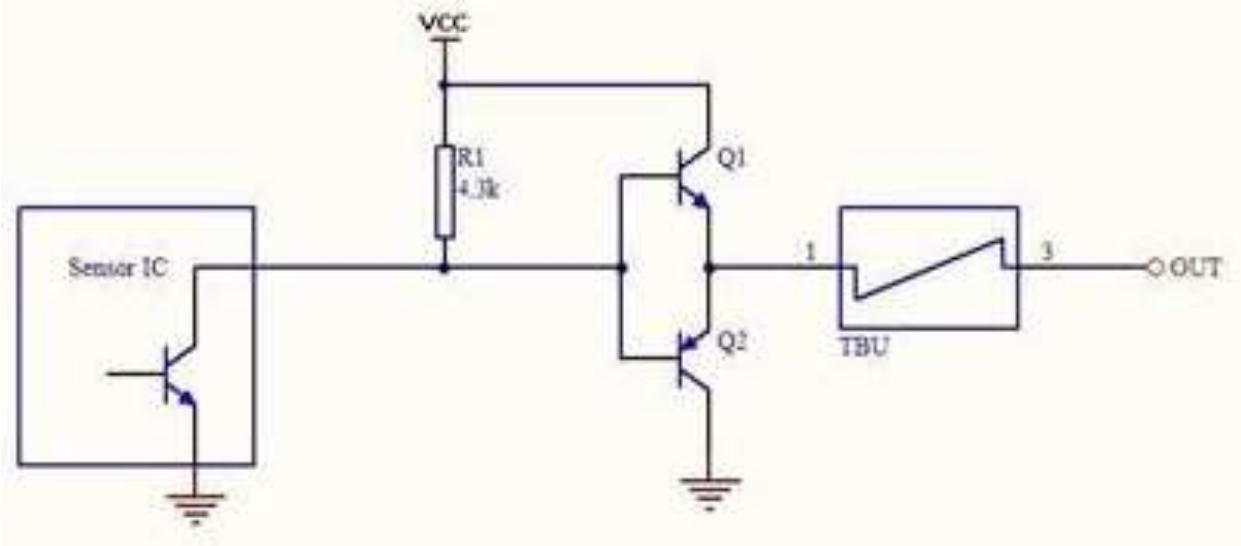
Design win reason as follows:

- ✓ High-end automotive LED lighting model
- ✓ Concern response time and potential risk
- ✓ Concern higher operation temperature range

PS: MF may not suitable because operation temp. range in vehicle regulation is -40~150 degC.

LVDS / Serial Port Protection Solution

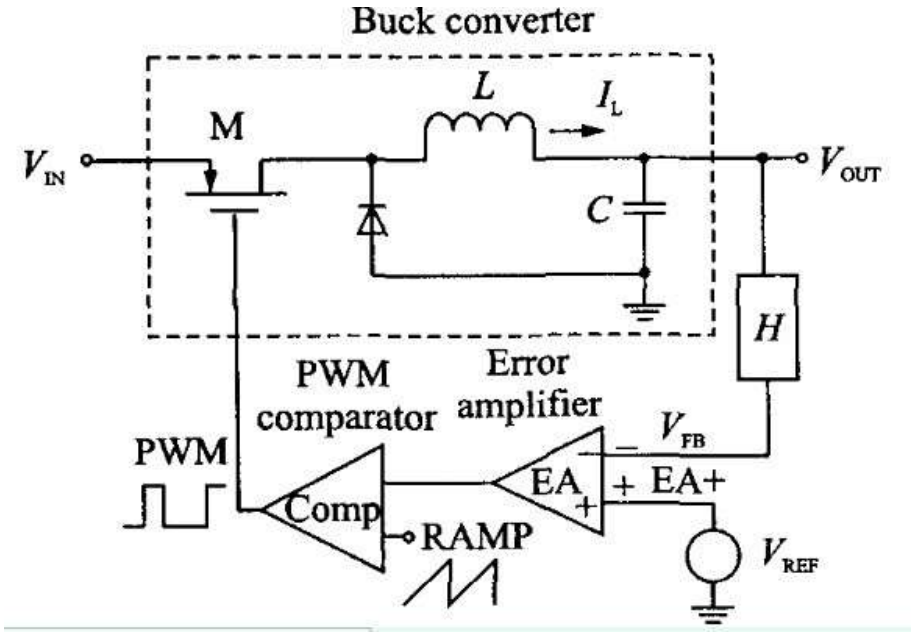
Current Solution: 2*TVS+2*PPTC
Next Solution: P40-G240-WH

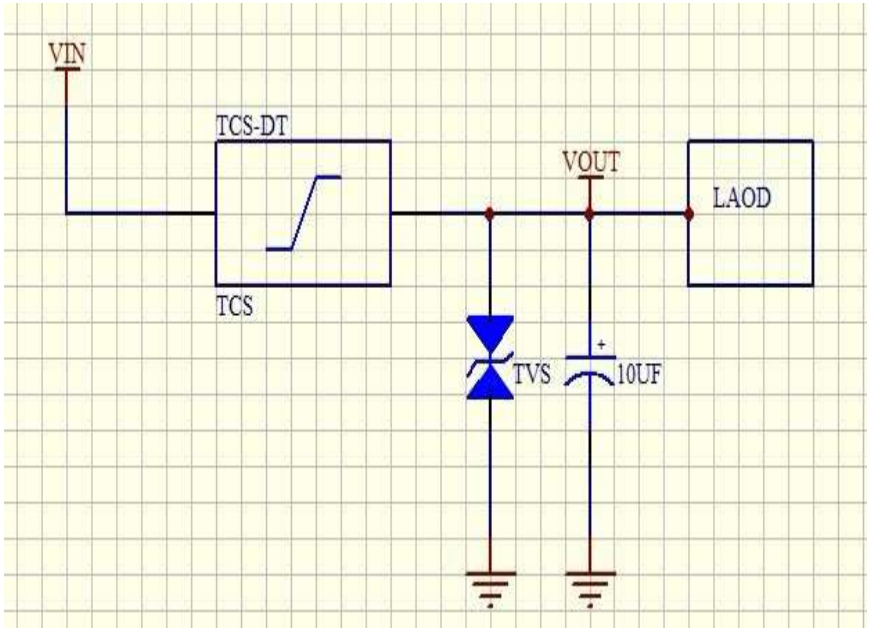


Application: IC's operation voltage is 5V and need pass 12V DC power cross testing

TBU Advantages: High reliability, it can work in a wide range of temperature; Fast response time, the output residual depression and small package size

4~20mA软启动应用电路图





- 传统软启动电路
- 推荐TCS软启动电路

USB Standards

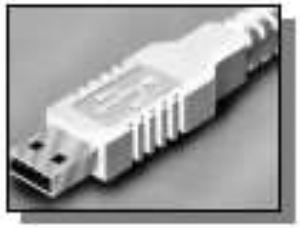
Universal Serial Bus – Offers a “Plug N Play” function that has become an industry standard for computer peripherals and digital media. Today, USB ports are used for charging and power transfer nearly as much as for data transfer.

USB 1.1 – Previous standard – 12 Mbps

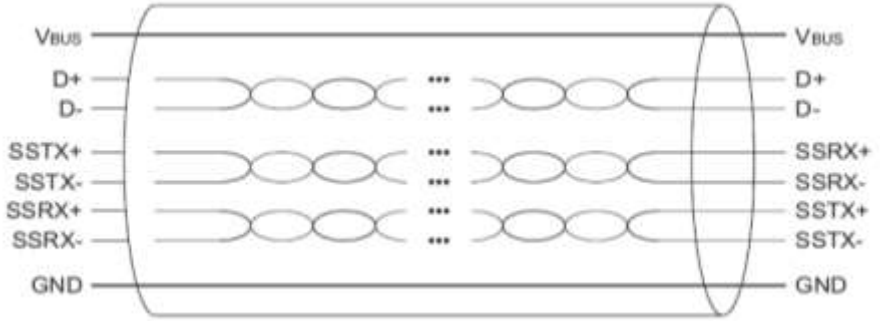
USB 2.0 – Current standard – 480 Mbps

USB OTG – Portable devices

USB 3.0 – New standard - 5Gbps (Released Nov 08)



USB 2.0 - 4 wire configuration,
pair for data, pair for power
Unidirectional data flow 2 wire diff. signaling



USB 3.0 - 9 wire configuration (gnd drain not shown)
Simultaneous bi-directional data flow 6 wire diff. signaling

USB 3.0 – New Power Changes

- Released in Nov 2008
- Aim:
  - More Speed - Super Speed 5Gbps
  - More power – 900 mA
  - Backwards compatibility

Parameter	USB 2.0	USB 3.0
Operating Voltage	4.40 Vdc - 5.25 Vdc	4.45 Vdc – 5.25 Vdc
Vbus Short Circuit Current	UL60950 – TTT <5 A / 60 sec	UL60950 – TTT <5 A / 60 sec
Max. Op. Current - Low Power Port	100 mA	**150 mA**
Max. Op. Current - High Power Port	500 mA	**2,000 mA**
Total Data Line Capacitance	<3 pF for 480 Mbps	<1 pF for 5 Gbps

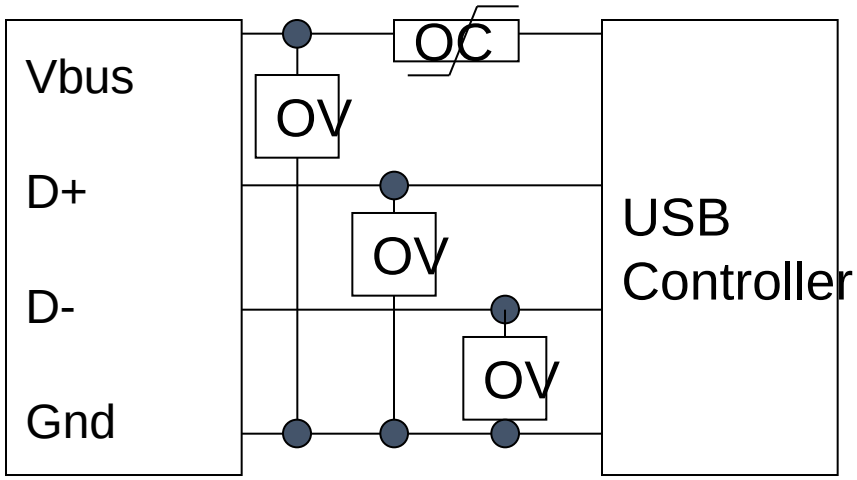
Why have USB Port Protection?

USB ports require Over Current and Over Voltage protection to protect the system from faults:

- Hot plugging
- Short circuit
- ESD
- Faulty equipment
- User error, etc…

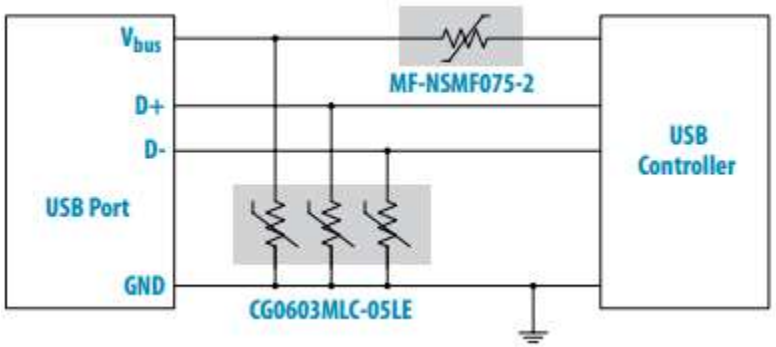
USB 2.0 Protection Considerations

- Overcurrent
  - Low resistance: <700 mOhms (350 mV max. drop)
  - 100 mA no trip (LP)/ 500 mA no trip (HP)
  - 5 A trip <60 sec (**UL60950**)
  - Package type: 1812 (typ.); 0805 (new)
- Overvoltage
  - ESD protection per **IEC61000-4-2**
  - Low capacitance – <10 pF per line
  - Signal clamping voltage >6 V
  - Package type: 0603 (typ.); 0402 (new)

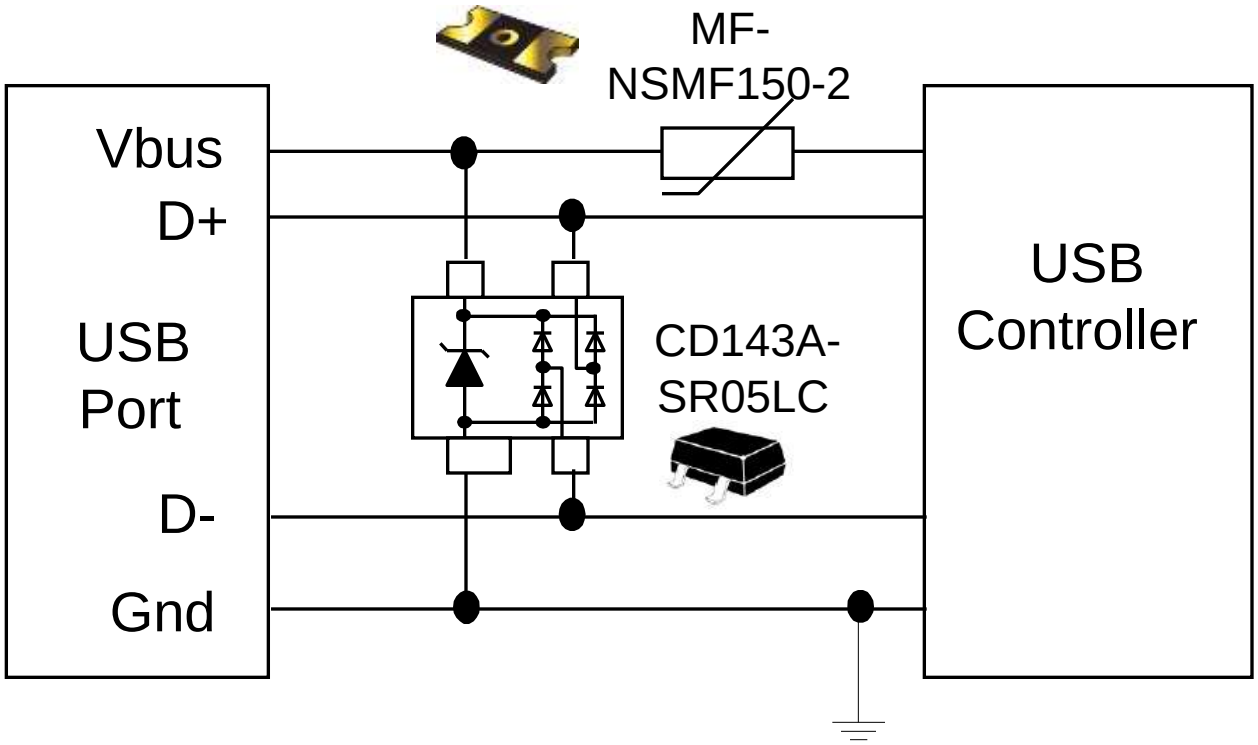


Connectivity Applications

- Example: USB 2.0 Interface/Port
  - MF-NSMF150-2 provides overcurrent protection for the USB controller
  - CG0603MLC-05LE provides ESD and EFT protection of the USB PHY
  - Bourns® PPTCs used in over 1 Billion USB ports
  - PPTCs are recommended in USB 2.0 standard

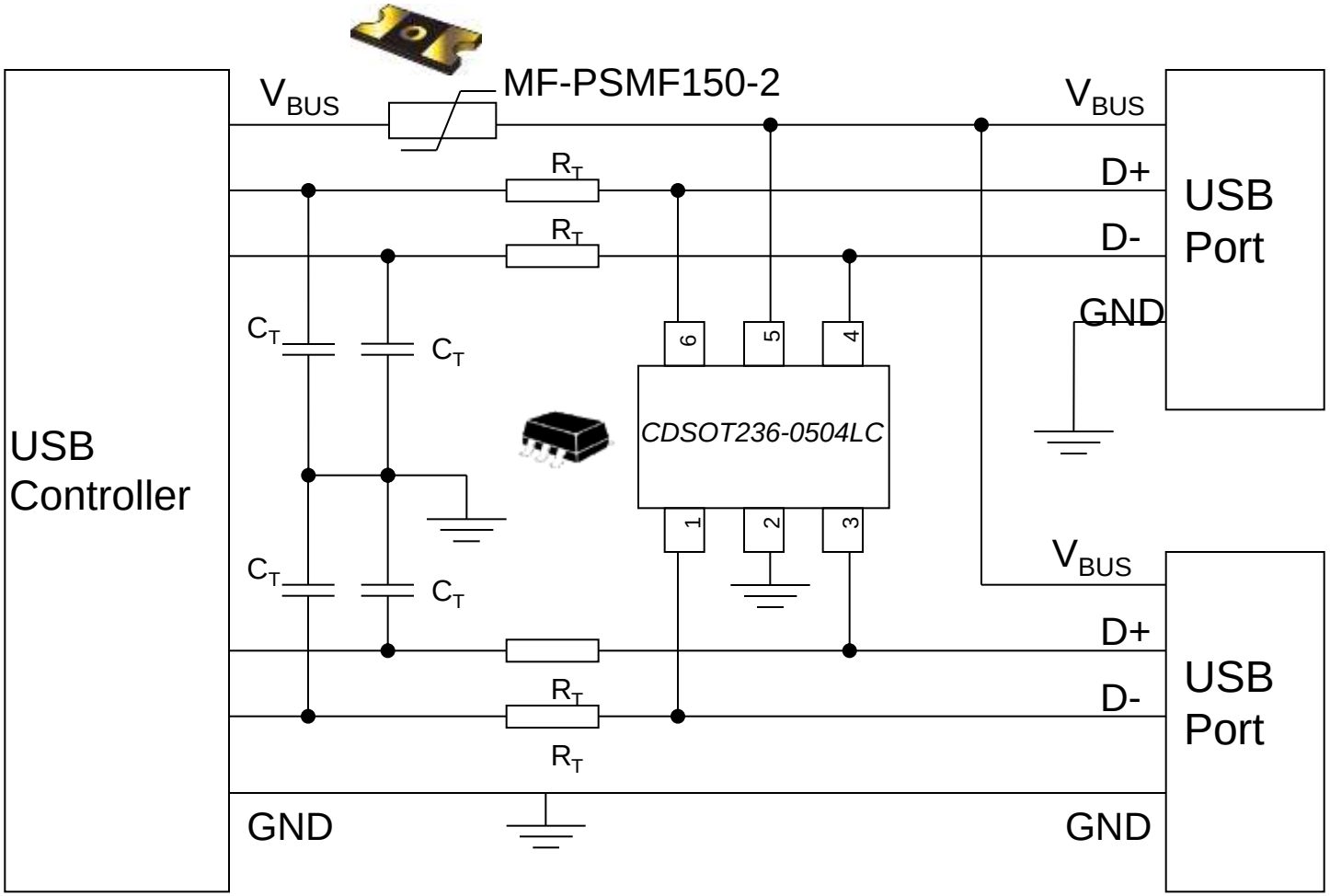


USB 2.0 Port Protection

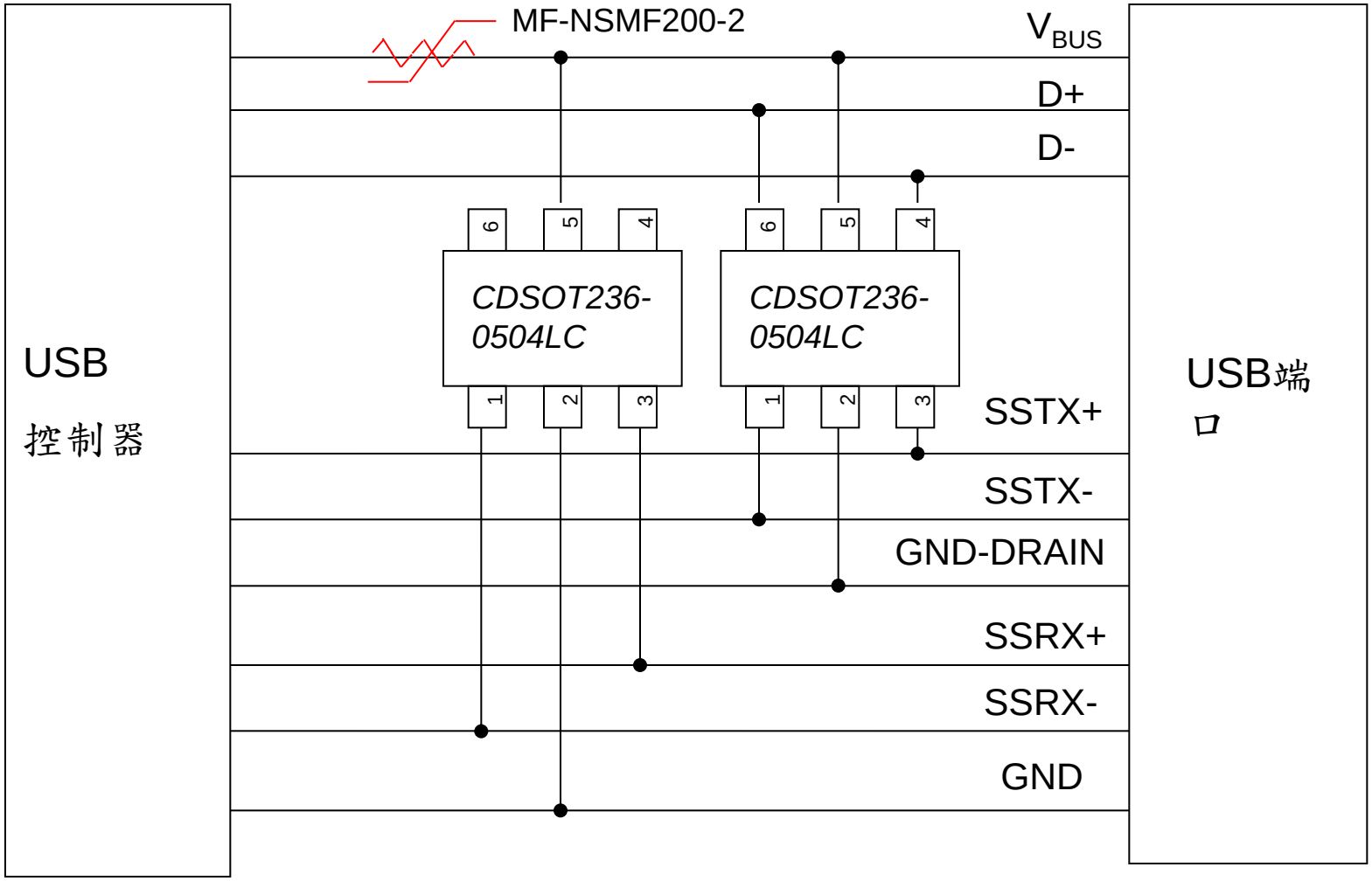


USB 1.1 Single Port Protection

USB 2.0 Port Protection



USB 3.0 Port Protection

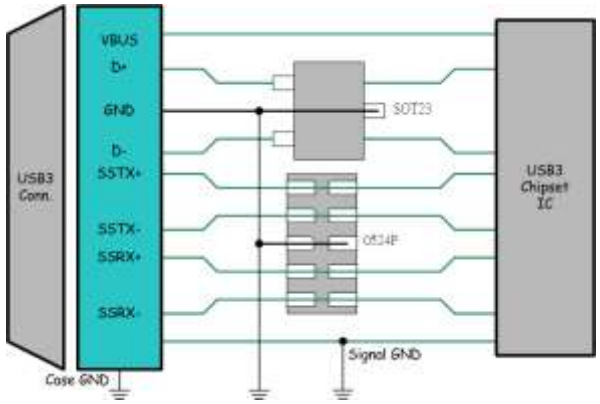


USB 3.0 Solution Overview

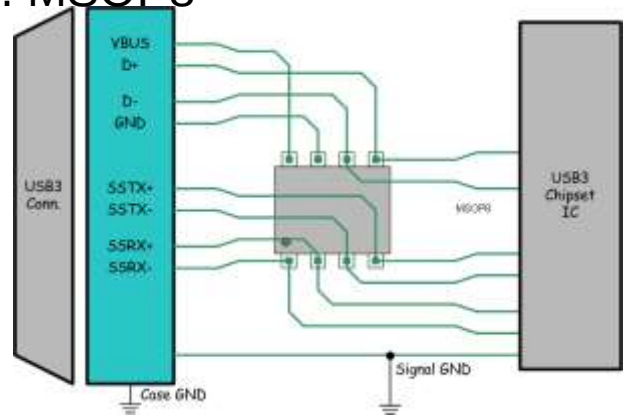
Success factor :

<Current >

1. 0524P+SOT23

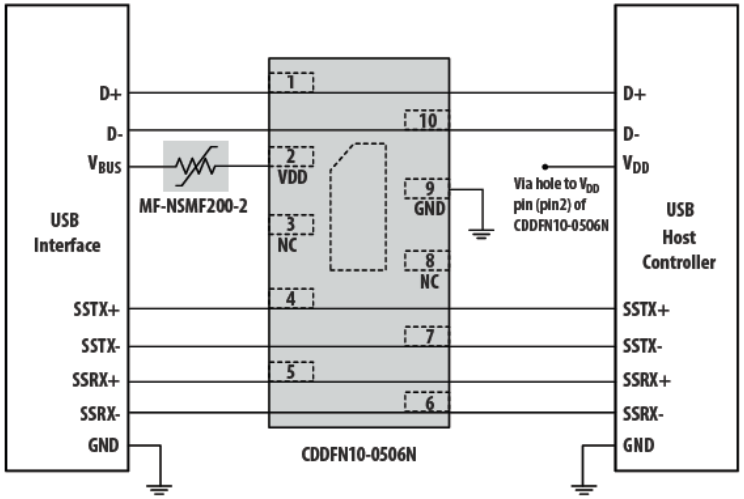


2. MSOP8



<Bourns' solution>

1. CDDFN10-0506N

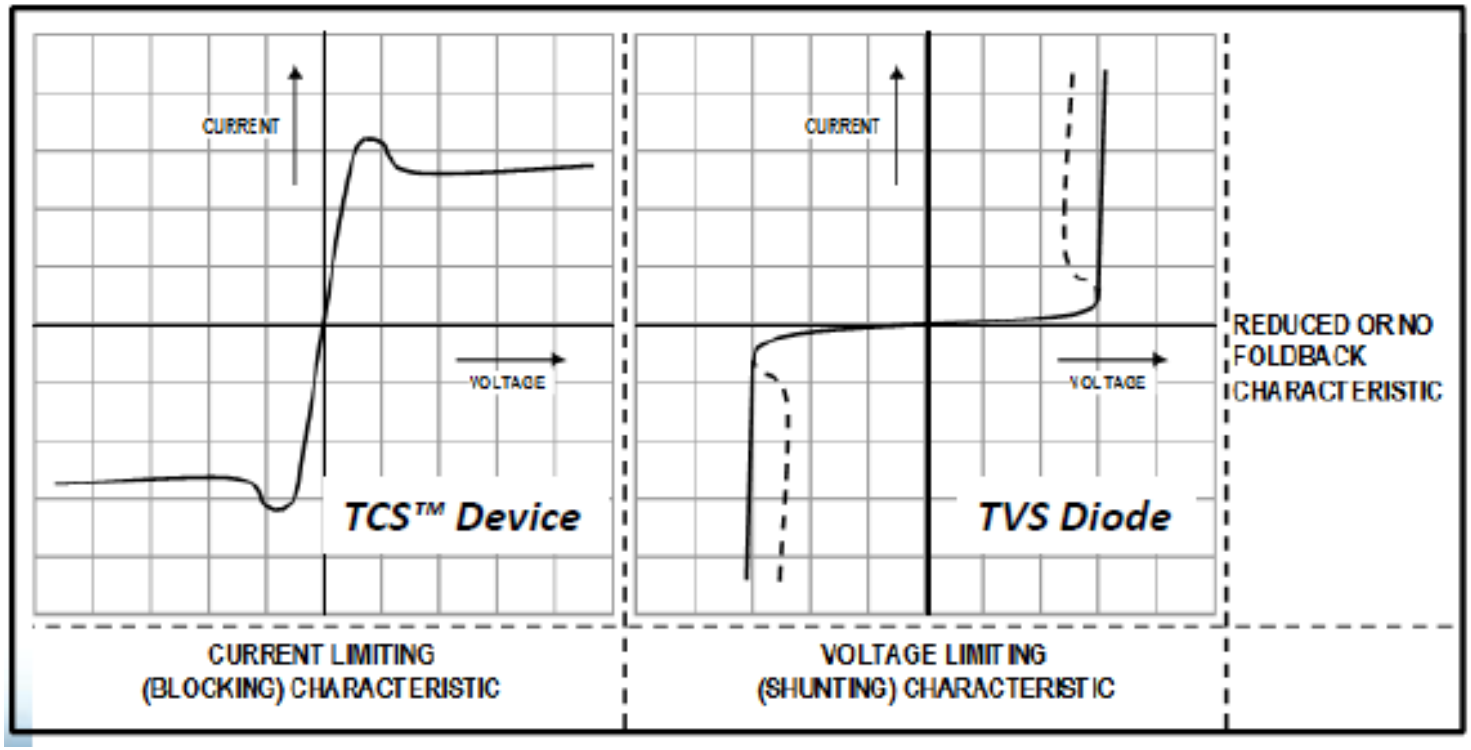


1. Straight flow thru design
2. 4 lines vs 6 lines channel
3. 0.5pF vs 0.3pF
4. Size & manufacture saving (1 for 2)

What Makes Bourns® TCS™ Products Innovative?

Current vs. Voltage Plot

- *A TCS™ product is a bidirectional device which has a general I-V curve as shown below. The I-V curve for a TVS diode is also shown for comparison. Note that a TCS™ device limits current while a TVS diode limits voltage.*



What are the TCS™ Target Applications?

- ***The General answer is: <u>Any application where a TVS diode alone does not achieve the desired results.</u>***

- ***Suggested Starting Applications***

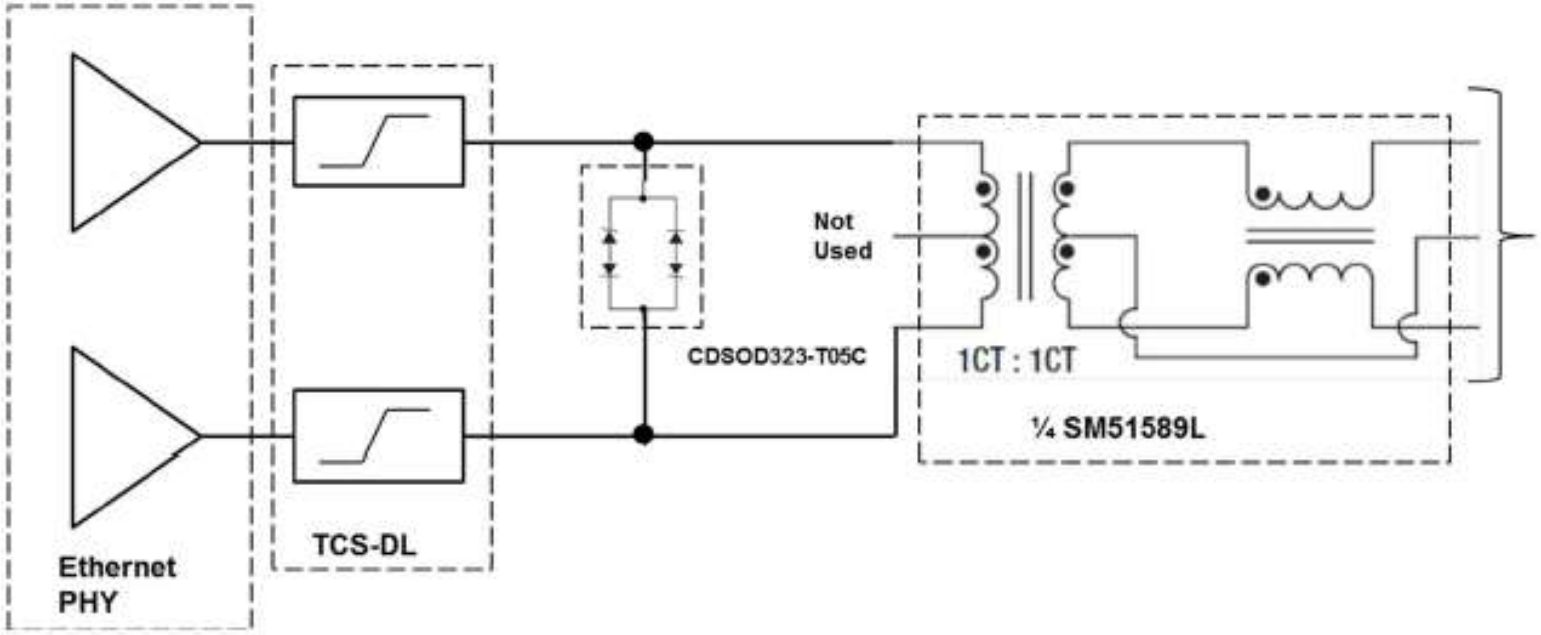
- *Differential high-speed signal/data line surge protection*
  - *xDSL Interfaces*
  - *GbE*
  - *PoE*

- *Other applications*
  - *Antennae*
  - *Surge protection devices*
  - *Audio/video interfaces*
  - *Serial data interfaces*
  - *HART modem transmitters*

- *Create an almost "Ideal Diode" using a TCS™ device in coordination with a voltage limiting device.*
- *Applications using 5V TVS diodes are also good candidates.*

Bourns® TCS™ Product Applications

Gigabit Ethernet (GbE)



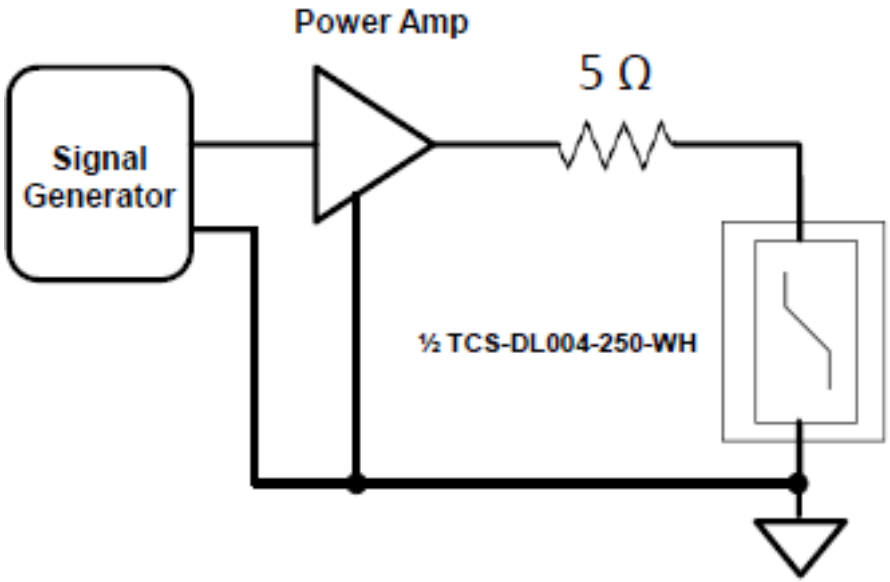
The above solution uses a TCS-DL device in conjunction with a TVS diode to reduce the stress on the PHY input/outputs.

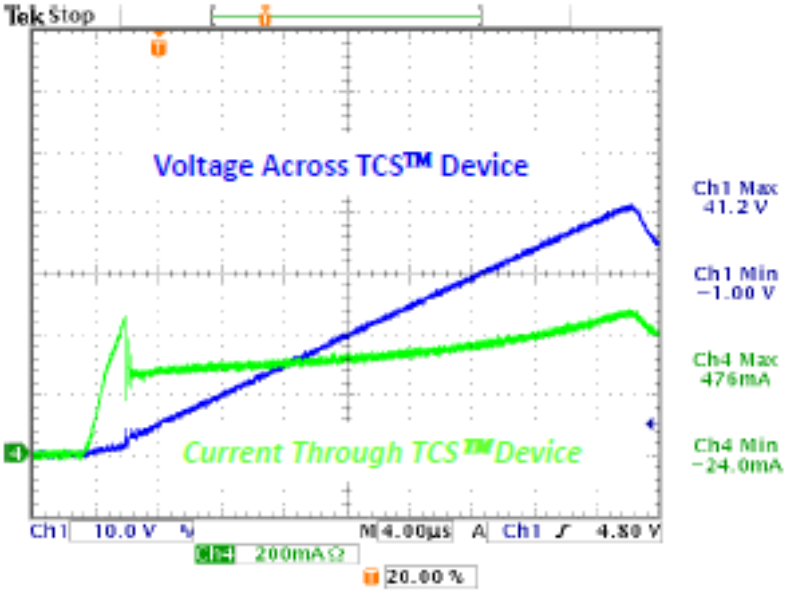
Bourns P/N TCS-DL004-250-WH

Device Characteristics

Response for one side of dual channel TCS-DL004-250-WH to a ~1 V/µs Slew Rate Input Voltage.

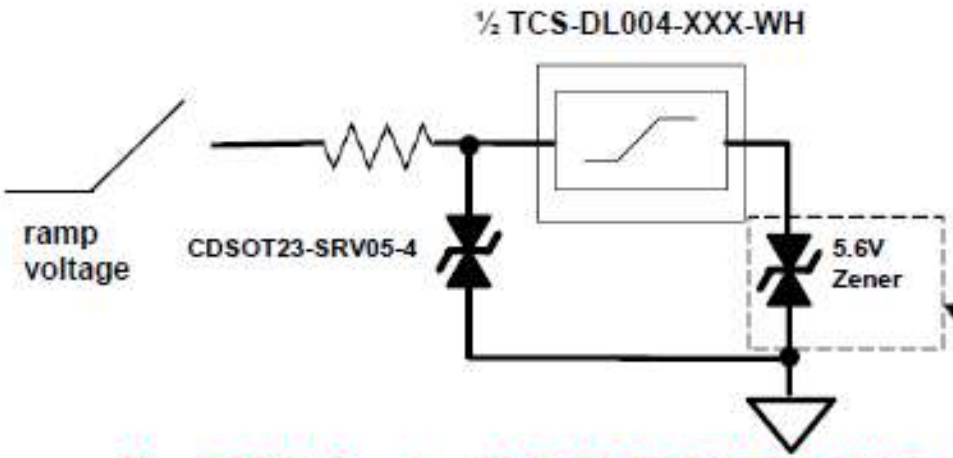
Test Circuit

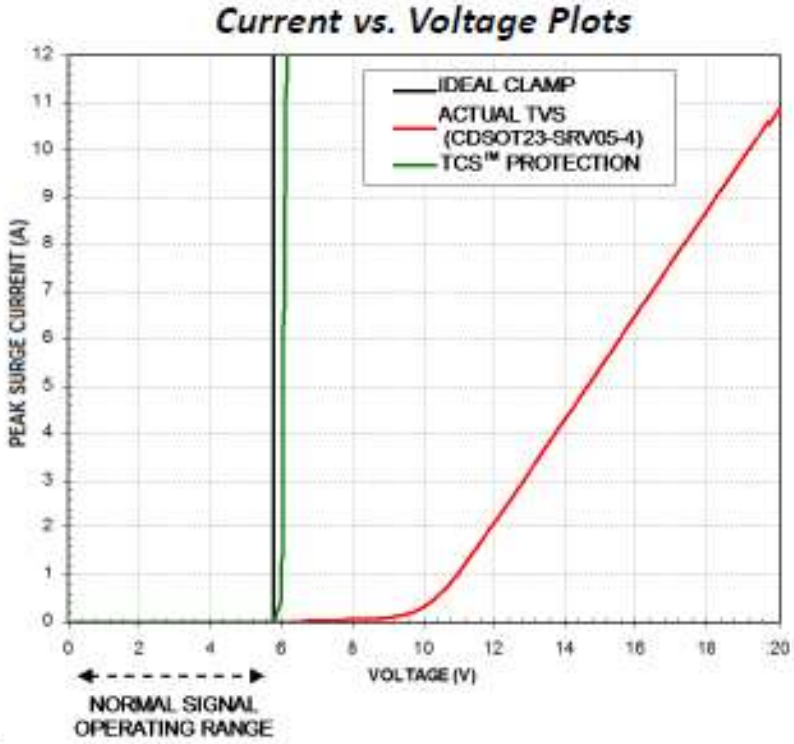




Using a TCS™ to Create an "Ideal Clamp Diode"

- *Black Line – Ideal "Brick Wall" Diode*
- *Red Line – CDSOT23-SRV05-4 TVS diode*
- *Green Line – Close to "Ideal Response" using: TVS Diode, TCS™, Zener Diode to represent a devices ESD protection*





Represents the ESD structure of the protected device

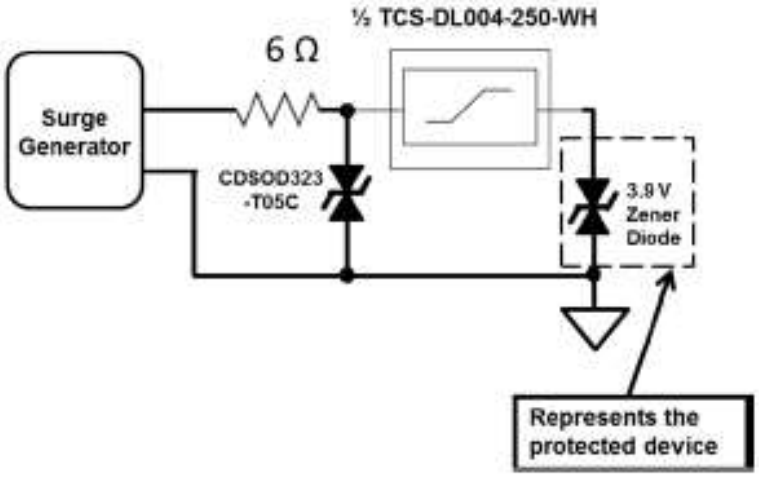
The TCS™ Device TCS-DL004-250-WH Behaves Like an "Ideal Clamp" When Compared to a TVS Diode (CDSOT23-SRV05-4)

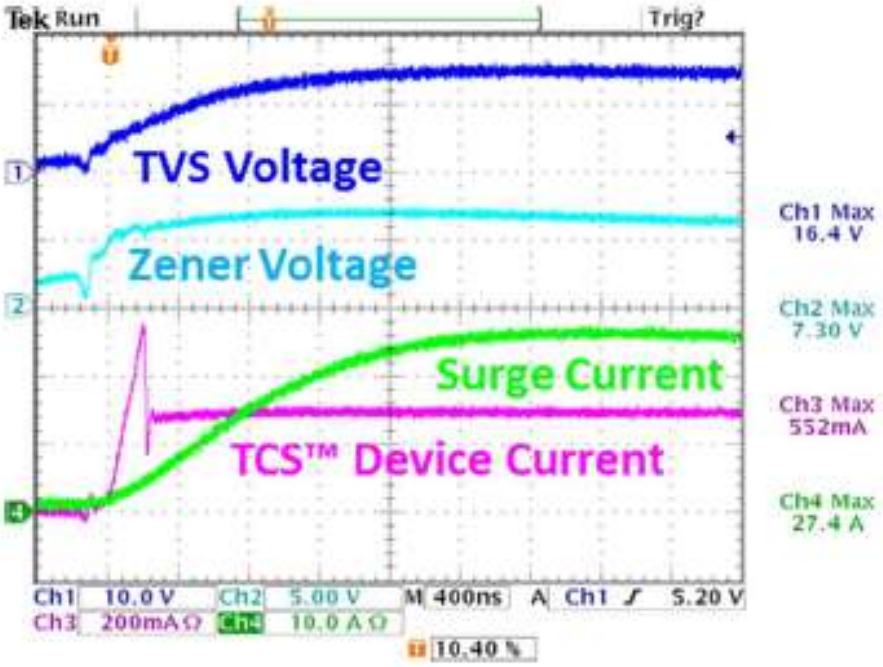
Bourns P/N TCS-DL004-250-WH

Generic application for one side of dual channel device.

Response for one side of dual channel TCS-DL004-250-WH to a 1.2/50 µs, 8/20 µs CW (~25 A Peak)

Test Circuit





Protected Device sees: Peak Voltage: <5 V after initial peak (less than ½ the TVS diode voltage)
Peak Current: ~300 mA after initial peak of 550 mA

Bourns P/N TCS-DL004-XXX-WH

Generic Application for Dual Channel Devices

- ***Summary of the Response of the TCS-DL004-250-WH to a 1.2/50 µs, 8/20 µs CW Surge (~25 A Peak)***

  - *The peak voltage across the protected device is ~7 V which is significantly lower than the ~16 V across the TVS diode.*

  - *The TCS-DL004-250-WH limits the current into the protected device to ~300 mA after the initial peak of 550 mA.*

    - *Without the TCS™, the peak current into the protected device is typically several Amps.*

Bourns® TCS™ Product Applications

GbE Signal Line Application Summary

Protecting a PHY with a TCS-DL004-250-WH as compared to TVS protection alone:

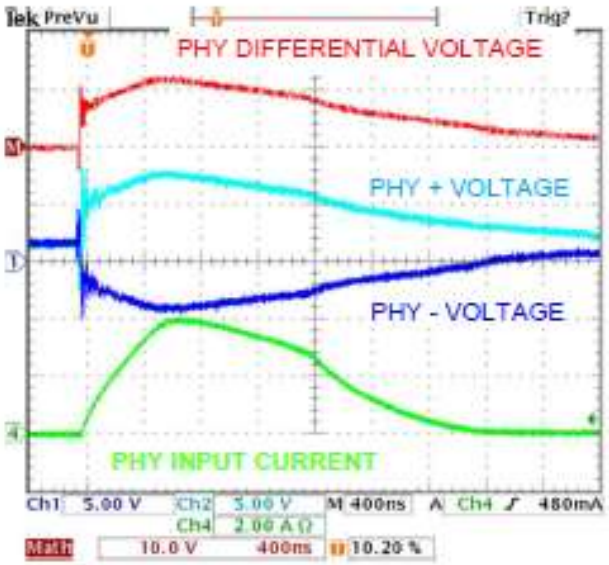
- ***The TCS-DL004-250-WH significantly reduces the current seen by the GbE PHY signal inputs.***
  - *After the initial peak, current is reduced by ~90 %.*
- ***The TCS-DL004-250-WH also isolates the PHY inputs from the voltage across the TVS diode.***
  - *Peak PHY input voltage is determined by its ESD protection and the current through the TCS-DL device. In this case, the voltage level is reduced by over 50 %.*
- ***The energy the PHY had to absorb was reduced by more than 90 %.***

Bourns® TCS™ Product Applications

GbE Signal Line Application: 1.2/50, 8/20 µs CW Surge Test (800 V/100 A)

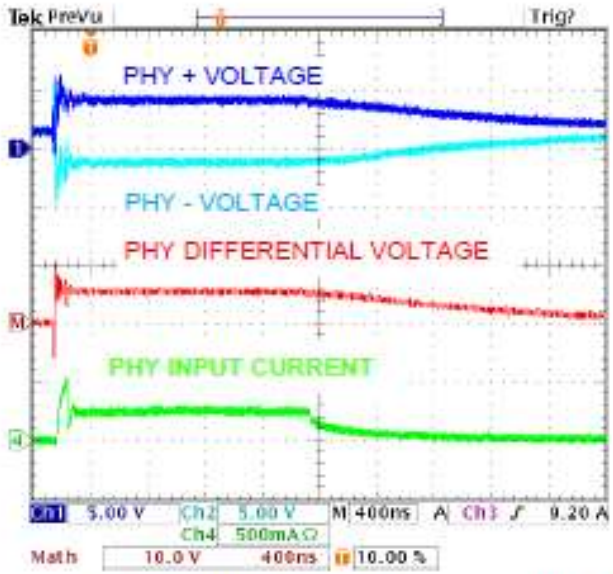
Protecting a Typical Ethernet Port with a TCS-DL004-250-WH

With TVS Diode Only



PHY sees: Peak Voltage: >12 V
Peak Current: 4 A
Energy: ~ 50 µJ

With TCS™ Device and TVS Diode



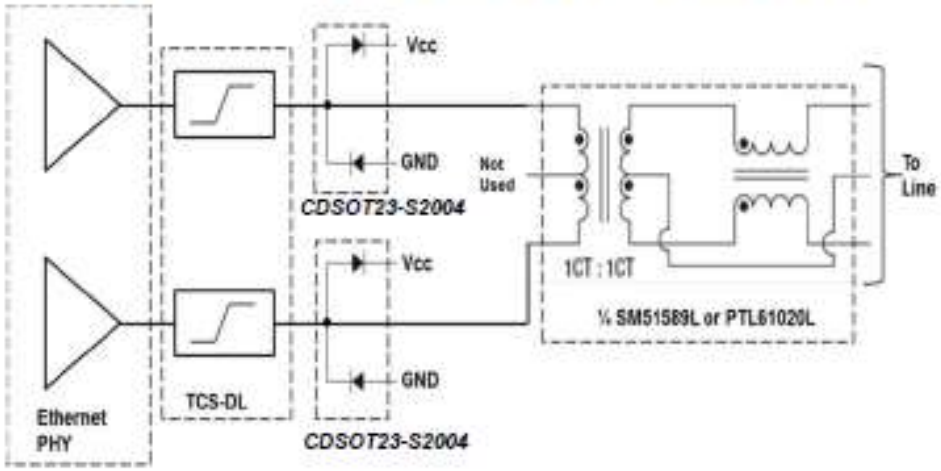
PHY sees: Peak Voltage: <6 V after initial peak
Peak Current: <300 mA after initial peak
Energy: ~ 3 µJ

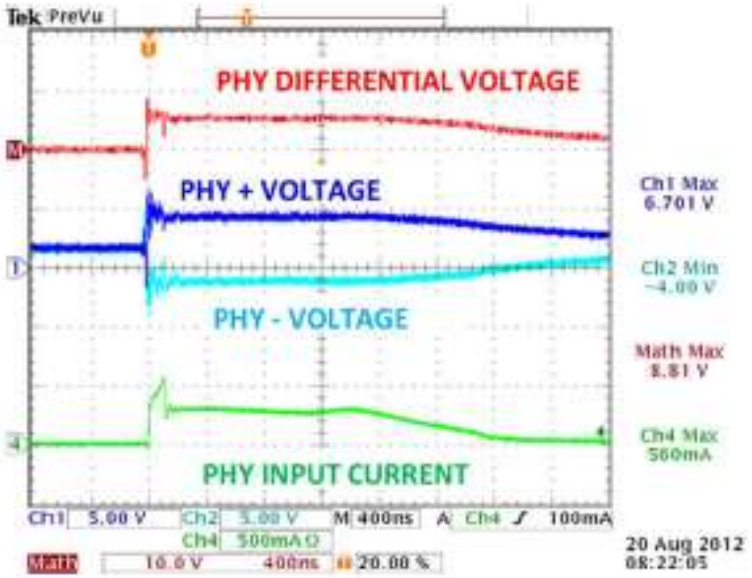
TCS™ Device reduces PHY stress by more than 90 %

Alternative GbE Solution

With TCS™ and Clamp Diodes

TCS-DL004-250-WH with CDSOT23-S2004





PHY sees:

Peak Voltage: <6 V
Peak Current: 560 mA (quickly reduced to 300mA)
Energy: ~ 3 µJ

Stress on the PHY is virtually identical to the TCS™/TVS Design even with a softer voltage clamp design!

Bourns® Inductors

J.W.Miller MAGNETICS
A Bourns Company

- Through-hole
  - Standard
    - Axial Series
    - Radial Series
  - High Current
    - Axial Series
    - Radial Series
    - Toroid Series
    - Common Mode Series
- SMD
  - Dual Chokes (CMC)
    - CMC
      - SRF Series
    - Signal Line
      - Sector W. Bifilar W.
        - DR331 DR221
  - Chip Inductors
    - Multilayer
      - Ferrite
        - Standard CS Series
      - Ceramic
        - Standard CI Series
    - Wirewound
      - Open CW Series
      - Sealed CM Series
  - Power Chokes – *Focus Products*
    - Non-Shielded
      - SDR Series
    - Semi-Shielded
      - SRN Series
    - Shielded
      - SRR Series SRU Series
    - High Current
      - SRP Series


Power Inductors – Overview

Semi-Shielded Power Inductors – SRN Models

- Features: Semi-shielded, reduced radiation
- Available Models: 15
- Footprint Range: 3 x 3 to 10 x 10 mm
- Height Range: 1 to 6 mm
- Inductance Range: 0.5 to 470 uH
- Rated Current Range: 0.28 to 10 A

Shielded High Current Inductors – SRP Models

- Features: Iron powder core, low radiation, high saturation current, up to 60 A
- Available Models: 19
- Footprint Range: 4.8 x 4 to 14 x 14 mm
- Height Range: 1.2 to 7 mm
- Inductance Range: 0.1 to 47 uH
- Rated Current Range: 1.5 to 55 A

Common Mode Chokes – Power

- 7100, 7300, 7400, 7500, 8100
- PM3700, SRF0703, SRF1260, SRF1280
- Power conversion application
- High perm. toroid or UU core, close magnetic loop construction to maximize CM impedance
- Available Models: 9
- Inductance Range: 0.2 – 50mH
- Rated Current Range: 0.27 – 20A
- Frequency Range: 10K – 50MHz
- Size Range: 0.75-1.7” (L) x 0.43-0.9” (W) x 0.6-1.2” (H)

Bourns® Inductors for Automotive Buck Converters and EMI Filtering

- SRP7030 2.2 µH I peak 12 Amps
- Small Form Factor (7.8 x 7.0 mm)
- AEC-Q200 Test Reports Available

- **SRP Series**
  - High Current Shielded Inductors
  - 0.1 – 10 µH
  - Up to 50 A
  - Operating Temperature Up to 150 ° C

Inductive Components - Automotive

Recommended Products

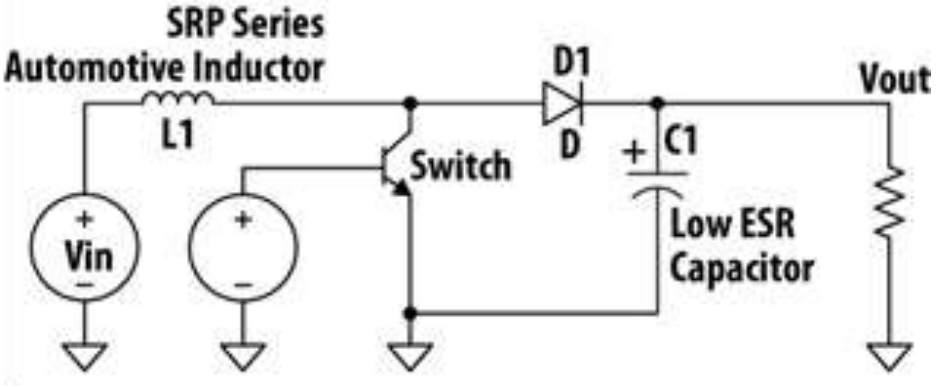
High Current Power Inductors SRP Series

These series are produced in the factory with ISO/TS16949 certificate available or in process; for many models there is the PAPP level 3 available.

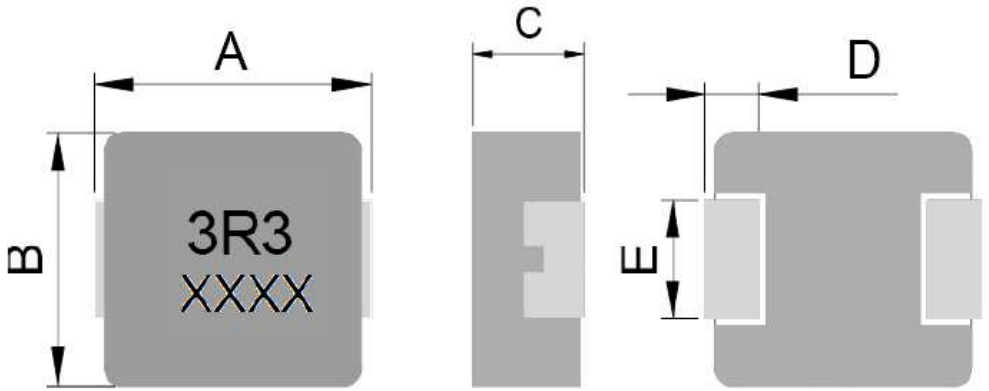
PART NO.	Inductance L0 (uH) ±20% @0A	Rdc (mΩ) typ. @25℃	Rdc (mΩ) max. @25℃	Irms(A) typ.	Isat(A) typ.
SRP1265-1R0M	1.0	1.7	2.3	30	48
SRP1265-3R3M	3.3	5.7	6.8	18	30

- 100% Drop in for Vishay IHLP5050

Bourns Inductor in Start Stop DC DC Converter

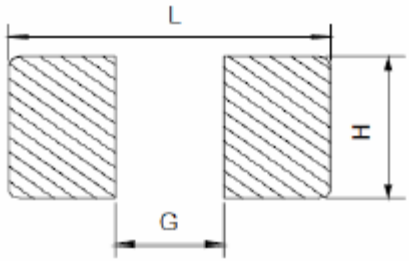


Basic Functional Diagram of
DC DC Boost Converter



Chip Size:mm

A: 13.5±0.5
B:12.5±0.3
C:6.2±0.3
D:2.3±0.3
E:4.7±0.3
G: 8.0
H: 5.0
L: 14.2

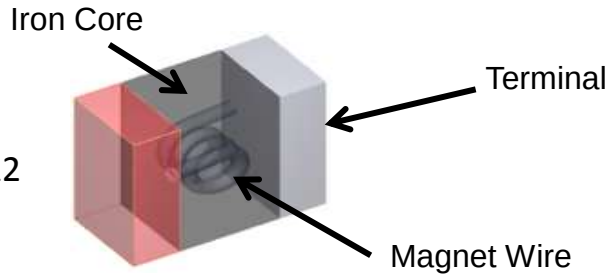


Bourns Automotive Approved Inductors

Series	Standard Model	Inductor Value Range(uH)	Max Current Range(A)	Saturation Current Range (A)	Diameter or LxW mm	Core	Shielded
SRF0703A	SRF0703	34.1~608.2	2.66~0.65	PLM	7.6x7.6	Ferrite (Drum)	Y
SRF0905A	SRF0905	10-6500	1.6~0.3	PLM	9.2x6	Ferrite (Toroid)	Y
SRF1260A	SRF1260	0.47~1000	17.6~0.57	33~0.7	12.5x12.5	Ferrite (Drum)	Y
SRF1280A	SRF1280	1.67~4020	8.94~0.307	PLM	12.5x12.5	Ferrite (Drum)	Y
SDE0604A	SDR0604	1.2-120	5.~0.75	6.0-0.6	5.8	Ferrite (Drum)	N
SDE1006A	SDE1006	1.2~820	7.2~0.45	7.2~0.45	9	Ferrite (Drum)	N
SDR1307A	SDR1307	1.5~1000	9.5~0.65	20~1.0	13	Ferrite (Drum)	N
SRR0735A	SRR0735	10~680	2.1~0.21	1.85~0.22	7.3x7.3	Ferrite (Drum)	Y
SRR0745A	SRR7045	10~1000	2.1~0.2	2.5~0.24	7.3x7.3	Ferrite (Drum)	Y
SRR1210A	SRR1210	1.0~1000	2.19~0.58	16.5~0.7	12x12	Ferrite (Drum)	Y
SRR1260A	SRR1260	1~1000	9.4~0.68	10~0.6	12.5x12.5	Ferrite (Drum)	Y
SRR1280A	SRR1280	4.7~1000	8.2~0.68	8.8~0.8	12.5x12.5	Ferrite (Drum)	Y
SRU1028A	SRU1028	1-150	7~0.7	8.0~0.65	10x10	Ferrite (Drum)	Y
SRU1038A	SRU1038A	1.5~330	7.2~055	7.0~0.55	10x10	Ferrite (Drum)	Y
SRU1048A	SRU1048	1.5~330	7~0.65	7.2~0.52	10x10	Ferrite (Drum)	Y
SRU3028A	SRU3028	10~33	0.72~0.47	0.86~0.48	3.3x3.5	Ferrite (Drum)	Y
SRU5028A	SRU5028	1.2~100	3.5~0.47	3.4~0.42	5.2x5.2	Ferrite (Drum)	Y
SRU6025A	SRU6025	1.2~220	4.0~0.42	3.2~0.24	6.2x6.5	Ferrite (Drum)	Y
SRU8028A	SRU8028A	2.5~100	4.5~0.75	4.2~0.7	8x8	Ferrite (Drum)	Y

High Current Low-Profile Inductors 1.0 mm

Construction:



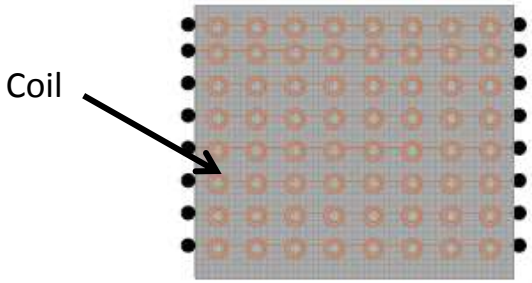
New Product

P/N:
SRP2010, SRP2012, SRP2512

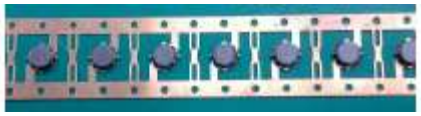
Applications:
DC/DC Converters, DV/DSC, GPS, HD, Laptops, Smart Phones, SSD, Tablets, Handheld Electronics Devices

Why Bourns® Model SRP High Current Inductor Series?

- Array Production Method: Multiply production rate to reduce cost and shorten lead time

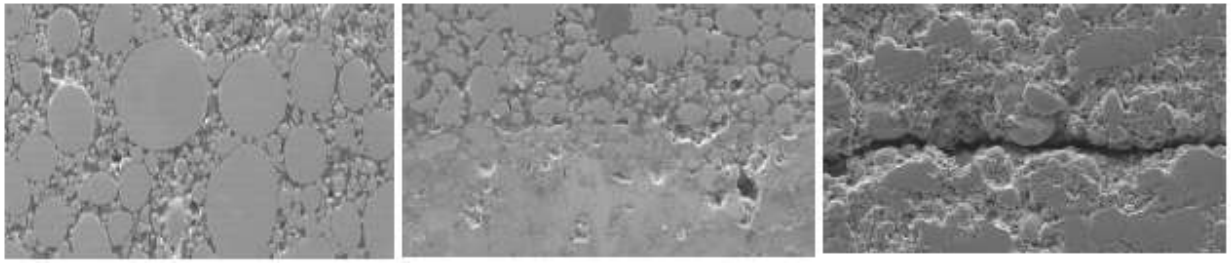


vs.



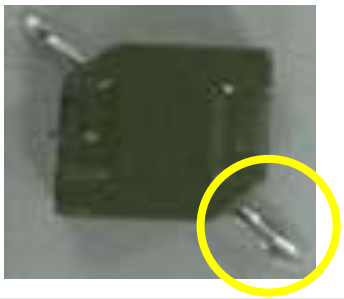
Conventional piece-by-piece production method

- Excellent Iron Material Density: Increase inductor's current handling capability and enhance mechanical strength



Bourns - High Density | Competition - Porosity | Competition - Microcrack

Product Structure

	Inner	Semi-Product	Finish product
SRP clip type (Old Type Product)	Single Coil 	Molding the coil directly. The Wire is kept as the terminal to be solder joint with the clip. 	Assemble the semi-part with the clip to be the product's pad. 
SRP "A" (New Type Product) for higher inductance values with leadframe only	Coils spot welding with lead-frame 	Molding the coil and lead-frame together. 	Adjust the lead-frame to be products' pad. 

Production Line and Monthly Capacity

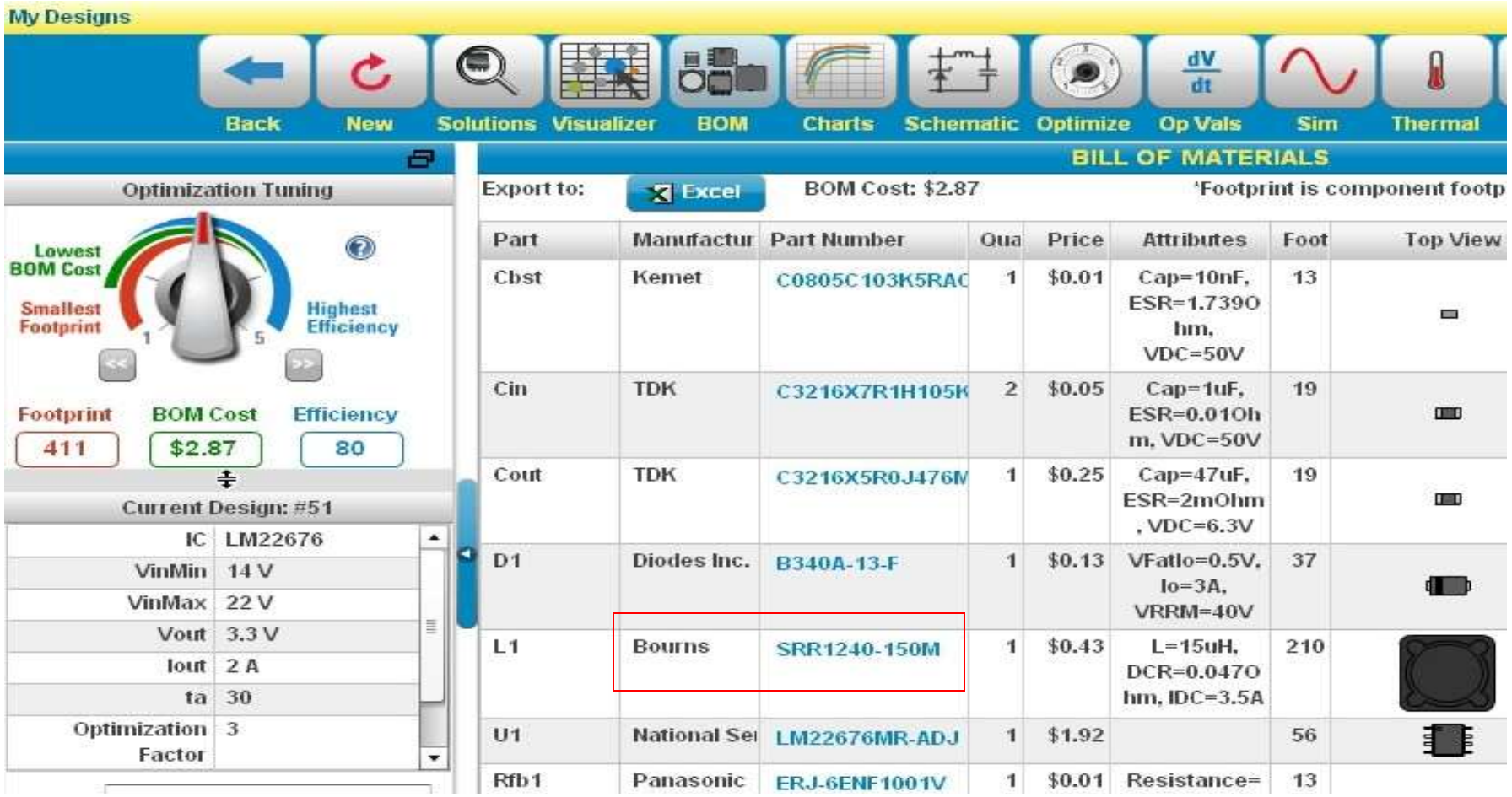
	Production Line area	Monthly Capacity	Production Line Operator #
SRP clip type (Old Type Product)	5000 m2	15KK pcs	300
SRP “A” (New Type Product)	10000 m2	35KK pcs	500

Sales Tools - Designer Kits

- SMD Non-Shielded, Semi-Shielded, Shielded and High Current Inductors

Inductors ➔ Bourns Part-number Selection

TI - WEBENCH

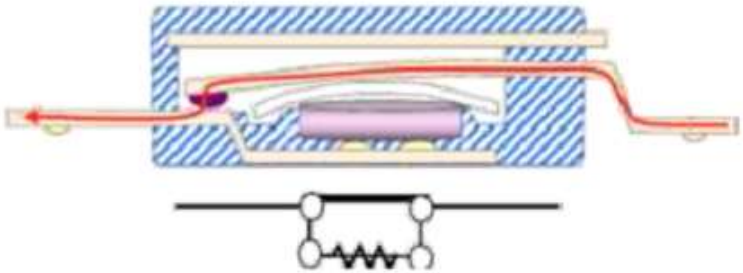


BOURNS®

Komatsulite

- The mini-breaker – What is it?
- A bi-metal switch and a PTC
- Closed state is the normal state

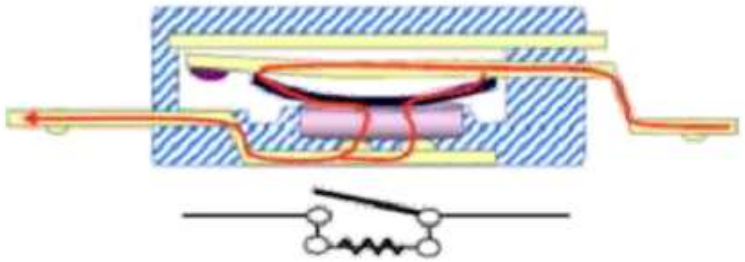
Closed State



Minimal resistance:

saves battery life
reduces recharge time
allows large current draws

Open State



The PTC function:

keeps the bi-metal switch open
provides power for essential device functionality

Multifuse® PTC Resettable Fuses
Standard Devices

- Polymer PTC resettable fuses for:
  - Over current Protection
  - Over temperature Protection
- 6 to 90 V operating voltages
- Hold currents from 50 mA to 11.0 A
- AEC-Q200-Rev C
- Agency approval - UL, CSA & TÜV
- High temperature polymers available with operating temperatures between –40° C to +125° C
- Built in TS-16949 facility
- RoHS compliant standard & halogen free upon request
- Designed to protect a wide range of cabin & under the hood electronics

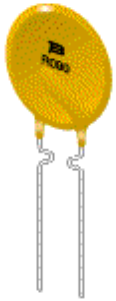
Multifuse® Product Portfolio - Automotive

MF-SM Series

MF-SMHT Series

MF-SMDF Series
MF-MSMF Series
MF-USMF Series
MF-NSMF Series
MF-PSMF Series
MF-FSMF Series

Surface Mount Type



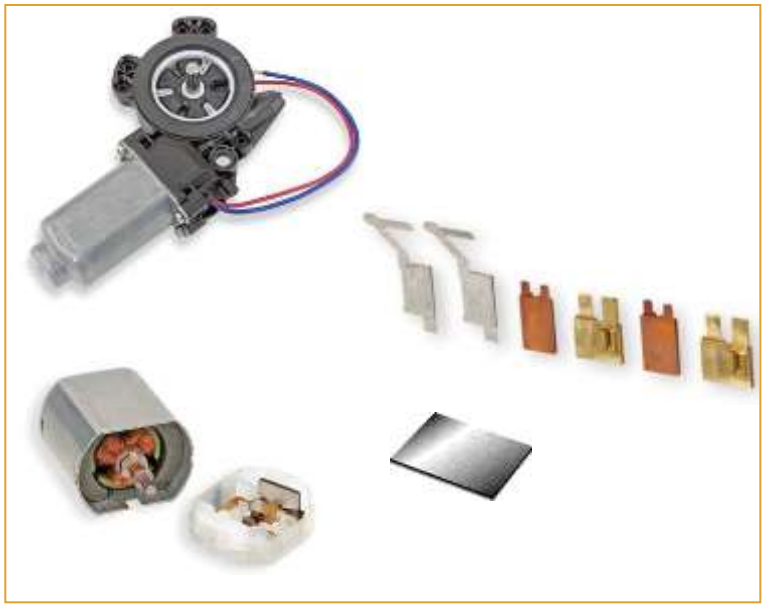
MF-R Series
MF-RX Series
MF-RHT Series
MF-RG Series

Radial Lead Type

Custom Type

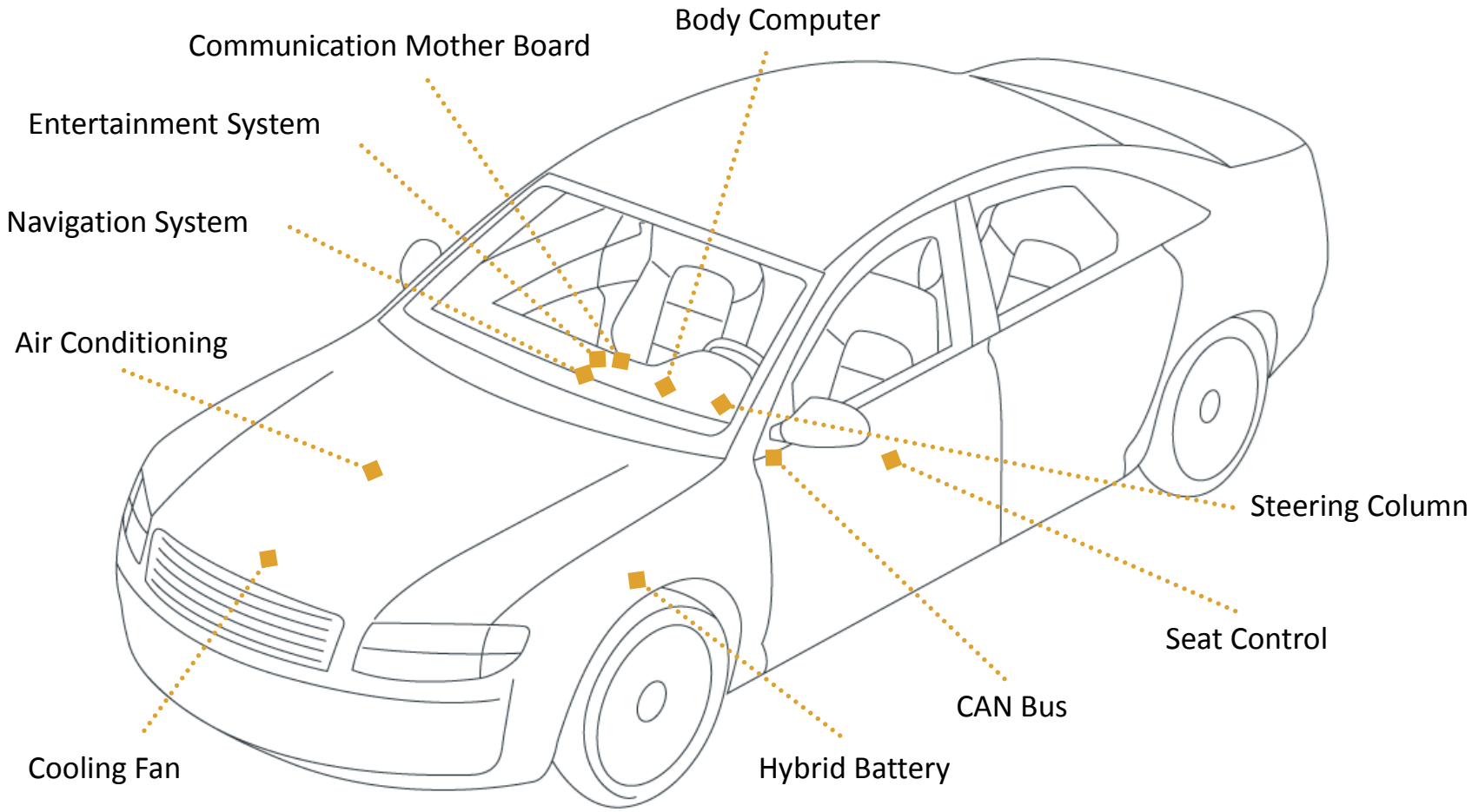
HT – high temperature material (-40 ºC ~ 125 ºC) critical for many automotive applications

Multifuse® PTC Resettable Fuses
DC Motor Protection



- Resettable fuses to protect dc motors in:
  - Window lift modules
  - Electric Seats
  - Central locking
  - Sun roofs & convertible roofs
  - Mirrors
- Devices are designed & tested to meet the requirements of each individual motor
- Dedicated DC motor test lab & technicians
- Devices available as:
  - Lead frame or non lead frame package
  - High temp or stand temp polymers

Some Multifuse® Product Applications

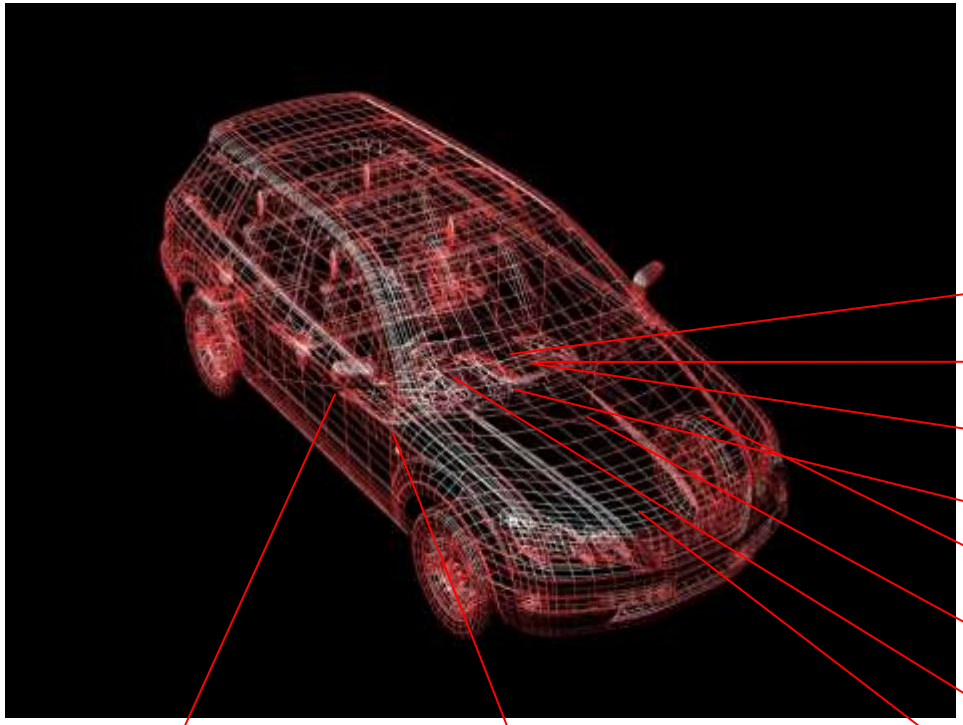


Representative Multifuse® Customers

Logos and trademarks are the property of the companies below

Some Multifuse® Applications

Applications we are in today	Customers
Navigation systems	Bitron
Entertainment systems (USB)	Continental
internal light	Kostal
Steering column	Hella
Air conditioning	Delphi
CAN Bus	Bosch
RF control module	Panasonic Automotive
Body computer	Visteon
Mother board	Magneti Marelli
Communication	TRW
Cooling fan	Johnson Control
Air conditioning	Sanyo Automotive
Seat control	



Body computer

Communication Mother board

Navigation system

Entertainment system

Hybrid battery

Air conditioning

Steering column

Cooling fan

CAN Bus

Seat control

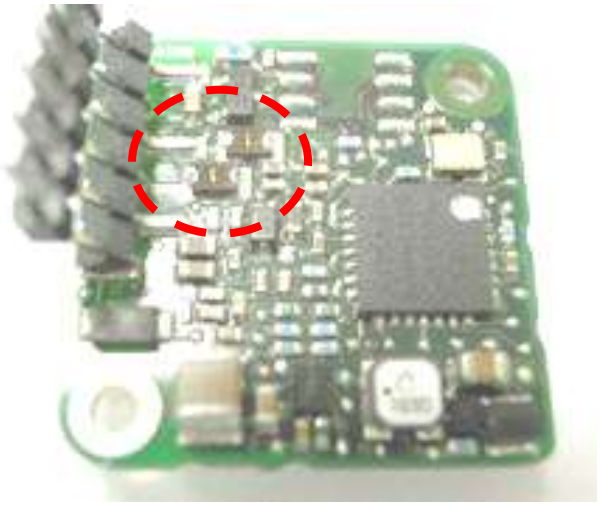
Selection of Multifuse in Vehicle Projects

• Ford	– hybrid SUV battery	MF-MSMF020
	– Galaxy internal light	MF-RX185
	– Real view camera	MF-PSHT010X
• Audi A6	– Steering column	MF-MSMF014 & 050
	– Air conditioning	MF-SM260
	– CAN Bus	MF-MSMF020
	– RF control module	MF-MSMF020
• Fiat	– Body computer	MF-NSMF020
	– Mother board	MF-MSMF010 & 050
	– Communication	MF-MSMF050 and MF-NSMF020
• Peugeot/Citroen	– Cooling fan	MF-RHT070
	– Air conditioning	MF-MSMF010 & 050
• Nissan	– Seat control	MF-MSMF075
	– Seat control	MF-PSHT010X

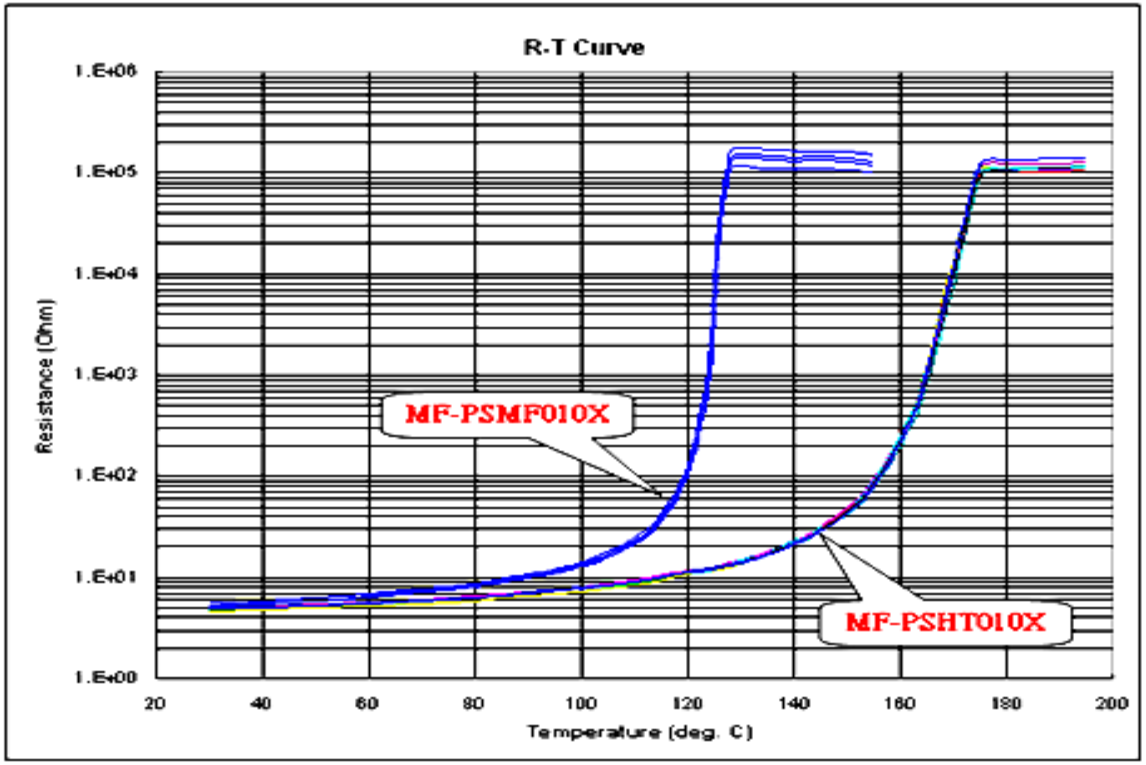
MF-PSHT & USHT model families

- Models : MF-PSHT010X, USHT050X
- Feature : higher working temperature (-40 ℃ ~ 125℃)

MF-PSMF working temperature (-40 ℃ ~ 85℃)
MF-PSHT working temperature (-40 ℃ ~ 125℃)

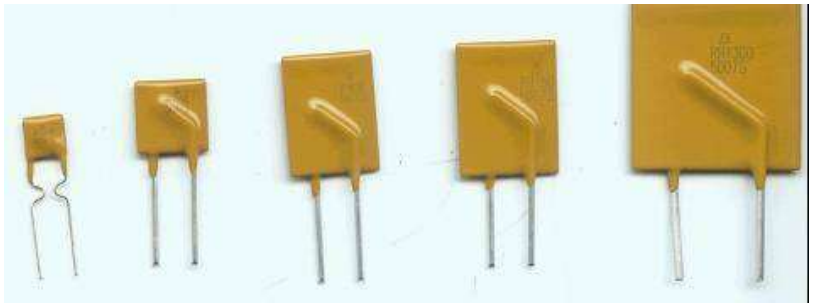


MF-PSHT010X & MF-PSMF010X R-T curve comparison

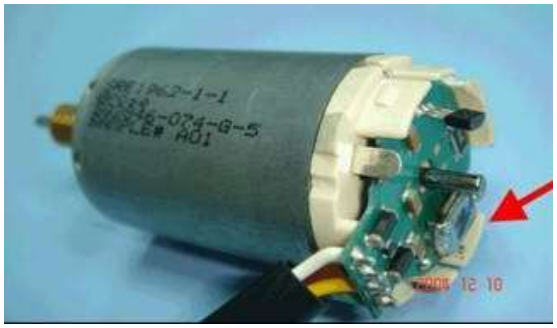


Multifuse PTC for DC Motors

MF-RHT
MF-RG



MF-DC



MF-SMHT
MF-PSHT
MF-USHT

Automotive Circuit Protection Solutions

Types Available:
- *TVS diodes*
- *Multifuse® PTC resettable fuses*
- *Metal alloy stunts*
- *ChipGuard® MLVs*

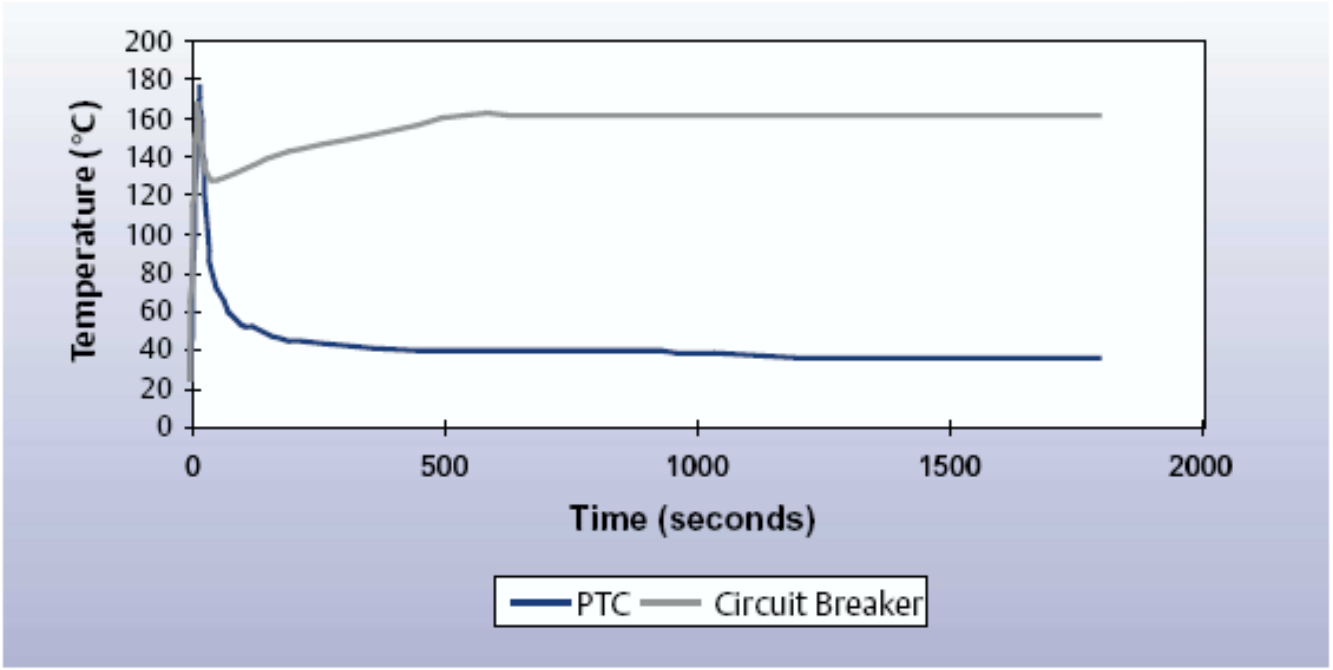
Features:
Overcurrent and overvoltage protection for automotive applications, TS16949 quality system, resettable PTCs suitable for application temperatures up to 125 ˚C, majority certified to AEC-Q200-Rev C, wide range of current ratings (0.05 – 20 A), dedicated automotive CP team

Applications:
- *Window regulators*
- *Seat adjustment motors*
- *Sunroof activation motors*
- *Powerbus (mode protection) applications*
- *Other DC motor applications*
- *Car alarm systems*
- *Power steering motors*
- *GPS shark fin antennae*
- *Cooling & HVAC systems*

PPTCs *vs* other overcurrent protectors

Device	Cycles during Faults	Contacts (erode, weld shut, develop deposits)	Resistance & Power dissipations	Vibration & Thermal shock	Ressettable
PPTC	No	No	Low	Minimum effects	Yes
CPPTC	No	No	High	May crack	Yes
Fuse	No	No	Low	Minimum effects	No
Bimetallic	Yes	Yes	Low	Effects mechanical contacts	Yes
Magnetic Circuit Breaker	Yes	Yes	Low	Effects mechanical contacts	Yes

Motor Protection



Circuit breaker sets and resets keeping the motor windings at a Hot temperature.

PTCs latch off reducing the current and keeping the motor at a much lower temperature.

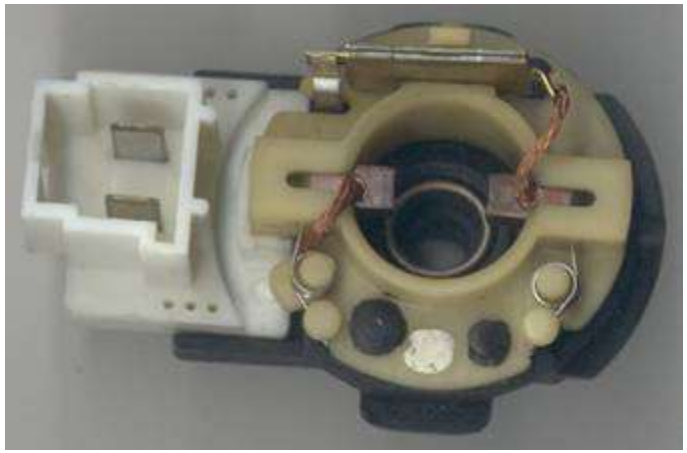
PPTC Advantages over Bi-metals

- **Fast Trip Time**
  - A PPTC has a lower thermal mass than other solutions and heats up more rapidly.
- **Smaller size**
  - PPTC products use a smaller area than bi-metallic fuses and are easier to design into the motor.
- **Low Initial Resistance**
  - With their lower resistance, PPTC ’ s make the design more efficient by tripping faster in event of a stall current surge.
- **Scalable Electrical Design Technology**
  - Allows for greater design flexibility in terms of electrical characteristics

PPTC Advantages over Bi-metals

- **Long Term Reliability**
  - A PPTC has no moving parts, so there is no mechanical wear and tear. Also PTCs are mechanically more stable for high shock and vibration environments.
- **No hysteresis**
  - A PPTC latches onces tripped and maintains the tripped position until the fault is removed and power cycled. This reduces the temperature of the motor and unnecessary cycling. Bi-Metals cycle on/off maintaining the motor at a higher temperature and reducing the cycle life. Also conserves battery life.
- **Failure modes**
  - PTCs have a very low probability of failing short. Bimetals run the risk of contacts welding and arcing creating unknown failure modes.

Application - Motor Protection



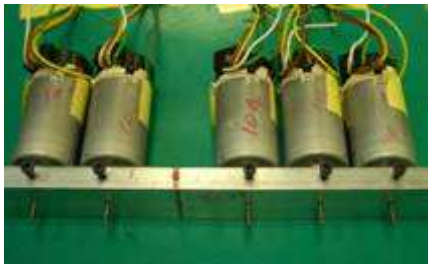
Hold Currents to 23 amps

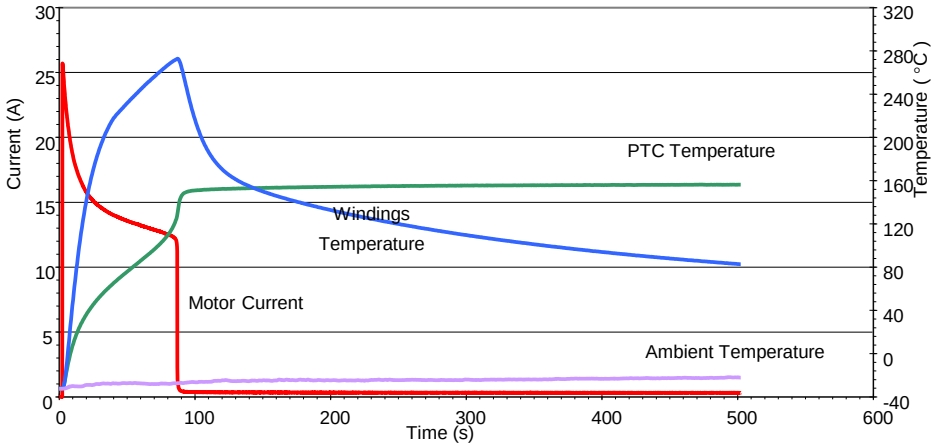
Metal plated to withstand start up current

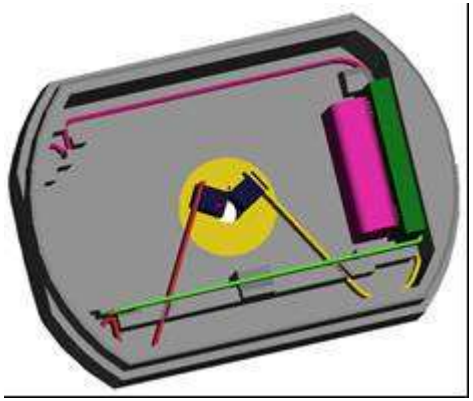
Designed into existing housing

Bourns – DC motor capabilities

- High Temperature Polymer
- Customized application testing
- RoHS Compliance
- Customization of components

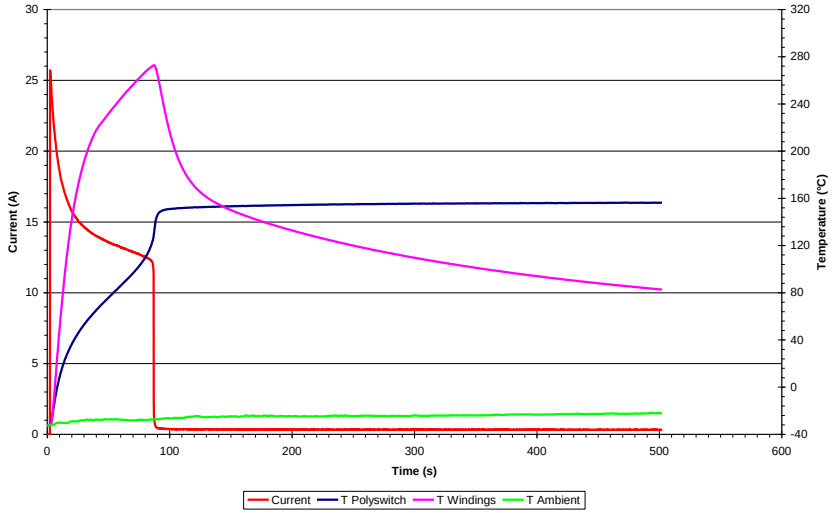






Motor Test Lab capabilities

- Multifuse test lab is a UL TCP certified lab.
- Locked rotor test
- Thermal protection
- Time to trip
- Reset times
- Cycle life e.g. 1000 cycles
- Trip endurance tests
- Battery Run down



–Winding Temperature Measurement

–PTC Temperature Measurement

–Ambient Temperature Measurement

Quality System Certificate

- QS9000/ISO9001, certified by UL
- TL9000/ISO9001, certified by UL
- TS16949, certified by UL

Agency Approval Matrix

Safety Test Item

		Aging\ Trip Endurance	H-C-Humid /Humidity	Overload	Endurance (Trip cycle Life)	Cold Operation Cycling	Thermal Runway	High Temp. Storage Aging	I-Hold --> I-Trip	Thermal Condition	Temp. Stress	Insulation Testing
UL 1434	Test Conditions	1000 hrs @ Vmax & Itrip (Trip State for 1000 hrs)	24 hrs @ Tss, 168 hrs @ 40°C & 95% RH, 8 hrs @ 0°C	50 Cycles of 120%Imax & Vmax	6000 cycles of 250%Itrip & Vmax	1000 cycles of Vmax &Itrip @ 0°C	2 minutes of 200%Vmax	N/A	N/A	N/A	N/A	N/A
	Samples	3	3	3	3	3	3	N/A	N/A	N/A	N/A	N/A
	Pass / Fail Criteria	<20% shift in trip temp.	<20% shift in trip temp.	<20% shift in trip temp.	<20% shift in trip temp.	<20% shift in trip temp.	<20% shift in trip temp.	N/A	N/A	N/A	N/A	N/A
CA - 3A	Test Conditions	4 hrs @ Vmax, 4 hrs @ 120%Vmax, 64 hrs @ Vmax	168 hrs @ 40°C & 95% RH	Accepts UL data	Accepts UL data	Accepts UL data	Accepts UL data	300 hrs @ Ttrip + 30°C	Hold @ I-hold within 30 min. Trip @ I-trip within 15 min.	N/A	N/A	N/A
	Samples	6	6	Accepts UL data	Accepts UL data	Accepts UL data	Accepts UL data	6	6	N/A	N/A	N/A
	Pass / Fail Criteria	R-T drift, PTC effect	R-T drift, PTC effect	Accepts UL data	Accepts UL data	Accepts UL data	Accepts UL data	R-T drift, PTC effect	I-hold: no trip I-trip: trip	N/A	N/A	N/A
EN60730	Test Conditions	Accepts UL data	Accepts CSA data	N/A	Accepts UL data	Accepts UL data	Accepts UL data	N/A	N/A	1000 hrs @ 85°C	24 hrs @ -10°C, 4 hrs @ 60°C	500 Vdc@devices rated <50V, or 1000 Vdc @ devices rated >50V
	Samples	Accepts UL data	Accepts CSA data	N/A	Accepts UL data	Accepts UL data	Accepts UL data	N/A	N/A	6	6	6
	Pass / Fail Criteria	Accepts UL data	Accepts CSA data	N/A	Accepts UL data	Accepts UL data	Accepts UL data	N/A	N/A	R-T drift, PTC effect	R-T drift, PTC effect	R-T drift, PTC effect

Bourns Test Lab is UL TCP Certified

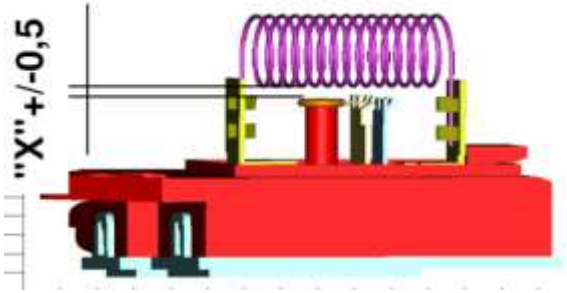
AEC Q200 Testing Program

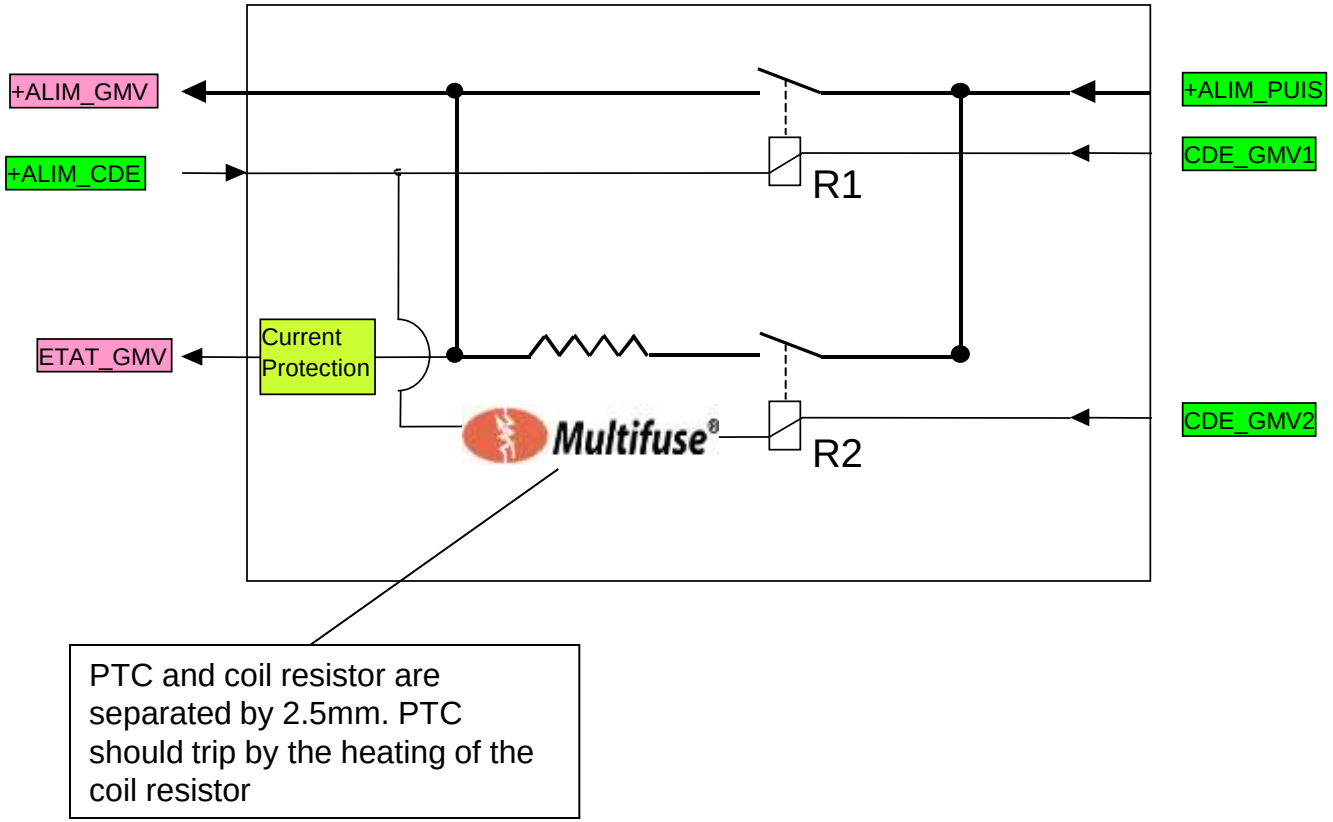
- AEC-Q200-REV-C: Automotive Electronics Council a joint effort of Delphi Packard, Delco Electronic Systems, DaimlerChrysler and Visteon
- AEC-Q200 Stress Test Qualification for Automotive Grade Passive Components. First and second tier automotive suppliers have adopted this standard.
- Bourns can offer compliance with the AEC-Q200 standard on the majority of products

Production / Sample & Agency Testing

- Standard Production:
  - 100% resistance testing
- Sample Testing (70pcs every 50K units):
  - Time to Trip (5A, 25sec)
  - Trip Endurance (Vmax, Imax, 48hrs)
  - Cycles Life (Vmax Imax 6sec/120sec, 100cycles)
  - I hold
  - I trip
- Custom production/sample testing available at customer's request.
- Agency testing once a year (family)

Cooling Fan Speed Control

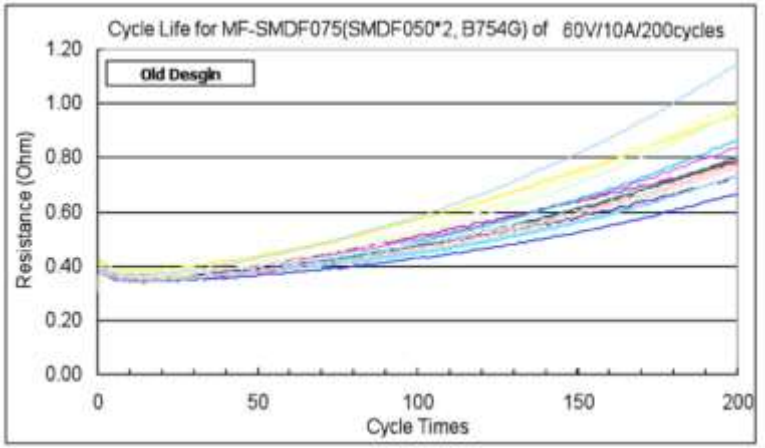




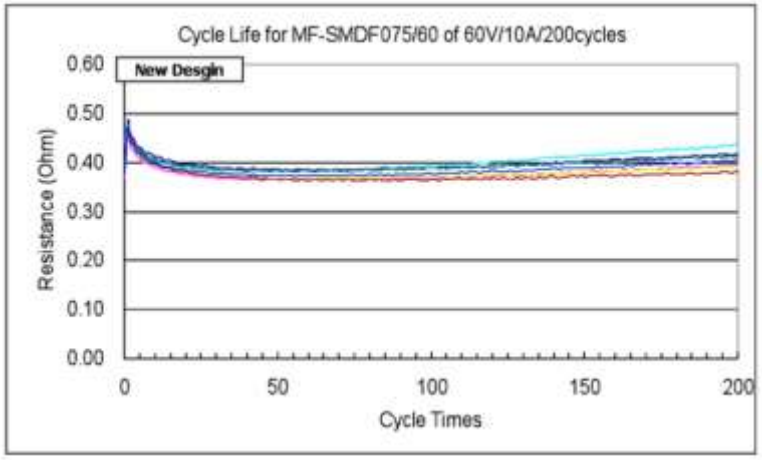
Next Generation Technology: *FreeXpansion®*
PTC Resettable Fuse

- Improved resistance stability
- Greater reliability
- Higher voltage capability
- Higher current capability
- Smaller footprints
  - 0805 size
  - 0603 size

Conventional PTC



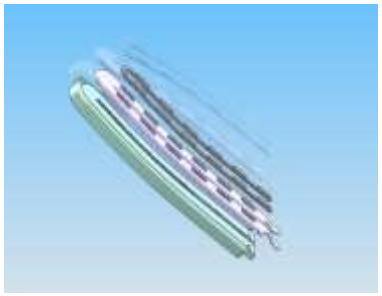
FreeXpansion® PTC



Creating Uniqueness - Heaters

New Product Roadmap

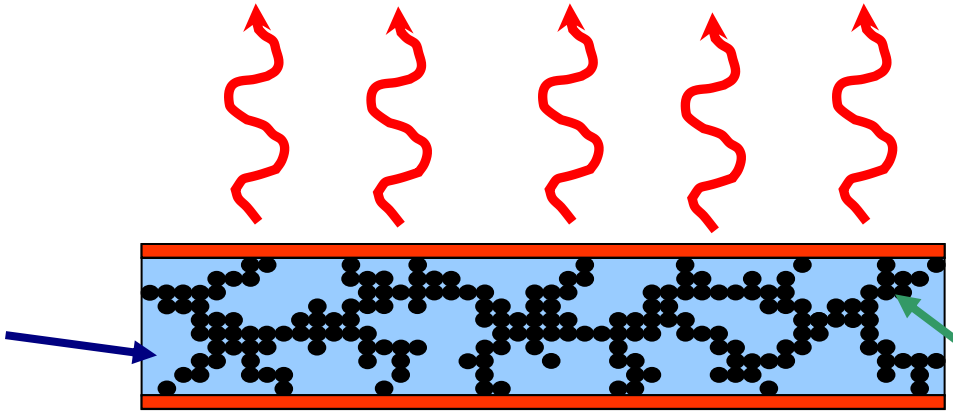
Medical Heater (J&J)



Automotive Heater (BORG)

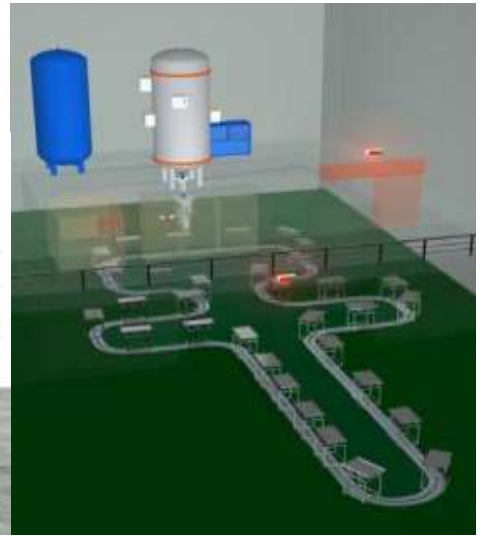
HVAC Heater (BORG)

Heats at the rate of I^2R – reaches thermal equilibrium in tripped state



E-Beam facility

- Bringing e-beaming in house, in a new purpose built facility (multi million dollar investment)
- Advantages:
  - Helps reduce lead times by up to 1 week
  - Gives Bourns more control over its costs
  - Allows for tighter resistance tolerances which is critical in telecom, motor & battery applications
  - Reduce the amount of e-beam cycles (many products have 2 e-beam cycles)
  - Helps develop higher voltage materials
  - Faster development times



Bourns Automotive Approved PPTCs

Series	Max Operating Temperature (°C)	Voltage (V)	Current (A)	R1Max (Ω)	Nominal Trip Current (A) at 23C	Time to Trip at 23C (S)	Trip Current at 23C at Time to Trip (A)	Format
MF-RHT	125	16	0.7~13	0.01~0.8	1.4~24	4~13	3.5~60	Radial
MF-SMHT	125	16	1.36~1.6	0.15~0.33	2.72~3.2	10	8	2920 & 3425 package
MF-PSHT	125	16	0.1	7.5	0.6	1.5	2.5	0805 Package
MF-RG	85	16	3~5	0.034~0.0975	5.1~8.5	1-2	15-25	Radial
MF-R	85	60	0.05~11	0.014~22	0.1-22	5-20	0.5-40	Radial
MF-SM	85	6-60	0.3~3	0.048~4.8	0.6-6	3-35	1.5-8	2920 & 3425 package
MF-LSMF	85	6-33	1.85~3.0	0.075~0.15	3.7-5.2	2.5-20	8	2920 package
MF-MSMF	85	6-60	0.1~2.6	0.08~15	0.3-5.2	0.06-5	0.5-8	1812 Package
MF-NSMF	85	6-30	0.12~2	0.085~8.5	0.29-4	0.1-1	1-8	1206 Package

Power Resistor Solutions

Types Available:
Power resistors, power shunt resistors

Function:
Surge, snubber resistors, voltage feedback

Power Range:
0.125 W to 100 W

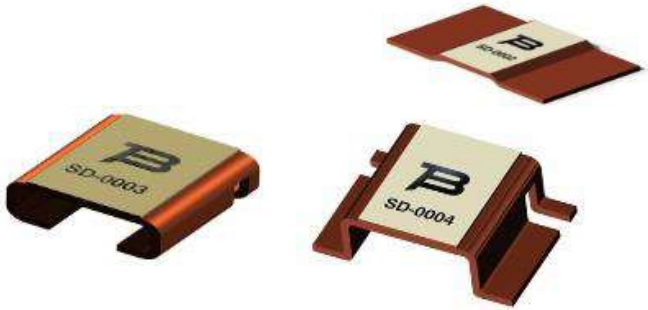
Resistor Materials:
Thick-film, metal alloys, wirewound

Formats:
Surface mount (chip and TO-220, DPAK), through- hole (TO-220), chassis mount, axial.

Temperature Coefficient:
As low as ±15 PPM/° C

Resistance Range:
From 0.2 mΩ to 100 KΩ

Applications:
Bourns® power resistors are used in power supplies, motor drives and electricity meters in telecom equipment, industrial equipment and automotive electronics.

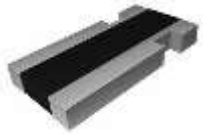


Founding Technology – Latest Innovations

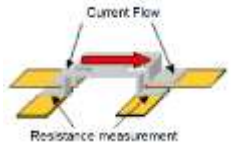
Fixed Resistor technology is the foundation of Bourns technology going back to 1947

Majority of Bourns product lines are based on resistor technology such as trimmers, sensors & control, automotive sensors, fixed resistors.

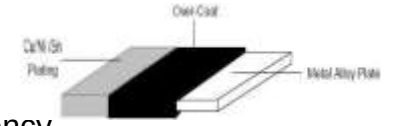
Fixed Resistor technology is at the forefront of our innovation strategy:



- **Current sense** resistors such as:
  - CST Series – 4 terminal / 1W / 0.5mΩ resistors. Designed for computer motherboards and graphic cards

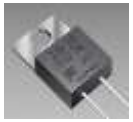


  - CRE / CRF / CRA Series – 2 terminal / up to 3W / >1mΩ / 0805 ~ 2512 SMD
    Designed for computer motherboards and battery packs

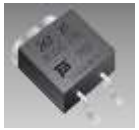


- **Power Resistors** - AEC-Q200 Qualified for Automotive Applications
  - PWR163 Series is a DPAK style power resistor. Very low inductance is ideal for high frequency applications such as audio amplifiers. It has excellent pulse characteristics allowing use in current limiting or capacitor discharge circuits.

  - PWR220T-20 Series is a TO-220 DPAK style 20 Watt resistor. Manufactured using thick film on alumina ceramic technology, it is used in current measurement, snubber, bleeder and discharge circuits. Bourns resistors have sulfur resistant layer that protects resistors for decades.

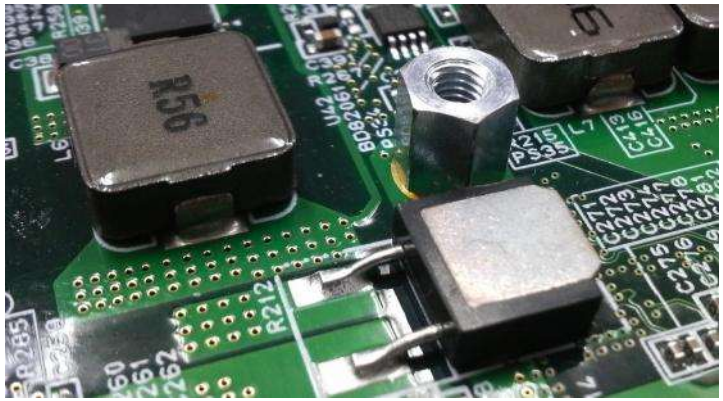


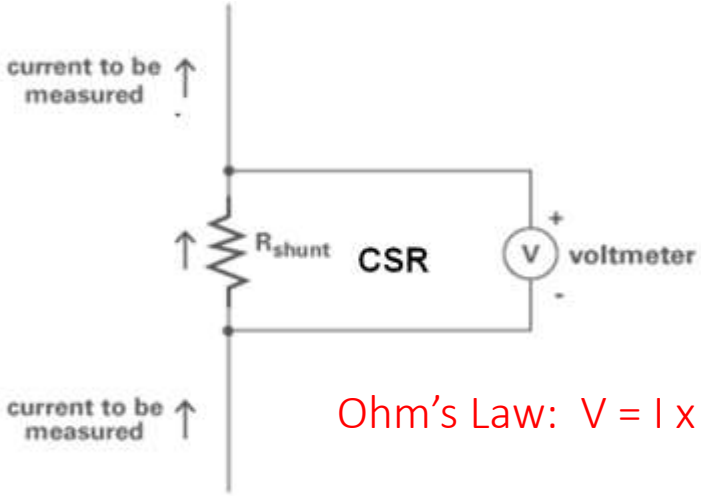
  - PWR220T-35 Series is a TO-220 DPAK style power 35 Watt resistor
  - PWR263S-20 Series is a TO263 DPAK style power 20 Watt resistor
  - PWR263S-35 Series is a TO263 DPAK style power 35 Watt resistor



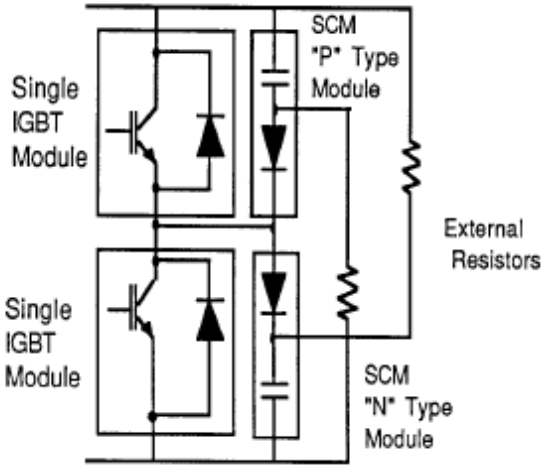
New product focus – High Power PWR series

- **Function of PWR**
  - Current Sense
    - For Ohmic Values less than 1 Ohm
    - Voltage Feedback
  - Current Limiting
    - For Ohmic Values between 1 Ohm and 15K
    - Dummy load
    - Relay Driver
    - R C D Snubber
    - Pulse Generator
    - Battery Charging





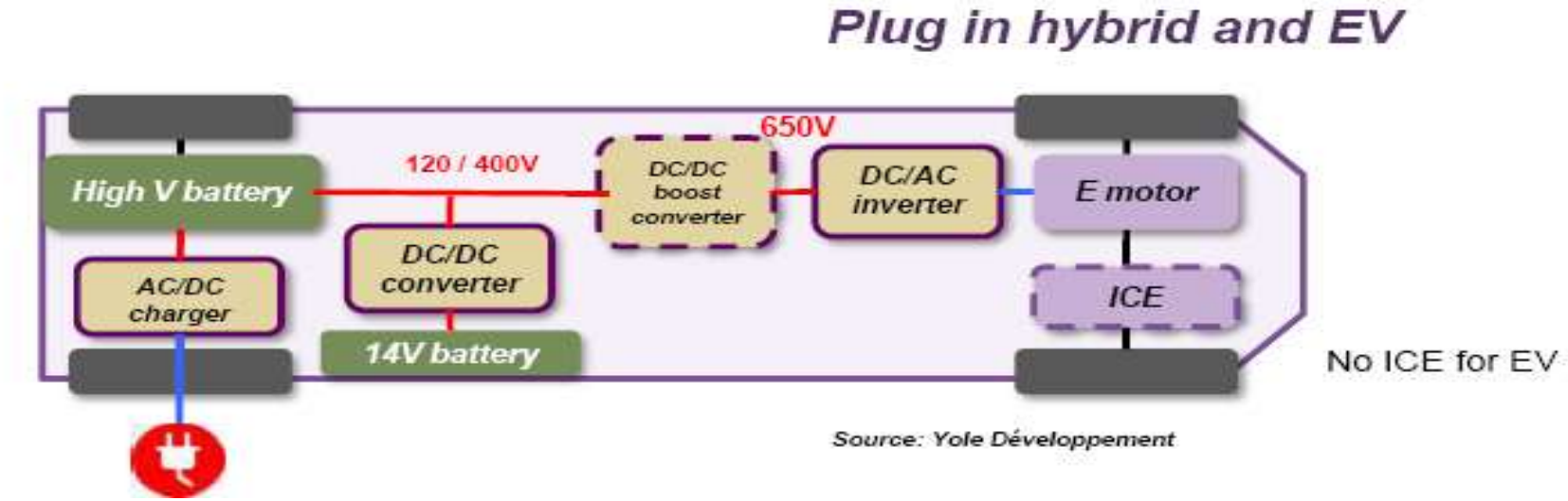
Ohm's Law: V = I x R



Limiting the overshoot caused by switching IGBTs on and off is achieved by Snubber circuits.

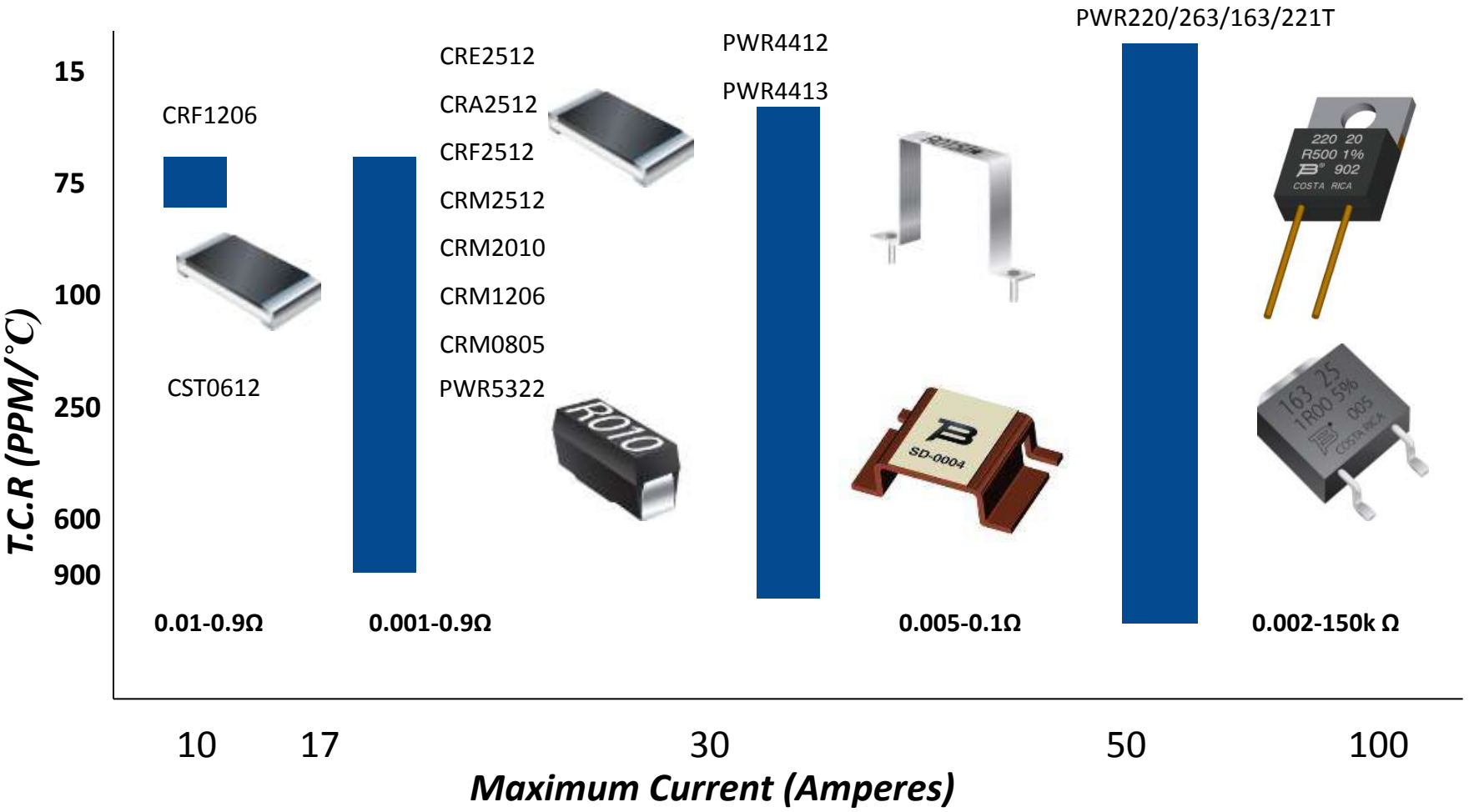
New product focus – High Power PWR series

- **Focus application**
  - Automotive
    - Plug in Hybrids, Full Electric Vehicles
    - DC/DC, Converter, Inverter Drive for E Motor, Battery Charger (RCD Snubbers, Current Sense)
  - Standard Industrial & Telecom
    - Network Storage, Industrial Lighting, Network Switches, Test Equipment, Industrial Electric Motor Drives, Audio Amplifiers
    - (Rectifiers, DC/DC Converter, Inverter Supply (RCD Snubbers)



Fix Resistor products

Diagram



Bourns Current Sense Resistors

- Maximum Current Capability of 50 Amps
- SMD, Open Frame, TO220 Housings
- TCRs as low as 15 PPM available
- Operating Temperaturs as high as 325˚C
- For information on Design Kits, Datasheets, Application Notes please visit www.bourns.com

High Power Current Sense Chip Resistors

Model	Power (W)	Resistor	Resistance Range	Tolerance	TCR (PPM/°C)	Application	
CRA2010	**1.5**	**Special Alloy**	0.01 ohms to 0.100 ohms	1% ,5%	±75 ppm	Power supplies, Stepper motor drives	
CRA2512	**3**	**Special Alloy**	0.01 ohms to 0.100 ohms	1% ,5%	±75 ppm	Power supplies, Stepper motor drives	
CRF2512	**(2W) 0.100 to 0.010** **(1W) 0.015 to 0.040**	**Thin Film**	0.015 ohms to 0.040 ohms/ 0.003 ohms to 0.010 ohms/ 0.001 ohms to 0.002 ohms	1% ,5%	±75 ppm ±100 ppm ±275 ppm	Power supplies, Stepper motor drives	
CRM0805/CRM1206/CRM1206/CRM2010/CRM2512	**0.25/0.5/1/2**	**Thick Film**	.047 ohm to 1 megohm	1% ,5%	±100 ppm ±150 ppm ±200 ppm	Power supplies, Stepper motor drives	

Low & High Value Chip Resistors (CRL&CRH)

Model	Power (W)	Resistance Range	Tolerance	TCR (PPM/°C)	Application	
CRL0805	**0.125**	0.05 ohms to 9.1 ohms	1% & 5%	±200 ppm/±400 ppm	Portable devices, medical device	
CRL0603	**0.1**	0.10 ohms to 9.1 ohms	1% & 5%	±200 ppm	Portable devices, medical device	
CRL1206	**0.25**	0.02 ohms to 9.1 ohms	1% & 5%	±200 ppm/±600 ppm	Portable devices, medical device	
CRL2010/CRL 2512	**0.5/1**	0.02 ohms to 9.1 ohms	1% & 5%	±200 ppm/±600 ppm	Portable devices, medical device	
CRH0805	**0.125**	1.02 mega ohms to10 mega ohms	1%	±200 ppm	X-Ray devices	
CRH1206	**0.250**	1.02 mega ohms to10 mega ohms	1%	±200 ppm	X-Ray devices	

Ultra-Tight Tolerance Precision Chip Resistors

(Thin Thin Film)

Model	Power (W)	Resistor	Resistance Range	Tolerance	TCR (PPM/°C)	Application	
CRT0402	**0.0625**	**Thin Film**	50 ohms to 100K ohms	0.01% to 1%	± 5 ppm to ± 50 ppm	Hand hold devices, servers	
CRT0603	**0.100**	**Thin Film**	4.7 ohms to 402 ohms	0.01% to 1%	± 5 ppm to ± 50 ppm	Oil and gas meters	
CRT0805	**0.125**	**Thin Film**	1 ohms to 1 mega ohms	0.01% to 1%	± 5 ppm to ± 50 ppm	Hand hold devices, servers, Oil and gas meters	
CRT1206	**0.125**	**Thin Film**	1 ohms to 2 mega ohms	0.01% to 1%	± 5 ppm to ± 50 ppm	Process Control Computer	

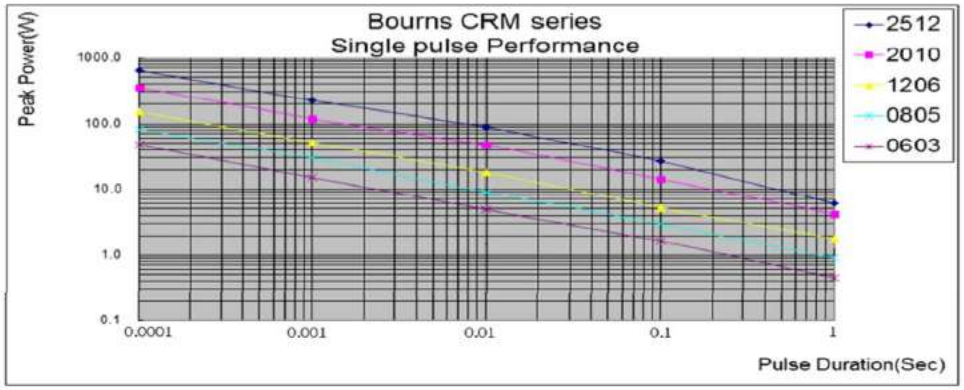
Thick Film Chip Resistors

For current sensing

CRM Series - chip resistors with high power ratings

	CRM0805	CRM1206	CRM2010	CRM2512
Resistance range	47 mohm to 1 Mohm			110 mohm to 1Mohm
Power rating	0,25 W	0,5 W	1 W	2 W
TCR	±100 ppm/°C ±200 ppm/°C			
Tolerance	±1 %, ±5 %			
Working temperature	-55 to +155°C			

- Strong pulse performance
- Power supplies
- Stepper motor drives
- Current limiting
- Snubber



BOURNS®

Thin film v.s. Thick film

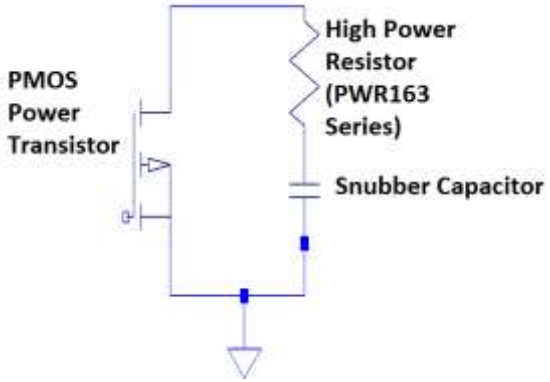
Thin Film

- Cost higher
- Sputtering resistive layer
- Homogeneous film
- Highly stable materials
- HF stable, low noise
- Low TCR (±25ppm)
- Narrow tolerance
  (±0.1% ~ ±1%)

Thick Film

- Cost low
- Printing & firing resistive layer
- Material with standard performance
- Higher noise
- Standard TCR
- (±100 ~ ±200ppm)
- Standard tolerance
- (±1% ~ ±5%)

PWR263/220



- TO-263/TO-220 Package
- 20/25/30/35/50/70/100 Watts of Power (at 25C)
- Thickfilm Resistor element mounted on a metal Backplane and over moulded in Black Epoxy
- ROHS Compliant
- Lead Free Reflow Soldering Compatible
- Non Inductive
- Excellent Pulse Power Characteristics
- Resistor Electrically Isolated from Backplane
- TCR of 100PPM/˚C

Bourns Advantage

- Competitive price
  - Bourns can offer cost reductions to customers if they switch from a competitor to Bourns
  - Bournsquote will give out special pricing when requested to support sales
- 4 week lead-time min.
- Excellent quality (manufactured by TESA)
- Capacity: Max. 30K/wk
- Sample availability
- Modifications available
  - Special resistance value (3 weeks to do customization!)
  - Additional configurations

Friendly technical and sales staff

- Available through major distributors

New product focus – High Power PWR series

- **Automotive capabilities**
  - Costa Rica plant is TS16949 certified
  - AEC approved products
  - PPAP capability
  - Factory audits facilitated
  - Specialized testing available
  - Assembled parts (with wire)

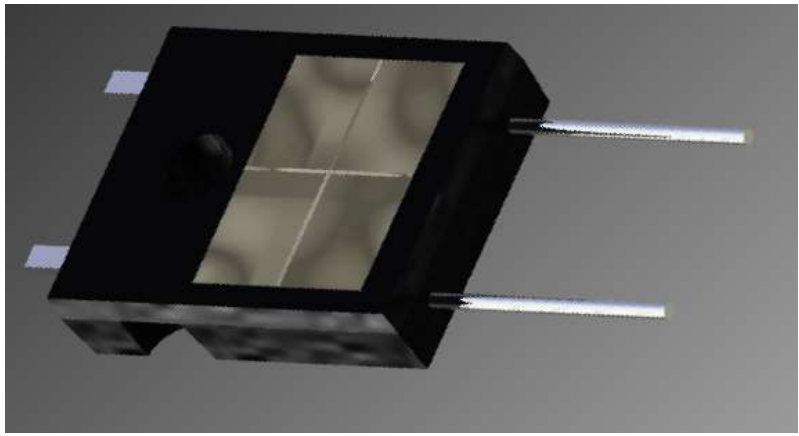
Model	Format	Features
PWR163 PWR263S-20 PWR263S-35	SMD DPAK 	Resistance Range 0.02 ohms-130Kohms Tolerances: 1 %, 5 % TCR ±100 ppm/°C Power: 20, 30, 35, ***50W*** , **70W, 100W** Superior Surge Performance Withstands high Temperatures Tested to 2000 hrs vs 1000 hrs standard (Therefore higher MTBF)
PWR220T-20 PWR220T-35 PWR221T-30 ***PWR221T-50***	Through-Hole TO220	
PWR247-70 ***PWR247-100***	***TO247*** ***Q1 2015*** 	

- **Cross reference**

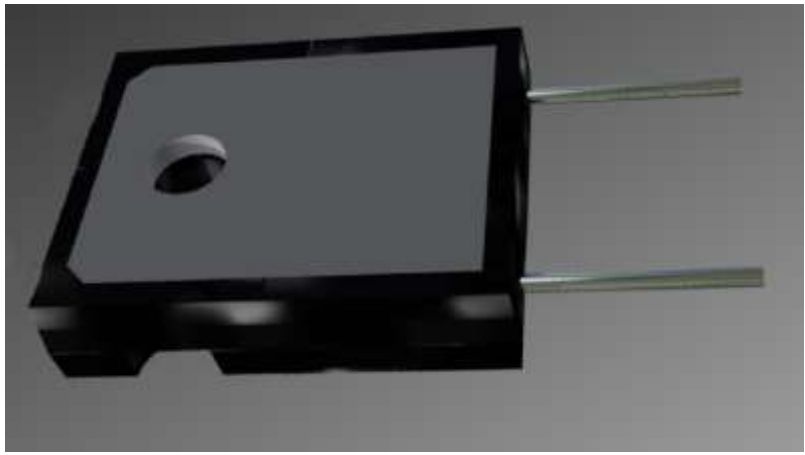
	BOURNS	VISHAY	CADDOCK	BI
DPAK	PWR163		MP725	
D2PAK	PWR263	D2TO		SMHP
TO-220	PWR220T	RTO	MP820/MP850	MHP
TO-220	PWR221T	LTO30	MP930	

New Products

- PWR 247, 100W TO-247 Package
- Two packaging options
  - Bare ceramic back
    - No metal backplate
    - Popular configuration in the market
    - No backplate attachment operation
    - Ceramic 0.040” limits heat conduction to the heatsink
    - Difficult to mold, requires pin extension to hold the element in position, difficult to index for auto placement.
    - Exposed pin ends

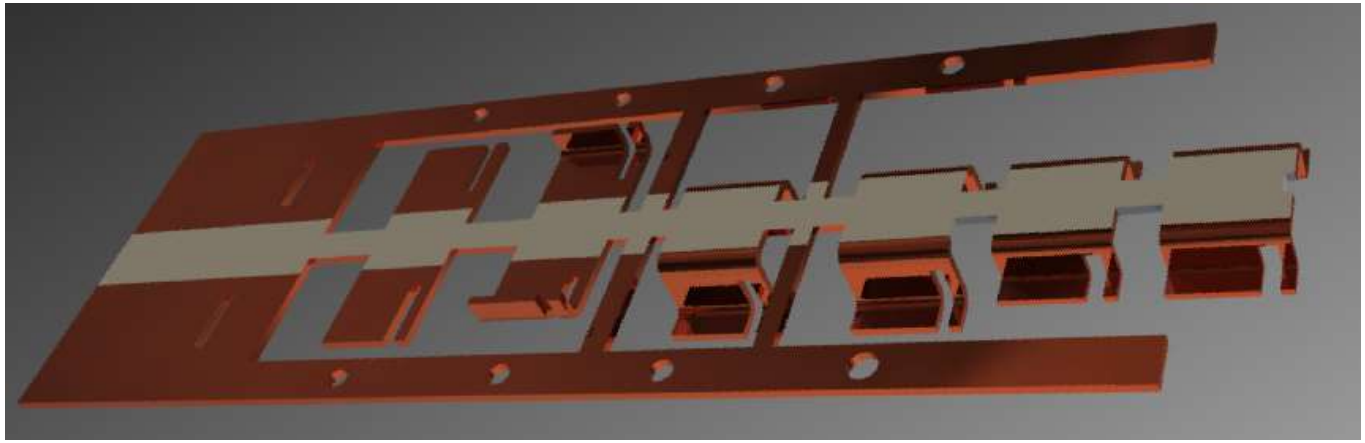


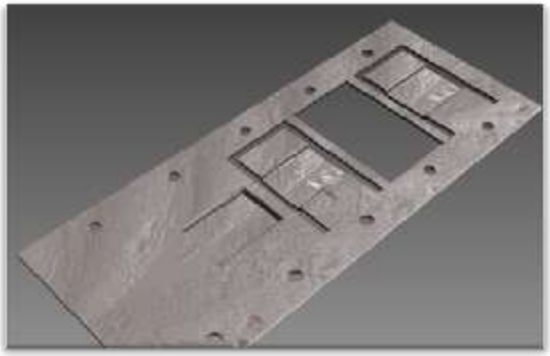
  - Heatsink Back
    - Metal backplate covering most of the area
    - Requires back plate attachment operation
    - 0.025” ceramic allows for better heat conduction to heatsink
    - Hole in the backplate allows for easy indexing in the mold.
    - More expensive

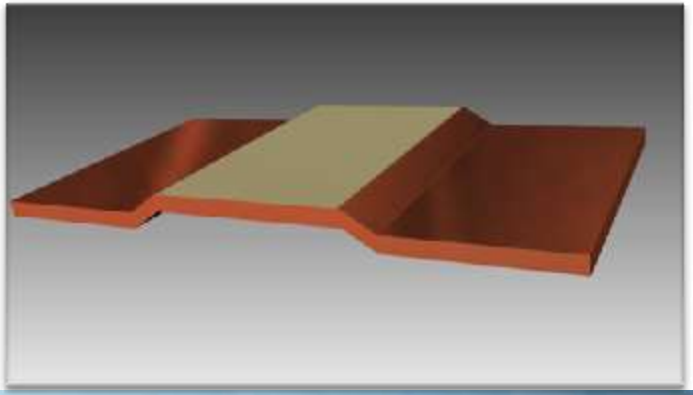


SHUNTS

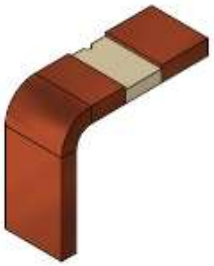
- Very low Resistance values
- Made out of Electron Bean welded resistive element to copper sheets
- Die forming out of the metal sheet







Isabellenhutte products

PRODUCT DESCRITION: CURRENT SENSOR SHUNT **CSS**				REV: C
MARKET REFERENCE **ISABELLENHUETTE [ISA]**	PRODUCT OUT LINE: DRAWING:			STYLE:
BVE/ BVS/ BVT [2 TERMINALS]	**SD-0005** 	**SD-0006** 	**SD-0007** 	**H**
BVB/ BRS [4 TERMINALS]	**SD-0003** 			**C**
BVR [4 TERMINALS]	SD-0004 			**J**
BVH [THROUHOLE]	SD- 			**N**
LEAR	**SD-0008** 			**L**

ISABELLENHUETTE [ISA]

BOURNS STYLE

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BVx		BVE	2-termimal-resistors with large connectors for high performance.	5930	10 W	1 %	0.0002 Ω	0.002 Ω	50 ppm/K

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BVx		BVS	2-terminal-resistors made of composite material	3920	12 W	1 %	0.0002 Ω	0.005 Ω	50 ppm/K

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BVx		BVT	2-terminal-resistors made of composite material.	2512	3 W	1 %	0.0003 Ω	0.0068 Ω	50 ppm/K

H

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BVx		BVB	4-terminal-resistors made of composite material. Perfectly suitable for the use on DBC or ceramic. Space-saving design.	2725	12 W	1 %	0.0002 Ω	0.005 Ω	20 ppm/K

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BRS		BRS	2-terminal-resistors made of composite material. Perfectly suitable for the use on DBC or ceramic. Space-saving design.	3812	2 W	1 %	0.002 Ω	0.010 Ω	100 ppm/K

C

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BVx		BVH	Heavy copper connectors	3820	5 W	3 %	0.0003 Ω	0.002 Ω	300 ppm/K

N

Type/ series	Picture	Type	Description	Connector style	Power	Tolerance	Resistance (min)	Resistance (max)	TC
BVx		BVR	4-terminal-resistors made of composite material. Perfectly suitable for the use on DBC.	4026	5 W	1 %	0.0002 Ω	0.003 Ω	20 ppm/K

J

PART NUMBER:

CSS2H-2512-L500F

MODEL:
CSS = CURRENT SENSOR SHUNT

PIN COUNT:
2 or 4

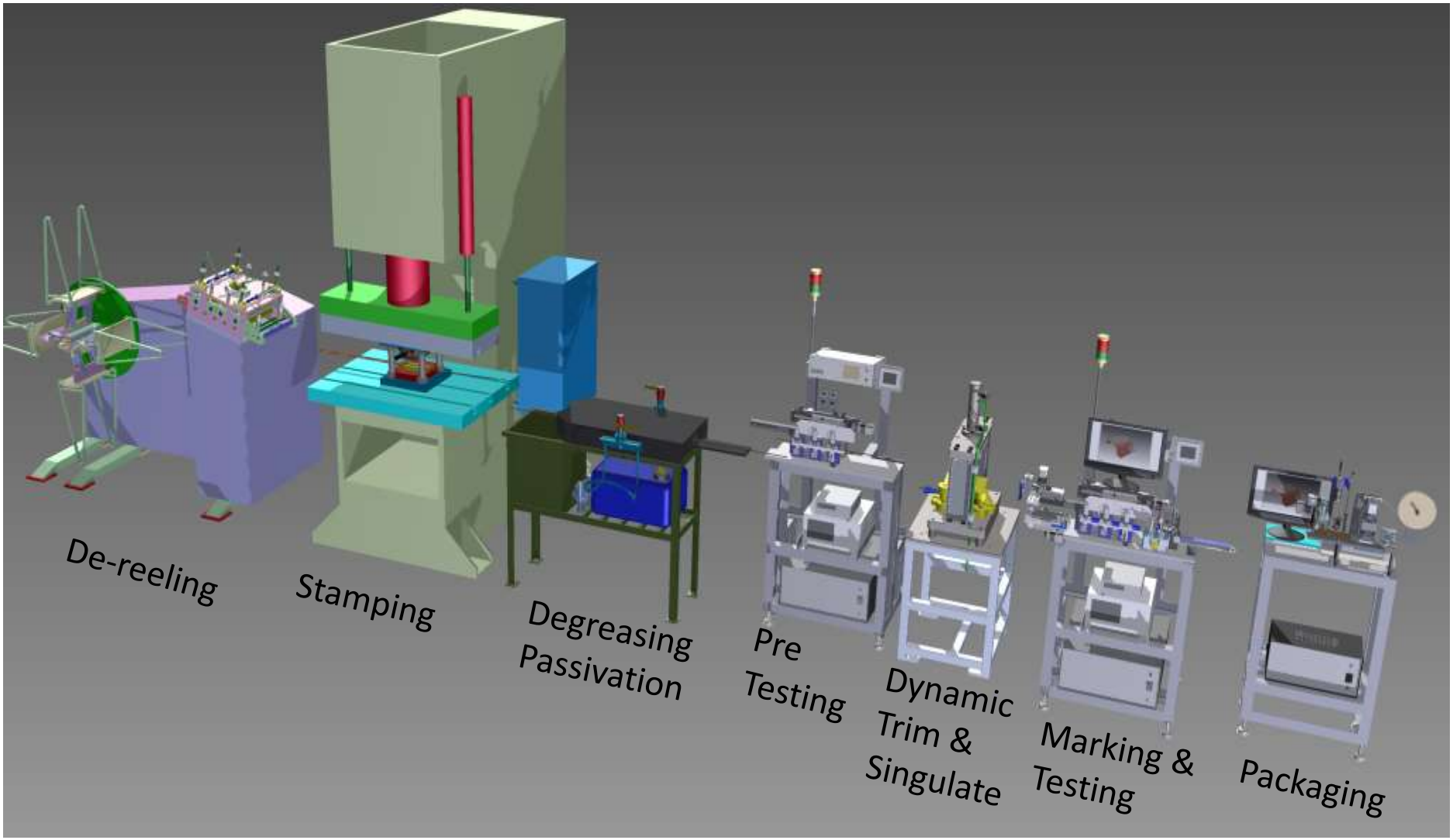
STYLE:
C,H,J [N,L]

SIZE:
L x W (INCH THOU)

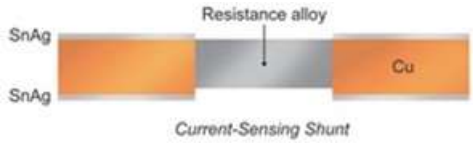
RESISTANCE:
(milliohms)
“L” represents decimal point

ABSOLUTE TOLERANCE:
F = 1%
J = 5%

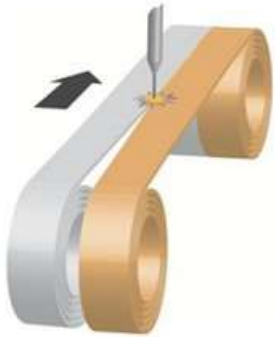
Shunt Production Line

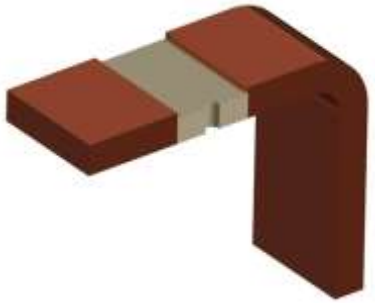


Production Considerations



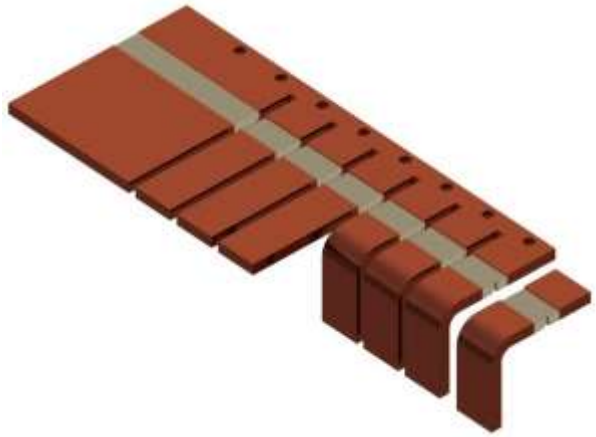
- Every new model requires its own specific raw material
- To make 1 new model, requires to buy ~20lbs of material, this produced ~3k pcs @ $2700 per part
- Therefore we will not be doing a general release of every part number





Product Release

1. Release specific customer project, Delta (Lear)
2. Release individual part numbers first :
   - Equivalent to ISA BVE 1mΩ & 2mΩ
   - Equivalent to ISA BVT 1mΩ & 2mΩ
   - Equivalent to ISA BVR 1mΩ & 2mΩ
3. Flesh out families with specific customer requests



Cross list [preliminary]

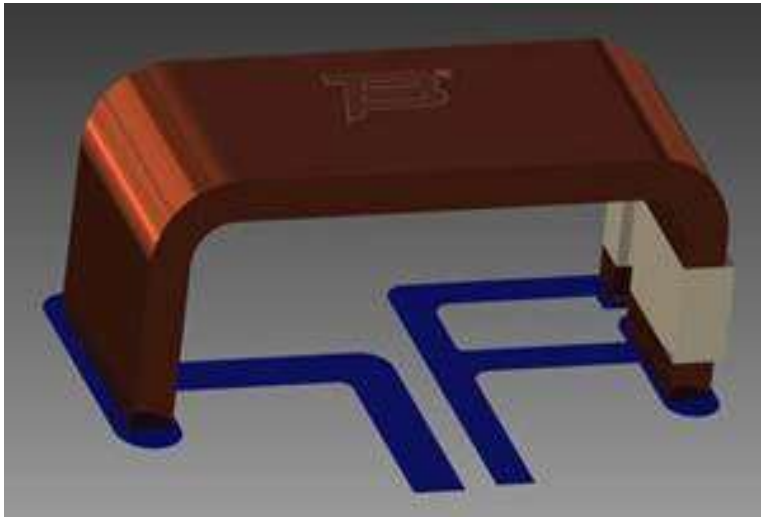
ISA P/N	BOURNS P/N	REFERENCE SKETCH	OUT LINE DWG
BVR-Z-R0005-1.0	**CSS4J-4026-L500F**	SD-0004	I-3995
BVT-Z-R0005-1.0	**CSS2H-2512-L500F**	SD-0005	I-3996
BVS - M - R0005 - 1.0	**CSS2H-3920-L500F**	SD-0006	I-3993
BVE-M-R0005-1.0	**CSS2H-5930-L500F**	SD-0007	I-3994
BVB - Z - R0005 - 1.0	**CSS4C-2725-L500F**	TBA	TBA
BVH-M-R0005-5.0	**CSS4N-3820-L500J**	TBA	TBA
BVN - Z - R0005 - 1.0	**CSS2C-1216-L500F**	TBA	TBA

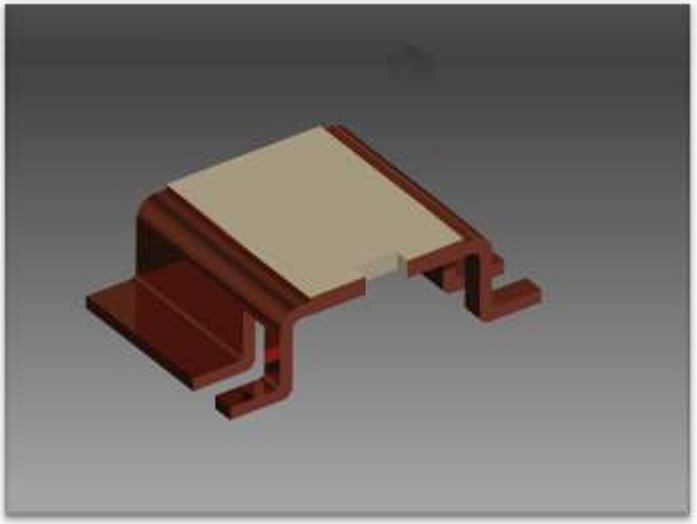
shunt: definition

an electrical conductor joining two points of a circuit, through which more or less of a current may be diverted.

"One indication is a shunt or a short circuit of a medium between the common control element and the devices."

ISA BVR
VISHAY

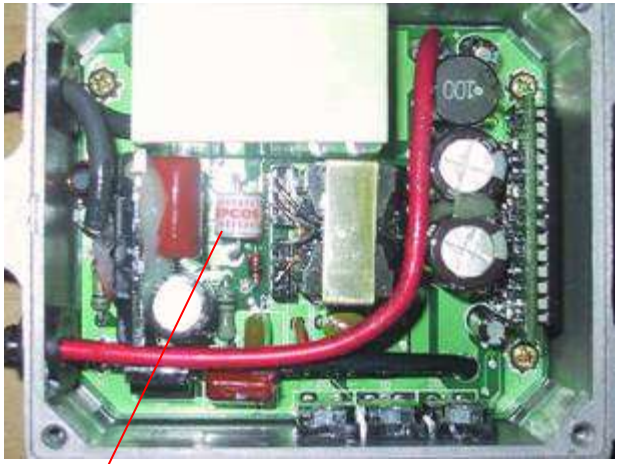


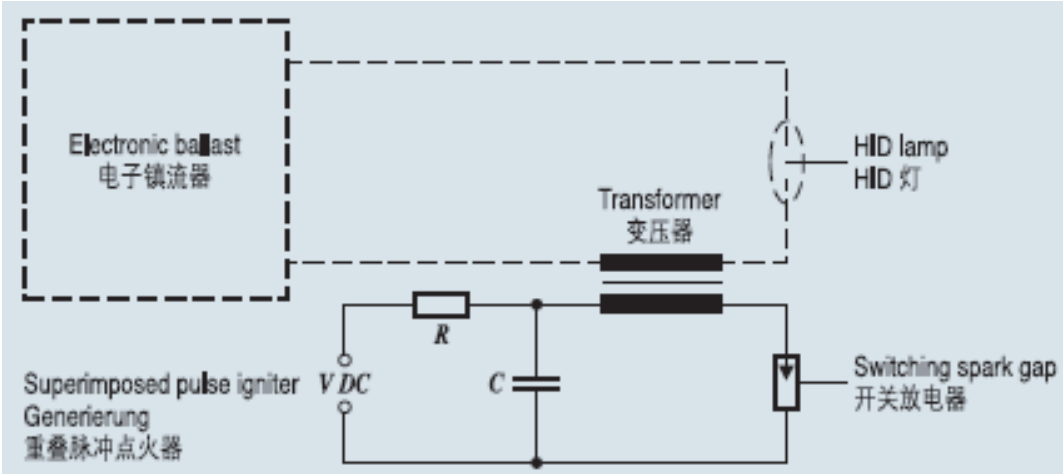


Bourns Automotive Approved GDT

Model	Breakdown Voltage (V)	Breakdown Time	Operating Temperature (°C)	Peak Current
ST-0350	350	Max 50ns	-40~160	Approximately 500A
ST-0450	450	Max 50ns	-40~160	Approximately 500A
ST-0470	470	Max 50ns	-40~160	Approximately 500A
ST-0600	600	Max 50ns	-40~160	Approximately 750A
ST-0620	620	Max 50ns	-40~160	Approximately 750A
ST-0750	750	Max 50ns	-40~160	Approximately 450A
ST-0800	800	Max 50ns	-40~160	Approximately 450A
ST-0840	840	Max 50ns	-40~160	Approximately 450A
ST-1000	1000	Max 50ns	-40~160	Approximately 400A

Switching Spark Gap in HID Ballast
(氙气高压放电灯用汽车车灯安定器)



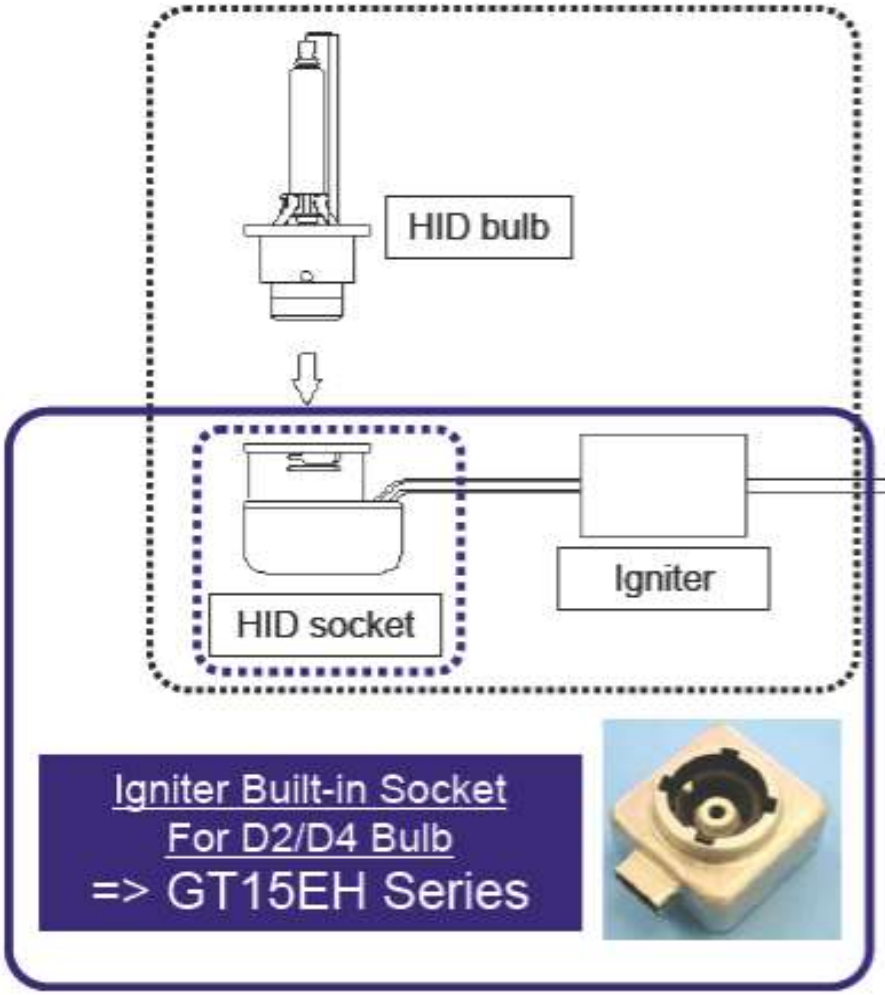


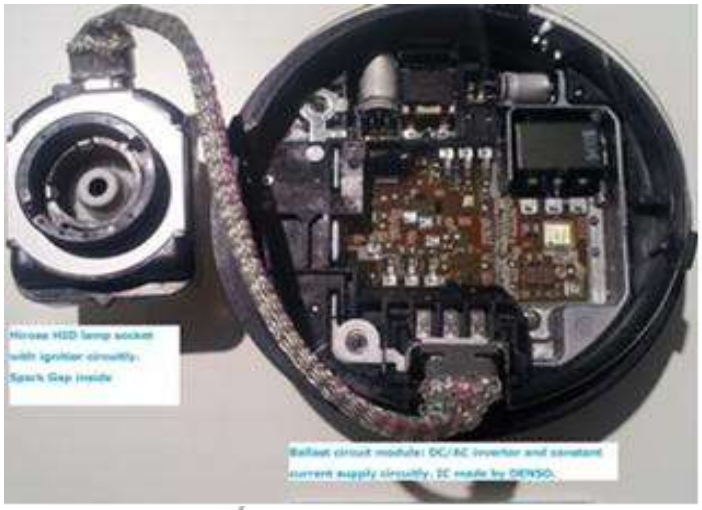
Epcos FS06X-1NG, R608XSA

Bourns ST-0800-BLT-STD
ST-0600-BLT-STD

PS: HID安定器启动时，高压点灯电路放电使高压包副边会有短暂的超高压23KV，击穿氙气灯，产生负阻特性，为后续全桥供应低压大电流短暂预热后进入弧光辉光，进入稳定状态，灯电压电流进入额定值稳定发光。

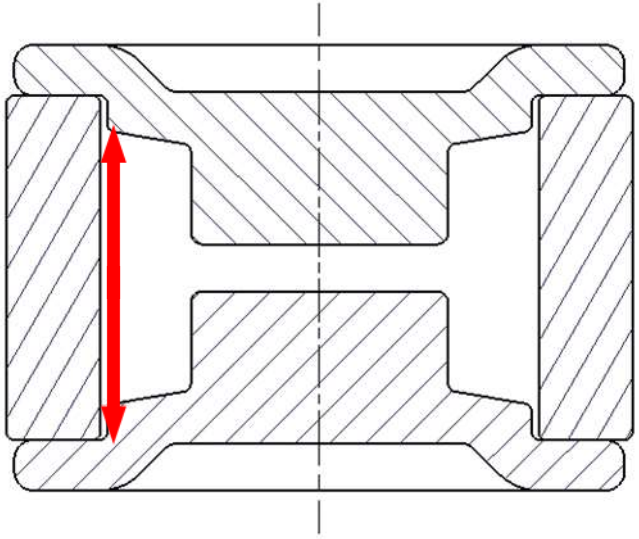
D4/D5 Bulb of HID Lamp (GT15EHK-2S)



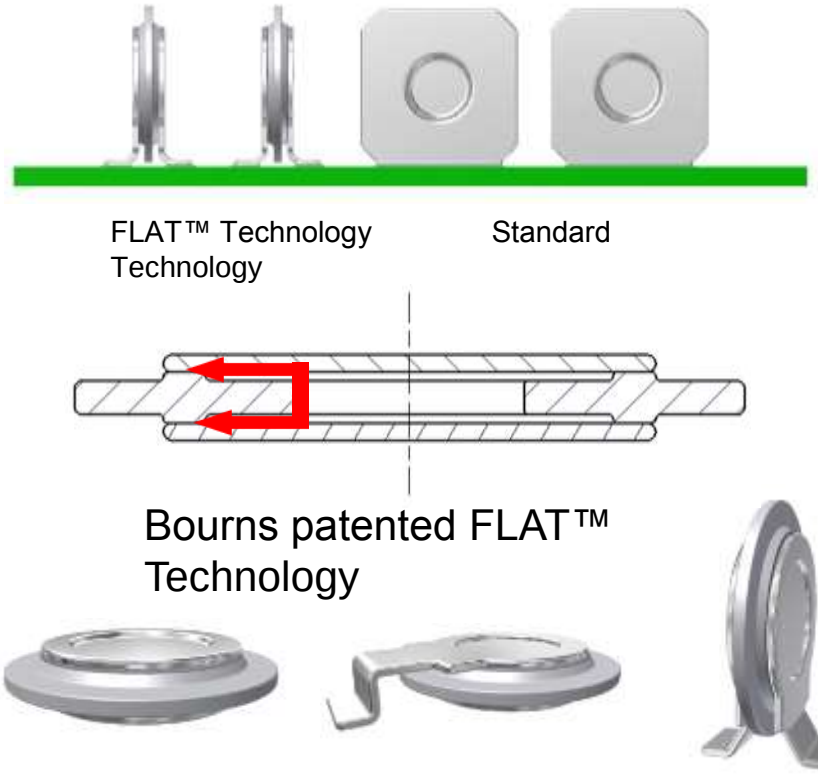


Two preferences are necessarily:
1. The Switching Operations is 200K times at least.
2. GDT's Switching Voltage can keep 575V~625V when switch 100K times.
3. Operating Temperature (-40~160° C)

FLAT™ sets a new standard in GDT Technology



Standard GDT Technology

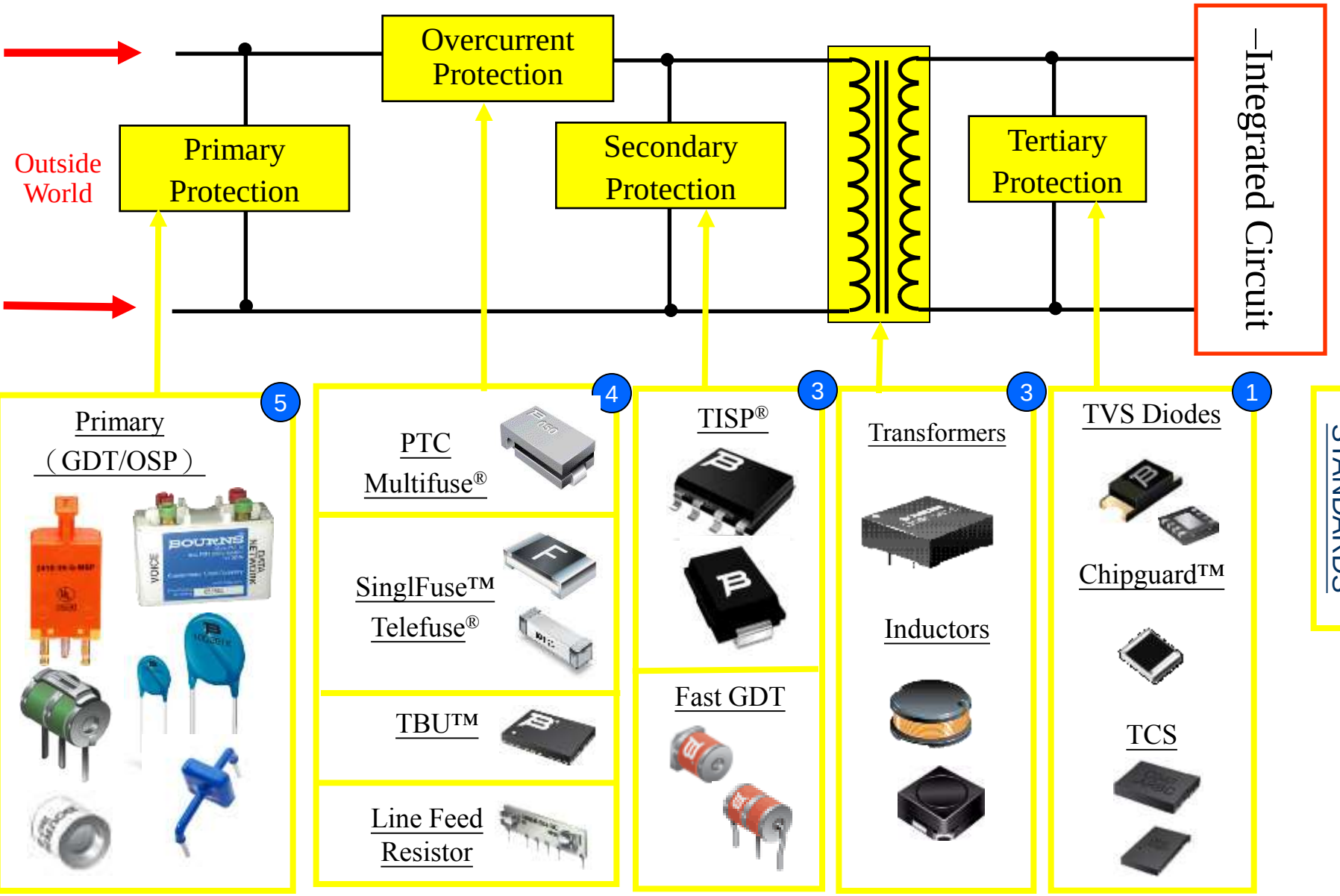


Bourns patented FLAT™ Technology

Bourns patented FLAT™ GDT designs maintains a ”wrinkled”, length of the insulating pathway for any creeping current. This key feature provides the opportunity to ”squeeze” the component in the axial direction thus shrinking its height and overall volume.

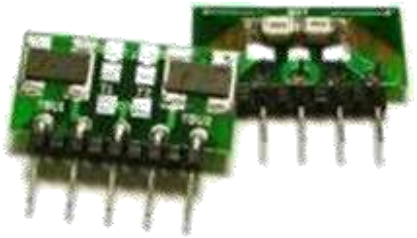
Questions you might have…

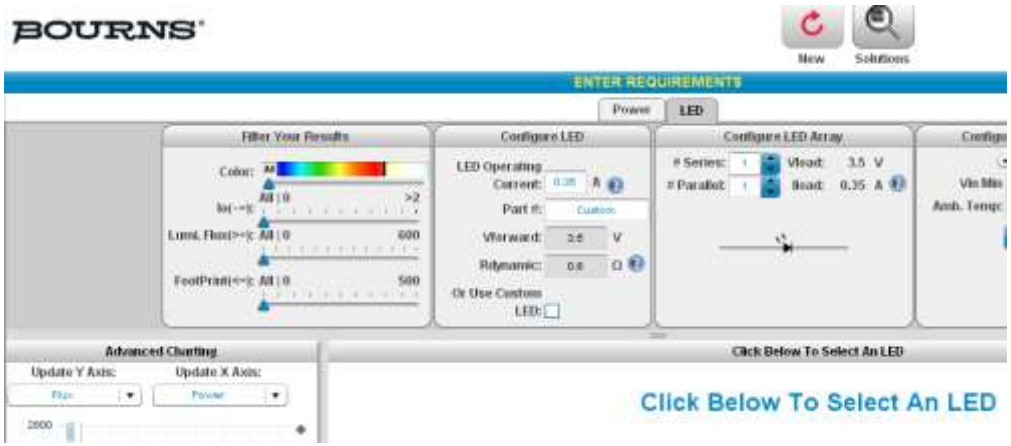
	MF	FR	MAG	ESD
Can you support PPAP level 1 to 4?	Yes	Yes	Yes	Yes
Are the factories TS16949 certified?	Yes	Yes	Yes	Yes
Can you handle intensive customer audits?	Yes	Yes	Yes	Yes
Are your products AEC approved?	Yes	Yes	Yes	Yes
If a quality issue arises, can you support & allow customers into the site immediately?	Yes	Yes	Yes	Yes
Are you able to provide visibility of component cost structure?	Yes	Yes	Yes	Yes
Can you support products for up to 10 years?	Yes	Yes	Yes	Yes

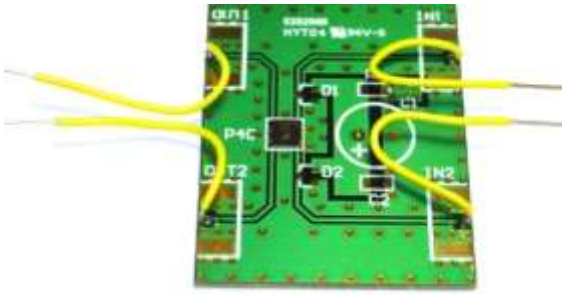

Outside World
Primary Protection
Overcurrent Protection
Secondary Protection
Tertiary Protection
Integrated Circuit
5
Primary
（GDT/OSP）
4
PTC
Multifuse®
SinglFuse™
Telefuse®
TBU™
Line Feed
Resistor
3
TISP®
Fast GDT
3
Transformers
Inductors
1
TVS Diodes
Chipguard™
TCS
STANDARDS

Engineering Tools

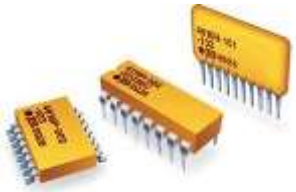
- Application notes
- Evaluation boards
- Data sheets
- Lab kits
- FAE support
- Online LED design tool







Further Automotive Applications Made by BOURNS®

Resistor and RC Networks 	Switches 	Chip Resistors & Chip Arrays 	Power Resistor 	Inductors & Transformers 
Multifuse® Resettable Fuses 	GDT Gas Discharge Tubes 	ChipGuard® ESD Protection Solutions 	Power Semiconductor 	Commercial Panel Controls & Encoders