Automotive Selection Guide

TVS & ESD / Diode Rectifier / Zener / MOSFET / BJT / FRED / SiC

AEC-Q101 Qualified

Marketing
May 2022 V.1

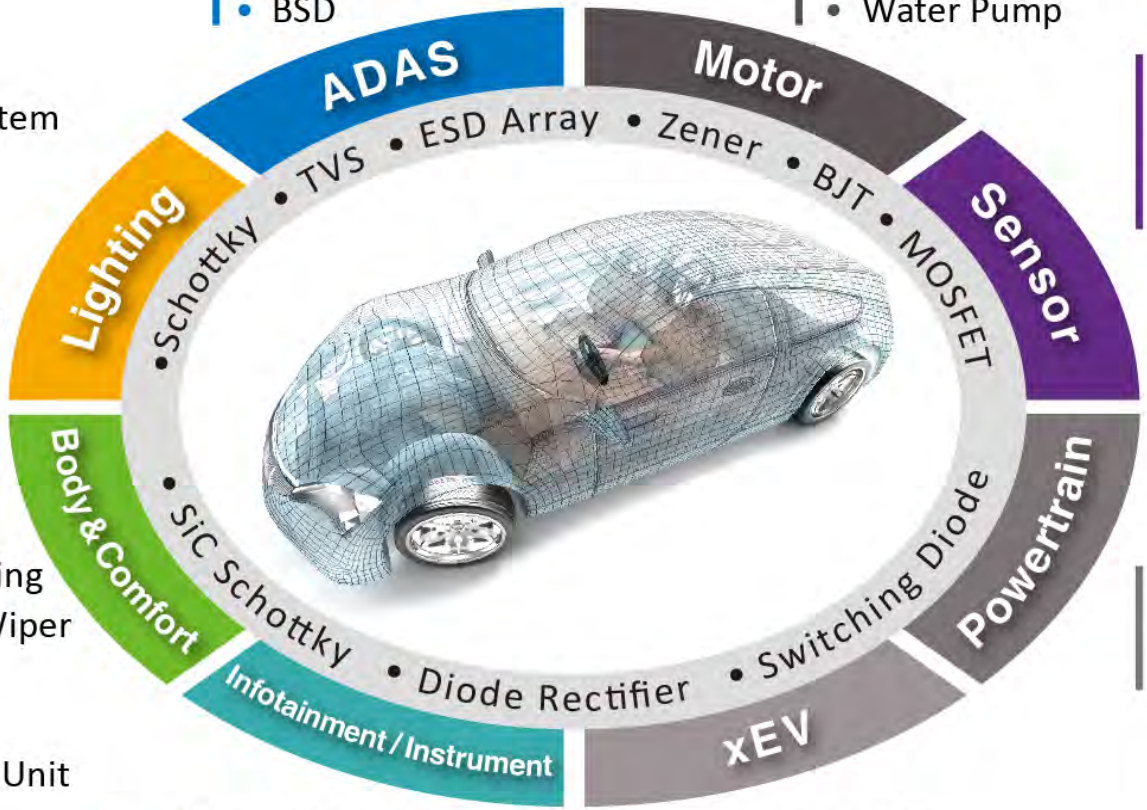
CONTENT

公司简介

强茂集团在分离器件领域拥有最完整IDM资源，业务涵盖晶圆设计、制造、封装测试到销售自有品牌产品。集团持续不断地投入创新与研发，结合生产自动化能力与制造技术优化，透过全球市场布局与营销战略，致力于绿能应用市场发展，电动车、风力发电、太阳能及储能系统等产业。落实环境友善管理、关怀员工与贡献社会，提升企业永续发展，实践全球2050年净零排放的环境永续目标。**我们的愿景：在半导体元件领域，站上世界第一，并成为环境，顾客与员工值得信赖的伙伴**

✓成立于: 1986　✓ TWSE: 2000 上市　✓全球员工数: 3,300　✓2021年营收：$4.57 亿美金

汽车应用分类



- APA
- LDWS/FCW
- BSD

- Cooling Fan
- Oil Pump
- Water Pump

- Matrix LED Headlight System
- AHB
- AFS
- DRL
- Interior Lamp
- Rear Lamp

- Ultrasonic Sensor
- Front/Rear/Side Camera
- Millimeter Wave Radar
- Lidar

- Air Conditioning
- Windshield Wiper
- Seats
- Seat Belt
- Body Control Unit
- Sunroof
- Rearview Mirror
- USB Charger

- Start-stop System
- Engine Control Unit
- EPS

- Analog/Digital Audio Player
- Navigation Device
- E-Mirror
- Event Data Recorder(EDR)
- Dashboard
- In-Vehicle Networks

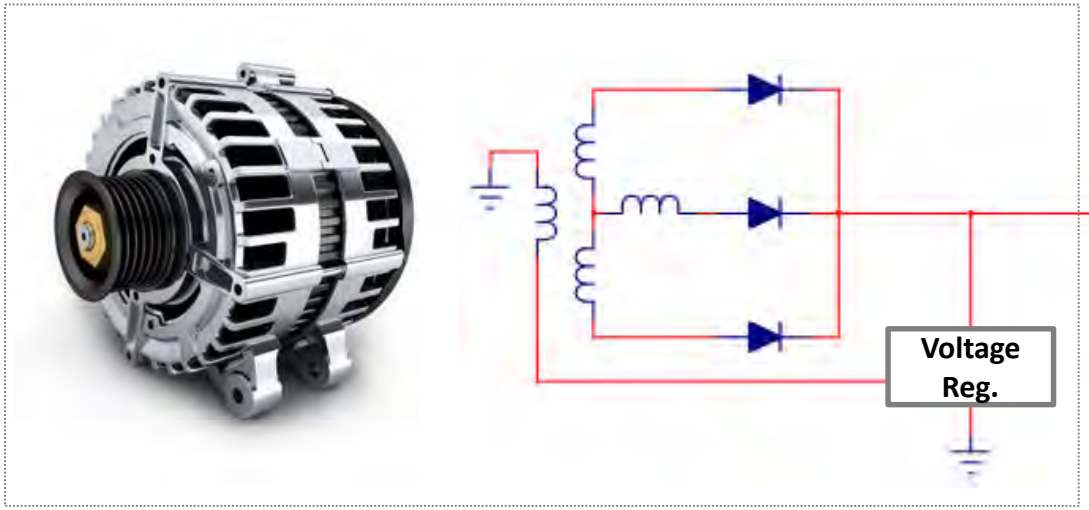
- BMS
- DC/DC Converter
- OBC
- Electric Vehicle Charging Station

汽车电控单元浪涌防护介绍

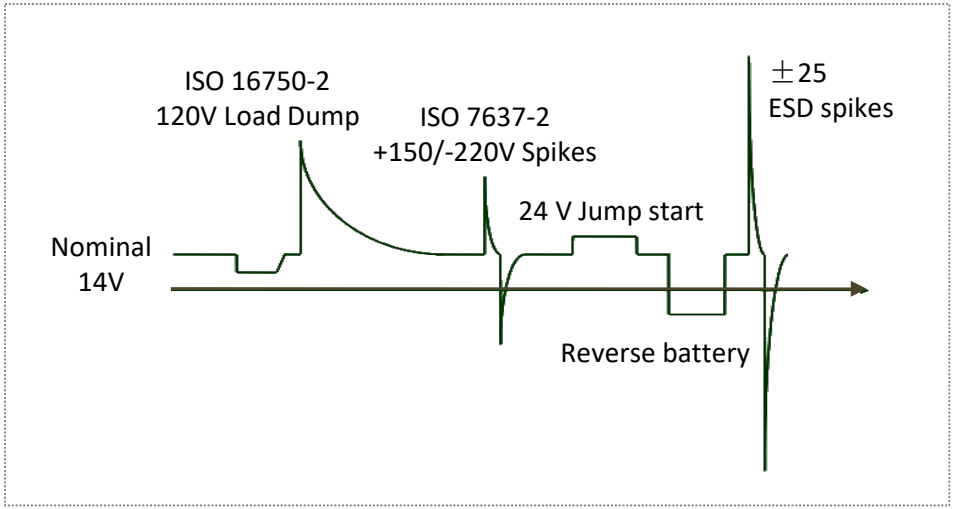
ISO 7637-2 / ISO 16750-2 / ISO 10605

- 相关测试标准
- 电力线传导与耦合浪涌防护措施
- 数据线辐射与耦合线浪涌防护措施
- 防逆二极管 IFSM 选型评估建议
- 强茂相关产品发展规划

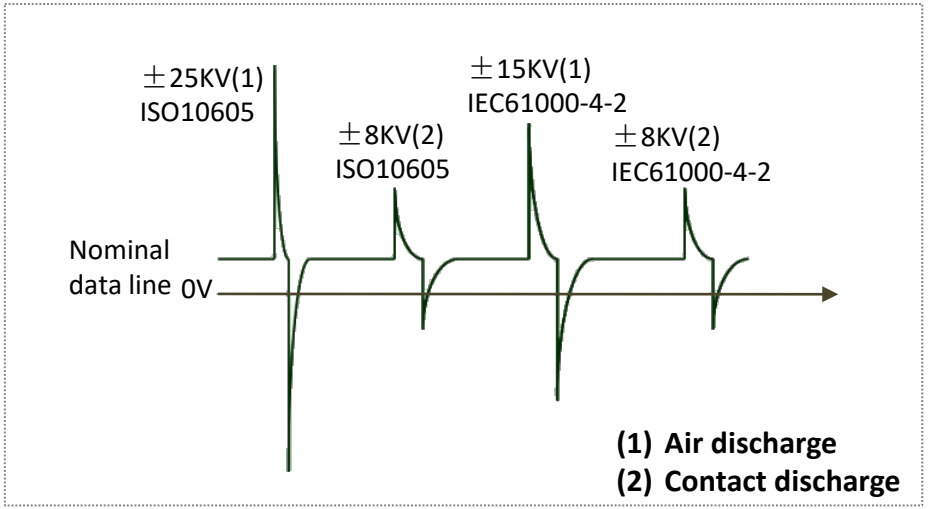
Where do Automotive Transients Surge Come From ?
汽车瞬态浪涌来自何处



Power Line Transient Surge Wave



Data Line Transient Surge Wave



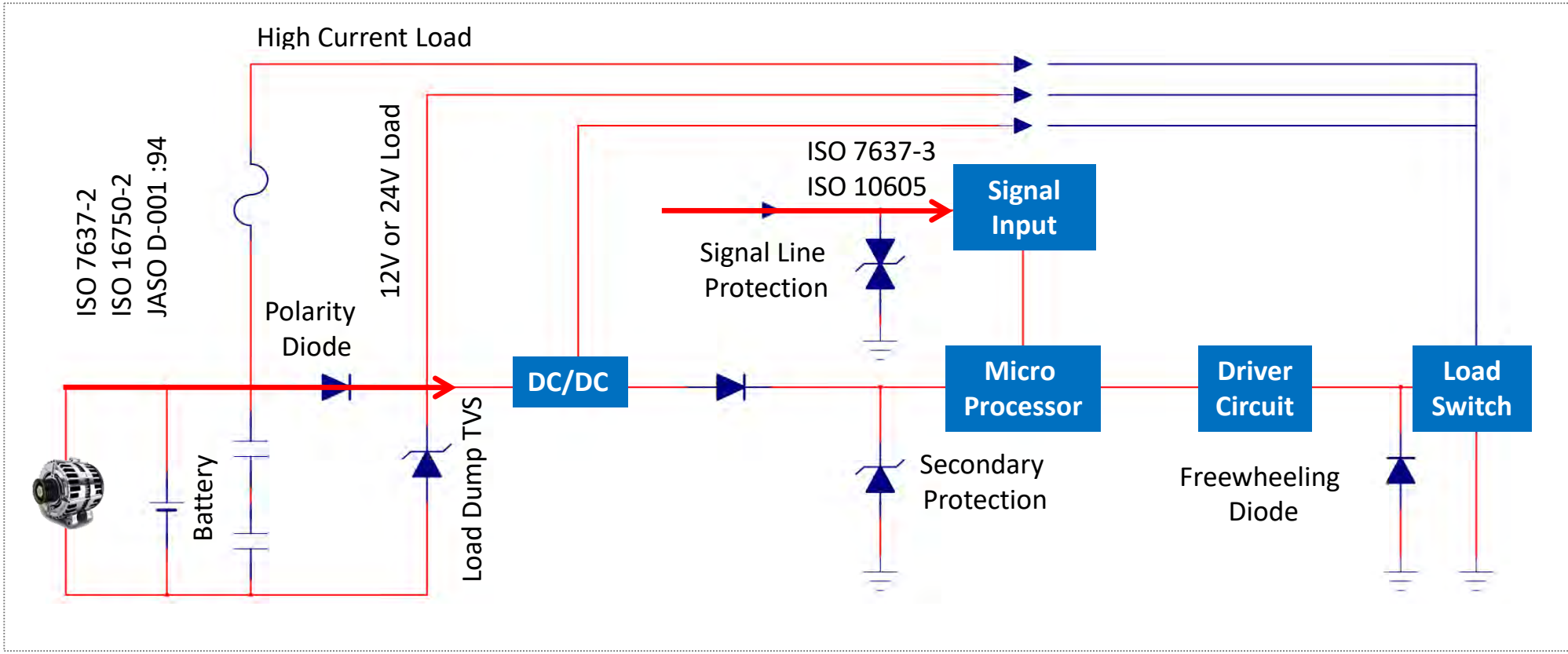
Standard of Testing Criteria 相关测试标准

Related standards overview

Category	Standard types	Standard Number	Standard Titles
Electrical Loads	ISO	ISO 16750-2	Road vehicles -- Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads
	ISO	ISO 21848	Road vehicles -- Electrical and electronic equipment for a supply voltage of 42 V — Electrical loads
Electrical disturbances from conduction and coupling	ISO	ISO 7637-2	Road vehicles -- Electrical disturbances from conduction and coupling — Part 2 : Electrical transient conduction along supply lines only
	ISO	ISO 7637-3	Road vehicles -- Electrical disturbances from conduction and coupling — Part 3 : Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines
ESD	ISO	ISO 10605	Road vehicles -- Test methods for electrical disturbances from electrostatic discharge

Power Line Conduction and Coupling Surge Protection
电力线传导与耦合浪涌防护措施
TVS and diode solutions

- 电力线瞬态凸波冲击，源自电源端因负载条件突变产生的低电压高能量瞬态脉冲。标准：ISO7637-2，ISO16750-2，JASO D-001：94
- 数据线端的瞬态凸波干扰源，与汽车组件运行过程中产生的低能量高电压瞬态脉冲，主要为ESD。相关标准有ISO7637-3，ISO10605，IEC61000-4-2



Automotive Environment Test Levels

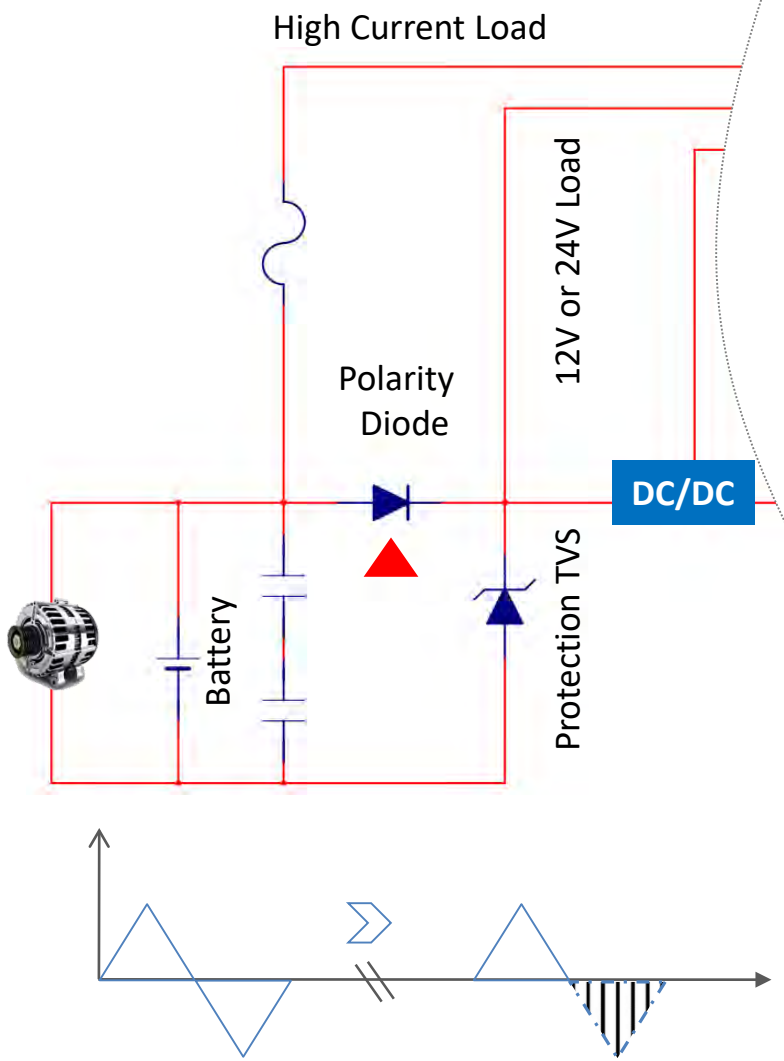
Power line specified in ISO 7637-2 2011(E) and ISO 16750-2

Test Pulse	12V System		24V System		Min. number of pulses or test time
	Test pulse severity level U_S(V)		Test pulse severity level U_S(V)		
	IV	III	IV	III	
1	-150	-112	-600	-450	500 pulses
2a	+112	+55	+112	+55	500 pulses
2b	+10	+10	+20	+20	10 pulses
3a	-220	-165	-300	-220	1h
3b	+150	+112	+300	+220	1h
4	6.5	5	--	10	1 pulse
5a	87V/Ri=0.5Ω/t_d=400mS	65V/Ri=4Ω/t_d=40mS	173V/Ri=1Ω/t_d=350mS	123V/Ri=8ΩS/t_d=100mS	10 pulses
5b	40V/Ri=0.5Ω/t_d=400mS	30V/Ri=4Ω/t_d=40mS	50V/Ri=1Ω/t_d=350mS	50V/Ri=8ΩS/t_d=100mS	10 pulses

- The test Pulse 4, 5a, and 5b have been removed from ISO 7637-2-2011, since they are specified in ISO 16750-2 2010 and ISO 21848.

Power Line Transient Surge Protection

Reverse battery protection



Functional Definition功能定义

- To Prevent polarity of circuit reversed and circuit reverse surge.防止线路极性接反与线路反向凸波

Testing Standard相关测试标准

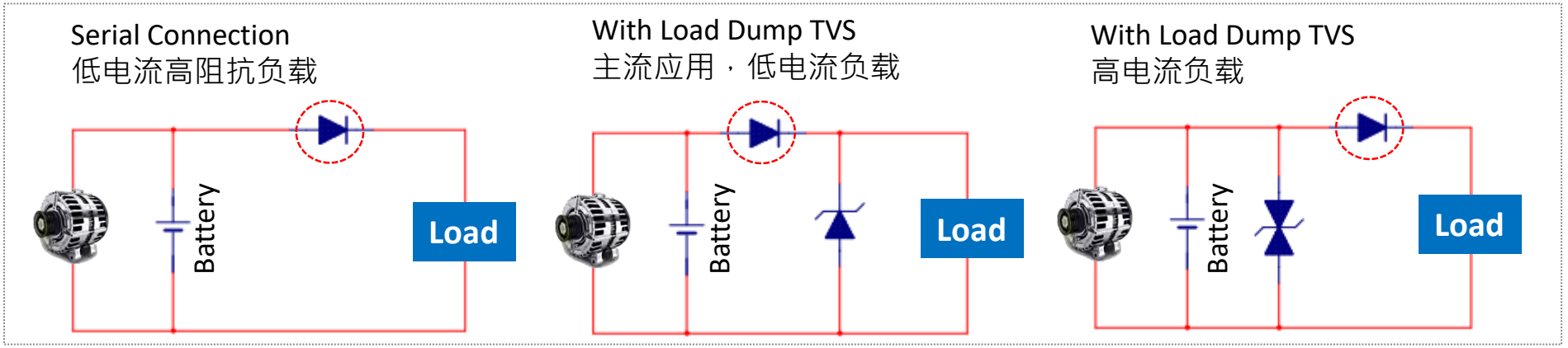
- ISO 7637-2 : 2011(E) pulse 1 and pulse 3a
  - 100V(pulse 1) and -150V (3a) for 12V Power train
  - 600V(pulse 1) and -200V (3a) for 24V Power train
- ISO 16750-2 : 4.7 Reversed Voltage
- JSAO D001:94
  - type B-1(-80V), B-2(-260V) for 12V Power train
  - type E(-320V) for 24V Power train

Key Parameters防逆二极管关键参数

- Reverse breakdown voltage (VBR)
- Average forward current (IFAV/package/TR)
- Maximum forward current (IFSM)

Reverse Battery Protection with General Rectifier

Polarity diode connection type

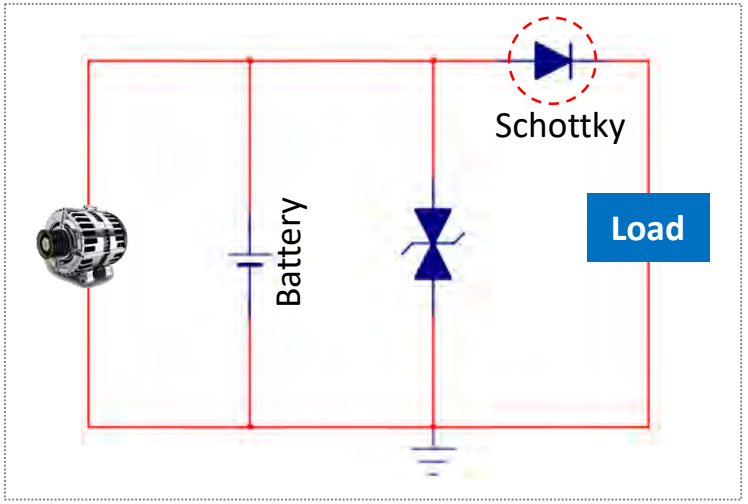


Recommended General Purpose Rectifiers

Package	Current				
	1A	2A	3A	5A	8A
SOD-123FL/HE	GS1010FL-AU				
SMA	GS1M-AU				
SMB		S2M-AU			
SMC			S3M-AU	S5M-AU	S8M-AU

Reverse Battery Protection with Schottky Rectifier

- 负载电流较高的应用中，为降低电源端线损，可评估采用具低顺向压降（VF）的超级肖特基二极管取代传统整流管。
- 根据不同应用系统和标准，建议采用60V-100V的肖特基二极管。
- 右图接线方式确保ISO7637-2中脉冲1和脉冲3a负向脉冲冲击不会超过肖特基的崩溃电压而发生击穿。

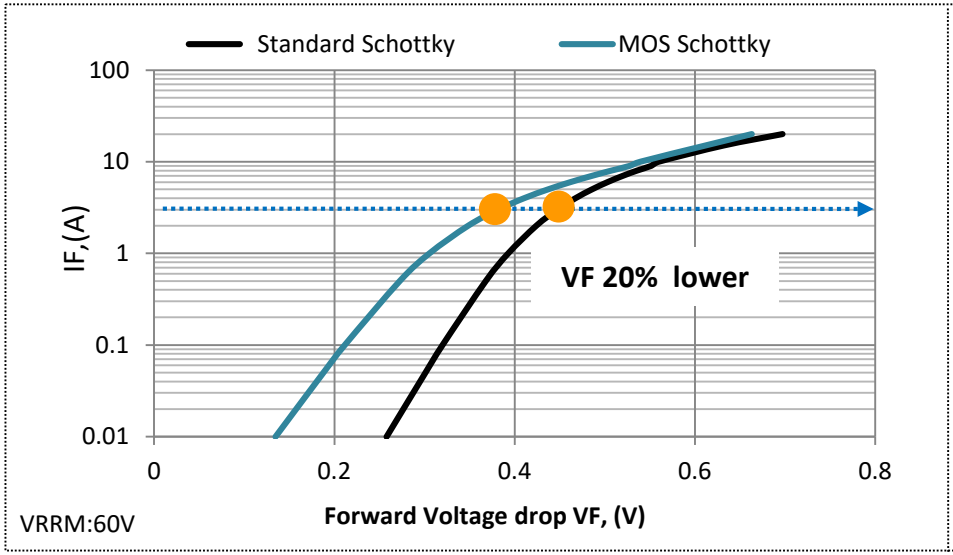


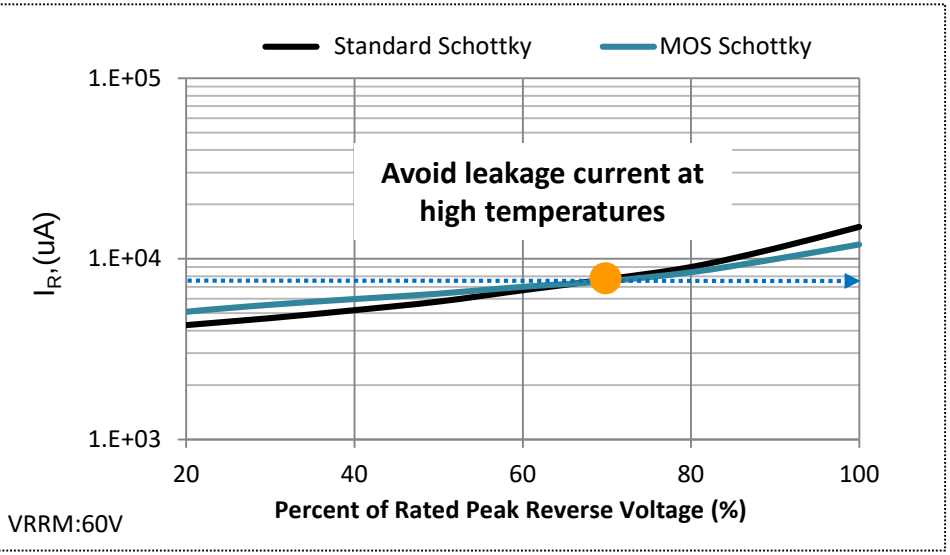
Recommended Power Schottky

Wafer type	Package	Current			
		2A	3A	5A	8A
Planar	SMA	BR210-AU			
	SMB		BR310-AU		
	SMC		MB310-AU	MB510-AU	*MB810

**AEC-Q101 In development*

Planar MOS Schottky Advantage



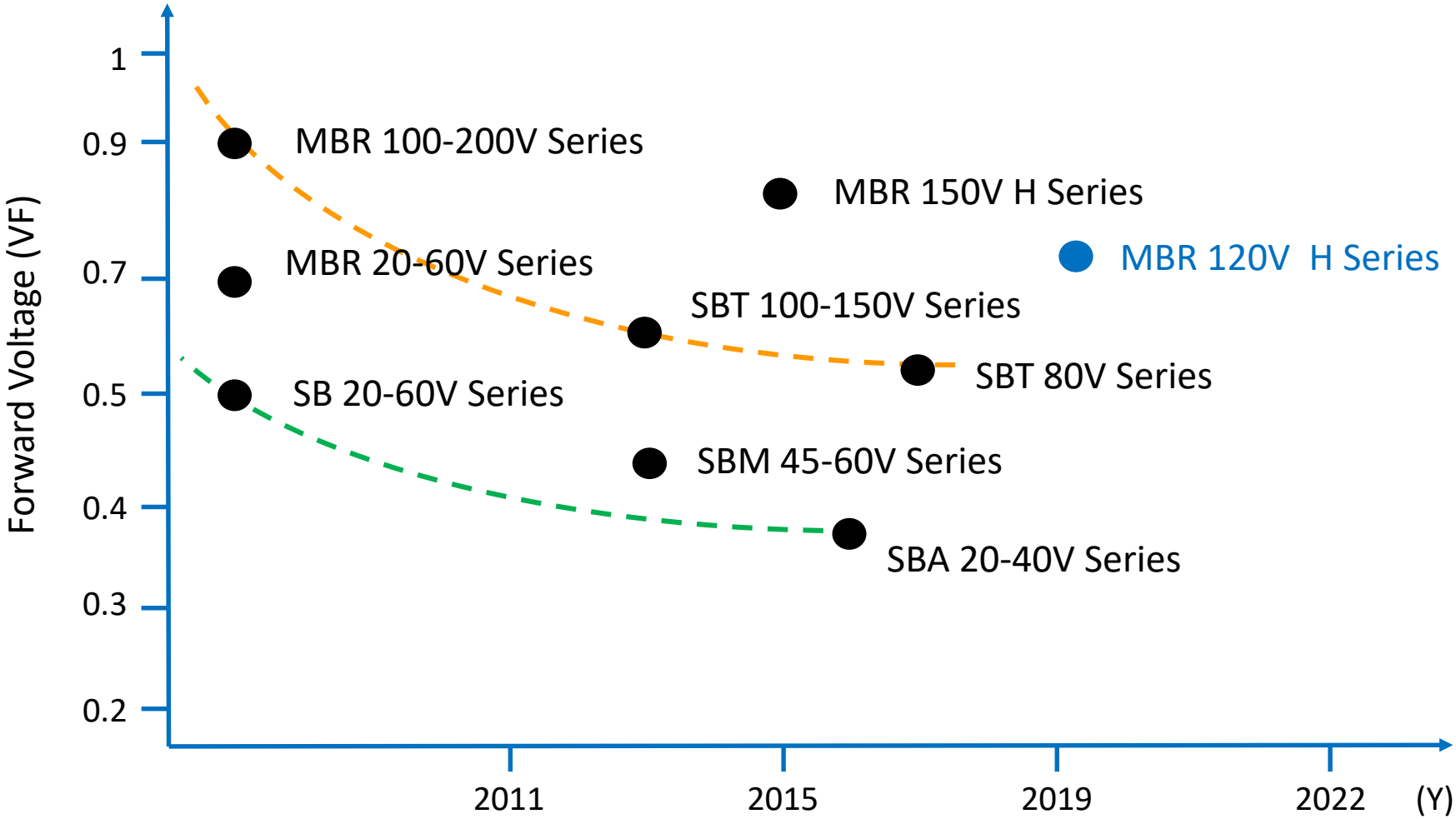


IF_{AV}	DFN2L	SOD-323	SOD-323HE	SOD-123	SOD-123FL	SOD-123HE	SMAF-C	SMBF
0.5A	●							
1A		●	●	●				
2A			●	●	●	●		
3A					●	●	●	
5A							●	●
8A								●
10A								
15A								
Series	SBAxxQ-AU	SBAxxCS-AU	SBAxxCH-AU	SBAxxAS-AU	SBAxxAL-AU	SBAxxAH-AU	SBAxxAFC-AU	SRMxxF-AU

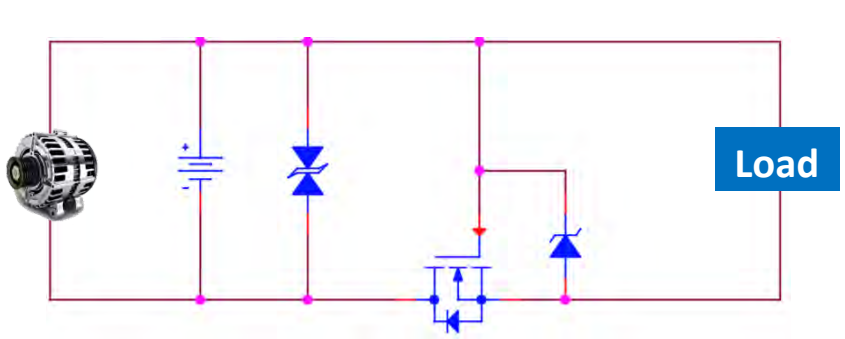
20V to 40V

40V to 60V

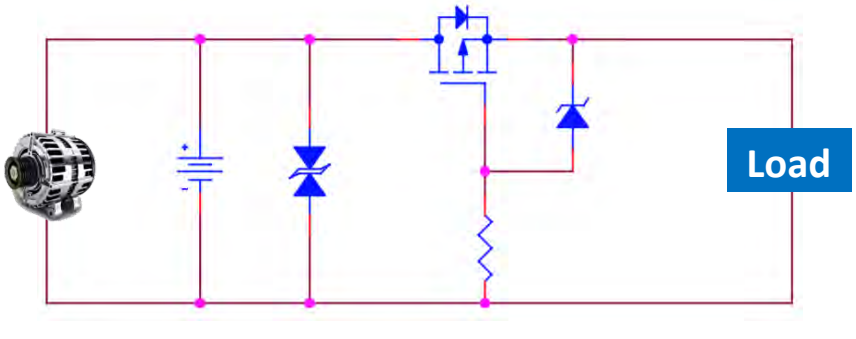
Schottky Rectifier Technology Evolution



Reverse Battery Protection with MOSFET



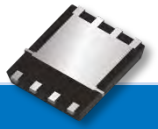
N MOSFET



P MOSFET

- 在较大负载电流应用中，为改善传统二极管防逆的固有缺陷，可以采用低R_{DSON}的MOSFET 代替传统二极管作为防逆接保护。 P_D=ID*R_{DSON} 远低于二极管的IF*VF
- N-MOS has lower R_{DSON} when compared to P-MOS at same chip size, however N-MOS control circuit is much simple.
- 建议采用60V-100V MOSFET 作为防逆MOSFET。前置 Load Dump TVS (双向)，确保瞬态正负浪涌不超过 MOSFET 的V_{DS} 。

Recommend MV MOSFET



V_{DS}	V_{GS}	Ch.	R_{DS}(ON) 10V	R_{DS}(ON) 4.5V	TO-252AA	DFN3333-8L	DFN5060-8L
V	V	N/P	(mΩ) max.				
-60	20	P	48	65	PJD16P06A-AU	PJQ4463AP-AU	PJQ5463A-AU
-60	20	P	68	85	PJD15P06A-AU		PJQ5465A-AU
60	20	N	12	15	PJD45N06A-AU		PJQ5462A-AU
60	20	N	17	20	PJD40N06A-AU	PJQ4464AP-AU	PJQ5466A1-AU
100	20	N	25	28.5	PJD50N10AL-AU		PJQ5476AL-AU

Power Line Transient Surge Protection

Definition 功能定义

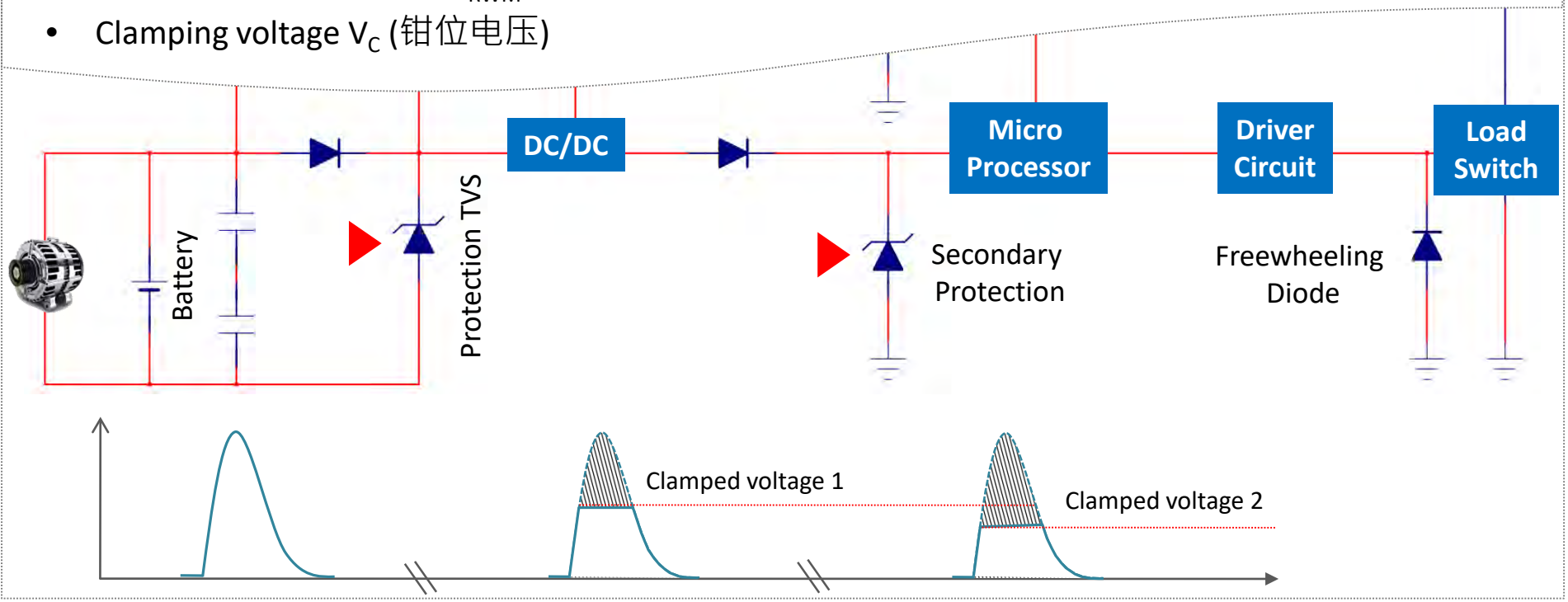
- To control the transient surge on power line/cable of the vehicle to protect the module.

Test standard 相关测试标准

- ISO 7637-2, IS016750-2, ISO 21848, JSO D001 : 94

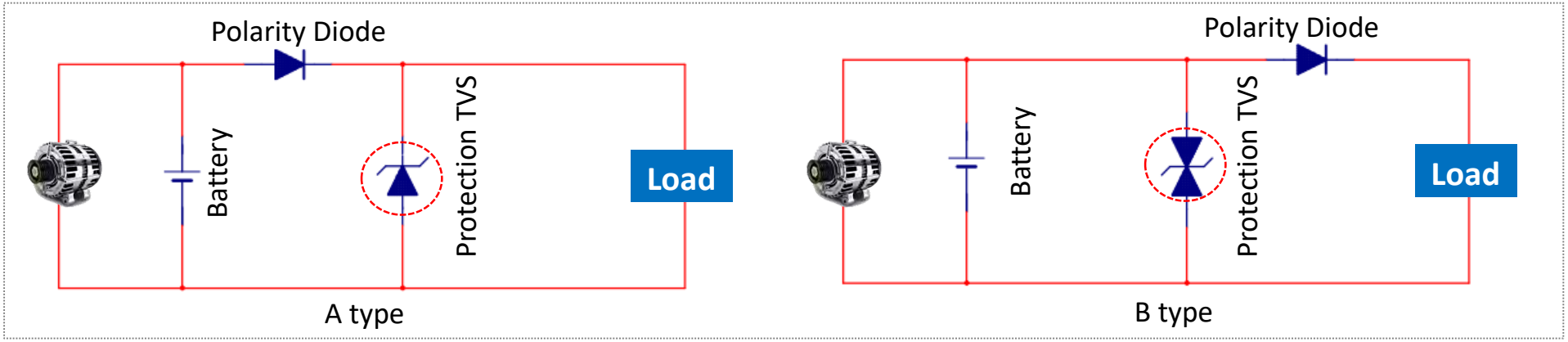
Key parameter 关键参数

- Max P_{PP} and Max I_{PP} 最大钳制功率 P_{PP}与最大钳制电流I_{PP}
- Safety threshold voltage V_{RWM} (安全阀值电压)
- Clamping voltage V_C (钳位电压)



Power Line Transient Surge Protection

Two types of TVS Protection



- **TVS选择与连接类型**
  （A type & B type）

根据设计与防护需要选择单向TVS 和双向TVS

- B type 则建议采用双向TVS保护,因大电流负载正常负载电流较高。
- 一般选用崩溃电压60V-100V 且VF值较低的二极管或者MOSFET 做防逆保护

- **TVS钳位电压V_C**

- 最大钳位电压，必须低于受保护电子模块的最大耐受电压，以确保受保护器件在高浪涌冲击与Load Dump 测试条件下不会损坏。
- ***建议选型时至少预留10% 的安全余量***

- **TVS安全阀值电压V_{RWM}**

- 必须确保V_{RWM} ≥系统最大正常工作电压以避免TVS在正常情况下误动作
- *结合应用与测试条件，选择合适的V_C & I_{PP}*

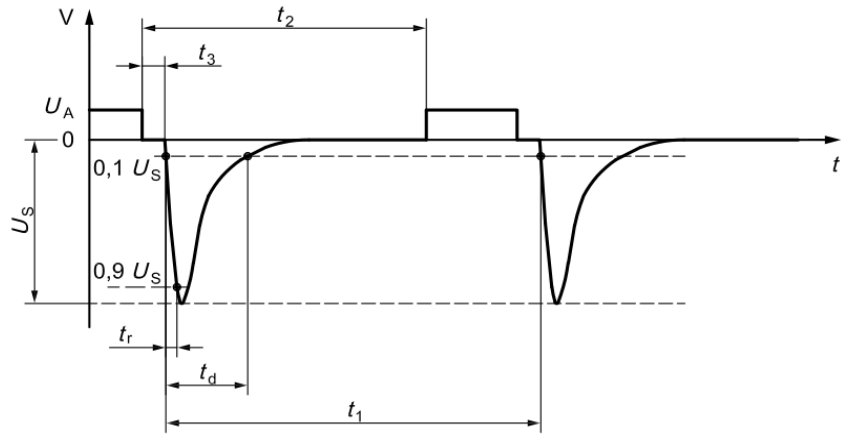
System U_N	12V	24V
Recommend TVS V_{RWM}	22V/24V/27V	30V/33V/36V

Automotive Power TVS

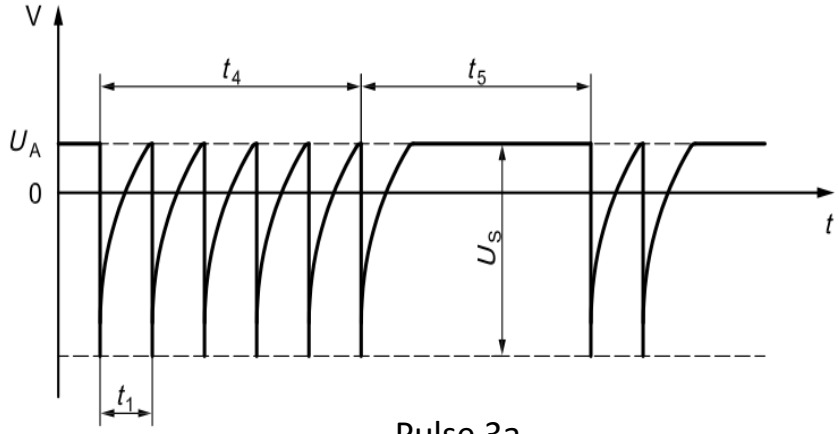
For ISO 7637-2 pulse 1 to pulse 3b Transients Protection

TVS series	Package	UNI / BI	P_D (W)	12V System Level IV (V)					24V System Level IV (V)				
				1	2a	2b	3a	3b	1	2a	2b	3a	3b
				-150	+112	+10	-220	+150	-600	+112	+20	-300	+300
P4FLxxA-AU	SOD-123FL	UNI	400	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
P4SMAJxxA-AU	SMA	UNI & BI	400	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
P6AFCxxA-AU	SMAF-C	UNI	600	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
P6SMBJxxA-AU	SMB	UNI & BI	600	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
P6KExxA-AU	DO-15	UNI & BI	600	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass
1.5SMCJxxA-AU	SMC	UNI & BI	1500	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass

- Pulse 1 与Pulse 3a 为负脉冲浪涌，如线路未加装防逆二极管单向TVS 在浪涌期间，会处于顺向导通状态。持续的大电流会导致TVS 热击穿。**如无防逆二极管，则建议采用600W 以上TVS 或者双向TVS**。



Pulse 1

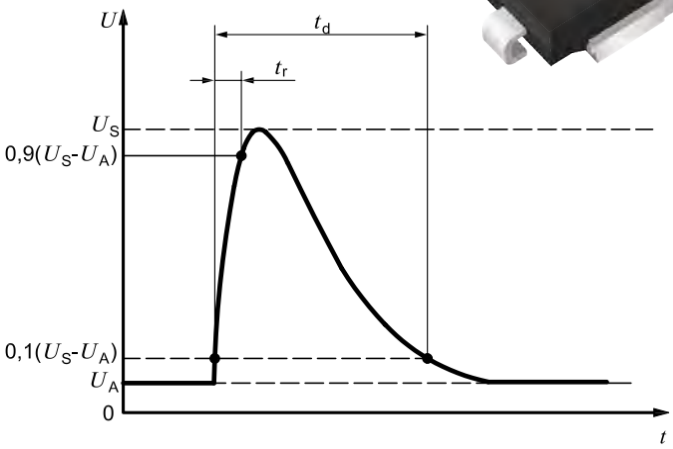


Pulse 3a

Automotive Power TVS

For ISO 7637-2 & ISO 16750-2 pulse 5a Load Dump Protection

Parameter	Type of System		ISO 16750-2	ISO 7637-2
	U_N =12V	U_N=24V	Pulses	Pulses
U_S (V)	79 ≤ U_S ≤ 101	151 ≤ U_S ≤ 202	10 Pulses at intervals of 1min	1Pulse
Ri (Ω)	0.5 ≤ Ri ≤ 4	1 ≤ Ri ≤ 8		
t_d (mS)	40 ≤ U_S ≤ 400	100 ≤ U_S ≤ 350		
t_r (mS)	10 (+0/-5)	10 (+0/-5)		



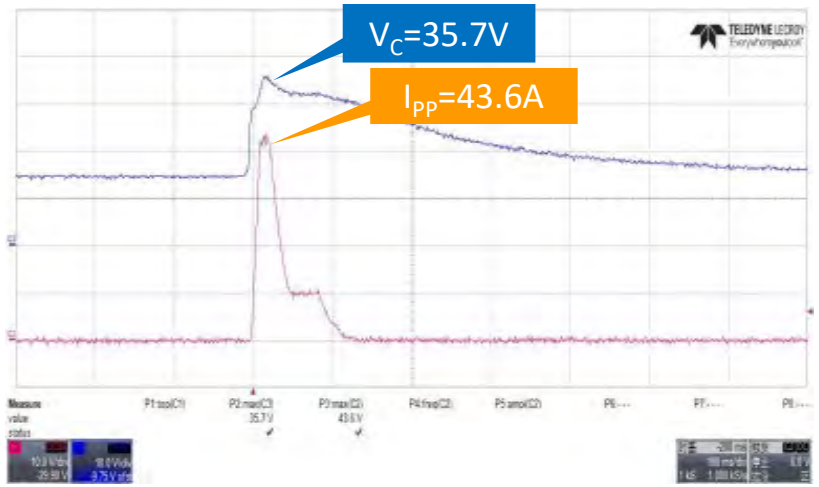
ISO 16750-2 2010 Test pulse a

- ISO 16750-2 pulse a replaces ISO 7637-2 (2004) pulse 5a
- ISO16750-2 Pulse A 相较于ISO7637-2 (2004) 5a 更为严苛。测试脉冲次数由原来的单次冲击，提升为10分钟内测试10次。此条件要求Load Dump 保护器件和防逆接保护器件，具备更高的电流冲击耐受能力。
- 连续大电流冲击，且要求 Load Dump 保护器件和防逆接保护器件具备更高的结温耐受能力。
- I_{PP} decided by V_C and test Ri : $I_{clamping}$ = (US-$V_{clamping}$)/Ri
- For pulse 5a : 推荐选用PANJIT's DO-218 high power package: SM8SxxA-AU, SM6SxxA-AU, SM5SxxA-AU series products.

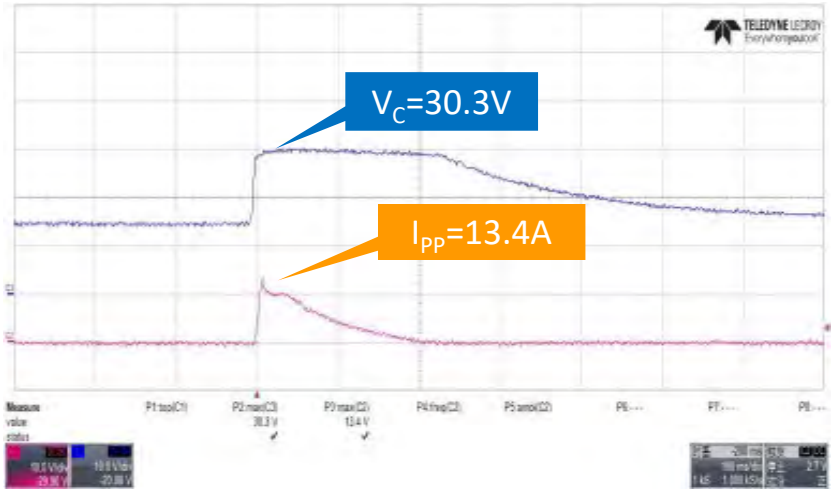
SMxSxxA-AU Load Dump TVS

In ISO 16750-2 5a Load Dump Surge Test

12V System SM5S24A-AU

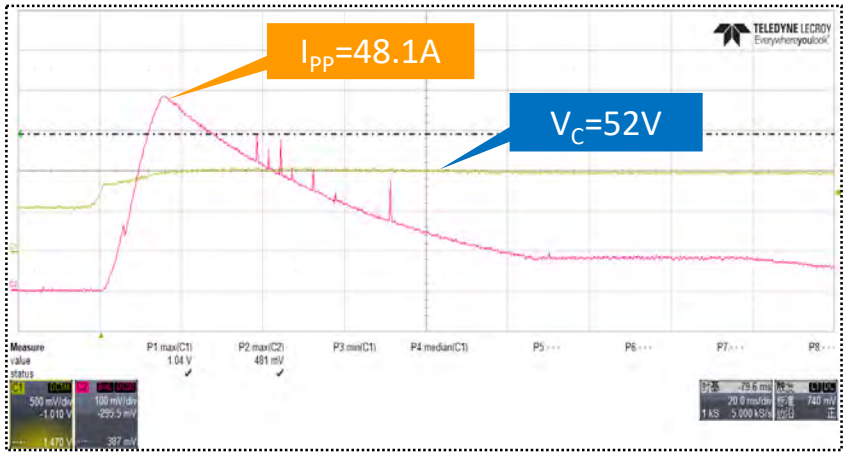


Test Condition U_N=12V Ri=0.5Ω U_S=101V t_d=400mS

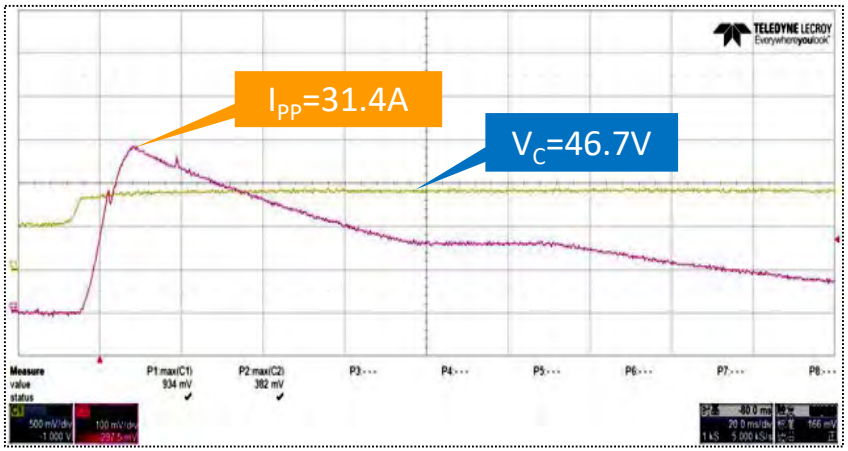


Test Condition U_N=12V Ri=5Ω U_S=101V t_d=400mS

24V System SM8S36A-AU



Test Condition U_N=24V Ri=3Ω U_S=202V t_d=400mS



Test Condition U_N=24V Ri=8Ω U_S=202V t_d=400mS

SMxSxxA-AU Load Dump TVS Series

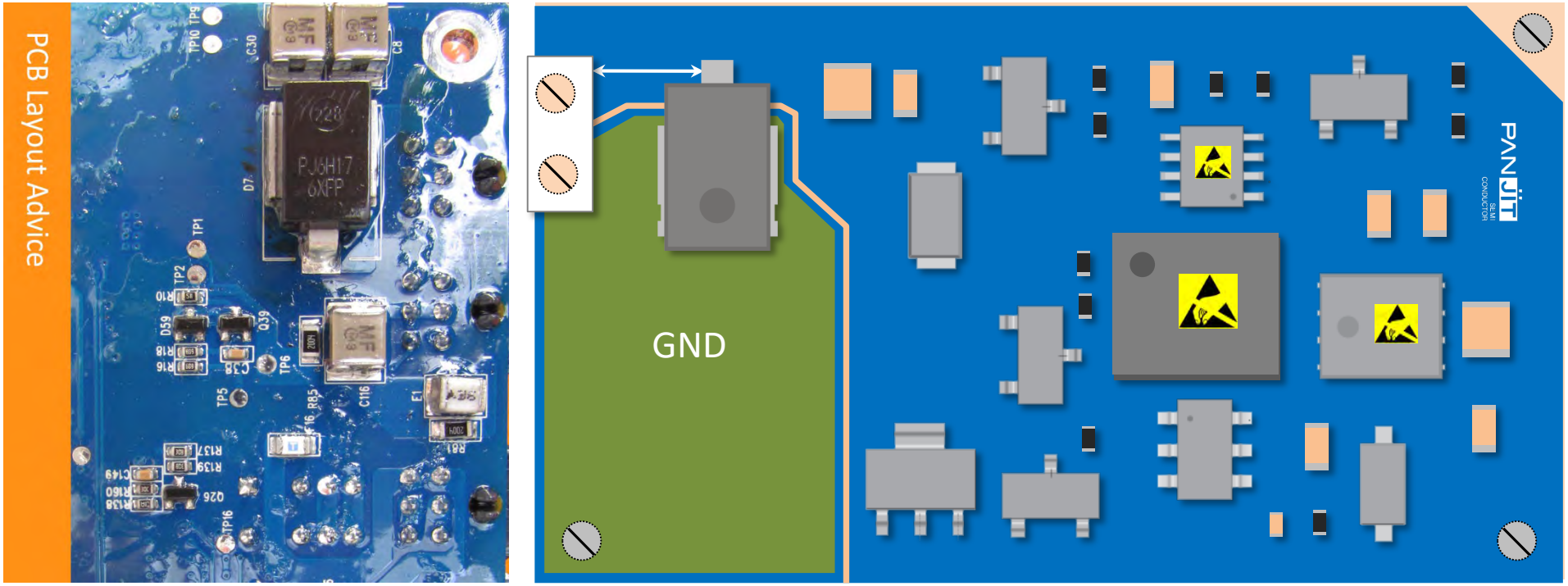
PANJIT offers 3 series Load Dump TVS: SM5SxxxA-AU/SM6SxxxA-AU/SM8SxxxA-AU.

- 最大吸收功率分别为3600W, 4600W, 6600W respectively and the V_{RWM} range is from 14V to 48V. These 3 series TVS are mainly for the Load Dump protection of 12V and 24V automotive.

Part Number	P_D(W)	V_{RWM} (v)	V_{BR}@I_T		I_T(mA)	I_R@V_{RWM}	V_C@I_{PP}	I_{PP}	Application V_N (V)
			Min.	Max.					
SM5S20A-AU	3600	20	22.2	24.5	5	0.5	32.4	111	12
SM5S22A-AU	3600	22	24.4	26.9	5	0.5	35.5	101	12
SM5S24A-AU	3600	24	26.7	29.5	5	0.5	38.9	93	12
SM5S30A-AU	3600	30	33.3	36.8	5	0.5	48.4	74	24
SM5S33A-AU	3600	33	36.7	40.6	5	0.5	53.3	68	24
SM5S36A-AU	3600	36	40	44.2	5	0.5	58.1	62	24
SM6S20A-AU	4600	20	22.2	24.5	5	0.5	32.4	142	12
SM6S22A-AU	4600	22	24.4	26.9	5	0.5	35.5	130	12
SM6S24A-AU	4600	24	26.7	29.5	5	0.5	38.9	118	12
SM6S30A-AU	4600	30	33.3	36.8	5	0.5	48.4	95	24
SM6S33A-AU	4600	33	36.7	40.6	5	0.5	53.3	86	24
SM6S36A-AU	4600	36	40	44.2	5	0.5	58.1	79	24
SM8S20A-AU	6600	20	22.2	24.5	5	0.5	32.4	204	12
SM8S22A-AU	6600	22	24.4	26.9	5	0.5	35.5	186	12
SM8S24A-AU	6600	24	26.7	29.5	5	0.5	38.9	170	12
SM8S30A-AU	6600	30	33.3	36.8	5	0.5	48.4	136	24
SM8S33A-AU	6600	33	36.7	40.6	5	0.5	53.3	124	24
SM8S36A-AU	6600	36	40	44.2	5	0.5	58.1	114	24

Load Dump TVS PCB Layout Advice

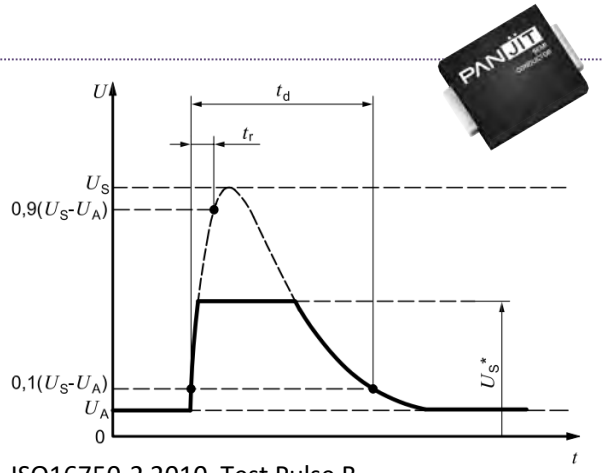
- TVS放置靠近电源输入接口位置，可降低电感效应，提升TVS 响应速度
- 敏感器件尽远离Load Dump TVS 与输入端口，可有效减少凸波浪涌干扰
- PCB PAD Layout 与DO-218AB PAD 大小匹配，确保焊接后，散热底板可和PCB PAD 贴合，减少TVS 与PCB 间的热阻
- TVS钳制热损，通过PCB消散，周边未用区域尽量利用成地，降低干扰和提升TVS的热消散能力



Power TVS

For ISO 7637-2 & ISO 16750-2 Pulse 5b Load Dump Protection

Parameter	Type of System		ISO 16750-2	ISO 7637-2
	U_N =12V	U_N=24V	Pulses	Pulses
U_S (V)	79 ≤ U_S ≤ 101	151 ≤ U_S ≤ 202	5 Pulses at intervals of 1min	1pulse
U_S*V (V)	35	65		
Ri (Ω)	0.5 ≤ Ri ≤ 4	1 ≤ Ri ≤ 8		
t_d (mS)	40 ≤ U_S ≤ 400	100 ≤ U_S ≤ 350		
t_r (mS)	10 (+0/-5)	10 (+0/-5)		

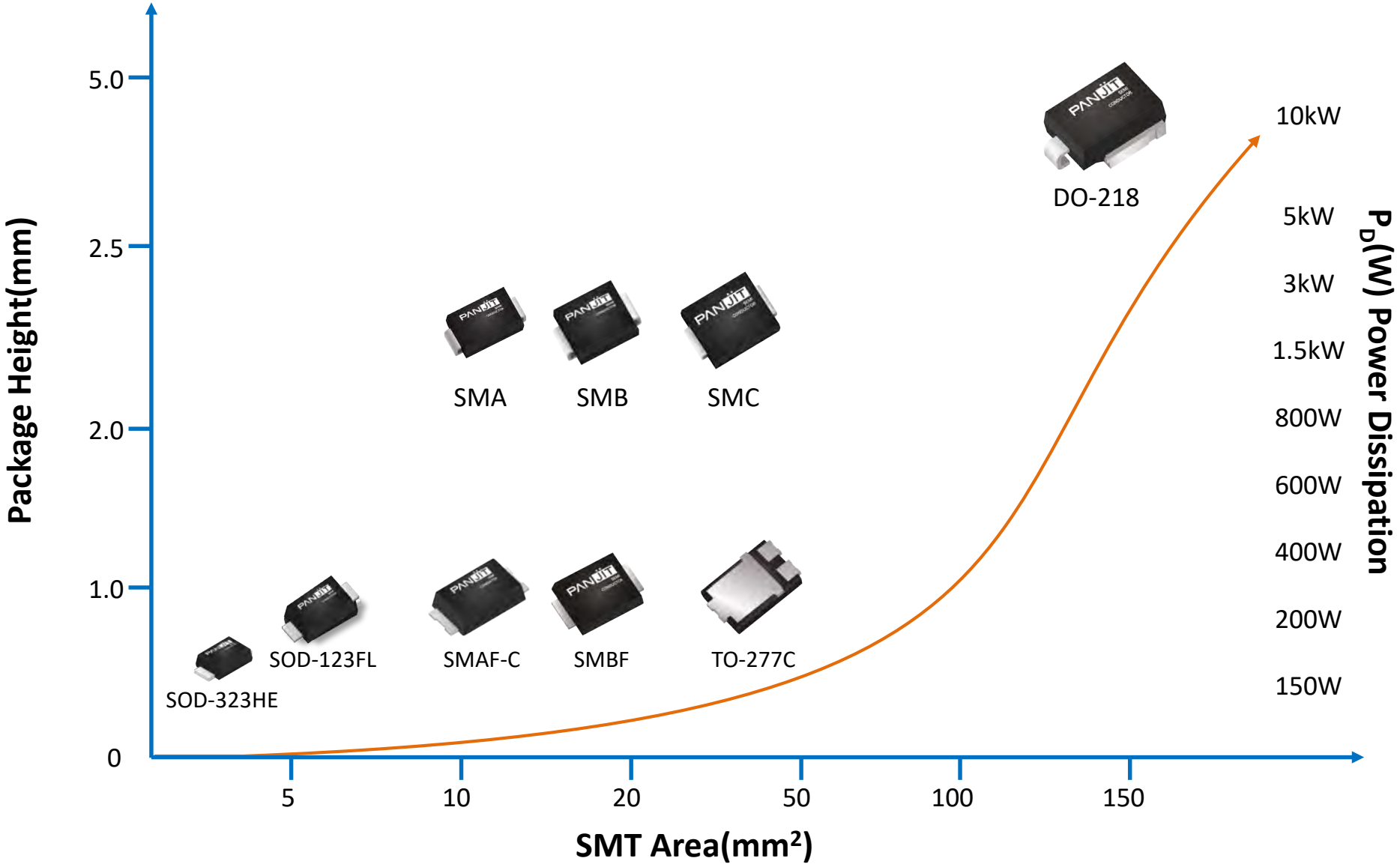


ISO16750-2 2010 Test Pulse B

- ISO16750-2 Pulse B 替换 ISO7637-2 (2004) Pulse 5b
- ISO16750-2 Pulse B 相较于ISO7637-2 (2004) 5B 更严苛。测试脉冲次数由单次冲击提升为5分钟内连续测试5次
- Pulse B 根据不同应用条件，**建议选用P6SMBJxxA-AU/1.5SMCJxxA-AU /3.0SMCJxxA-AU/SM5xxA-AU 系列**

TVS series	Package	UNI/BI	P_D(W)	12V System Level IV (V)		24V System Level IV (V)	
				III	IV	III	IV
				30V/Ri=4Ω t_d=40mS	40V/Ri=0.5Ω t_d=400mS	50V/Ri=8ΩS t_d=100mS	50V/Ri=1Ω t_d=350mS
P6SMBJxxA-AU	SMB	UNI / BI	600	PASS	FAIL	FALL	FAIL
1.5SMCJxxA-AU	SMC	UNI / BI	1500	PASS	FAIL	FAIL	FAIL
3.0SMCJxxA-AU	SMC	UNI / BI	3000	PASS	FAIL	FAIL	FAIL
SM5xxA-AU	DO-218AB	UNI	3600	PASS	PASS	PASS	PASS
Notes	12V System recommend TVS V_{RWM} : 22V/24V/26V/28V; 24V Recommend TVS V_{RWM} : 30V/33V/36V						

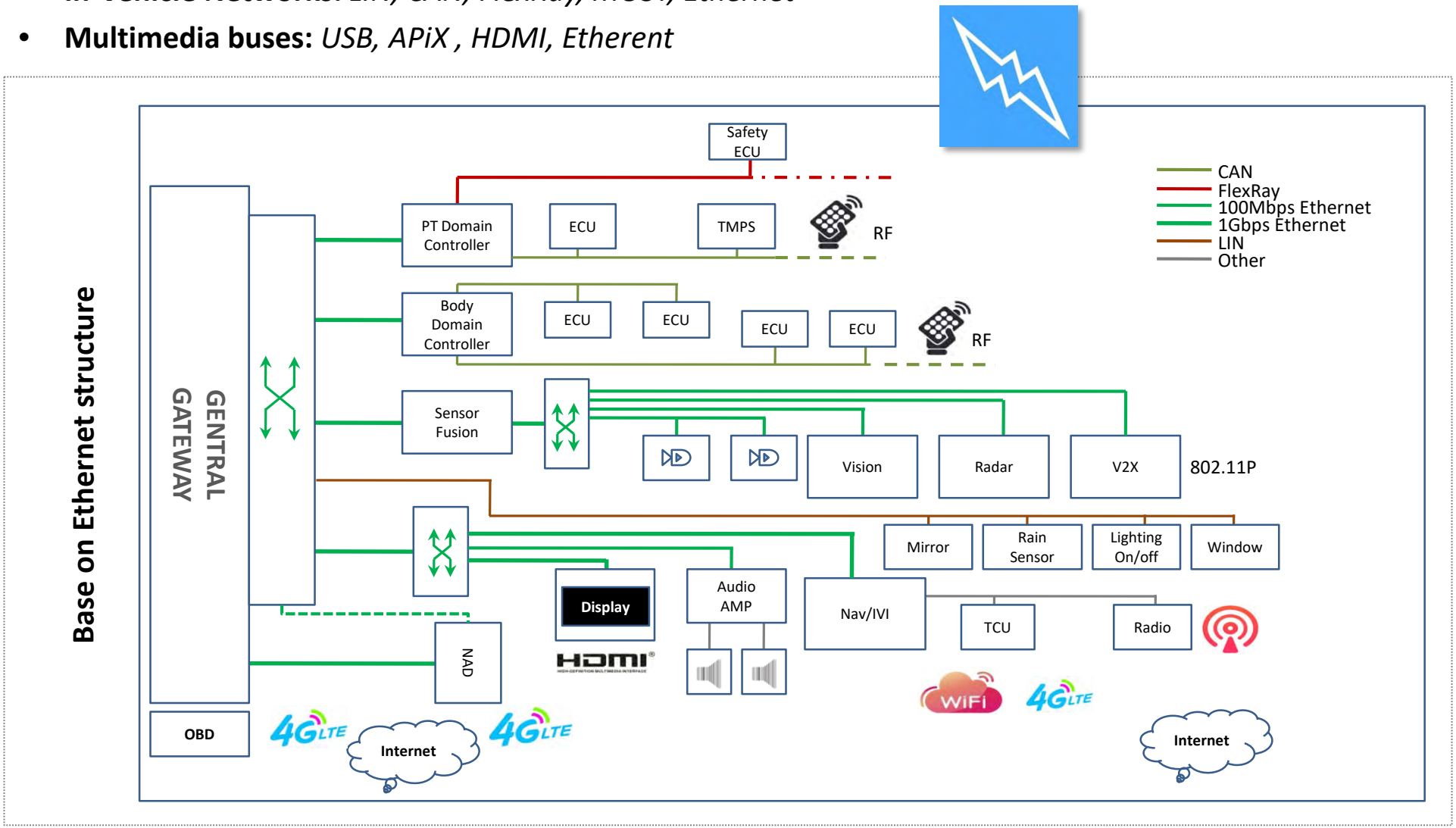
Automotive Grade Power TVS Road Map



Data Line Transients Protection

ESD and Electrical Transient Transmission Protection (ESD Array Solution)

- **In-Vehicle Networks:** *LIN, CAN, FlexRay, MOST, Ethernet*
- **Multimedia buses:** *USB, APiX , HDMI, Etherent*



Automotive Environment Test Levels

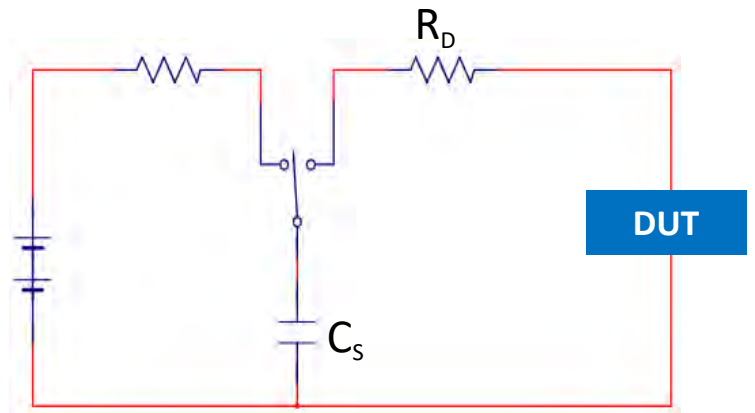
Data Line - ISO 10605 (ESD)

ISO 10605 Test models and conditions

Application	State	Discharge Position	Discharge Module		ESD Model
			C_S (pF)	R_D (Ω)	
ECU	Powered	Inside	330	330	Air & Contact
		Outside	150	330	Contact
ECU	Unpowered	Outside	150	330 or 2000	Air & Contact

ISO 10605 Test levels

State	ESD Model	Severity test levels				Min. number of pulses
		I	II	III	IV	
Powered	Air (kV)	±4	±6	±7	±8	>3
	Contact (kV)	±4	±8	±14	±15	
Unpowered	Air (kV)	±4	±6	--	±8	
	Contact (kV)	±4	±15	--	±25	



ISO10605 ESD Test Model

Automotive Environment Test Levels

Data Line - ISO 7637-3 (Electrical Transient Transmission)

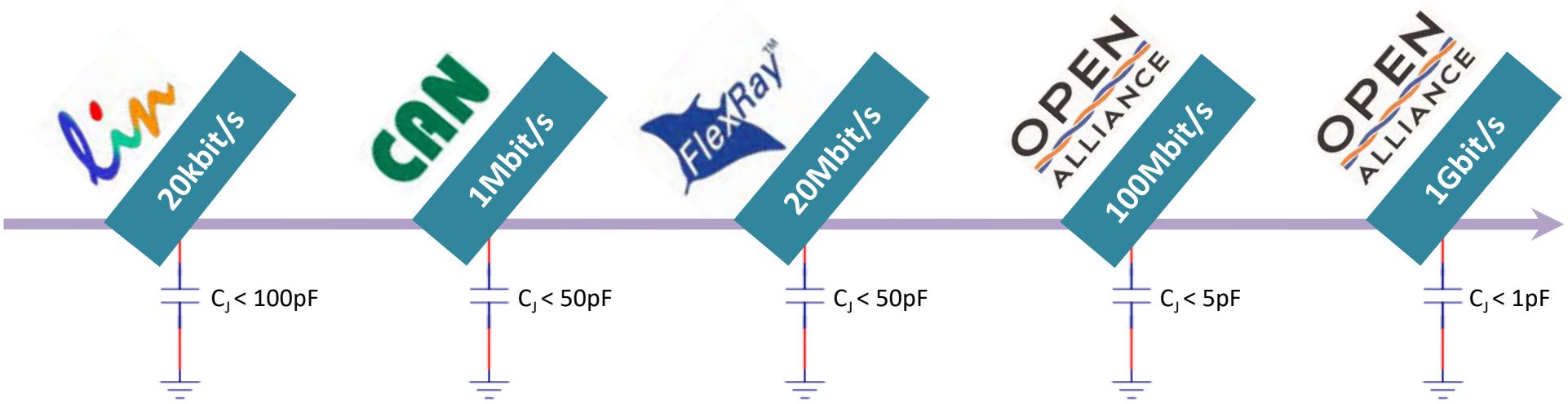
Test pulse	12V system test pulse severity levels U_S (V)				Test time (Minutes)
	I	II	III	IV	
Fast a (DCC and CCC)	-10	-20	-40	-60	10
Fast b (DCC and CCC)	+10	+20	+30	+40	10
DCC slow +	+8	+15	+23	+30	5
DCC slow -	-8	-15	-23	-30	5
ICC slow +	+3	+4	+5	+6	5
ICC slow -	-3	-4	-5	-6	5

Test pulse	24 V system test pulse severity levels U_S (V)				Test time (Minutes)
	I	II	III	IV	
Fast a (DCC and CCC)	-14	-28	-56	-80	10
Fast b (DCC and CCC)	+14	+28	+56	+80	10
DCC slow +	+15	+25	+35	+45	5
DCC slow -	-15	-25	-35	-10	5
ICC slow +	+4	+6	+8	+10	5
ICC slow -	-4	-6	-8	-10	5

Data Line Transient Surge Protection

In-Vehicle Networks

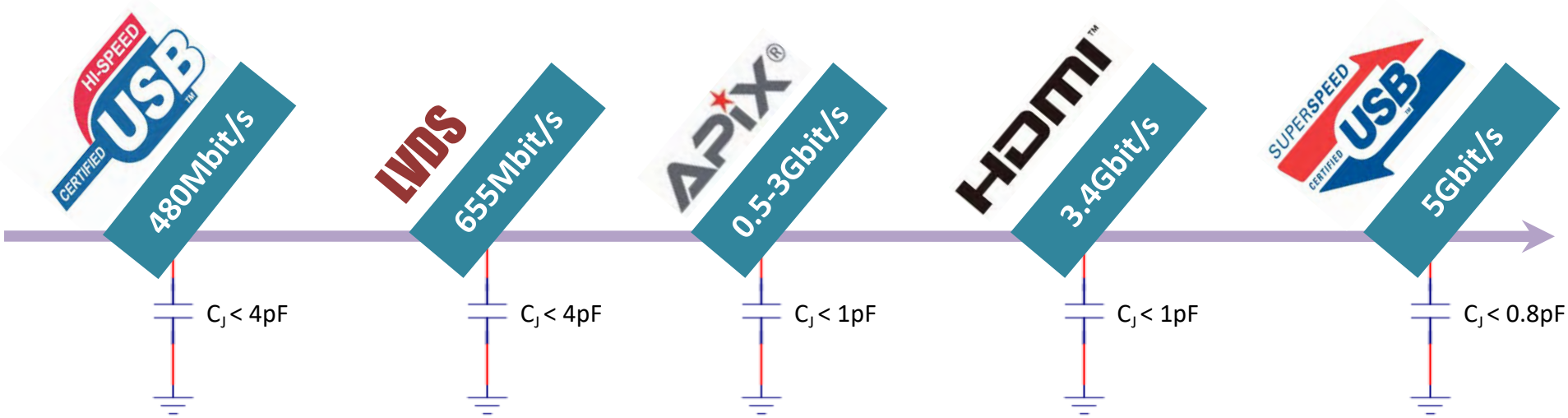
- **LIN (Local interconnect Network)**低速串行通讯总线：主要应用如驾驶员辅助、自动门锁或窗式升降器，与之通信各种智能传感器 。如：自动大灯、自动雨刮的光线传感器和雨量传感器。
- **CAN (Controller Area Network)** 高速串行通讯总线：主要应用于车身控制模块，如防抱死系统 (ABS)，发动机管理系统或电源控制。
- **FlexRay** 超高速串行通讯总线：数据速率20Mbit/S。应用于引擎控制、ABS、悬挂控制和线控转向等。
- **Ethernet 车载以太网(BroadR-Reach)**：传输速率高达100Mbit/S，满足智能汽车控制系统的高速数据传输和带宽要求。主要应用于ADAS、全景视觉探测等。*随着智能汽车，车联网等应用的高速发展，千兆以太网技术有望成为下一代汽车的主流通讯总线。*



Data Line Transient Surge Protection

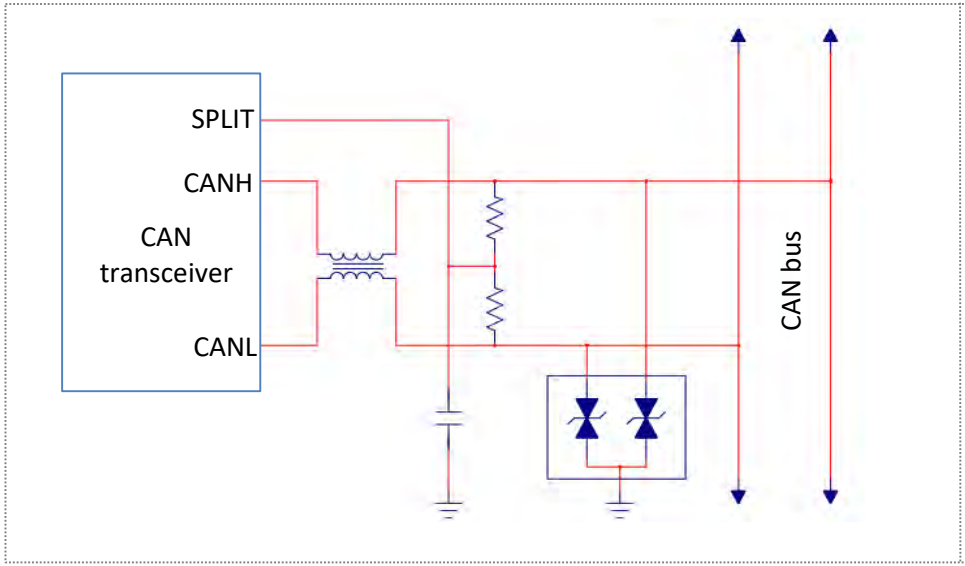
Multimedia Buses

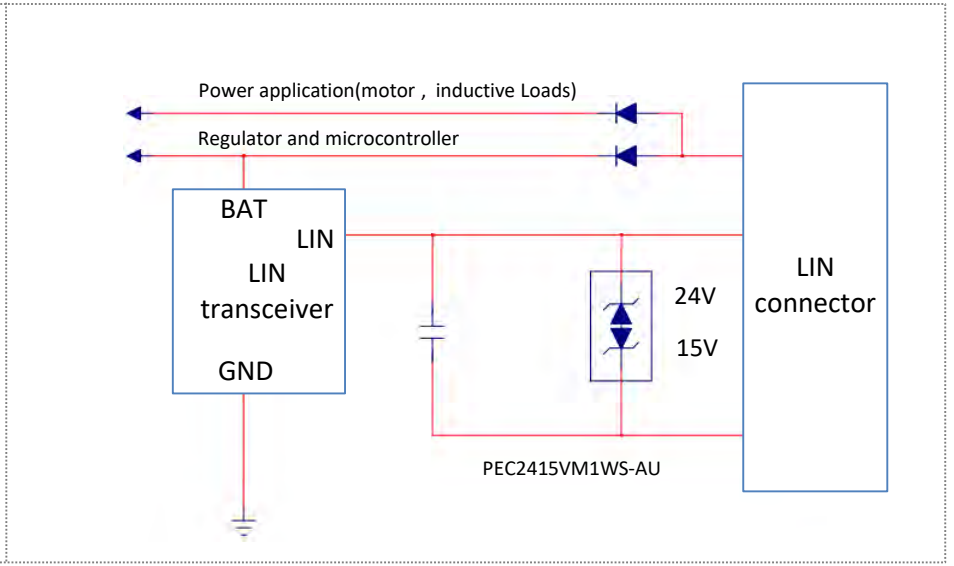
- **USB2.0**：通用的数据传输端口。具传输速度快，支持热插拔和多个设备的特点。其最大传输速度可达480Mbit/S 主要应用于车载充电端口，连接媒体播放器以及软体更新。
- **LVDS (Low-Voltage Differential Signaling)** 低压差分信号传输总线：具低功耗、低误码率、低串扰和低辐射等特点。传输速度高达 655Mbit/S。应用于视频信号传输，主板显示和液晶显示屏接口。
- **APIX (Automotive Pixel link)**：最大传输速度可达3Gbit/S。主要用于传输影像或周边信息给显示屏幕和摄影机
- **HDMI (High Definition Multimedia Interface)**：数字化视频/音频接口技术。适合影像传输的专用型数字化接口，可同时传送音 频和影像信号。HDMI2.0最高数据传输速度可达6Gbit/S。
- **USB Type-C**：消费性电子产品最新的连接标准。出现在部分汽车，其传输速度高达5Gbit/S。兼具快速充电功能，可取代USB2.0 成为主流的车载标配端口。



In-Vehicle Networks ESD Protection

CAN and LIN Bus





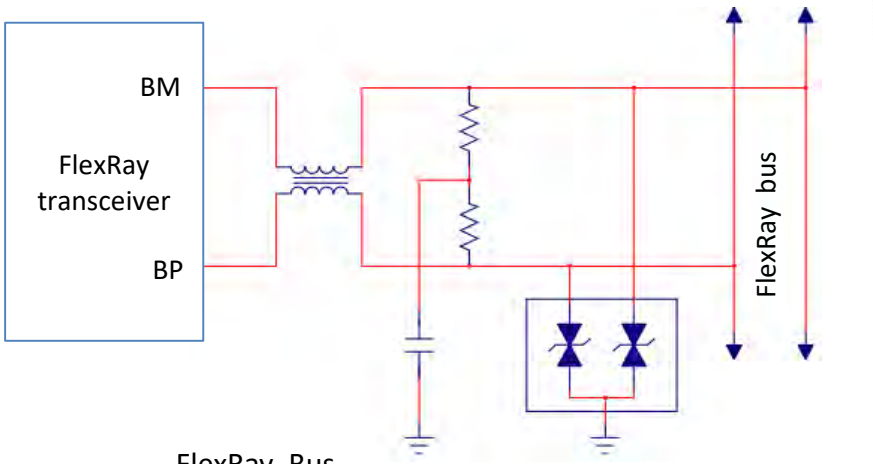
- PANJIT has develop products with series of voltage and package which could be used on CAN bus and LIN bus accordingly. All products complies with IEC-61000-4-2 and ISO 10605 standard and are AEC-Q101 qualified.

Recommend ESD Array for CAN &LIN

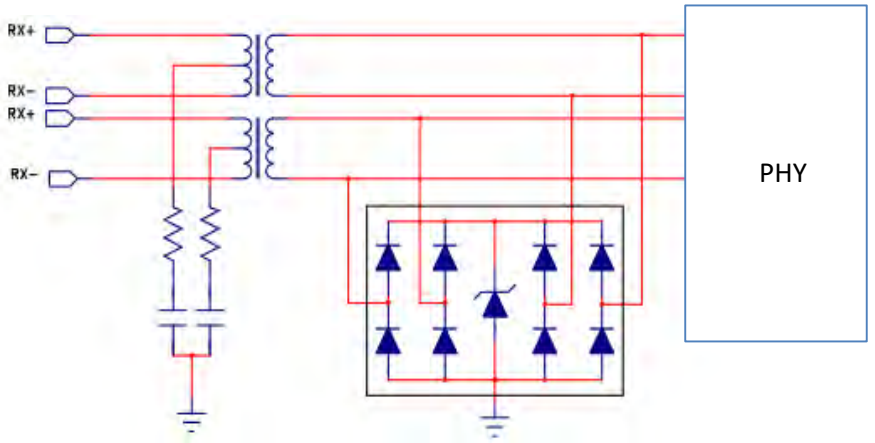
Part Number	UNI / BI	Ch.	V_{RWM} Max. (V)	V_{BR} Min. (V)	V_{BR} Max. (V)	I_R@V_{RWM} nA	V_C@I_{PP} Max.	I_{PP}	C_J Max.	Package	Application
PEC3124C2A-AU	BI	2	24	25.4	30.3	50<	60	3	15	SOT-23	CAN
PEC3324C2A-AU	BI	2	24	26.2	30.3	50<	43	7	30	SOT-23	CAN
PEC3815CS-AU	BI	1	15	16.0	22.5	500	33	4	40	SOD-323	LIN
PEC3824CS-AU	BI	1	24	25.5	35.5	50	45	3	15	SOD-323	LIN
PEC3836CS-AU	BI	1	36	37.5	52.5	50	70	1.5	12	SOD-323	LIN

In-Vehicle Networks ESD Protection

FlexRay and Ethernet Bus



FlexRay Bus



Ethernet (Broad R-Reach, 100Base-TX)

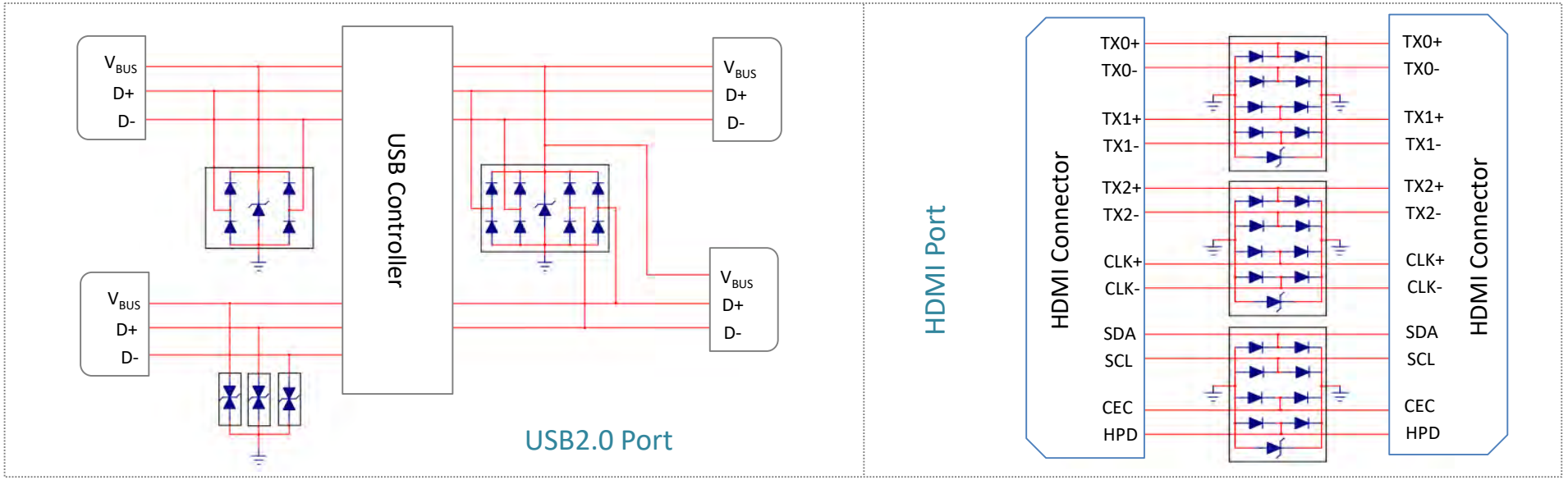
- PANJIT has ESD products with 0.6 pF which could apply on FlexRay and Ethernet application and support transfer speed which exceed 100Mbit.

Recommend ESD Array

Part Number	UNI / BI	Ch.	V_{RWM} (v)	V_{BR} Min.(V)	I_R@V_{RWM} nA	V_C@I_{PP} Max.(V)	I_{PP}	C_J Typ.(pF)	ESD IEC61000-4-2	Package	Application
PEC3824C2A-AU	BI	2	24	26.2	50<	43	7	25	±30KV	SOT-23	FlexRay
PEC3824C2C-AU	BI	2	24	25.4	50<	43	3	17	±30KV	SOT-323	FlexRay
PEC3824C2E-AU	BI	2	24	25.4	50<	43	3	17	±30KV	SOT-523	FlexRay
PE1605C4A6-AU	UNI	4	5.5	6	1000<	15	4	0.6	±20KV	SOT-23 6L	Ethernet

Multimedia and Infotainment Buses ESD Protection

LVDS, HDMI, USB2.0, APiX

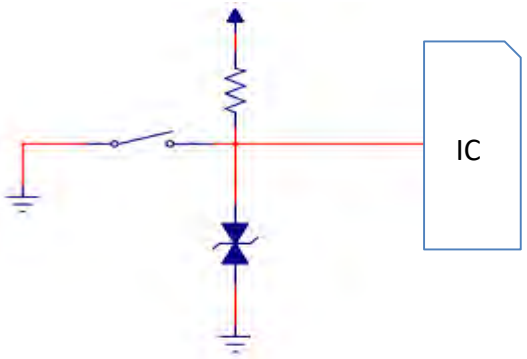


- PANJIT has series of ESD products, which the C_J is smaller then 0.8 pF, that could apply on high speed data parts such as USB, HDMI, and can support transfer speed exceeding 1Gbit.

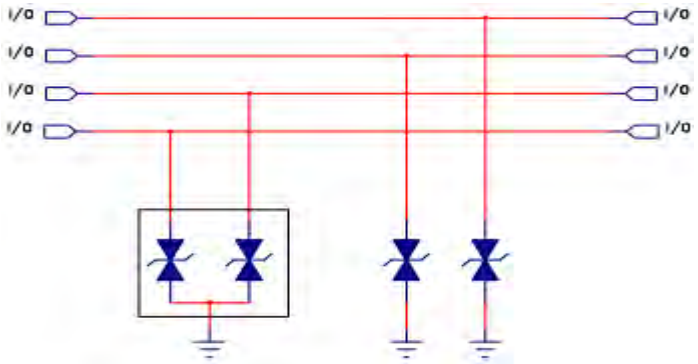
Recommend ESD Array

Part Number	UNI / BI	Ch.	V_{RWM} (v)	V_{BR} Min.(V)	I_R@V_{RWM} nA	V_C@I_{PP} Max.(V)	I_{PP}	C_J Typ.(pF)	ESD IEC61000-4-2	Package	Application
PEC1605M1Q-AU	BI	1	5.5	6.8	75	12	1	0.6	±20KV	DFN 2L	USB
PJE5V0U8TB-AU	UNI	2	5	5.8	1000	15	4	0.8	±18KV	SOT-523	USB
PE1605C4A6-AU	UNI	4	5.5	6	1000<	15	4	0.6	±20KV	SOT-23 6L	LVDS

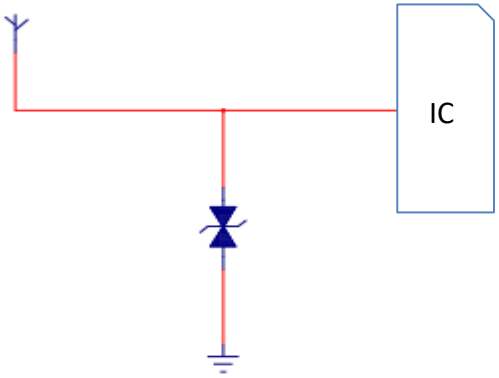
Keys, I/O, Antenna ESD Protection



Keys



I/O

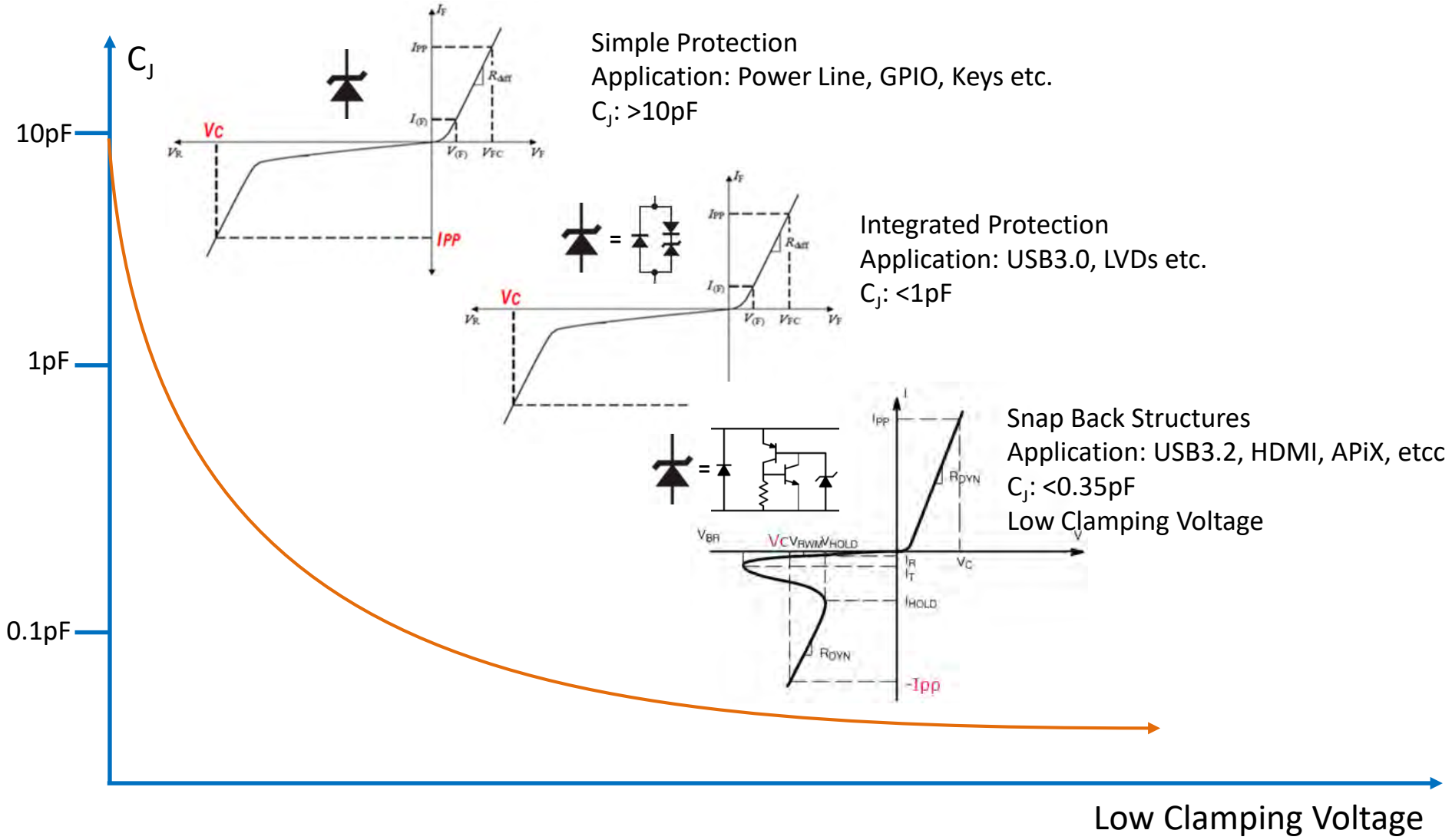


Antenna

Recommend ESD Array

Part Number	UNI / BI	Ch.	V_{RWM} (v)	V_{BR} Min.(V)	$I_R@V_{RWM}$ nA	$V_C@I_{PP}$ Max.(V)	I_{PP}	C_J Typ.(pF)	ESD IEC61000-4-2	Package	Application
PEC1605M1Q-AU	BI	1	5.5	6.8	75	12	1	0.6	±20KV	DFN 2L	Antenna
PEC3808C2A-AU	BI	2	8	8.5	500	18	8	55	±30KV	SOT-23	I/O
PEC3812C2A-AU	BI	2	12	13	500	27	5	50	±30KV	SOT-23	I/O
PEC3812C2C-AU	BI	2	12	13	500	27	5	50	±30KV	SOT-323	I/O
PEC3812C2E-AU	BI	2	12	13	500	27	5	50	±30KV	SOT-523	I/O

ESD Technology Evolution

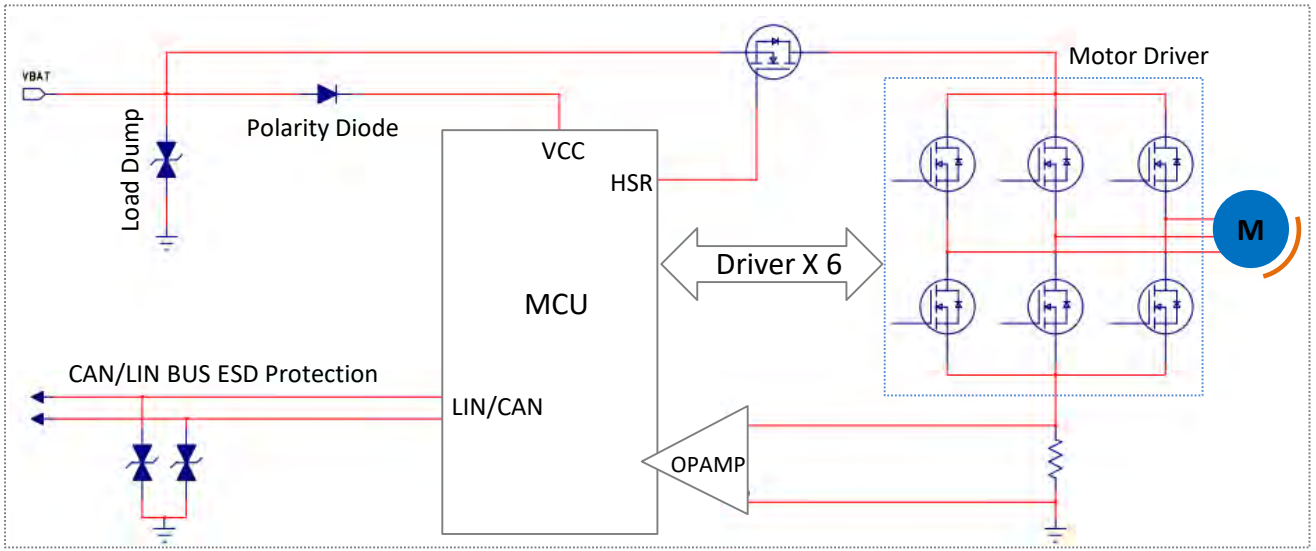


车载电子应用案例

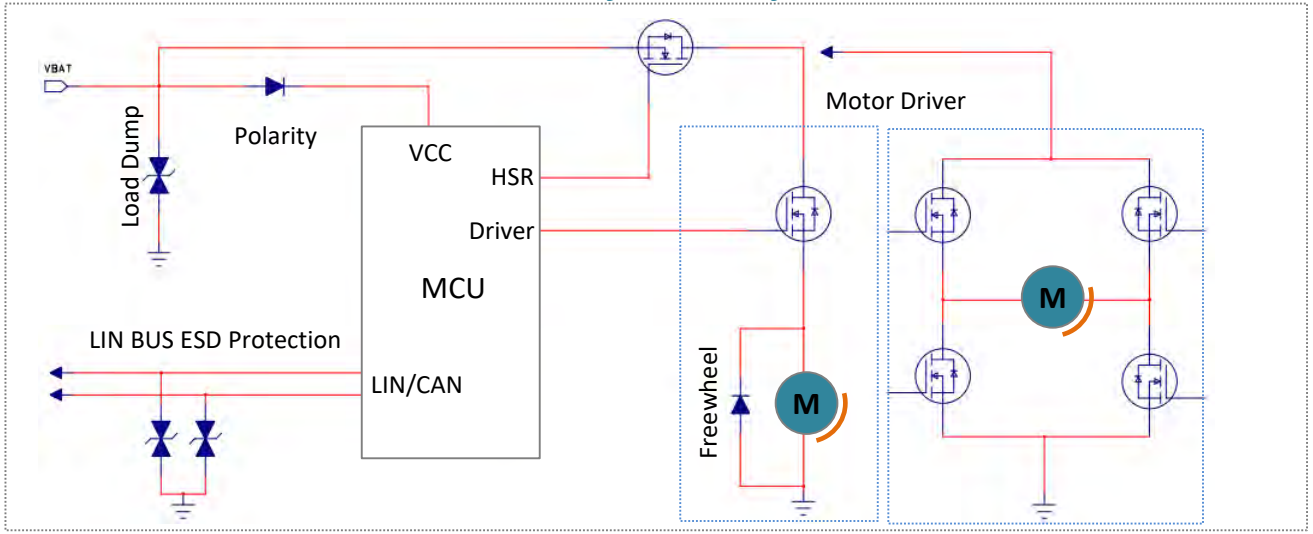
- 马达控制 (油泵，水泵，散热风扇，自动天窗...)
- LED车灯 (矩阵大灯，尾灯，氛围灯...)
- 汽车电子喇叭
- New USB充电器
- New 无线充电收发器

Automotive Motor Control 马达控制

BLDC Motor: Cooling Fan, Oil Pump, Water Pump, Windows Lifter, HVAC etc.



BDC Motor: Mirror Control, Sunroof, Seat Adjustment, Value Shutters etc.

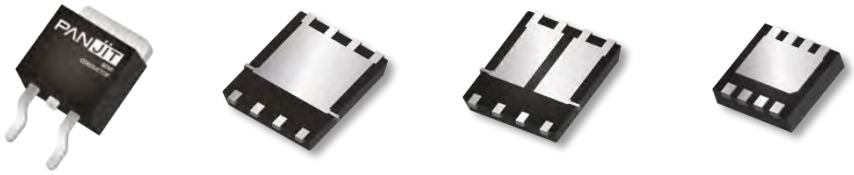


Solutions for Automotive Motor Control 马达控制

Recommend MOSFET for Motor Driver

VDS (V)	VGS (V)	Channel	Rds(on)@10V (mΩ, max.)	Rds(on)@4.5V (mΩ, max.)	TO-252AA	DFN5060-8L	DFN5060B-8L (Dual Channel)	DFN3333-8L
40V Series, for 12V Automotive systems								
40	20	N	32	44	PJD25N04-AU	PJQ5450-AU	PJQ5850-AU	PJQ4450P-AU
40	20	N	12	17	PJD40N04-AU	PJQ5448-AU	PJQ5848-AU	PJQ4448P-AU
40	20	N	9.5	13.5	PJD50N04-AU	PJQ5446-AU	PJQ5846-AU	PJQ4446P-AU
40	20	N	6.5	8.5	PJD60N04-AU	PJQ5444-AU	PJQ5844-AU	PJQ4442P-AU
40	20	N	5.5	7	PJD80N04-AU	PJQ5442-AU		PJQ4444P-AU
40	20	N	3.8	5	PJD100N04-AU	PJQ5440-AU		
60V Series, for 24V Automotive systems								
60	20	N	34	40	PJD25N06A-AU	PJQ5468A-AU		PJQ4468AP-AU
60	20	N	21	24	PJD35N06A-AU	PJQ5466A-AU		PJQ4466AP-AU
60	20	N	17	20	PJD40N06A-AU	PJQ5466A1-AU	PJQ5866A-AU	PJQ4464AP-AU
60	20	N	12	15	PJD45N06A-AU	PJQ5462A-AU		

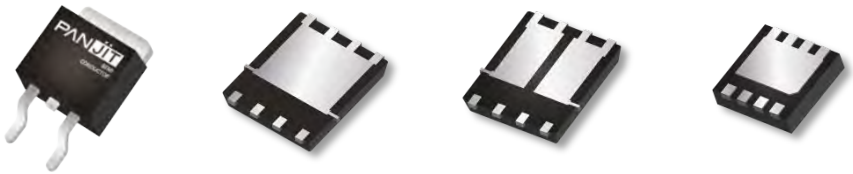
◎ for 175°C operating junction temperature



Solutions for Automotive Motor Control

Recommend MOSFET in the 2022Y H2 Release

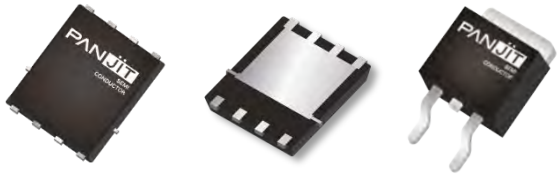
VDS (V)	VGS (V)	Channel	Rds(on)@10V (mΩ, max.)	Rds(on)@4.5V (mΩ, max.)	DFN3333-8L	DFN5060-8L	TO-252AA	DFN5060B-8L (Dual Channel)
40V(Logic), SGT								
40	20	N	(6.5)/7.8	(9.1)/11.8	PJQ4548P-AU	PJQ5448-AU	PJD30N04S-AU	PJQ5948-AU
40	20	N	(4.2)/5.0	(5.6)/7.6	PJQ4546P-AU	PJQ5446-AU	PJD55N04S-AU	PJQ5946-AU
40	20	N	(2.3)/2.9	(3.0)/3.9	-	PJQ5444-AU	PJD60N04S-AU	-
40	20	N	(1.8)/2.2	(2.4)/3.1	-	PJQ5442-AU	PJD65N04S-AU	-
40	20	N	(1.3)/1.6	(1.6)/2.1	-	PJQ5440-AU	-	-
40V(Standard), SGT								
40	20	N	(9.5)/11	-	PJQ4548VP-AU	PJQ5448V-AU	PJD25N04V-AU	PJQ5948V-AU
40	20	N	5.5	-	PJQ4546VP-AU	PJQ5446V-AU	PJD50N04V-AU	-
40	20	N	(2.95)/3.5	-	-	PJQ5444V-AU	PJD55N04V-AU	-
40	20	N	2.3	-	-	PJQ5442V-AU	PJD06N04V-AU	-
40	20	N	(1.75)/2.1	-	-	PQJ5440V-AU	-	-



Solutions for Automotive Motor Control

Recommend MOSFET in the 2022Y H2 Release

VDS (V)	VGS (V)	Channel	Rds(on)@10V (mΩ, max.)	Rds(on)@4.5V (mΩ, max.)	DFN3333-8L	DFN5060-8L	TO-252AA
30V w/ESD, Standard Trench							
-30	25	P	(15)/18	(23.6)/30.7	PJQ4439EP-AU	PJQ5439E-AU	PJD40P03E-AU
-30	25	P	(12)/14.4	(20)/27	PJQ4437EP-AU	PJQ5437E-AU	PJD45P03E-AU
-30	25	P	(9.7)/11.7	(15.3)/30	PJQ4435EP-AU	PJQ5435E-AU	PJD55P03E-AU
-30	25	P	(6.7)/8	(10.4)/13.5	PJQ4433EP-AU	PJQ5433E-AU	PJD70P03E-AU
-30	25	P	(5.1)/6.1	(8)/10.4	PJQ4431EP-AU	PJQ5431E-AU	PJD90P03E-AU
40V w/ESD, Standard Trench							
-40	25	P	(9.2)/11	22	PJQ4453EP-AU	PJQ5453E-AU	PJD60P04E-AU
-40	25	P	(7.2)/9	20	PJQ4451EP-AU	PJQ5451E-AU	PJD75P04E-AU
-40	25	P	(3.3)/4	6	-	PJQ5449E-AU	-
-40	25	P	(2.5)/3	(3.8)/5	-	PJQ5447E-AU	-



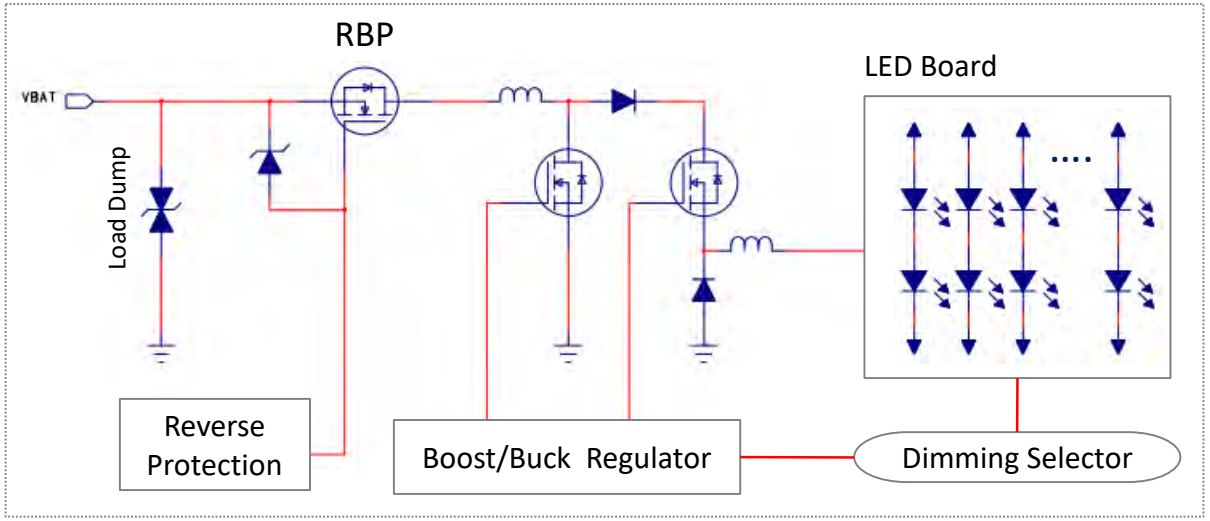
Solutions for Automotive Motor Control 马达控制

Recommend Diodes (TVS, ESD, Rectifier)

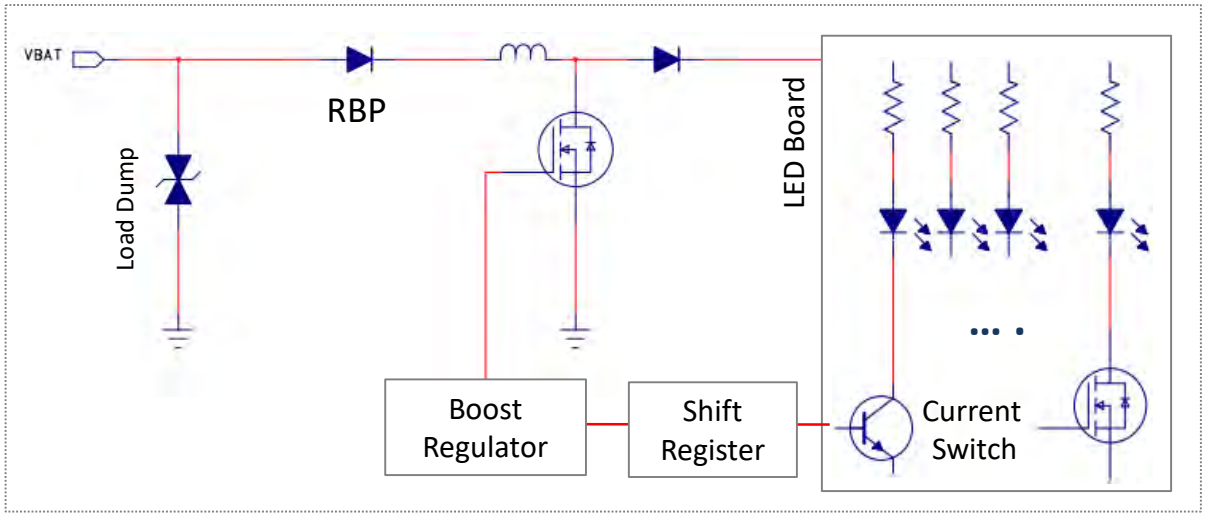
Part Number	Type	Specification Description	Package	Application
P6SMBJxxCA-AU	Power TVS	600W/24V/28V/33V /36V Bi-directional TVS	SMB	Transient Protection
PJEC2415VM1WS-AU	ESD Array	Single Channel 24V/15V ±30KV LIN Bi-directional ESD	SOD-323	LIN
PEC3324C2A-AU	ESD Array	Dual Channel 24V/ ±30KV CAN Bi-directional ESD	SOT-23	CAN
GS1004FL-AU	General Rectifier	1A/400V	SOD-123FL	Polarity
MBR5H60AFC-AU	Power Schottky	5A/60V VF<0.75V	SMAF-C	DC/DC
SB3H60AH-AU	High performance Schottky	3A/60V VF < 0.7V	SOD-123HE	DC/DC , Polarity
SS30100HE-AU	Power Schottky	3A/100V VF < 0.8V	SOD-123HE	DC/DC , Polarity
BAS316-AU	Switching	400mW, 100V/250mA Trr < 4nS	SOD-323	Switching

Automotive LED Lighting LED车灯

Front Lighting



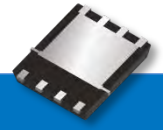
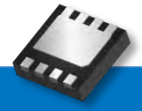
Rear Lighting and Interior Lighting



Solutions for Automotive LED Lighting LED车灯

Recommend LV & MV MOSFET



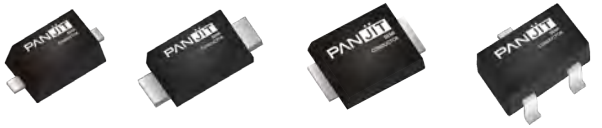



VDS (V)	VGS (V)	Channel	Rds(on) @10V (mΩ, max.)	Rds(on) @4.5V (mΩ, max.)	SOT-223	TO-252AA	DFN5060-8L	DFN3333-8L	Application
40	20	N	9.5	13.5		PJD50N04-AU	PJQ5446-AU	PJQ4446P-AU	RBP
40	20	N	6.5	8.5		PJD60N04-AU	PJQ5444-AU	PJQ4442P-AU	
40	20	N	5.5	7		PJD80N04-AU	PJQ5442-AU	PJQ4444P-AU	
60	20	N	95	110	PJW4N06A-AU				Current Switch
60	20	N	75	90	PJW5N06A-AU	PJD11N06A-AU		PJQ4460AP-AU	Buck & Boost
60	20	N	50	60		PJD16N06A-AU			
60	20	N	34	40		PJD25N06A-AU	PJQ5468A-AU	PJQ4468AP-AU	
60	20	N	21	24		PJD35N06A-AU	PJQ5466A-AU	PJQ4466AP-AU	
60	20	N	12	15		PJD45N06A-AU	PJQ5462A-AU		
100	20	N	130	135	PJW5N10-AU	*PJD10N10			Current Switch
100	20	N	50	55		*PJD25N10	*PJQ5474A		Boost
100	20	N	25	28.5		PJD50N10AL-AU	PJQ5476AL-AU	PJQ4476AP-AU	

**AEC-Q101 In development*

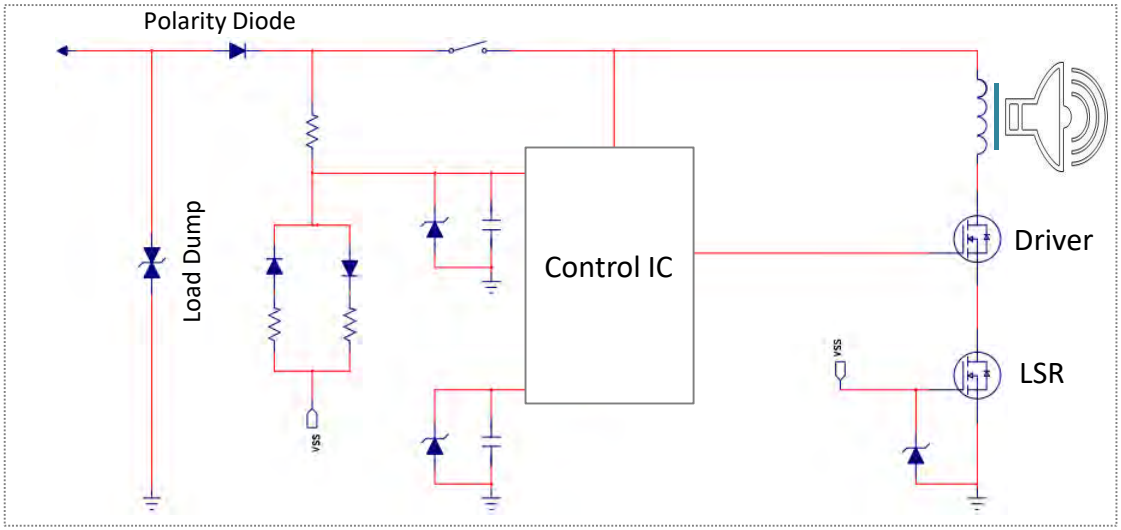
Solutions for Automotive LED Lighting LED车灯

Other Parts Proposals (TVS , ESD, Rectifier, BJT)



Part Number	Type	Specification Description	Package	Application
SMxSxxA-AU	Load Dump TVS	3600W/4600W/6600W 20V-36V Meet ISO16750 5a/5b	DO-218AB	Load Dump
P6SMBJxxCA-AU	TVS	600W/24V/28V/33V /36V Bi-directional TVS	SMB	Load Dump
PJEC2415VM1WS-AU	ESD Array	Single Channel 24V/15V ±30KV LIN Bi-directional ESD	SOD-323	LIN
PEC3324C2A-AU	ESD Array	Dual Channel 24V/±30KV CAN Bi-directional ESD	SOT-23	CAN
MBR5H60AFC-AU	Power Schottky	5A/60V VF<0.75	SMAF-C	Boost
SS1060FL-AU	Power Schottky	1A/60V VF<0.7V	SOD-123FL	Buck
SS2060FL-AU	Power Schottky	2A/60V VF<0.7V	SOD-123FL	Buck
MB3H60AH-AU	Power Schottky	3A/60V VF<0.7V	SOD-123HE	Buck or RBP
BCP56-16-AU	BJT	1A/100V HFE-100-250 NPN Transistor	SOT-223	Current Switch
BCX56-16-AU	BJT	1A/100V HFE-100-250 NPN Transistor	SOT-89	Current Switch

Solutions for Automotive Electronic Horn 汽车电子喇叭



Recommend MV MOSFET

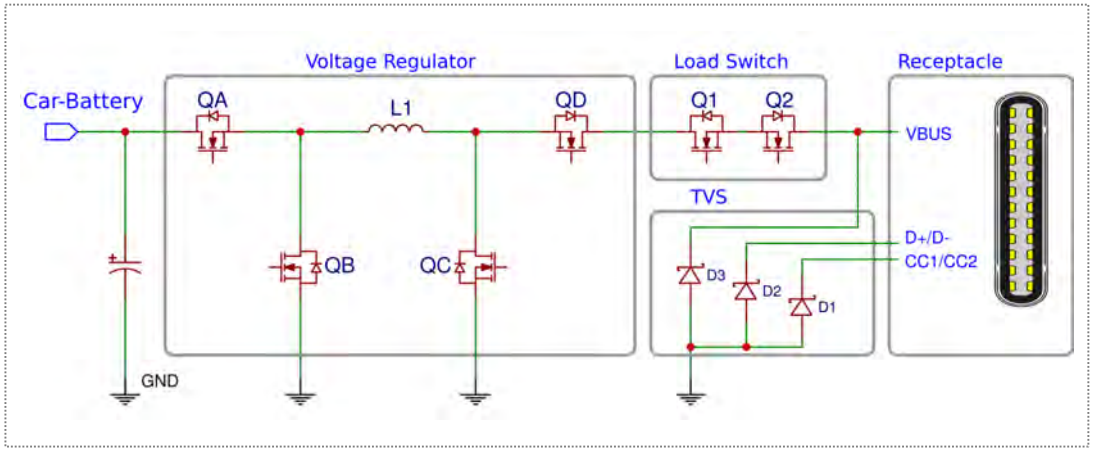
VDS (V)	VGS (V)	Channel	Rds(on)@10V (mΩ, max.)	Rds(on)@4.5V (mΩ, max.)	TO-252AA	DFN5060-8L	DFN3333-8L	Application
100	20	N	50	55	*PJD25N10	*PJQ5474A		Driver
100	20	N	25	28.5	PJD50N10AL-AU	PJQ5476AL-AU	PJQ4476AP-AU	
30	20	N	7	10	*PJD80N03	*PJQ5410	PJQ4404P-AU	LSR
30	20	N	9	13	*PJD55N03	*PJQ5420	PJQ4408P-AU	

Recommend Diodes (TVS, Zener, Schottky)

**AEC-Q101 In development*

Part Number	Type	Specification	Package	Application
P6SMBJxxCA-AU	Power TVS	600W/24V/28V/33V /36V Bi-directional TVS	SMB	Transient Protection
MB510-AU	Power Schottky	5A/100V VF < 0.8V	SMC	Polarity
BZT52-Cxx-AU	Zener Diode	500mW 2.4V to 7.5V ±5% Zener Diode	SOD-123	OVP

Solutions for USB Power Delivery Car Charging



Recommend LV MOSFET

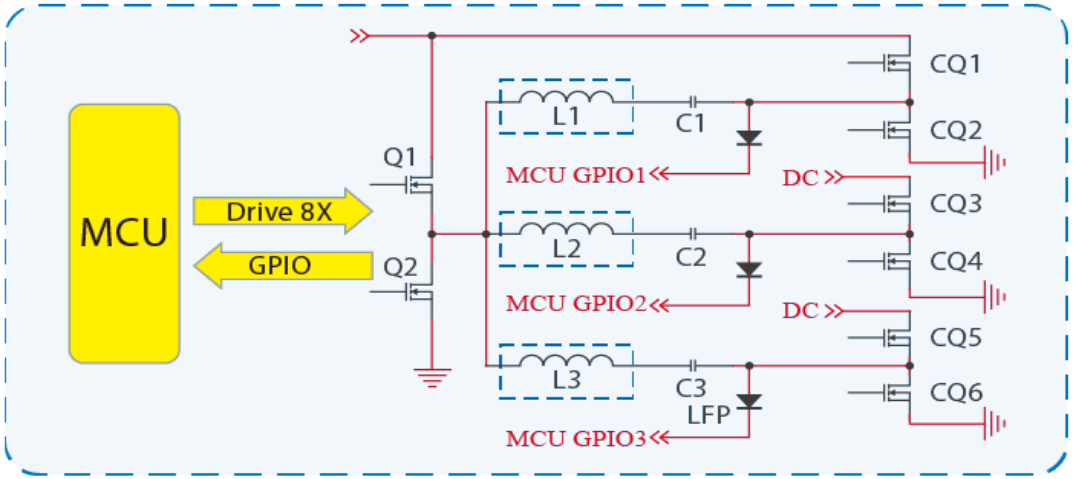
VDS (V)	VGS (V)	Channel	Rds(on)@10V (mΩ, max.)	Rds(on)@4.5V (mΩ, max.)	DFN5060-8L	DFN3333-8L	Application
30	20	N	2.4	3.3	*PJQ5426	-	Load Switch / Voltage Regulator
30	20	N	3.8	5.5	PJQ5424-AU	PJQ4402P-AU	
30	20	N	6	9	*PJQ5410	PJQ4404P-AU	
40	20	N	5.5	7.5	PJQ5442-AU	PJQ4444P-AU	
40	20	N	6.5	9	PJQ5444-AU	PJQ4442P-AU	
40	20	N	9.5	14	PJQ5446-AU	PJQ4446P-AU	

**AEC-Q101 In development*

Recommend Diodes (TVS,ESD Protection)

Part Number	Type	Specification	Package	Application
PE1605C4E6-AU	UNI	V_{RWM}：5.5V,C_J：0.6pF,ESD：±20KV	SOT-563	TVS / ESD Protection
PEC1605M1Q-AU	BI	V_{RWM}：5.5V,C_J：0.6pF,ESD：±20KV	DFN 2L	
P6AF12A-AU	UNI	P_{PPM}：600W,V_{RWM}：12V,Vc@30.2A=19.9V	SMAF	

Solutions for Wireless Charging Transmitter

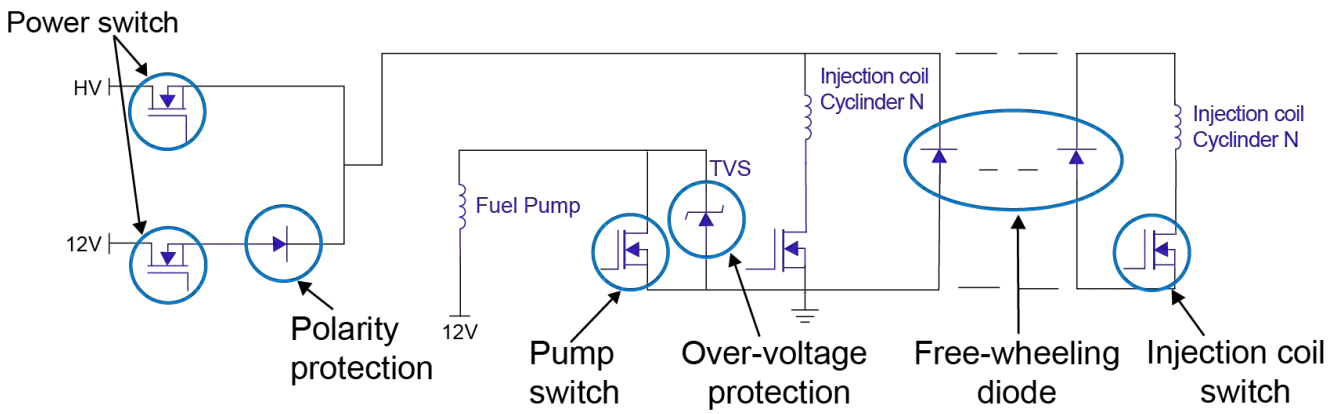


Recommend Devices

Power	PANJIT Part No.	
Watt	DFN5060-8L	DFN3333-8L
10W-15W	*PJQ5410	PJQ4401P-AU
	*PJQ5412	PJQ4404P-AU
	*PJQ5420	*PJQ4407P
	PJQ5462A-AU	PJQ4408P-AU
	PJQ5466A-AU	*PJQ4410P
	PJQ5466A1-AU	*PJQ4411P
	-	*PJQ4414P
	-	PJQ4464AP-AU
	-	PJQ4466AP-AU
20W-30W	PJQ5424-AU	PJQ4402P-AU

*AEC-Q101 In development

Solutions for Engine Control Unit



Recommend Devices

Part Number	Type	Specification Description	Package	Application
P6SMBJ24CA-AU	TVS	600W,24V	SMB	
PJQ5476AL-AU PJD50N10AL-AU	Medium Voltage MOSFET	100V/42A, 25mΩ 100V/42A, 25mΩ	DFN5060-8L TO-252	Injection Switch (12V boost)
PJQ5476AL-AU PJD50N10AL-AU	Medium Voltage MOSFET	100V/42A, 25mΩ 100V/42A, 25mΩ	DFN5060-8L TO-252	Injector Switch (High side)
PJQ5466A1-AU PJD40N06A-AU	Medium Voltage MOSFET	60V/42A, 17mΩ 60V/40A, 17mΩ	DFN5060-8L TO-252	Injector Switch (Low side)
PJQ5866A-AU	Medium Voltage MOSFET	Dual，60V/40A, 17mΩ,	DFN5060B-8L	Oxygen Sensor
PEC3124C2A-AU	ESD Protection	24V	SOT-23	ESD Protection

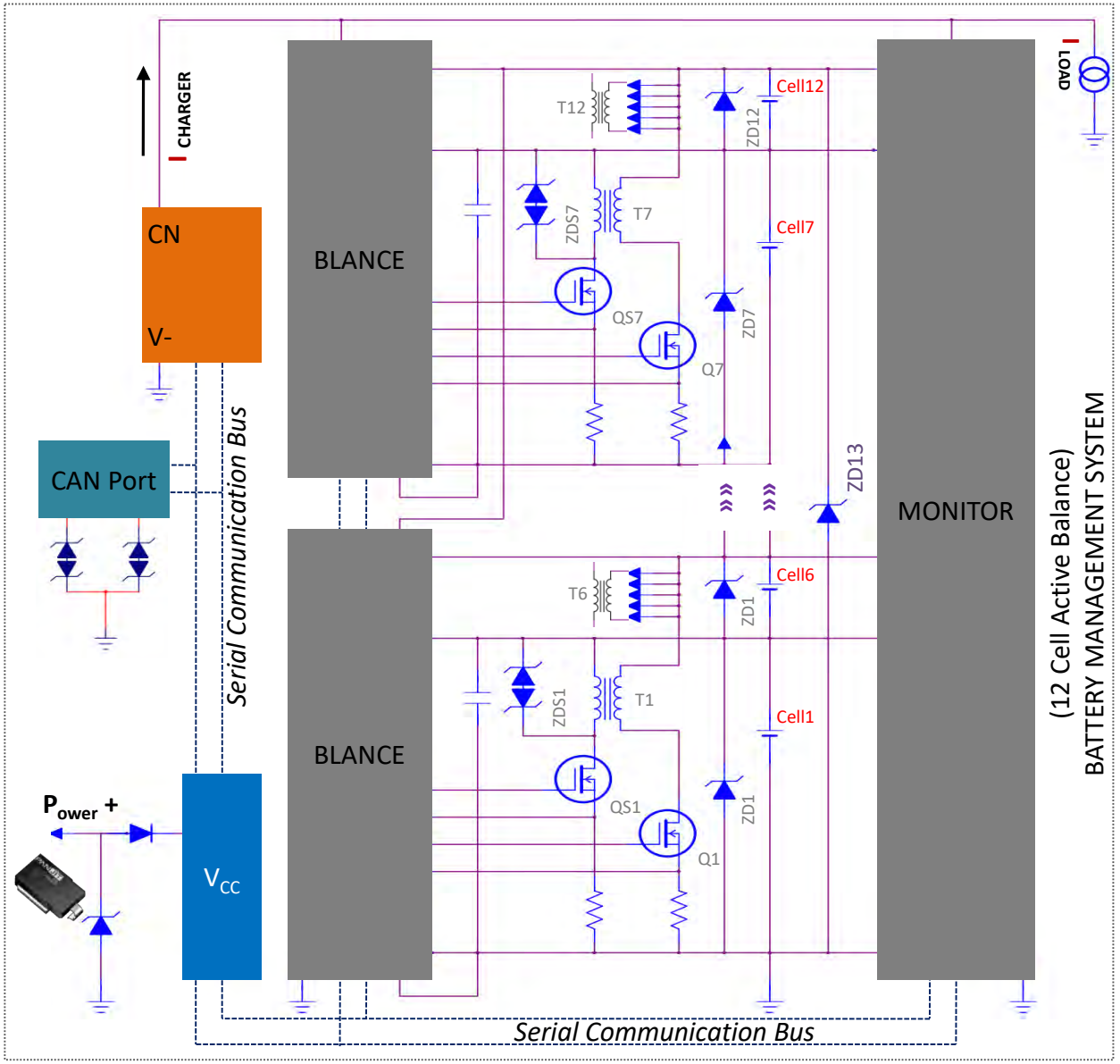
xEV Applications电动汽车应用

- 电动汽车电池管理系统 (BMS)
- 直流充电桩
- 车载充电机 (OBC)

Solutions for xEV BMS

Main product

- Power TVS for power line transient surge protection.
- Zener and TVS diode for battery module hot plug-in protection
- Balancer switching MOSFET
- CAN port ESD protection array
- Schottky diodes for DC/DC converter



Recommend Diode for xEV BMS

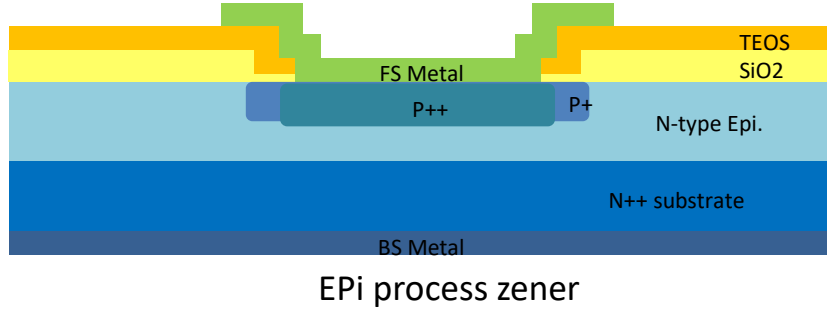
Part Number	Type	Specification Description	Package	Application
1.5SMCxxA-AU	TVS	22V-36V, 1500W,TVS Pass pulse 5b	SMC	Load Dump
SM8SxxA-AU	TVS	22V-36V ,6600W, TVS Pass pulse 5a,5b	DO-218AB	Load Dump
P4FL5.0A-AU	TVS	400W, 5.0V Ultra Low IR TVS	SOD-123FL	hot plug-in protection
P4SMAJxxA-AU	TVS	400W, 54-75V High Voltage TVS Uni / Bi	SMA	Battery Stack Protection
P6SMBJxxA-AU	TVS	600W, 54-75V High Voltage TVS Uni / Bi	SMB	Battery Stack Protection
P6AFCxxA-AU	TVS	600W, 33-64V Low Profile TVS	SMAF-C	Battery Stack Protection
PEC3124C2A-AU	ESD Array	24V, 180W, ±30KV Bidirectional ESD protection	SOT-23	CAN Bus ESD Protection
PEC3324C2A-AU	ESD Array	24V, 300W, ±30KV Bidirectional ESD protection	SOT-23	CAN Bus ESD Protection
PEC3215C2A-AU	ESD Array	15V, 150W, ±30KV Bidirectional ESD protection	SOT-23	CAN Bus ESD Protection
PZS515V6BCH-AU	Zener	500mW, 5.6V Ultra Low IR	SOD-323HE	hot plug-in protection
PZS515V6BAS-AU	Zener	500mW, 5.6V Ultra Low IR	SOD-123	hot plug-in protection
PZS5112BCH-AU	Zener	500mW, 12V Ultra Low IR	SOD-323HE	MOS G/S ESD Protection
SS1040HE-AU	Power Schottky	1.0A, 40V, VF<0.55V	SOD-123HE	DC/DC Converter
SS10100HE-AU	Power Schottky	1.0A, 100V, VF<0.8V	SOD-123HE	DC/DC Converter
SS10150HE-AU	Power Schottky	1.0A, 150V, VF<0.85V	SOD-123HE	DC/DC Converter
MB510-AU	Power Schottky	1.0A, 40V, VF<0.55V	SMC	Polarity Diode
*SRT8100UF	High performance Schottky	8.0A, 100V, VF<0.7V	SMBF	Polarity Diode

**AEC-Q101 In development*

Ultralow I_R Zener for BMS Hot Plug-in Protection

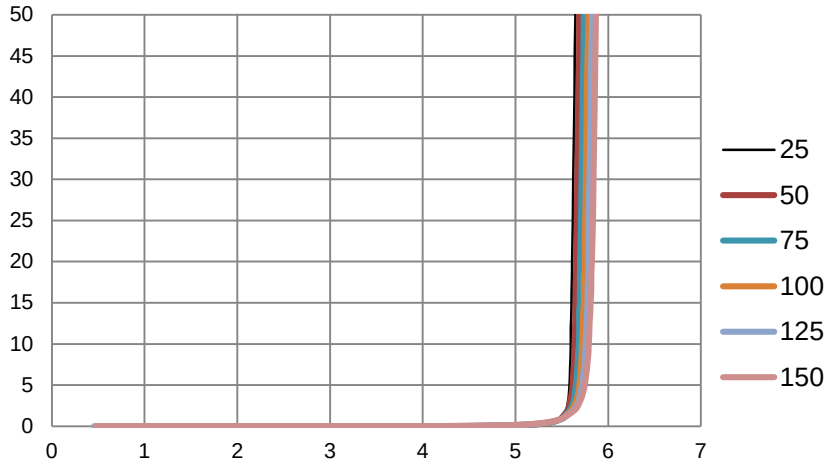
EPI process Zener advantage

- PANJIT EPi 工艺超低反向漏电汽车级稳压二极管，具有极低的高温反向漏电特性，5.0V-6.2V 低压段产品高温125°反向漏电I_R<3uA@V_R=4.2V 。
- 适合BMS电池监控端口热插拔浪涌保护。可有效降低电池组的待机耗损，同时改善其SOC一致性。

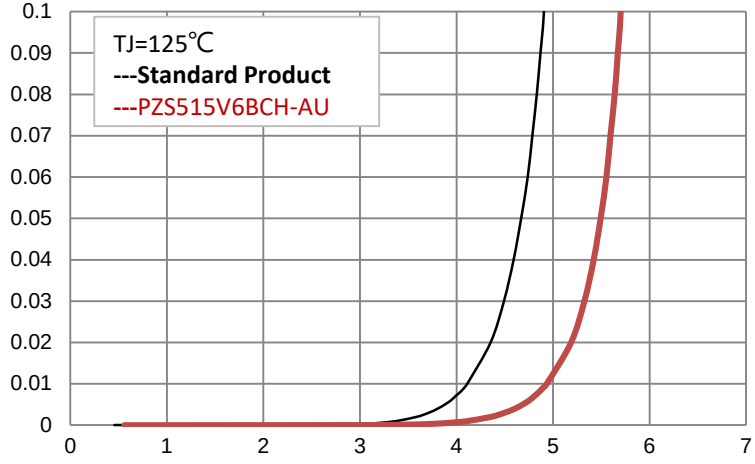


EPi process zener

Ultra Low I_R Zener VS Standard

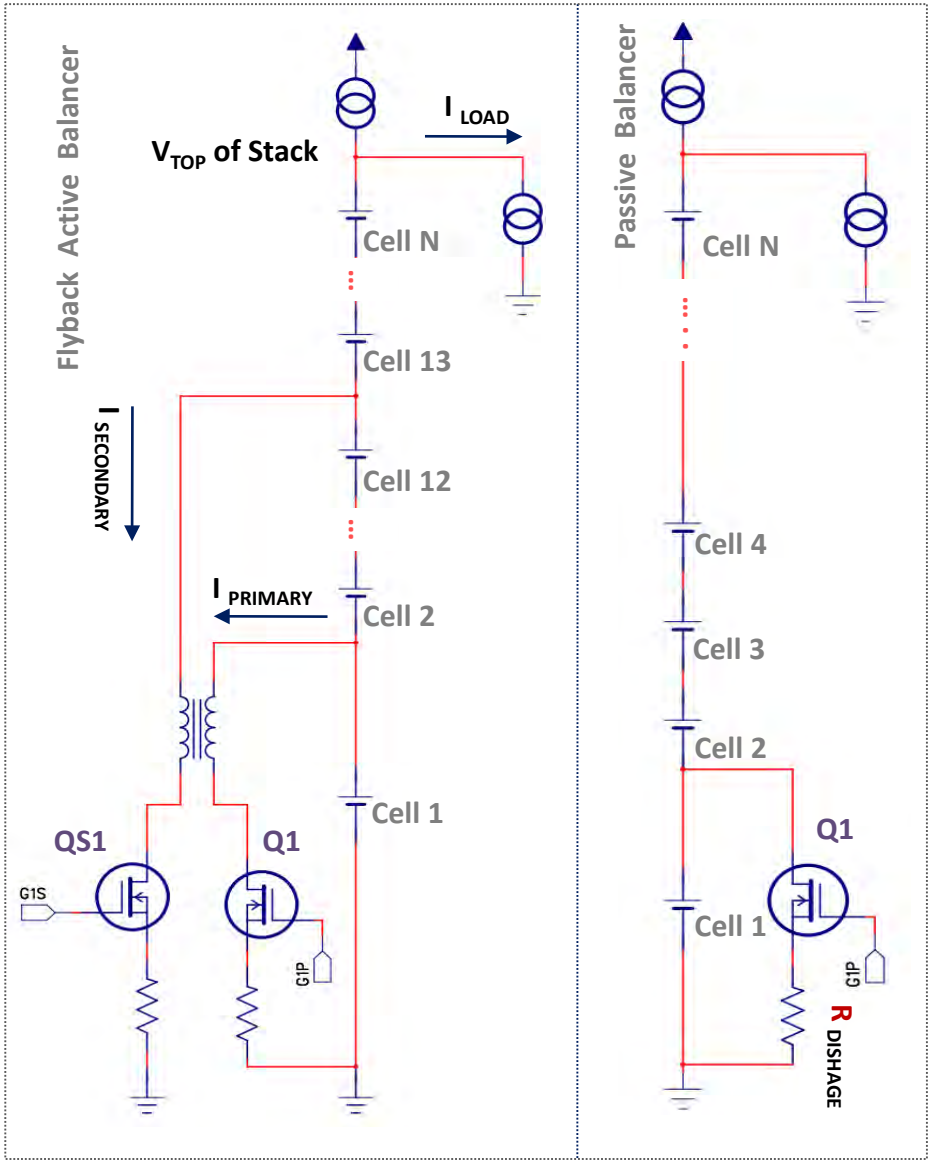


V_R(V)	1.5	2.4	3.3	4.2	5
25° I_R(uA)	0.00	0.01	0.03	1.0	7
125° I_R(uA)	0.00	0.02	0.08	2	20



V_R(V)	1.5	2.4	3.3	4.2	5
BZT52-C5V6S-AU (uA)	0.001	0.03	0.7	20	100
PZS515V6BCH-AU (uA)	0.00	0.02	0.08	2	20

BMS Balancer MOSFET Selection Guide



- **How to select MOFET V_{DS} for BMS balancer**
  - ✓ 针对带变压器的主动均衡开关MOSFET选择，(1)根据平衡电流及散热条件选择合适的MOSFET 封装和电流外，(2)根据电池堆栈额定电压和变压器匝比来确定初级与次级 MOSFET的V_{DS}，以确保MOSFET在运行过程的可靠性
- **Primary MOSFET VDS selection suggestion**

$$V_{DS}(\text{min.}) > \text{V}_{\text{CELL}} * (1 + \frac{\text{S}}{\text{T}})$$

- **Secondary MOSFET VDS selection suggestion**

$$V_{DS}(\text{min.}) > \text{V}_{\text{CELL}} * (\text{T} + \text{S})$$

T: ***Turns ratio (primary and secondary)***
S: ***The amount of battery stacked on the secondary***

- **Passive balancer MOSFET VDS selection suggestion**
  - ✓ As for choosing the balancing MOSFET for Passive balancer, the V_{DSS} is suggested to be 10% more above the voltage of the stacked battery .

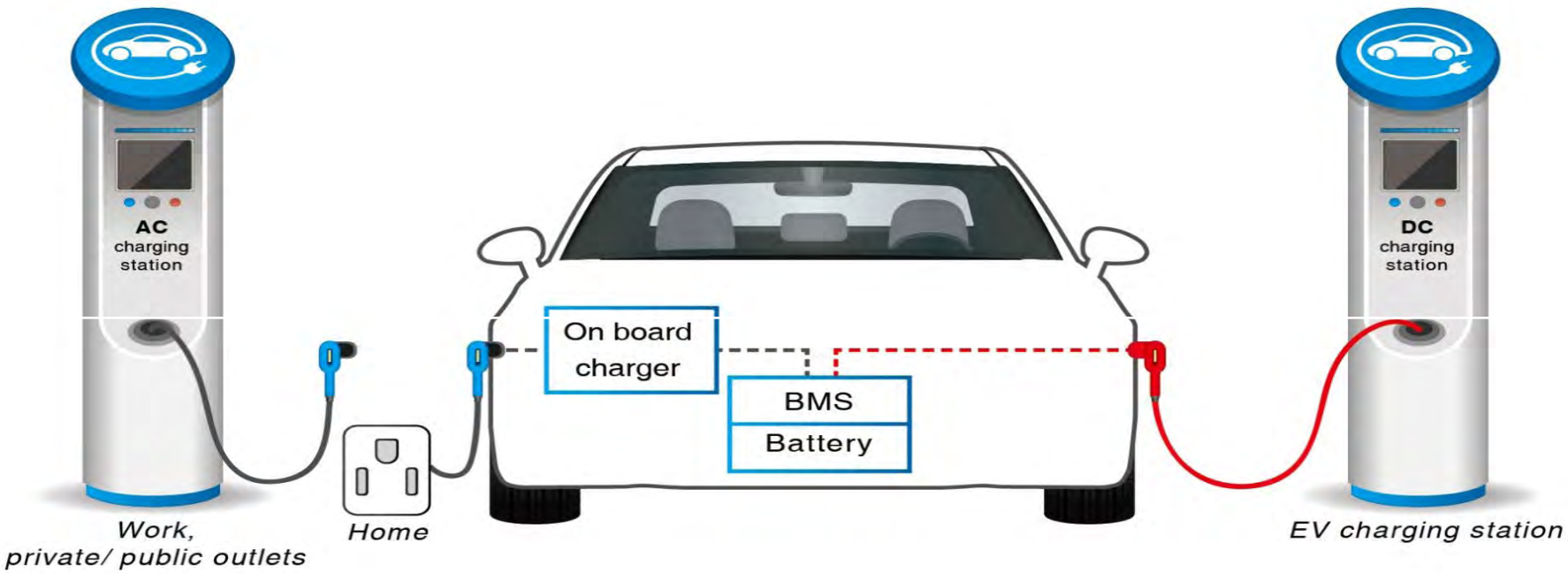
$$V_{DS}(\text{min.}) > \text{V}_{\text{CELL}} * \text{S} * 1.1$$

LV & MV MOSFET for balancer

VDS (V)	VGS (V)	Channel	Rds(on)@10V (mΩ, max.)	Rds(on)@4.5V (mΩ, max.)	SOT-23	SOT-223	TO-252AA	DFN5060-8L	DFN3333-8L
30	10	N(ESD)		1200	*PJA3428				
50	20	N(ESD)	1600	2500	PJA138K-AU				
50	20	N(ESD)	1450	1950	PJA3438-AU				
60	20	N(ESD)	3000	4000	2N7002K-AU				
Passive Balancer									
30	20	P	110	150	PJA3409-AU				
60	20	P	190	240	PJA3461-AU				
100	20	P	650	700	*PJA3471				
DC/DC, Power Control, Active Balancer									
60	20	N	95	110		PJW4N06A-AU			
60	20	N	75	90		PJW5N06A-AU	PJD11N06A-AU		PJQ4460AP-AU
60	20	N	50	60			PJD16N06A-AU		PJQ4464AP-AU
60	20	N	34	40			PJD25N06A-AU	PJQ5468A-AU	PJQ4468AP-AU
60	20	N	21	24			PJD35N06A-AU	PJQ5466A-AU	PJQ4466AP-AU
60	20	N	17	20			PJD40N06A-AU	PJQ5466A1-AU	PJQ4464AP-AU
100	20	N	310	320		*PJW3N10A	*PJD6N10A		
100	20	N	115	120			*PJD13N10A	*PJQ5472A	
100	20	N	50	55			*PJD25N10	*PJQ5474A	
100	20	N	25	28.5			PJD50N10AL-AU	PJQ5476AL-AU	PJQ4476AP-AU
-60	20	P	110	130		PJW4P06A-AU	PJD14P06A-AU	PJQ5461A-AU	
-60	20	P	68	85		PJW5P06A-AU	PJD15P06A-AU	PJQ5463A-AU	
-60	20	P	48	65			PJD16P06A-AU	PJQ5465A-AU	
-100	20	P	210	230		*PJW3P10A	*PJD10P10A		
-100	20	P	140	170			*PJD14P10A		
150	20	N	65	--			*PJD30N15		
150	20	N	35	--			*PJD40N15	*PJQ5494	

**AEC-Q101 In development*

EV/HEV Charging Model



AC Charging (Normal Charging)

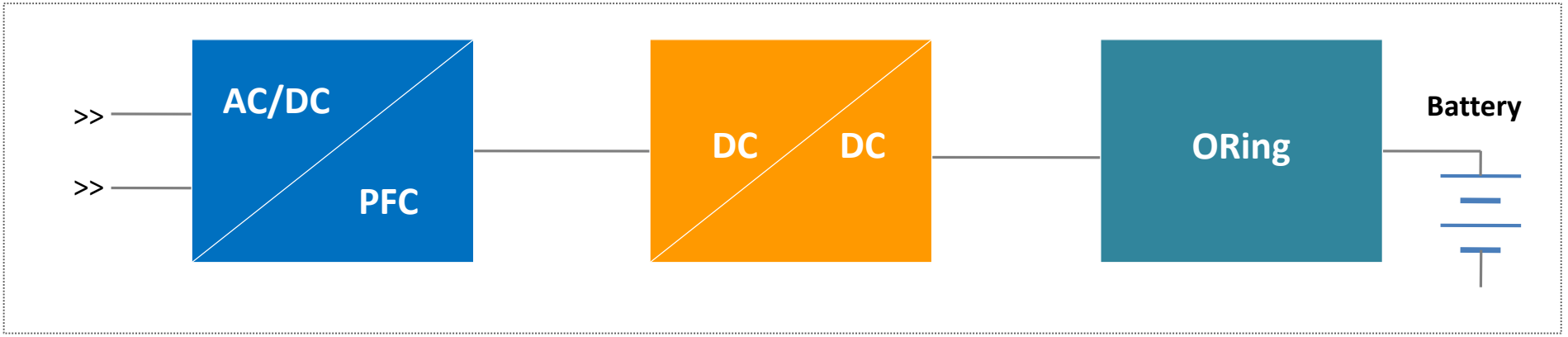
利用电动汽车自带的车载充电机(OBC)，将交流220V 双相或者380V 三相电引入后AC/DC 转换后对动力电池包充电。主要适用于家庭住所，办公商超等泊车充电。*OBC 主流充电功率3.3KW/6.6KW，充电时间比较慢。*

DC Charging (Fast Charging)

利用多个直流充电模块（10KW-20KW）组合成功率超过60KW 的充电桩直接对汽车动力电池包充电，充电速度比AC充电快4-10倍，主要应用于市政，公路等大型充电站。

EV/HEV Charging System

EV/HEV Charging System Block Diagram



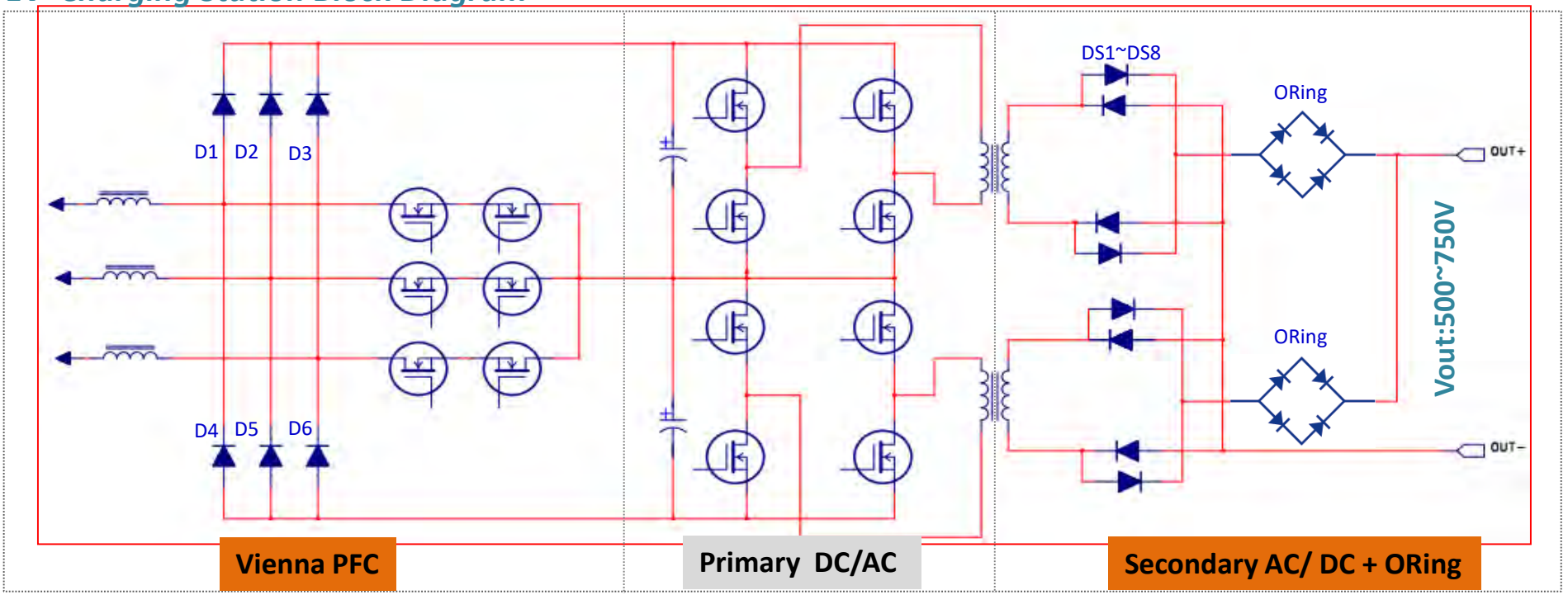
- 600V/1000V/1200V PSDxxxxxx1 series FRED
- 650V/1200V SiC Schottky

- 600V/1000V/1200V QRT series FRED
- 650V/1200V SiC Schottky

- GBJ series power Bridge

EV/HEV Charging Station

EV Charging Station Block Diagram

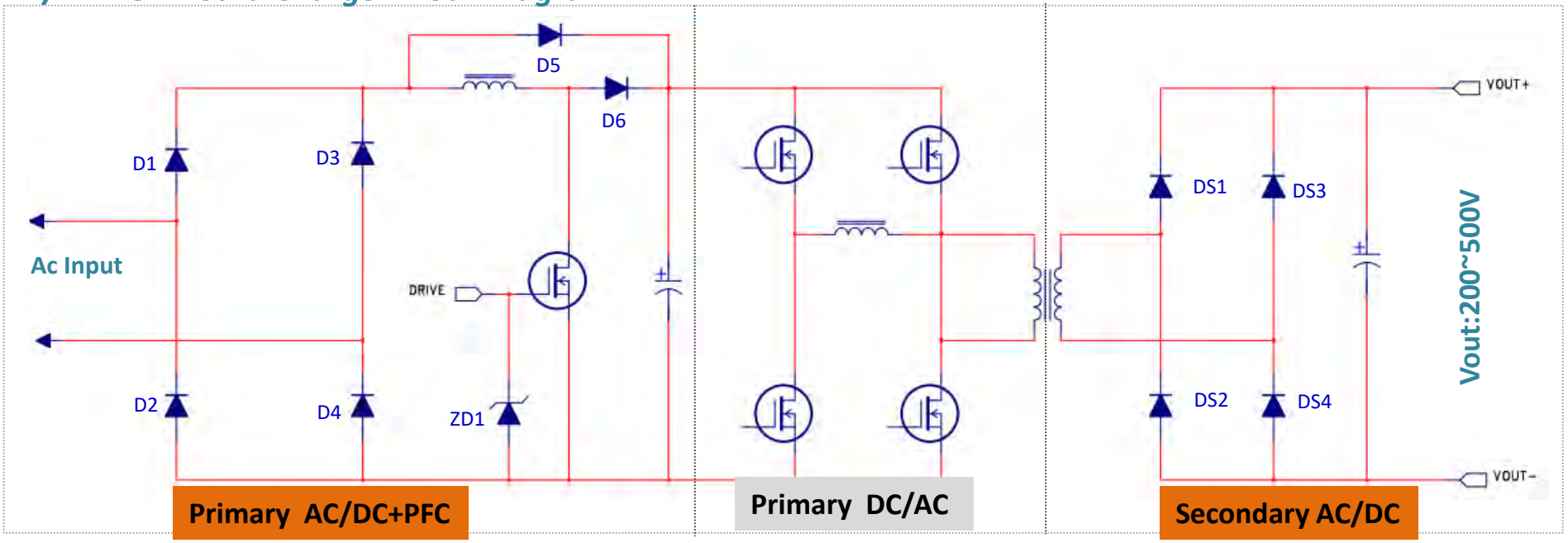


Application-AU	Type	Part Number	Rating	Package	Ref.
Vienna PFC	FRED	*PSDH30120S1	30A/1200V	TO-247AD 2LD	D1-D6
		*PSDH60120S1	60A/1200V	TO-247AD 2LD	
Secondary AC/DC	FRED	*PSDP3060S1	30A/600V	TO-220AC	DS1-DS8
		*PSDH3060S1	30A/600V	TO-247AD 2LD	
		*PSDH6060S1	60A/600V	TO-247AD 2LD	
ORing Diode	Bridge	*GBJ35M	35A/1000V	GBJ	ORing

**AEC-Q101 In development*

EV On Board Charger

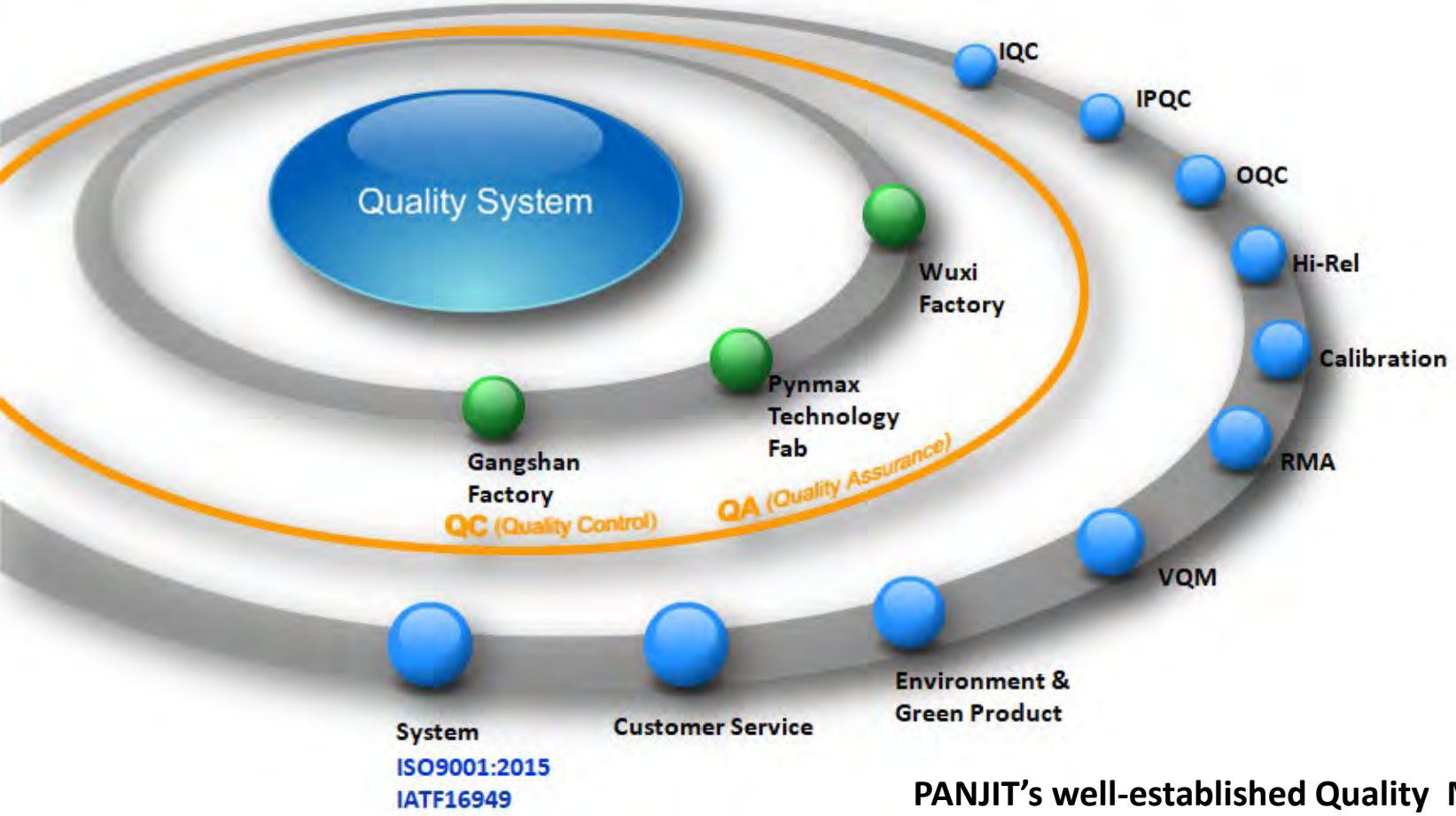
EV/HEV On Board Charger Block Diagram



Application-AU	Type	Part Number	Rating	Package	Ref.
PFC	SiC Diodes	*PCDP1065G1	10A/650V	TO-220AC	D6
PFC MOSFET Protection	Power TVS	P4SMAJ15CA-AU	400W/15V	SMA	ZD1
Secondary AC/DC	FRED	*PSDP3060S1	30A/600V	TO-220AC	DS1-DS4
		*PSDH3060S1	30A/600V	TO-247AD 2LD	
		*PSDH6060S1	60A/600V	TO-247AD 2LD	

**AEC-Q101 In development*

Quality Management Systems



PANJIT's well-established Quality Management Systems allows the company to collaborate efficiently and structurally manage its quality-related activities in order to provide its customers with defect-free products and services at the right time.

The QMS engages it employees in creating values for themselves and therefore to our customers.

Automotive Quality

- **AUTOMOTIVE QUALITY PRINCIPLES**
  At Panjit, Quality is an integral part of the entire product life cycle which begins from product conceptualization to manufacturing and to other associated services. That is why we drive continuous improvement in our processes , building Quality in the manufacturing floors, laboratories and offices.

- **International Standards Certification**
  Our manufacturing sites that produce automotive products are certified to IATF 16949 and OHSAS 18001 thus ensuring our workforce is protected while producing products of the highest quality and reliability.

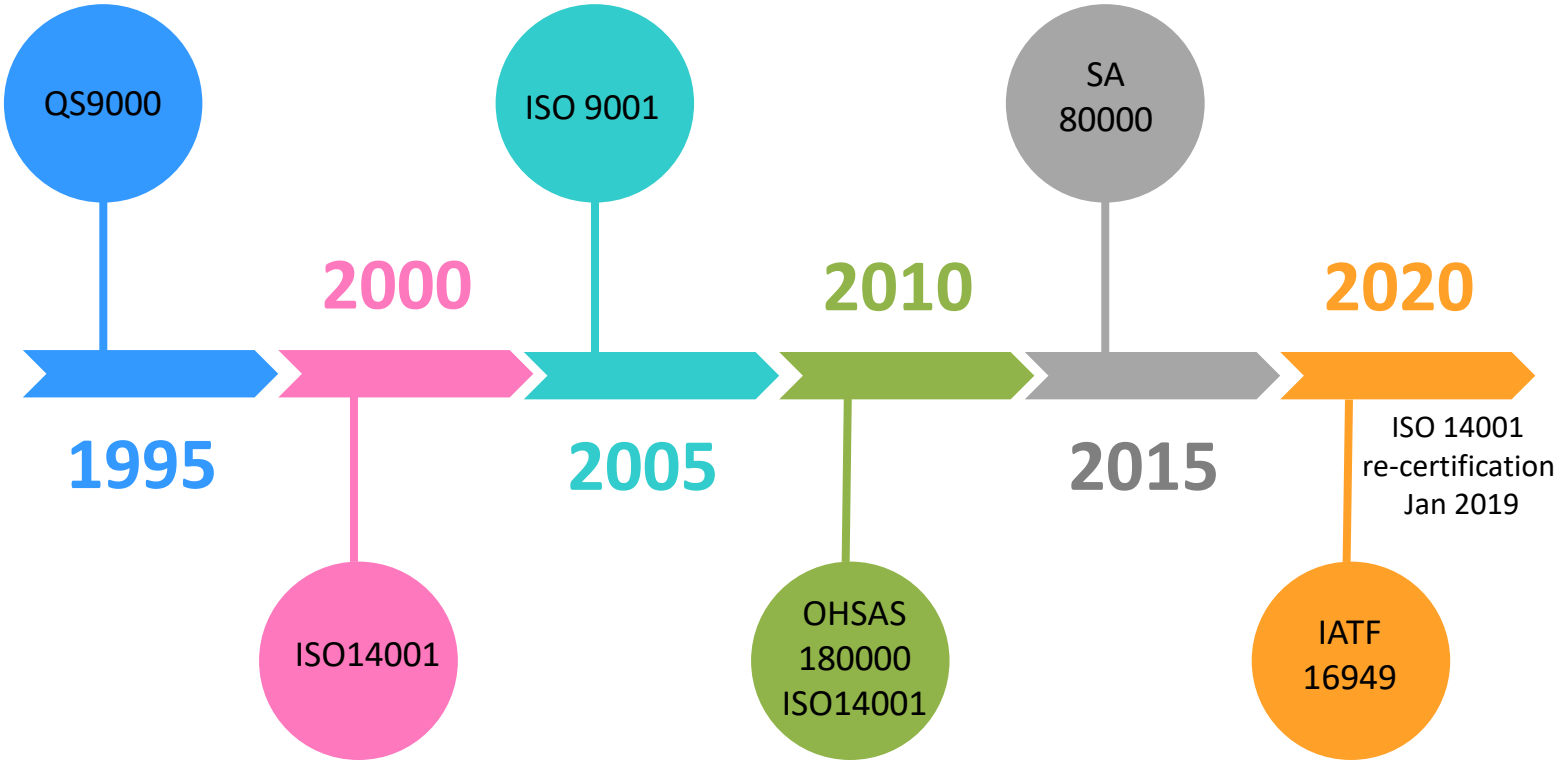
- **Product and Process Development**
  The key to deliver reliable and superior products are using robust design practices and world-class process control. Our APQP process adopts a structured approach from product design to qualification. PANJIT focuses on prevention at the design stage and best practice standardization on mass production.

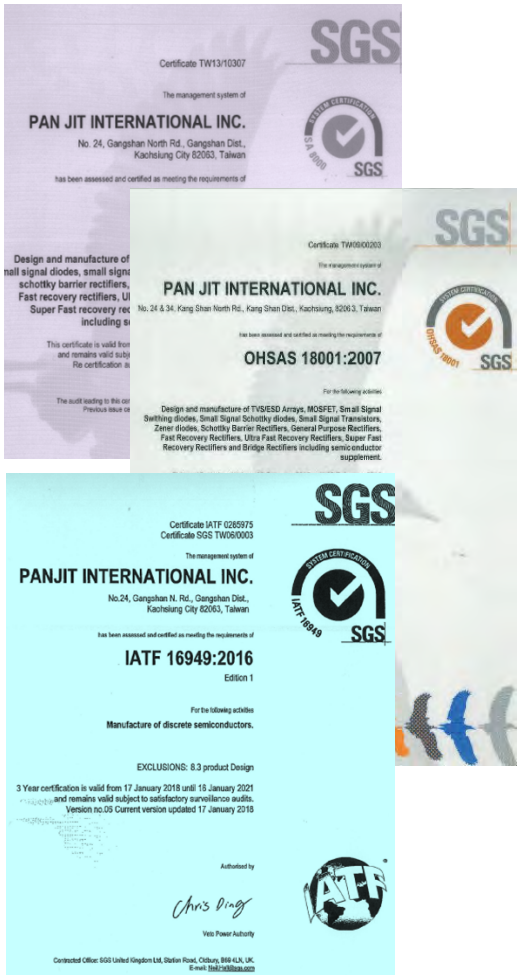
- **Automated processes and dedicated people**
  The manufacturing processes are equipped with best-in-class equipment, automated systems and controlled by our highly skilled employees. The performance at every stage of the process is monitored electronically to ensure process stability in order to meet our goal of zero-defect product.

- **Quality Mindset**
  All employees are expected to act as quality advocates at their respective area. We are sensitive to abnormality and engage teams to detect the underlying root cause and implement robust solutions. Thus, the Quality mindset of ‘ZERO DEFECT’ is ingrained throughout the whole organization.

PANJIT Quality Milestones

Through the years, PANJIT continuously upgrades the quality and sustainability management systems in order to keep its promise of delivering defect-free product to customer through engaged workforce with zero impact to environment.





** The above certifications is for PANJIT Gangshan but equivalent quality roadmap is available for Pynmax and PANJIT Wuxi as requested.*

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