

AEC-Q200 Overview

Capacitors, Inductors, Resistors, Circuit Protection



**IN Your
Future**



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AEC-Q200

Passive component reliability test standard

To run safely in a harsh environment, an automobile must have its electronic components keep operating normally. These electronic components cannot be put on the market as components conforming to AEC-Q200 requirements unless they pass environment tests, electrical tests, etc., conducted under severe test conditions. Passive components to be certified by AEC-Q200 tests and test items to be applied are listed in the following table.

Various components to be tested include capacitors, resistors and varistors, with test items being specified for each component. Test items vary also depending on whether a component to be tested is a lead component or a surface mount device (SMD).

In addition, capacitors of different types should be tested with different test items. So, these tests must be conducted carefully.

AEC-Q200 grades

AEC standards classify components into different grades corresponding to their service temperature ranges. These grades define individual places where classified components are allowed to be used. AEC-Q200 provides five grade categories, and components with a lower grade number must be able to withstand lower and higher temperatures.

Different grades defined by AEC-Q200

Grade	Temperature range		Types of passive components	Typical places of use of components
	Low temperature	High temperature		
0	-50°C	+150°C	Resistors X8R ceramic capacitors	Most of the engine room
1	-40°C	+125°C	Networks (capacitors), resistors, inductors, transformers, thermistors, oscillators, vibrators, varistors, and all types of ceramic/tantalum capacitors	Most of the engine room
2	-40°C	+105°C	Aluminium electrolytic capacitors	High-temperature area of the passenger room
3	-40°C	+85°C	Film capacitors, ferritic EMI suppressors, networks (resistances/resistance capacitors)	Most of the passenger room
4	0°C	+70°C		A place for mounting non-electrical equipment

AUTOMOTIVE APPLICATION GUIDE

EPS

Power Inductors High Performance Series



Hybrid Capacitors



Electrolytic Capacitors



DC / DC Converter

Power Inductors specify Low Profile and High Performance



Hybrid Capacitors



High Voltage Film Capacitors



Inverter

Power Inductors specify Low Profile and High Performance



Hybrid Capacitors



High Voltage Film Capacitors



Electrolytic Capacitors



High Power / Anti-Sulfurated Resistors



E-Pumps / Compressors

Power Inductors LP / High Performance / High Vibration Proof



Hybrid Capacitors



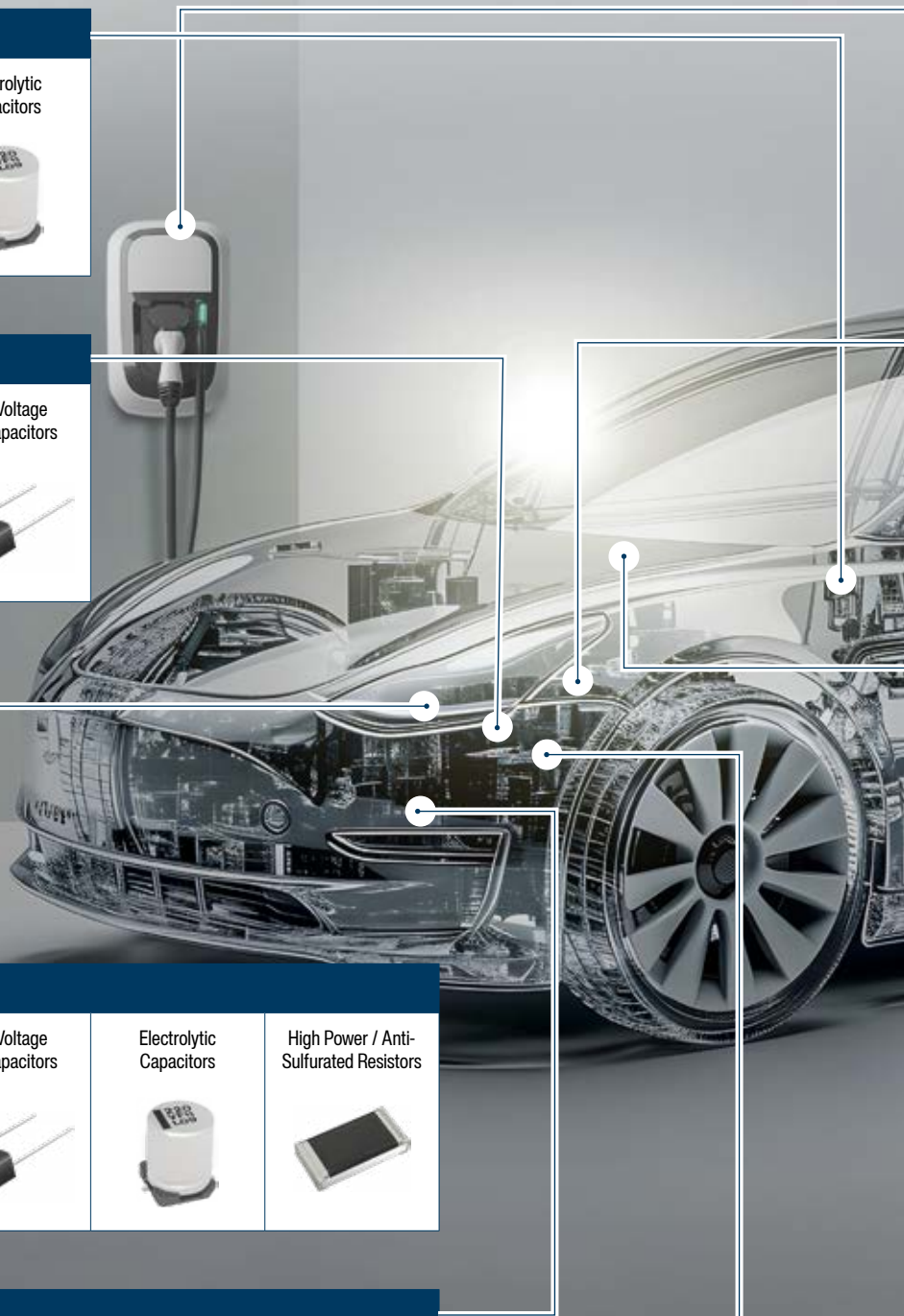
High Voltage Film Capacitors

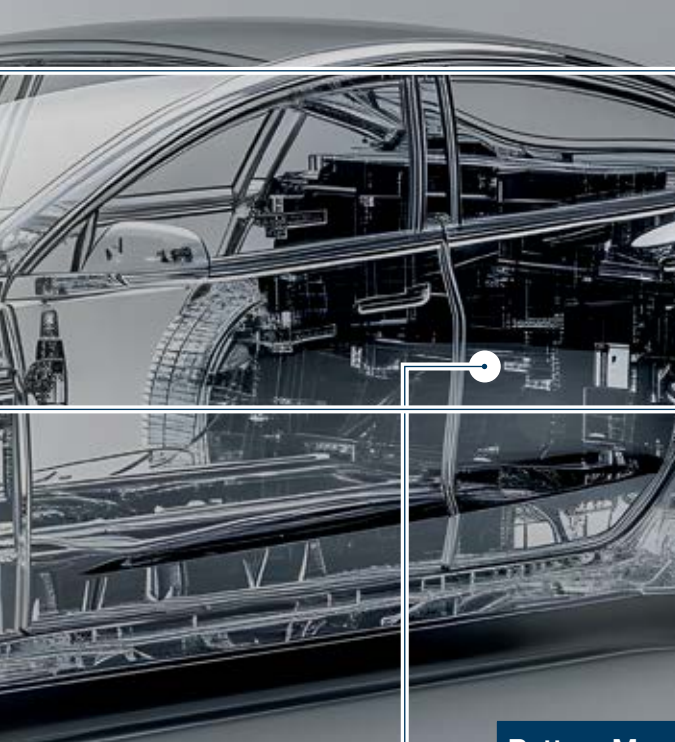


Electrolytic Capacitors







High Temperature / Thin Film Resistors













Charging Wall Box

<p>Power Inductors Low Profile Series</p> 	<p>Hybrid Capacitors</p> 	<p>High Voltage Film Capacitors</p> 	<p>Electrolytic Capacitors</p> 	<p>Current Sense / High Power Resistors</p> 
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On Board Charger

<p>Power Inductors High Performance / Large Current Series</p> 	<p>Hybrid Capacitors</p> 	<p>High Voltage Film Capacitors</p> 	<p>High Power / Current Sense Resistors</p> 
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ADAS

<p>Power Inductors LP Series</p> 	<p>Hybrid Capacitors</p> 	<p>Electrolytic Capacitors</p> 	<p>Thin Film Resistors</p> 
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Battery Management System

<p>Power Inductors Low Profile (LP) / High Performance / High Vibration Proof (HP) Series</p> 	<p>Hybrid Capacitors</p> 	<p>High Voltage Film Capacitors</p> 	<p>Electrolytic Capacitors</p> 	<p>Thin Film / Current Sense Resistors</p> 
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Actuator

<p>Power Inductors LP / High Performance / High Vibration Proof</p> 	<p>Hybrid Capacitors</p> 	<p>High Voltage Film Capacitors</p> 	<p>Electrolytic Capacitors</p> 	<p>Current Sense / Thin Film Resistors</p> 
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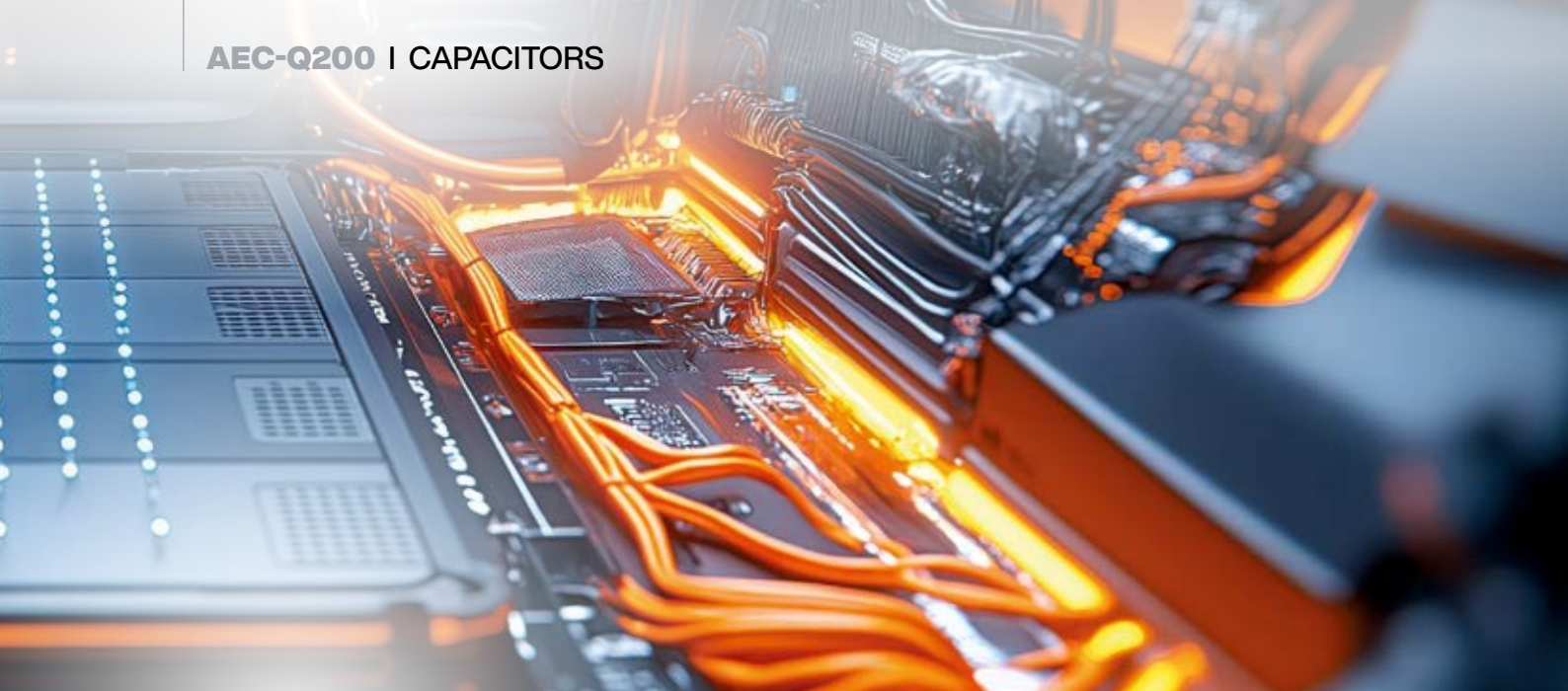


PASSIVE COMPONENTS - CAPACITORS

Hybrid capacitors		
Series	Prefix	Features
ZA	EEHZA	SMT/Radial, 105°C 10000h, low-cost
ZC	EEHZC	SMT/Radial, 125°C 4000h, low-cost
ZK	EEHZK	SMT/Radial, 125°C 4000h
ZKU	EEHZKU	SMT/Radial, 125°C 4000h, miniaturized version of ZK
ZL	EEHZL	SMT, 135°C 4000h, largest capacitance for case size up to Ø10x10mm
ZT	EEHZT	SMT/Radial, 125°C 4000h
ZTU	EEHZTU	SMT, 135°C 4000h, balanced performance for case size up to Ø10x10mm
ZV	EEHZV	SMT, 135°C 4000h, highest ripple current for case size up to Ø10x10mm
ZVU	EEHZVU	SMT/Radial, 135°C 4000h, miniaturized version of ZV
ZS	EEHZZS	SMT/Radial, 135°C 4000h
ZSU	EEHZZSU	SMT/Radial, 125°C 4000h
ZU	EEHZU	SMT, 135°C 4000h, high performance for case size from to Ø10x12.5mm
ZUU	EEHZUU	SMT, 135°C 4000h, best performance for case size from to Ø10x12.5mm
ZE	EEHZE	SMT/Radial, 145°C 2000h
ZF	EEHZF	SMT/Radial, 150°C 1000h

Anti-vibration variants of SMT type are available for diameter 6mm and above

Film Capacitors (Metallized PP Film Capacitor)	
Series	Features
ECWFJ	Cost-effective, max. temperature 125°C @ 200h, humidity resistance 40°C 95% VR @ 1000h
ECWFG	Max. temperature 125°C @ 200h, high humidity resistance 85°C 85% VR*0.7 @ 500h
EZPV	Max. temperature 125°C @ 200h, high humidity resistance 85°C 85% VR*0.7 @ 500h
EZPV-D	Cost-effective, max. temperature 125°C @ 200h, humidity resistance 40°C 95% VR @ 1000h



Aluminium Electrolytic Capacitor SMD type		
Series	Prefix	Features
TCU	EEETC-----U-	High temperature, miniaturization, 125°C 3000h
TC	EEETC	High temperature, 125°C 2000 to 3000h
TQ	EEETQ	High temperature, miniaturization, 125°C 2000h
TP	EEEFPP	High temperature, long life, 125°C 2000 to 4000h
TK	EEETK	High temperature, 125°C 2000 to 3000h
TG	EEE/VTG	High temperature, 125°C 1000 to 2000h
FH	EEEFH	Longest life, 105°C 7000 to 10000h
FN	EEEFN	Miniaturization, low ESR, 105°C 2000h
FT	EEEFPT	Miniaturization, 105°C 2000 to 5000h
FP	EEEFPP	Low ESR, 105°C 2000h
FK	EEE/VFK	Low ESR, 105°C 2000 to 5000h
HB	EEEFHB	105°C 2000h
HC	EEEFHC	Long life, 105°C 3000 to 5000h
HD	EEEFHD	Long life, 105°C 5000h

* Anti-vibration variants of SMT type are available for diameter 6mm and above

Aluminium Electrolytic Capacitor THT type		
Series	Prefix	Features
FP-A	EEU/A-FP	High ripple current, large capacitance, 105°C 4000h to 5000h
FK-A	EEU/A-FK	Low impedance, 105°C 3000h to 5000h
FC-A	EEU/A-FC	Low impedance, 105°C 1000h to 5000h
TP-A	EEU/A-TP	High ripple current, 135°C 1000h to 2000h
TA-A	EEU/A-TA	Heat cycle, 1000 cycle, sleeve: polyester, 125°C 2000h
HD-A	EEU/A-HD	Miniaturization, 105°C 2000h
NHG-A	ECA--HG	105°C 1000h to 2000h



PASSIVE COMPONENTS - INDUCTORS

Power Inductors (metal core technology)							
CASE SIZE	ETQP Series	Part Number	Height (mm)	Inductance Range (uH)	Vibration Resistance	Temperature range	Sat Rated Current (A)
5x5mm	Low profile	ETQP3M***KVP	3	0.33 -10	30 G	-55°C to +155°C	4.2 - 21.8
	High performance	ETQP3M***YFP	3	2.2, 3.3		-40°C to +150°C	8.6, 10.9
		ETQP4M***YFP	4	4.6, 22		3.1, 7.7	
6x6mm	Low profile	ETQP3M***KVN	3	0.68 - 33	30 G	-55°C to +155°C	3 - 20.2
	High performance	ETQP3M***YFN	3	0.68 - 1.5		-40°C to +150°C	16 - 24
		ETQP4M***YFN	4.5	2.2 - 47		3.8 - 14.4	
7.5x7mm	High performance	ETQP5M***YFM	5.4	3.3 - 68	10 G	-40°C to +150°C	3.9 - 14.4
		ETQP5M101YGM	5	95			3.1
8.5x8mm	Low profile	ETQP4M***KVK	4	0.68 - 33	10 G	-55°C to +155°C	4.7 - 29
	High performance	ETQP5M***YFK	5.4	2.5 - 10		-40°C to +150°C	5.4 - 20.1
		ETQP5M101YGK	5	100		3	
	High vibration	ETQP5M2R5YSK	5.4	2.45	50 G	21.7	
10.7x10mm	Low profile	ETQP4M***KVC	4	1 - 100	10 G	-55°C to +155°C	3.5 - 34.6
	High performance	ETQP5M***YFC	5.4	1.5 - 66		-40°C to +150°C	4.9 - 35.1
		ETQP5M***YGC	5	3.3 - 97		3 - 23.4	
10.9x10mm	High performance	ETQP5M***YLC	5	0.33 - 2	10 G	-40°C to +150°C	31.3 - 56.7
		ETQP6M***YLC	6	1.5 - 14	10 G		11.2 - 32
	High vibration	ETQP5M***YSC	5	0.68 - 44	50 G		29.8 - 40
		ETQP6M2R5YSC	6	2.5	50 G		23.7
12.6x13.2mm	Large current	ETQP8M***JFA	8	0.68 - 4.7	30 G	-40°C to +160°C	24.7 - 56.9
15.6x17.2mm		ETQPAM***JFW	10.5	0.33 - 0.68			71-103



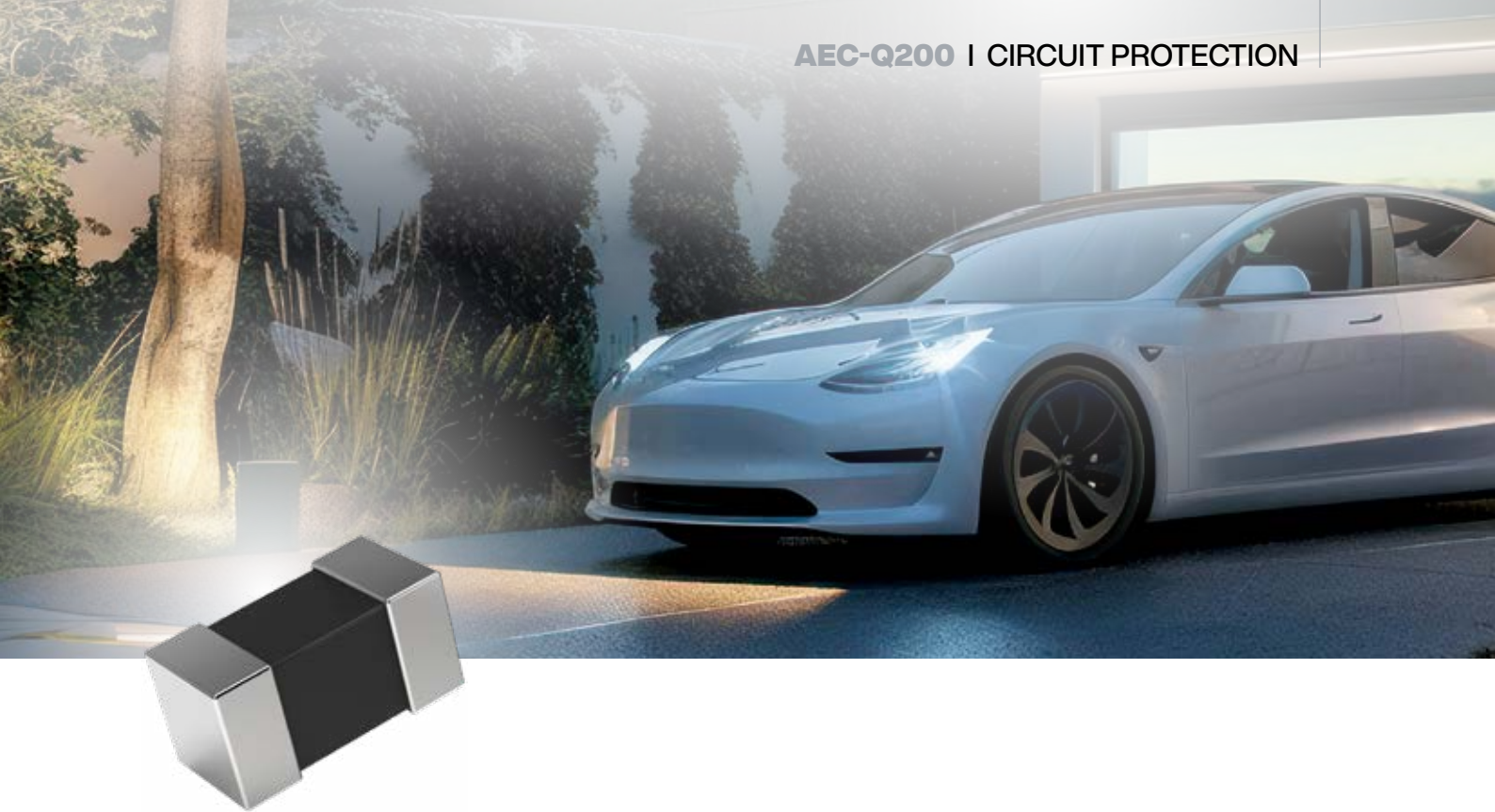
PASSIVE COMPONENTS - RESISTORS

Chip Resistors

Panasonic offers a wide range of high-specifications resistors with properties that can meet the demands of the automotive market:

- The thin film ERA*A series offers high reliability even in high temperature and high humidity environments. They are optimal for use in-vehicle control circuits. The high-end ERA*V series offers additional properties in terms of sulphuration resistance, highest power and voltage for the same case size and ESD withstand.
- The small & high-power thick film resistors include ERJP, which present anti-surge properties, ERJH with improved temperature range and ERJS/U for anti-sulphurated specifications. All Panasonic thick-film resistors present high reliability under temperature cycles with improved solder cracking resistance thanks to their soft termination structure.
- For current sensing, Panasonic offers a wide range of thick-film resistors which allow to reduce costs compared to metal plate technology. The ERJ*BW/CW series with their double-sided structures and the ERJB/D series with wide terminal shunts enable low resistance values at a maximum power rating of 2W.

Resistors	
Series	Description
ERA*A	Thin film – high reliability
ERA*V/K	Thin film – high stability and reliability
ERA* P	Thin film - high voltage
ERJS, ERJU, ERJUP ,ERJU*R except for ERJU0X/U01	Thick film – anti-sulphurated
ERJC	Thick film – anti-sulphurated & wide terminal
ERJPB	Thick film – high precision
ERJPA, ERJPO, ERJT, ERJPM8	Thick film – anti-surge & anti-pulse
ERJH, ERJHP	Thick film – high temperature
ERJ*BS/Q, ERJ*DS/Q, ERJ*RS/Q, ERJ12ZS/Q, ERJ1TRS/Q, ERJL*	Thick film – low resistance
ERJ*LW, ERJ*BW, ERJ*CW	Thick film – low resistance – double-sided
ERJA, ERJB, ERJD	Thick film – low resistance – wide terminal
ERJ2G, ERJ2RK, ERJ2RH, ERJ2RCF, ERJ3G, ERJ3EK, ERJ3RB, ERJ3RE, ERJ6GE, ERJ6EN, ERJ6RB, ERJ6RE	Thick film – standard
ERJ8G, ERJ8ENF, ERJ1T, ERJ12, ERJ14	Thick film – standard (NRND)
ERJMS4	Metal plate



PASSIVE COMPONENTS - CIRCUIT PROTECTION

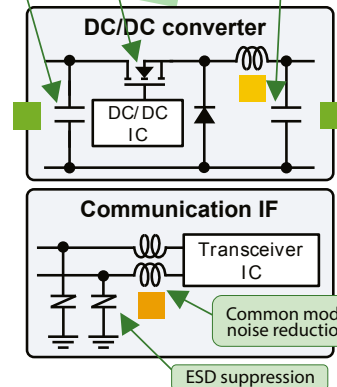
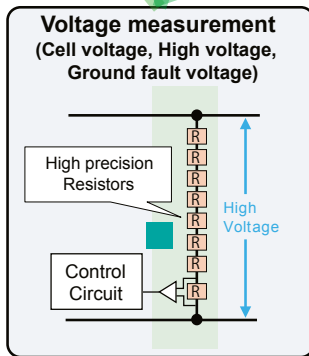
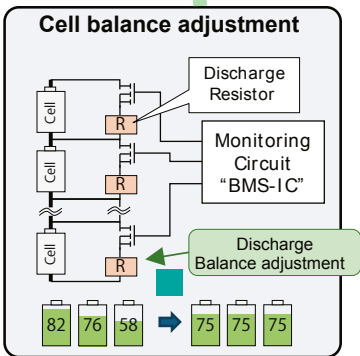
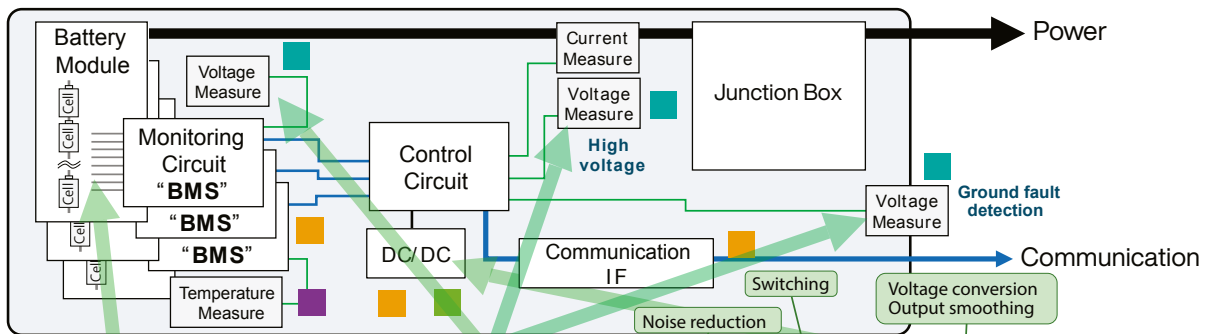
Circuit protection	
NTC Thermistors	
ERT-J0*****M	NTC Thermistor, SMT, 0402
ERT-J1*****M	NTC Thermistor, SMT, 0603
ZNR surge absorbers	
ERZ-HF2M220D	ZNR Surge Absorbers, SMT, 8.0x6.4x5.5mm
Multilayer varistors	
EZJ-P0*****M	Multilayer Varistors, SMT, 0402
EZJ-P1*****M	Multilayer Varistors, SMT, 0603, -55~150°C
EZJ-Z1*****M	Multilayer Varistors, SMT, 0603, -55~125°C
EZJ-Z2Y390KM	Multilayer Varistors, SMT, 0805
ESD suppressor	
EZAEG3W11AV	ESD suppressor – high withstand type



EXAMPLE APPLICATION

Battery Management System

Block Diagram:



Our devices	
■	Hybrid capacitor
■	Power inductor
■	SMD resistor
■	Chip varistor
■	Thermistor

Design consideration

- EMI/EMC performance
- Voltage and current rating
- High reliability
- Heat dissipation properties

Recommended product

Capacitor

- Hybrid capacitors ([ZC](#) / [ZL](#) / [ZK](#) / [ZKU](#))

Power inductor

- Low cost / low profile series ([LE](#) / [LP](#))
- High current series ([ETQP*](#)/[JF*](#))

Circuit protection

- Chip varistors ([EZJ](#))
- Thermistor ([ERT/0402](#) size)

Resistor

- High power resistors ([ERJP](#))
- High voltage resistors ([ERJPM](#) / [ERA8P](#))
- Low ohmic resistors / wide terminal shunt resistors ([ERJB](#) / [ERJD](#))
- High precision resistors ([ERA*A](#))

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