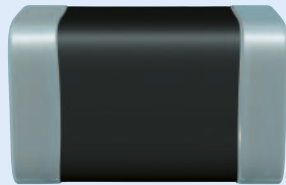


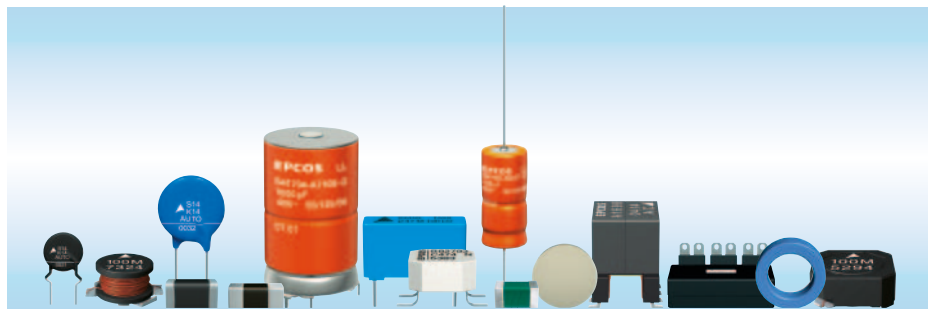
EPCOS Application Guide 2012

Automotive

Electronic Components for e-Mobility Applications



EPCOS Components for e-Mobility Applications



At the core of e-mobility are electric drives in both cars and other motorized vehicles such as electric bikes or scooters. The demands on the drive electronics is raising the requirements on the electronic components, modules and systems used. Its strong technology and product portfolio makes us a competent and innovative partner for manufacturers of hybrid and electric vehicles. We enable the development of technologically superior solutions, especially with our components for use in converters and in the powertrain.

We provide solutions based on EPCOS film capacitors for all applications designed to store electrical energy in the DC link circuit and for suppression of ripple voltages. Key components here are the power capacitor chips, or PCC™ that feature flexible dimensions and form factor as required by the respective application. We also offer a wide range of power inductors and transformers with rated powers of up to 3 kW for use in power conversion systems. As the electric motor dissipates no usable heat to warm the vehicles, EVs require supplementary heating units. Our new EPCOS PTC heating elements are very well suited for this purpose and can be connected directly to the high-voltage battery.

On the following pages you will find further special features that distinguish our products and solutions for use in e-mobility applications.

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EPCOS Components for e-Mobility Applications

Special Features



Aluminum Electrolytic Capacitors

- Capacitors with AEC-Q200 qualification available

Axial-lead and soldering star series

- High vibration resistance up to 40 g
- High ripple-current capability with low ESR at high temperatures

Snap-in series

- Design for on-board charger applications with high capacitance values

Ceramic Transient Voltage Suppressors (CTVS) - MLVs and CU varistors

- Reliable ESD protection up to 25 kV for high-speed data buses
- Highly rugged on extreme thermal cycles and repetitive pulses
- Automotive grade ratings (load-dump, jump-start)
- Nickel barrier series acc. to AEC-Q200

Ferrites

- Recommended materials for automotive applications: N49, N87, N92, N95, N97
- CAN bus choke materials: K1, K10
- Suitability of other materials depends on transformer design
- Wide range of ferrite accessories

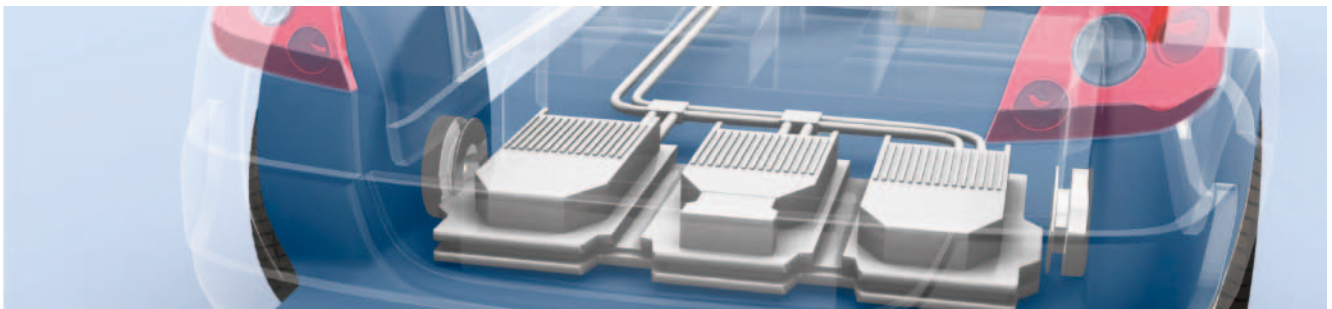
Film Capacitors (medium power)

- Long-term stability
- High pulse strength
- Excellent overvoltage capability
- Very low inductance
- Low fire hazard due to liquid-free technology
- Standard and customized designs
- Capacitors with AEC-Q200 qualification available

Inductors

- Wide temperature range from -55 °C to +150 °C
- Miniaturized versions
- High mechanical strength
- Suitable for lead-free soldering profiles acc. to JEDEC J-STD 020D
- Qualified acc. to AEC-Q200

EPCOS Components for e-Mobility Applications



NTC Thermistors

Glass-encapsulated NTCs, leaded NTCs, temperature probes

- High measuring accuracy and long-term stability
- Short response time
- Temperature measurement up to +260 °C
- Heat resistant and highly stable
- Rugged design
- Compact dimensions
- Overmolded package
- Cable-bound or integrated connector versions
- Humidity resistant
- Customer-specific designs

Inrush current limiters

- Long-term stability
- No derating of steady state current necessary at 0 °C and +60 °C
- Usable in series connections up to 265 V RMS

SMD NTCs

- Qualified acc. to AEC-Q200

Power Capacitors

- Power capacitor chips (PCC) for DC-link function
- Long-term stability
- High pulse handling capability
- High peak and RMS current handling capability
- High overvoltage strength up to twice the rated voltage
- Very low inductance (max. 20 nH)
- Low fire hazard due to liquid-free technology
- Standard and customized designs

PTC Thermistors

- Limit temperature sensors
- Inrush current limiters (self-protecting resistors)
- Heating elements

Surge Arresters

- Very high discharge current
- Excellent protection characteristics
- Stable performance over useful life
- Very high insulation resistance
- EN 61643-11 class III

Transformers

- Material class –40 °C to +155 °C
- High power density
- Advanced thermal behaviour
- Platform designs qualified acc. to AEC-Q200

Varistors

Leaded disk varistors





- Stable protection level
- Minimum leakage current
- High resistance to cyclic temperature stress

EPCOS Components for e-Mobility Applications

Overview									
	Battery management systems	Boost converters	Car and battery climatization	DC/DC converters	Electrical motors	Lithium ion battery - cell management	Motor inverters	On-board chargers	Wall chargers
Aluminum electrolytic capacitors									
Axial-lead and soldering star		•		•			•		
Snap-in								•	•
Ceramic transient voltage suppressors (CTVS) - MLVs and CU varistors									
Automotive series	•					•		•	
CU varistors		•		•				•	
Ferrites									
E, ELP cores	•			•					
PM, PQ cores								•	•
Quader cores									•
Ring cores				•			•		
RM, RM LP cores								•	•
Film capacitors (medium power)									
MKP		•		•			•	•	•
MKT		•		•			•	•	•
Y2, X2		•		•			•	•	•
Inductors									
CAN-/ FlexRay bus chokes	•		•	•		•	•	•	
Power inductors	•		•	•		•		•	
SIMID 0603 ... 2220	•		•	•					
NTC thermistors									
Glass-encapsulated NTCs	•	•	•	•		•	•	•	•
Inrush current limiters								•	•
Leaded NTCs	•	•	•	•		•	•	•	•
SMD NTCs	•	•	•	•	•	•	•	•	•
Temperature probes	•	•	•	•	•	•	•	•	•
Power capacitors									
Power capacitor chips (PCC LP)				•	•		•	•	
PTC thermistors									
Heating elements			•						
Inrush current limiters (self-protecting resistors)	•	•		•			•	•	•
SMD PTCs	•					•			
Surge arresters									
EF type series								•	•
Transformers									
Current-sense transformers				•			•	•	
Gate-drive transformers				•			•	•	
Power chokes				•				•	
Power transformers				•				•	
Varistors									
EnergetiQ series Q14, Q20									•
ETFV14, ETFV20, ETFV25									•
Leaded disk varistors S14, S20								•	•




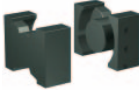








EPCOS Components for e-Mobility Applications



Characteristics				
Series		Technical data	Features	Ordering code/ type
Aluminum electrolytic capacitors				
Axial-lead and soldering star		V_R : 25 ... 250 V DC	Large can size available (up to 21 × 49 mm) in different mechanical constructions	B41690/B41790
		C_R : 22 ... 10000 μ F		B41691/B41791 B41693/B41793
Snap-in		V_R : 150 ... 470 V DC C_R : 220 ... 560 μ F	Compact can size (30 × 30 ... 35 × 50 mm) Different terminal configurations available, e.g. 3 terminals (4.5 mm) Special design for high vibration resistance available	B43504 Upon request
Ceramic transient voltage suppressors (CTVS) - MLVs and CU varistors				
Automotive series		Temperature range up to +125 °C	Bidirectional ESD protection acc. to ISO 10606 and IEC 61000-4-2 Level 4 Load-dump and/ or jump-start pulse protection Qualified acc. to AEC-Q200	B72500T...
		V_R : 15 ... 34 V DC C_R : 10 pF ... 10 μ F V_{RMS} : 14 ... 30 V AC W_{LD} : 1 ... 25 J Case sizes: 0603, 0805, 1206, 1210, 1812, 2220		B72510T... B72520T... B72530T... B72540V... B72542V... B72580V... B72582V...
		Temperature range up to +150 °C		B72500E... B72510E... B72520E... B72530E... B72540E... B72590E...
CU varistors		V_R : 16 ... 34 V DC C_R : 600 ... 2300 pF V_{RMS} : 14 ... 30 V AC W_{LD} : 6 ... 12 J Case sizes: 3225, 4032	Jump-start and load-dump protection acc. to ISO 7637, pulse 5 Overvoltage protection in replacement of standard disk varistors (5 and 7 mm diameter) Qualified acc. to AEC-Q200	B72650M... B72660M...

EPCOS Components for e-Mobility Applications



Characteristics				
Series		Technical data	Features	Ordering code/ type
Ferrites				
E cores		Material: N27, N30, N87, N97 A_L : 30 ... 12100 nH	E and ELP cores are available in a wide variety of sizes E and ELP cores are supplied in single units	E 5 ... E 80
ELP cores		Material: N49, N87, N92, N97 A_L : 160 ... 12500 nH		ELP 14 ... ELP 64
PM cores		Material: N27, N87, N97 A_L : 250 ... 16000 nH	PM cores are suitable for high-power transformers and energy storage chokes PM cores are supplied in sets	PM 50 .. PM 114
PQ cores		Material: N49, N87, N95, N97 A_L : 250 ... 6700 nH	PQ cores are a preferred shape for power conversion PQ cores are supplied in sets	PQ 20 ... PQ 50
Quader cores		Material: K1, N27, N87, N92, N97 A_L : 70 ... 21300 nH	Quader cores can be used for contact-less power transfer applications	B67410
Ring cores		Material: K1, K10, N27, N30, N87, T35, T37, T38, T65 A_L : 70 ... 21300 nH	Ring cores are primarily used as EMC chokes for suppressing RF interference	R 2.5 ... R 202
RM cores		Material: K1, M33, N30, N41, N48, N49, N87, N92, N97, T35, T38 A_L : 16 ... 16000 nH	RM cores are ideal for low-loss/highly stable filter coils Sizes are specified according to IEC 60431 RM cores are supplied in sets	RM 4 ... RM 14
RM cores Low Profile		Material: N49, N87, N95 A_L : 160 ... 11500 nH	Low-profile cores are acc. to IEC 61860 Low-profile cores are supplied in sets	RM 4 LP ... RM 14 LP
Film capacitors (medium power)				
MKP		V_R : 450 ... 1300 V DC C_R : 1 nF ... 110 μ F	High current capability Low ESR 2-pin and 4-pin versions available	B32674 ... B32678 B32774 ... B32778
MKT		V_R : 63 ... 630 V DC C_R : 1 nF ... 220 μ F	High pulse strength High contact reliability	B32520 ... B32529
X2		V_R : 305 V AC C_R : 10 nF ... 10 μ F	All necessary safety approvals: ENEC, UL, CSA	B32921 ... B32926 B32932 ... B32936
Y2		V_R : 300 V AC C_R : 1 nF ... 1 μ F	All necessary safety approvals: ENEC, UL, CSA	B32021 ... B32926

EPCOS Components for e-Mobility Applications



Characteristics				
Series		Technical data	Features	Ordering code/ type
Inductors				
CAN-/ FlexRay bus chokes		L_R : 5 μ H ... 4.7 mH I_R : up to 1.2 A	Miniaturized types ACT45B, B82789 in size 1812 Bifilar and sector winding Temperatures up to +150 °C For reflow soldering and gluing	ACT45B (B82787...) B82789C0... B82789S0... B82793C0... B82793S0...
Power inductors		L_R : 0.82 ... 1000 μ H I_R : up to 11 A Case sizes: 6 x 6 ... 12 x 12 mm	Shielded and unshielded versions Low DC resistance Temperature up to +150 °C Qualified acc. to AEC-Q200	B82462A... B82462G... B82464A... B82464G... B82464P... B82472P... B82473M... B82475M... B82477P...
SIMID 0603-C		L_R : 1 ... 220 nH I_R : 110 ... 1800 mA Case size: 0603	Copper plated ceramic core Laser cut winding Epoxy coated	B82496C...
SIMID 0805-F		L_R : 2.7 ... 820 nH I_R : 180 ... 1000 mA Case size: 0805	Cubic coil with ceramic core Epoxy molded flat top for vacuum pickup Winding ends welded to the terminals	B82498F...
SIMID 1210-H		L_R : 0.1 ... 680 μ H I_R : 61 ... 2050 mA Case size: 1210	Ferrite drum core Laser welded winding Flame retardant molding	B82422H...
SIMID 1812-T/C		L_R : 1 ... 1000 μ H I_R : 55 ... 1300 mA Case size: 1812	Ferrite drum core Laser welded winding Flame retardant molding	B82432C...
				B82432T...
SIMID 2220		L_R : 1 μ H ... 10 mH I_R : 25 ... 3510 mA Case size: 2220	Ferrite drum core Laser welded winding Flame retardant molding	B82442...






EPCOS Components for e-Mobility Applications



Characteristics				
Series		Technical data	Features	Ordering code/ type
NTC thermistors				
Glass-encapsulated NTCs G1541 G1551 G1561		Temperature range: -55 ... +260 °C (G1541: +250 °C) Rated resistance at +25 °C: 2 ... 100 kΩ Resistance tolerance: ±1% ... ±5% Insulation resistance: > 100 MΩ 500 V DC (1 s)	High-temperature resistant Insulated wires with high insulation voltage Non-standard wire configurations	B57541G1... B57551G1... B57561G1...
Inrush current limiters S364		Rated resistance at 25 °C: 1 ... 10 Ω I_{max} : up to 16 A V_{RMS} : 265 V	Limiting of inrush current Taped versions for automatic processing UL approval (E69802) High accuracy and easy mounting Lead spacing 5 and 7.5 mm	B57***S***M...
Leaded NTCs S86* S87* S88* S964 S971 S981		Temperature range: -55 ... +155 °C Rated resistance at +25 °C: 2 ... 100 kΩ Resistance tolerance: ±1% ... ±5%	Nonstandard lead configurations Taped versions for automatic processing Lead spacing 2.5 and 5.0 mm (S87*, S88*) UL approval (S86*)	B5786*S... B5787*S... B5788*S... B579**S...
SMD NTCs		Temperature range: -40 ... +150 °C Rated resistance at 25 °C: 4.7 ... 100 kΩ Case sizes: 0402, 0603, 0805 Resistance tolerance: ±3%, ±5% (±1% for selected types) B-tolerance: ±3% (±1% for selected types)	Qualified acc. to AEC-Q200 Operating temperatures up to +150 °C	B57***V5...
Temperature probes Surface temperature sensor for battery temperature		Temperature range: -40 ... +125 °C	Robust design Easy mounting Short response time	Upon request
Outside temperature sensor		Temperature range: -40 ... +85 °C IP6K6, IPX9K for 30 s	Water immersion test: 2000 h/ +80 °C Thermal cycling: 480 cycles with applied voltage 120000 cycles on/off Thermal shock: 200 cycles in air transition time < 30 s	Upon request

EPCOS Components for e-Mobility Applications



Characteristics				
Series		Technical data	Features	Ordering code/ type
Power capacitors				
Power capacitor chips: PCC LP		V_R : 100 ... 1000 V DC C_R : 100 ... 3000 μ F Temperature range: -40 ... +105 °C Short time operation: max. +125 °C	Volume fill factor of nearly 1 Low inductance (max. 20 nH) Long useful life (approx. 10000 h) Standard and customized designs	B25655J... B25655M...
PTC thermistors				
Heating elements		Round and rectangular disks available	Self-protecting Wide range of temperatures, resistances and sizes Customer-specific solutions available	Upon request
Inrush current limiters (self-protecting resistors)		R_R : 22 Ω , $V_{link,max}$: 360 V	Small size	B59105J0130A020
		R_R : 56 Ω , $V_{link,max}$: 620 V	Self-protecting	B59107J0130A020
		R_R : 100 Ω , $V_{link,max}$: 800 V	Customer-specific solutions available	B59109J0130A020
SMD PTCs		V_{max} : 32V Rated resistance: 470 Ω Temperature tolerance: \pm 5 °C Case sizes: 0402, 0603, 0805	Qualified according to AEC-Q200 Lead-free tinned terminations	B59721A... B59641A... B59421A...
Surge arresters				
EF		DC breakdown voltage: 270, 470, 600, 800, 1500, 2500 V Max. discharge current 8/20 μ s: 10 kA	High discharge current and isolation resistance High follow current High voltage types available Application in series with MOV Small size	B88069X2641... B88069X4131... B88069X4301... B88069X5080... B88069X5690... B88069X6461...

EPCOS Components for e-Mobility Applications



Characteristics				
Series		Technical data	Features	Ordering code/ type
Transformers				
Current-sense transformers (CTEM series): EP7		I_{sense} : up to 20 A _{RMS}	Basic isolation High inductance values > 7 mH	B78*
Gate-drive transformers (GTEM series): R6.3, R10		$V \times t$: up to 150 μ Vs bipolar	Basic isolation Small coupling capacity < 10 pF	B78*
Power chokes (PCEM series): ER47, ER51		L_R : 1 ... 3 μ H I_R : up to 210 A	Basic isolation Low DC resistance	B78*
Power transformers (PTEM series): ER52, ER60		Power: 1800 ... 3000 W $U_{in,typ}$: 240 ... 420 V $U_{out,typ}$: 14 ... 18 V	Basic isolation New cooling concept	B78*
Varistors				
ThermoFuse varistors ETFV14 ETFV20 ETFV25	  	I_{max} 8/20 μ s: 6 kA I_{max} 8/20 μ s: 10 kA I_{max} 8/20 μ s: 20 kA V_{RMS} : 130 ... 420 V	Disk varistor and fuse in one housing Space saving Monitoring option with 3 rd lead UL approval to UL 1449	B72214T... B72220T... B72225T...
EnergetiQ varistors Q14 Q20	 	I_{max} 8/20 μ s: 8 kA I_{max} 8/20 μ s: 15 kA V_{RMS} : 130 ... 460 V	Maximum load capacity at minimum component Height miniaturization High surge current rating up to 15 kA	B72214Q... B72220Q...
Leaded disk varistors S14 S20	 	I_{max} 8/20 μ s: up to 6 kA I_{max} 8/20 μ s: up to 12 kA V_{RMS} : 11 ... 1100 V	High surge current ratings up to 12 kA High energy ratings (2 ms) up to 440 J For high energy absorption	B72214S... B72220S...

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The following applies to all products named in this publication:

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