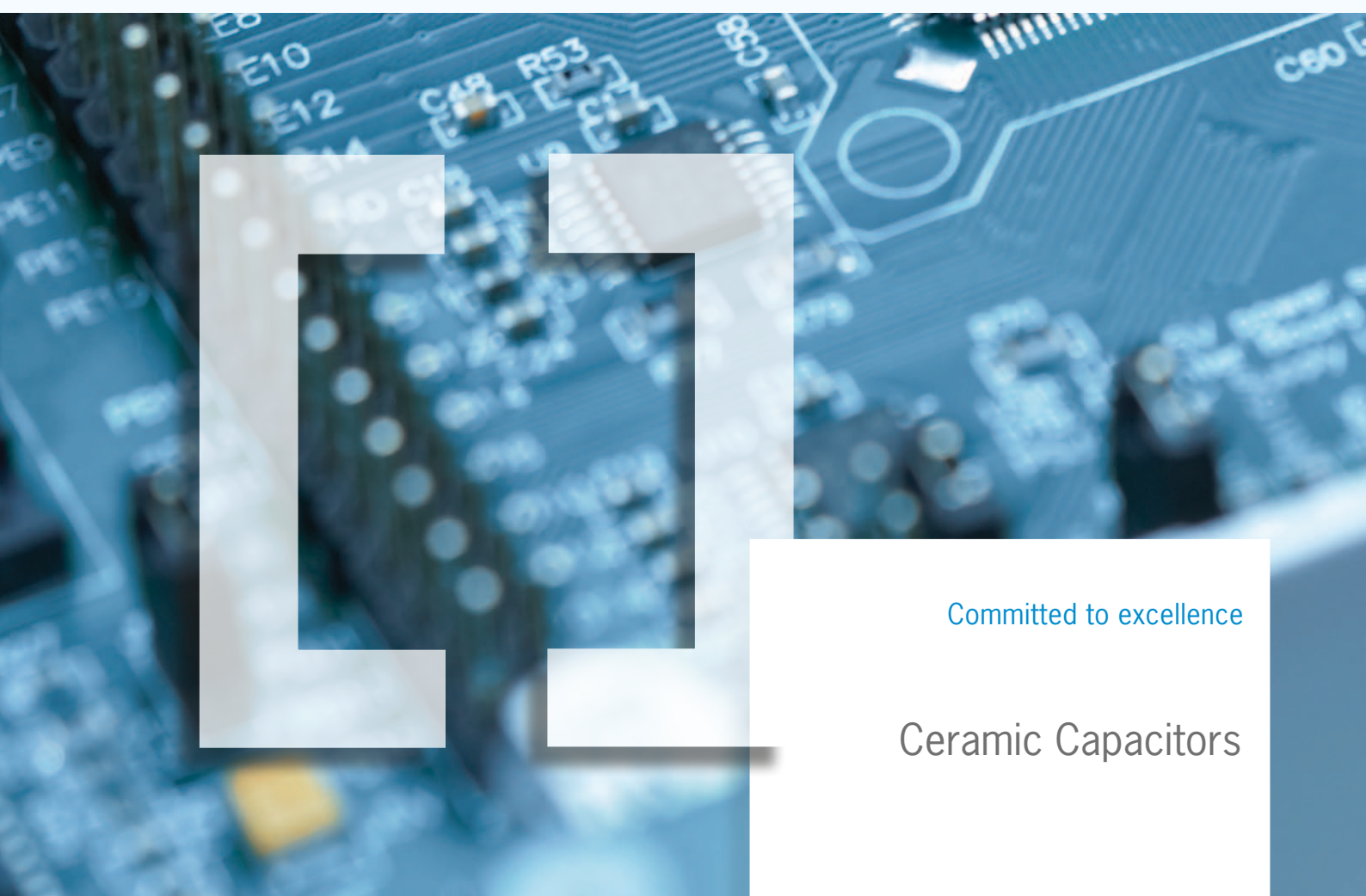




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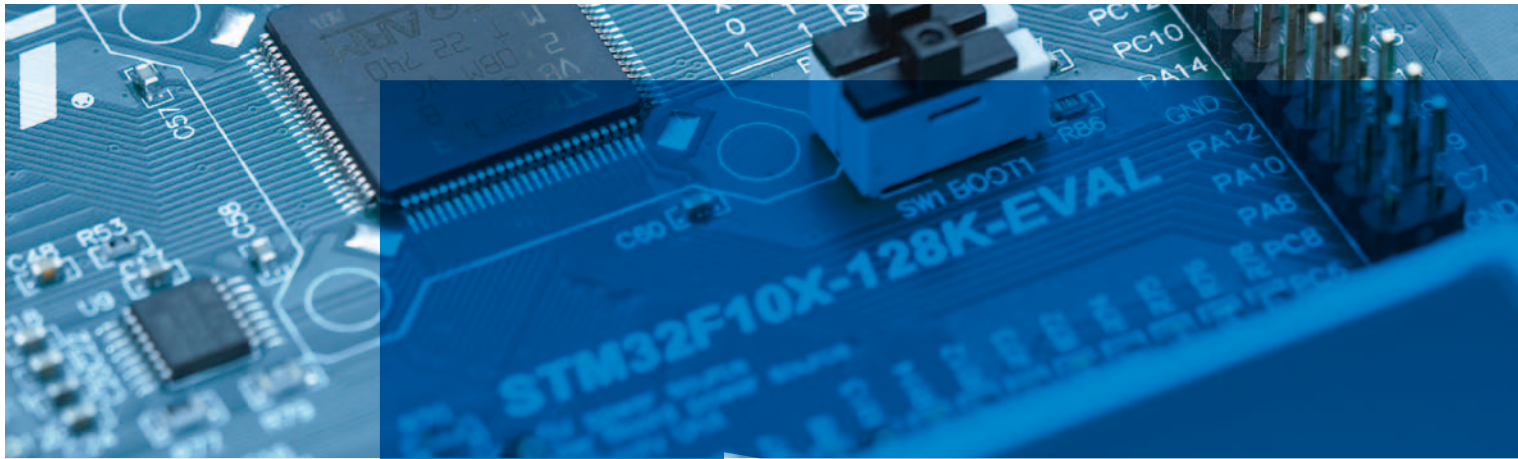
Passive Components



Committed to excellence

Ceramic Capacitors

Consult | Components | Logistics | Support



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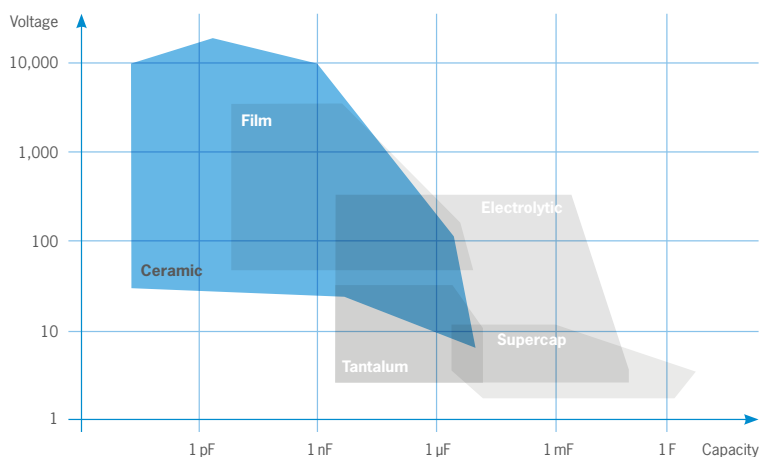
We are one of the leading distributors for electronic components on the world market. As we generate about one fourth of our total turnover with passive components, they represent an important business unit at Rutronik. Our focus is to provide a comprehensive product portfolio combined with high quality and technical standards.

Ceramic Capacitors with the widest range of capacity and voltage

Ceramic Capacitors have the highest electrical performance. Based on the function, the parts are more and more specialised with increased requests for automotive AEC-Q200 specifications and rising RFQ of High Cap / Voltage.

We offer you:

- Worldwide franchises with major manufacturers and world market leaders for electronic components
- High reliability due to multiple suppliers for the same products
- Competent product consulting and technical support based on exceptional expertise of product specialists with great market experience
- Complete supply chain with innovative inventory management via VMI and flexible DI solutions for calculation of processing costs

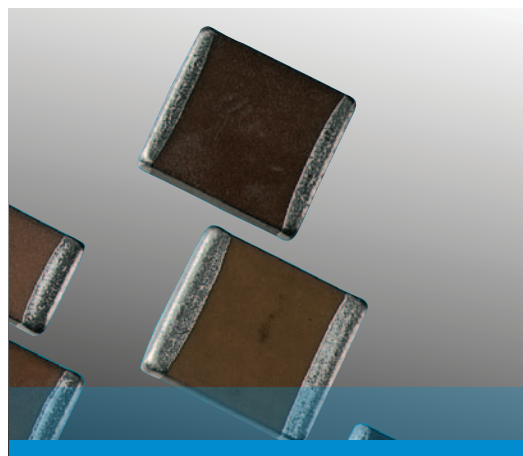
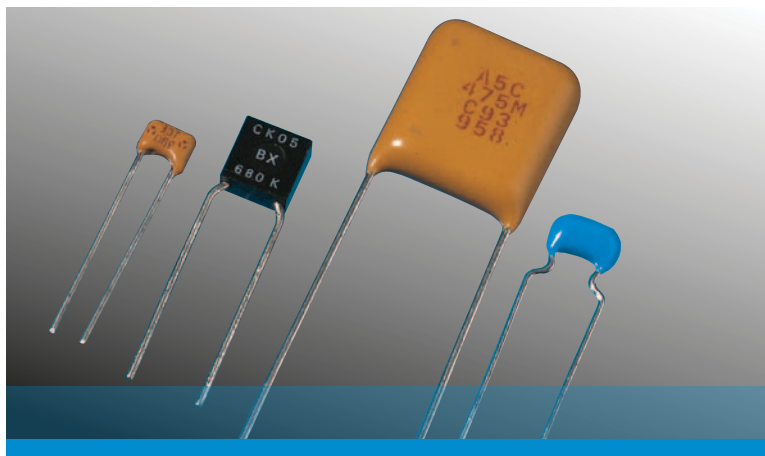


Our Product portfolio

	Semiconductors
	Passive Components
	Electromechanical Components
	Displays & Boards
	Storage Technologies
	Wireless Technologies
	Lighting Solutions
	Photovoltaic Solutions

Our key customer list includes leading companies in the following sectors: Industrial, Automotive, Consumer, Telecommunications, Information, Communication and Medical.





Overview. Quick Guide to Ceramic Capacitors.

Figure				
Type	Multilayer Chip, Type KC	AEC-Q200-Types	Multilayer Chip Array, Type KN	Multilayer Leaded, Radial+Axial Type KV
Size / Leadspace	01005, 0201, 0402, 0603, 0805 , 1206, 1210, 1808, 1812, 2211, 2220, 2225, 3640	0402, 0603, 0805, 1206, 1210, 1812, 2220	0612, 0508, 0405 (0203, 0306 in development) (2 or/and 4 caps)	Leadspace 2.5, 5.0, 7.5, 10
Ceramic	NP0(COG), X5R/X7R/X8R, X8L, Y5V	NP0(COG), X7R, X8R, X8L	NP0(COG), X5R/X7R, Y5V	NP0(COG), X7R, Z5U/Y5V
Voltage	4.0V 5 kV	10V 3 kV	6.3V 100V	25V 630V
Capacity	0.47 pF - 220 μ F	0.47 pF - 47 μ F	10 pF - 2.2 μ F	1 pF - 10 μ F
Notice	Also available with: ■ Soft Termination ■ Open Mode ■ + 150°C Spec.	Also available with: ■ Soft Termination ■ Open Mode ■ Float Mode Design ■ + 150°C Spec.	AEC-Q200 – Types available	AEC-Q200 & +150°C (X8R) Types available!

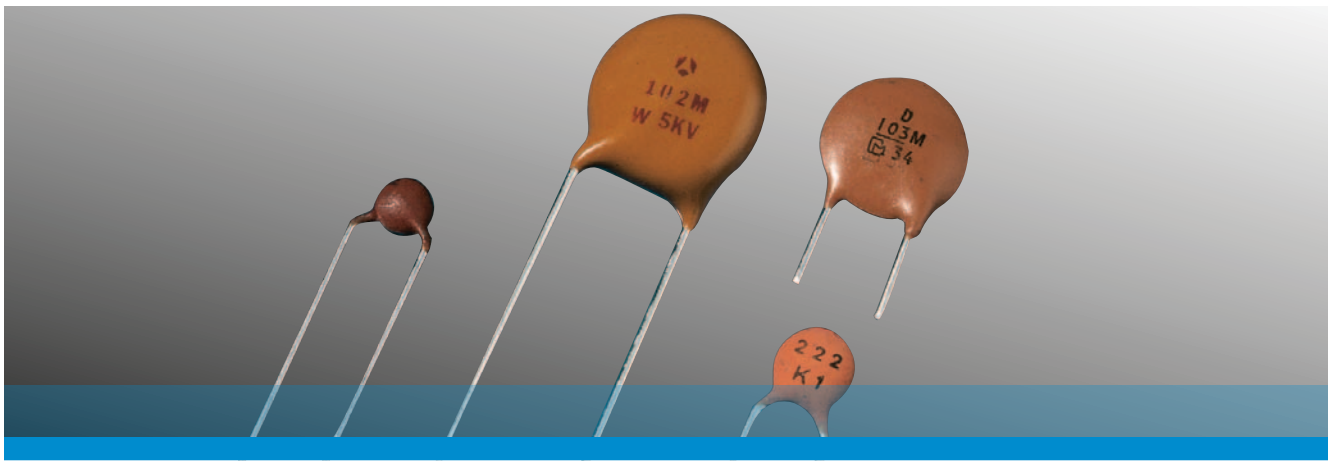


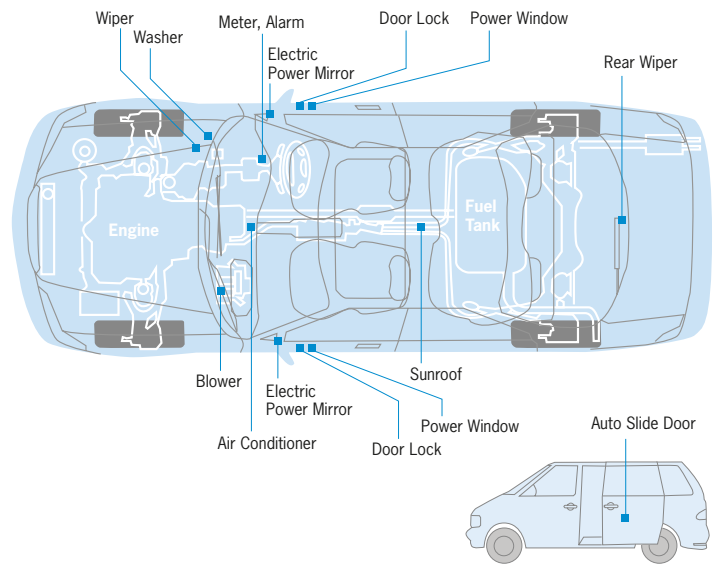
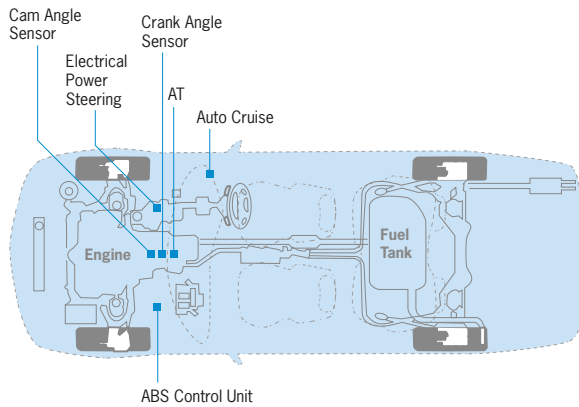
Figure				
Type	Multilayer Advanced, Type KVA	Single Layer (Disc), Type KE	Suppression (Safety), Type KF	Special Capacitors
Size / Leadspace	2-, 4- leads, Dual inline, Chip and leaded and several others	Leadspace 2.5, 5.0, 7.5, 10, 15	X-Y-Class X2, Y3, Y2, X1Y2, X1Y1; Leaded LSP 5.0, 7.5, 10, 12.5 & Chip (1808 - 2220)	„MegaCap“; Plate and cylindrical types; Pot-Caps; Feed-thru Array
Ceramic	NPO (COG), X7R, Z5U	P100, NPO(COG), N1500; 2B4, Y5E,Y5V (B, C, .. F)	NP0, X7R, Y5P, Y5U, (B, E,)	High Frequency, RF Microwave; „Silicon“-SMD-Caps; Low Inductance
Voltage	25V 5kV	50V 15kV	250Vac (300Vac, 440Vac)	Tip&Ring-Caps; „X2Y“-Filter; and others
Capacity	10pF - 1300µF	1.0pF - 100nF	10pF - 56nF	
Notice	Military and ESA types available!	Still in program!	Attention: also chips available!	



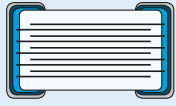
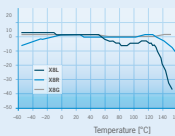
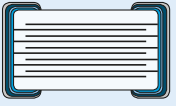
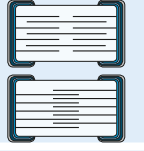
Overview. Quick Guide MLCC (**M**ulti**L**ayer**C**eramic**C**hip).

Type	Standard			Automotive qualified AEC-Q200	Short circuit protection (Also AEC-Q200 qualified available)	High temp. +150°C spec. (Also AEC-Q200 qualified available)
Size-Range	01005 to 2220	01005 to 2220	0201 to 2220	0402 to 2220	0603 to 2220	0603 to 1812
Ceramic	NP0 (COG)	X5R/X7R	Y5V	NP0 (COG)/X7R	X7R	X8R, X8L, X8G
Temperature	-55 to +125 °C	-55 to +85/+125 °C	-30 to +85 °C	-55 to +125 °C	-55 to +125 °C	-55 to +150 °C
Temperature Drift	±30 ppm/°C	±15%	+22/-85 %	like standard	like standard	X8R: ±15 % X8L: +15/-40 % X8G: ±30 ppm/°C
Tolerance (Std.)	±0.25 pF/±5 %	±10%	-20+80 %	±0.25 pF/ ±5%/±10 %	±0.25 pF/ ±5%/±10 %	±0.25 pF/ ±5%/±10 %
E-Series	E-24	E-12	E-6	E-12/E-6	E-6	E-6
Voltage	10V to 5kV	4.0V to 5kV	4.0V to 250V	6.3V to 3kV	10V to 3kV	16V to 100V
Preferred Range	1.0 pF to 1.0 nF E-12 up to 10 nF E-6 values	1.0 nF to 1.0 µF E-6 up to 220 µF E-3 values	1.0 µF to 47 µF E-3 values	10 pF to 1.0 µF E-6 up to 47 µF E-3 values	On request	On request
Comment				Also available: Arrays AEC-Q200 qualified	Soft Termination Open Mode Design Float Mode Design	Also available as leaded version
Supplier	AVX, Murata, Samsung, TDK, Vishay, Yageo (Phycomp)			AVX, Murata, Samsung, TDK, Vishay		AVX, Murata, Vishay, TDK
Special Chips	250 Vac types, with supression-approval too = „Safety“-SMD; 2- and 4-Cap-Arrays; other sizes, e.g. 01005; Multi-Chip-Constructions; High Frequency, FR, Microwave; Feedthru; and several other specials on request					

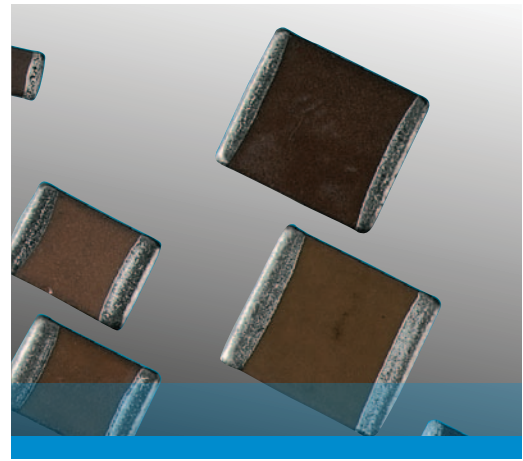
Examples for several automotive application



Choose the right MLCC. Comparison of different versions.

Figure	    					
Type version	Standard	AEC-Q200	+150°C - specified	Flexitem/ Soft Termination	OpenMode/ FR-Design	Combined Design
	Commercial Parts	Automotive qualified	High Temperature	Other names are e.g. Soft, Polymer, Flexible Termination, Softelectrode, FlexiCap		Flexitem/Softtermination with Cascade-Design (Floating-, Serial-Electrode) or Open Mode Design
Generally	Standard Specs and qualifications	Increased sample plans with more and higher criteria	Standard Specs and qualifications, but specified up to +150°C	Standard Specs and qualifications, but: - bending strength > 5mm - tendency to open beyond	Standard Specs and qualifications, but construction avoids a short circuit caused by typical bending cracks	AEC-Q200- Spec. Highest protection against short circuit
Bending strength	1mm (some 2mm)	NPO 3mm, X7R 2mm	1 mm (some 2mm)	X7R > 5 mm	1 mm	X7R > 5mm
Temp.-Cycles	5 cycles	1000 cycles	5 cycles	3000 cycles (AVX)	5 cycles	3000 cycles (AVX)
Thermal shock	no	yes	no	no	no	yes
Visual check	by sample plan	100%	by sample plan	by sample plan	by sample plan	100%
Other differences see detailed specifications supplier by supplier, e.g. vibration, ESD, high temperature exposure (storage), moisture resistance, etc.						
Ceramic	NPO (COG), X5R/X7R/X8R, Y5V	NPO (COG), X7R, X8R (L)	X8G, X8R, X8L	X7R	X7R, X8R, X5R	X7R
Voltage	4.0V ... 5kV	10V ... 3kV	10V ... 100V	10V ... 3kV	16V ... 630V	16V - 100V
Capacitance	0.47 pF ... 220 µF	0.47 pF ... 47 µF	100 pF ... 4.7 µF (up to 10 µF dev.)	200 pF ... 22 µF	150 pF ... 22 µF	1.0nF ... 1.0 µF
Notice		Many items also available as Soft Termination / Open Mode / +150°C	Also available as AEC-Q200 or/and Soft Termination	Also available as +150°C or/and AEC-Q200	Also available as AEC-Q200	AEC-Q200- Spec. Highest protection against short circuit

AEC-Q200 is an international standard with enhanced stress test qualification.



Increase Capacitance. High Cap MLCC.

Definition		Types									
Size Dimensions	Ceramic	X5R					X7R				
	Temperature	-55 to +85 °C					-55 to +125 °C				
	Tolerance	±10% / ±20%					±10% / ±20%				
	Voltage	25V	16V	10V	6.3V	50V	25V	16V	10V	6.3V	
0402 1.0x0.5 mm	Capacitance	1.0 µF	2.2 µF	10 µF	10 µF	100 nF	100 nF	220 nF	470 nF	1.0 µF	
0603 1.0x0.5 mm	Capacitance	10 µF	10 µF	22 µF	22 µF	1.0 µF	1.0 µF	1.0 µF	2.2 µF	10 µF	
0805 2.0x1.25 mm	Capacitance	22 µF	22 µF	22 µF	47 µF	2.2 µF	4.7 µF	10 µF	10 µF	22 µF	
1206 3.2x1.6 mm	Capacitance	22 µF	47 µF	100 µF	100 µF	10 µF	10 µF	10 µF	22 µF	22 µF	
1210 3.2x2.5 mm	Capacitance	22 µF	100 µF	100 µF	220 µF	10 µF	22 µF	22 µF	47 µF	100 µF	

For highest volumetric efficiency and also for replacements against higher nominal cap. values in tantalum or electrolytic caps Rutronik offers together with the world's leading MLCC-manufacturers a wide range of High-CV-Chips including world's top values in „materials“ X5R and X7R.

Available from: AVX, Murata, Samsung, TDK, Yageo.



Advanced. Leadframe and stacked MLCC.

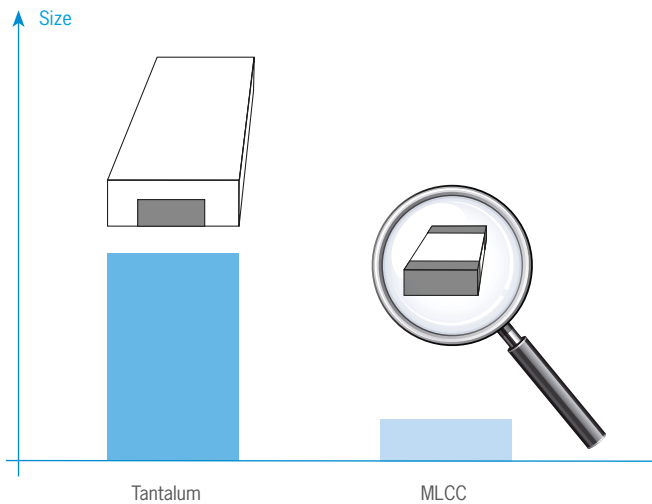
To improve power handling with large chips there exists a wide program of MLCC with „J“-leadframe for surface mounting. The leadframe provides higher robustness against thermal and mechanical shocks as well as excellent performance on aluminium circuit substrates. These capacitors are specifically designed for applications requiring high reliability performance in harsh environments. They have very low ESR (Equivalent Series Resistance) and ESL (Equivalent Series Inductance).

In addition to that more capacitance is obtainable on one single capacitor space with two or more MLCC stacked. Furthermore, there is a possibility of vertical stacking of the ceramic elements, which allows very high capacitance in a small volume (TurboCap).

Another possibility for using large chips with less concerns on handling stress is a MLCC with size 2220 in a molded leadframe tantalum style case (MH Series).

Series	Structure	Capacitance	Voltage	Number of Stacked MLCC
MegaCap (TDK)		47nF - 100µF	16V - 630V	1 - 2
KRM + KCM		330nF - 47µF	25V - 630V	1 - 2
RH (AVX)		47nF - 47µF	50V - 500V	1 - 2
Stacked MLC SM + RM (AVX)		10nF - 1300µF	50V - 500V	1 - 5
TurboCap (AVX)		820nF - 220µF	25V - 100V (500V in dev.)	3, 5, 10
MH (AVX)		1.0µF - 22µF	25V - 100V	1

Available from: AVX (RH, RM, SM, MH Series & TurboCap), TDK (MegaCaps), Murata (KRM+KCM)



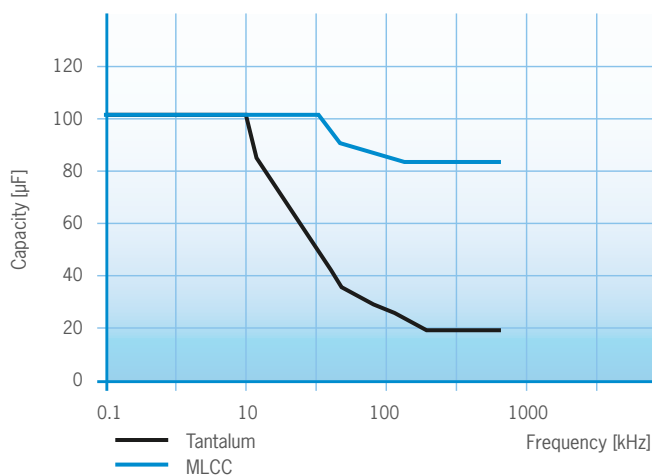
Tantalum Replacement by High Cap MLCC.

Due to various motivations more and more customers are replacing their tantalum caps with ceramic caps for new designs. Reasons can be:

- Price stability of ceramic chips, price increase of tantalums
- Common shortage of tantalums, longer lead times
- Higher reliability
- Less required space
- Better interference suppression
- Less heating
- No voltage derating (at Tantalum up to 50 %)

There are several aspects which have to be considered when replacing a tantalum with a ceramic capacitor. In the following you will find main criteria.

Compared to a tantalum capacitor the MLCC is much more stable especially at higher frequency. As a result of this, depending on the frequency you can reduce the capacity of a MLCC when replacing a tantalum.

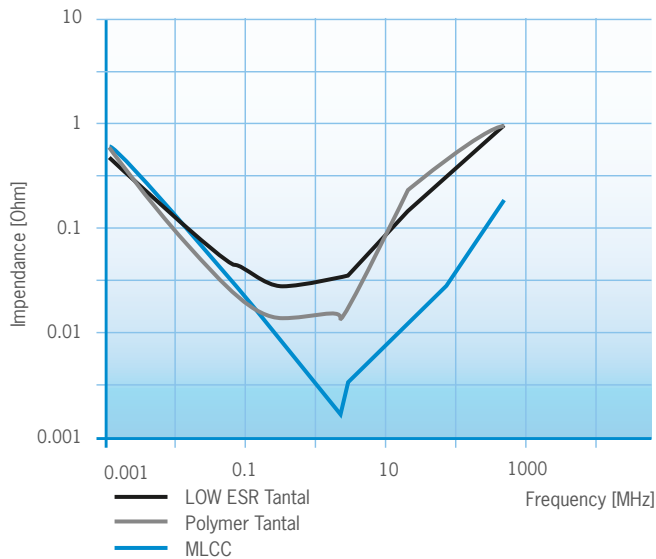


Generally:

- Frequency ≥ 100 kHz
> 10 - 20 % of the original value
- $10 \text{ kHz} \geq \text{Frequency} \leq 100 \text{ kHz}$
> 50 % of the original value
- Frequency $\leq 10 \text{ kHz}$
> 100 % of the original value

Considering the function of the capacitor:

- Decoupling: 10% to 50% of the original value
- Smoothing: 10% to 100% of the original value
- Time constant: Same capacitance level needed like tantalum

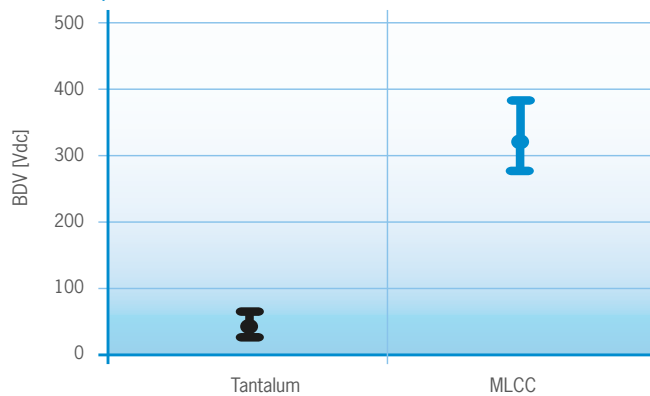


Also the impedance of a MLCC is better than at Tantalum. At high frequencies above 100 kHz the ESR stays considerably smaller.

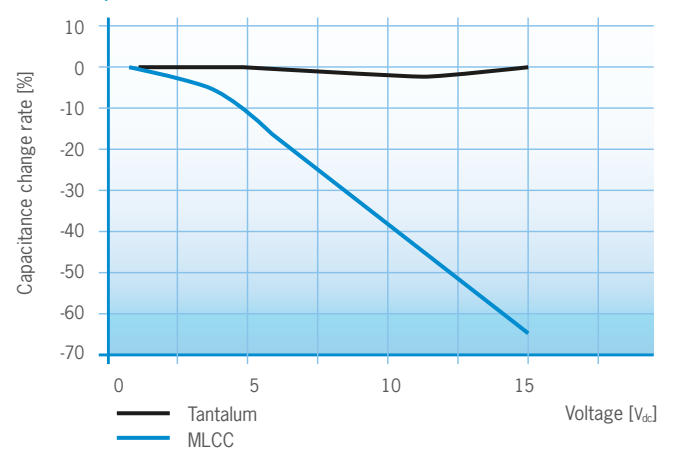
Observing the Break Down Voltage the MLCC is clearly saver than tantalum. The BDV of MLCC is multiple higher than at tantalum. For this reason ceramic capacitors are more reliable over life time.

Regarding DC Bias, the capacity of a tantalum stays much more stable over the voltage in comparison to a MLCC. Especially High Cap MLCC show considerable fluctuations by increasing voltage.

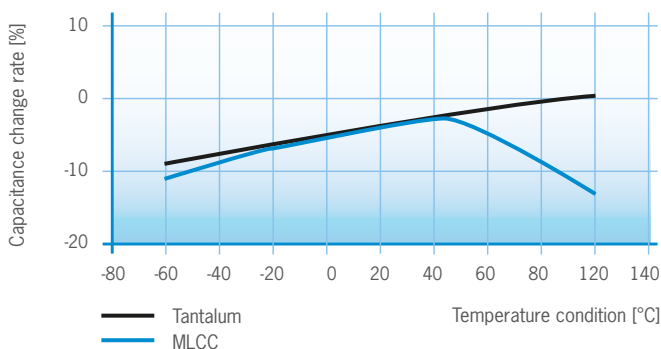
Part (10 μ F, 16V)



Part (10 μ F, 16V)



Part (10 μ F, 16V)



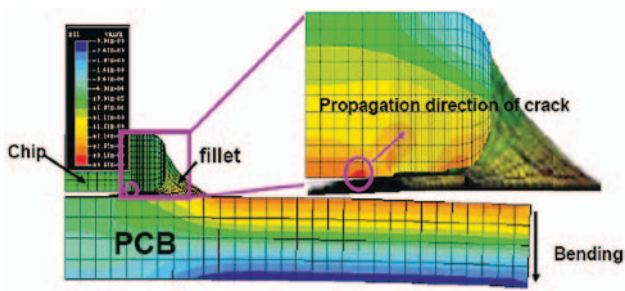
Also temperature is important for the calculation. At rising temperature the tantalum is normally more stable than MLCC.



Be on the safe side. Avoid cracks and short circuits.

Introduction

A crack generates a conductive path leading to a dropping down of the insulation-resistance accelerated by humidity and temperature. Frequently this causes almost a short circuit. Based on the fact that most of the problems with failed MLCC (>90%) are caused by bending-cracks, the first aim usually should be to avoid too high mechanical stresses by sufficient and optimized handling in the electronic production. But nevertheless for higher reliability and security of the device against blowing up and burning, there exist several special versions of ceramic chip capacitors to minimize the risk of cracks and short circuits. These solutions mostly include also the automotive specification AEC-Q200.

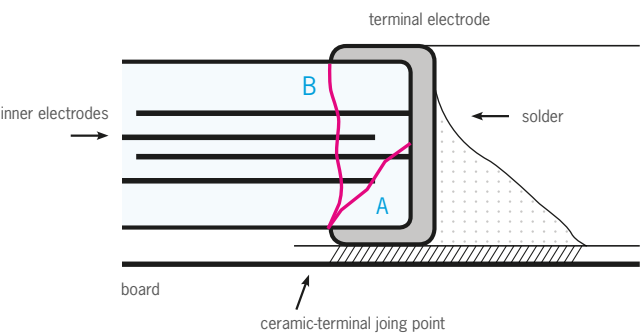


MLCC cracking by pcb bending

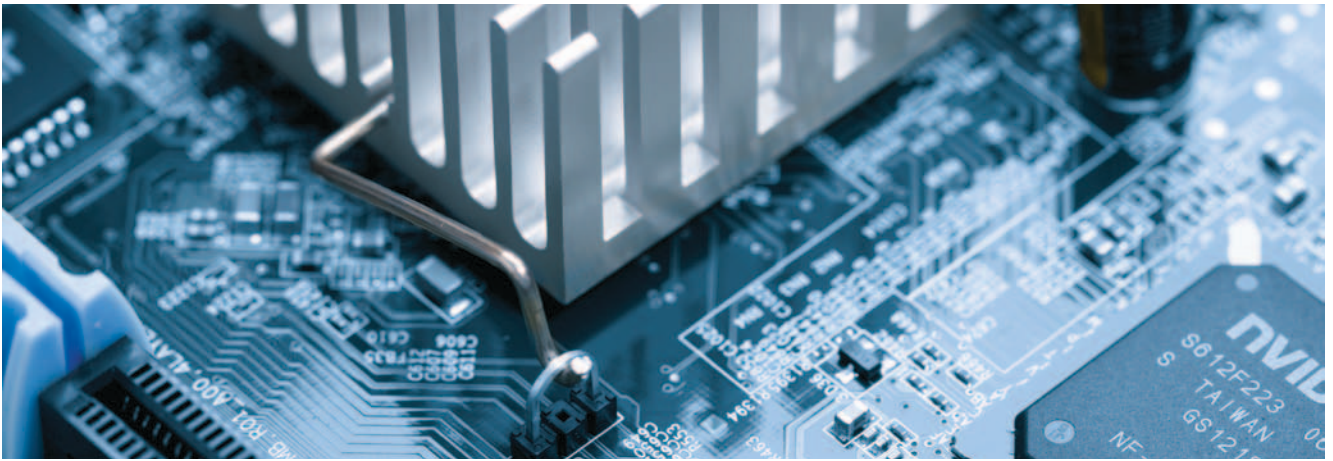
Analysis of the stress applied by board-bending using definite element method.

Mode of cracking

The mode of cracking changes in the direction from A to B by the thickness of the capacitor and the amount of solder.

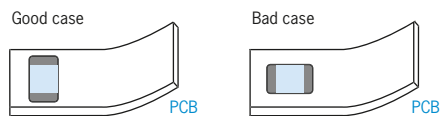


- Crack mode A: (1) Thick capacitor
(2) Small amount of solder
- Crack mode B: (1) Thin capacitor
(2) Excessive amount of solder

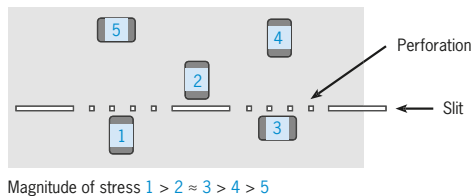


Cautions for prevention of crack

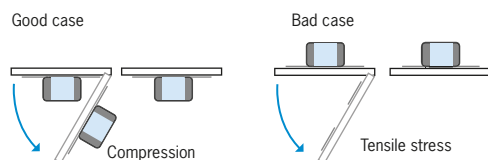
1. Direction of chip placement vs. Direction of PCB breaking line:



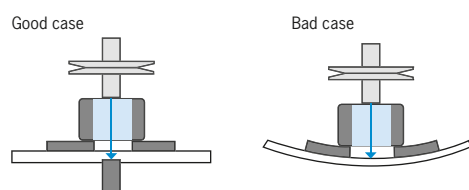
2. Distance & direction between chip and breaking line:



3. Direction of PCB Bending:



4. Over-press during chip placement makes PCB bent:



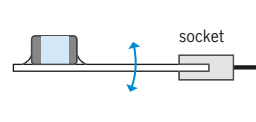
[Support pin should be used.]

5. By putting connectors and so on:



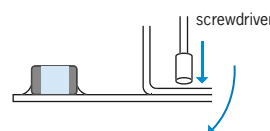
[Set the suitable clearance to the hole for setting.]

6. By inserting or pulling out the socket:

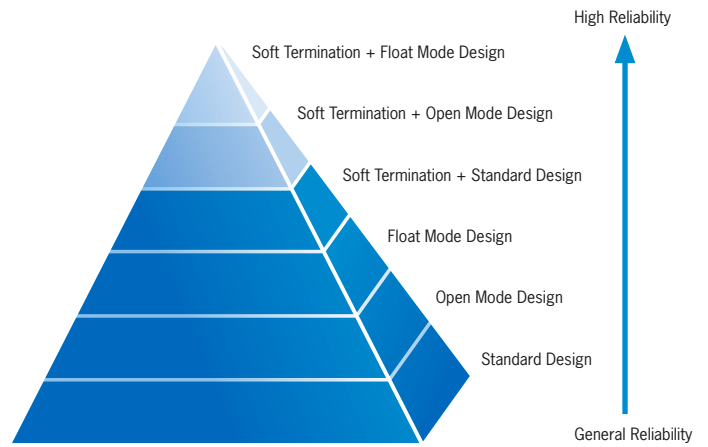


[Set the work not to bend the substrate.]

7. By tightening the machine screw:

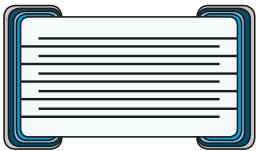


[Set the work setting that substrate does not bend.
Use suitable and torque screwdriver which does not tighten screws too much.]



MLCC crack & short circuit protection. Soft Termination.

Soft Termination + Standard Design



In addition to the standard chip design with its high volumetric efficiency a conductive epoxy coat between first termination layer and the NiSn plating is used.

Through this flexible epoxy coat the MLCC withstands much higher bending stresses.

Beyond this in case of too high mechanical stress instead of the chip the layer tends to brake.

Soft Termination + Open Mode Design

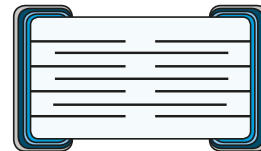


Combines the feature of flexible conductive epoxy coat with an OpenMode/FR Design.

But: this construction results in lower cap.-values in comparison to standard chip design.

Additional assurance to avoid a short circuit in the improbable case of a typical bendingcrack.

Soft Termination + Float Mode Design



Combines the feature of a flexible conductive epoxy coat with an internal serial construction of two caps.

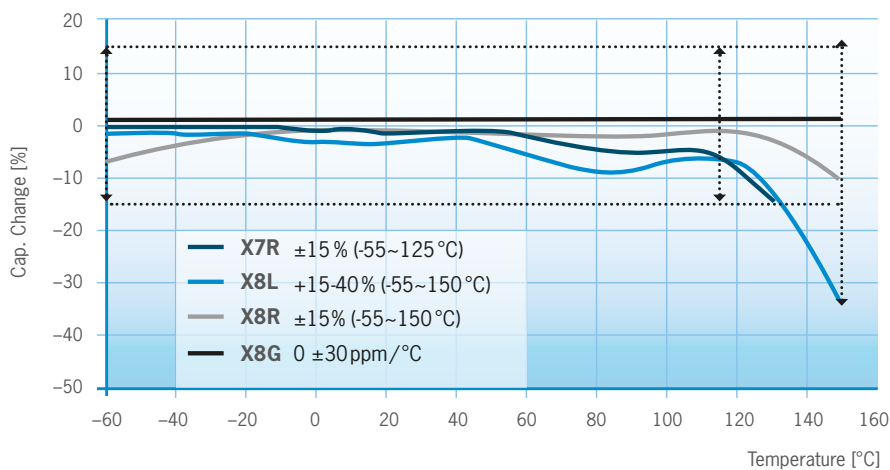
Maximum capacity is about a third compared to a standard design based both on series connection and the gap between the two active areas.

Double insurance: in the improbable case of a crack almost no short circuit is possible!

Supplier Overview

Supplier	Flexiterm / Soft- / Polymer- / Termination	Combined Designs Flexiterm / Soft Termination with		AEC-Q200
		Open Mode Design	Cascade Design	
AVX				
Murata				
Samsung				
TDK				
Vishay				

 available



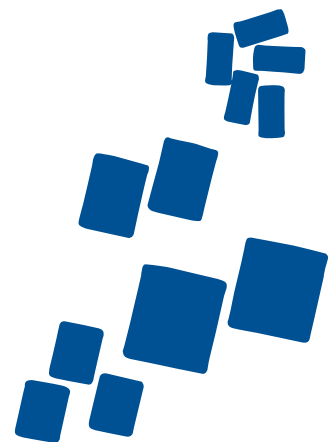
High Temperature. 150°C.

MLCC specified up to 150°C.

Their electrostatic capacity temperature response is stable at 15 % even in high temperature ranges (up to 150°C). Provides high-precision performance because their electrostatic capacity temperature response is $\pm 7.5\%$ in semi-high temperature ranges (up to 125°C). Mostly used in automotive applications in the engine bay.

Available from AVX, Murata, Vishay, TDK.

AVX also as Flexitem[®] (with Soft Termination)

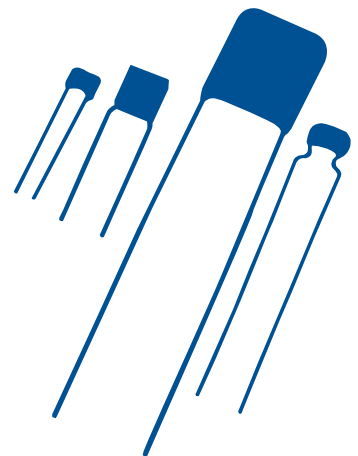


MLC Radial Automotive & 150°C – new leaded types.

Based on strong increase of sensors, both in automotive applications and for mounting on leadframes instead of pcb's, leaded multilayer capacitors (MLC) become more and more interesting.

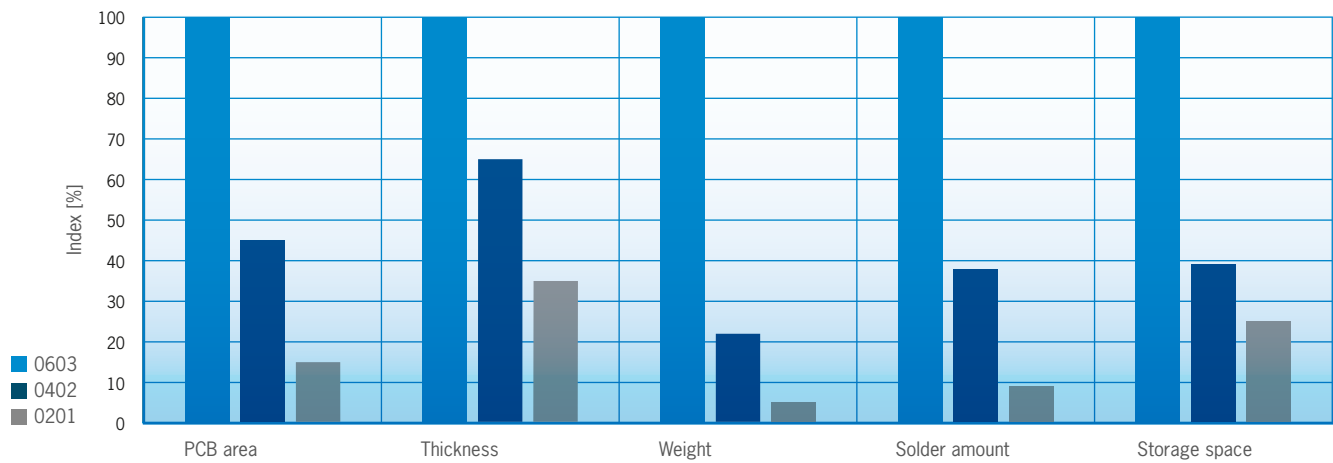
To fulfil automotive and high temperature requirements these MLC have been created with AEC-Q200 qualification and additionally with some values specified up to 150°C. One of the best-known functions are the suppression capacitors for Hall Sensors.

Besides AVX and Murata, Vishay also launched a new programme of leaded automotive Ceramic Capacitors. Vishay not only offers radial but also axial types up to 150°C.



Ceramic	NPO	X7R	X8L	X8R
TCC/Temp.	$\pm 30\text{ppm}/^\circ\text{C}$ -55 to +125°C	$\pm 15\%$ -55 to +125°C	$\pm 15-40\%$ -55 to +150°C	$\pm 15\%$ -55 to +150°C
Tolerance	$\pm 5\%$ / $\pm 10\%$	$\pm 10\%$ / $\pm 20\%$	$\pm 10\%$ / $\pm 20\%$	$\pm 10\%$ / $\pm 20\%$
Voltage	50V - 200V	50V - 100V	50V	25V-50V
Capacitance-Range radial	1.0pF - 10 nF	330pF - 1 μF	—	1 nF / 10 nF / 100n-470nF
Capacitance-Range axial	100pF - 10 nF	330pF - 1 μF	1.0nF- 1.0 μF	470pF-330nF

Available from AVX, Murata, Vishay.



MLCC – Advantages of miniaturisation

Save space. Small sizes.

Definition		Commercial Types				AEC-Q200	
Size Dimensions	Ceramic	NP0	X5R	X7R	Y5V	NP0	X7R
	Temperature	-55 to +125 °C	-55 to +85 °C	-55 to +125 °C	-30 to +85 °C	-55 to +125 °C	-55 to +125 °C
	Tolerance	±5% / ±10%	±10% / ±20%	±10% / ±20%	-20 + 80%	±5% / ±10%	±10% / ±20%
01005 0.4x0.2mm	Voltage	16V	6.3V	10 V	–	–	–
	Capacitance	0.2 pF - 47 pF	680 pF - 10 nF	100 pF - 1.0 nF	–	–	–
0201 0.6x0.3mm	Voltage	10V - 50V	4V - 50V	6.3V - 50V	6.3V - 16V	25V	10V - 25V
	Capacitance	0.5 pF - 100 pF	100 pF - 1.0 μF	47 pF - 10 nF	1 nF - 100 nF	0.3 pF - 100 pF	100 pF - 10 nF
0402 1.0x0.5mm	Voltage	16V-100V	4V - 25V	6.3V-100V	6.3V - 50V	25V-100V	10V-100V
	Capacitance	0.5 pF - 1.0 nF	1 nF - 2.2 μF (10 μF)	100 pF - 220 nF	2.2 nF - 1.0 μF	0.5 pF - 1.0 nF	120 pF - 100 nF

Nowadays the electronic market requires:

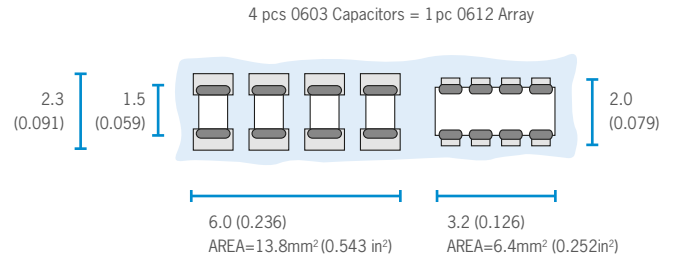
- that more and more applications are getting smaller or
- that more functions are integrated within the existing device sizes.

As a result of this the space for electronic components on the pcb is limited. Therefore the market trend leads to capacitors with smaller sizes to save space on the pcb area. Further advantages could be:

- less thickness
- less weight
- less solder amount
- less storage space

Besides 0402 (1.0x0.5mm) well-known is case size 0201 (0.6x0.3mm). The smallest ceramic capacitor 01005 (0.4x0.2mm) is also already in production.

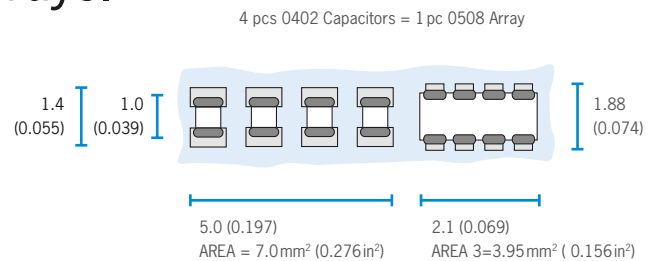
Available from: AVX, Murata, Samsung, TDK, Vishay, Yageo.



The 0612 4-element capacitor array gives a PCB space saving of over 50% vs four 0603 discretes and over 70% vs four 0805 discrete capacitors.

Save space. Multilayer Chip Arrays.

Higher efficiency to save space can be provided by Arrays, means 2 or 4 caps included in one part. Available sizes are 0405 (1.0x1.37mm) including 2 caps, 0508 (1.25x2.0mm) including 2 or 4 caps and 0612 (1.6x3.2mm) with 4 caps. Upon request special versions like „Multivalue“, „Feedthru“ or „Filter“ are possible. Smaller sizes 0306 (0.8x1.6mm) and 0204 (0.6x0.9mm) are both in development as 2-Cap version.

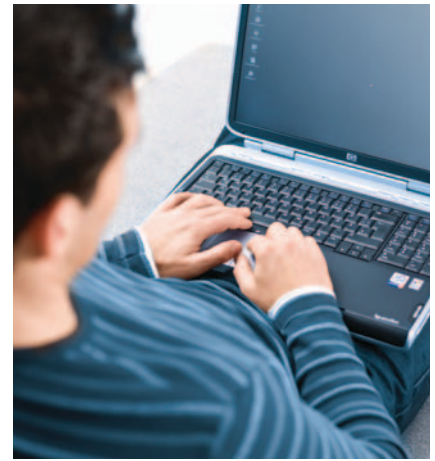


The 0508 4-element capacitor array gives a PCB space saving of over 40% vs four 0402 discretes and over 70% vs four 0603 discrete capacitors.

Definition		Commercial Types				AEC-Q200		
Size Dimensions No of caps	Ceramic	NPO	X5R	X7R	Y5V	NPO	X7R	X8R
	Temperature	-55 to +125°C	-55 to +85°C	-55 to +125°C	-30 to +85°C	-55 to +125°C	-55 to +125°C	-55 to +150°C
	Tolerance	±5%/ ±10%	±10%/ ±20%	±10%/ ±20%	-20 + 80%	±5%/ ±10%	±10%/ ±20%	±10%/ ±20%
0405 1.0x1.37mm 2-Caps	Voltage	16V - 50V	6.3V - 16 V	6.3V - 50 V	–	50 V	–	16 V
	Capacitance	10pF - 1.0nF	22nF - 1 µF	100pF - 150nF	–	10pF - 100pF	–	220pF - 680pF
0508 1.25x2.0mm 2-Caps	Voltage	16V - 100V	6.3V - 16V	6.3V - 100V	–	100V	16V - 100V	–
	Capacitance	10pF - 470pF	120nF - 2.2µF	220pF - 100nF	–	22pF - 470pF	470pF - 100nF	–
0508 1.25x2.0mm 4-Caps	Voltage	16V - 100V	6.3V - 10V	6.3V - 100V	25V	16V - 100V	16V - 100V	–
	Capacitance	1.0pF - 270pF	1.0µF (120nF - 820nF)*	220pF - 100nF	100nF	10pF - 270pF	220pF - 10nF	–
0612 1.6x3.2mm 4-Caps	Voltage	16V - 100V	6.3V - 16V	6.3V - 100V	25V	16V - 100V	10V - 100V	–
	Capacitance	10pF - 470pF. 1nF on request	1.0µF (330nF - 2.2µF)*	220pF - 100nF (120nF - 270nF)*	10nF - 100nF	10pF - 470pF	220pF - 100nF	–

* in development

Available from: AVX (also with AEC-Q200), Murata, Samsung, Yageo.



High Voltage MLCC. 250V – 5 kV.

A lot of well-known leaded high voltage capacitors (discs) can be replaced by chips (MLCC). In particular nowadays they are mostly used for applications like LCD backlight converters.

To avoid arc-over problems, Vishay offers a special solution with the HVArc Guard Capacitors. This series provides in comparison to standard or competitor components:

- Increased voltage breakdown ratings
- Reduced body sizes
- Extended capacitor ranges
- No need to coat the parts or the pcb



HV Arc Guard Capacitor with no Surface Arc-over



Standard Capacitor with Surface Arc-over

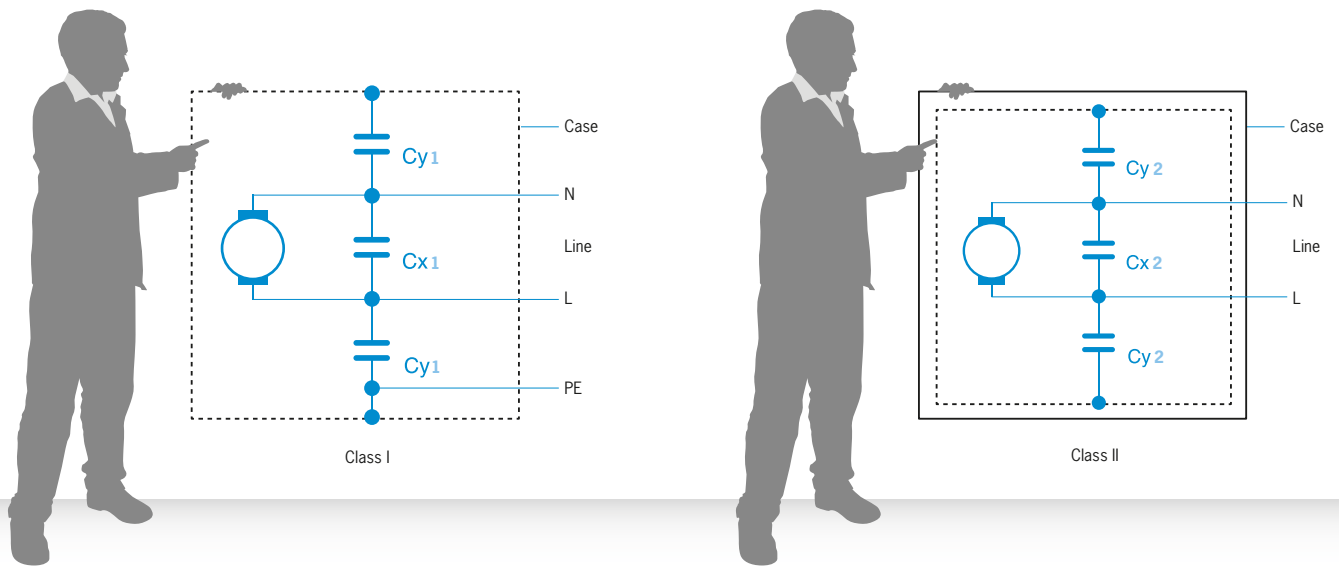
Definition		Types			
Size Dimensions	Ceramic	NP0		X7R	
	Temperature	-55 to +125 °C		-55 to +125 °C	
	Tolerance	±5%/±10%		±10%/±20%	
	Feature	Standard	HV Arc Guard®	Standard	HV Arc Guard®
0805 2.0x1.25mm	Voltage	250 V - 1.0 kV	1.0 kV - 1.5 kV	250 V - 1.0 kV	630 V - 1.0 kV
	Capacitance	0.5 pF - 2.7 nF	10 pF - 390 pF	100 pF - 22 nF	470 pF - 3.3 nF
1206 3.2x1.6mm	Voltage	250V - 2.0 kV	1.0 kV - 1.5 kV	250 V - 2.0 kV	250 V - 1.0 kV
	Capacitance	1.0 pF - 8.2 nF	10 pF - 1.5 nF	10 pF - 100 nF	220 pF - 47 nF
1210 3.2x2.5mm	Voltage	250 V - 3.0 kV	1.0 kV - 1.5 kV	250 V - 2.0 kV	250 V - 1.0 kV
	Capacitance	10 pF - 27 nF	10 pF - 2.7 nF	100 pF - 220 nF	220 pF - 82 nF
1812 4.5x3.2mm	Voltage	250 V - 4.0 kV	–	250 V - 3.0 kV	250 V - 1.0 kV
	Capacitance	10 pF - 47 nF	–	10 pF - 470 nF	220 pF - 270 nF
2220 5.7x5.0mm	Voltage	500 V - 5.0 kV	1.0 kV - 1.5 kV	250 V - 3.0 kV	–
	Capacitance	10 pF - 22 nF	470 pF - 5.6 nF	100 pF - 1.0 µF	–

+ 2225
5.7 x 6.35 mm
1.0 kV - 2.5 kV
470 pF - 8.2 nF

+ 1808
4.5 x 2.0 mm
250 V - 1000 V
220 pF - 100 nF

Above you find preferred sizes, also available in 1808 / 1825 / 2225 / 3640 with voltages up to 5 kV. Several parts from AVX and Vishay (HV Arc Guard) are available with Flexiterm- / Polymer-Termination.

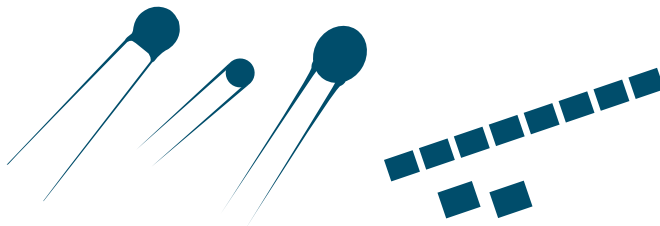
Available from: AVX, Murata, Samsung, TDK, Vishay, Yageo.



Safety and Suppression. „X-“ & „Y-“ Capacitors.

Electrical equipment belongs to protection **class I**, their case is in connection to potential earth (PE). Any failure at Y-capacitors causes no danger of electric shock if connection to potential earth is not interrupted.

Electrical equipment belongs to protection **class II**, it has no electrical connection to potential earth. Any failure at Y-capacitors could endanger a person touching the device if casing insulation is damaged.



In most applications the usage of such types is regulated by law. These capacitors are components with approvals like:



Also available for several years: Safety-Capacitors as SMD (MLCC): Save space of about 70%

X-Y-Class	Y3-SMD	X2Y3-SMD	Y2-SMD	X1Y2-SMD	X2-SMD	X1Y2	X1Y2	X1Y1	X1
Test-Voltage	1.5 k Vac	1.5 k Vac	1.5 k Vac	1.5 k Vac	1075 Vdc	2.0 k Vac	2.6 k Vac	4.0 k Vac	3.5 k Vac
Cap.-Range	10 pF - 1.5 nF / 1.8 nF - 4.7 nF	10 pF - 2.2 nF / 10 pF - 4.7 nF	10 pF - 330 pF	10 pF - 4.7 nF	10 nF - 56 nF	10 pF - 12 nF	10 pF - 10 nF	10 pF - 4.7 nF	4.7 nF - 22 nF
Size/ Lead-space	1808 / 1812	1808 / 1812	1808	1808 ... 2220	2220	5.0 (7.5)	7.5 (10)	10 (12.5)	7.5

Available from: Murata (also SMD), Vishay (also SMD), Yageo (only SMD)



Always the right frequency. High Frequency/RF Microwave Chips.

The non-ideal characteristics of a real capacitor can be ignored at low frequencies.

Physical size imparts inductance to the capacitor and dielectric and metal electrodes result in resistive losses, but these often are of negligible effects on the circuit. At the very high frequencies of radio communication ($>100\text{MHz}$) and satellite systems ($>1\text{GHz}$), these effects become important.

Recognizing that a real capacitor will exhibit inductive and resistive impedances in addition to capacitance, the ideal capacitor for these high frequencies is an ultra low loss component which can be fully characterized in all parameters with total repeatability from unit to unit.

Application examples are:

- Wireless systems
(e.g. keyless entry system, alarm system, etc.)
- Communication market
(Mobile Phones, Telephone Networks, etc.)
- Navigation systems
- TV systems (Satellite, Cable)
- Test & Measurement Equipment
- Radar systems
- GPS, GSM
- SMART Metering

Typical series from our suppliers are:

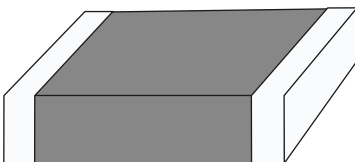
AVX: SLC, U, Accu-P, SQ (former AQ) and HQ Series

Murata: GJM, GQM, ERB, GMA Series

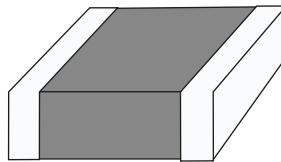
Vishay: VJ HiFreq RF Serie

Samsung: High Frequency Series

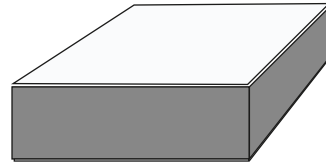
Yageo: Microwave



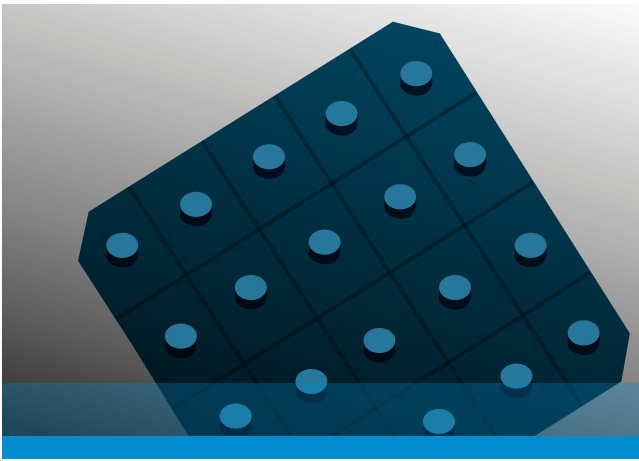
Series:
U, Accu-P, GJM, GQM,
ERB, VJ HiFreq RF, High
Frequency, Microwave



SQ, HQ



SLC, GMA



Low inductance.

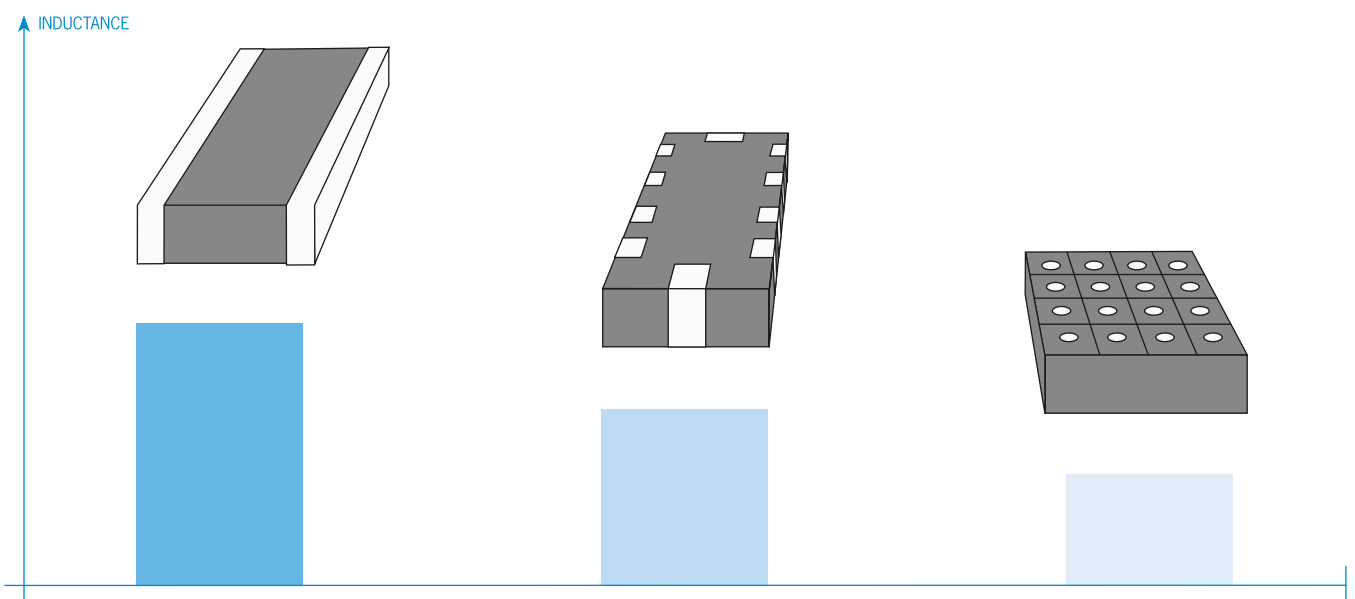
Low inductance products are specially designed with lower inductance than standard MLCC. In general, there are three factors that drive the need for these parts:

- Speed: the higher the operating frequency, the greater the need for Low Inductance MLCC (typically 300MHz and more)
- Power: the higher the power demand of the IC, the greater the need for Low Inductance MLCC
- Voltage: the lower the voltage, the lower the voltage drop minimum to keep the IC operating

Application examples are:

- High end battery powered devices
- Lightweight military systems
- Harsh environment CPU applications

Available from AVX, Murata, Samsung, Yageo, TDK.





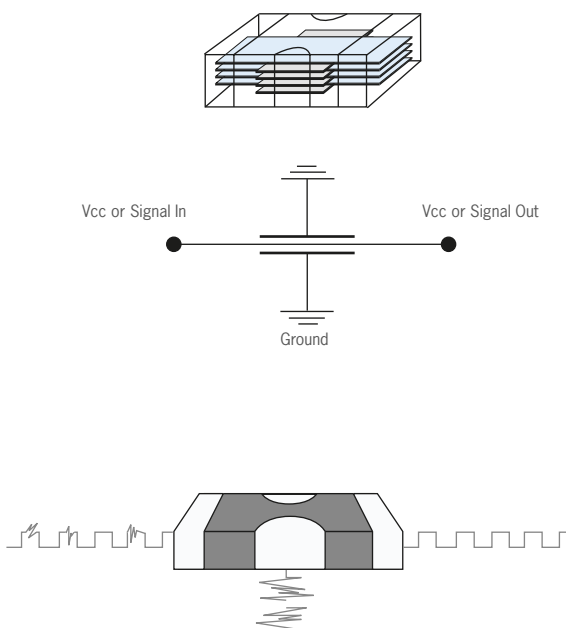
EMI Filtering. Feedthru & X2Y.

The X2Y and Feedthru are special designed devices performing as a broadband filter enabling better EMC compliance for electrical equipment in a wide range of applications.

Feedthru

The construction of a feedthru capacitor provides low parallel inductance and offers excellent decoupling capability for all high di/dt environments and provides significant noise reduction in digital circuits up to 5 GHz.

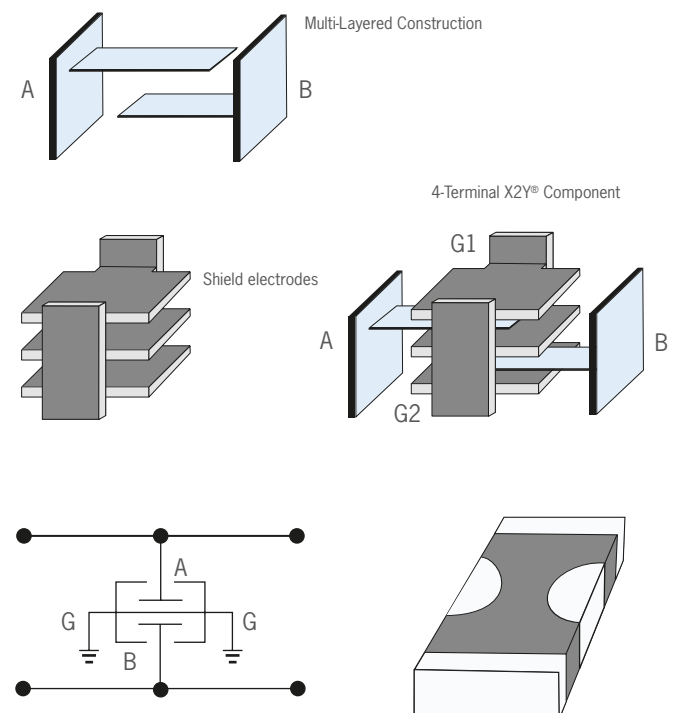
Available from AVX, Murata, TDK.

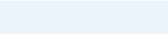
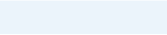
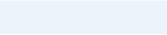
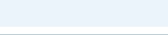
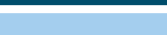
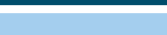
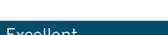
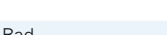


X2Y

New design of X2Y® series comprises two identical Y-capacitors and one X-capacitor. Thanks to the construction the device provides noise cancellation within the device, reducing ESL and offering superior decoupling and filtering.

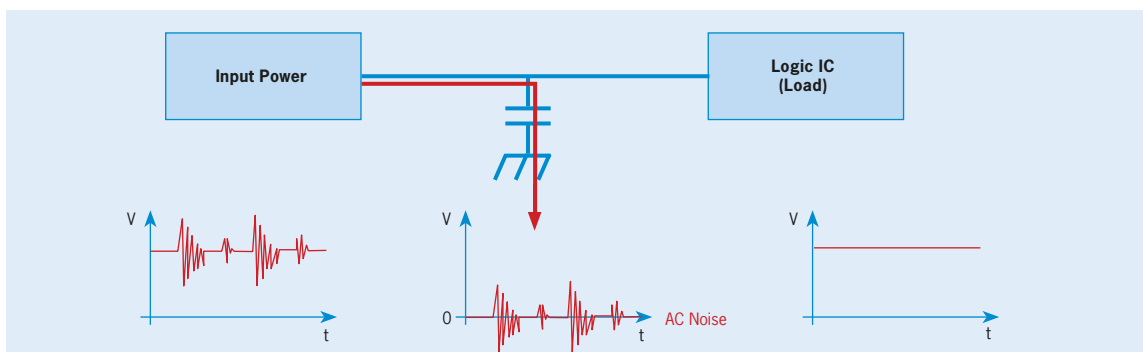
Available from Yageo, Samsung.



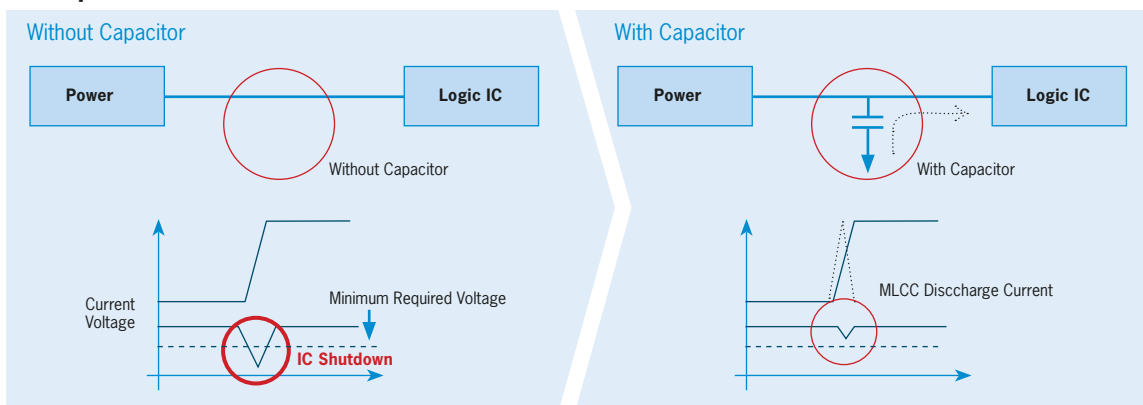
	Polarity	High Cap Range	Impedance / ESR characteristics	Temperature characteristics	High Voltage Resistance (overload)	Reliability
Electrolytic						
Polymer						
Ceramic						
Film						
Tantalum						
Niobium						
Capacitor technology comparison			Excellent	Good	Normal	Bad

Capacitors in general. Main functions.

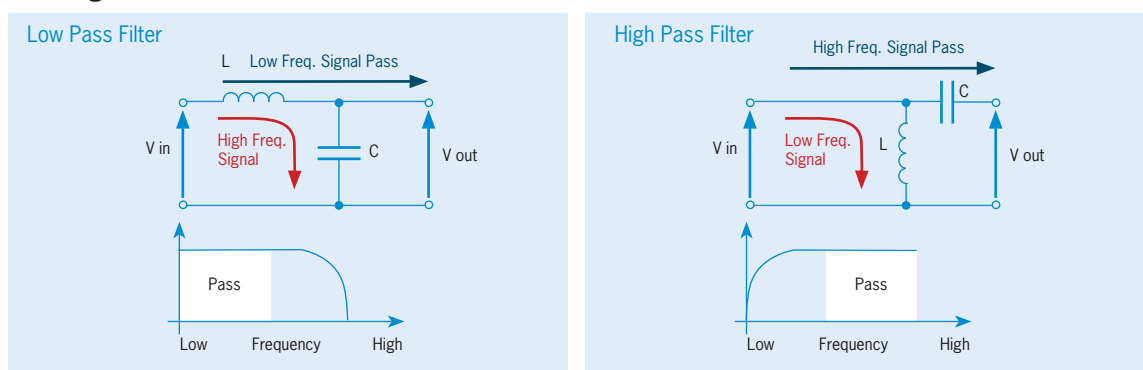
Decoupling



Backup



Filtering



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