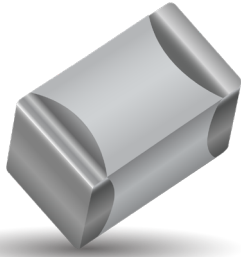


Automotive MLCC with FLEXITERM[®], KAF Series

General Specifications

GENERAL DESCRIPTION



With increased requirements from the automotive industry for additional component robustness, KYOCERA AVX recognized the need to produce a MLCC with enhanced mechanical strength. It was noted that many components may be subject to severe flexing and vibration when used in various under the hood automotive and other harsh environment applications.

To satisfy the requirement for enhanced mechanical strength, KYOCERA AVX had to find a way of ensuring electrical integrity is maintained whilst external forces are being applied to the component. It was found that the structure of the termination needed to be flexible and after much research and development, KYOCERA AVX launched FLEXITERM[®]. FLEXITERM[®] is designed to enhance the mechanical flexure and temperature cycling performance of a standard ceramic capacitor. The industry standard for flexure is 2mm minimum. Using FLEXITERM[®], KYOCERA AVX provides up to 5mm of flexure without internal cracks. Beyond 5mm, the capacitor will generally fail "open".

As well as for automotive applications FLEXITERM[®] will provide Design Engineers with a satisfactory solution when designing PCB's which may be subject to high levels of board flexure.

PRODUCT ADVANTAGES

- High mechanical performance able to withstand, 5mm bend test guaranteed
- Increased temperature cycling performance, 3000 cycles and beyond
- Flexible termination system
- Reduction in circuit board flex failures
- Base metal electrode system
- Automotive or commercial grade products available
- AECQ200 Qualified
- Approved to VW 80808 Specification

APPLICATIONS

High Flexure Stress Circuit Boards

- e.g. Depanelization: Components near edges of board.

Variable Temperature Applications

- Soft termination offers improved reliability performance in applications where there is temperature variation.
- e.g. All kind of engine sensors: Direct connection to battery rail.

Automotive Applications

- Improved reliability.
- Excellent mechanical performance and thermo mechanical performance.

HOW TO ORDER

KAF	31	G	R7	1H	475	K	U
Series	Size	Thickness	Dielectric		Capacitance Code Code (in pF)	Capacitance Tolerance	Packaging
AEC-Q200 FLEXITERM [®] SERIES	15 = 0603 21 = 0805 31 = 1206 32 = 1210 42 = 1808 43 = 1812 55 = 2220	See Cap Chart	CG = COG R7 = X7R R8 = X8R L8 = X8L G8 = X8G	0J = 6.3V 2H = 500V 1A = 10V 2J = 630V 1C = 16V 3A = 1000V 1E = 25V 3N = 1500V 1H = 50V 3D = 2000V 2A = 100V 3E = 2500V 2D = 200V 3U = 3000V 2E = 250V	2 Significant Digits +Number of zeros eg 10uF = 106 10nF = 103 47pF = 470	B = ± 0.1pF (<10pF)* C = ± 0.25pF (<10pF)* D = ± 0.5pF (<10pF)* F = ± 1%* G = ± 2%* J = ± 5% K = ± 10% M = ± 20%	See Table Below

NOTE: Contact factory for availability of Tolerance Options for Specific Part Numbers.

PACKAGING CODES

Code	EIA (inch)	IEC (mm)	7" Paper	7" Embossed	13" Paper	13" Embossed
15	0603	1608	T	U	M	L
21	0805	2012	T	U	M	L
31	1206	3216	T	U	M	L
32	1210	3225	T	U	M	L
42	1808	4520		Y		K
43	1812	4532		V		S
55	2220	5750		V		S

*thickness determines paper or plastic embossed packaging

Automotive MLCC with FLEXITERM[®], KAF Series

Specifications and Test Methods

PERFORMANCE TESTING

AEC-Q200 Qualification:

- Created by the Automotive Electronics Council
- Specification defining stress test qualification for passive components



Testing:

Key tests used to compare soft termination to AEC-Q200 qualification:

- Bend Test
- Temperature Cycle Test

BOARD BEND TEST RESULTS

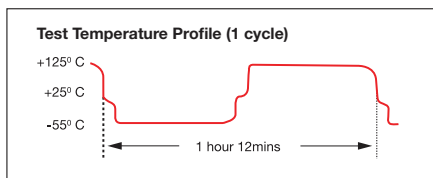
Style	Conventional Termination	FLEXITERM [®]
0603	>2mm	>5mm
0805	>2mm	>5mm
1206	>2mm	>5mm

TEMPERATURE CYCLE TEST PROCEDURE

Test Procedure as per AEC-Q200:

The test is conducted to determine the resistance of the component when it is exposed to extremes of alternating high and low temperatures.

- Sample lot size quantity 77 pieces
- TC chamber cycle from -55°C to +125°C for 1000 cycles
- Interim electrical measurements at 250, 500, 1000 cycles
- Measure parameter capacitance dissipation factor, insulation resistance



BOARD BEND TEST PROCEDURE

According to AEC-Q200

Test Procedure as per AEC-Q200:

Sample size: 20 components
Span: 90mm Minimum deflection spec: 2 mm

- Components soldered onto FR4 PCB (Figure 1)
- Board connected electrically to the test equipment (Figure 2)

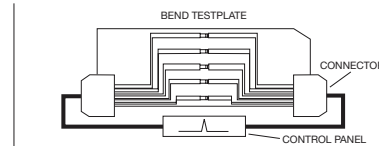


Fig 1 - PCB layout with electrical connections

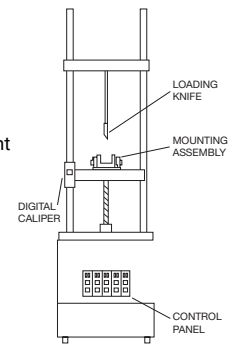
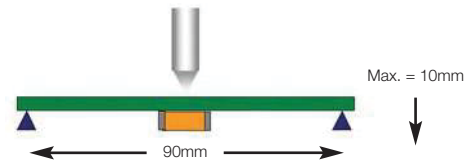


Fig 2 - Board Bend test equipment

ENHANCED SOFT TERMINATION BEND TEST PROCEDURE

Bend Test

The capacitor is soldered to the printed circuit board as shown and is bent up to 10mm at 1mm per second:



- The board is placed on 2 supports 90mm apart (capacitor side down)
- The row of capacitors is aligned with the load stressing knife



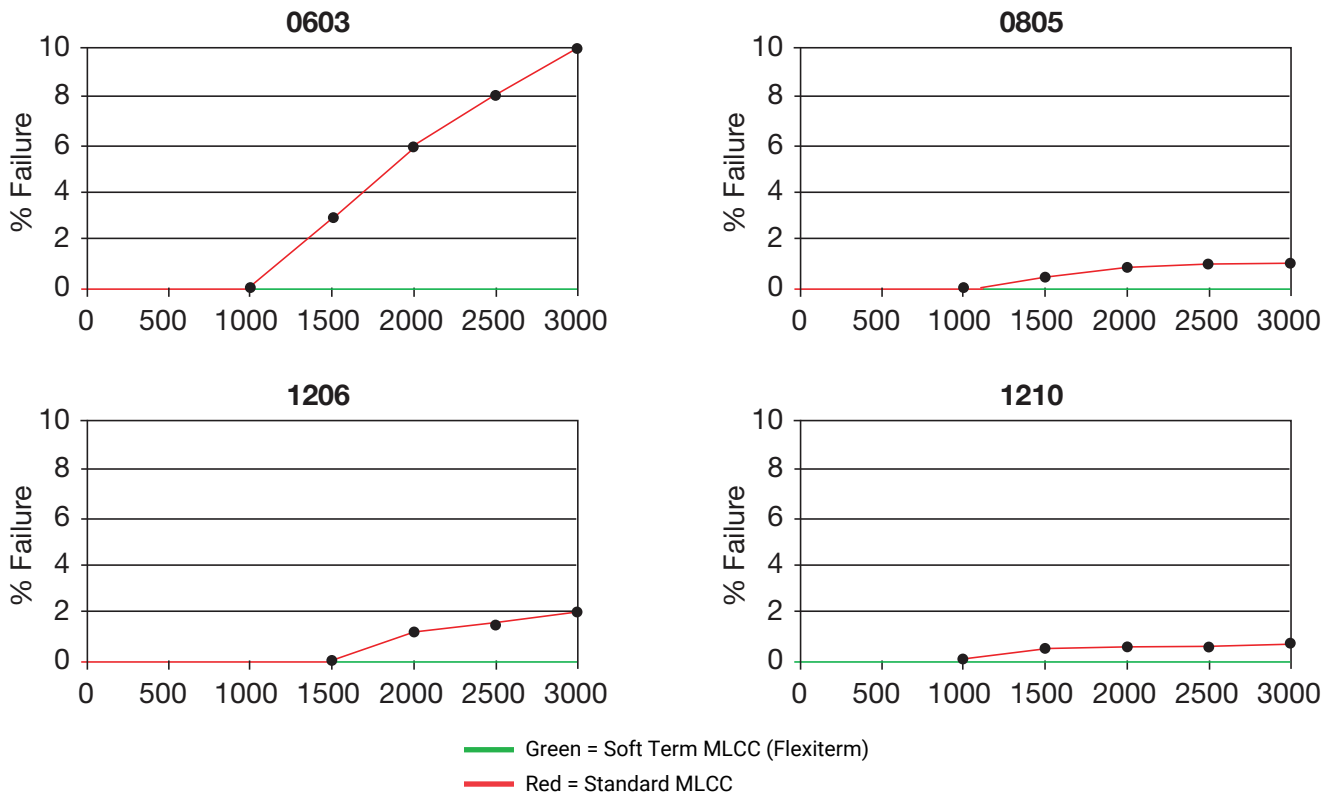
- The load is applied and the deflection where the part starts to crack is recorded (Note: Equipment detects the start of the crack using a highly sensitive current detection circuit)
- The maximum deflection capability is 10mm

Automotive MLCC with FLEXITERM[®], KAF Series

Specifications and Test Methods



BEYOND 1000 CYCLES: TEMPERATURE CYCLE TEST RESULTS



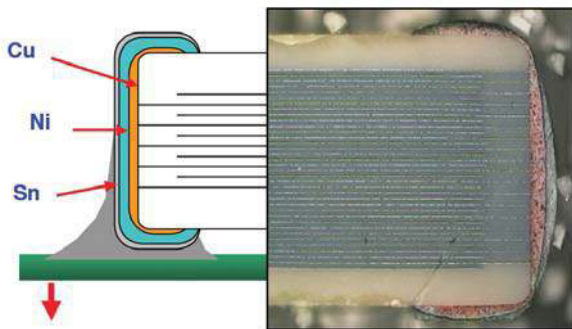
Soft Term - No Defects up to 3000 cycles

AEC-Q200 specification states 1000 cycles compared to 3000 temperature cycles.

FLEXITERM[®] TEST SUMMARY

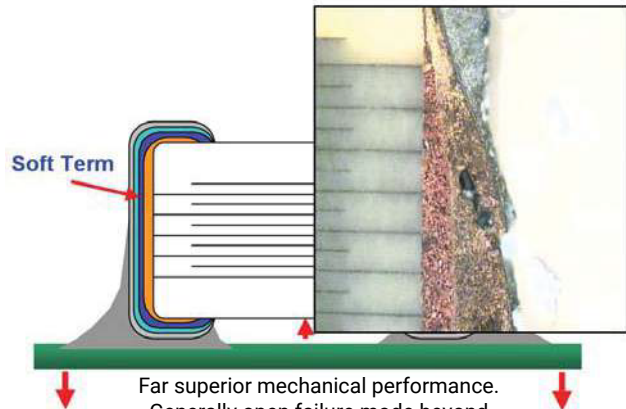
- Qualified to AEC-Q200 test/specification with the exception of using 3000 temperature cycles (up to +150°C bend test guaranteed greater than 5mm).
- FLEXITERM[®] provides improved performance compared to standard termination systems.
- Board bend test improvement by a factor of 2 to 4 times.
- Temperature Cycling:
 - 0% Failure up to 3000 cycles
 - No ESR change up to 3000 cycle

WITHOUT SOFT TERMINATION



Major fear is of latent board flex failures.

WITH SOFT TERMINATION



Far superior mechanical performance. Generally open failure mode beyond 5mm flexure

Automotive MLCC with FLEXITERM® - NP0

Capacitance Range

SIZE		0603					0805					1206					1210														
Soldering		Reflow/Wave					Reflow/Wave					Reflow/Wave					Reflow/Wave														
(L) Length	mm (in.)	1.6 ± 0.15 (0.063 ± 0.006)					2.01 ± 0.2 (0.079 ± 0.008)					3.2 ± 0.2 (0.126 ± 0.008)					3.2 ± 0.2 (0.126 ± 0.008)														
(W) Width	mm (in.)	0.81 ± 0.15 (0.032 ± 0.006)					1.25 ± 0.2 (0.049 ± 0.008)					1.6 ± 0.2 (0.063 ± 0.008)					2.5 ± 0.2 (0.098 ± 0.008)														
(t) Terminal	mm (in.)	0.35 ± 0.15 (0.014 ± 0.006)					0.5 ± 0.25 (0.02 ± 0.01)					0.5 ± 0.25 (0.02 ± 0.01)					0.5 ± 0.25 (0.02 ± 0.01)														
WVDC		25V	50V	100V	200V	250V	25V	50V	100V	200V	250V	25V	50V	100V	200V	250V	500V	630V	1000V	50V	100V	200V	250V	500V	630V	1000V					
0R5	0.5	A	A	A	A		B	B	B	B																					
1R0	1.0	A	A	A	A		B	B	B	B																					
100	10	A	A	A	A		B	B	B	B																					
120	12	A	A	A	A		B	B	B	B																					
150	15	A	A	A	A		B	B	B	B																					
180	18	A	A	A	A		B	B	B	B																					
220	22	A	A	A	A		B	B	B	B																					
270	27	A	A	A	A		B	B	B	B																					
330	33	A	A	A	A		B	B	B	B																					
390	39	A	A	A	A		B	B	B	B																					
470	47	A	A	A	A		B	B	B	B																					
560	56	A	A	A	A	A*	B	B	B	B																					
680	68	A	A	A	A	A*	B	B	B	B																					
820	82	A	A	A	A	A*	B	B	B	B																					
101	100	A	A	A	A	A*	B	B	B	B																					
121	120					A*	A*	B	B	B	B																				
151	150					A*	A*	B	B	B	B																				
181	180					A*	A*	B	B	B	B																				
221	220					A*	A*	B	B	B	B																				
271	270					A*	A*	B	B	B	B																				
331	330					A*	A*	B	B	B	B																				
391	390					A*	A*	B	B	B	B																				
471	470					A*	A*	B	B	B	B																				
561	560					A*	A*	B	B	B	B																				
681	680					A*	A*	A*	B	B	B																				
821	820	A*	A*	A*	A*	A*	A*	B	B	B	B																				
102	1000	A*	A*	A*	A*	A*	A*	B	B	B	B														K*	K*					
122	1200	A*	A*	A*	A*	A*	A*																			C*	C*				
152	1500	A*	A*	A*	A*	A*	A*																				G*	G*			
182	1800	A*	A*	A*	A*			B	B	B	B																	G*	G*		
222	2200	A*	A*	A*				B	B	B	B																	G*	G*	G*	
272	2700	A*	A*					A	A	A	A																		G*	G*	
332	3300	A*	A*					A	A	A	A																			G*	G*
392	3900	A*	A*					A	A	A	A																			G*	G*
472	4700	A*	A*					A	A	A	A																			G*	G*
562	5600	A*	A*					A	A																					G*	G*
682	6800	A*	A*					A	A																					K*	K*
822	8200	A*						A	A																					K*	K*
103	10000	A*						A	A																					K*	K*
123	12000																													K*	K*
153	15000																													L*	L*
183	18000																													L*	L*
223	22000																													L*	L*
273	27000																													L*	L*
333	33000																													L*	L*
393	39000																													L*	L*
473	47000																													L*	L*
563	56000																													L*	L*
683	68000																													L*	L*
823	82000																													L*	L*
104	100000																													L*	L*

*These dimensions differ from the standard in table above and are:

0603 L = 1.6 ± 0.2 mm, W = 0.8 ± 0.2 mm
 1210 L = 3.2 ± 0.4 mm, W = 2.5 ± 0.3 mm

Case Size	0603 (KAF15)			0805 (KAF21)			1206 (KAF31)			1210 (KAF32)		
Thickness Letter	A	B	A	B	G	C	G	K	L			
Max Thickness (mm)	0.90	0.94	1.45	0.94	1.78	1.27	1.78	2.29	2.80			
Carrier Tape	PAPER	PAPER	EMB	PAPER	EMB	EMB	EMB	EMB	EMB			
Packaging Code 7" reel	T	T	U	T	U	U	U	U	U			
Packaging Code 13" reel	M	M	L	M	L	L	L	L	L			
	PAPER						EMBOSSED					

Automotive MLCC with FLEXITERM® - X8R / X8L

Capacitance Range

KYOCERA AVX has developed a range of multilayer ceramic capacitors designed for use in applications up to 150°C. These capacitors are manufactured with an X8R and an X8L dielectric material. X8R material has capacitance variation of ± 15% between -55°C and +150°C. The X8L material has capacitance variation of ±15% between -55°C to 125°C to 125°C and +15/40% from +125°C to +150°C.

The need for X8R and X8L performance has been driven by customer requirements for parts that operate at elevated temperatures. They provide a highly reliable capacitor with low loss and stable capacitance over temperature. They are ideal for automotive under the hood sensors, and various industrial applications. Typical industrial application would be drilling monitoring system. They can also be used as bulk capacitors for high temperature camera modules.

X8R

SIZE		0603			0805			1206		
Soldering		Reflow/Wave			Reflow/Wave			Reflow/Wave		
(L) Length	mm (in.)	1.6 ± 0.15 (0.063 ± 0.006)			2.01 ± 0.2 (0.079 ± 0.008)			3.2 ± 0.2 (0.126 ± 0.008)		
(W) Width	mm (in.)	0.81 ± 0.15 (0.032 ± 0.006)			1.25 ± 0.2 (0.049 ± 0.008)			1.6 ± 0.2 (0.063 ± 0.008)		
(t) Terminal	mm (in.)	0.35 ± 0.15 (0.014 ± 0.006)			0.5 ± 0.25 (0.02 ± 0.01)			0.5 ± 0.25 (0.02 ± 0.01)		
WVDC		25V	50V	100V	25V	50V	100V	25V	50V	100V
271	Cap 270	A	A	A						
331	(pF) 330	A	A	A	B	B	B			
471	470	A	A	A	B	B	B			
681	680	A	A	A	B	B	B			
102	1000	A	A	A	B	B	B	B	B	
152	1500	A	A	A	B	B	B	B	B	
182	1800	A	A	A	B	B	B	B	B	
222	2200	A	A	A	B	B	B	B	B	
272	2700	A	A	A	B	B	B	B	B	
332	3300	A	A	A	B	B	B	B	B	
392	3900	A	A	A	B	B	B	B	B	
472	4700	A	A	A	B	B	B	B	B	
562	5600	A	A	A	B	B	B	B	B	
682	6800	A	A	A	B	B	B	B	B	
822	8200	A	A	A	B	B	B	B	B	
103	Cap 0.01	A	A	A	B	B	B	B	B	
123	(uF) 0.012	A	A		B	B	B	B	B	
153	0.015	A	A		B	B	A	B	B	
183	0.018	A	A		B	B	A	B	B	
223	0.022	A	A		B	B	A	B	B	
273	0.027	A	A		B	B		B	B	
333	0.033	A	A		B	B		B	B	
393	0.039	A	A		B	B		B	B	
473	0.047	A	A		B	B		B	B	
563	0.056	A			A	A		N	N	
683	0.068	A			A	A		N	N	
823	0.082				A	A		N	N	
104	0.1				A	A		N	N	
124	0.12				A	A		N	N	
154	0.15				A	A		N	N	
184	0.18				A			N	N	
224	0.22				A			N	N	
274	0.27							N	N	
334	0.33							N	N	
394	0.39							E	G	
474	0.47							E	G	
684	0.68							G	G	
824	0.82							G	G	
105	1							G	G	
WVDC		25V	50V	100V	25V	50V	100V	25V	50V	100V
SIZE		0603			0805			1206		

Case Size	0603(KAF15)		0805(KAF21)		1206(KAF31)				1210(KAF32)	2220(KAF55)
Thickness Letter	A	B	B	A	B	N	E	G	L	C
Max Thickness	0.90	0.95	0.94	1.45	0.94	1.27	1.52	1.78	2.79	2.80
Carrier Tape	PAPER	PAPER	PAPER	EMB	PAPER	EMB	EMB	EMB	EMB	EMB
Packaging Code 7" reel	T	T	T	U	T	U	U	U	U	V
Packaging Code 13" reel	M	M	M	L	M	L	L	L	L	S
	PAPER				EMBOSSED (EMB)					

X8L

SIZE		0603			0805			1206			1210			2220			
Soldering		Reflow/Wave			Reflow/Wave			Reflow/Wave			Reflow/Wave			Reflow Only			
(L) Length	mm (in.)	1.6 ± 0.15 (0.063 ± 0.006)			2.01 ± 0.2 (0.079 ± 0.008)			3.2 ± 0.2 (0.126 ± 0.008)			3.2 ± 0.2 (0.126 ± 0.008)			5.7 ± 0.5 (0.224 ± 0.02)			
(W) Width	mm (in.)	0.81 ± 0.15 (0.032 ± 0.006)			1.25 ± 0.2 (0.049 ± 0.008)			1.6 ± 0.2 (0.063 ± 0.008)			2.5 ± 0.2 (0.098 ± 0.008)			5 ± 0.4 (0.197 ± 0.016)			
(t) Terminal	mm (in.)	0.35 ± 0.15 (0.014 ± 0.006)			0.5 ± 0.25 (0.02 ± 0.01)			0.5 ± 0.25 (0.02 ± 0.01)			0.5 ± 0.25 (0.02 ± 0.01)			0.64 ± 0.39 (0.025 ± 0.015)			
WVDC		25V	50V	100V	25V	50V	100V	16V	25V	50V	100V	10V	25V	50V	100V	25V	50V
271	Cap 270	A	A														
331	(pF) 330	A	A	A	B	B	B										
471	470	A	A	A	B	B	B										
681	680	A	A	A	B	B	B										
102	1000	A	A	A	B	B	B				B	B	B				
152	1500	A	A	A	B	B	B				B	B	B				
182	1800	A	A	A	B	B	B				B	B	B				
222	2200	A	A	A	B	B	B				B	B	B				
272	2700	A	A	A	B	B	B				B	B	B				
332	3300	A	A	A	B	B	B				B	B	B				
392	3900	A	A	A	B	B	B				B	B	B				
472	4700	A	A	A	B	B	B				B	B	B				
562	5600	A	A	A	B	B	B				B	B	B				
682	6800	A	A	A	B	B	B				B	B	B				
822	8200	A	A	A	B	B	B				B	B	B				
103	Cap 0.01	A	A	A	B	B	B				B	B	B				
123	(uF) 0.012	A	A		B	B	B				B	B	B				
153	0.015	A	A		B	B	B				B	B	B				
183	0.018	A	A		B	B	B				B	B	B				
223	0.022	A	A		B	B	B				B	B	B				
273	0.027	A	A		B	B	B				B	B	B				
333	0.033	A	A		B	B	A				B	B	B				
393	0.039	A	A		B	B	A				B	B	B				
473	0.047	A	A		B	B	A				B	B	B				
563	0.056	A	A		B	B	A				B	B	B				
683	0.068	A	A		B	B	A				B	B	B				
823	0.082	A	A		B	B	A				B	B	N				
104	0.1	A	A		B	B	A				B	B	N				
124	0.12				B	A					B	B	N				
154	0.15				B	A					B	B	N				
184	0.18				A	A					B	B	B	G			
224	0.22				A	A					B	B	B	G			
274	0.27				A	A					B	N	N				
334	0.33				A	A					B	N	E				
394	0.39				A	A					N	N	E				
474	0.47				A	A					N	N	E				
684	0.68				A	A					N	G	G				
824	0.82				A	A					N	G	G				
105	1				A	A					N	G	G				
155	1.5				A						G	G	G				
225	2.2				A						G	G	G			L	L
475	4.7										G	G				L	L
106	10															L	L
WVDC		25V	50V	100V	25V	50V	100V	16V	25V	50V	100V	10V	25V	50V	100V	200V	250V
SIZE		0603			0805			1206			1210			2220			

Automotive MLCC with FLEXITERM® - X8R / X8L

General Specifications

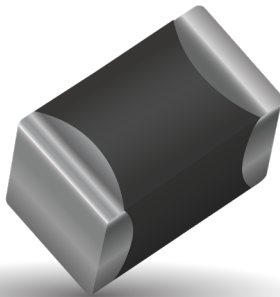
APPLICATIONS FOR X8R AND X8L CAPACITORS

- All market sectors with a 150°C requirement
- Automotive on engine applications
- Oil exploration applications
- Hybrid automotive applications
 - Battery control
 - Inverter / converter circuits
 - Motor control applications
 - Water pump
- Hybrid commercial applications
 - Emergency circuits
 - Sensors
 - Temperature regulation



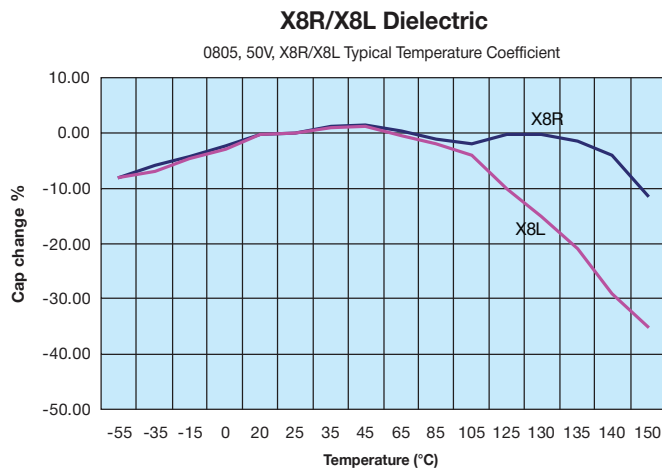
ADVANTAGES OF X8R AND X8L MLC CAPACITORS

- Both ranges are qualified to the highest automotive AEC-Q200 standards
- Excellent reliability compared to other capacitor technologies
- RoHS compliant
- Low ESR / ESL compared to other technologies
- Tin solder finish
- FLEXITERM® available
- 100V range available



ENGINEERING TOOLS FOR HIGH VOLTAGE MLC CAPACITORS

- Samples
- Technical Articles
- Application Engineering
- Application Support



Automotive MLCC with FLEXITERM® - X7R, 4V to 500V

Capacitance Range



SIZE		0402				0603				0805				1206				1210				1812				2220										
Soldering		Reflow/Wave				Reflow/Wave				Reflow/Wave				Reflow/Wave				Reflow Only				Reflow Only				Reflow Only										
(L) Length	mm (in.)	1.0 ± 0.2 (0.039±0.008)				1.6 ± 0.15 (0.063 ± 0.006)				2.01 ± 0.2 (0.079 ± 0.008)				3.2 ± 0.2 (0.126 ± 0.008)				3.2 ± 0.2 (0.126 ± 0.008)				4.5 ± 0.3 (0.177 ± 0.012)				5.7 ± 0.5 (0.224 ± 0.02)										
(W) Width	mm (in.)	0.5± 0.2 (0.02±0.008)				0.81 ± 0.15 (0.032 ± 0.006)				1.25 ± 0.2 (0.049 ± 0.008)				1.6 ± 0.2 (0.063 ± 0.008)				2.5 ± 0.2 (0.098 ± 0.008)				3.2 ± 0.2 (0.126 ± 0.008)				5 ± 0.4 (0.197 ± 0.016)										
(t) Terminal	mm (in.)	0.25 ± 0.15 (0.010±0.006)				0.35 ± 0.15 (0.014 ± 0.006)				0.5 ± 0.25 (0.02 ± 0.01)				0.5 ± 0.25 (0.02 ± 0.01)				0.5 ± 0.25 (0.02 ± 0.01)				0.61 ± 0.36 (0.024 ± 0.014)				0.64 ± 0.39 (0.025 ± 0.015)										
WVDC		10V	16V	25V	50V	6.3V	10V	16V	25V	50V	100V	200V	250V	6.3V	10V	16V	25V	50V	100V	200V	250V	16V	25V	50V	100V	200V	250V	50V	100V	25V	50V	100V	200V	250V	500V	
101	100																																		Q	Q
221	220	A	A	A	A																														Q	Q
271	270	A	A	A	A																														Q	Q
331	330	A	A	A	A																														Q	Q
391	390	A	A	A	A																														Q	Q
471	470	A	A	A	A																														Q	Q
561	560	A	A	A	A																														Q	Q
681	680	A	A	A	A																														Q	Q
821	820	A	A	A	A																														Q	Q
102	1000	A	A	A	A																														Q	Q
122	1220	A	A	A	A																														Q	Q
152	1500	A	A	A	A																														Q	Q
182	1800	A	A	A	A																														Q	Q
222	2200	A	A	A	A																														Q	Q
272	2700	A	A	A	A																														Q	Q
332	3300	A	A	A	A																														Q	Q
392	3900	A	A	A	A																														Q	Q
472	4700	A	A	A	A																														Q	Q
562	5600	A	A	A	A																														Q	Q
682	6800	A	A	A	A																														Q	Q
822	8200	A	A	A	A																														Q	Q
103	Cap 0.01	A	A	A	A																													G	Q	
123	(F) 0.012	A	A																																Q	Q
153	0.015	A	A																																Q	Q
183	0.018	A	A																																Q	Q
223	0.022	A	A																																Q	Q
273	0.027	A	A																																Q	Q
333	0.033	A	A																																Q	Q
393	0.039																																		Q	Q
473	0.047																																		Q	Q
563	0.056																																		Q	Q
683	0.068																																		Q	Q
823	0.082																																		Q	Q
104	0.1																																		Q	Q
124	0.12																																		Q	Q
154	0.15																																		Q	Q
224	0.22																																		Q	Q
334	0.33																																		Q	Q
474	0.47																																		Q	Q
684	0.68																																		Q	Q
105	1.0																																		Q	Q
155	1.5																																		Q	Q
225	2.2																																		Q	Q
335	3.3																																		Q	Q
475	4.7																																		Q	Q
106	10																																		Q	Q
226	22																																		Q	Q

*The dimensions are:
Length (mm) 3.2 ± 0.4
Width (mm) 1.6 ± 0.3

Case Size	0402 (KAF05)	0603(KAF15)			0805(KAF21)			1206(KAF31)				1210(KAF32)				1812(KAF43)				2220(KAF55)				
Thickness Letter	A	A	B	B	K	A	A	B	N	E	G	H	Q	C	F	G	K	L	Y	Z	G	J	A	C
Max Thickness(mm)	0.56	0.90	0.95	0.94	1.40	1.45	0.94	1.27	1.52	1.78	1.9	0.94	1.27	1.52	1.78	2.29	2.80	1.02	1.27	2.29	2.80	2.29	2.80	
Carrier Tape	PAPER	PAPER	PAPER	PAPER	EMB	EMB	PAPER	EMB	EMB	EMB	EMB	PAPER	EMB	EMB	EMB	EMB	EMB	EMB	EMB	EMB	EMB	EMB	EMB	
Packaging Code 7' reel	H	T	T	T	U	U	T	U	U	U	U	T	U	U	U	U	U	V	V	V	V	V	V	
Packaging Code 13' reel	N	M	M	M	L	L	M	L	L	L	L	M	L	L	L	L	L	S	S	S	S	S	S	



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