JOHANSON DIELECTRICS

X2Y® for Today's Circuits

Circuit designers today are challenged with maintaining Signal and Power Integrity amid increasing Electro-Magnetic Compliance (EMC) requirements, while at the same time lowering system costs. X2Y® Technology is an enabler to this end, providing a quantum leap in circuit performance. X2Y® replaces multiple standard passives and Integrated Passive Components with a single device, freeing precious board space for additional active components or design miniaturization. In short, X2Y® gives end-users the cost advantage they need to compete in today's market.

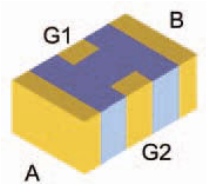
X2Y® Technology Overview

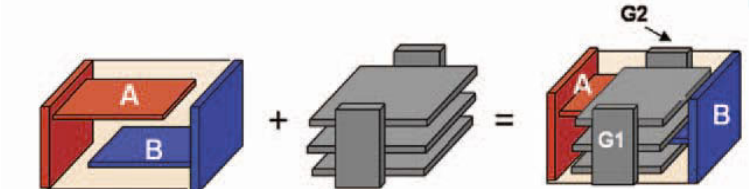
X2Y® components share many common traits with conventional multi-layer ceramic capacitors (MLCC) to facilitate adoption by end-users into their manufacturing processes

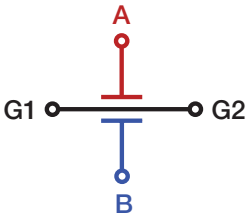
- Same component sizes (0603, 0805, 1206, etc.)
- Same pick and place equipment
- Same voltage ratings
- Same dielectric, electrode and termination materials
- Same industry test standards for component reliability

The X2Y® design - A Capacitive Circuit

A standard bypass capacitor has opposing electrode layers stacked inside. An X2Y® adds another set of electrode layers to effectively surround each existing electrode within the stack of a two-terminal capacitor. The only external difference is two additional side terminations, creating a four-terminal capacitive circuit, which allows circuit designers a multitude of attachment options.

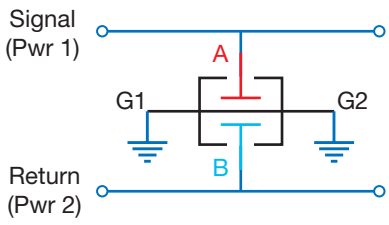






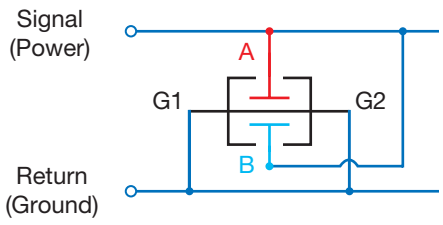
X2Y® Circuit 1: Filtering

When used in circuit 1 configuration the X2Y® filter capacitor is connected across two signal lines. Differential mode noise is filtered to ground by the two Y capacitors, A & B. Common mode noise is cancelled within the device.



X2Y® Circuit 2: Decoupling

When used in circuit 2 configuration A & B capacitors are placed in parallel effectively doubling the apparent capacitance while maintaining an ultra-low inductance.



EMI Filtering with X2Y®

Many experts agree that balance is the key to a "quiet" circuit. X2Y® is a balanced circuit device with two equal halves, tightly matched in both phase and magnitude with respect to ground. This effectively eliminates the need for a common mode choke*. Several advantages are gained by two balanced capacitors sharing a single ceramic component body.

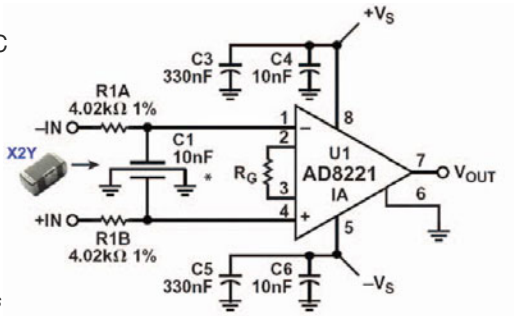
- *Exceptional common mode rejection*
- *Effects of aging & temperature are equal on both caps*
- *Effect of voltage variation eliminated*
- *Matched line-to-ground capacitance*

InAmp Input Filter Example

In this example, a single Johanson X2Y® component was used to filter noise at the input of a DC instrumentation amplifier. This reduced component count by 3-to-1 and costs by over 70% vs. conventional filter components that included 1% film Y-capacitors.

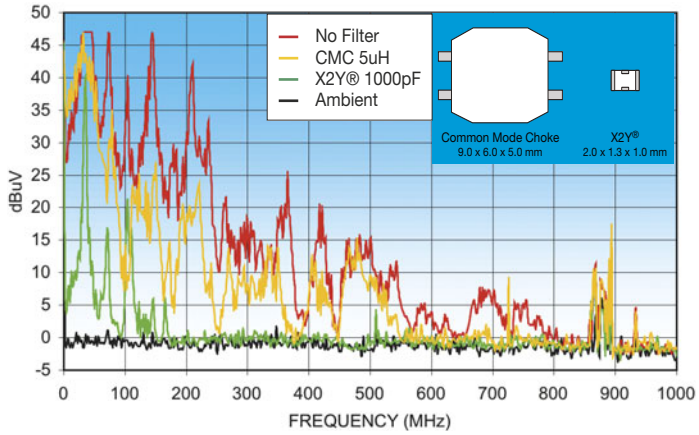
Parameter	X2Y® 10nF	Discrete 10nF, 2 @ 220 pF	Comments
DC offset shift	< 0.1 µV	< 0.1 µV	Referred to input
Common mode rejection	91 dB	92 dB	

Source: Analog Devices, "A Designer's Guide to Instrumentation Amplifiers (2nd Edition)" by Charles Kitchin and Lew Counts



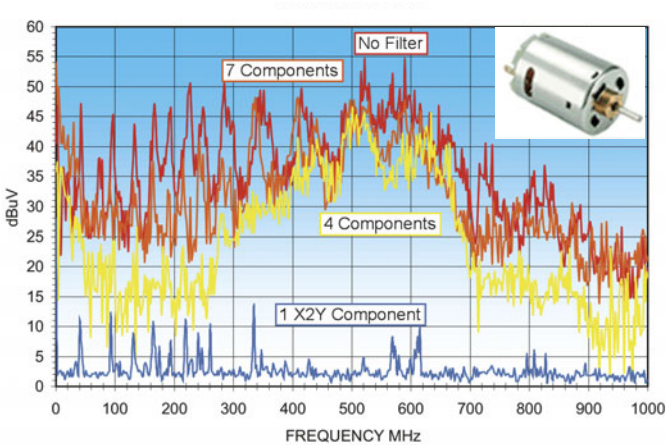
Common Mode Choke Replacement

In this example, a 5 µH common mode choke is replaced by an 0805, 1000pF X2Y® component acheiving superior EMI filtering by a component a fraction of the size and cost.



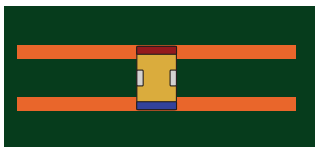
DC Motor EMI Reduction: A Superior Solution

One X2Y® component has successfully replaced 7 discrete filter components while achieving superior EMI filtering.

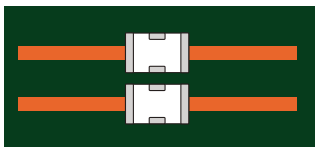


Signal Line Filter for USB & RJ45

One X2Y® component can effectively filter high speed signal lines replacing replacing multiple inductive and ferrite components.



Signal lines filtered with X2Y®



Signal lines filtered with LC Filter Chip

Other X2Y® Filter Applications

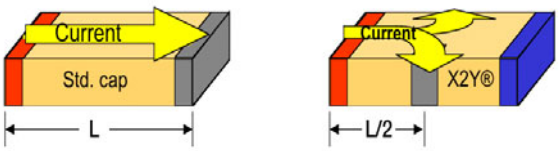
DC-DC converters, power I/O, connectors (RJ45, D-sub), audio/voice/data, CAN, high-speed differential. Effectively replaces common mode chokes, inductors, ferrites and feedthru capacitors.

Decoupling with X2Y®

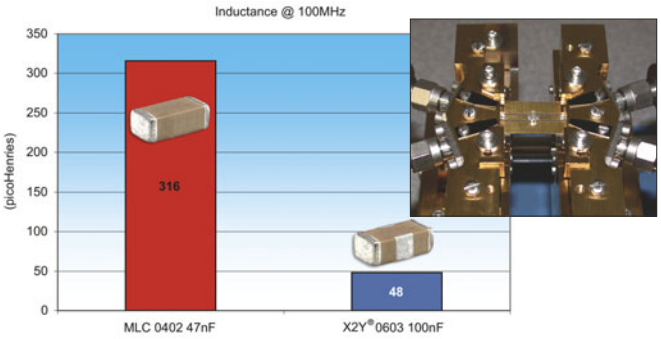
The low inductance advantages of the X2Y® Capacitor Circuit enables high-performance bypass networks at reduced system cost.

- Low ESL (device only and mounted)
- Broadband performance
- Effective on PCB or package
- Lower via count, improves routing
- Reduces component count
- Lowers placement cost

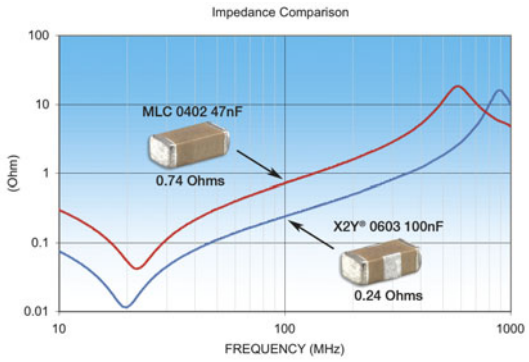
Component Performance

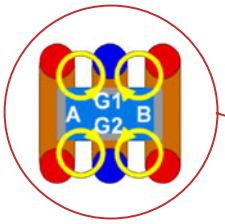


The X2Y® has short, multiple and opposing current paths resulting in lower device inductance.

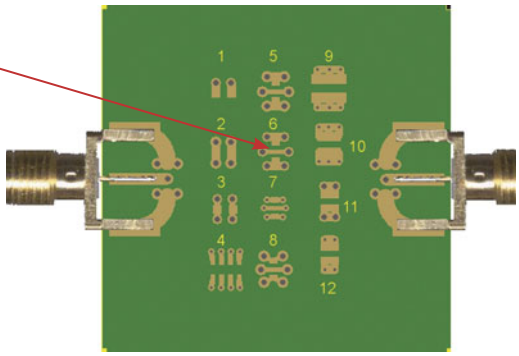


Mounted Performance





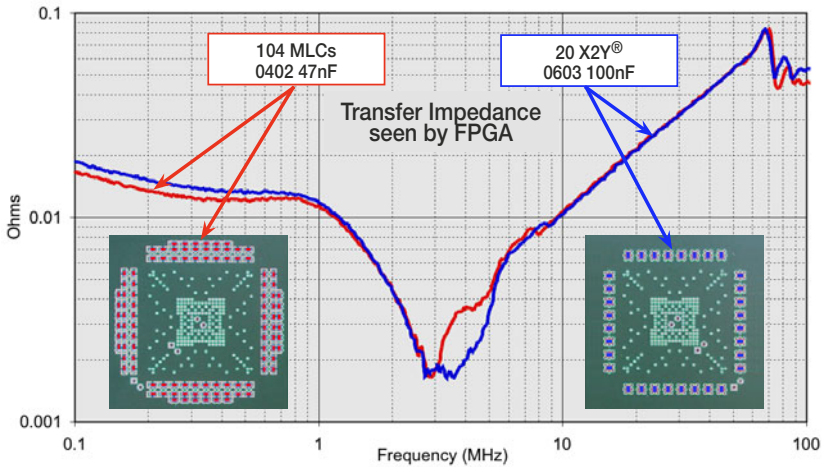
Mutual coupling from opposing polarity vias lowers inductance when mounted on a PCB.



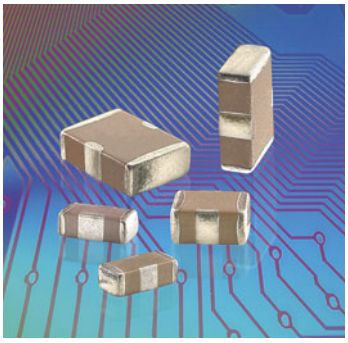
SYSTEM PERFORMANCE

1:5 MLCC Replacement Example

X2Y's® proven technology enables end-users to use one X2Y capacitor to replace five conventional MLCCs in a typical high performance IC bypass design. Vias are nearly cut in half, board space is reduced and savings are in dollars per PCB.



X2Y® Filter & Decoupling Capacitors



X2Y® filter capacitors employ a unique, patented low inductance design featuring two balanced capacitors that are immune to temperature, voltage and aging performance differences.
These components offer superior decoupling and EMI filtering performance, virtually eliminate parasitics, and can replace multiple capacitors and inductors saving board space and reducing assembly costs.

Advantages

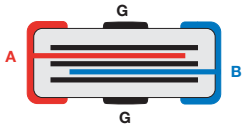
- Superior noise suppression
- Differential and common mode attenuation
- Replace multiple components with one device
- Matched capacitance line to ground, both lines
- Low inductance due to cancellation effect

Applications

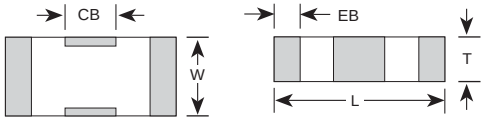
- FPGA / ASIC Decoupling
- µ-Processor Decoupling
- Broadband EMI Filtering
- DC Motor Noise Suppression
- Cellular Handsets

Equivalent Circuits

Cross-sectional View



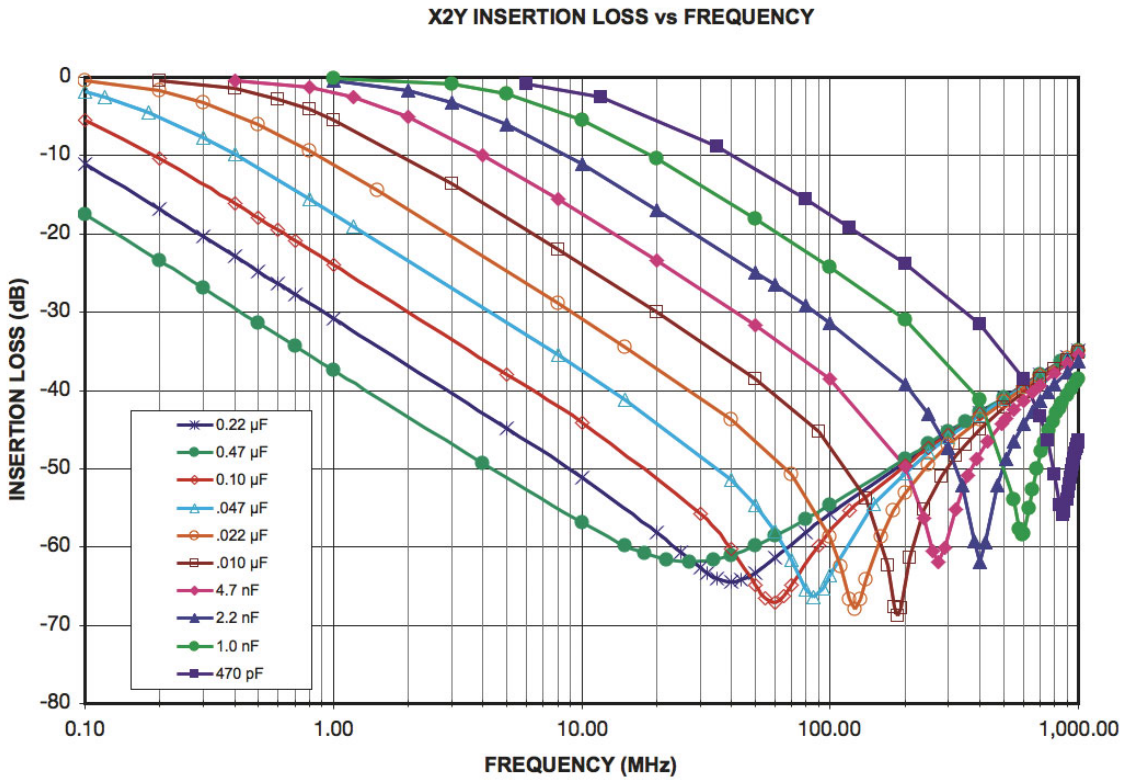
Dimensional View



CHIP SIZE		DIELECTRIC	VOLTAGE (WVDC)	CAPACITANCE RANGE			JOHANSON PART NUMBER
EIA	JDI			Circuit 1	Order Code	Circuit 2	
0402	X07	X7R	6.3	5000pF - .012µF	502 - 123	.010µF - .024µF	6R3X07W***MV4*
			50	1500pF	152	3000pF	500X07W152MV4*
0603	X14	NPO	50	1.0pF - 220pF	1R0 - 221	2.0pF - 440pF	500X14N***MV4*
		X7R	6.3	0.10µF	104	0.20µF	6R3X14W104MV4*
			25	.018µF - .022µF	183 - 223	.036µF - .044µF	250X14W***MV4*
			50	470pF - .012µF	471 - 123	940pF - .024µF	500X14W***MV4*
0805	X15	NPO	50	10pF - 470pF	100 - 471	20pF - 940pF	500X15N***MV4*
			100	10pF - 330pF	100 - 331	20pF - 660pF	101X15N***MV4*
		X7R	50	1000pF - .039µF	102 - 393	2000pF - .078µF	500X15W***MV4*
			100	1000pF - .022µF	102 - 223	2000pF - .044µF	101X15W***MV4*
1206	X18	NPO	50	1000pF	102	2000pF	500X18N102MV4*
		X7R	50	.022µF - 0.10µF	223 - 104	.044µF - 0.20µF	500X18W***MV4*
			100	.022µF - .047µF	223 - 473	.044µF - 0.20µF	101X18W***MV4*
1210	X41	X7R	50	.047µF - 0.27µF	473 - 274	.094µF - 0.54µF	500X41W***MV4*
			100	.047µF - 0.15µF	473 - 154	.094µF - 0.30µF	101X41W***MV4*
1410	X44	X7R	50	0.22µF - 0.40µF	224 - 404	0.44µF - 0.80µF	500X44W***MV4*
			100	0.22µF - 0.22µF	224 - 224	0.44µF - 0.44µF	101X44W***MV4*
1812	X43	X7R	50	0.22µF - 0.56µF	224 - 564	0.44µF - 1.12µF	500X43W***MV4*
			100	0.22µF - 0.47µF	224 - 474	0.44µF - 0.94µF	101X43W***MV4*

Circuit 1 (Balanced Filtering) = A (or B) to G Circuit 2 (Decoupling) = A + B to G [A to B capacitance = 1/2 C1]
Rated voltage is for A or B to ground. A to B rating is 2 X Vrated Contact the factory for other voltage ratings and capacitance values.

X2Y® Filter & Decoupling Capacitors



Mechanical Characteristics

	0402 (X07)		0603 (X14)		0805 (X15)		1206 (X18)		1210 (X41)		1410 (X44)		1812 (X43)	
	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
L	0.045 ± 0.003	1.143 ± 0.076	0.064 ± 0.005	1.626 ± 0.127	0.080 ± 0.008	2.032 ± 0.203	0.124 ± 0.010	3.150 ± 0.254	0.125 ± 0.010	3.175 ± 0.254	0.140 ± 0.010	3.556 ± 0.254	0.174 ± 0.010	4.420 ± 0.254
W	0.024 ± 0.003	0.610 ± 0.076	0.035 ± 0.004	0.889 ± 0.102	0.050 ± 0.008	1.270 ± 0.203	0.063 ± 0.010	1.600 ± 0.254	0.098 ± 0.010	2.489 ± 0.254	0.098 ± 0.010	2.490 ± 0.254	0.125 ± 0.010	3.175 ± 0.254
T	0.020 max	0.508 max	0.026 max	0.660 max	0.040 max	1.016 max	0.050 max	1.270 max	0.070 max	1.778 max	0.070 max	1.778 max	0.090 max	2.286 max
EB	0.008 ± 0.003	0.203 ± 0.076	0.009 ± 0.004	0.229 ± 0.102	0.009 ± 0.004	0.229 ± 0.102	0.009 ± 0.004	0.229 ± 0.102	0.009 ± 0.005	0.229 ± 0.127	0.009 ± 0.005	0.229 ± 0.127	0.009 ± 0.005	0.229 ± 0.127
CB	0.010 ± 0.003	0.305 ± 0.076	0.018 ± 0.004	0.457 ± 0.102	0.022 ± 0.005	0.559 ± 0.127	0.040 ± 0.005	1.016 ± 0.127	0.045 ± 0.005	1.143 ± 0.127	0.045 ± 0.005	1.143 ± 0.127	0.045 ± 0.005	1.143 ± 0.127

How to Order X2Y® EMI Filter Capacitors

500	X18	W	473	M	V	4	E

VOLTAGE
6R3 = 6.3 V
250 = 25 V
500 = 50 V
101 = 100 V

CASE SIZE
X07 = 0402
X14 = 0603
X15 = 0805
X18 = 1206
X41 = 1210
X43 = 1812

DIELECTRIC
N = NPO
W = X7R

CAPACITANCE
1st two digits are significant; third digit denotes number of zeros.
474 = 0.47 µF
105 = 1.00 µF

TOLERANCE
M = ± 20%

TERMINATION
V = Ni barrier w/ 100% Sn Plating

MARKING
4 = Unmarked

TAPE MODIFIER

Code	Tape	Reel
E	Embossed	7"
U	Embossed	13"
T	Paper	7"
R	Paper	13"

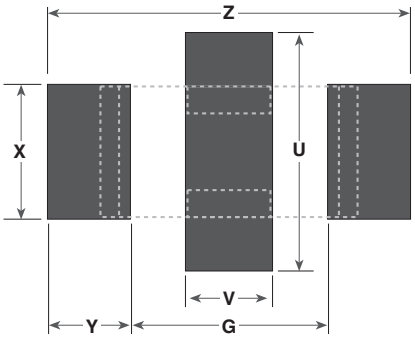
Tape specs. per EIA RS481

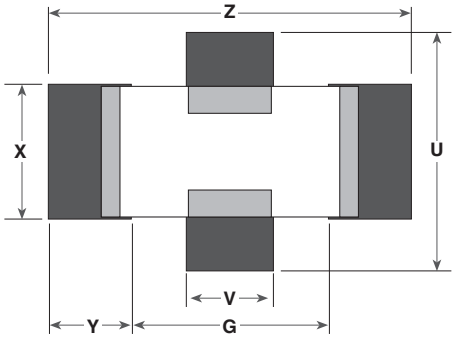
P/N written: 500X18W473MV4E

X2Y® Filter & Decoupling Capacitors

Solder Pad Recommendations

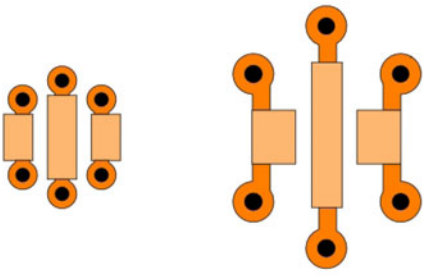
	0402 (X07)		0603 (X14)		0805 (X15)		1206 (X18)		1210 (X41)		1410 (X44)		1812 (X43)	
	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm	IN	mm
X	0.020	0.51	0.03 0	0.76	0.050	1.27	0.065	1.65	0.100	2.54	0.100	2.54	0.125	3.18
Y	0.020	0.51	0.025	0.64	0.035	0.89	0.040	1.02	0.040	1.02	0.040	1.02	0.040	1.02
G	0.024	0.61	0.040	1.02	0.050	1.27	0.080	2.03	0.080	2.03	0.100	2.54	0.130	3.30
V	0.015	0.38	0.020	0.51	0.022	0.56	0.040	1.02	0.045	1.14	0.045	1.14	0.045	1.14
U	0.039	0.99	0.060	1.52	0.080	2.03	0.120	3.05	0.160	4.06	0.160	4.06	0.190	4.83
Z	0.064	1.63	0.090	2.29	0.120	3.05	0.160	4.06	0.160	4.57	0.180	4.57	0.210	5.33





Optimizing X2Y Performance with Proper Attachment Techniques

X2Y® capacitors excel in low inductance performance for a myriad of applications including EMI/RFI filtering, power supply bypass / decoupling. How the capacitor is attached to the application PCB is every bit as important as the capacitor itself. Proper attention to pad layout and via placement insures superior device performance. Poor PCB layouts squander performance, requiring more capacitors, and more vias to do the same job. Figure 1 compares the X2Y® recommended layout against a poor layout. Because of its long extents from device terminals to vias, and the wide via separation, the poor layout shown performs badly. It exhibits approximately 200% L1 inductance, and 150% L2 inductance compared to recommended X2Y® layouts.



Good Layout Poor Layout

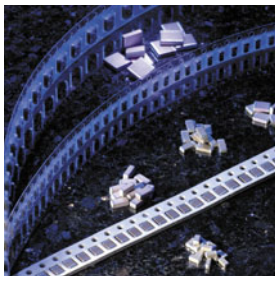
Figure 1

For further details on via placement and it's effect on mounted inductance, please refer to X2Y Attenuators, LLC. application note #3008 "Get the Most from X2Y Capacitors with Proper Attachment Techniques" at www.x2y.com

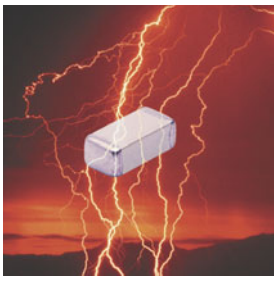
JOHANSON DIELECTRICS, INC.

www.johansondielectrics.com

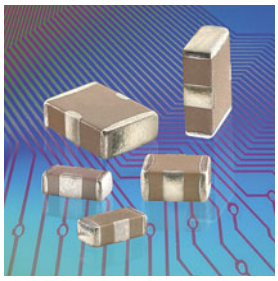
SYLMAR, CALIFORNIA



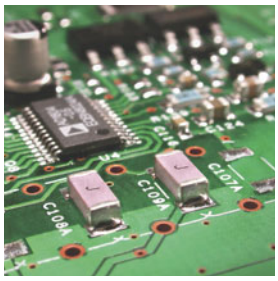
Surface Mount Ceramic Capacitors



High Voltage Ceramic Capacitors



X2Y® EMI Filter Capacitors



Y1 & Y2 Safety Certified Capacitors

JOHANSON TECHNOLOGY, INC.

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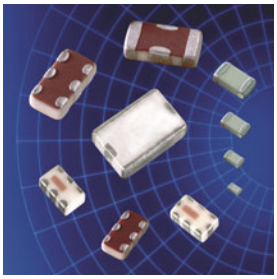
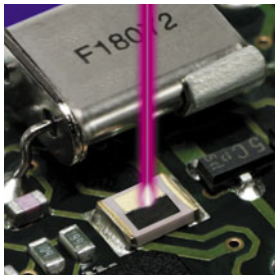
CAMARILLO, CALIFORNIA

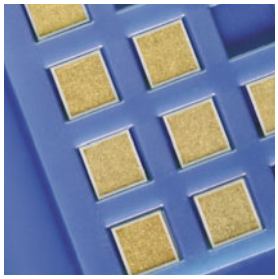
High Frequency Capacitors & Inductors



900 MHz - 6.0 GHz Ceramic Components



LASERtrim® Tuning Capacitors

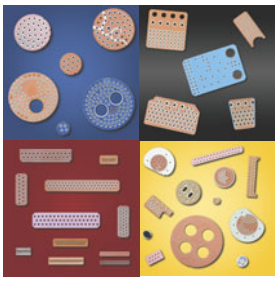


Single Layer Microwave Capacitors

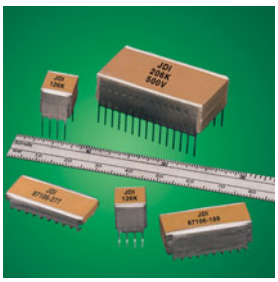
ADVANCED MONOLYTHIC CERAMICS

www.amccaps.com

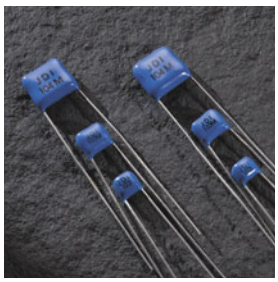
OLEAN, NEW YORK



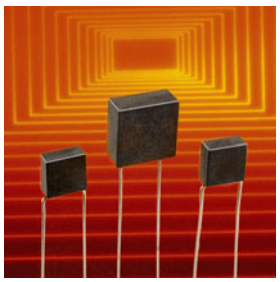
Ceramic Planar Array Filters



Switchmode Ceramic Capacitors



Radial Leaded High Voltage MLCCs



High Temperature Radial Leaded MLCCs

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