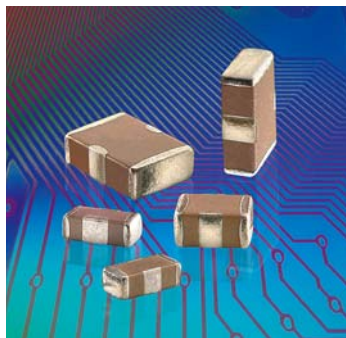


# X2Y<sup>®</sup>



## Technology In Balance

# 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

- One device for EMI suppression or decoupling
- Replace up to 7 components with one X2Y
- Differential and common mode attenuation
- Matched capacitance line to ground, both lines
- Low inductance due to cancellation effect

## APPLICATIONS

- Amplifier Filter & Decoupling
- High Speed Data Filtering
- EMC I/O Filtering
- FPGA / ASIC /  $\mu$ -P Decoupling
- DDR Memory Decoupling

| Circuit 1<br>(1 Y-Cap.)  |           | <10pF | 10pF | 22pF                                                                                                                                  | 27pF | 33pF | 47pF | 100pF | 220pF | 470pF | 1000pF | 1500pF | 2200pF | 4700pF | .010 $\mu$ F | .015 $\mu$ F | .022 $\mu$ F | .039 $\mu$ F | .047 $\mu$ F | .10 $\mu$ F | .18 $\mu$ F | .22 $\mu$ F | .33 $\mu$ F | .40 $\mu$ F | .47 $\mu$ F | 1.0 $\mu$ F |
|--------------------------|-----------|-------|------|---------------------------------------------------------------------------------------------------------------------------------------|------|------|------|-------|-------|-------|--------|--------|--------|--------|--------------|--------------|--------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Circuit 2<br>(2 Y-Caps.) |           | <20pF | 20pF | 44pF                                                                                                                                  | 54pF | 66pF | 94pF | 200pF | 440pF | 940pF | 2000pF | 3000pF | 4400pF | 9400pF | .020 $\mu$ F | .030 $\mu$ F | .044 $\mu$ F | .078 $\mu$ F | .094 $\mu$ F | .20 $\mu$ F | .36 $\mu$ F | .44 $\mu$ F | .68 $\mu$ F | .80 $\mu$ F | .94 $\mu$ F | 2.0 $\mu$ F |
| SIZE                     | CAP. CODE | XR    | 100  | 220                                                                                                                                   | 270  | 330  | 470  | 101   | 221   | 471   | 102    | 152    | 222    | 472    | 103          | 153          | 223          | 393          | 473          | 104         | 184         | 224         | 334         | 404         | 474         | 105         |
| 0402 (X07)               | NPO       | 50    | 50   | 50                                                                                                                                    | 50   | 50   | 50   | 50    |       |       |        |        |        |        |              |              |              |              |              |             |             |             |             |             |             |             |
|                          | X7R       |       |      |                                                                                                                                       |      |      |      |       | 50    | 50    | 50     | 50     | 50     | 50     | 16           |              |              |              |              |             |             |             |             |             |             |             |
| 0603 (X14)               | NPO       | 100   | 100  | 100                                                                                                                                   | 100  | 100  | 50   | 50    | 50    |       |        |        |        |        |              |              |              |              |              |             |             |             |             |             |             |             |
|                          | X7R       |       |      |                                                                                                                                       |      |      |      | 100   | 100   | 100   | 100    | 100    | 100    | 100    | 50           | 25           | 25           |              | 16           | 10          |             | 6.3         |             |             |             |             |
|                          | X5R       |       |      |                                                                                                                                       |      |      |      |       |       |       |        |        |        |        |              |              |              |              |              |             |             | 16          | 10          |             | 10          | 10          |
| 0805 (X15)               | NPO       |       | 100  | 100                                                                                                                                   | 100  | 100  | 100  | 100   | 100   | 50    |        |        |        |        |              |              |              |              |              |             |             |             |             |             |             |             |
|                          | X7R       |       |      |                                                                                                                                       |      |      |      | 100   | 100   | 100   | 100    | 100    | 100    | 100    | 100          | 50           | 50           |              | 50           | 25          | 10          |             |             |             |             |             |
| 1206 (X18)               | NPO       |       |      | <b>VOLTAGE RATINGS</b><br>6.3 = 6.3 VDC<br>10 = 10 VDC<br>16 = 16 VDC<br>25 = 25 VDC<br>50 = 50 VDC<br>100 = 100 VDC<br>500 = 500 VDC |      |      |      |       |       |       | 100    |        |        |        |              |              |              |              |              |             |             |             |             |             |             |             |
|                          | X7R       |       |      |                                                                                                                                       |      |      |      |       |       |       |        |        |        |        | 100          | 100          | 100          |              | 100          | 100         |             | 16          | 16          |             | 10          |             |
| 1210 (X41)               | X7R       |       |      |                                                                                                                                       |      |      |      |       |       |       |        |        |        |        | 500          |              |              |              |              | 100         |             | 100         | 100         |             | 25          | 16          |
| 1410 (X44)               | X7R       |       |      |                                                                                                                                       |      |      |      |       |       |       |        |        |        |        |              | 500          |              |              |              |             |             |             |             | 100         |             |             |
| 1812 (X43)               | X7R       |       |      |                                                                                                                                       |      |      |      |       |       |       |        |        |        |        |              |              |              | 500          |              |             |             |             |             |             | 100         |             |
|                          | X7R       |       |      |                                                                                                                                       |      |      |      |       |       |       |        |        |        |        |              |              |              |              | 500          |             |             |             |             |             |             | 100         |

SEE PART NUMBER LISTING TABLE ON PAGES 7 & 8 Contact factory for part combinations not shown.  
 Circuit 1 capacitance measured Line-to-Ground (A or B to G)    Circuit 2 capacitance measured Power-to-Ground (A + B to G)  
 Rated voltage is from line to ground in Circuit 1, power to ground in Circuit 2.

## HOW TO ORDER X2Y® FILTER & DECOUPLING CAPACITORS

P/N written: 100X14W104MV4T

|                                                                                                                     |                                                                                                                    |                                                    |                                                                                                                                                                                      |                                |                                                                                                                                                   |          |                                                                                                                                                                                                                 |      |      |      |   |          |    |   |       |    |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---|----------|----|---|-------|----|
| <b>100</b>                                                                                                          | <b>X14</b>                                                                                                         | <b>W</b>                                           | <b>104</b>                                                                                                                                                                           | <b>M</b>                       | <b>V</b>                                                                                                                                          | <b>4</b> | <b>T</b>                                                                                                                                                                                                        |      |      |      |   |          |    |   |       |    |
| <b>VOLTAGE</b><br>6R3 = 6.3 V<br>100 = 10 V<br>160 = 16 V<br>250 = 25 V<br>500 = 50 V<br>101 = 100 V<br>501 = 500 V | <b>CASE SIZE</b><br>X07 = 0402<br>X14 = 0603<br>X15 = 0805<br>X18 = 1206<br>X41 = 1210<br>X43 = 1812<br>X44 = 1410 | <b>DIELECTRIC</b><br>N = NPO<br>W = X7R<br>X = X5R | <b>CAPACITANCE</b><br>(Circuit 1)<br>1st two digits are significant; third digit denotes number of zeros.<br>102 = 1000 pF = 1 nF<br>103 = 0.01 μF = 10 nF<br>104 = 0.10 μF = 100 nF | <b>TOLERANCE</b><br>M = ± 20%  | <b>TERMINATION</b><br>V = Ni barrier w/<br>100% Sn Plating<br>Available on select parts:<br>F = Polyterm®<br>soft polymer termination<br>T = SnPb |          | <b>TAPE MODIFIER</b><br><table><tr><td>Code</td><td>Tape</td><td>Reel</td></tr><tr><td>E</td><td>Embossed</td><td>7"</td></tr><tr><td>T</td><td>Paper</td><td>7"</td></tr></table><br>Tape specs. per EIA RS481 | Code | Tape | Reel | E | Embossed | 7" | T | Paper | 7" |
| Code                                                                                                                | Tape                                                                                                               | Reel                                               |                                                                                                                                                                                      |                                |                                                                                                                                                   |          |                                                                                                                                                                                                                 |      |      |      |   |          |    |   |       |    |
| E                                                                                                                   | Embossed                                                                                                           | 7"                                                 |                                                                                                                                                                                      |                                |                                                                                                                                                   |          |                                                                                                                                                                                                                 |      |      |      |   |          |    |   |       |    |
| T                                                                                                                   | Paper                                                                                                              | 7"                                                 |                                                                                                                                                                                      |                                |                                                                                                                                                   |          |                                                                                                                                                                                                                 |      |      |      |   |          |    |   |       |    |
|                                                                                                                     |                                                                                                                    |                                                    |                                                                                                                                                                                      | <b>MARKING</b><br>4 = Unmarked |                                                                                                                                                   |          |                                                                                                                                                                                                                 |      |      |      |   |          |    |   |       |    |

X2Y® technology patents and registered trademark under license from X2Y ATTENUATORS, LLC

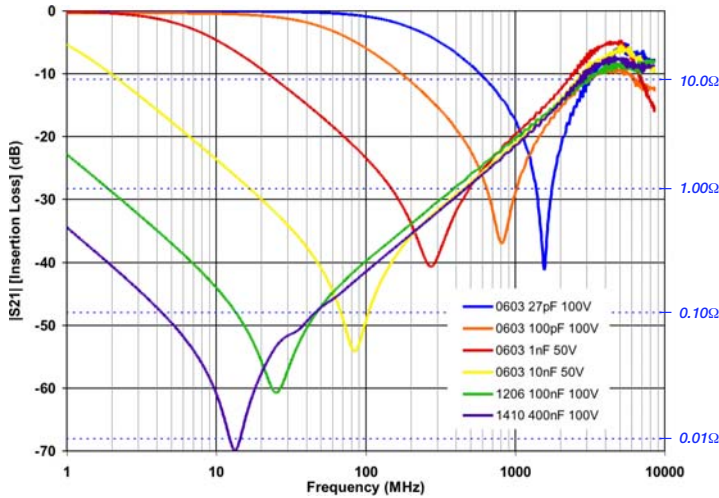
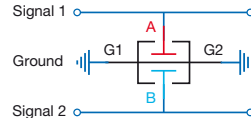


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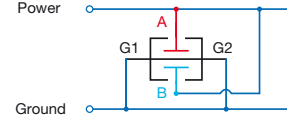
# X2Y® FILTER & DECOUPLING CAPACITORS



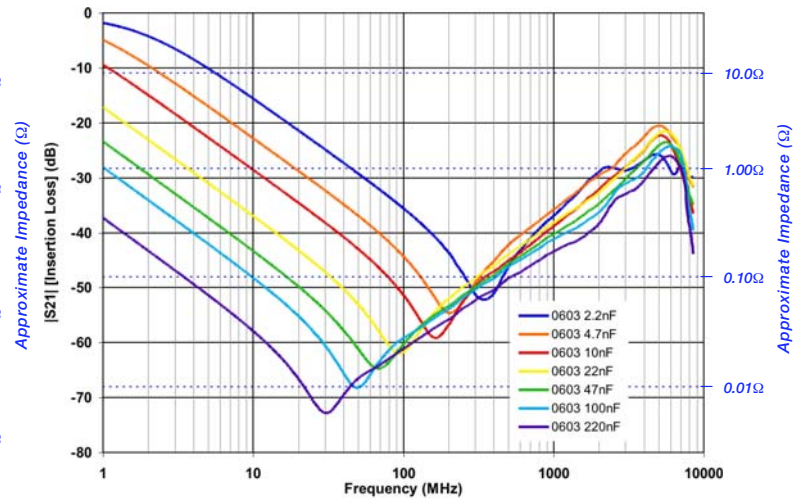
## Filtering Circuit 1 S21 Signal-to-Ground



## Decoupling Circuit 2 S21 Power-to-Ground



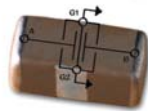
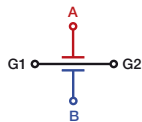
Labeled capacitance values below follow the P/N order code or Y cap value (Circuit 1.)  
Effective capacitance measured in Circuit 2 is 200% of the labeled Circuit 1 Y cap value.



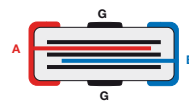
## ELECTRICAL CHARACTERISTICS

| ELECTRICAL CHARACTERISTICS                   | NPO                                                                                                | X7R                                                                                                             | X5R                                               |
|----------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| Temperature Coefficient:                     | 0±30ppm/°C (-55 to +125°C)                                                                         | ±15% (-55 to +125°C)                                                                                            | ±15% (-55 to +85°C)                               |
| Dielectric Strength:                         | WVDC ≤ 100V: 2.5 X WVDC, 25°C, 50mA max.<br>WVDC = 500V: 1.4 X WVDC, 25°C, 50mA max.               |                                                                                                                 |                                                   |
| Dissipation Factor:                          | 0.1% max.                                                                                          | WVDC ≥ 50 VDC: 2.5% max.<br>WVDC = 25 VDC: 3.5% max.<br>WVDC = 10-16 VDC: 5.0% max.<br>WVDC = 6.3 VDC: 10% max. | WVDC ≥ 50 VDC: 5% max.<br>WVDC ≤ 25 VDC: 10% max. |
| Insulation Resistance<br>(Min. @ 25°C, WVDC) | C≤ 0.047µF: 1000 ΩF or 100 GΩ, whichever is less<br>C> 0.047µF: 500 ΩF or 10 GΩ, whichever is less |                                                                                                                 |                                                   |
| Test Conditions:                             | C > 100 pF; 1kHz ±50Hz; 1.0±0.2 VRMS<br>C ≤ 100 pF; 1Mhz ±50kHz; 1.0±0.2 VRMS                      | 1.0kHz±50Hz @ 1.0±0.2 Vrms                                                                                      |                                                   |
| Other:                                       | See main catalog page 18 for additional dielectric specifications.                                 |                                                                                                                 |                                                   |

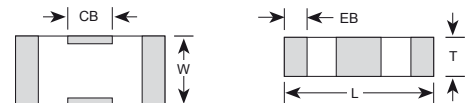
## Equivalent Circuits



## Cross-sectional View



## Dimensional View



## 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  | 0.025 ± 0.003 | 0.635 ± 0.076 | 0.035 ± 0.005 | 0.889 ± 0.127 | 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 | 0.010 ± 0.006 | 0.254 ± 0.152 | 0.012 ± 0.008 | 0.305 ± 0.203 | 0.016 ± 0.010 | 0.406 ± 0.254 | 0.018 ± 0.010 | 0.457 ± 0.254 | 0.018 ± 0.010 | 0.457 ± 0.254 | 0.022 ± 0.012 | 0.559 ± 0.305 |
| CB | 0.012 ± 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 |

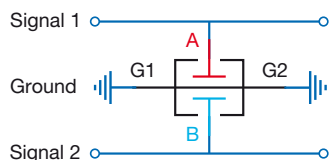
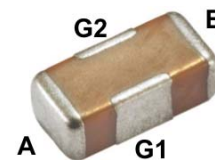
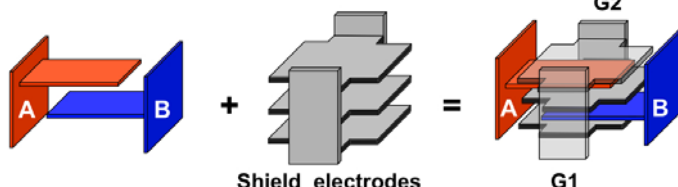


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# X2Y® FILTER & DECOUPLING CAPACITORS

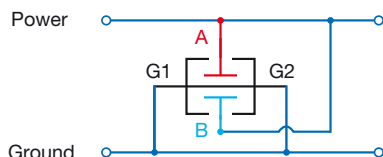
## The X2Y® Design - A Balanced, Low ESL, “Capacitor Circuit”

The X2Y® capacitor design starts with standard 2 terminal MLC capacitor's opposing electrode sets, A & B, and adds a third electrode set (G) which surround each A & B electrode. The result is a highly versatile three node capacitive circuit containing two tightly matched, low inductance capacitors in a compact, four-terminal SMT chip.



### X2Y® Circuit 1: Filtering

Circuit 1 connects the X2Y® filter capacitor across two signal lines. Common-mode noise is filtered to ground (or reference) by the two Y-capacitors, A & B. Because X2Y® is a balanced circuit that is tightly matched in both phase and magnitude with respect to ground, common-to-differential mode noise conversion is minimized and any differential-mode noise is cancelled within the device. The low inductance of the capacitors extends their high frequency attenuation considerably over discrete MLCs.



### X2Y® Circuit 2: Power Bypass / Decoupling

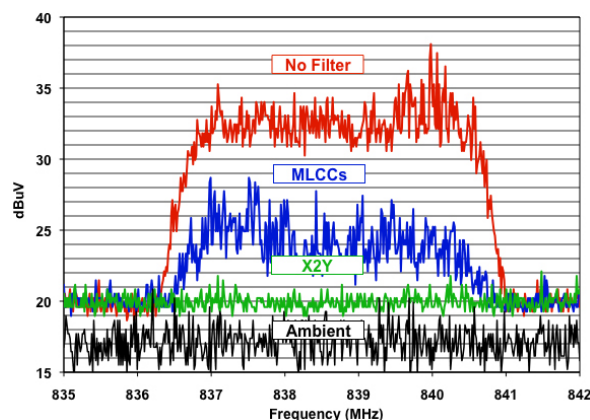
Circuit 2 connects the A & B capacitors in parallel doubling the total capacitance while reducing the inductance. X2Y capacitors exhibit up to 1/10th the device inductance and 1/5th the mounted inductance of similar sized MLC capacitors enabling high-performance bypass networks with far fewer components and vias. Low ESL delivers improved High Frequency performance into the GHz range.

## GSM RFI Attenuation in Audio & Analog

GSM handsets transmit in the 850 and 1850 MHz bands using a TDMA pulse rate of 217Hz. These signals cause the GSM buzz heard in a wide range of audio products from headphones to concert hall PA systems or “silent” signal errors created in medical, industrial process control, and security applications. Testing was conducted where an 840MHz GSM handset signal was delivered to the inputs of three different amplifier test circuit configurations shown below whose outputs were measured on a HF spectrum analyzer.

- 1) No input filter, 2 discrete MLC 100nF power bypass caps.
- 2) 2 discrete MLC 1nF input filter, 2 discrete MLC 100nF power bypass caps.
- 3) A single X2Y 1nF input filter, a single X2Y 100nF power bypass cap.

X2Y configuration provided a nearly flat response above the ambient and up to 10 dB improved rejection than the conventional MLCC configuration.

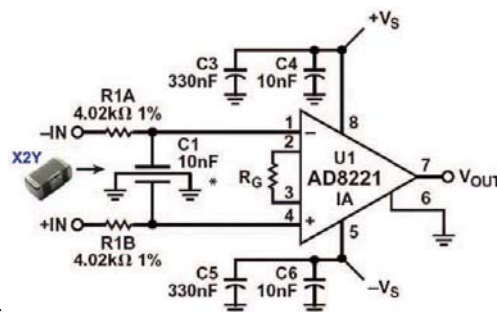


## Amplifier Input Filter Example

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®<br>10nF  | Discrete<br>10nF, 2 @ 220 pF | Comments          |
|-----------------------|---------------|------------------------------|-------------------|
| DC offset shift       | < 0.1 $\mu$ V | < 0.1 $\mu$ V                | 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



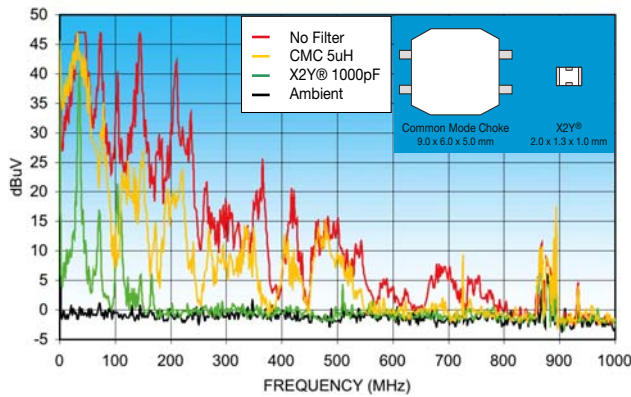
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# X2Y® FILTER & DECOUPLING CAPACITORS



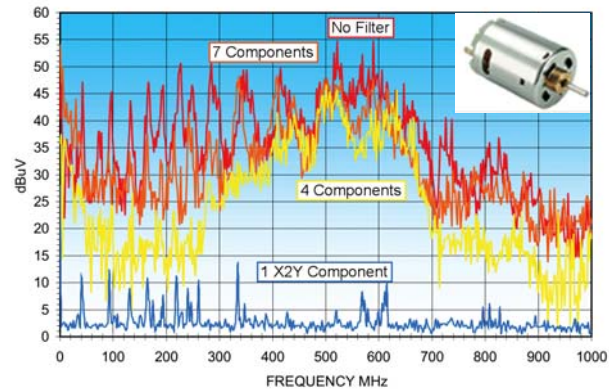
## Common Mode Choke Replacement

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



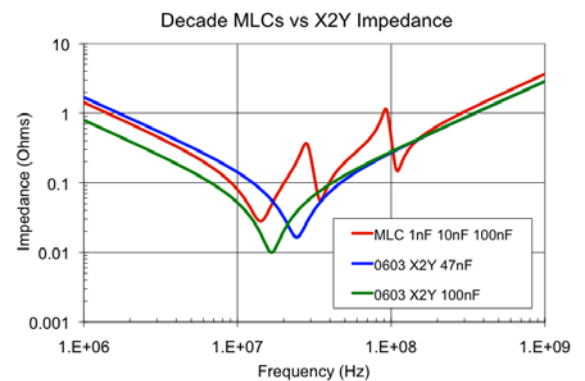
## DC Motor EMI Reduction: A Superior Solution

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



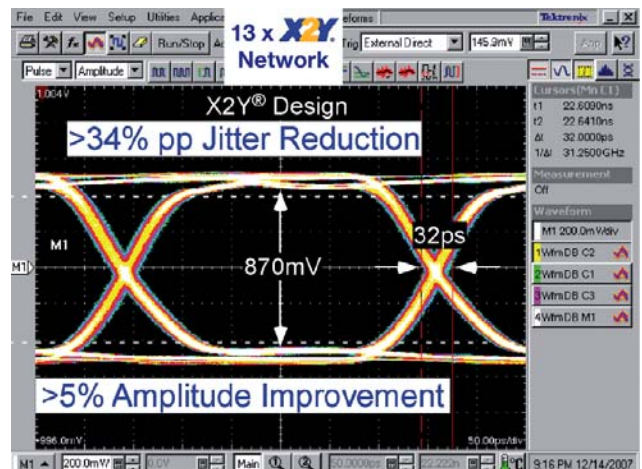
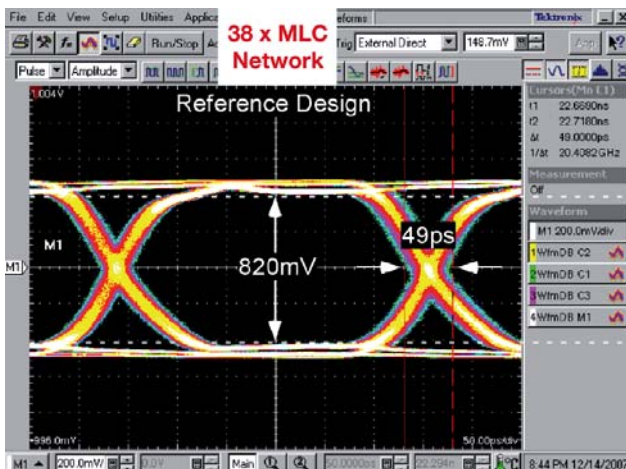
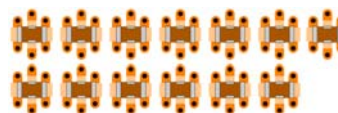
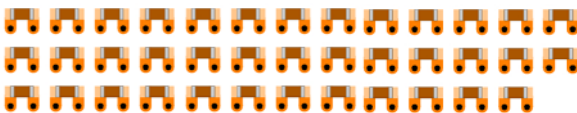
## Eliminating Capacitor Anti-Resonance Issue

A common design practice is to parallel decade capacitance values to extend the high frequency performance of the filter network. This causes an unintended and often over-looked effect of anti-resonant peaks in the filter networks combined impedance. X2Y's very low mounted inductance allows designers to use a single, higher value part and completely avoid the anti-resonance problem. The impedance graph on right shows the combined mounted impedance of a 1nF, 10nF & 100nF 0402 MLC in parallel in RED. The MLC networks anti-resonance peaks are nearly 10 times the desired impedance. A 100nF and 47nF X2Y are plotted in BLUE and GREEN. (The total capacitance of X2Y (Circuit 2) is twice the value, or 200nF and 98nF in this example.) The single X2Y is clearly superior to the three paralleled MLCs.



## X2Y High Performance Power Bypass - Improve Performance, Reduce Space & Vias

Actual measured performance of two high performance SerDes FPGA designs demonstrate how a 13 component X2Y bypass network significantly outperforms a 38 component MLC network. For more information see [http://johansondielectrics.com/pdfs/JDI\\_X2Y\\_STXII.pdf](http://johansondielectrics.com/pdfs/JDI_X2Y_STXII.pdf)



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## 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 | 0.035      | 0.89 | 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      | 4.06 | 0.180      | 4.57 | 0.210      | 5.33 |  |

Use of solder mask beneath component is not recommended because of flux/contaminant entrapment.

## OPTIMIZING X2Y PERFORMANCE ON THE PCB

X2Y capacitors deliver excellent performance in EMI/RFI filtering and Power Bypass applications. Physical and electrical placement on the PCB is critical in achieving good results. A low inductance, dual ground connection is mandatory.

**EMI Filter Applications** Low inductance PCB routing examples are shown in figures 1 and 2. Figures 3-5 show unbalanced and high inductance connections and should be avoided. See detailed application note [X2Y EMI Filter Evaluation and PCB Design Guidelines](#).

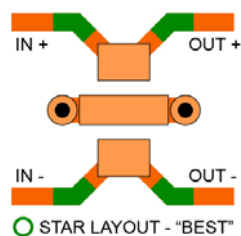


Fig. 1

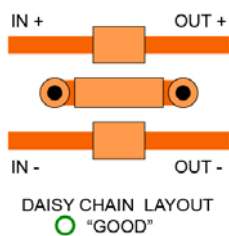


Fig. 2

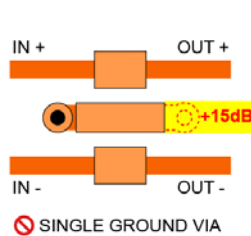


Fig. 3

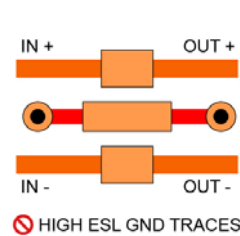


Fig. 4

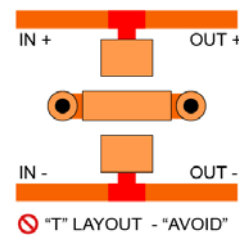
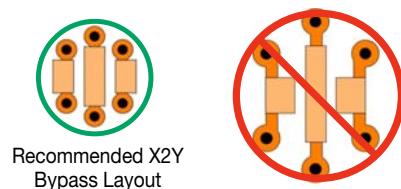


Fig. 5

**PDN / Power Bypass Applications** Figures on right compare 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 exhibits approximately 200% L1 inductance, and 150% L2 inductance compared to recommended X2Y layouts. See detailed application note [X2Y Power Bypass Mounting](#).



## LAB EVALUATION SOLDERING PRECAUTIONS

Ceramic capacitors (X2Y and standard MLC types) can be easily damaged when hand soldered. Thermal cracking of the ceramic body is often invisible even under a microscope. Factors that increase thermal cracking risk:

1. 4 terminals to solder can increase hand-soldering time and temperature exposure
2. Pb-free solders have higher reflow temperatures
3. Low inductance connections to ground are inherently good heat-sinks

A damaged component may exhibit a short circuit immediately and not recover, or may operate with intermittent Insulation Resistance (IR) levels. If you are not achieving expected results and have followed the other guidelines carefully, check to see you are adhering to the soldering guidelines below:

- Always pre-heat the PCB and component to within 50°C of solder reflow temperature at 2°C/sec. maximum.
- Use contact-less hand solder tools such as a hot air pencil, IR lamp, etc.
- Avoid over-heating of the ceramic component, temperature limit: 260°C for 20-30 seconds max.
- Use a soldering iron as last resort; 20W max. tip, NO CONTACT with ceramic, limit solder time to 5 seconds max.

A reliable, cost effective prototype PCB reflow soldering process is possible using a household toaster oven. There are several good procedures available on-line by googling "Toaster Oven Soldering"



| SIZE | TC      | Y-CAPACITOR |           | VOLTAGE<br>RATING (DC) | JOHANSON P/N   | REEL QTY |
|------|---------|-------------|-----------|------------------------|----------------|----------|
|      |         | VALUE       | TOLERANCE |                        |                |          |
| 0402 | NPO/COG | 1.8pF       | ±0.5pF    | 50                     | 500X07N1R8CV4T | 4,000    |
|      |         | 2.2pF       | ±0.5pF    | 50                     | 500X07N2R2CV4T | 4,000    |
|      |         | 4.7pF       | ±0.5pF    | 50                     | 500X07N4R7CV4T | 4,000    |
|      |         | 5.6pF       | ±0.5pF    | 50                     | 500X07N5R6CV4T | 4,000    |
|      |         | 10pF        | ±20%      | 50                     | 500X07N100MV4T | 4,000    |
|      |         | 22pF        | ±20%      | 50                     | 500X07N220MV4T | 4,000    |
|      |         | 27pF        | ±20%      | 50                     | 500X07N270MV4T | 4,000    |
|      |         | 33pF        | ±20%      | 50                     | 500X07N330MV4T | 4,000    |
|      |         | 47pF        | ±20%      | 50                     | 500X07N470MV4T | 4,000    |
|      |         | 100pF       | ±20%      | 50                     | 500X07N101MV4T | 4,000    |
|      | X7R     | 100pF       | ±20%      | 50                     | 500X07W101MV4T | 4,000    |
|      |         | 220pF       | ±20%      | 50                     | 500X07W221MV4T | 4,000    |
|      |         | 470pF       | ±20%      | 50                     | 500X07W471MV4T | 4,000    |
|      |         | 1.0nF       | ±20%      | 50                     | 500X07W102MV4T | 4,000    |
|      |         | 1.5nF       | ±20%      | 50                     | 500X07W152MV4T | 4,000    |
|      |         | 2.2nF       | ±20%      | 50                     | 500X07W222MV4T | 4,000    |
|      |         | 4.7nF       | ±20%      | 50                     | 500X07W472MV4T | 4,000    |
|      |         | 10nF        | ±20%      | 16                     | 160X07W103MV4T | 4,000    |
| 0603 | NPO/COG | 1.8pF       | ±20%      | 100                    | 101X14N1R8CV4T | 4,000    |
|      |         | 2.2pF       | ±20%      | 100                    | 101X14N2R0CV4T | 4,000    |
|      |         | 4.7pF       | ±20%      | 100                    | 101X14N4R7CV4T | 4,000    |
|      |         | 5.6pF       | ±20%      | 100                    | 101X14N5R6CV4T | 4,000    |
|      |         | 10pF        | ±20%      | 100                    | 101X14N100MV4T | 4,000    |
|      |         | 22pF        | ±20%      | 100                    | 101X14N220MV4T | 4,000    |
|      |         | 27pF        | ±20%      | 100                    | 101X14N270MV4T | 4,000    |
|      |         | 33pF        | ±20%      | 100                    | 101X14N330MV4T | 4,000    |
|      |         | 47pF        | ±20%      | 100                    | 101X14N470MV4T | 4,000    |
|      |         | 100pF       | ±20%      | 50                     | 500X14N101MV4T | 4,000    |
|      |         | 220pF       | ±20%      | 50                     | 500X14N221MV4T | 4,000    |
|      |         | 100pF       | ±20%      | 100                    | 101X14W101MV4T | 4,000    |
|      |         | 220pF       | ±20%      | 100                    | 101X14W221MV4T | 4,000    |
|      |         | 470pF       | ±20%      | 100                    | 101X14W471MV4T | 4,000    |
|      |         | 1.0nF       | ±20%      | 100                    | 101X14W102MV4T | 4,000    |
|      |         | 1.5nF       | ±20%      | 100                    | 101X14W152MV4T | 4,000    |
|      |         | 2.2nF       | ±20%      | 100                    | 101X14W222MV4T | 4,000    |
|      |         | 4.7nF       | ±20%      | 100                    | 101X14W472MV4T | 4,000    |
|      |         | 10nF        | ±20%      | 50                     | 500X14W103MV4T | 4,000    |
|      |         | 15nF        | ±20%      | 25                     | 250X14W153MV4T | 4,000    |
|      |         | 22nF        | ±20%      | 25                     | 250X14W223MV4T | 4,000    |
|      |         | 47nF        | ±20%      | 16                     | 160X14W473MV4T | 4,000    |
|      |         | 100nF       | ±20%      | 10                     | 100X14W104MV4T | 4,000    |
|      |         | 220nF       | ±20%      | 6.3                    | 6R3X14W224MV4T | 4,000    |
|      | X5R     | 220nF       | ±20%      | 16                     | 160X14X224MV4T | 4,000    |
|      |         | 330nF       | ±20%      | 10                     | 100X14X334MV4T | 4,000    |
|      |         | 470nF       | ±20%      | 10                     | 100X14X474MV4T | 4,000    |
|      |         | 1.0µF       | ±20%      | 10                     | 100X14X105MV4T | 4,000    |

Parts listed in the table are standard parts and carry the highest DC voltage rating for their size and value. Legacy part number requirements for lower voltage codes are fulfilled with the higher voltage rating which exceeds the requirement. Please contact the factory for part values or voltage combinations that are not shown.



# X2Y® FILTER & DECOUPLING CAPACITORS

| SIZE | TC      | Y-CAPACITOR |           | VOLTAGE RATING (DC) | JOHANSON P/N   | REEL QTY |
|------|---------|-------------|-----------|---------------------|----------------|----------|
|      |         | VALUE       | TOLERANCE |                     |                |          |
| 0805 | NPO/COG | 10pF        | ±20%      | 100                 | 101X15N100MV4E | 4,000    |
|      |         | 22pF        | ±20%      | 100                 | 101X15N220MV4E | 4,000    |
|      |         | 27pF        | ±20%      | 100                 | 101X15N270MV4E | 4,000    |
|      |         | 33pF        | ±20%      | 100                 | 101X15N330MV4E | 4,000    |
|      |         | 47pF        | ±20%      | 100                 | 101X15N470MV4E | 4,000    |
|      |         | 100pF       | ±20%      | 100                 | 101X15N101MV4E | 4,000    |
|      |         | 220pF       | ±20%      | 50                  | 500X15N221MV4E | 4,000    |
|      |         | 470pF       | ±20%      | 50                  | 500X15N471MV4E | 4,000    |
|      | X7R     | 47pF        | ±20%      | 100                 | 101X15W470MV4E | 4,000    |
|      |         | 100pF       | ±20%      | 100                 | 101X15W101MV4E | 4,000    |
|      |         | 220pF       | ±20%      | 100                 | 101X15W221MV4E | 4,000    |
|      |         | 470pF       | ±20%      | 100                 | 101X15W471MV4E | 4,000    |
|      |         | 1nF         | ±20%      | 100                 | 101X15W102MV4E | 4,000    |
|      |         | 1.5nF       | ±20%      | 100                 | 101X15W152MV4E | 4,000    |
|      |         | 2.2nF       | ±20%      | 100                 | 101X15W222MV4E | 4,000    |
|      |         | 4.7nF       | ±20%      | 100                 | 101X15W472MV4E | 4,000    |
|      |         | 10nF        | ±20%      | 100                 | 101X15W103MV4E | 4,000    |
|      |         | 15nF        | ±20%      | 50                  | 500X15W153MV4E | 4,000    |
|      |         | 22nF        | ±20%      | 50                  | 500X15W223MV4E | 4,000    |
|      |         | 47nF        | ±20%      | 50                  | 500X15W473MV4E | 4,000    |
|      |         | 100nF       | ±20%      | 25                  | 250X15W104MV4E | 4,000    |
|      |         | 180nF       | ±20%      | 10                  | 100X15W184MV4E | 4,000    |
| 1206 | NPO/COG | 1nF         | ±20%      | 100                 | 101X18N102MV4E | 3,000    |
|      | X7R     | 10nF        | ±20%      | 100                 | 101X18W103MV4E | 3,000    |
|      |         | 15nF        | ±20%      | 100                 | 101X18W153MV4E | 3,000    |
|      |         | 22nF        | ±20%      | 100                 | 101X18W223MV4E | 3,000    |
|      |         | 47nF        | ±20%      | 100                 | 101X18W473MV4E | 3,000    |
|      |         | 100nF       | ±20%      | 100                 | 101X18W104MV4E | 3,000    |
|      |         | 220nF       | ±20%      | 16                  | 160X18W224MV4E | 3,000    |
|      |         | 330nF       | ±20%      | 16                  | 160X18W334MV4E | 3,000    |
| 1210 | X7R     | 470nF       | ±20%      | 10                  | 100X18W474MV4E | 3,000    |
|      |         | 10nF        | ±20%      | 500                 | 501X41W103MV4E | 2,000    |
|      |         | 100nF       | ±20%      | 100                 | 101X41W104MV4E | 2,000    |
|      |         | 220nF       | ±20%      | 100                 | 101X41W224MV4E | 2,000    |
|      |         | 330nF       | ±20%      | 100                 | 101X41W334MV4E | 2,000    |
| 1410 | X7R     | 1000nF      | ±20%      | 16                  | 160X41W105MV4E | 2,000    |
|      |         | 15nF        | ±20%      | 500                 | 501X44W153MV4E | 2,000    |
| 1812 | X7R     | 400nF       | ±20%      | 100                 | 101X44W404MV4E | 2,000    |
|      |         | 39nF        | ±20%      | 500                 | 501X43W393MV4E | 1,000    |
|      |         | 470nF       | ±20%      | 100                 | 101X43W474MV4E | 1,000    |

Parts listed in the table are standard parts and carry the highest DC voltage rating for their size and value.

Legacy part number requirements for lower voltage codes are fulfilled with the higher voltage rating which exceeds the requirement.

Please contact the factory for part values or voltage combinations that are not shown.

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