ceramic capacitors

api technologies corp.
Spectrum Control

Ceramic Capacitors

we offer performance and cost alternatives to meet varied voltage, capacitance, packaging and budgetary requirements

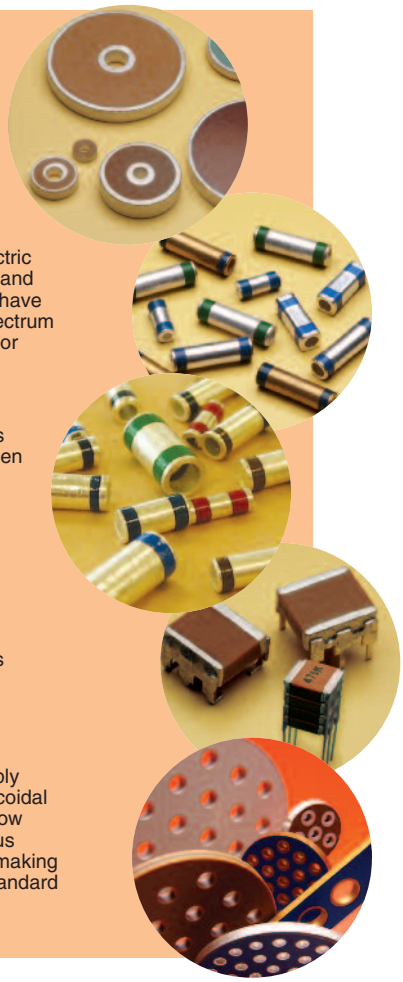
Discoidal Feed-Through Capacitors are ideal for by-pass and filtering applications with a low inductance construction suited for high frequency applications. Their low profile and rugged design is an excellent alternative to ceramic tubes… **CC3-CC7**

Tubular Feed-Through Capacitors are small and lightweight with high dielectric strength and are impervious to moisture and contamination. Feed-through capacitors have a uniform insertion loss over a broad spectrum range and are ideal for multi-pin connector applications… **CC8-CC9**

Tubular Pi Capacitors have similar characteristics to feed-through capacitors in addition to a narrower transition between the pass and stop bands, effectively stopping high frequency interference without affecting desired frequencies and providing filtering of noise content close to signal content … **CC10-CC11**

SMPS (Switch Mode Power Supply) Capacitors deliver lower equivalent series resistance, lower equivalent series inductance, lower ripple voltage and less self-heating when compared to other capacitive elements… **CC13-CC16**

Planar Capacitors offer a faster assembly time compared to stand-alone chips, discoidal or tubular capacitors. They also have a low profile and are capable of meeting various geometric and electrical configurations, making Spectrum's planar capacitors the new standard in EMI suppression applications… **CC17**



API Technologies' Expertise

Inside every EMI filter is a ceramic feed-through capacitor. The Spectrum Control line of ceramic capacitors is designed to provide solutions to a wide range of filtering applications. Our ceramic capacitors are ideal for EMI/RFI suppression filters, medical implantable devices, commercial and military applications, power supplies and converters.

Custom Ceramic Capacitors

We offer many variations of discoidal, tubular and array capacitors to fit your custom application:

- Various OD, ID, thickness and length configurations
- Pressed discoidals with surface printed terminals
- Multi hole discoidal designs
- Miniature discoidals down to .080" OD
- Arrays
- Custom style capability
- High voltage designs available
- High temperature designs available
- Square tubes for surface mount applications
- Lapped feed-through capacitors

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Discoidal Capacitors

Ceramic discoidal feed-through capacitors are the building blocks of the EMI filter industry. API's Spectrum Control discoidal capacitors provide great versatility in meeting varied voltage, capacitance and dimensional requirements. Our nonpolar, multilayer capacitors are small, reliable and high in dielectric strength. Operational temperatures of –55°C to +125°C are achieved with no voltage de-rating.

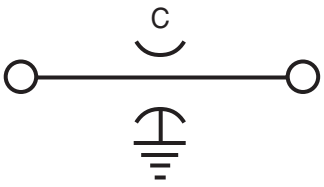
The versatile nature of our discoidals makes them ideally suited for by-pass and filtering applications. Due to their low inductance construction, these capacitors perform extremely well in high frequency applications. The circular geometry of a discoidal feed-through capacitor offers many paths to ground, resulting in lower impedance and better filtering performance.

The low profile and rugged design of our discoidal capacitors offer an excellent alternative to ceramic tubes.

Features

- Excellent high frequency performance
- Low profile design
- Rugged construction
- Low impedance, many paths to ground
- Low inductance, non-polar
- AC applications up to 240V
- DC applications up to 500V
- -55°C to +125°C operation

Feed-Through Circuit

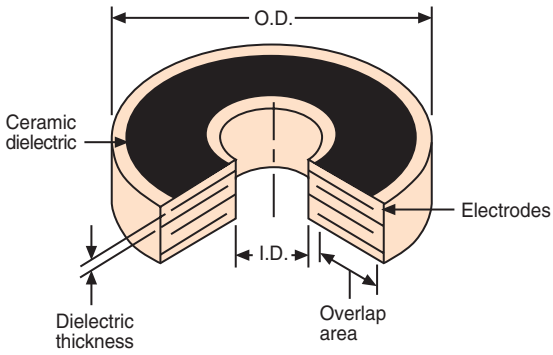


Specialty Ceramic Capacitors

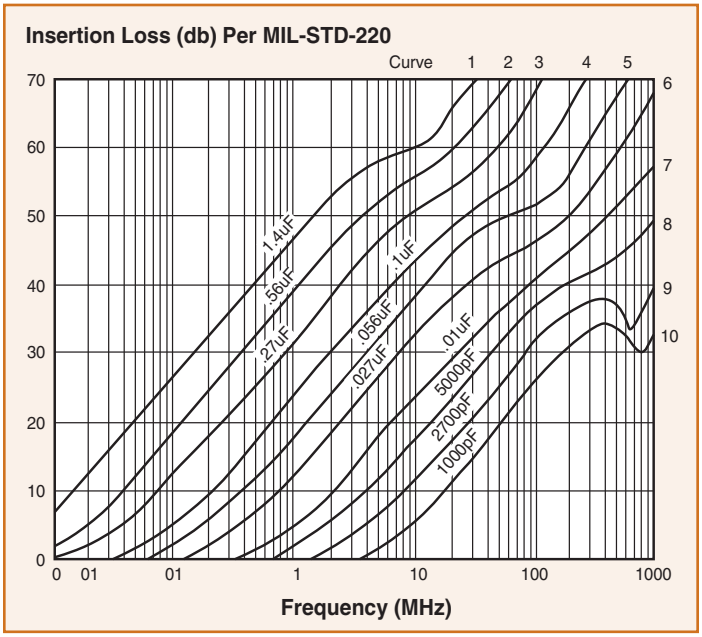
We offer many variations of discoidal and array capacitors to fit your custom application:

- Various OD, ID and thickness configurations
- Pressed discoidals with surface printed terminals
- Multi-hole discoidal designs
- Miniature discoidals down to .080" OD
- Arrays
- Custom style capability
- High voltage designs available
- High temperature designs available

Multilayer Discoidal



Insertion Loss



Metallization

Standard metallization is solderable silver.
Other metallizations are available upon request.

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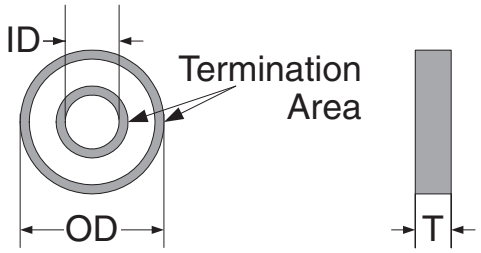
Discoidal NP0



OD	(in)	**0.080** ±0.005				**0.100** ±0.005				**0.135** ±0.005				**0.150** ±0.010				**0.195** ±0.010				**0.340** ±0.010				**0.595** ±0.010			
	(mm)	**2.03** ±0.13				**2.54** ±0.13				**3.43** ±0.13				**3.81** ±0.25				**4.95** ±0.25				**8.64** ±0.25				**15.11** ±0.25			
ID	(in)	**0.030** ±0.005				**0.040** ±0.005				**0.040** ±0.005				**0.045** ±0.005				**0.062** ±0.005				**0.055** ±0.005				**0.095** ±0.005			
	(mm)	**0.76** ±0.13				**1.02** ±0.13				**1.02** ±0.13				**1.14** ±0.13				**1.52** ±0.13				**1.40** ±0.13				**2.41** ±0.13			
T Max	(in)	0.045				0.060				0.060				0.110				0.120				0.120				0.125			
	(mm)	1.14				1.52				1.52				2.79				3.05				3.05				3.18			
Term BW	(in)	0.000 - 0.015				0.000 - 0.020				0.000 - 0.025				0.000 - 0.025				0.002 - 0.025				0.005 - 0.045				0.005 - 0.055			
	(mm)	0.00 - 0.38				0.00 - 0.51				0.00 - 0.64				0.00 - 0.64				0.05 - 0.64				0.13 - 1.14				0.13 - 1.40			
Cap(pF) \ WV(VDC)		500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50
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Note: AC voltage determined upon request

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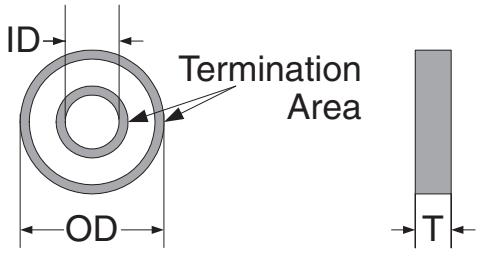
Discoidal X7R



OD	(in)	**0.080** ±0.005				**0.100** ±0.005				**0.135** ±0.005				**0.150** ±0.010				**0.195** ±0.010				**0.340** ±0.010				**0.595** ±0.010			
	(mm)	**2.03** ±0.13				**2.54** ±0.13				**3.43** ±0.13				**3.81** ±0.25				**4.95** ±0.25				**8.64** ±0.25				**15.11** ±0.25			
ID	(in)	**0.030** ±0.005				**0.040** ±0.005				**0.040** ±0.005				**0.045** ±0.005				**0.062** ±0.005				**0.055** ±0.005				**0.095** ±0.005			
	(mm)	**0.76** ±0.13				**1.02** ±0.13				**1.02** ±0.13				**1.14** ±0.13				**1.52** ±0.13				**1.40** ±0.13				**2.41** ±0.13			
T Max	(in)	0.045				0.060				0.060				0.110				0.120				0.120				0.125			
	(mm)	1.14				1.52				1.52				2.79				3.05				3.05				3.18			
Term BW	(in)	0.000 - 0.015				0.000 - 0.020				0.000 - 0.025				0.000 - 0.025				0.002 - 0.025				0.005 - 0.045				0.005 - 0.055			
	(mm)	0.00 - 0.38				0.00 - 0.51				0.00 - 0.64				0.00 - 0.64				0.05 - 0.64				0.13 - 1.14				0.13 - 1.40			
WV(VDC) / Cap(pF)		500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50
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Note: AC voltage determined upon request

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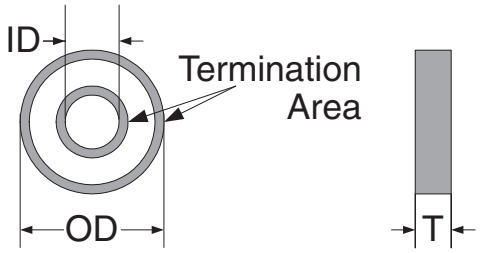
Discoidal Z5U



OD	(in)	**0.080** ±0.005				**0.100** ±0.005				**0.135** ±0.005				**0.150** ±0.010				**0.195** ±0.010				**0.340** ±0.010				**0.595** ±0.010			
	(mm)	**2.03** ±0.13				**2.54** ±0.13				**3.43** ±0.13				**3.81** ±0.25				**4.95** ±0.25				**8.64** ±0.25				**15.11** ±0.25			
ID	(in)	**0.030** ±0.005				**0.040** ±0.005				**0.040** ±0.005				**0.045** ±0.005				**0.062** ±0.005				**0.055** ±0.005				**0.095** ±0.005			
	(mm)	**0.76** ±0.13				**1.02** ±0.13				**1.02** ±0.13				**1.14** ±0.13				**1.52** ±0.13				**1.40** ±0.13				**2.41** ±0.13			
T Max	(in)	0.045				0.060				0.060				0.110				0.120				0.120				0.125			
	(mm)	1.14				1.52				1.52				2.79				3.05				3.05				3.18			
Term BW	(in)	0.000 - 0.015				0.000 - 0.020				0.000 - 0.025				0.000 - 0.025				0.002 - 0.025				0.005 - 0.045				0.005 - 0.055			
	(mm)	0.00 - 0.38				0.00 - 0.51				0.00 - 0.64				0.00 - 0.64				0.05 - 0.64				0.13 - 1.14				0.13 - 1.40			
Cap(pF) \ WV(VDC)		500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50
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Note: AC voltage determined upon request

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Discoidal Electrical Testing

Electrical Parameter	Test Method	Temperature Coefficient NP0	X7R	Z5U
Temperature Coefficient	EIA 198	±30 ppm/ °C, - 55 to +125°C	±15%, -55 to +125°C	+22, -56%, +10 to +85°C
Capacitance Tolerance	EIA Tolerance Code	K, M, P	K, M, P	M, P, Z
Capacitance Test@ 25°C	MIL-STD-202, Method 305	Cap ≤ 100 pF: 1 MHz, 1 Vrms Cap > 100 pF: 1 KHz,1 Vrms	1 KHz, 1 Vrms	1 KHz, 0.5 Vrms
Dissipation Factor @ 25°C	MIL-STD-202, Method 305	0.15% Max	3.5% Max	3.5% Max
Aging Rate (Per Decade)		0%	<2.0%	<3.5%
Insulation Resistance @ 25°C	MIL-STD-202, Method 302	1000 MΩ · µF or 100 KMΩ, whichever is less	1000 MΩ · µF or 100 KMΩ, whichever is less	1000 MΩ · µF or 100 KMΩ, whichever is less
Insulation Resistance @ 125°C	MIL-STD-202, Method 302	100 MΩ · µF or 10 KMΩ, whichever is less	100 MΩ · µF or 10 KMΩ, whichever is less	100 MΩ · µF or 10 KMΩ, whichever is less
Dielectric Withstanding Voltage	MIL-STD-202, Method 301	250% of Rated Voltage, 5 second hold, 30-50 mA	250% of Rated Voltage, 5 second hold, 30-50 mA	250% of Rated Voltage, 5 second hold, 30-50 mA

Discoidal Part Numbering System

After determining the capacitor properties required for a given application, use information from pages AC4-7 and the part numbering system below to place the order. If there are any questions, do not hesitate to contact API's customer service.

Example: **340055AX145P6B0**

The part number shown represents a discoidal with an outer diameter of 0.340" and inner diameter of 0.055". The voltage rating for this part is 50 VDC. The ceramic type will be X7R. The capacitance value is 1,400,000 pF with a tolerance of +100, -0%. The termination will be silver and the parts will receive bulk packaging. Since the last identifier in the part number is "0", there are no special requirements.

340	055	A	X	145	P	6	B	0
Outer Diameter Example: 0.340" = 340	**Inner Diameter** Example: 0.055" = 055	**Voltage Rating** A: 50 VDC B: 100 VDC C: 200 VDC E: 500 VDC	**Ceramic Code** N: NP0 X: X7R Z: Z5U	**EIA Cap Code** Example: 1,400,000 pF = 145	**EIA Cap Tolerance** K: ±10% M: ±20% P: +100 -0% Z: +80 -20%	**Termination** 6: Silver	**Packaging** B: Bulk	**Special Requirements** 0: None D: Class B G: Custom

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Spectrum Control

Tubular FT Capacitors

API Technologies' Spectrum Control brand manufactures a wide variety of tubular feed-through (FT) ceramic capacitors, which are small in size, lightweight, nonpolar and offer high dielectric strength. Operating temperatures of –55°C to +125°C are achieved with no voltage de-rating. All capacitors are fired to produce true monolithic structures, which are impervious to moisture and contamination. Outer terminations feature a nickel barrier and a final metal layer, typically silver.

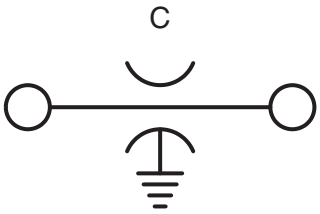
Feed-through tubular capacitors are ideally suited for by-pass and filtering applications. Due to the cylindrical design, the capacitors will have uniform insertion loss over a broad frequency range. This structure yields a low inductance when compared to conventional wound capacitors.

Solid FT capacitors have no internal electrodes and find their primary usage in low cost applications. Multilayered FT capacitors have a higher capacitance to volume ratio and are ideally suited for greater filtering at lower frequencies. Multilayered FT capacitors are also designed for applications where source impedances are high and sharp attenuation rise is critical.

Features

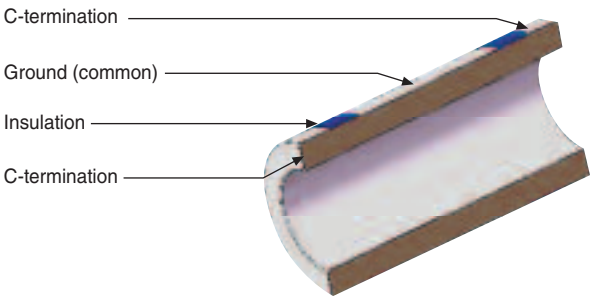
- Low cost solution for general purpose filtering
- Ideal for multi-pin connector applications
- High ratio of capacitance to volume
- Low inductance, non-polar
- Impervious to moisture and contamination
- -55°C to +125°C operation

Feed-Through Circuit

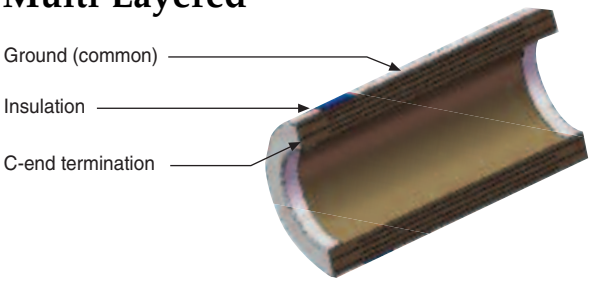


Feed-Through Construction

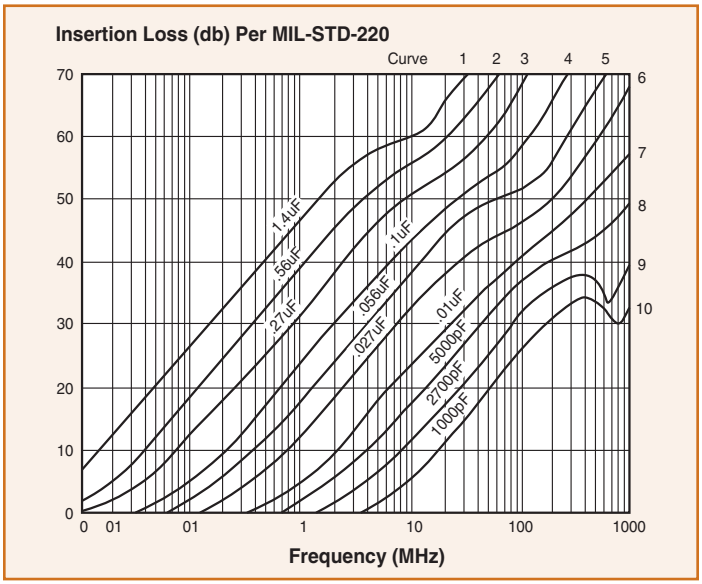
Solid



Multi Layered



Insertion Loss



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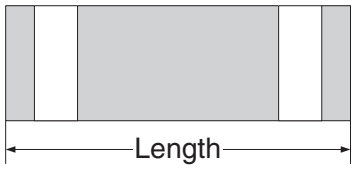
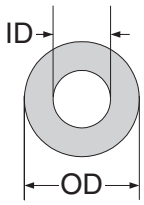
Tubular FT Specifications





Banding Dimensions

Center Dimension, min.	0.065"	1.651 mm
Tip Dimension, min.	0.002"	0.051 mm
Bandwidth, 200 VDC min.	0.025"	0.635 mm
Bandwidth, 100 VDC min.	0.020"	0.508 mm
Bandwidth, 50 VDC min.	0.015"	0.381 mm

TCC																							
	OD	(in)	**0.081** ±0.002						**0.090** ±0.003												**0.122** ±0.004		
		(mm)	**2.06** ±0.05						**2.29** ±0.08												**3.10** ±0.10		
	ID	(in)	**0.050** ±0.002						**0.060** ±0.003												**0.082** ±0.004		
		(mm)	**1.27** ±0.05						**1.52** ±0.08												**2.08** ±0.10		
	Length	(in)	**0.173** ±0.010			**0.235** ±0.010			**0.173** ±0.010			**0.235** ±0.010			**0.300** ±0.010			**0.315** ±0.010			**0.250** ±0.010		
		(mm)	**4.39** ±0.25			**5.97** ±0.25			**4.39** ±0.25			**5.97** ±0.25			**7.62** ±0.25			**8.00** ±0.25			**6.35** ±0.25		
	WV(VDC) / Cap(pF)		200	100	50	200	100	50	200	100	50	200	100	50	200	100	50	200	100	50	200	100	50
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	27,000																						

KEY: Solid Multi-layered

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Spectrum Control

Tubular Pi Capacitors

As with the feed-through tubular capacitors, the Pi (π) tubular capacitors offered by API's Spectrum Control brand are small in size, lightweight, nonpolar and offer high dielectric strength. Operating temperatures of -55°C to +125°C are achieved with no voltage de-rating. All capacitors are fired to produce true monolithic structures, which are impervious to moisture and contamination. Outer terminations feature a nickel barrier and a final metal layer, typically silver.

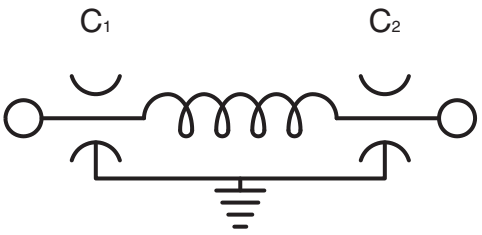
Compared to feed-through tubular capacitors, Pi tubular capacitors have a much narrower transition between the pass and stop bands. Pi capacitors are effective in stopping high frequency interference without affecting necessary frequencies immediately below the stop band.

Similar to feed-through tubular capacitors, Pi tubular capacitors can be designed with a solid or multilayered configuration. Solid Pi tubular capacitors are more cost effective, but limited in capacitance values. Multilayered Pi tubular capacitors can cover a wider range of capacitance, while still maintaining the mechanical strength of a solid Pi tubular capacitor in a similar case size.

Features

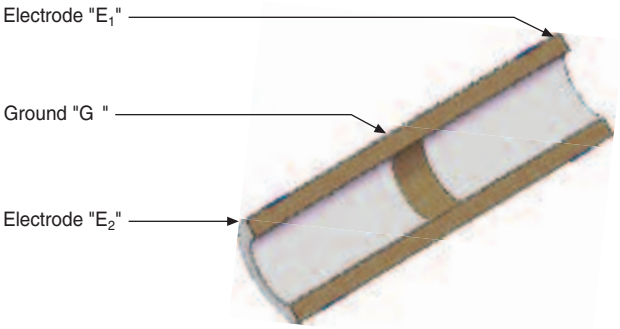
- Provide filtering of noise content close to signal content
- Ideal for multi-pin connector applications
- High ratio of capacitance to volume
- Low inductance, nonpolar
- Impervious to moisture and contamination
- -55°C to +125°C operation

Pi Circuit

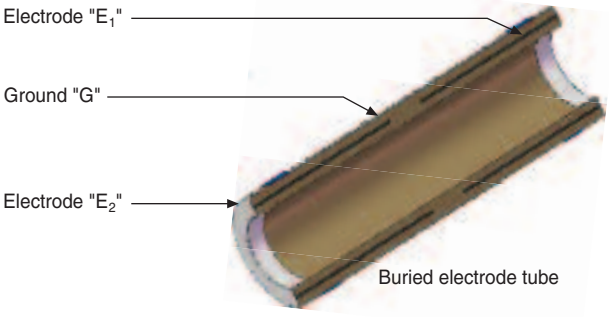


$C_1 + C_2 = C_{Total}$
Inductive Element not included.

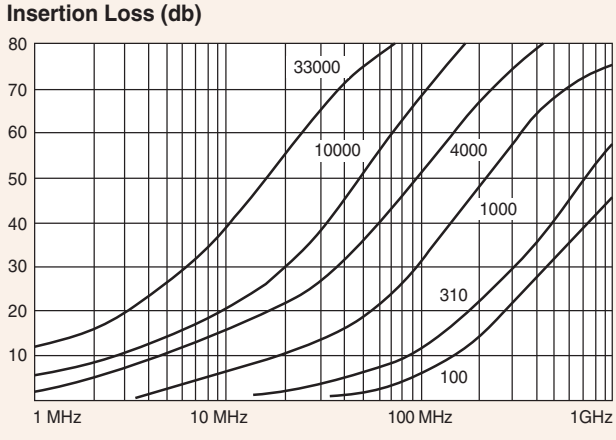
Solid



Multi-layered Tube



Insertion Loss



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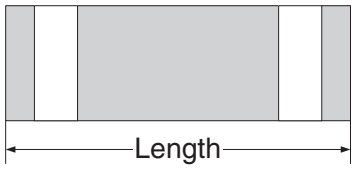
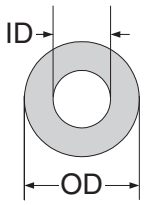
Tubular Pi Specifications





Banding Dimensions

Center Dimension, min.	0.065"	1.651 mm
Tip Dimension, min.	0.002"	0.051 mm
Bandwidth, 200 VDC min.	0.025"	0.635 mm
Bandwidth, 100 VDC min.	0.020"	0.508 mm
Bandwidth, 50 VDC min.	0.015"	0.381 mm

TCC																							
	OD	(in)	**0.081** ±0.002						**0.090** ±0.003												**0.122** ±0.004		
		(mm)	**2.06** ±0.05						**2.29** ±0.08												**3.10** ±0.10		
	ID	(in)	**0.050** ±0.002						**0.060** ±0.003												**0.082** ±0.004		
		(mm)	**1.27** ±0.05						**1.52** ±0.08												**2.08** ±0.10		
	Length	(in)	**0.173** ±0.010			**0.235** ±0.010			**0.173** ±0.010			**0.235** ±0.010			**0.300** ±0.010			**0.315** ±0.010			**0.250** ±0.010		
		(mm)	**4.39** ±0.25			**5.97** ±0.25			**4.39** ±0.25			**5.97** ±0.25			**7.62** ±0.25			**8.00** ±0.25			**6.35** ±0.25		
	WV(VDC) / Cap(pF)		200	100	50	200	100	50	200	100	50	200	100	50	200	100	50	200	100	50	200	100	50
NP0	10 Max																						
	12																						
	27																						
	33																						
	39																						
	47																						
	56																						
	68																						
	82																						
	100																						
	120																						
	150																						
	180																						
	220																						
	270																						
X7R	180																						
	220																						
	270																						
	330																						
	390																						
	470																						
	560																						
	680																						
	820																						
	1,000																						
	1,200																						
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Y5V	1,800																						
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	10,000																						
	12,000																						
	15,000																						
	18,000																						
	22,000																						
	27,000																						

KEY: Solid Multi-Layered

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Spectrum Control

General Tubular Capacitor Information

Specialty Tubular Products

We offer many variations of tubular capacitors to fit your custom application:

- Various OD, ID and length configurations
- Square tubes for surface mount applications
- Lapped feed-through capacitors
- Custom style capability

Tubular Electrical Testing

Electrical Parameter	*Test Method*	*Temperature Coefficient*		
		NP0	*X7R*	*Y5V*
Temperature Coefficient	EIA 198	±30 ppm/ °C, - 55 to +125°C	±15%, -55 to +125°C	+22, –82%, -30 to +85°C
Capacitance Tolerance	EIA Tolerance Code	M, P	N, P, Z	N, P, Z
Capacitance Test @ 25°C	MIL-STD-202, Method 305	Cap ≤ 100 pF: 1 MHz, 1 Vrms Cap > 100 pF: 1 KHz, 1 Vrms	1 KHz, 1 Vrms	1 KHz, 1.0 Vms
Dissipation Factor @ 25°C	MIL-STD-202, Method 305	0.15% Max	3.5% Max	3.5% Max
Aging Rate (Per Decade)		No Aging	<2.0%	<2.5%
Insulation Resistance @ 25°C	MIL-STD-202, Method 302	50 K Megohm or 500 Ohm-Farad, whichever is lower	50 K Megohm or 500 Ohm-Farad, whichever is lower	50 K Megohm or 500 Ohm-Farad, whichever is lower
Insulation Resistance @ 125°C	MIL-STD-202, Method 302	5 K Megohm or 50 Ohm-Farad, whichever is lower	5 K Megohm or 50 Ohm-Farad, whichever is lower	5 K Megohm or 50 Ohm-Farad, whichever is lower
Dielectric Withstanding Voltage	MIL-STD-202, Method 301	250% of Rated Voltage, 5 second hold, 30-50 mA	250% of Rated Voltage, 5 second hold, 30-50 mA	250% of Rated Voltage, 5 second hold, 30-50 mA

Tubular Part Numbering System

After determining the capacitor properties required for a given application, use information from pages AC9-12 and the part numbering system below to place the order. If there are any questions, do not hesitate to contact API's customer service.

Example: **I8150173X7R471M**

The part number shown represents a Pi tubular capacitor with an outer diameter of 0.081" and inner diameter of 0.050". The voltage rating for this part is 200 VDC. The ceramic type will be X7R. The capacitance value is 470 pF with a tolerance of ±20%. The termination will be silver and the parts will receive bulk packaging.

I	*81*	*50*	*173*	*X7R*	*471*	*M*
Voltage Rating	**Outer Diameter**	**Inner Diameter**	**Length**	**Ceramic Code**	**EIA Cap Code**	**EIA Cap Tolerance**
A: FT, 50 VDC	Example:	Example:	Example:	NP0	Example:	M: ±20%
C: FT, 100 VDC	0.081" = 81	0.050" = 50	0.173" = 173	X7R	470 pF = 471	N: ±30%
E: FT, 200 VDC				Y5V		P: +100 -0%
G: Pi, 50 VDC						Z: +80 -20%
H: Pi, 100 VDC						
I: Pi, 200 VDC						

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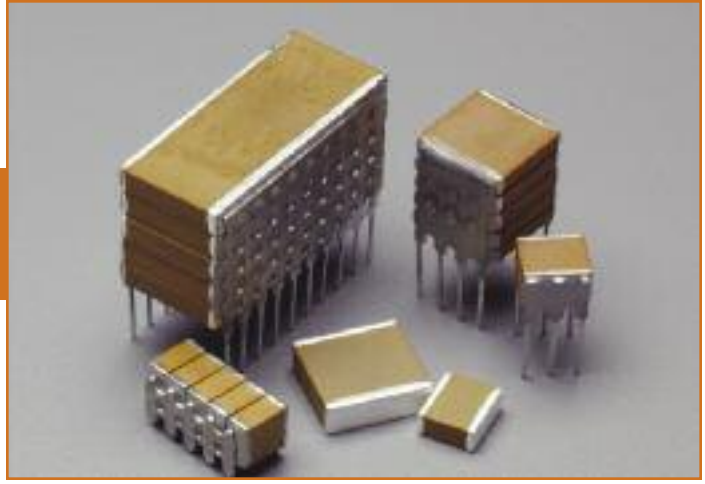
Mil Qualified & DSCC Certified
SMPS Capacitor Assemblies



API Technologies' Spectrum Control line of MIL-PRF-49470 qualified and DSCC 87106 certified Switch Mode Power Supply capacitors are designed to provide superior performance in high frequency switching applications. These capacitors are ideal for high energy density products found in both military and commercial markets.

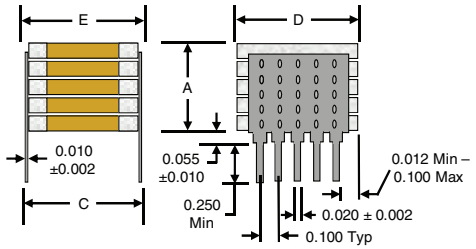
- Capacitance values 0.01µF to 47µF
- Leaded parts safeguard against thermal and mechanical stresses

API's High-speed SMPS capacitors have the following characteristics when compared to other capacitive elements:

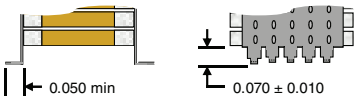
- Lower Equivalent Series Resistance (ESR)
- Lower Equivalent Series Inductance (ESL)
- Lower ripple voltage and less self heating

Style/Size		Dimensions A max	B max	C ±0.025"	D ±0.025"	E max	Leads/ Side
SMP-3	(in)	0.650	0.715	0.450	1.050	0.500	10
	(mm)	16.50	18.16	11.42	26.65	12.69	
SMP-4	(in)	0.650	0.715	0.400	0.400	0.440	4
	(mm)	16.50	18.16	10.15	10.15	11.17	
SMP-5	(in)	0.650	0.715	0.250	0.250	0.300	3
	(mm)	16.50	18.16	6.35	6.35	7.62	

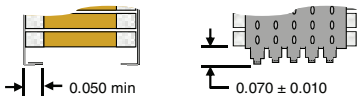
N Lead Configuration



L Lead Configuration



J Lead Configuration



6/M Surface Mount Configuration

Dielectric Characteristics

API offers SMPS capacitors in two basic dielectric classes, with individual designs tailored to meet specific performance characteristics.

Dielectric Type	Stability Class	Description
BP (NPO/COG)	Ultra Stable Class I	Effects on electrical properties are minimal with variations in operating temperature, voltage, frequency or time. Used in applications which require stable performance.
BQ, BR and BX	Stable Class II	Class II dielectrics will exhibit a predictable shift in performance characteristics when exposed to variations in temperature, voltage, frequency or time. Selected for applications where blocking, coupling, by-passing and frequency discriminating elements are used. Offers higher capacitance than Class I (COG).

SMPS Part Numbering System

Example: **SMP3X124KENMB00**

The part number shown represents a size 3 SMPS capacitor. The ceramic type will be BX, capacitance value is 120,000 pF, with a tolerance of ±10%. The voltage rating is 500 VDC, termination will be "N" style leads and the parts will receive marking/ bulk packaging.

SMP3	X	124	K	E	N	M	B	00
Case Size	**Ceramic Code**	**EIA Cap Code**	**EIA Cap Tolerance**	**Voltage Rating**	**Termination**	**Marking**	**Packaging**	**Special Requirements**
SMP3 SMP4 SMP5	P: BP Q: BQ R: BR X: BX	Example: 120,000 pF	J: ±5% K: ±10% M: ±20%	Z: 25 VDC A: 50 VDC B: 100 VDC C: 200 VDC E: 500 VDC	J: Leads in L: Leads out N: Leads straight	M: Marked U: Unmarked	T: Tape & Reel F: Foam carrier/ boxed W: Waffle	GA:87106 Group A HR:Hi-Rel*

* HR: Hi-Rel designation reflects MIL-PRF-49470, level B, QPL approval

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Spectrum Control

Military/Hi-Rel & Commercial/Industrial Grade
SMPS Capacitor Assemblies

API Technologies' Spectrum Control brand offers high reliability/military grade and commercial/industrial grade capacitors designed to provide superior performance in high frequency switch mode power supply applications. These capacitors are ideal for bulk capacitance and pulsing applications and are available in a range of different footprints and mounting configurations. The high reliability/military grade is based on the design principals and test requirements defined by MIL-PRF-49470.

- Leaded options safeguard against thermal and mechanical stresses in larger package sizes
- Capacitance values 0.01 µF to 150 µF
- Stable Class II, BX, BR, BQ and X7R dielectric materials offer reliable operation and predictable performance characteristics related to temperature, frequency and voltage

API's line of Spectrum Control high-speed Switch Mode Power Supply capacitors have the following characteristics when compared to other capacitor technologies:

- Lower Equivalent Series Resistance (ESR)
- Lower Equivalent Series Inductance (ESL)
- Lower ripple voltage and less self heating

Electrical Characteristics

VTC	WVDC	Maximum Capacitance Value									
		2225	2425	3530	3640	3940	4540	5550	6560	7565	44105
X7R	50	156	156	276	396	476	566	826	127	157	157
X7R	100	685	685	126	186	206	256	396	566	686	586
X7R	200	475	475	685	825	106	126	156	256	336	276
X7R	500	155	155	275	395	395	475	685	825	126	126
BX	50	475	565	106	126	156	185	276	396	576	476
BX	100	215	335	475	575	825	825	125	186	226	276
BR	200	125	155	255	395	395	475	685	106	126	126
BQ	500	564	684	125	155	185	185	275	475	565	565

Dimensions (Refer to drawings on page 14)

Dimensions in (mm)	Case Size									
	2225	2425	3530	3640	3940	4540	5550	6560	7565	44A5
C ±0.025 (0.635)	0.235 (5.97)	0.250 (6.35)	0.360 (9.14)	0.370 (9.40)	0.400 (10.16)	0.460 (11.68)	0.560 (14.22)	0.660 (16.76)	0.760 (19.30)	0.450 (11.42)
D Min - Max	0.224–0.275 (5.69–6.99)	0.224–0.275 (5.69–6.99)	0.275–0.325 (6.99–8.26)	0.350–0.425 (8.89–10.80)	0.350–0.425 (8.89–10.80)	0.350–0.425 (8.89–10.80)	0.450–5.25 (11.43–13.34)	0.550–0.625 (13.97–15.88)	0.600–0.675 (15.24–17.15)	0.950–1.075 (24.13–27.31)
E Max	0.300 (7.62)	0.300 (7.62)	0.420 (4.67)	0.430 (10.92)	0.440 (11.17)	0.530 (13.46)	0.630 (16.00)	0.730 (18.54)	0.830 (21.08)	0.500 (12.70)
A Max	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)	0.650 (16.51)
# Leads/Side	3	3	3	4	4	4	5	6	6	10

Note: C dimension for non-leaded chip capacitors equals dimension specified less the thickness of the leads or 0.020" total

SMPS Part Numbering System

Example: **2225X824KAJMBHR**

The part number shown represents a 2225 size SMPS capacitor. The ceramic type is X7R / BX, capacitance value is 0.82 µF, with a tolerance of ±10%. The voltage rating is 50 VDC, termination is "J" style leads, Group A testing is M49470 Group A, Subgroups 1 & 2 and the parts will receive marking / bulk packaging.

2225	X	824	K	A	J	M	B	HR
Case Size Ref Dimensions Table	**Ceramic Code**	**EIA Cap Code**	**EIA Cap Tolerance**	**Working Voltage**	**Lead Configurations**	**Marking**	**Packaging**	**Special Requirements***
A: 1.0 B: 1.1 C: 1.2 D: 1.3 E: 1.4 F: 1.5 G: 1.6 H: 1.7 J: 1.8 K: 1.9 L: 2.0 For dimensions ≥1.000" Substitute letters above eg. 44A5 = 44105 chip size	B: X7R Q: BQ R: BR X: BX	824= 820,000 pF= 0.82 µF 125= 1,200,000 pF= 1.2 µF 156= 15,000,000 pF= 15 µF	K: ±10% M: ±20%	A: 50 VDC B: 100 VDC C: 200 VDC E: 500 VDC	J: Leads in L: Leads out N: Leads straight 6: Ag termination M: PdAg termination	M: Marked U: Unmarked (Std)	B: Bulk F: Foam carrier/ boxed S: Special T: Tape & Reel - 7 in W: Waffle	00: Standard HR: M49470 XX: Custom

* 00 Designation reflects sample visual / mechanical inspection, plus 100% Capacitance, DF, DWV & IR testing @ +25°C
HR designation reflects Group A, Subgroups 1 & 2 inspection per MIL-PRF-49470

Additional package sizes, capacitance values and higher voltage ratings available, please contact factory.

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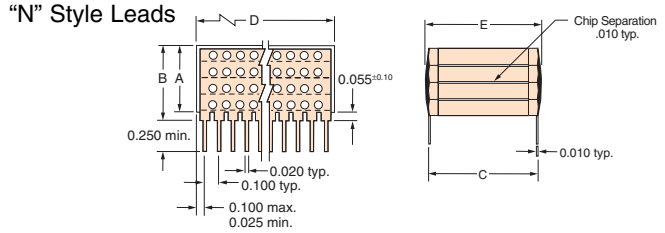
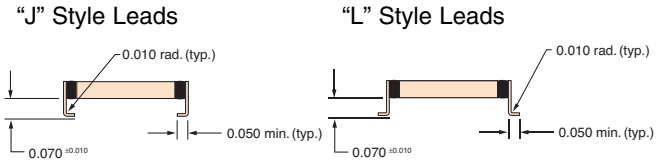
SMPS Specifications





	BP				BX				BR				BQ			
	Working Volts DC				Working Volts DC				Working Volts DC				Working Volts DC			
Cap Value (µF)	500	200	100	50	500	200	100	50	500	200	100	50	500	200	100	50
0.01																
0.012																
0.015																
0.018																
0.022																
0.027																
0.033																
0.039																
0.047																
0.056																
0.068																
0.082																
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39																
47																

KEY: SMP-3 SMP-4 SMP-5

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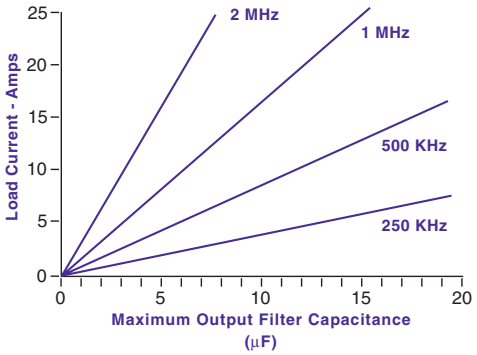
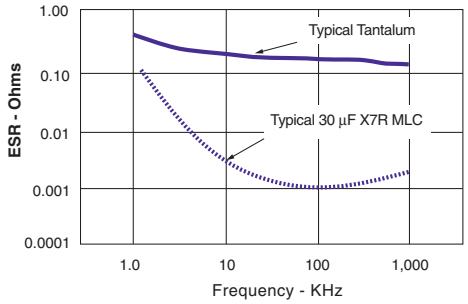
SMPS Capacitor Electrical Testing

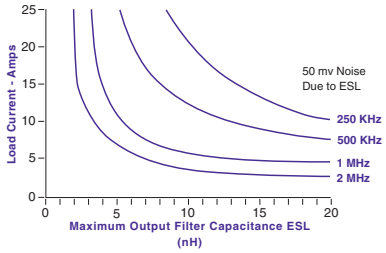
Absolute Maximum Output Capacitance
Assuming no ESL and no ESR



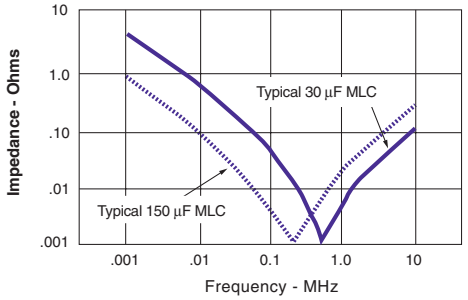
ESR vs. Frequency



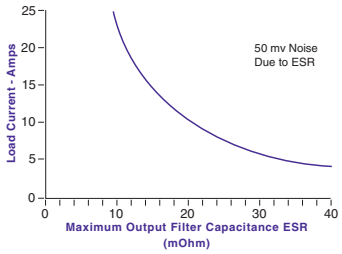
Absolute Maximum Capacitance ESL
Assuming no ESR - Capacitive Induced Ripple



Impedance vs. Frequency



Absolute Maximum Capacitance ESR
Assuming no ESL - Capacitive Induced Ripple



Test Group	*Test Order*	*Test*	*Test Method*	*Post Test Requirements*	*Sampling Procedure*
Group A	1	Visual and Mechanical			13 samples 0 failures
	2	Materials, Designs, Construction and Workmanship			
	3	Physical Dimensions and Marking			
	4	Capacitance and Dissipation Factor	MIL-STD-202 Method 305		100%
	5	Dielectric Withstanding Voltage	MIL-STD-202 Method 301, 2.5x DCWV except 500V @ 1.5x		
	6	Insulation Resistance	MIL-STD-202 Method 302 @ DCWV, 25 C	>100,000 megohms or 1,000 megohm-uF, whichever is less	
Group B Sub Grp I	1	Voltage and Temperature Limits			12 samples 1 failure
	2	Resistance to Solvents	MIL-STD-202 Method 215		
	3	Immersion	MIL-STD-202 Method 104 test condition B	No mechanical damage. Dielectric strength, capacitance, df and 25 C IR to original limits	
	4	Terminal Strength	MIL-STD-202 Method 211 test condition A. Case codes 1-4, 6-5 lbs case code 5-4 lbs	No evidence of loosening or rupturing of terminals	
Group B Sub Grp II	1	Resistance to Soldering Heat	MIL-STD-202 Method 210 N lead style test condition B, J and L styles test condition I	No mechanical damage. Dielectric strength, capacitance, df and 25 C IR to original limits	12 samples 1 failure
	2	Moisture Resistance	MIL-STD-202 Method 106, 20 cycles	No mechanical damage. Dielectric strength, capacitance, df and 25 C IR to original limits	
Group B Sub Grp III	1	Life	MIL-STD-202 Method 108, 1000 hrs. 2x DCWV except 1.2x 500 DCWV	No mechanical damage. Dielectric strength, capacitance, df, 125 C IR and 25 C IR to original limits	12 samples 1 failure
Optional		Solderabililty Group A			
		Thermal Shock and Voltage Conditioning			

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Spectrum Control

Planar Capacitors

API Technologies' Spectrum Control brand designs and manufactures a wide range of planar capacitor arrays. Using over 25 years expertise in multilayer ceramic capacitor manufacturing, planar capacitors offer many advantages over stand-alone chip, discoidal or tubular capacitors: low profile, compact, quick assembly time. Various custom and industry standard geometries are available and our designs can incorporate multiple capacitance values, feed-through holes and ground holes. With a combination of versatility and function, API's planar capacitors are quickly becoming the new standard in filtered connectors used in EMI suppression applications.

Features

- Unparalleled electrical performance and reliability
- Fast prototyping and short lead times
- 100% electrical and dimensional testing of critical parameters
- Custom packaging to suit end user needs
- Custom and standard designs available

Mechanical Specifications

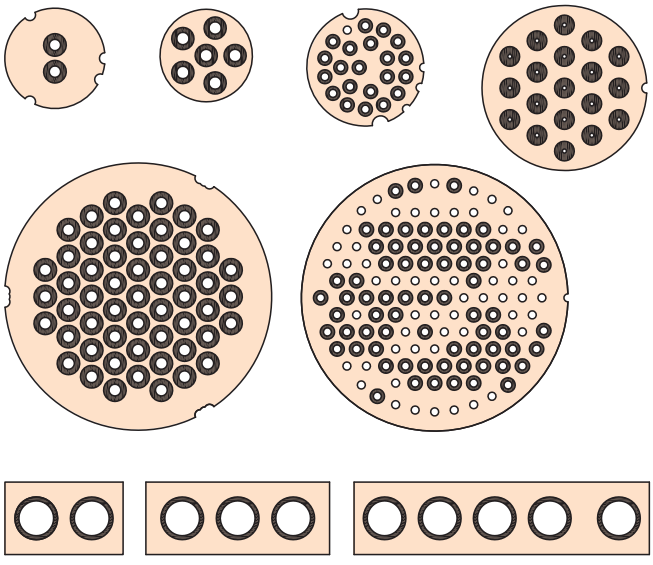
Dielectrics:	EIA Codes: NP0 (COG), X7R, Z5U
Termination:	Fired-on: silver, solderable silver plating: gold, silver or copper over nickel barrier
Surface:	Lapped, termination bandwidth and insulative coating options
Geometry:	Military circulars, D-Sub, ARINC, Micro-D, custom configurations
Thickness:	Up to .150"

Electrical Specifications

Operating Temperature	-55°C - 125°C
Capacitance	Up to 1µF
Capacitance Tolerance	±10%, ±20%, +100%
Capacitance Rating	Up to 1500VDC
Dielectric Withstanding Voltage	Up to 3000VDC
Dissipation Factor	< 3.5%
Insulation Resistance	1000 MΩ, µF or 10KMΩ

The electrical properties listed above are typical, and can be exceeded based on customer requirements and mechanical configuration. Since many variables affect the design, it is best to contact us directly for a detailed assessment of your planar capacitor needs.

Typical Design Layouts



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Dielectric Characteristics

Capacitor Selection

Multilayer capacitors (MLC) and single layer capacitors are categorized by performance with temperature. Component selection is typically determined by dielectric performance, electrical environment and temperature stability.
In determining the proper component for a specific application, the following information should be considered.

Dielectric Type

There are three basic dielectric classes (characteristics) available:

DIELECTRIC PROPERTIES

Dielectric Type	Stability Class	Description
BP (NPO and COG)	Ultra Stable Class I	Effects on electrical properties are minimal with temperature, frequency or time. Used in applications which require stable performance.
BQ, BR, BX and X7R	Stable Class II	Effects on electrical properties predictably change with temperature, voltage, frequency and time. Selected for applications where blocking, coupling, by-passing and frequency discriminating elements are used. Offers higher capacitance than Class I (COG).
Z5U and Y5V	General Purpose Class II	Exhibits a greater variation of properties with temperature. Dielectric constant is higher than Class I and Class II dielectrics. Extremely high capacitance per unit volume and used in general performance applications.

Dielectric Characteristics

NPO (COG)

Operating Temperature Range	-55°C to 125°C
Temperature Coefficient	0 ± 30 ppm/°C
Dissipation Factor	.001 (0.1%) max. @ 25°C
Insulation Resistance: 25°C	10^6 Megohms
125°C	10^5 Megohms
Dielectric Withstanding Voltage	50 to 200V, 2.5 x VDCW 201 to 500V, 1.5 x VDCW, or 500V*, >500V, 1.2 VDCW, or 750V*
Aging Rate	0% per decade hour
Test Parameters	1 KHz, 1.0 ± 0.2 VRMS, 25°C 1 MHz for capacitance ≤1,000 pF

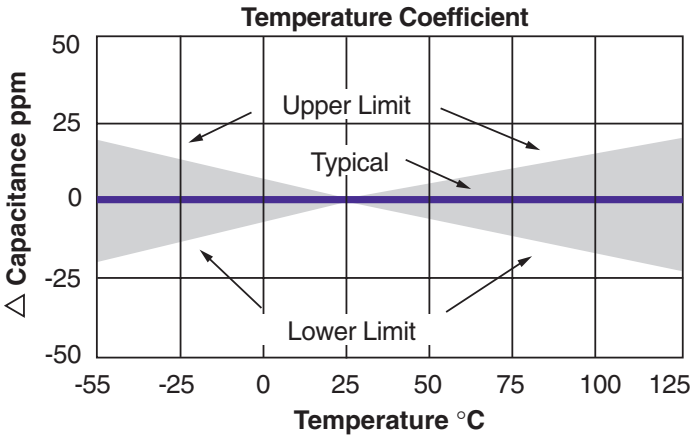
** Whichever is greater*

Capacitor Size

The capacitor body size impacts its utility to the design requirements in respect to capacitance value and voltage rating. Typically smaller units are less expensive and provide for greater space savings. Because mass affects the thermal response of the chips, size should be considered when selecting the attachment method to the circuit.

TERMINATION MATERIAL

Material Type	Recommended Usage
Silver Palladium	Nonmagnetic application requirements. Recommended for conductive epoxy and leaded attachment methods. For soldering applications, use solder reflow below 230°C.
Silver	Most ductile of the available termination methods. Used in applications which will be leaded, to minimize thermal stresses.

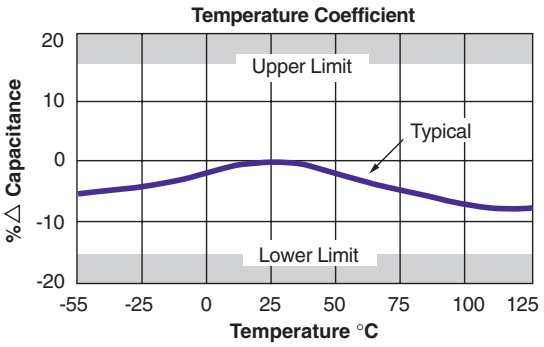


Dielectric Characteristics

Dielectric Characteristics Continued

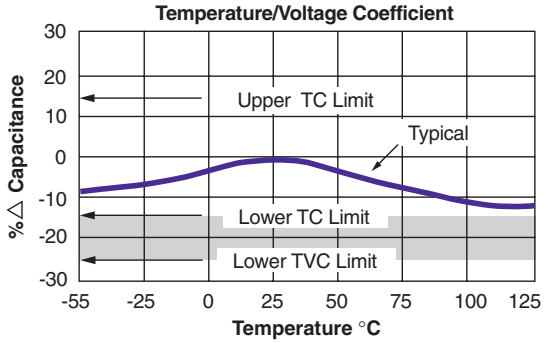
X7R

Operating Temperature Range	-55°C to 125°C
Temperature Coefficient	± 15% △C max.
Dissipation Factor	.025 (2.5%) max. @ 25°C
Insulation Resistance: 25°C	10^6 Megohms
125°C	10^5 Megohms
Dielectric Withstanding Voltage	50 to 200V, 2.5 x VDCW
	201 to 500V, 1.5 x VDCW, or 500V*,
	>500V, 1.2 VDCW, or 750V*
Aging Rate	<2.0% per decade hour
Test Parameters	1 KHz, 1.0 VRMS ± 0.2 VRMS, 25°C



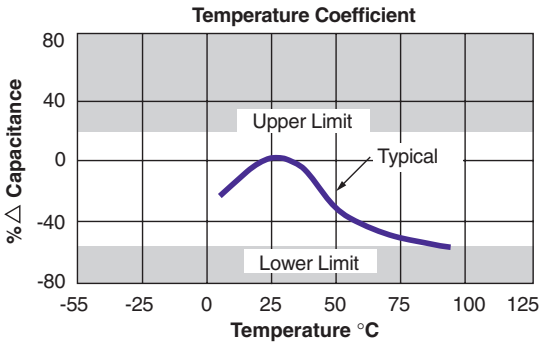
BX

Operating Temperature Range	-55°C to 125°C
Temperature Coefficient	± 15% △C max.
Temperature Voltage Coefficient	+ 15% - 25% △C max.
Dissipation Factor	.025 (2.5%) max. @ 25°C
Insulation Resistance: 25°C	10^6 Megohms
125°C	10^5 Megohms
Dielectric Withstanding Voltage	50 to 200V, 2.5 x VDCW
	201 to 500V, 1.5 x VDCW, or 500V*,
	>500V, 1.2 VDCW, or 750V*
Aging Rate	2.0% per decade hour
Test Parameters	1 KHz, 1.0 VRMS ± 0.2 VRMS, 25°C



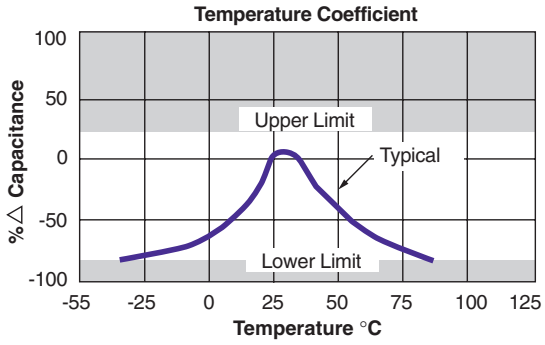
Z5U

Operating Temperature Range	+10°C to 85°C
Temperature Coefficient	+ 22% - 56% △C max.
Dissipation Factor	.030 (3.0%) max. @ 25°C
Insulation Resistance: 25°C	10^5 Megohms
Dielectric Withstanding Voltage	50 to 200V, 2.5 x VDCW
	250V, 1.5 x VDCW
Aging Rate	-2.0% per decade hour
Test Parameters	1 KHz, 0.5 VRMS ± 0.1 VRMS, 25°C



Y5V

Operating Temperature Range	-30°C to 85°C
Temperature Coefficient	+ 22% - 82% △C max.
Dissipation Factor	.050 (5.0%) max. @ 25°C
Insulation Resistance: 25°C	10^5 Megohms
Dielectric Withstanding Voltage	50 to 200V, 2.5 x VDCW
	250V, 1.5 x VDCW
Aging Rate	-2.0% per decade hour
Test Parameters	1 KHz, 1.0 VRMS ± 0.2 VRMS, 25°C



** Whichever is greater*

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Processing & Soldering Notes

General Soldering Recommendations for Leadless Ceramic Capacitors

Soldering Ceramic Capacitors with High Temperature Process

SN10 solder
Ramp rate, heating and cooling . .approximately 30°C/min
Peak temperature . . . . . .approximately 320°C
Dwell at peak . . . . . .< 30 seconds

An RMA flux may be needed.

Soldering Ceramic Capacitors with Medium Temperature Process

SN96 solder
Ramp rate, heating and cooling....approximately 30°C/min
Peak temperature .....approximately 250°C
Dwell at peak .....< 30 seconds

Soldering Ceramic Capacitors with Low Temperature Process

SN62 solder
Ramp rate, heating and cooling....approximately 30°C/min
Peak temperature .....approximately 220°C
Dwell at peak .....< 30 seconds

Notes

Care must be taken to minimize the time silver terminations are exposed to molten solder to avoid leaching (amalgamation of the silver into molten solder). API recommends the use of a silver (Ag) bearing solder when terminating directly to ceramic capacitors to reduce the potential for leeching. Gradual heating and cooling of the components are essential to prevent thermal stresses to the ceramic.

Application Note: Soldering Recommendations for Switch Mode Power Supply Capacitors

- SMPS capacitors are highly durable structures designed to provide long service per lifetime, however they require attention to basic considerations during assembly. Like all ceramic components, SMPS capacitors are subject to thermal stresses. For this reason, preheating of the capacitor assemblies is recommended. Preheat components using hot plate to 120 to 150°C, or within 50 to 60°C of the soldering temperature being applied. Avoid over-exposure to high temperatures during assembly and allow for gradual, post-assembly cooling.
- For hand iron soldering, recommended soldering iron tip temperature is 330 to 350°C. Contact the pad adjacent to the pre-tinned lead should be made from below the PCB (opposite of the component side), and the dwell time on the solder joint should be less than five seconds. An aluminum heat sink plate may be placed adjacent to the SMPS lead frame to protect the ceramic body during assembly. Avoid direct contact between soldering iron and ceramic during assembly process. Soldering time is dependant upon heat sinking provided by the chassis and board material, so a longer preheat cycle may be required.
- Standard solders (Sn60, Sn63, Sn60/38/2) may be used. Please consult the factory for use with RoHS compliant solders.
- Use a controlled temperature profile ramp not exceeding 4°C per second as measured by an attached low mass thermocouple.
- Soldering time and temperatures can vary with component size, board material and layout. Please consult the factory for assistance.