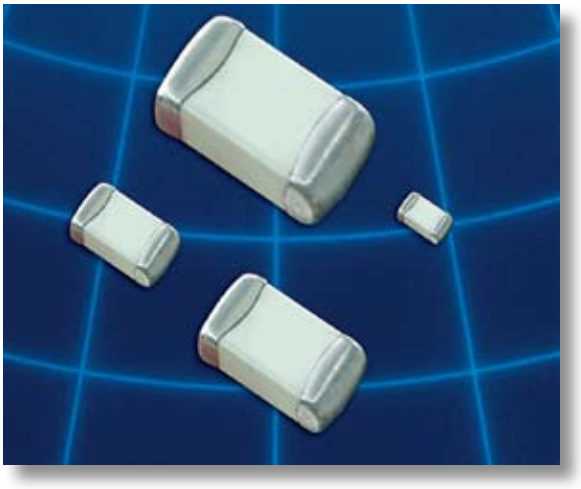
Multi-Layer High-Q Capacitors



These lines of multilayer capacitors have been developed for High-Q and microwave applications.

• The **S-Series** (R03S, R07S, R14S, R15S) capacitors give an ultra-high Q performance, and exhibit NP0 temperature characteristics.

• The **L-Series** (R05L) capacitors give mid-high Q performance, and exhibit NP0 temperature characteristics.

• The **E-Series** (S42E, S48E, S58E) capacitors give excellent high-Q performance from HF to Microwave frequencies. Typical uses are high voltage, high current applications. They are offered in chip (Ni barrier or Non-Magnetic Pt.-Ag) or in Non-Magnetic leaded form.

• The **W-Series** (R05W) capacitors offer a large capacitance value in an ultra-small 0201 package size. These exhibit a X7R temperature characteristic.

• RoHS compliance is standard for all unleaded parts (see termination options box).

How to Order

252 — **VOLTAGE (DC)**
6R3 = 6.3 V
160 = 16 V
250 = 25 V
500 = 50 V
251 = 250 V
501 = 500 V
102 = 1000 V
152 = 1500 V
202 = 2000 V
252 = 2500 V
362 = 3600 V
502 = 5000 V
722 = 7200 V

S48 — **CASE SIZE**
R03 (01005)
R05 (0201)
R07 (0402)
R14 (0603)
R15 (0805)
S42 (1111)
S48 (2525)
S58 (3838)

E — **DIELECTRIC**
S = Ultra High Q NPO
L = High Q NPO
E = Ultra High Q NPO, High Voltage, High Power, W= X7R

470 — **CAPACITANCE (pF)**
1st two digits are significant; third digit denotes number of zeros, R = decimal.
100 = 10 pF
101 = 100 pF

K — **TOLERANCE**
A = ± 0.05 pF
B = ± 0.10 pF
C = ± 0.25 pF
D = ± 0.50 pF
F = ±1 %
G = ±2%
J = ±5%
K = ± 10%

For tolerance availability, see chart.

Y — **TERMINATION**
Nickel Barrier Types
G = Ni/Au
T = Ni/Sn-Pb
V = Ni / 100% Sn
Non Magnetic Types
*C = Non-Leaded Cu
*1 = Microstrip Ribbon Leads (E-Series Only)
*2 = Axial Ribbon

4 — **MARKING**
3 = Cap Code & Tolerance
4 = No Marking
6 = EIA Code
(Marking on 0805 and larger only)

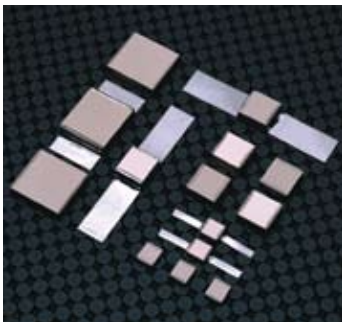
E — **PACKAGING**
S = Bulk
W = Waffle Pack

<u>01005 - 0603</u>
Y = Paper 5" Reel
T = Paper 7" Reel
*R = Paper 13" Reel

<u>0805 - 3838</u>
Z = Embossed 5" Reel
E = Embossed 7" Reel
*U = Embossed 13" Reel

Tape specifications conform to EIA RS481

Part Number written: **252S48E470KY4E**



"*" - Not available for all MLCC - Call factory for info.

Low ESR / High-Q Capacitor Selection Chart

Cap. Value \ EIA Size			Miniature Size - Portable Electronics				RF Power Applications						
			01005 (R03S)	0201 (R05)		0402 (R07S)	0603 (R14S)	0805 (R15S)	1111 (S42E)		2525** (S48E)	3838** (S58E)	
				NPO (R05L)	X7R* (R05W)								
Capacitance pF	Code		Voltage										
0.1	0R1												
0.2	0R2		16 V	25 V		50 V	250 V		500V	1000V			
0.3	0R3		16 V	25 V		50 V	250 V	250 V	500V	1000V			
0.4	0R4		16 V	25 V		50 V	250 V	250 V	500V	1000V			
0.5	0R5		16 V	25 V		50 V	250 V	250 V	500V	1000V			
0.6	0R6		16 V	25 V		50 V	250 V	250 V	500V	1000V			
0.7	0R7		16 V	25 V		50 V	250 V	250 V	500V	1000V			
0.8	0R8		16 V	25 V		50 V	250 V	250 V	500V	1000V			
0.9	0R9		16 V	25 V		50 V	250 V	250 V	500V	1000V			
1.0	1R0		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
1.1	1R1		16 V	25 V		50 V	250 V	250 V	500V	1000V			
1.2	1R2	A	16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
1.3	1R3		16 V	25 V		50 V	250 V	250 V	500V	1000V			
1.4	1R4	B	16 V	25 V		50 V	250 V	250 V	500V	1000V			
1.5	1R5		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
1.6	1R6		16 V	25 V		50 V	250 V	250 V	500V	1000V			
1.7	1R7	C	16 V	25 V		50 V	250 V	250 V	500V	1000V			
1.8	1R8		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
1.9	1R9	D	16 V	25 V		50 V	250 V	250 V	500V	1000V			
2.0	2R0		16 V	25 V		50 V	250 V	250 V	500V	1000V			
2.1	2R1		16 V	25 V		50 V	250 V	250 V	500V	1000V			
2.2	2R2		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
2.4	2R4		16 V	25 V		50 V	250 V	250 V	500V	1000V			
2.7	2R7		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
3.0	3R0		16 V	25 V		50 V	250 V	250 V	500V	1000V			
3.3	3R3		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
3.6	3R6		16 V	25 V		50 V	250 V	250 V	500V	1000V			
3.9	3R9		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
4.3	4R3		16 V	25 V		50 V	250 V	250 V	500V	1000V			
4.7	4R7		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
5.1	5R1		16 V	25 V		50 V	250 V	250 V	500V	1000V			
5.6	5R6	B	16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
6.2	6R2		16 V	25 V		50 V	250 V	250 V	500V	1000V			
6.8	6R8	C	16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
7.5	7R5		16 V	25 V		50 V	250 V	250 V	500V	1000V			
8.2	8R2	D	16 V	25 V		50 V	250 V	250 V	500V	1000V			
9.1	9R1		16 V	25 V		50 V	250 V	250 V	500V	1000V			
10	100		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
11	110		16 V	25 V		50 V	250 V	250 V					
12	120	F	16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
13	130		16 V	25 V		50 V	250 V	250 V	500V	1000V			
15	150		16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
16	160	G	16 V	25 V		50 V	250 V	250 V	500V	1000V			
18	180			25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
20	200	J		25 V		50 V	250 V	250 V	500V	1000V			
22	220			25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
24	240			25 V		50 V	250 V	250 V	500V	1000V			
27	270	K		25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V
30	300			25 V		25 V	250 V	250 V	500V	1000V			
33	330			25 V		25 V	250 V	250 V	500V	1000V	2500V	3600V	7200V

*** The R05W parts, which are X7R, can only be provided with "K" tolerance.**
Consult factory for Non-Standard values.

Low ESR / High-Q Capacitor Selection Chart

Cap. Value \ EIA Size			Miniature Size - Portable Electronics				RF Power Applications						
			01005 (R03S)	0201 (R05)		0402 (R07S)	0603 (R14S)	0805 (R15S)	1111 (S42E)		2525** (S48E)	3838** (S58E)	
				NPO (R05L)	X7R* (R05W)								
Capacitance pF	Capacitance Code	Tolerance	Voltage										
36	360	F G J K		25 V			250 V	250 V	500V	1000V			
39	390			25 V			250 V	250 V	500V	1000V	2500V	3600V	7200V
43	430			25 V			250 V	250 V	500V	1000V			
47	470			25 V			250 V	250 V	500V	1000V	2500V	3600V	7200V
51	510			25 V			250 V	250 V	500V	1000V			
56	560			25 V			250 V	250 V	500V	1000V	2500V	3600V	7200V
62	620			25 V			250 V	250 V	500V	1000V			
68	680			25 V			250 V	250 V	500V	1000V	2500V	3600V	7200V
75	750			25 V			250 V	250 V	500V	1000V			
82	820			25 V			250 V	250 V	500V	1000V	2500V	3600V	7200V
91	910			25 V			250 V	250 V	500V	1000V			
100	101			25 V			250 V	250 V	500V	1000V	2500V	3600V	7200V
110	111				16 V			250 V	300V				
120	121							250 V	300V		2500V	3600V	5000V
130	131							250 V	300V				
150	151							250 V	300V		2500V	3600V	5000V
160	161							250 V	300V				
180	181							250 V	300V		2500V	3600V	5000V
200	201							250 V	300V				
220	221				16 V			250 V	200V		2500V	3600V	
240	241								200V				
270	271								200V		2500V	3600V	
300	301								200V				
330	331								200V		1500V	3600V	
360	361								200V				
390	391								200V		1500V	3600V	
430	431	G J K							200V				
470	471				16 V				200V		1500V	2500V	
510	511								100V				
560	561								100V		1000V	2500V	
620	621								100V				
680	681				16 V				50V		1000V	2500V	
750	751								50V				
820	821				16 V				50V		1000V	1000V	
910	911								50V				
1000	102				10 V				50V		1000V	1000V	
1200	122										1000V	1000V	
1500	152										500V	1000V	
1800	182										500V	1000V	
2200	222				10 V						300V	1000V	
2700	272										300V	500V	
3300	332											500V	
3900	392											500V	
4700	472				10 V							500V	
5100	512											500V	
10000	103				6.3 V								

*** The R05W parts, which are X7R, can only be provided with "K" tolerance.**
Consult factory for Non-Standard values.

Dielectric Characteristics

	NPO	X7R
TEMPERATURE COEFFICIENT:	0 ± 30ppm /°C, -55 to 125°C	± 15%, -55 to 125°C
QUALITY FACTOR / DF:	Q >1,000 @ 1 MHz, Typical 10,000	16VDC DF≤ 3.5% @ 1 KHz, 25°C 10VDC DF≤ 5.0% @ 1 KHz, 25°C
INSULATION RESISTANCE:	>10 GΩ @ 25°C,WVDC; 125°C IR is 10% of 25°C rating	>500 ΩF* or 10 GΩ* @ 25°C,WVDC; 125°C IR is 10% of 25°C rating * whichever is less
DIELECTRIC STRENGTH:	2.5 X WVDC Min., 25°C, 50 mA max	2.5 X WVDC Min., 25°C, 50 mA max
TEST PARAMETERS:	1MHz ±50kHz, 1.0±0.2 VRMS, 25°C	1KHz ±50Hz, 1.0±0.2 VRMS, 25°C
AVAILABLE CAPACITANCE:	Size 01005: 0.2 - 10 pF Size 0201: 0.2 - 100 pF Size 0402: 0.2 - 33 pF Size 0603: 0.2 - 430 pF Size 0805: 0.3 - 220 pF Size 1111: 0.2 - 1000 pF Size 2525: 1.0 - 2700 pF Size 3838: 1.0 - 5100 pF	100 - 10,000 pF

Mechanical & Environmental Characteristics

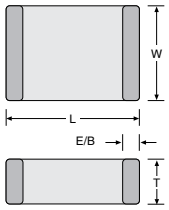
	SPECIFICATION	TEST PARAMETERS
SOLDERABILITY:	Solder coverage ≥ 90% of metalized areas No termination degradation	Preheat chip to 120°-150°C for 60 sec., dip terminals in rosin flux then dip in Sn62 solder @ 240°±5°C for 5±1 sec
RESISTANCE TO SOLDERING HEAT:	No mechanical damage Capacitance change: ±2.5% or 0.25pF Q>500 I.R. >10 G Ohms Breakdown voltage: 2.5 x WVDC	Preheat device to 80°-100°C for 60 sec. followed by 150°-180°C for 60 sec. Dip in 260°±5°C solder for 10±1 sec. Measure after 24±2 hour cooling period
TERMINAL ADHESION:	Termination should not pull off. Ceramic should remain undamaged.	Linear pull force* exerted on axial leads soldered to each terminal. *0402 ≥ 2.0lbs, 0603 ≥ 2.0lbs (min.)
PCB DEFLECTION:	No mechanical damage. Capacitance change: 2% or 0.5pF Max	Glass epoxy PCB: 0.5 mm deflection
LIFE TEST:	No mechanical damage Capacitance change: ±3.0% or 0.3 pF Q>500 I.R. >1 G Ohms Breakdown voltage: 2.5 x WVDC	Applied voltage: 200% rated voltage, 50 mA max. Temperature: 125°±3°C Test time: 1000+48-0 hours
THERMAL CYCLE:	No mechanical damage. Capacitance change: ±2.5% or 0.25pF Q>2000 I.R. >10 G Ohms Breakdown voltage: 2.5 x WVDC	5 cycles of: 30±3 minutes @ -55°+0/-3°C, 2-3 min. @ 25°C, 30±3 min. @ +125°+3/-0°C, 2-3 min. @ 25°C Measure after 24±2 hour cooling period
HUMIDITY, STEADY STATE:	No mechanical damage. Capacitance change: ±5.0% or 0.50pF max. Q>300 I.R. ≥ 1 G-Ohm Breakdown voltage: 2.5 x WVDC	Relative humidity: 90-95% Temperature: 40°±2°C Test time: 500 +12/-0 Hours Measure after 24±2 hour cooling period
HUMIDITY, LOW VOLTAGE:	No mechanical damage. Capacitance change: ±5.0% or 0.50pF max. Q>300 I.R. = 1 G-Ohm min. Breakdown voltage: 2.5 x WVDC	Applied voltage: 1.5 VDC, 50 mA max. Relative humidity: 85±2% Temperature: 40°±2°C Test time: 240 +12/-0 Hours Measure after 24±2 hour cooling period
VIBRATION:	No mechanical damage. Capacitance change: ±2.5% or 0.25pF Q>1000 I.R. ≥ 10 G-Ohm Breakdown voltage: 2.5 x WVDC	Cycle performed for 2 hours in each of three perpendicular directions Frequency range 10Hz to 55 Hz to 10 Hz traversed in 1 minute. Harmonic motion amplitude: 1.5mm

Mechanical Characteristics

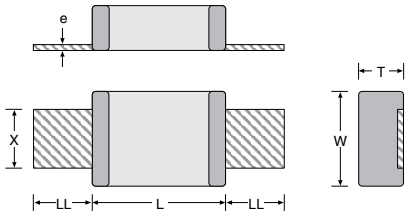
Size	Units	Length	Width	Thickness	End Band
01005	In	.016 ±.001	.008 ±.001	.008 ±.001	.006 Max.
(0402)	mm	(0.40 ±0.03)	(0.20 ±0.03)	(0.20 ±0.03)	(0.15 Max.)
0201	In	.024 ±.001	.012 ±.001	.012 ±.001	.008 Max.
(0603)	mm	(0.60 ±0.03)	(0.30 ±0.03)	(0.30 ±0.03)	(0.20 Max.)
0402	In	.040 ±.004	.020 ±.004	.020 ±.004	.010 ±.006
(1005)	mm	(1.02 ±0.1)	(0.51 ±0.1)	(0.51 ±0.1)	(0.25 ±.15)
0603	In	.062 ±.006	.032 ±.006	.030 +.005/-.003	.014 ±.006
(1608)	mm	(1.57 ±0.15)	(0.81 ±0.15)	(0.76 +.13-.08)	(0.35 ±.15)
0805	In	.080 ±.008	.050 ±.008	.040 ±.006	.020 ±.010
(2012)	mm	(2.03 ±0.20)	(1.27 ±0.20)	(1.02 ±.15)	(0.50 ±.25)

E-Series Lead Style Selection

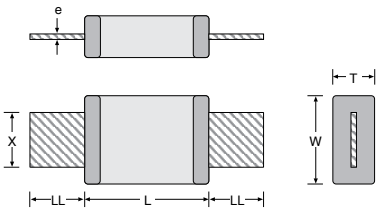
Unleaded Terminations Code "Y" (Pt.-Ag), "V" (Ni / 100% Sn), or "T" (Ni / SnPb)



Microstrip Ribbon Leads (Non-Magnetic), Termination Code "1"



Axial Ribbon Leads (Non-Magnetic), Termination Code "2"



Lead	Size	Units	L	Tol	W	Tol	T	E / B
Y, V, T	S42E	In	0.110	+.020 -.010	0.110	+/- .020	0.102 Max.	0.015 Typ.
		mm	2.79	+0.51 -0.25	2.79	+/- 0.51	2.59 Max.	0.38 Typ.
	S48E	In	0.230	+.025 -.010	0.250	+/- .015	0.150 Max.	0.025 Typ.
		mm	5.84	+0.63 -0.25	6.35	+/- 0.38	3.81 Max.	0.63 Typ.
	S58E	In	0.380	+.015 -.010	0.380	+/- .010	0.170 Max.	0.025 Typ.
		mm	9.65	+0.38 -0.25	9.65	+/- 0.25	4.32 Max.	0.63 Typ.

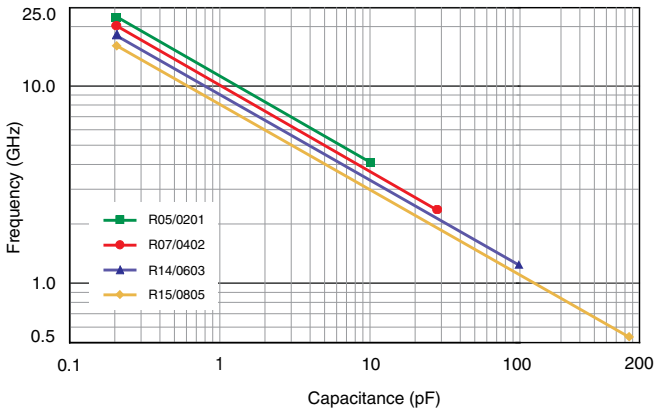
For all E-Series Models:

OPERATING TEMP. :	-55 to +125°C
INSULATION RESISTANCE:	>1000 ΩF or >10 GΩ, whichever is less @ 25°C WVDC
TEMPERATURE COEFFICIENT:	0 ± 30ppm /°C, -55 to 125°C
DISSIPATION FACTOR (TYP.):	< 0.05% @ 1 MHz

Lead	Size	Units	L	Tol	W	Tol	T (max)	E/B (typ)	LL(min)	X	Tol	e	Tol
1	S42E	In	0.135	+/- .015	0.110	+/- .020	0.120	0.015	0.25	0.093	+/-0.005	0.004	+/- 0.001
		mm	3.43	+/- 0.38	2.79	+/- 0.51	3.05	0.38	6.35	2.36	+/- 0.13	0.102	+/- 0.025
	S48E	In	0.245	+/- 0.025	0.250	+/- 0.015	0.160	0.025	0.50	0.240	+/- 0.005	0.004	+/- 0.001
		mm	6.22	+/- 0.64	6.35	+/-0.38	3.81	0.63	12.7	6.10	+/- 0.13	0.102	+/- 0.025
	S58E	In	0.38	+0.035 / - 0.010	0.38	+/- 0.010	0.170	0.04 MAX.	0.750	0.35	+/- 0.010	0.010	+/- 0.005
		mm	9.65	+0.89 / -0.25	9.65	+/- 0.25	4.32	1.02 MAX.	19.05	8.89	+/- 0.25	0.25	+/- 0.13
2	S42E	In	0.135	+/- .015	0.110	+/- .020	0.102	0.015	0.25	0.093	+/-0.005	0.004	+/- 0.001
		mm	3.43	+/- 0.38	2.79	+/- 0.51	2.59	0.38	6.35	2.36	+/- 0.13	0.102	+/- 0.025
	S48E	In	0.245	+/- 0.025	0.250	+/- 0.015	0.160	0.025	0.50	0.240	+/- 0.005	0.004	+/- 0.001
		mm	6.22	+/- 0.64	6.35	+/-0.38	3.81	0.63	12.7	6.10	+/- 0.13	0.102	+/- 0.025
	S58E	In	0.38	+0.035 / - 0.010	0.38	+/- 0.010	0.170	0.04 MAX.	0.750	0.35	+/- 0.010	0.010	+/- 0.005
		mm	9.65	+0.89 / -0.25	9.65	+/- 0.25	4.32	1.02 MAX.	19.05	8.89	+/- 0.25	0.25	+/- 0.13

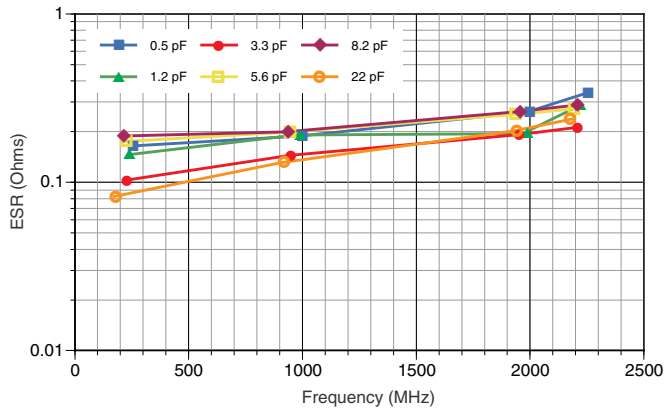
SERIES RESONANCE CHART

Typical Series Resonant Frequency (Series Mounted)

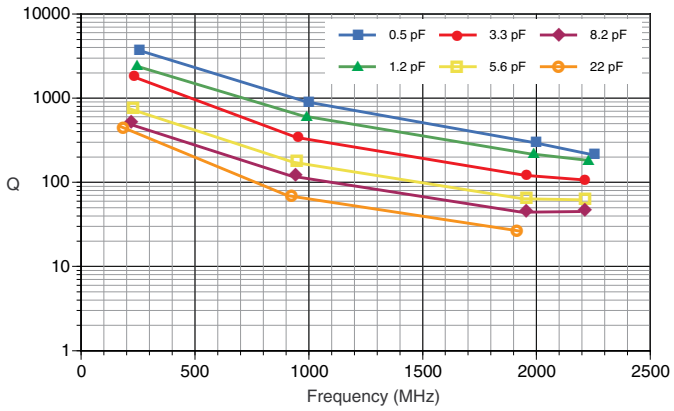


RF CHARACTERISTICS - L-SERIES

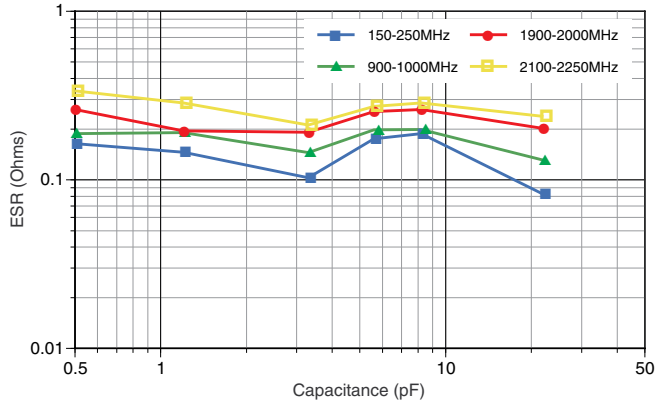
ESR vs Frequency: 0201/R05L



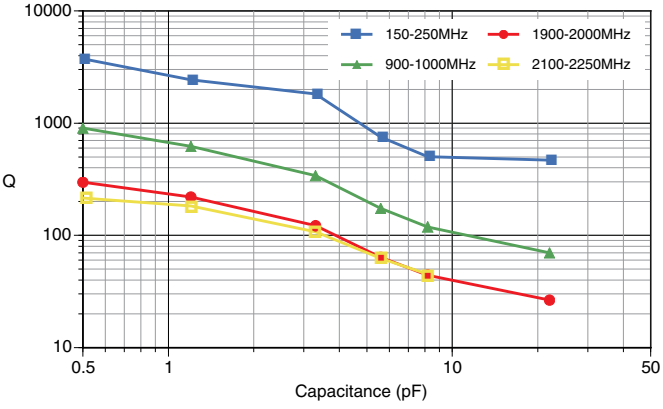
Q vs Frequency: 0201/R05L



ESR vs Capacitance: 0201/R05L

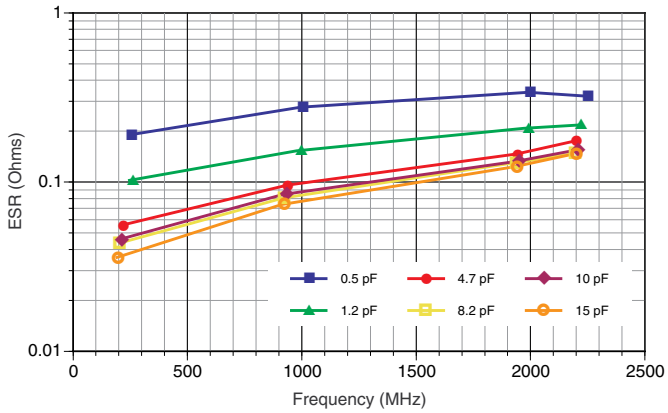


Q vs Capacitance: 0201/R05L

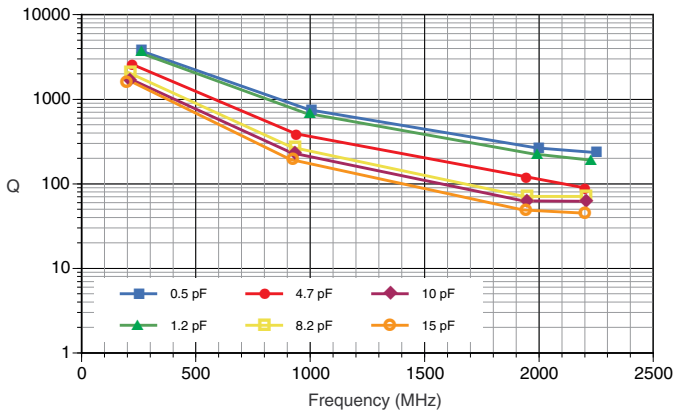


S-Series RF Characterisitcs versus Frequency

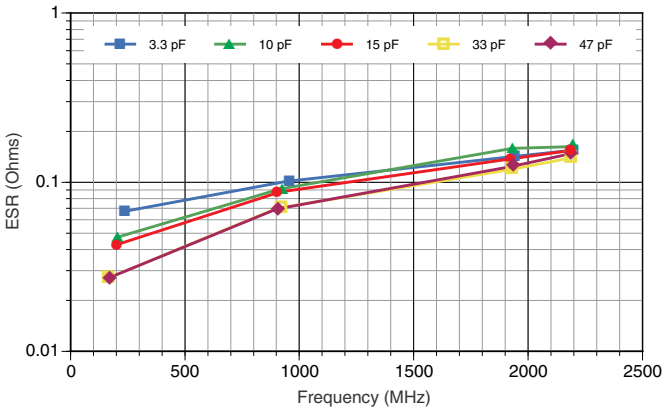
Equivalent Series Resistance: 0402/R07S



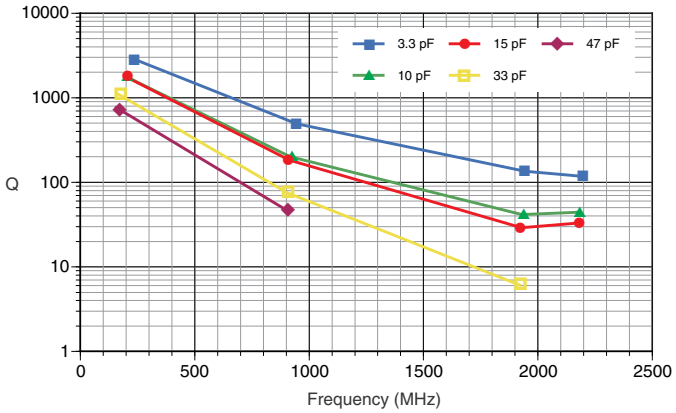
Q Factor: 0402/R07S



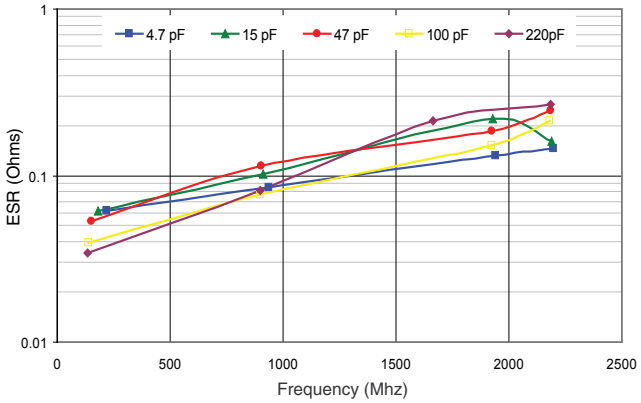
Equivalent Series Resistance: 0603/R14S



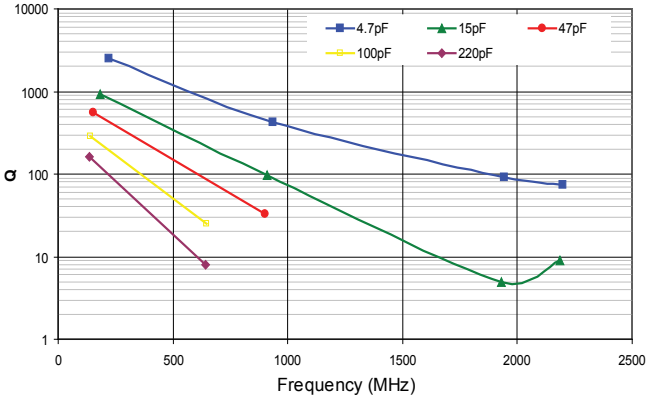
Q Factor: 0603/R14S



Equivalent Series Resistance: 0805/R15S



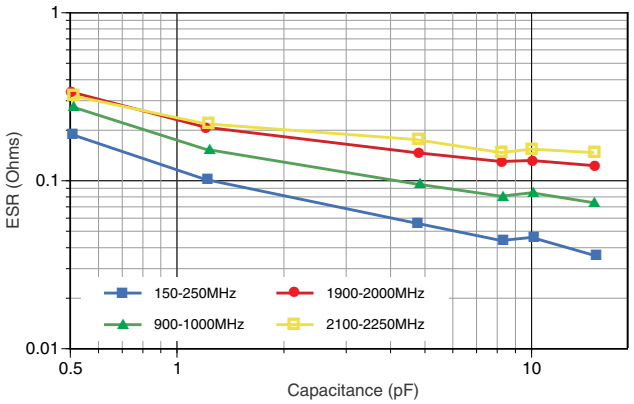
Q Factor: 0805/R15S



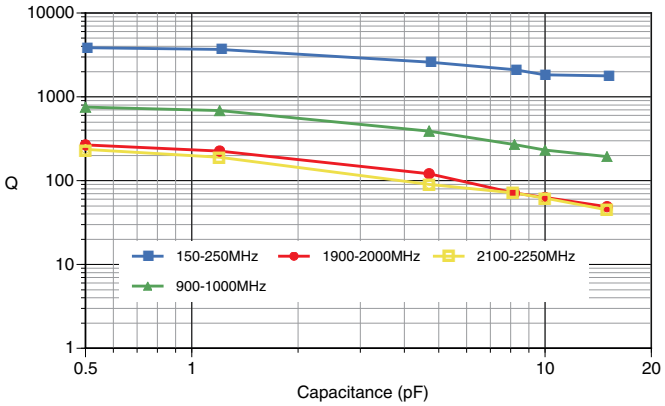
Measurements performed on a Boonton 34A Resonant Coaxial Line and represent typical capacitor performance.

S-Series RF Characterisitcs versus Capacitance

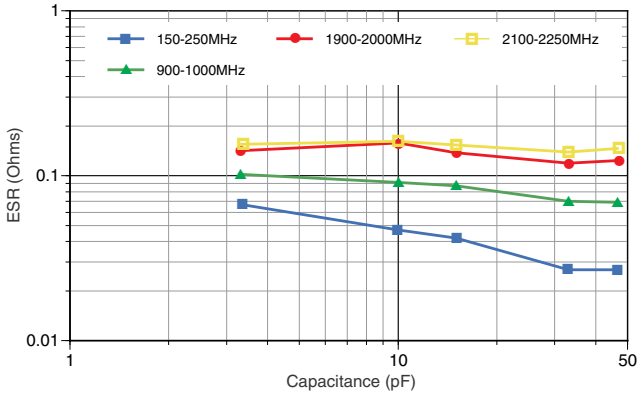
Equivalent Series Resistance: 0402/R07S



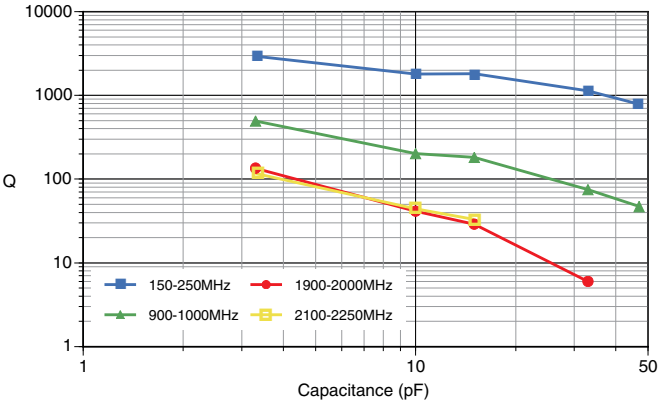
Q Factor: 0402/R07S



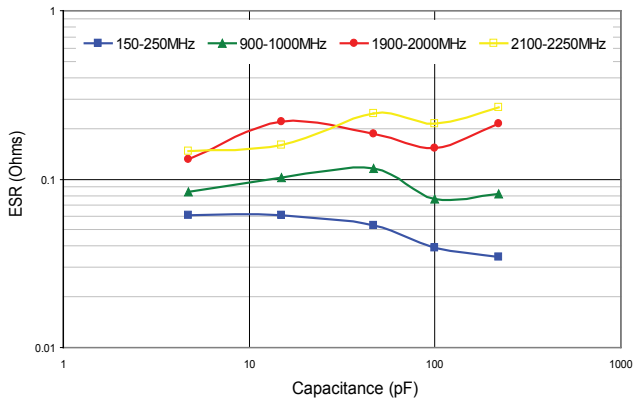
Equivalent Series Resistance: 0603/R14S



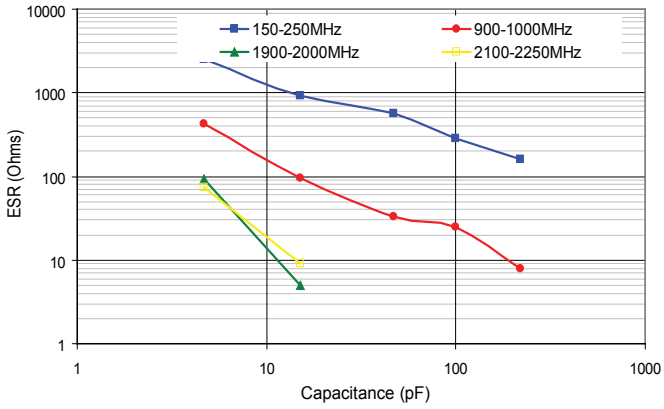
Q Factor: 0603/R14S



Equivalent Series Resistance: 0805/R15S

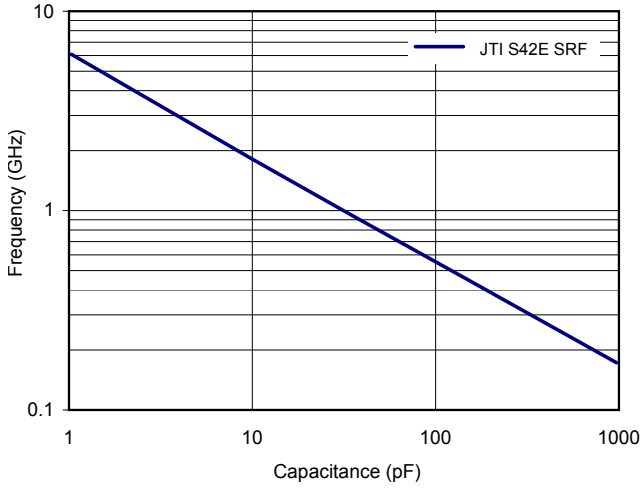


Q Factor: 0805/R15S



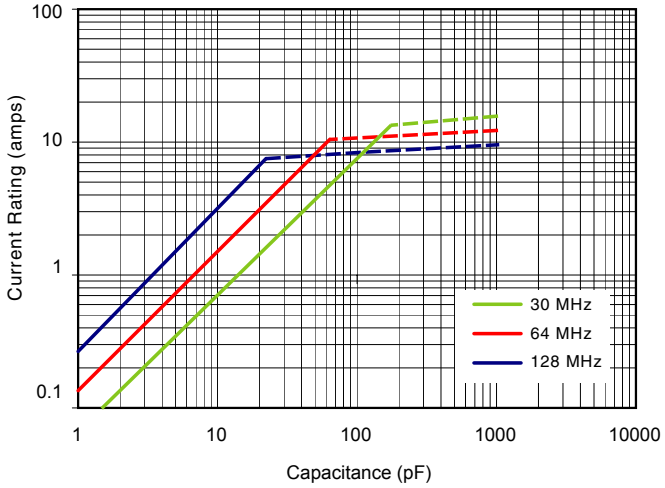
Measurements performed on a Boonton 34A Resonant Coaxial Line and represent typical capacitor performance.

SRF (Shunt Mount), S42E, Typical



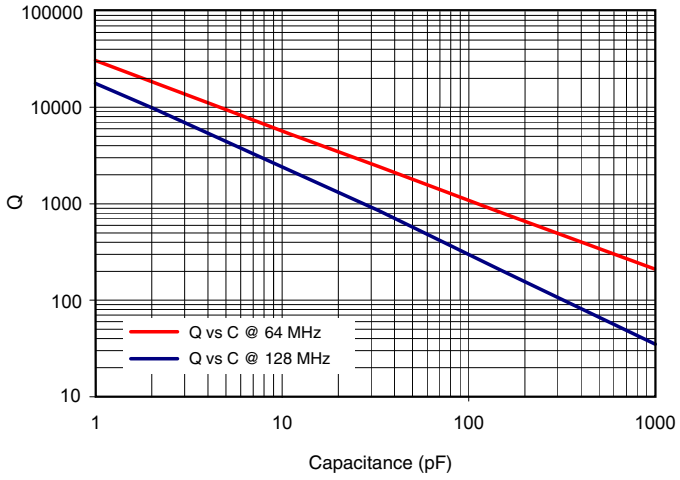
As measured on a 8720C VNA, using a Shunt-Through fixture, and using the S11 magnitude dip to determine the SRF

Current Rating vs. Capacitance, S42E, Typical (Preliminary)



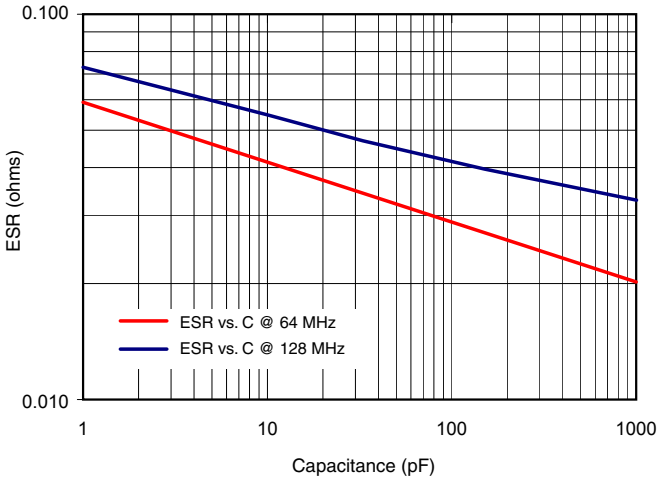
Solid traces show voltage limited current (Vrms)
Dotted traces show power dissipation limited current (Based on 3 Watts Power Dissipation, and 125 degrees C case temp.)

S42E Q vs. Capacitance, Typical



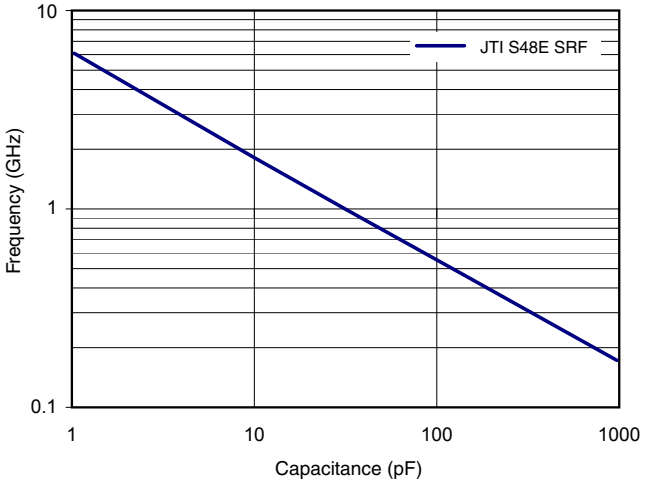
As measured on a 4287A LCR meter, using a 16092A fixture

S42E ESR vs. Capacitance, Typical



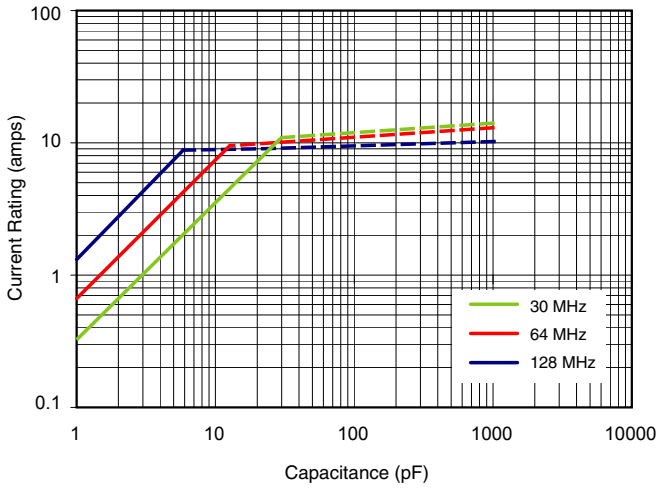
As measured on a 4287A LCR meter, using a 16092A fixture

SRF (Shunt Mount), S48E, Typical (Preliminary)



As measured on a 8720C VNA, using a Shunt-Through fixture, and using the S11 magnitude dip to determine the SRF

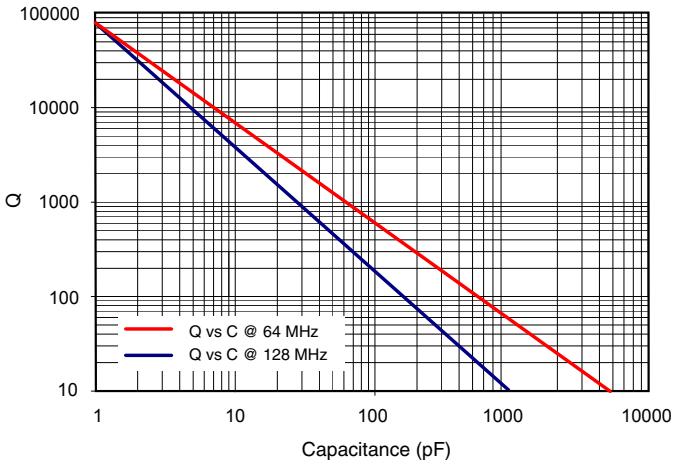
Current Rating vs. Capacitance, S48E, Typical (Preliminary)



Solid traces show voltage limited current (Vrms)

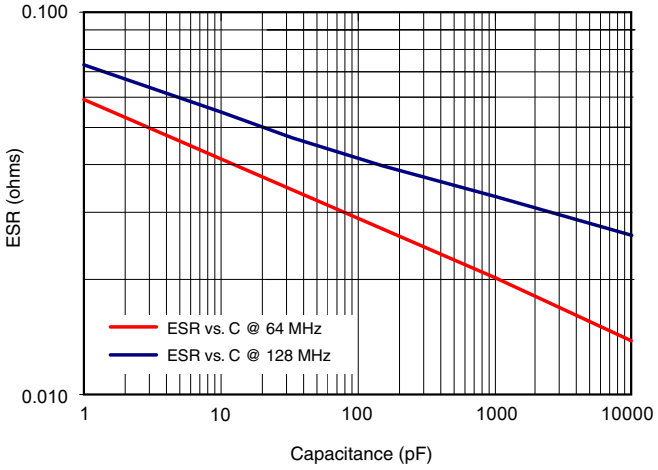
Dotted traces show power dissipation limited current (Based on 4 Watts Power Dissipation, and 125 degrees C case temp.)

S48E Q vs. Capacitance, Typical (Preliminary)



As measured on a 4287A LCR meter, using a 16092A fixture

S48E ESR vs. Capacitance, Typical (Preliminary)



As measured on a 4287A LCR meter, using a 16092A fixture