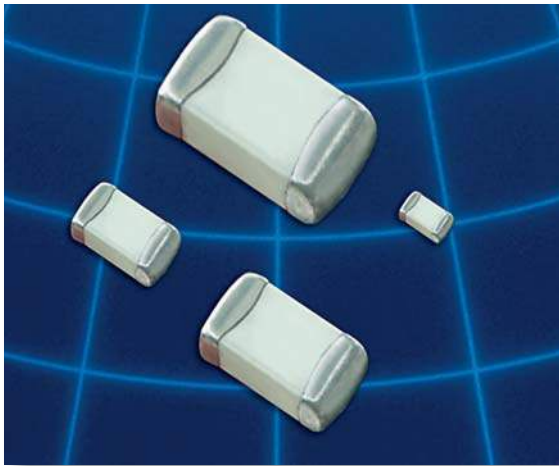


# MULTI-LAYER HIGH-Q CAPACITORS



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

<b>252</b>	<b>S48</b>	<b>E</b>	<b>470</b>	<b>K</b>	<b>V</b>	<b>4</b>	<b>E</b>
<b>VOLTAGE (DC)</b> 6R3 = 6.3 V 160 = 16 V 250 = 25 V 500 = 50 V 201 = 200 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	<b>CASE SIZE</b> R03 (01005) R05 (0201) R07 (0402) R14 (0603) R15 (0805) S42 (1111) S48 (2525) S58 (3838)	<b>CAPACITANCE (pF)</b> 1st two digits are significant; third digit denotes number of zeros, R = decimal. 100 = 10 pF 101 = 100 pF	<b>DIELECTRIC</b> S = Ultra High Q NPO L = High Q NPO E = Ultra High Q NPO, High Voltage, High Power, W = X7R	<b>TOLERANCE</b> 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.	<b>TERMINATION</b> <b>Nickel Barrier</b> V = Ni/Sn (Green) T = Ni/SnPb G = Ni/Au (Green) <b>Non-Mag*</b> U = Cu/Sn (Green) C = Cu/SnPb <b>Leaded (All Non-Mag)*</b> 1 = Microstrip 2 = Axial Ribbon 3 = Axial Wire 4 = Radial Ribbon 5 = Radial Wire	<b>MARKING</b> 3 = Cap Code & Tolerance 4 = No Marking 6 = EIA Code (Marking on 0805 and larger only)	<b>PACKAGING</b> S = Bulk W = Waffle Pack <b>01005 - 0603</b> Y = Paper 5" Reel T = Paper 7" Reel *R = Paper 13" Reel <b>0805 - 3838</b> Z = Embossed 5" Reel E = Embossed 7" Reel *U = Embossed 13" Reel Tape specifications conform to EIA RS481

Part Number written: **252S48E470KV4E**



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

## LOW ESR / HIGH-Q CAPACITOR SELECTION CHART

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)		Voltage											
Cap. Value	Capacitance pF	Code												
0.1	0R1													
0.2	0R2		16 V	25 V		50/200 V	250 V		500V	1000V				
0.3	0R3		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
0.4	0R4		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
0.5	0R5		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
0.6	0R6		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
0.7	0R7		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
0.8	0R8		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
0.9	0R9		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
1.0	1R0		16 V	25 V		50/200 V	250 V	250 V	500V	1000V	2500V	3600V	7200V	
1.1	1R1		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
1.2	1R2	A	16 V	25 V		50/200 V	250 V	250 V	500V	1000V	2500V	3600V	7200V	
1.3	1R3		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
1.4	1R4	B	16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
1.5	1R5		16 V	25 V		50/200 V	250 V	250 V	500V	1000V	2500V	3600V	7200V	
1.6	1R6	C	16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
1.7	1R7		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
1.8	1R8	D	16 V	25 V		50/200 V	250 V	250 V	500V	1000V	2500V	3600V	7200V	
1.9	1R9		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
2.0	2R0		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
2.1	2R1		16 V	25 V		50/200 V	250 V	250 V	500V	1000V				
2.2	2R2		16 V	25 V		50/200 V	250 V	250 V	500V	1000V	2500V	3600V	7200V	
2.4	2R4		16 V	25 V		50/200 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	G	16 V	25 V		50 V	250 V	250 V	500V	1000V	2500V	3600V	7200V	
16	160		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		50 V	250 V	250 V	500V	1000V				
33	330			25 V		50 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

EIA Size Cap. Value		Miniature Size - Portable Electronics				RF Power Applications							
		01005 (R03S)	0201 (R05) NPO (R05L) X7R* (R05W)		0402 (R07S)	0603 (R14S)	0805 (R15S)	1111 (S42E)		2525** (S48E)	3838** (S58E)		
Capacitance pF	Code	Voltage											
36	360		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	F	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	G		16 V			250 V	500V					
120	121	J					250 V	500V		2500V	3600V	5000V	
130	131	K					250 V	500V					
150	151						250 V	500V		2500V	3600V	5000V	
160	161						250 V	500V					
180	181						250 V	500V		2500V	3600V	5000V	
200	201						250 V	500V					
220	221			16 V			250 V	500V		2500V	3600V		
240	241							500V					
270	271							500V		2500V	3600V		
300	301							500V					
330	331							500V		1500V	3600V		
360	361							500V					
390	391							500V		1500V	3600V		
430	431							500V					
470	471			16 V				500V		1500V	2500V		
510	511							500V					
560	561							500V		1000V	2500V		
620	621							500V					
680	681			16 V				50V		1000V	2500V		
750	751							50V					
820	821	G		16 V				50V		1000V	1000V		
910	911							50V					
1000	102	J		10 V				50V		1000V	1000V		
1200	122	K								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 - 100 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

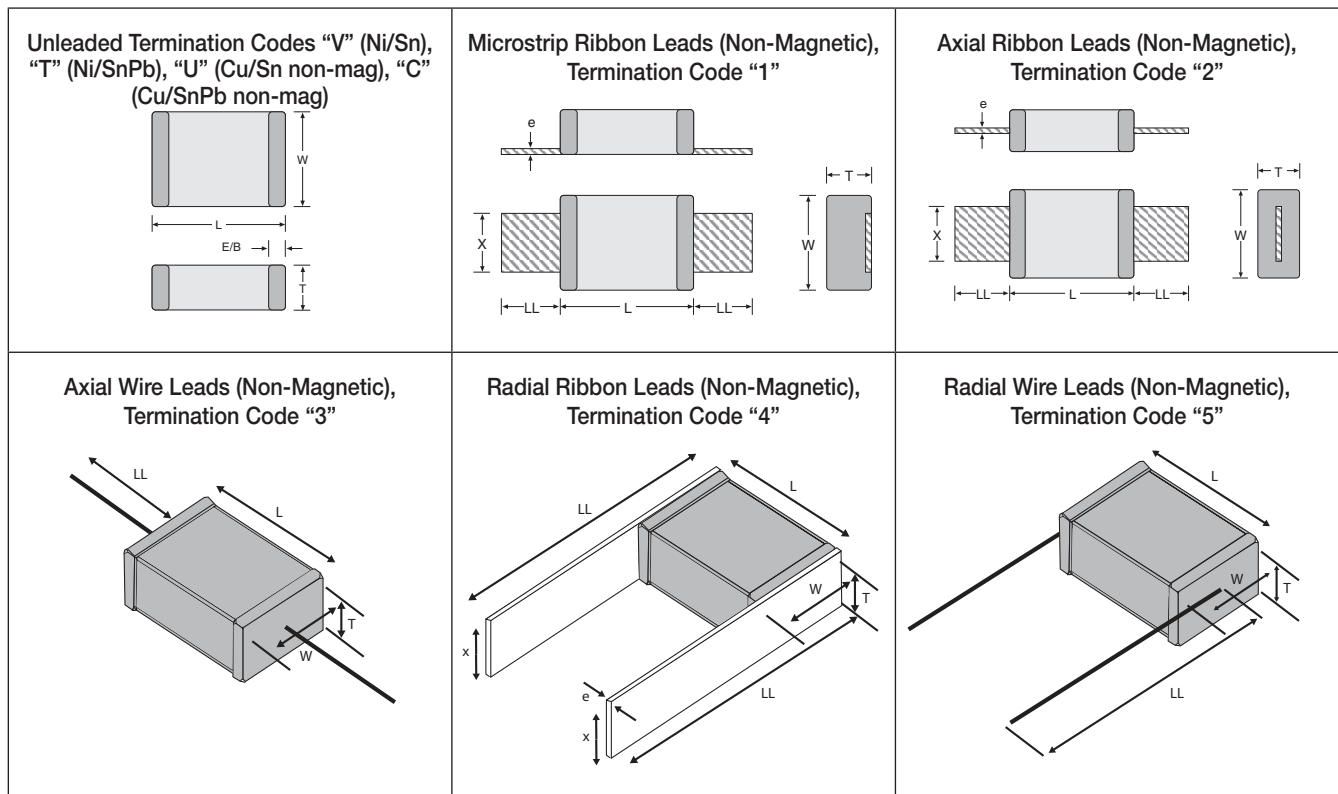
	SPECIFICATION	TEST PARAMETERS
SOLDERABILITY:	Solder coverage ≥ 90% of metalized areas No termination degradation	Preheat chip to 120°-150°C for 60 sec., dip terminals in rosin flux then dip in Sn62 solder @ 240°±5°C for 5±1 sec
RESISTANCE TO SOLDERING HEAT:	No mechanical damage Capacitance change: ±2.5% 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 TERMINATIONS AND LEADS



## E-SERIES TERMINATIONS AND LEADS

Termination	Size	Units	L	Tol	W	Tol	T	E / B	Tol
V, T U, C	S42E	In	0.110	+0.020 -0.010	0.110	+/- .015	0.102 Max.	0.015 Typ.	+/- 0.008
		mm	2.79	+0.51 -0.25	2.79	+/- 0.38	2.59 Max.	0.38 Typ.	+/- 0.20
	S48E	In	0.230	+0.025 -0.010	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	+0.015 -0.010	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.	

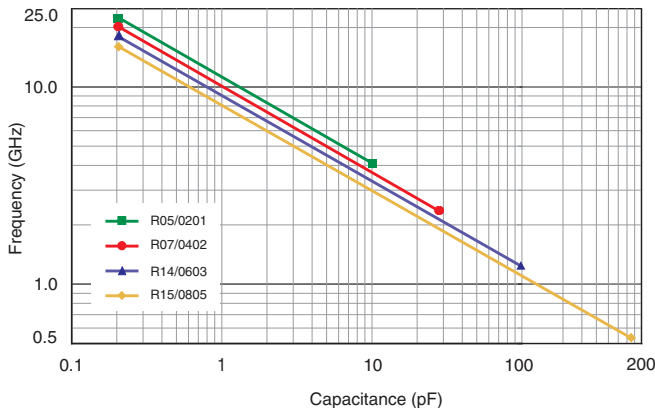
For all E-Series Models:

**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

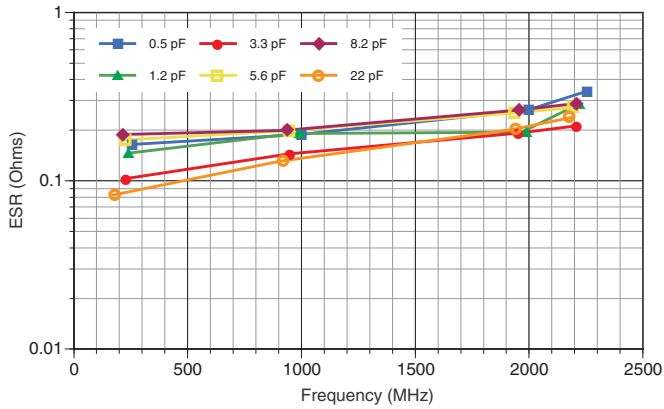
Lead	Size	Units	L	Tol	W	Tol	T (max)	E/B (typ)	LL(min)	X	Tol	e	Tol
1	S42E	In	0.135	+/- .015	0.110	+/- .020	0.120	0.015	0.25	0.093	+/-0.005	0.004	+/- 0.001
		mm	3.43	+/- 0.38	2.79	+/- 0.51	3.05	0.38	6.35	2.36	+/- 0.13	0.102	+/- 0.025
	S48E	In	0.245	+/- 0.025	0.250	+/- 0.015	0.160	0.025	0.50	0.240	+/- 0.005	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
3	S42E S48E S58E	In	0.145	+/- .020	0.110	+/- .015	0.102		0.50	#26 AWG, .016 (.406) dia. nominal			
		mm	3.68	+/- 0.51	2.79	+/- 0.38	2.59		12.70				
4	S42E S48E S58E	In	0.135	+/- .015	0.110	+/- .015	0.102		0.25	0.093	+/-0.005	0.004	+/- 0.001
		mm	3.43	+/- 0.38	2.79	+/- 0.38	2.59		6.35	2.36	+/- 0.13	0.102	+/- 0.025
5	S42E S48E S58E	In	0.145	+/- .020	0.110	+/- .015	0.102		0.50	#26 AWG, .016 (.406) dia. nominal			
		mm	3.68	+/- 0.51	2.79	+/- 0.38	2.59		12.70				

## SERIES RESONANCE CHART

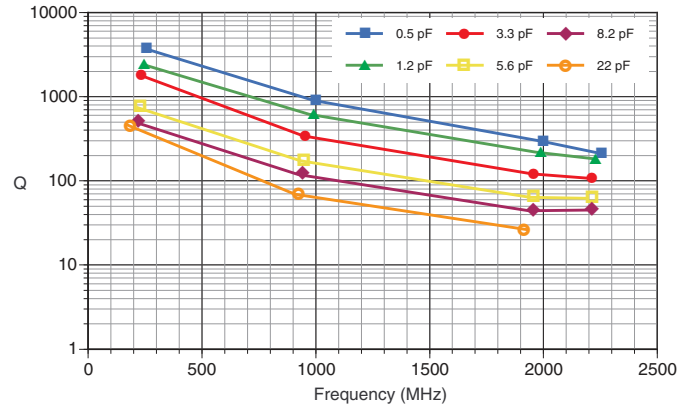
Typical Series Resonant Frequency (Series Mounted)



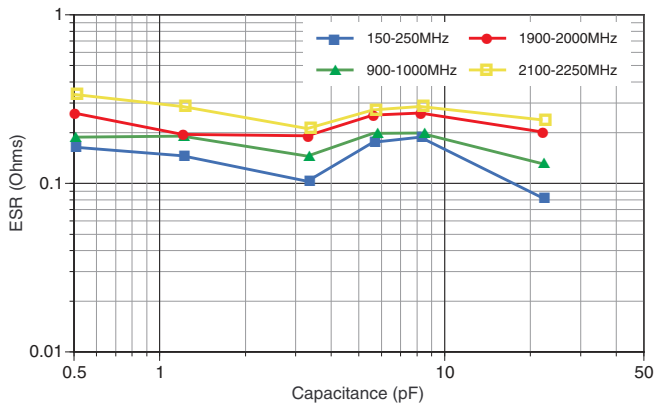
ESR vs Frequency: 0201/R05L



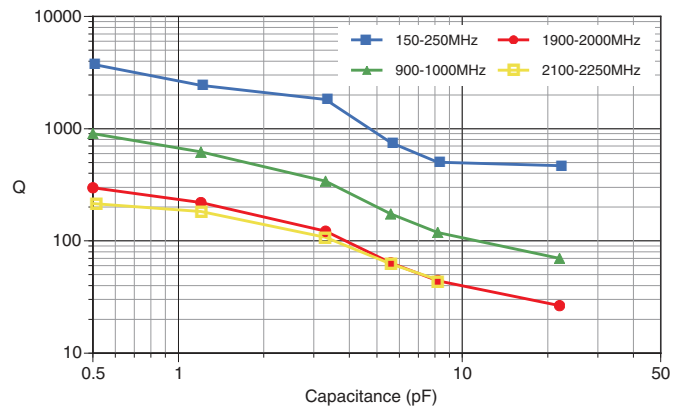
Q vs Frequency: 0201/R05L



ESR vs Capacitance: 0201/R05L

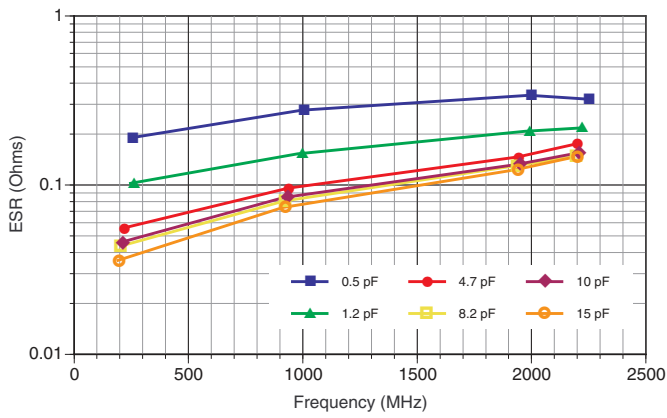


Q vs Capacitance: 0201/R05L

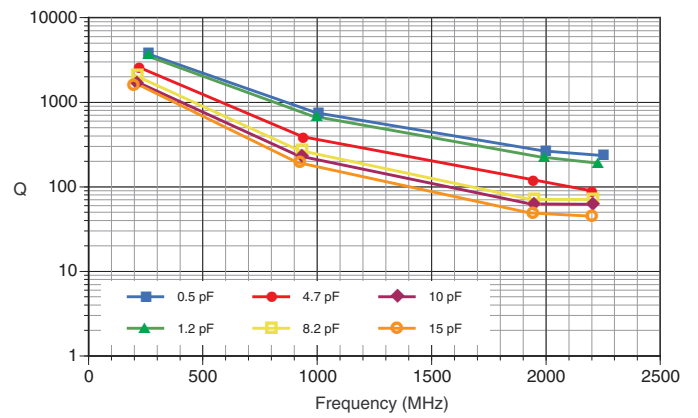


# S-SERIES RF CHARACTERISTICS VERSUS FREQUENCY

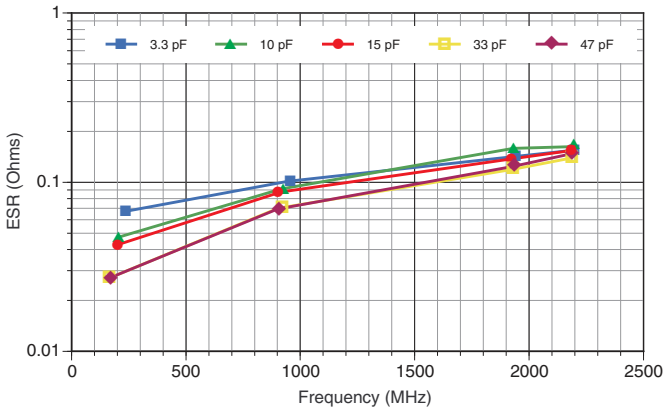
Equivalent Series Resistance: 0402/R07S



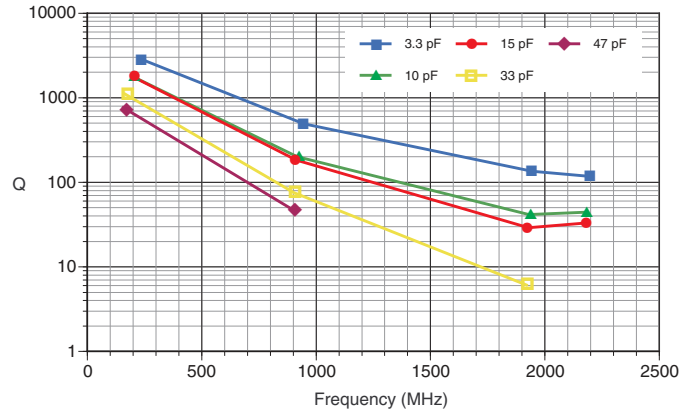
Q Factor: 0402/R07S



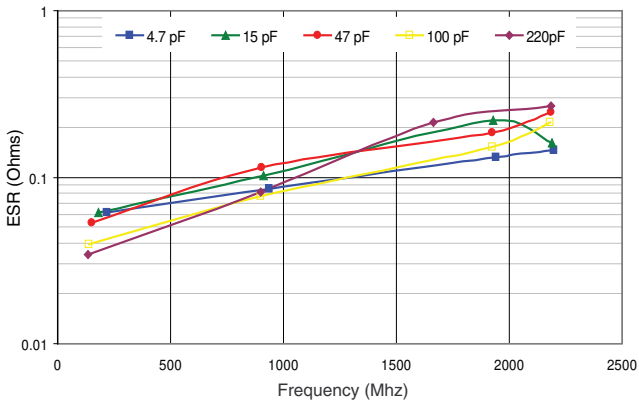
Equivalent Series Resistance: 0603/R14S



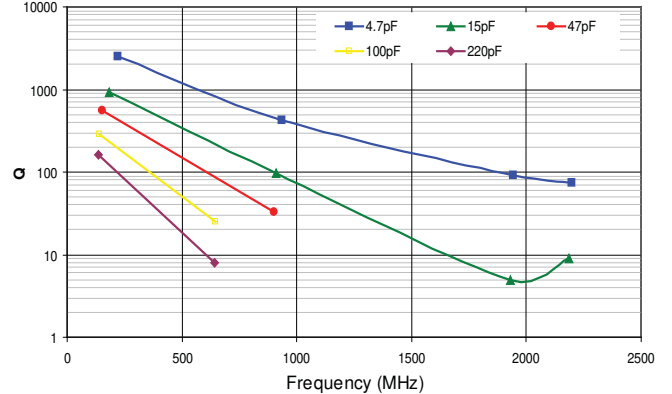
Q Factor: 0603/R14S



Equivalent Series Resistance: 0805/R15S



Q Factor: 0805/R15S

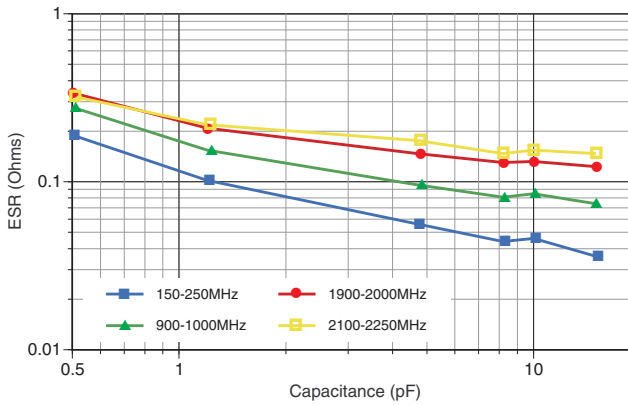


Measurements performed on a Boonton 34A Resonant Coaxial Line and represent typical capacitor performance.

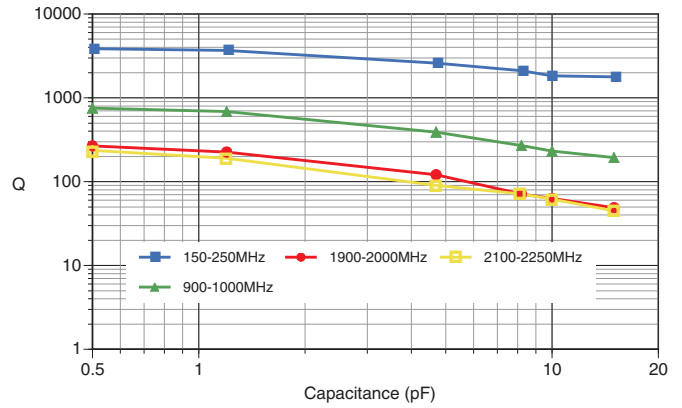


## S-SERIES RF CHARACTERISTICS VERSUS CAPACITANCE

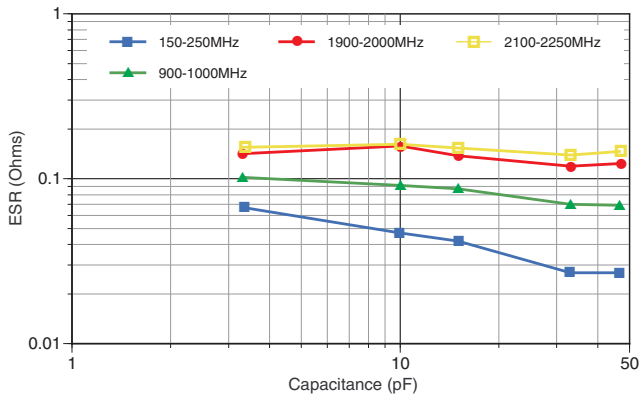
Equivalent Series Resistance: 0402/R07S



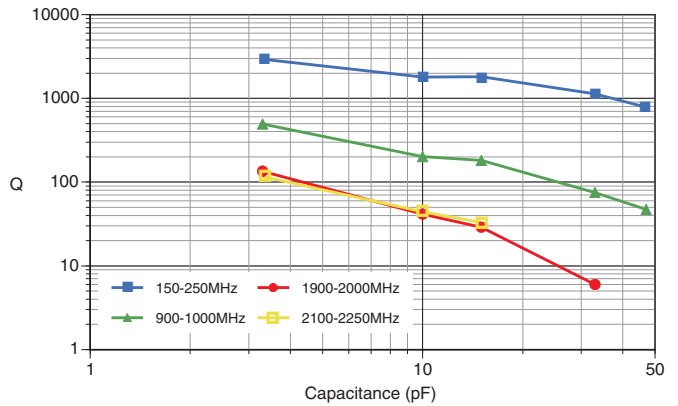
Q Factor: 0402/R07S



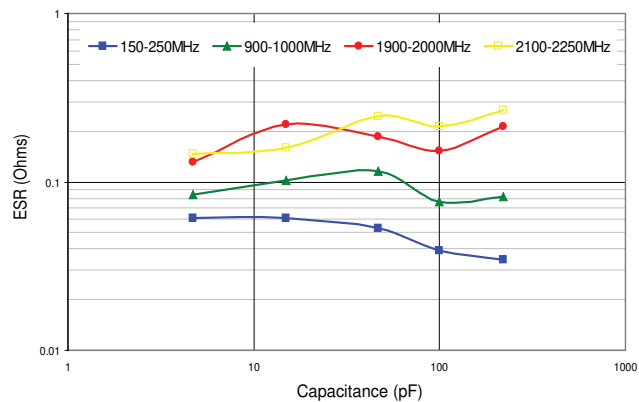
Equivalent Series Resistance: 0603/R14S



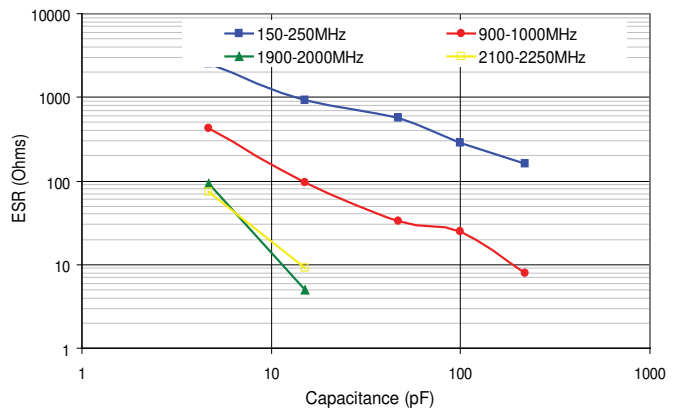
Q Factor: 0603/R14S



Equivalent Series Resistance: 0805/R15S



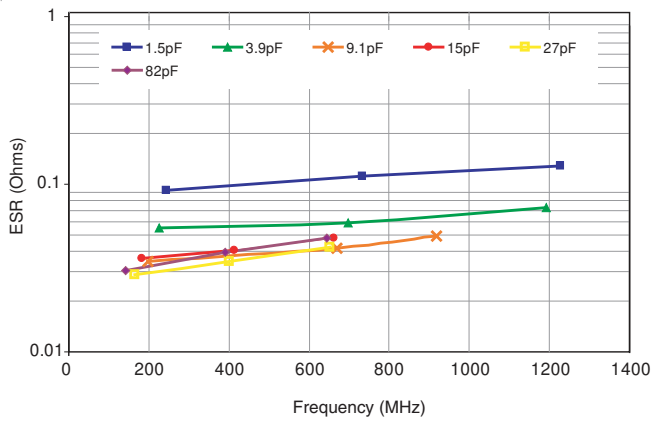
Q Factor: 0805/R15S



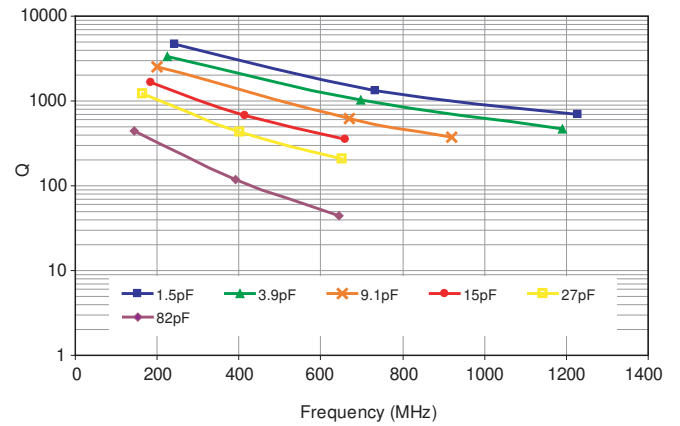
Measurements performed on a Boonton 34A Resonant Coaxial Line and represent typical capacitor performance.

## S42E SERIES RF CHARACTERISTICS VERSUS FREQUENCY

Equivalent Series Resistance: 1111/S42E

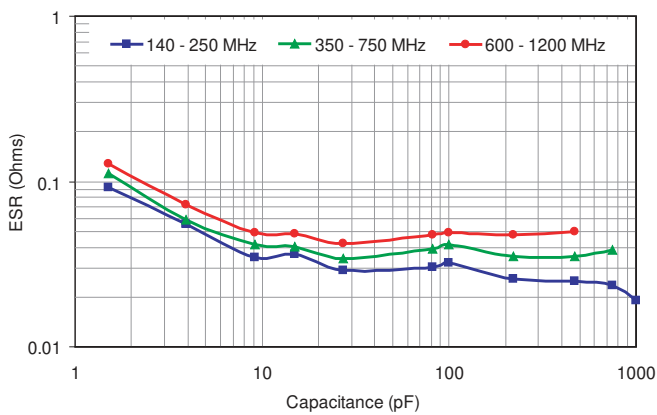


Q Factor: 1111/S42E

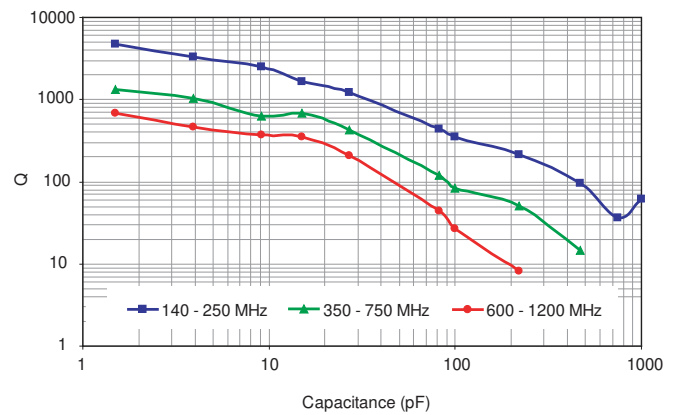


## S42E SERIES RF CHARACTERISTICS VERSUS CAPACITANCE

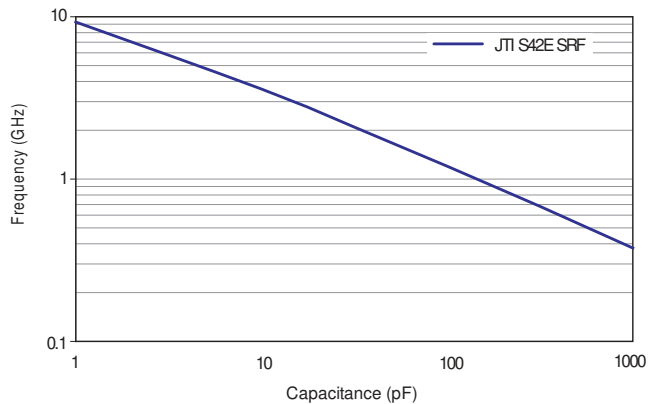
S42E Equivalent Series Resistance vs Capacitance, Typical



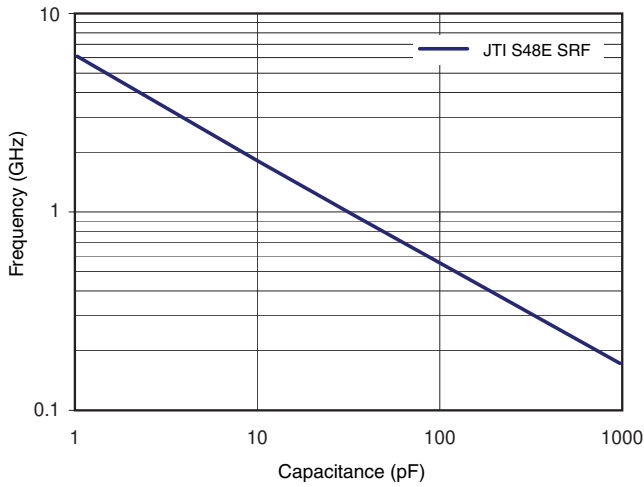
S42E Q vs. Capacitance, Typical



S42E SRF (Series Mount), Typical

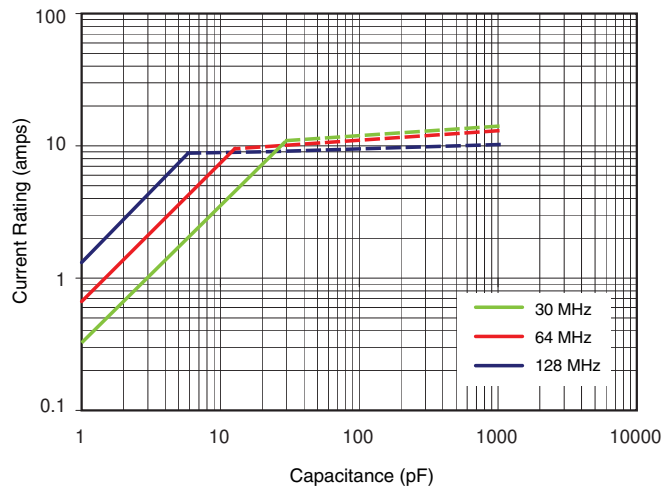


SRF (Shunt Mount), S48E, Typical (Preliminary)



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

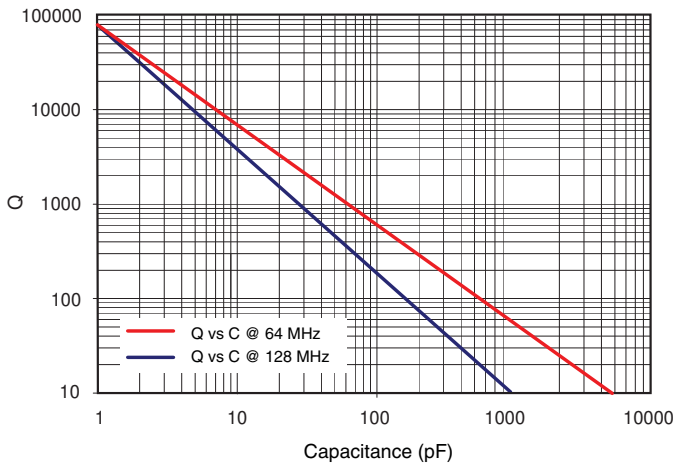
Current Rating vs. Capacitance, S48E, Typical (Preliminary)



Solid traces show voltage limited current (Vrms)

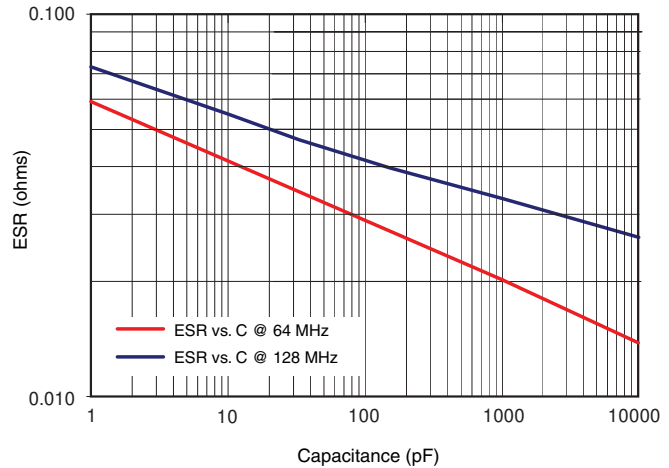
Dotted traces show power dissipation limited current (Based on 4 Watts Power Dissipation, and 125 degrees C case temp.)

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