NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

ELECTRONICS DIVISION TECHNICAL NOTE NO. 214

Cryogenic Measurements of Surface Mount Multi-layer Ceramic Chip Capacitors

Roger D. Norrod

November 10, 2009
Rev. March 9, 2010

NATIONAL RADIO ASTRONOMY OBSERVATORY
POST OFFICE 2 GREEN BANK WV 24944-0002
TELEPHONE 304-456-2011 FAX 304-456-2229

Cryogenic Measurements of Surface Mount Multi-layer Ceramic Chip Capacitors

Roger D. Norrod
November 9, 2009

1 Introduction

EDTN 205 reported cryogenic measurements (4K) of several chip capacitors and resistors[1]. Most of the devices tested for that report were designed for use in wire-bonded assemblies, i.e. were single-layer or other vertically oriented packages. Other researchers have published capacitor cryogenic test results[2]. This document reports on cryogenic tests of other types of chip capacitors, namely inexpensive, commonly available surface mount units in industry standard packages. For array receivers where costs are a significant concern, it will be advantageous if devices from several manufacturers are available for use in circuit designs, and surface mount rather than wirebond assembly techniques can be used.

All of the types were tested to 77K by dipping in liquid nitrogen and most to less than 20K using a closed-cycle refrigerator. The EIA has defined several classes of dielectric for use in capacitors; a Class 2, X5R (X5R signifies the allowed capacitance change over temperature, ±15% over -55 to +85˚C) sample was first tested and found to exhibit unacceptable capacitance change. The remaining samples tested were Class 1, C0G/NP0 types (0±30ppm/˚C over -55 to 125˚C). The units to test were selected by simply picking types available from stock from Digikey[3] in both large and small quantities (cut-tape) and in a wide range of values in the 0402 case size.

It was found that C0G/NP0 units from four manufacturers functioned quite well below 20K. The liquid nitrogen dip tests were found to be good indication of 20K performance because little or no change in capacitance was observed between 77K and 20K.

2 Test Setup and Procedure

The capacitor types tested are listed in Table 1, along with the available capacitance range in the 0402 size for reference. The Murata GRM is available in a wider range of capacitance but the specified Q is rather low ($Q \geq 1000$ at 1MHz for $C \geq 30$pF) and this type may not be appropriate for some microwave applications. The other three types are available in larger values in larger case sizes.

Table 1
Capacitor Manufacturers and Range

Type	0402 Range Available
AVX U Series	1-30 pF
Johanson S Series	0.2-33 pF
Murata GRM Series	0.5-1000 pF
Panasonic ECD Series	0.1-15 pF

To measure capacitance, a HP4275A LCR variable frequency meter set to 1MHz test frequency was used. The capacitor sample to be tested was mounted on a microstrip circuit in a test block, between a short 50Ω line and a pad with several ground vias. The 50Ω line connected to a coaxial K-connector. For the liquid nitrogen dip tests, a 14 inch length of 141 stainless cable connected to the HP4275A. For the refrigerated tests, a NRAO low-loss stainless airline connected to the test dewar wall, and then 30 inches of Belden 1673A flexible coax to the HP4275A. In both cases, the HP4275A was zeroed with no capacitor mounted (the 50Ω microstrip line open-circuited). After a few hours of 4275A warm-up, little drift was seen but the zero process was done at least once each day. Testing was limited to measuring capacitance change; other capacitor characteristics were not evaluated. It should be noted the test setup capacitance readings are consistently 20-25% higher than expected from the capacitors' marked values. The cause of this is currently unknown.

3 Results

Table 2 contains the 77K liquid nitrogen dip test results. For each sample, a Styrofoam cup was filled with liquid nitrogen, and the test block connected to the stainless steel coax was plunged into the nitrogen and allowed to stabilize. The percent change is defined relative to the room temperature value.

Table 2
Liquid Nitrogen Dip Test Results

ID	Type	300K Value	77K Value	% Change
1	Panasonic ECJ-0EB1A473K, 47,000pF, X5R	63700pF	13500pF	-79
2	Panasonic ECD-G0E100C, 10pF, 25V, C0G, #1	12.2	12.3	+0.8
3	Panasonic ECD-G0E100C, 10pF, 25V, C0G, #2	12.4	12.3	-0.8
4	AVX 0402U100JAT2A, 10pF, 50V, NP0, #1	11.7	12.0	+2.6
5	AVX 0402U100JAT2A, 10pF, 50V, NP0, #2	12.3	12.6	+2.4
6	Johanson 500R07S100GV4T, 10pF, 50V, C0G, #1	12.6	12.8	+1.6
7	Johanson 500R07S100GV4T, 10pF, 50V, C0G, #2	12.7	13.0	+2.4
8	Murata GRM1555C1H471JA01D, 470pF, 50V, C0G	594.5	597.0	+0.4

Tables 3-6 contain results for the closed-cycle refrigerator tests. The approximate 2 hour cool down time gave the opportunity to record capacitance at a few intermediate temperatures. The capacitance varied smoothly with no unusual changes noted.

Table 3
Refrigerated Test Results
Type Panasonic ECD-G0E100C

Temperature (K)	C (pF)	%Change	Time
294	10.3	--	08:06
248	10.3	0.0	08:30
149	10.2	-1.0	09:05
16	10.1	-1.9	09:53

Table 4
Refrigerated Test Results
Type Johanson 500R07S100GV4T

Temperature (K)	C (pF)	%Change	Time
294	13.0	--	14:30
243	13.0	0.0	14:55
197	13.0	0.0	15:10
164	13.0	0.0	
107	13.1	0.8	15:40
78	13.2	1.5	15:46
18	13.3	2.3	15:55

Table 5
Refrigerated Test Results
Type AVX 04025U100JAT2A

Temperature (K)	C (pF)	%Change	Time
295	12.2	--	11:00
238	12.0	-1.6	11:26
179	11.9	-2.6	11:48
77	11.8	-3.3	12:15
17	11.9	-2.6	12:43

Table 6
Refrigerated Test Results
Type Murata GRM1555C1H471JA01D

Temperature (K)	C (pF)	%Change	Time
295	575.8	--	14:25
250	576.2	0.0	14:48
207	576.7	0.2	15:03
192	576.9	0.2	15:07
157	577.4	0.3	15:20
99	577.5	0.3	15:36
77	576.9	0.2	15:41
50	576.5	0.1	15:45
16	575.5	-0.0	16:10

4 Summary

Multilayer ceramic chip capacitors with C0G/NP0 rated temperature coefficients from four manufacturers were tested at temperatures to less than 20K and found to function with less than a few percent change in value from room temperature. The capacitors tested are currently available at low cost in either large or small quantities and in a wide range of values, and are designed for surface mounting by hand or reflow soldering. All the units tested were in the EIA 0402 (0.040 X 0.020 inch footprint) package, although other size packages in the same series are available.

Percentage wise, the Panasonic ECD and Murata types change the least over the temperature range tested. The manufacturer's data sheets do not provide any information about the ceramic formulations in their capacitors, but the Murata type likely has significantly different dielectric constant than the others in order to achieve the larger values in the same 0402 envelope.

The liquid nitrogen dip tests were found to be a good indication of 20K performance; little or no change in capacitance was observed between 77K and 15K.

5 Acknowledgement

Thanks to Bob Simon for providing the microstrip test fixture and doing the assembly work.

6 References

1. A.R. Kerr and M. Lambeth, NRAO EDTN 205, "Cryogenic (4K) Measurements of Some Resistors and Capacitors", March 5, 2007.

2. Joseph C. Bardin, "Silicon-Germanium Heterojunction Bipolar Transistors For Extremely Low-Noise Applications", PhD Thesis, California Institute of Technology, Pasadena, CA, pp 154-155, May 2009.

3. http://www.digikey.com

7 Addendum

March 9, 2010

As noted in section 2, the capacitance readings obtained from the HP 4275A LCR meter were consistently about 20% higher than expected from labeled capacitor values. A GW LCR-814 portable meter has now been used to repeat some of the liquid nitrogen dip tests. One shortcoming of the GW meter is lower resolution than the HP, but it gives capacitance readings approximately equal to the capacitor labeled values. Results of dip tests of four samples are given in Table 7 - compare with Table 2. It appears the HP 4275A used has a scaling error, but the percent changes are consistent between the two meters. Therefore, the conclusions reached above are still valid.

Table 7
Liquid Nitrogen Dip Test with LCR-814 Meter

ID	Type	300K Value	77K Value	% Change
2	**Panasonic ECD-G0E100C, 10pF, 25V, C0G**	**10.1**	**10.2**	**+1**
4	**AVX 0402U100JAT2A, 10pF, 50V, NP0**	**10.0**	**10.3**	**+3**
6	**Johanson 500R07S100GV4T, 10pF, 50V, C0G**	**10.1**	**10.3**	**+2**
8	**Murata GRM1555C1H471JA01D, 470pF, 50V, C0G**	**478**	**480**	**+0.4**

APPENDIX

Capacitor Data Sheets

RF/Microwave C0G (NP0) Capacitors (RoHS)

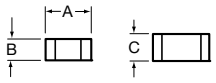
Ultra Low ESR, "U" Series, C0G (NP0) Chip Capacitors

GENERAL INFORMATION

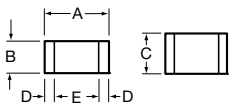
"U" Series capacitors are C0G (NP0) chip capacitors specially designed for "Ultra" low ESR for applications in the communications market. Max ESR and effective capacitance are met on each value producing lot to lot uniformity. Sizes available are EIA chip sizes 0603, 0805, and 1210.

DIMENSIONS: inches (millimeters)

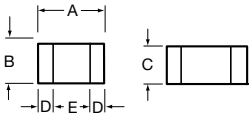
0402



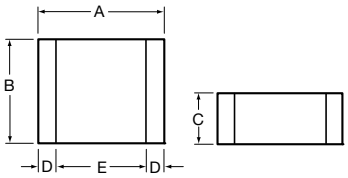
0603



0805



1210



inches (mm)

Size	A	B	C	D	E
0402	0.039±0.004 (1.00±0.1)	0.020±0.004 (0.50±0.1)	0.024 (0.6) max	N/A	N/A
0603	0.060±0.010 (1.52±0.25)	0.030±0.010 (0.76±0.25)	0.036 (0.91) max	0.010±0.005 (0.25±0.13)	0.030 (0.76) min
0805	0.079±0.008 (2.01±0.2)	0.049±0.008 (1.25±0.2)	0.040±0.005 (1.02±0.127)	0.020±0.010 (0.51±0.255)	0.020 (0.51) min
1210	0.126±0.008 (3.2±0.2)	0.098±0.008 (2.49±0.2)	0.050±0.005 (1.27±0.127)	0.025±0.015 (0.635±0.381)	0.040 (1.02) min

HOW TO ORDER

0805	1	U	100	J	A	T	2	A
Case Size 0402 0603 0805 1210	**Voltage Code** 3 = 25V 5 = 50V 1 = 100V 2 = 200V	**Dielectric = Ultra Low ESR**	**Capacitance** EIA Capacitance Code in pF. First two digits = significant figures or "R" for decimal place. Third digit = number of zeros or after "R" significant figures.	**Capacitance Tolerance Code** B = ±0.1pF C = ±0.25pF D = ±0.5pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	**Failure Rate Code** A = Not Applicable	**Termination** T= Plated Ni and Sn	**Packaging Code** 2 = 7" Reel 4 = 13" Reel 9 = Bulk	**Special Code** A = Standard

NOTE: Contact factory for availability of Termination and Tolerance Options for Specific Part Numbers.

ELECTRICAL CHARACTERISTICS

Capacitance Values and Tolerances:
Size 0402 - 0.2 pF to 22 pF @ 1 MHz
Size 0603 - 1.0 pF to 100 pF @ 1 MHz
Size 0805 - 1.6 pF to 160 pF @ 1 MHz
Size 1210 - 2.4 pF to 1000 pF @ 1 MHz

Temperature Coefficient of Capacitance (TC):
0±30 ppm/°C (-55° to +125°C)

Insulation Resistance (IR):
10^{12} Ω min. @ 25°C and rated WVDC
10^{11} Ω min. @ 125°C and rated WVDC

Working Voltage (WVDC):

Size		Working Voltage
0402	-	50, 25 WVDC
0603	-	200, 100, 50 WVDC
0805	-	200, 100 WVDC
1210	-	200, 100 WVDC

Dielectric Working Voltage (DWV):
250% of rated WVDC

Equivalent Series Resistance Typical (ESR):

0402	-	See Performance Curve, page 9
0603	-	See Performance Curve, page 9
0805	-	See Performance Curve, page 9
1210	-	See Performance Curve, page 9

Marking: Laser marking EIA J marking standard (except 0603) (capacitance code and tolerance upon request).

MILITARY SPECIFICATIONS
Meets or exceeds the requirements of MIL-C-55681

RoHS COMPLIANT
Pb: Free

RF/Microwave C0G (NP0) Capacitors (RoHS)

Ultra Low ESR, “U” Series, C0G (NP0) Chip Capacitors

CAPACITANCE RANGE

Cap (pF)	Available Tolerance	Size 0402	0603	0805	1210
0.2	B,C	50V	N/A	N/A	N/A
0.3	↓	↓	↓	↓	↓
0.4	↓	↓	↓	↓	↓
0.5	B,C	↓	↓	↓	↓
0.6	B,C,D	↓	↓	↓	↓
0.7	↓	↓	↓	↓	↓
0.8	↓	↓	↓	↓	↓
0.9	B,C,D	↓	↓	↓	↓

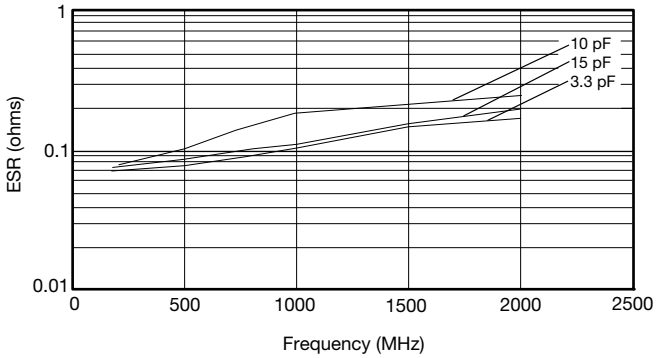
Cap (pF)	Available Tolerance	Size 0402	0603	0805	1210
1.0	B,C,D	50V	200V	200V	200V
1.1	↓	↓	↓	↓	↓
1.2	↓	↓	↓	↓	↓
1.3	↓	↓	↓	↓	↓
1.4	↓	↓	↓	↓	↓
1.5	↓	↓	↓	↓	↓
1.6	↓	↓	↓	↓	↓
1.7	↓	↓	↓	↓	↓
1.8	↓	↓	↓	↓	↓
1.9	↓	↓	↓	↓	↓
2.0	↓	↓	↓	↓	↓
2.1	↓	↓	↓	↓	↓
2.2	↓	↓	↓	↓	↓
2.4	↓	↓	↓	↓	↓
2.7	↓	↓	↓	↓	↓
3.0	↓	↓	↓	↓	↓
3.3	↓	↓	↓	↓	↓
3.6	↓	↓	↓	↓	↓
3.9	↓	↓	↓	↓	↓
4.3	↓	↓	↓	↓	↓
4.7	↓	↓	↓	↓	↓
5.1	↓	↓	↓	↓	↓
5.6	↓	↓	↓	↓	↓
6.2	B,C,D	↓	↓	↓	↓
6.8	B,C,J,K,M	↓	↓	↓	↓

Cap (pF)	Available Tolerance	Size 0402	0603	0805	1210
7.5	B,C,J,K,M	50V	200V	200V	200V
8.2	↓	↓	↓	↓	↓
9.1	B,C,J,K,M	↓	↓	↓	↓
10	F,G,J,K,M	↓	↓	↓	↓
11	↓	↓	↓	↓	↓
12	↓	↓	↓	↓	↓
13	↓	↓	↓	↓	↓
15	↓	↓	200V	↓	↓
18	↓	↓	100V	↓	↓
20	↓	↓	↓	↓	↓
22	↓	↓	↓	↓	↓
24	↓	↓	↓	↓	↓
27	↓	50V	↓	↓	↓
30	↓	N/A	↓	↓	↓
33	↓	↓	↓	↓	↓
36	↓	↓	↓	↓	↓
39	↓	↓	↓	↓	↓
43	↓	↓	↓	↓	↓
47	↓	↓	↓	↓	↓
51	↓	↓	↓	↓	↓
56	↓	↓	↓	↓	↓
68	↓	↓	↓	↓	↓
75	↓	↓	↓	↓	↓
82	↓	↓	↓	↓	↓
91	↓	↓	↓	↓	↓

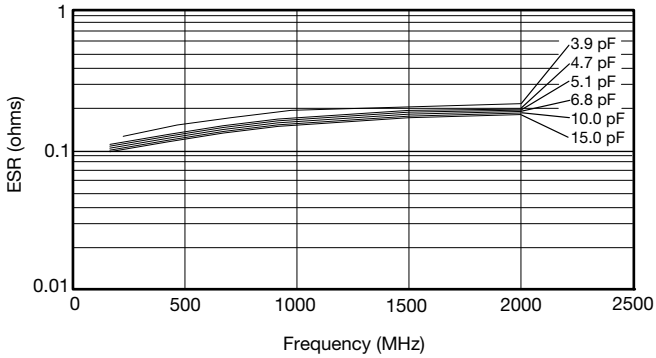
Cap (pF)	Available Tolerance	Size 0402	0603	0805	1210
100	F,G,J,K,M	N/A	100V	200V	200V
110	↓	↓	50V	↓	↓
120	↓	↓	50V	↓	↓
130	↓	↓	N/A	200V	↓
140	↓	↓	↓	100V	↓
150	↓	↓	↓	↓	↓
160	↓	↓	↓	100V	↓
180	↓	↓	↓	N/A	↓
200	↓	↓	↓	↓	↓
220	↓	↓	↓	↓	↓
270	↓	↓	↓	↓	↓
300	↓	↓	↓	↓	↓
330	↓	↓	↓	↓	↓
360	↓	↓	↓	↓	↓
390	↓	↓	↓	↓	↓
430	↓	↓	↓	↓	200V
470	↓	↓	↓	↓	100V
510	↓	↓	↓	↓	↓
560	↓	↓	↓	↓	↓
620	↓	↓	↓	↓	↓
680	↓	↓	↓	↓	↓
750	↓	↓	↓	↓	↓
820	↓	↓	↓	↓	↓
910	↓	↓	↓	↓	↓
1000	F,G,J,K,M	↓	↓	↓	↓

ULTRA LOW ESR, “U” SERIES

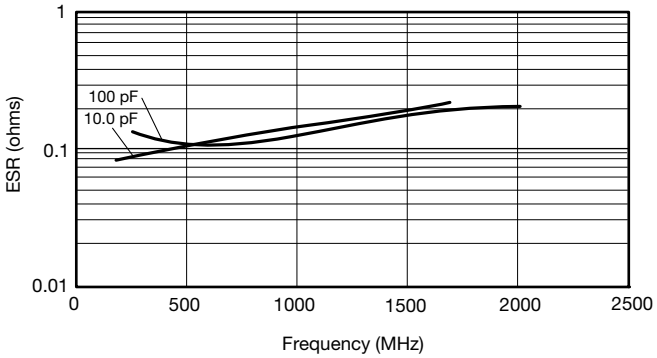
TYPICAL ESR vs. FREQUENCY
0402 “U” SERIES



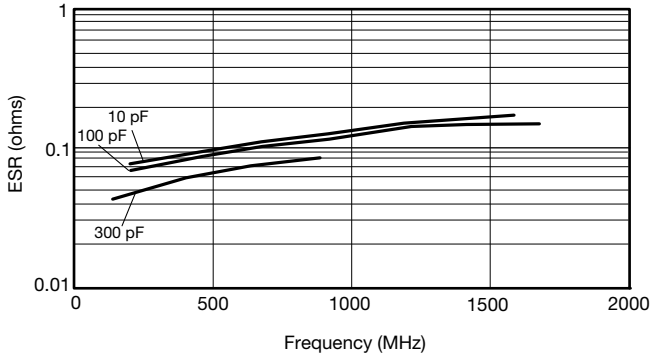
TYPICAL ESR vs. FREQUENCY
0603 “U” SERIES



TYPICAL ESR vs. FREQUENCY
0805 “U” SERIES

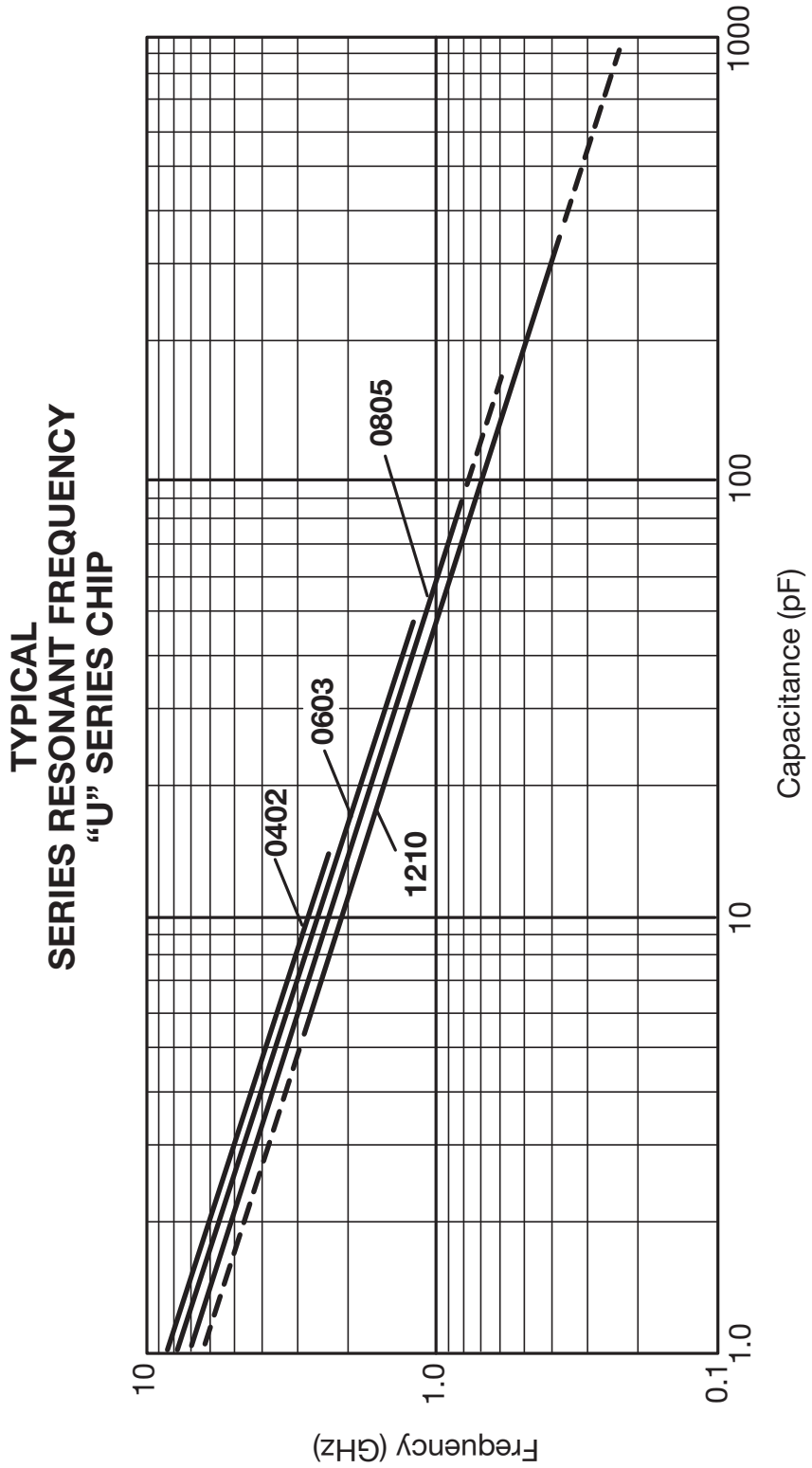


TYPICAL ESR vs. FREQUENCY
1210 “U” SERIES



ESR Measured on the Boonton 34A

RoHS COMPLIANT
Pb: Free


TYPICAL
SERIES RESONANT FREQUENCY
“U” SERIES CHIP
0805
0603
0402
1210
1000
100
10
1.0
Capacitance (pF)
10
1.0
0.1
Frequency (GHz)

RF/Microwave C0G (NP0) Capacitors (Sn/Pb)

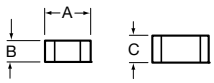
Ultra Low ESR, “U” Series, C0G (NP0) Chip Capacitors

GENERAL INFORMATION

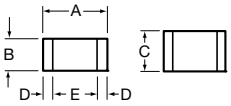
“U” Series capacitors are C0G (NP0) chip capacitors specially designed for “Ultra” low ESR for applications in the communications market. Max ESR and effective capacitance are met on each value producing lot to lot uniformity. Sizes available are EIA chip sizes 0603, 0805, and 1210.

DIMENSIONS: inches (millimeters)

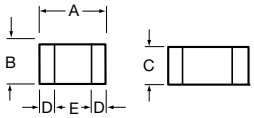
0402



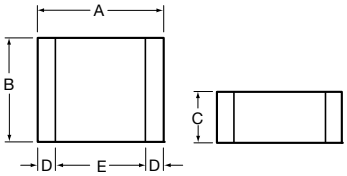
0603



0805



1210



inches (mm)

Size	A	B	C	D	E
0402	0.039±0.004 (1.00±0.1)	0.020±0.004 (0.50±0.1)	0.024 (0.6) max	N/A	N/A
0603	0.060±0.010 (1.52±0.25)	0.030±0.010 (0.76±0.25)	0.036 (0.91) max	0.010±0.005 (0.25±0.13)	0.030 (0.76) min
0805	0.079±0.008 (2.01±0.2)	0.049±0.008 (1.25±0.2)	0.040±0.005 (1.02±0.127)	0.020±0.010 (0.51±0.254)	0.020 (0.51) min
1210	0.126±0.008 (3.2±0.2)	0.098±0.008 (2.49±0.2)	0.050±0.005 (1.27±0.127)	0.025±0.015 (0.635±0.381)	0.040 (1.02) min

HOW TO ORDER

LD05	1	U	100	J	A	B	2	A

Case Size
LD02 = 0402
LD03 = 0603
LD05 = 0805
LD10 = 1210

Voltage Code
3 = 25V
5 = 50V
1 = 100V
2 = 200V

Dielectric = Ultra Low ESR

Capacitance
EIA Capacitance Code in pF.
First two digits = significant figures or “R” for decimal place.
Third digit = number of zeros or after “R” significant figures.

Capacitance Tolerance Code
B = ±0.1pF
C = ±0.25pF
D = ±0.5pF
F = ±1%
G = ±2%
J = ±5%
K = ±10%
M = ±20%

Failure Rate Code
A = Not Applicable

Termination
B = 5% min lead

Packaging Code
2 = 7" Reel
4 = 13" Reel
9 = Bulk

Special Code
A = Standard

ELECTRICAL CHARACTERISTICS

Capacitance Values and Tolerances:
Size 0402 - 0.2 pF to 22 pF @ 1 MHz
Size 0603 - 1.0 pF to 100 pF @ 1 MHz
Size 0805 - 1.6 pF to 160 pF @ 1 MHz
Size 1210 - 2.4 pF to 1000 pF @ 1 MHz

Temperature Coefficient of Capacitance (TC):
0±30 ppm/°C (-55° to +125°C)

Insulation Resistance (IR):
10^{12} Ω min. @ 25°C and rated WVDC
10^{11} Ω min. @ 125°C and rated WVDC

Working Voltage (WVDC):

Size		Working Voltage
0402	-	50, 25 WVDC
0603	-	200, 100, 50 WVDC
0805	-	200, 100 WVDC
1210	-	200, 100 WVDC

Dielectric Working Voltage (DWV):
250% of rated WVDC

Equivalent Series Resistance Typical (ESR):

0402	-	See Performance Curve, page 12
0603	-	See Performance Curve, page 12
0805	-	See Performance Curve, page 12
1210	-	See Performance Curve, page 12

Marking: Laser marking EIA J marking standard (except 0603) (capacitance code and tolerance upon request).

MILITARY SPECIFICATIONS
Meets or exceeds the requirements of MIL-C-55681

RF/Microwave C0G (NP0) Capacitors (Sn/Pb)

Ultra Low ESR, “U” Series, C0G (NP0) Chip Capacitors

CAPACITANCE RANGE

Cap (pF)	Available Tolerance	Size LD02	LD03	LD05	LD10
0.2	B,C	50V	N/A	N/A	N/A
0.3	↓	↓	↓	↓	↓
0.4	↓	↓	↓	↓	↓
0.5	B,C	↓	↓	↓	↓
0.6	B,C,D	↓	↓	↓	↓
0.7	↓	↓	↓	↓	↓
0.8	↓	↓	↓	↓	↓
0.9	B,C,D	↓	↓	↓	↓

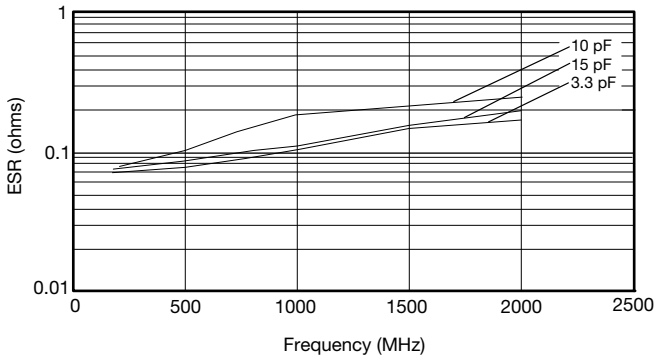
Cap (pF)	Available Tolerance	Size LD02	LD03	LD05	LD10
1.0	B,C,D	50V	200V	200V	200V
1.1	↓	↓	↓	↓	↓
1.2	↓	↓	↓	↓	↓
1.3	↓	↓	↓	↓	↓
1.4	↓	↓	↓	↓	↓
1.5	↓	↓	↓	↓	↓
1.6	↓	↓	↓	↓	↓
1.7	↓	↓	↓	↓	↓
1.8	↓	↓	↓	↓	↓
1.9	↓	↓	↓	↓	↓
2.0	↓	↓	↓	↓	↓
2.1	↓	↓	↓	↓	↓
2.2	↓	↓	↓	↓	↓
2.4	↓	↓	↓	↓	↓
2.7	↓	↓	↓	↓	↓
3.0	↓	↓	↓	↓	↓
3.3	↓	↓	↓	↓	↓
3.6	↓	↓	↓	↓	↓
3.9	↓	↓	↓	↓	↓
4.3	↓	↓	↓	↓	↓
4.7	↓	↓	↓	↓	↓
5.1	↓	↓	↓	↓	↓
5.6	↓	↓	↓	↓	↓
6.2	B,C,D	↓	↓	↓	↓
6.8	B,C,J,K,M	↓	↓	↓	↓

Cap (pF)	Available Tolerance	Size LD02	LD03	LD05	LD10
7.5	B,C,J,K,M	50V	200V	200V	200V
8.2	↓	↓	↓	↓	↓
9.1	B,C,J,K,M	↓	↓	↓	↓
10	F,G,J,K,M	↓	↓	↓	↓
11	↓	↓	↓	↓	↓
12	↓	↓	↓	↓	↓
13	↓	↓	↓	↓	↓
15	↓	↓	↓	↓	↓
18	↓	↓	200V	↓	↓
20	↓	↓	100V	↓	↓
22	↓	↓	↓	↓	↓
24	↓	↓	↓	↓	↓
27	↓	↓	↓	↓	↓
30	↓	50V	↓	↓	↓
33	↓	N/A	↓	↓	↓
36	↓	↓	↓	↓	↓
39	↓	↓	↓	↓	↓
43	↓	↓	↓	↓	↓
47	↓	↓	↓	↓	↓
51	↓	↓	↓	↓	↓
56	↓	↓	↓	↓	↓
68	↓	↓	↓	↓	↓
75	↓	↓	↓	↓	↓
82	↓	↓	↓	↓	↓
91	↓	↓	↓	↓	↓

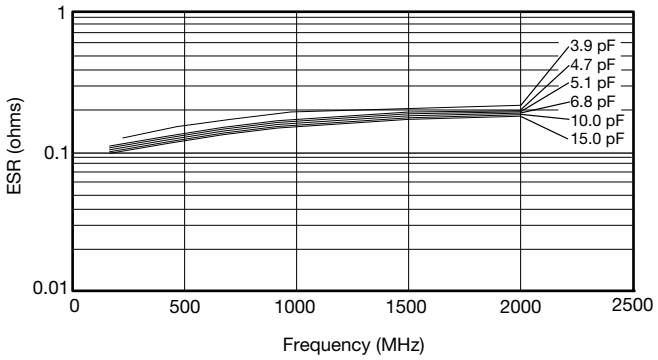
Cap (pF)	Available Tolerance	Size LD02	LD03	LD05	LD10
100	F,G,J,K,M	N/A	100V	200V	200V
110	↓	↓	50V	↓	↓
120	↓	↓	50V	↓	↓
130	↓	↓	N/A	200V	↓
140	↓	↓	↓	100V	↓
150	↓	↓	↓	↓	↓
160	↓	↓	↓	100V	↓
180	↓	↓	↓	N/A	↓
200	↓	↓	↓	↓	↓
220	↓	↓	↓	↓	↓
270	↓	↓	↓	↓	↓
300	↓	↓	↓	↓	↓
330	↓	↓	↓	↓	↓
360	↓	↓	↓	↓	↓
390	↓	↓	↓	↓	↓
430	↓	↓	↓	↓	200V
470	↓	↓	↓	↓	100V
510	↓	↓	↓	↓	↓
560	↓	↓	↓	↓	↓
620	↓	↓	↓	↓	↓
680	↓	↓	↓	↓	↓
750	↓	↓	↓	↓	↓
820	↓	↓	↓	↓	↓
910	↓	↓	↓	↓	↓
1000	F,G,J,K,M	↓	↓	↓	↓

ULTRA LOW ESR, “U” SERIES

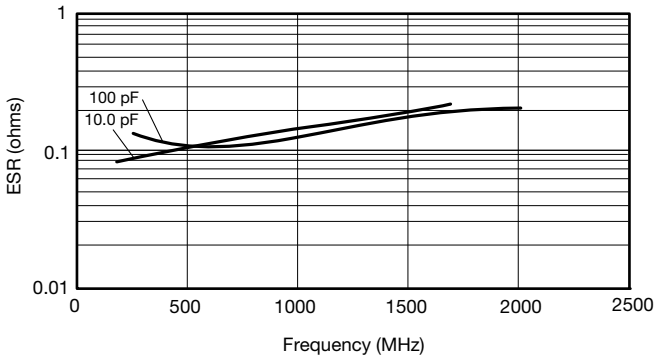
TYPICAL ESR vs. FREQUENCY
0402 “U” SERIES



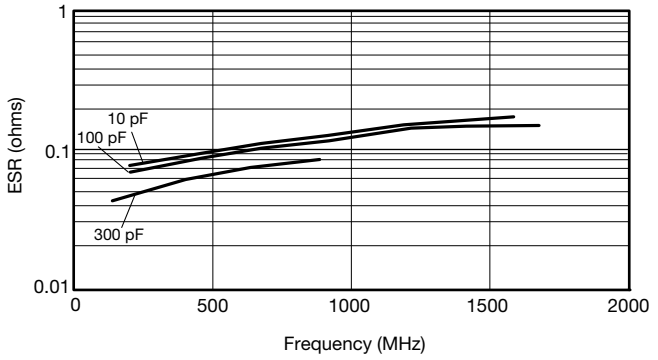
TYPICAL ESR vs. FREQUENCY
0603 “U” SERIES



TYPICAL ESR vs. FREQUENCY
0805 “U” SERIES



TYPICAL ESR vs. FREQUENCY
1210 “U” SERIES



ESR Measured on the Boonton 34A

Designer Kits

Communication Kits "U" Series

"U" SERIES KITS

0402

Kit 5000 UZ			
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance
0.5 1.0 1.5 1.8 2.2 2.4 3.0 3.6	B (±0.1pF)	4.7 5.6 6.8 8.2	B (±0.1pF)
		10.0 12.0 15.0	J (±5%)

***25 each of 15 values

0603

Kit 4000 UZ			
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance
1.0 1.2 1.5 1.8 2.0 2.4 2.7 3.0 3.3 3.9 4.7 5.6	B (±0.1pF)	6.8 7.5 8.2	B (±0.1pF)
		10.0 12.0 15.0 18.0 22.0 27.0 33.0 39.0 47.0	J (±5%)

***25 each of 24 values

0805

Kit 3000 UZ			
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance
1.0 1.5 2.2 2.4 2.7 3.0 3.3 3.9 4.7 5.6 7.5 8.2 9.1	B (±0.1pF)	15.0 18.0 22.0 24.0 27.0 33.0 36.0 39.0 47.0 56.0 68.0 82.0 100.0	J (±5%)
10.0 12.0	J (±5%)	130.0 160.0	

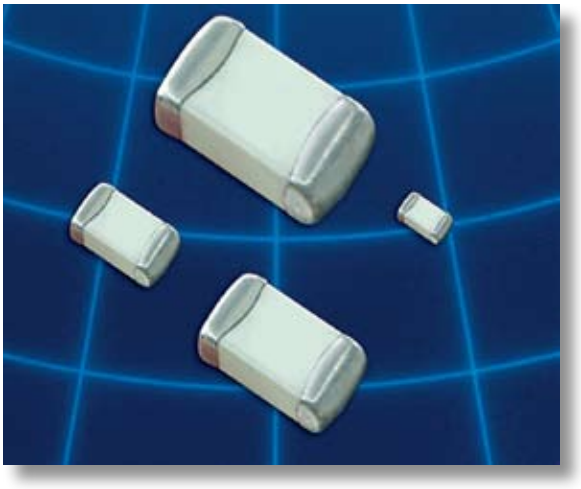
***25 each of 30 values

1210

Kit 3500 UZ			
Cap. Value pF	Tolerance	Cap. Value pF	Tolerance
2.2 2.7 4.7 5.1 6.8 8.2 9.1	B (±0.1pF)	36.0 39.0 47.0 51.0 56.0 68.0 82.0	J (±5%)
10.0 13.0 15.0 18.0 20.0 24.0 27.0 30.0	J (±5%)	100.0 120.0 130.0 240.0 300.0 390.0 470.0 680.0	

***25 each of 30 values

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)

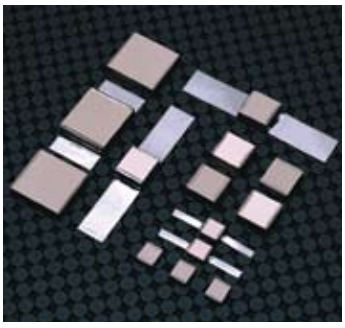
E — **PACKAGING**
S = Bulk
W = Waffle Pack

<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

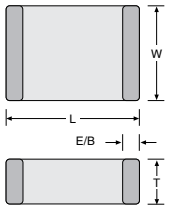
	SPECIFICATION	TEST PARAMETERS
SOLDERABILITY:	Solder coverage ≥ 90% of metalized areas No termination degradation	Preheat chip to 120°-150°C for 60 sec., dip terminals in rosin flux then dip in Sn62 solder @ 240°±5°C for 5±1 sec
RESISTANCE TO SOLDERING HEAT:	No mechanical damage Capacitance change: ±2.5%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

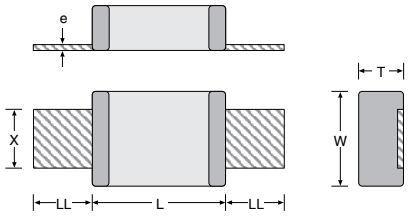
Size	Units	Length	Width	Thickness	End Band
01005	In	.016 ±.001	.008 ±.001	.008 ±.001	.006 Max.
(0402)	mm	(0.40 ±0.03)	(0.20 ±0.03)	(0.20 ±0.03)	(0.15 Max.)
0201	In	.024 ±.001	.012 ±.001	.012 ±.001	.008 Max.
(0603)	mm	(0.60 ±0.03)	(0.30 ±0.03)	(0.30 ±0.03)	(0.20 Max.)
0402	In	.040 ±.004	.020 ±.004	.020 ±.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

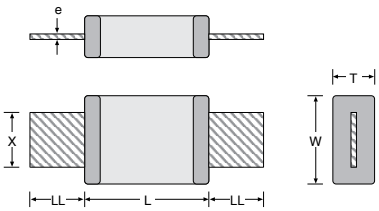
Unleaded Terminations Code "Y" (Pt.-Ag), "V" (Ni / 100% Sn), or "T" (Ni / SnPb)



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.

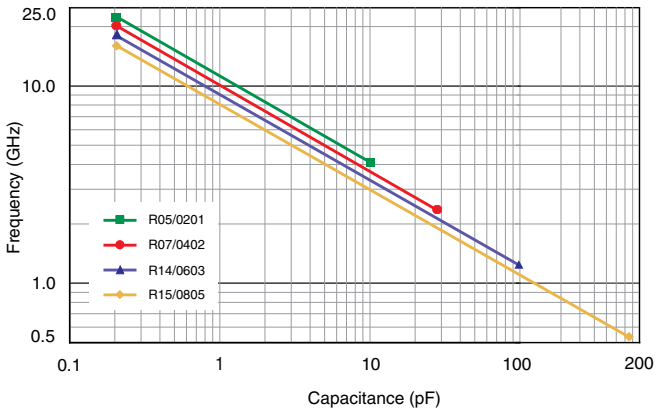
For all E-Series Models:

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

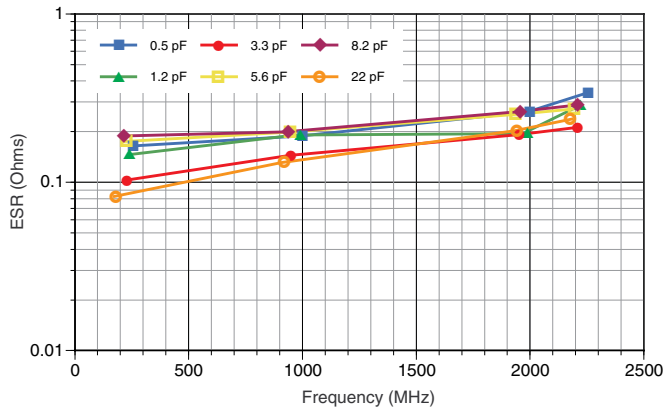
SERIES RESONANCE CHART

Typical Series Resonant Frequency (Series Mounted)

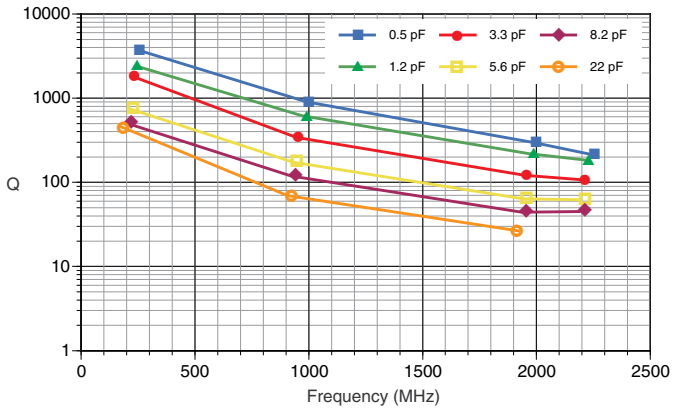


RF CHARACTERISTICS - L-SERIES

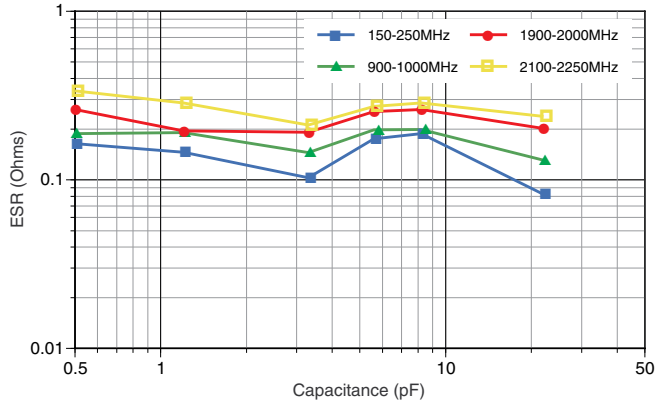
ESR vs Frequency: 0201/R05L



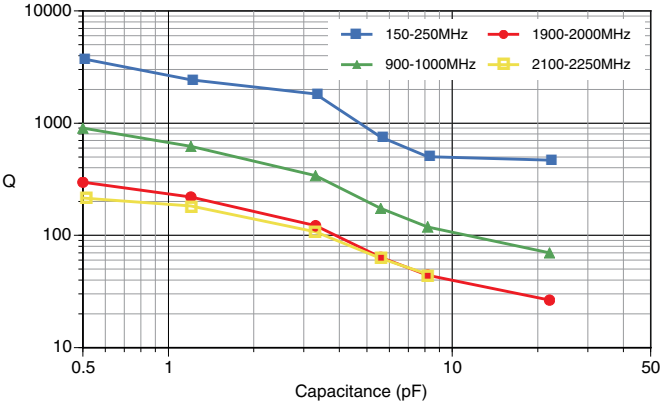
Q vs Frequency: 0201/R05L



ESR vs Capacitance: 0201/R05L

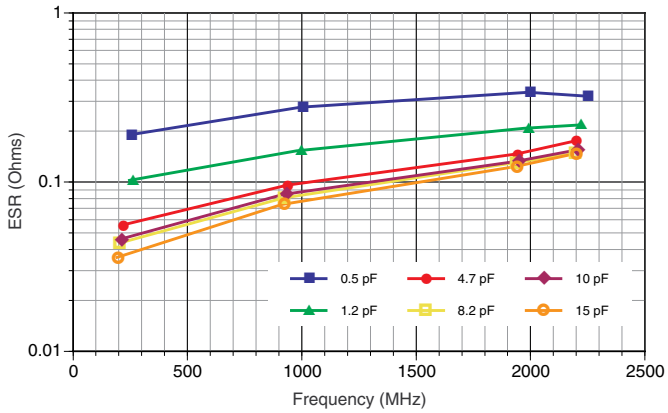


Q vs Capacitance: 0201/R05L

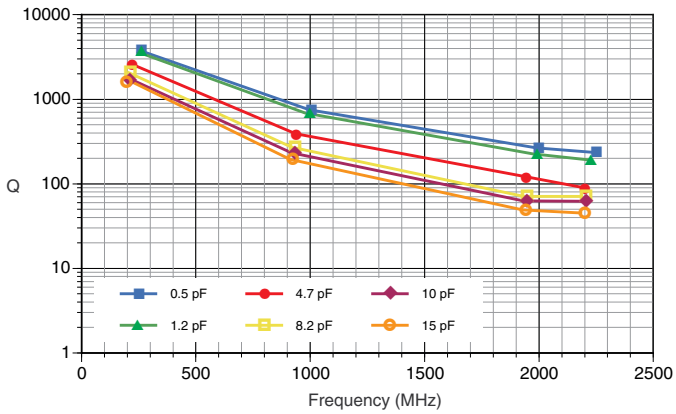


S-Series RF Characterisitcs versus Frequency

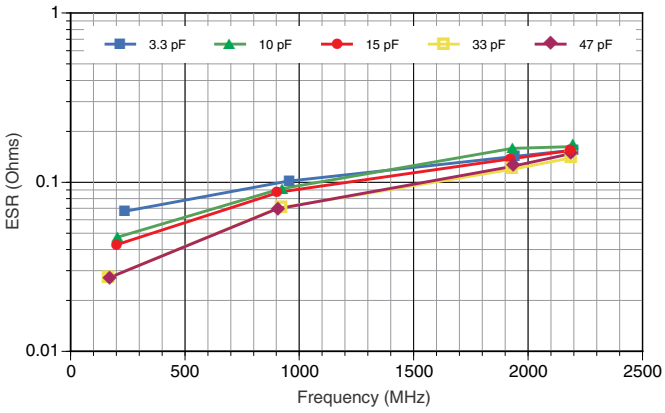
Equivalent Series Resistance: 0402/R07S



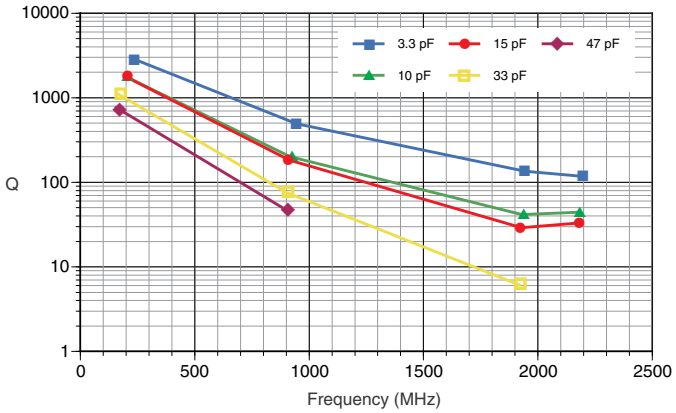
Q Factor: 0402/R07S



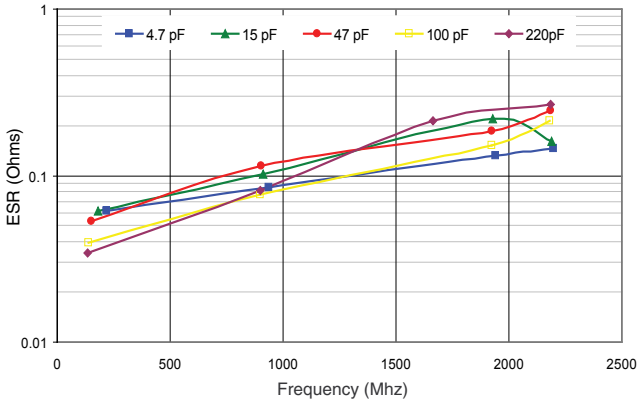
Equivalent Series Resistance: 0603/R14S



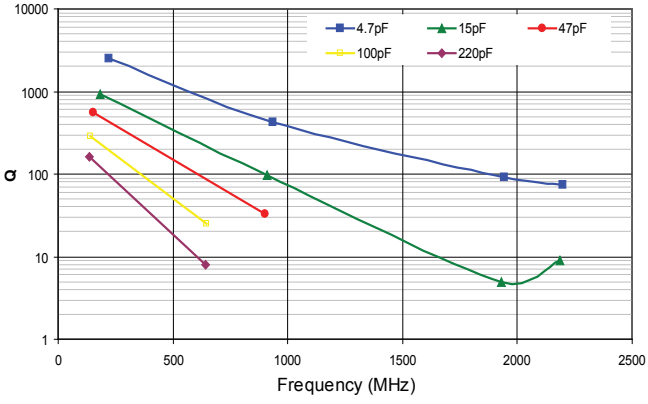
Q Factor: 0603/R14S



Equivalent Series Resistance: 0805/R15S



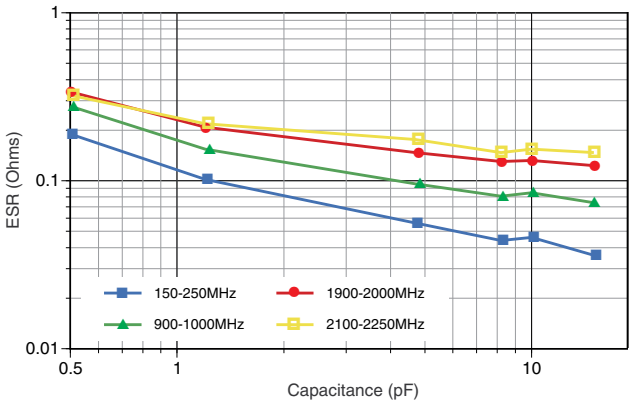
Q Factor: 0805/R15S



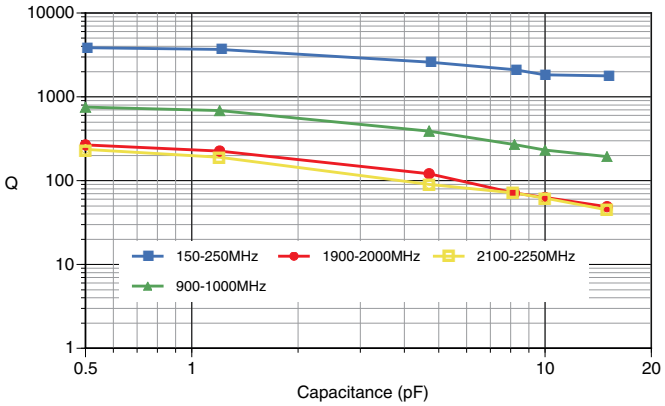
Measurements performed on a Boonton 34A Resonant Coaxial Line and represent typical capacitor performance.

S-Series RF Characterisitcs versus Capacitance

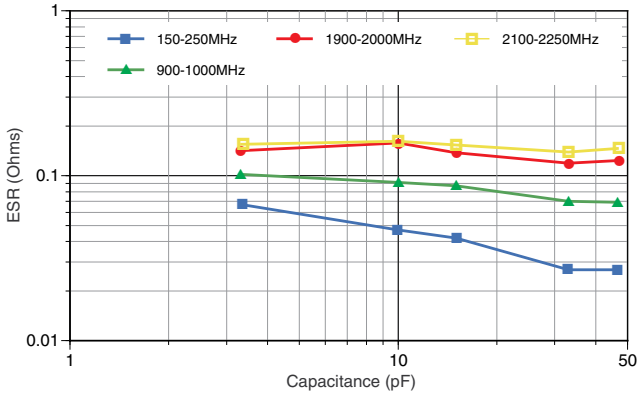
Equivalent Series Resistance: 0402/R07S



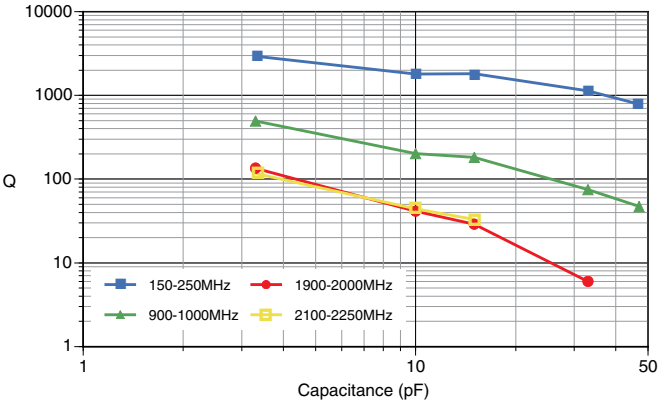
Q Factor: 0402/R07S



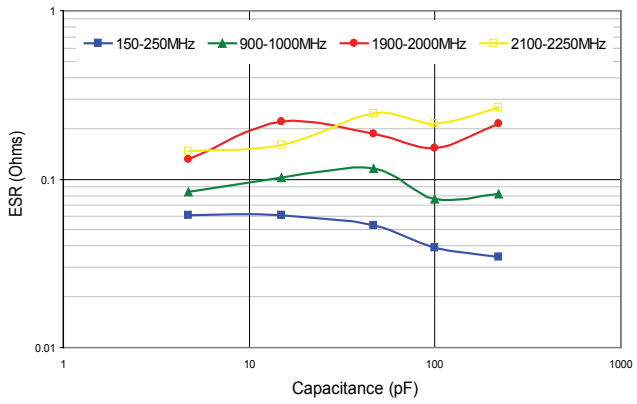
Equivalent Series Resistance: 0603/R14S



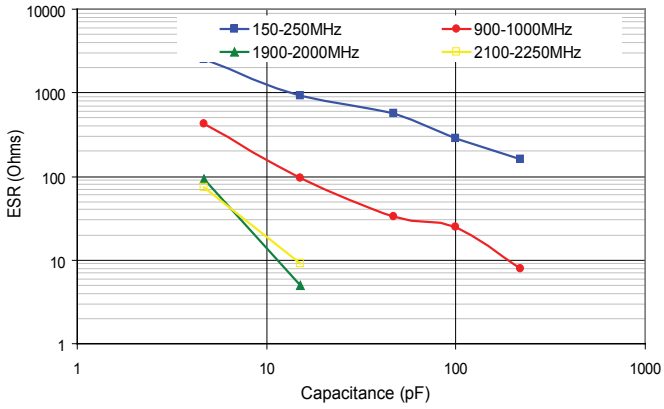
Q Factor: 0603/R14S



Equivalent Series Resistance: 0805/R15S

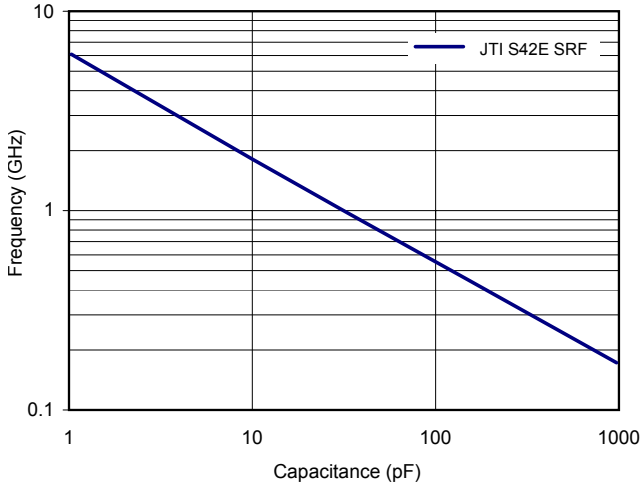


Q Factor: 0805/R15S



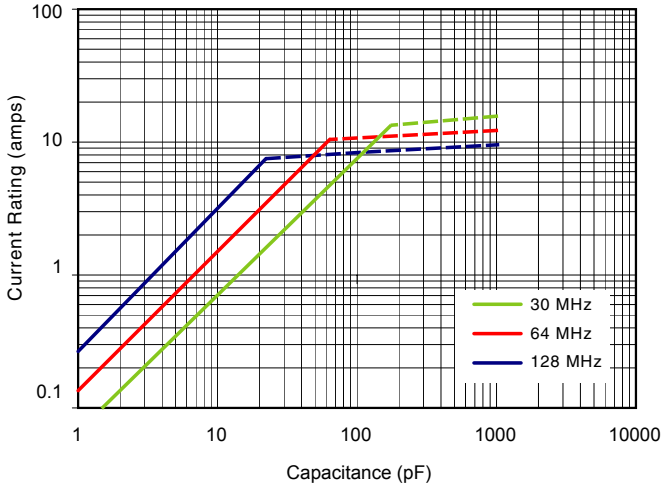
Measurements performed on a Boonton 34A Resonant Coaxial Line and represent typical capacitor performance.

SRF (Shunt Mount), S42E, Typical



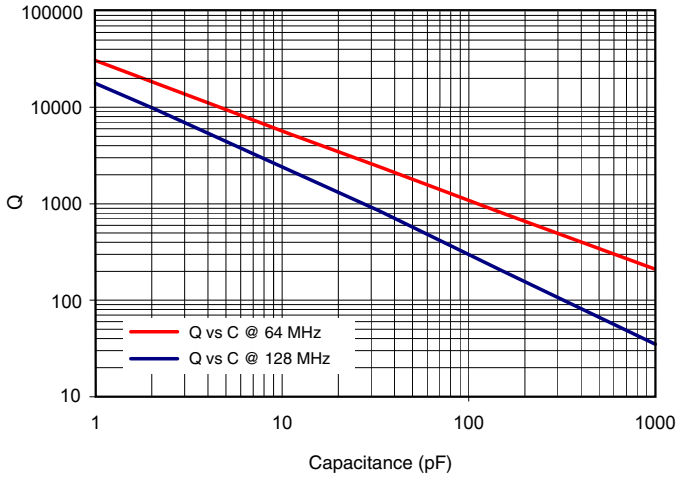
As measured on a 8720C VNA, using a Shunt-Through fixture, and using the S11 magnitude dip to determine the SRF

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



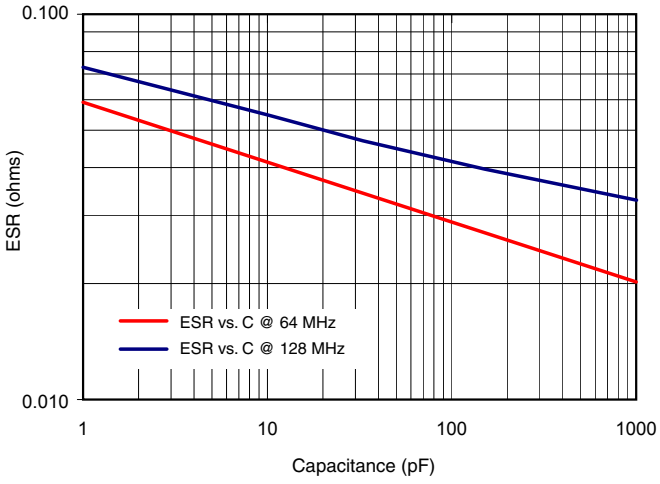
Solid traces show voltage limited current (Vrms)
Dotted traces show power dissipation limited current (Based on 3 Watts Power Dissipation, and 125 degrees C case temp.)

S42E Q vs. Capacitance, Typical



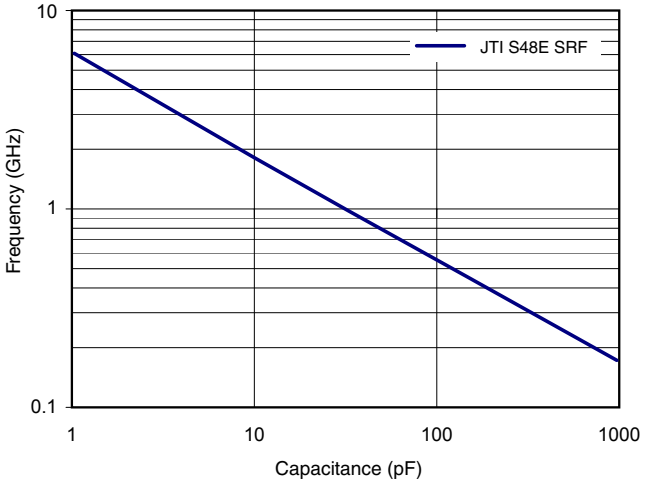
As measured on a 4287A LCR meter, using a 16092A fixture

S42E ESR vs. Capacitance, Typical



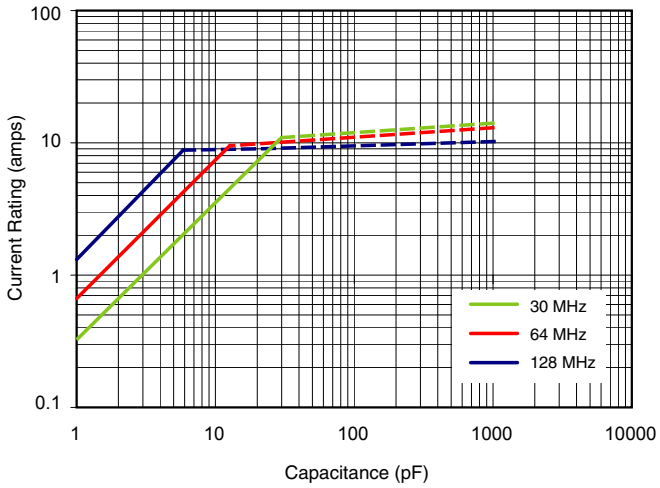
As measured on a 4287A LCR meter, using a 16092A fixture

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

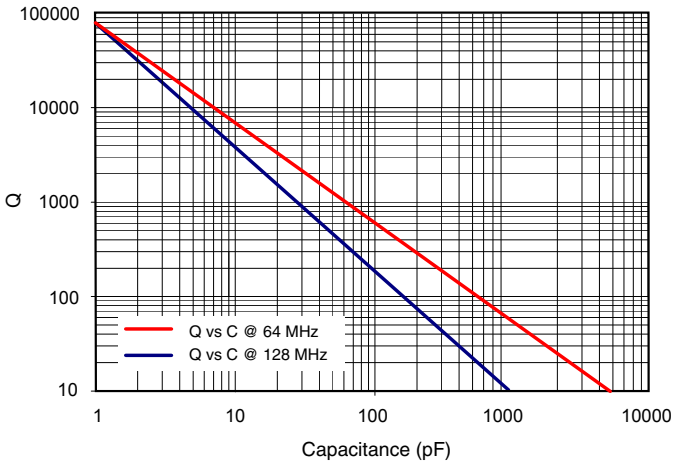
Current Rating vs. Capacitance, S48E, Typical (Preliminary)



Solid traces show voltage limited current (Vrms)

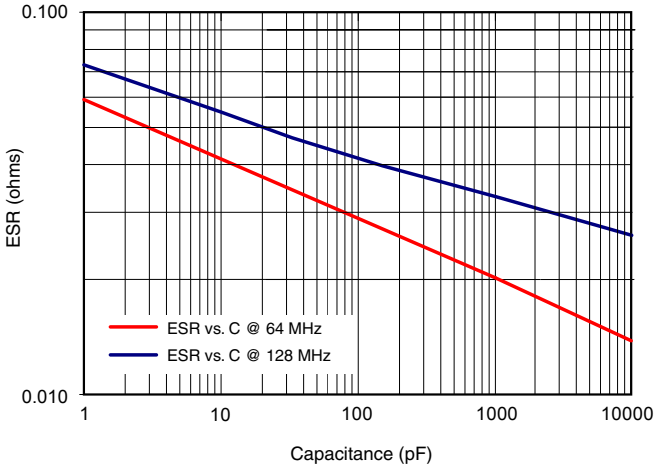
Dotted traces show power dissipation limited current (Based on 4 Watts Power Dissipation, and 125 degrees C case temp.)

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

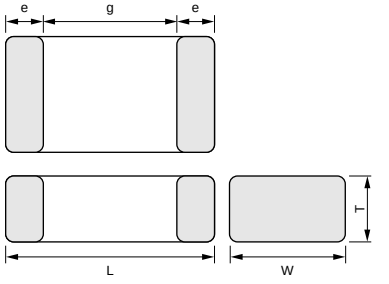
Data Sheet

Monolithic Ceramic Capacitors

GCM1555C1H471JA16□ (0402, C0G, 470pF, 50Vdc)

□: packaging code

RoHS regulation conformity parts



(in mm)

■ Dimensions

Length L	1.0mm±0.05mm
Width W	0.5mm±0.05mm
Thickness T	0.5mm±0.05mm
Electrode e	0.15 to 0.35mm
Electrode Gap g (min.)	0.3mm

■ Packaging

Code	Packaging	Minimum Quantity
D	180mm Paper Tape	10000
J	330mm Paper Tape	50000
C	Bulk Case	50000
B	Bulk(Bag)	1000

■ Rated Value

	Murata PN Code	Spec
Tenperature Char.	**5C**	C0G (EIA), 0±30ppm/°C
Capacitance	**471**	470pF
Capacitance Change	**J**	±5%
Rated Voltage	**1H**	50Vdc

■ Specifications

Please refer to
'GCM Series Specification and Test Methods'
PDF file.

GCM Series meets AEC-Q200 requirements.

- This data sheet is applied for CHIP MONOLITHIC CERAMIC CAPACITOR used for Automotive (For Power-train, Safety equipments) Electronics equipment for your design.

<Notice>

- Solderability of Tin plating termination chip might be deteriorated when low temperature soldering profile where peak solder temperature is below the Tin melting point is used. Please confirm the solderability of Tin plating termination chip before use.

- The RoHS compliance means that we judge from EU Directive 2002/95/EC the products do not contain lead, cadmium, mercury, hexavalent chromium, PBB and PBDE, except exemptions stated in EU Directive 2002/95/EC annex and impurities existing in natural world.
- This statement does not insure the compliance of any of the listed parts with any laws or legal imperatives developed by any EU members individually with regards to the RoHS Directive.

● Part Numbering

Chip Monolithic Ceramic Capacitors

(Part Number)

GC	M	18	8	R7	1H	102	K	A37	D
❶	❷	❸	❹	❺	❻	❼	❽	❾	❿

❶Product ID

❷Series

Product ID	Code	Series
GC	J	Soft Termination Type Power-train, Safety Equipment
	M	Power-train, Safety Equipment

❸Dimension (L×W)

Code	Dimension (L×W)	EIA
03	0.6×0.3mm	0201
15	1.0×0.5mm	0402
18	1.6×0.8mm	0603
21	2.0×1.25mm	0805
31	3.2×1.6mm	1206
32	3.2×2.5mm	1210
43	4.5×3.2mm	1812
55	5.7×5.0mm	2220

❹Dimension (T)

Code	Dimension (T)
3	0.3mm
5	0.5mm
6	0.6mm
8	0.8mm
9	0.85mm
A	1.0mm
B	1.25mm
C	1.6mm
D	2.0mm
E	2.5mm
M	1.15mm
N	1.35mm
Q	1.5mm
R	1.8mm
X	Depends on individual standards.

❺Temperature Characteristics

Temperature Characteristic Codes			Temperature Characteristics			Operating Temperature Range
Code	Public STD Code		Reference Temperature	Temperature Range	Capacitance Change or Temperature Coefficient	
5C	C0G	EIA	25°C	25 to 125°C	0±30ppm/°C	-55 to 125°C
7U	U2J	EIA	25°C	25 to 125°C	-750±120ppm/°C	-55 to 125°C
C7	X7S	EIA	25°C	-55 to 125°C	±22%	-55 to 125°C
R7	X7R	EIA	25°C	-55 to 125°C	±15%	-55 to 125°C

●Capacitance Change from each temperature

Murata Code	Capacitance Change from 25°C (%)					
	–55°C		–30°C		–10°C	
	Max.	Min.	Max.	Min.	Max.	Min.
5C	0.58	–0.24	0.40	–0.17	0.25	–0.11
7U	8.78	5.04	6.04	3.47	3.84	2.21

❻Rated Voltage

Code	Rated Voltage
0J	DC6.3V
1A	DC10V
1C	DC16V
1E	DC25V
YA	DC35V
1H	DC50V
2A	DC100V
2E	DC250V
2J	DC630V

❼Capacitance

Expressed by three-digit alphanumerics. The unit is pico-farad (pF). The first and second figures are significant digits, and the third figure expresses the number of zeros which follow the two numbers.
If there is a decimal point, it is expressed by the capital letter "**R**". In this case, all figures are significant digits.

Ex.)

Code	Capacitance
R50	0.5pF
1R0	1.0pF
100	10pF
103	10000pF

Continued on the following page.

Continued from the preceding page.

❽Capacitance Tolerance

Code	Capacitance Tolerance	TC	Series	Capacitance Step	
C	±0.25pF	C0G	**GCM**	≦5pF	E12, 1pF Step *
D	±0.5pF	C0G	**GCM**	6.0 to 9.0pF	E12, 1pF Step *
J	±5%	C0G	**GCM**	≧10pF	E12 Step
		U2J	**GCM**	E6 Step	
K	±10%	X7S, X7R	**GCJ/GCM**	E6 Step	
M	±20%	X7S, X7R	**GCM**	E6 Step	

***** E24 series is also available.

❾Individual Specification Code

Expressed by three figures.

❿Packaging

Code	Packaging
L	ø180mm Embossed Taping
D	ø180mm Paper Taping
K	ø330mm Embossed Taping
J	ø330mm Paper Taping
B	Bulk
C	Bulk Case

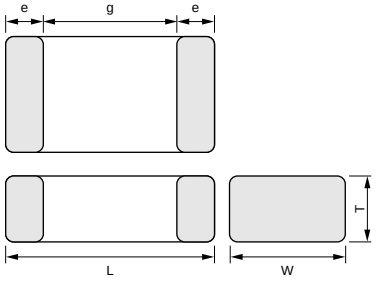
Data Sheet

Monolithic Ceramic Capacitors

GRM1555C1H471JA01☐ (0402, C0G, 470pF, 50Vdc)

☐: packaging code

RoHS regulation conformity parts



(in mm)

■ Dimensions

Length L	1.0mm±0.05mm
Width W	0.5mm±0.05mm
Thickness T	0.5mm±0.05mm
Electrode e	0.15 to 0.35mm
Electrode Gap g (min.)	0.3mm

■ Packaging

Code	Packaging	Minimum Quantity
D	180mm Paper Tape	10000
J	330mm Paper Tape	50000
C	Bulk Case	50000
B	Bulk(Bag)	1000

■ Rated Value

	Murata PN Code	Spec
Tenperature Char.	**5C**	C0G (EIA), 0±30ppm/°C
Capacitance	**471**	470pF
Capacitance Change	**J**	±5%
Rated Voltage	**1H**	50Vdc

■ Specifications

Please refer to
'GRM Series Specification and Test Methods (1)'
PDF file.

● This data sheet is applied for CHIP MONOLITHIC CERAMIC CAPACITOR used for General Electronics equipment for your design.

<Notice>

● Solderability of Tin plating termination chip might be deteriorated when low temperature soldering profile where peak solder temperature is below the Tin melting point is used. Please confirm the solderability of Tin plating termination chip before use.

● Use of Sn-Zn based solder will deteriorate reliability of MLCC. Please check with our sales represetatives for the use of Sn-Zn based solder in advance.

- The RoHS compliance means that we judge from EU Directive 2002/95/EC the products do not contain lead, cadmium, mercury, hexavalent chromium, PBB and PBDE, except exemptions stated in EU Directive 2002/95/EC annex and impurities existing in natural world.
- This statement does not insure the compliance of any of the listed parts with any laws or legal imperatives developed by any EU members individually with regards to the RoHS Directive.

⚠Note:

1. This datasheet is downloaded from the website of Murata Manufacturing co., ltd. Therefore, it's specifications are subject to change or our products in it may be discontinued without advance notice. Please check with our sales representatives or product engineers before ordering.
2. This datasheet has only typical specifications because there is no space for detailed specifications. Therefore, please approve our product specifications or transact the approval sheet for product specifications before ordering.

● Part Numbering

Chip Monolithic Ceramic Capacitors

(Part Number)

GR	M	18	8	B1	1H	102	K	A01	D
❶	❷	❸	❹	❺	❻	❼	❽	❾	❿

❶Product ID

❷Series

Product ID	Code	Series
GR	J	Soft Termination Type
	M	Tin Plated Layer
	4	Only for Information Devices / Tip & Ring
	7	Only for Camera Flash Circuit
ER	B	High Frequency Type
GQ	M	High Frequency for Flow/Reflow Soldering
GM	A	Monolithic Microchip
	D	for Bonding
GN	M	Capacitor Array
LL	L	Low ESL Wide Width Type
	A	Eight-termination Low ESL Type
	M	Ten-termination Low ESL Type
GJ	M	High Frequency Low Loss Type
GA	2	for AC250V (r.m.s.)
	3	Safety Standard Recognized Type

❸Dimension (L×W)

Code	Dimension (L×W)	EIA
02	0.4×0.2mm	01005
03	0.6×0.3mm	0201
05	0.5×0.5mm	0202
08	0.8×0.8mm	0303
0D	0.38×0.38mm	015015
0M	0.9×0.6mm	0302
11	1.25×1.0mm	0504
15	1.0×0.5mm	0402
18	1.6×0.8mm	0603
1M	1.37×1.0mm	0504
21	2.0×1.25mm	0805
22	2.8×2.8mm	1111
31	3.2×1.6mm	1206
32	3.2×2.5mm	1210
42	4.5×2.0mm	1808
43	4.5×3.2mm	1812
52	5.7×2.8mm	2211
55	5.7×5.0mm	2220

❹Dimension (T)

Code	Dimension (T)
2	0.2mm
2	2-elements (Array Type)
3	0.3mm
4	4-elements (Array Type)
5	0.5mm
6	0.6mm
7	0.7mm
8	0.8mm
9	0.85mm
A	1.0mm
B	1.25mm
C	1.6mm
D	2.0mm
E	2.5mm
F	3.2mm
M	1.15mm
N	1.35mm
Q	1.5mm
R	1.8mm
S	2.8mm
X	Depends on individual standards.

With the array type GNM series, "Dimension(T)" indicates the number of elements.

Continued on the following page.

Continued from the preceding page.

❺Temperature Characteristics

Temperature Characteristic Codes			Temperature Characteristics			Operating Temperature Range
Code	Public STD Code		Reference Temperature	Temperature Range	Capacitance Change or Temperature Coefficient	
1X	SL *1	JIS	20°C	20 to 85°C	+350 to -1000ppm/°C	-55 to 125°C
2C	CH *1	JIS	20°C	20 to 125°C	0±60ppm/°C	-55 to 125°C
2P	PH *1	JIS	20°C	20 to 85°C	-150±60ppm/°C	-25 to 85°C
2R	RH *1	JIS	20°C	20 to 85°C	-220±60ppm/°C	-25 to 85°C
2S	SH *1	JIS	20°C	20 to 85°C	-330±60ppm/°C	-25 to 85°C
2T	TH *1	JIS	20°C	20 to 85°C	-470±60ppm/°C	-25 to 85°C
3C	CJ *1	JIS	20°C	20 to 125°C	0±120ppm/°C	-55 to 125°C
3P	PJ *1	JIS	20°C	20 to 85°C	-150±120ppm/°C	-25 to 85°C
3R	RJ *1	JIS	20°C	20 to 85°C	-220±120ppm/°C	-25 to 85°C
3S	SJ *1	JIS	20°C	20 to 85°C	-330±120ppm/°C	-25 to 85°C
3T	TJ *1	JIS	20°C	20 to 85°C	-470±120ppm/°C	-25 to 85°C
3U	UJ *1	JIS	20°C	20 to 85°C	-750±120ppm/°C	-25 to 85°C
4C	CK *1	JIS	20°C	20 to 125°C	0±250ppm/°C	-55 to 125°C
5C	C0G *1	EIA	25°C	25 to 125°C	0±30ppm/°C	-55 to 125°C
5G	X8G *1	EIA	25°C	25 to 150°C	0±30ppm/°C	-55 to 150°C
6C	C0H *1	EIA	25°C	25 to 125°C	0±60ppm/°C	-55 to 125°C
6P	P2H *1	EIA	25°C	25 to 85°C	-150±60ppm/°C	-55 to 125°C
6R	R2H *1	EIA	25°C	25 to 85°C	-220±60ppm/°C	-55 to 125°C
6S	S2H *1	EIA	25°C	25 to 85°C	-330±60ppm/°C	-55 to 125°C
6T	T2H *1	EIA	25°C	25 to 85°C	-470±60ppm/°C	-55 to 125°C
7U	U2J *1	EIA	25°C	25 to 125°C *6	-750±120ppm/°C	-55 to 125°C
B1	B *2	JIS	20°C	-25 to 85°C	±10%	-25 to 85°C
B3	B	JIS	20°C	-25 to 85°C	±10%	-25 to 85°C
C7	X7S	EIA	25°C	-55 to 125°C	±22%	-55 to 125°C
C8	X6S	EIA	25°C	-55 to 105°C	±22%	-55 to 105°C
D7	X7T	EIA	25°C	-55 to 125°C	+22, -33%	-55 to 125°C
D8	X6T	EIA	25°C	-55 to 105°C	+22, -33%	-55 to 105°C
E7	X7U	EIA	25°C	-55 to 125°C	+22, -56%	-55 to 125°C
F1	F *2	JIS	20°C	-25 to 85°C	+30, -80%	-25 to 85°C
F5	Y5V	EIA	25°C	-30 to 85°C	+22, -82%	-30 to 85°C
L8	X8L	*3	25°C	-55 to 150°C	+15, -40%	-55 to 150°C
R1	R *2	JIS	20°C	-55 to 125°C	±15%	-55 to 125°C
R3	R	JIS	20°C	-55 to 125°C	±15%	-55 to 125°C
R6	X5R	EIA	25°C	-55 to 85°C	±15%	-55 to 85°C
R7	X7R	EIA	25°C	-55 to 125°C	±15%	-55 to 125°C
R9	X8R	EIA	25°C	-55 to 150°C	±15%	-55 to 150°C
W0	-	-	25°C	-55 to 125°C	±10% *4 +22, -33% *5	-55 to 125°C

*1 Please refer to table for Capacitance Change under reference temperature.
*2 Capacitance change is specified with 50% rated voltage applied.
*3 Murata Temperature Characteristic Code.
*4 Apply DC350V bias.
*5 No DC bias.
*6 Rated Voltage 100Vdc max : 25 to 85°C

Continued on the following page.

Continued from the preceding page.

●Capacitance Change from each temperature

JIS Code

Murata Code	Capacitance Change from 20°C (%)					
	–55°C		–25°C		–10°C	
	Max.	Min.	Max.	Min.	Max.	Min.
1X	–	–	–	–	–	–
2C	0.82	–0.45	0.49	–0.27	0.33	–0.18
2P	–	–	1.32	0.41	0.88	0.27
2R	–	–	1.70	0.72	1.13	0.48
2S	–	–	2.30	1.22	1.54	0.81
2T	–	–	3.07	1.85	2.05	1.23
3C	1.37	–0.90	0.82	–0.54	0.55	–0.36
3P	–	–	1.65	0.14	1.10	0.09
3R	–	–	2.03	0.45	1.35	0.30
3S	–	–	2.63	0.95	1.76	0.63
3T	–	–	3.40	1.58	2.27	1.05
3U	–	–	4.94	2.84	3.29	1.89
4C	2.56	–1.88	1.54	–1.13	1.02	–0.75

EIA Code

Murata Code	Capacitance Change from 25°C (%)					
	–55°C		–30°C		–10°C	
	Max.	Min.	Max.	Min.	Max.	Min.
5C/5G	0.58	–0.24	0.40	–0.17	0.25	–0.11
6C	0.87	–0.48	0.59	–0.33	0.38	–0.21
6P	2.33	0.72	1.61	0.50	1.02	0.32
6R	3.02	1.28	2.08	0.88	1.32	0.56
6S	4.09	2.16	2.81	1.49	1.79	0.95
6T	5.46	3.28	3.75	2.26	2.39	1.44
7U	8.78	5.04	6.04	3.47	3.84	2.21

❻Rated Voltage

Code	Rated Voltage
0E	DC2.5V
0G	DC4V
0J	DC6.3V
1A	DC10V
1C	DC16V
1E	DC25V
YA	DC35V
1H	DC50V
2A	DC100V
2D	DC200V
2E	DC250V
YD	DC300V
2H	DC500V
2J	DC630V
3A	DC1kV
3D	DC2kV
3F	DC3.15kV
BB	DC350V (for Camera Flash Circuit)
E2	AC250V
GB	X2; AC250V (Safety Standard Recognized Type GB)
GC	X1/Y2; AC250V (Safety Standard Recognized Type GC)
GD	Y3; AC250V (Safety Standard Recognized Type GD)
GF	Y2, X1/Y2; AC250V (Safety Standard Recognized Type GF)

❼Capacitance

Expressed by three-digit alphanumerics. The unit is pico-farad (pF). The first and second figures are significant digits, and the third figure expresses the number of zeros which follow the two numbers.If there is a decimal point, it is expressed by the capital letter "**R**". In this case, all figures are significant digits.

Ex.)

Code	Capacitance
R50	0.5pF
1R0	1.0pF
100	10pF
103	10000pF

Continued on the following page.

Continued from the preceding page.

❽Capacitance Tolerance

Code	Capacitance Tolerance	TC	Series	Capacitance Step	
W	±0.05pF	CΔ	**GRM/GJM**	≦9.9pF	0.1pF
B	±0.1pF	CΔ	**GRM/GJM**	≦9.9pF	0.1pF
			GQM	≦1pF	0.1pF
				1.1 to 9.9pF	1pF Step and E24 Series
			ERB	≦9.9pF	1pF Step and E24 Series
C	±0.25pF	CΔ	**GRM/GJM**	≦9.9pF	0.1pF
		except CΔ	**GRM**	≦5pF	* 1pF
		CΔ	**ERB**	≦9.9pF	1pF Step and E24 Series
			GQM	≦1pF	0.1pF
				1.1 to 9.9pF	1pF Step and E24 Series
D	±0.5pF	CΔ	**GRM/GJM**	5.1 to 9.9pF	0.1pF
		except CΔ	**GRM**	5.1 to 9.9pF	* 1pF
		CΔ	**ERB/GQM**	5.1 to 9.9pF	1pF Step and E24 Series
G	±2%	CΔ	**GJM**	≧10pF	E12 Series
		CΔ	**GQM/ERB**	≧10pF	E24 Series
J	±5%	CΔ–SL	**GRM/GA3**	≧10pF	E12 Series
		CΔ	**ERB/GQM/GJM**	≧10pF	E24 Series
K	±10%	B, R, X7R, X5R, ZLM	**GRJ/GRM/GR7/GA3**	E6 Series	
		C0G	**GNM**	E6 Series	
		B, R, X7R, X5R, ZLM	**GR4, GMD**	E12 Series	
M	±20%	B, R, X7R, X7S	**GRM/GMA**	E6 Series	
		X5R, X7R, X7S	**GNM**	E3 Series	
		X7R	**GA2**	E3 Series	
		X5R, X7R, X7S, X6S	**LLL/LLA/LLM**	E3 Series	
Z	+80%, -20%	F, Y5V	**GRM**	E3 Series	
R	Depends on individual standards.				

***** E24 series is also available.

❾Individual Specification Code

Expressed by three figures.

❿Packaging

Code	Packaging
L	ø180mm Embossed Taping
D	ø180mm Paper Taping
E	ø180mm Paper Taping (LLL15)
K	ø330mm Embossed Taping
J	ø330mm Paper Taping
F	ø330mm Paper Taping (LLL15)
B	Bulk
C	Bulk Case
T	Bulk Tray

High-Q Capacitors (Microwave Chip Capacitors)

Series: **ECD**

■ Features

- Low Capacitance with tight tolerance (0.1 to 15.0 pF, +/–0.05 pF to +/–5 %)
- High Q value / Low ESR at High Frequencies
- Ultra-Stable C0G Performance (0±30 ppm/°C)
- 0402 & 0201 Case sizes (0.1 to 15.0 pF & 0.1 to 5.6 pF, +/–0.05 pF,+/–0.075 pF etc)
- Pb Free
- RoHS compliant

■ Recommended Applications

- Microwave Circuitry
  - · Impedance Matching Circuitry
  - · Resonant Circuitry
  - · Coupling Circuitry
- RF modules, VCO, BPF, DUP, PA
- Cellular Phone, Bluetooth, Wireless LAN

■ Product Code

ECD: High-Q Capacitors

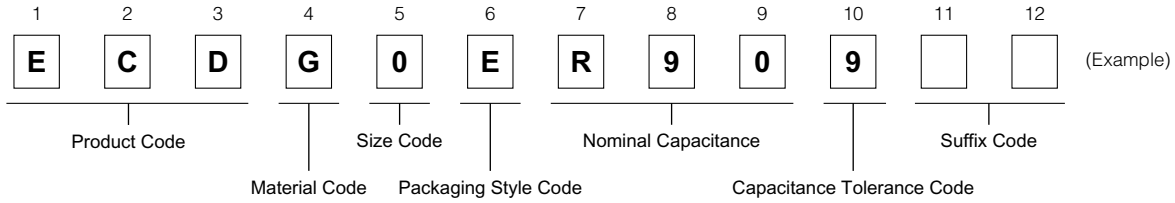
■ Handling Precautions

See Page 48 to 53

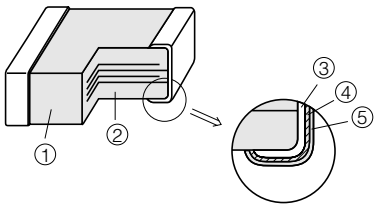
■ Packaging Specifications

See Page 45, 46, 56

■ Explanation of Part Numbers

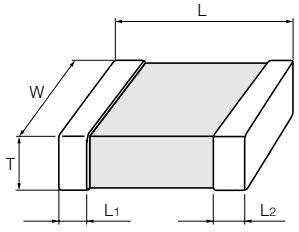


■ Construction



No	Name	
①	Ceramic dielectric	
②	Internal electrode	
③	Terminal electrode	Substrate electrode
④		Intermediate electrode
⑤		External electrode

■ Dimensions in mm (not to scale)



Size Code	Size (EIA)	L	W	T	L_1, L_2
Z	0201	0.60±0.03	0.30±0.03	0.30±0.03	0.15±0.05
0	0402	1.00±0.05	0.5±0.05	0.5±0.05	0.2±0.1

■ Packaging Styles and Standard Packaging Quantites

Quantity : pcs./reel

Packaging Style Code	Packaging Styles / Size / Thickness (mm)		0201 T=0.3	0402 T=0.5
E	φ180 reel	Paper taping (Pitch: 2 mm)	15,000	10,000

■ Temperature Characteristics

Temperature Characteristic Code	Temperature Coefficient
C0G	0±30 ppm/°C

These temperature coefficients are calculated between 25 °C and 85 °C

■ Rated Voltage

Rated Voltage
DC 25 V

■ Nominal Capacitance

Ex.	R10	1R0	2R7	120
Nominal Capacitance	0.10 pF	1.0 pF	2.7 pF	12 pF

The first two digits are significant figures of capacitance.Small number of people display the point by R.

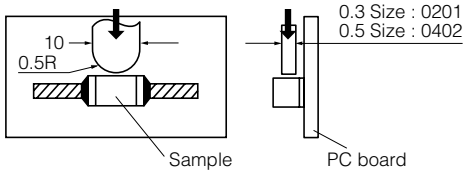
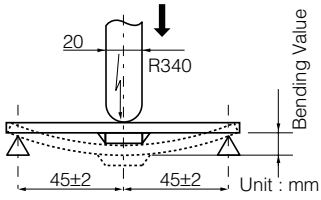
■ Capacitance tolerance

Size (EIA)	Tolerance Code	Capacitance Range	Capacitance Tolerance
0201	8	0.10 to 0.50 pF	±0.05 pF
	9	0.60 to 0.90 pF	±0.075 pF
	B	1.0 to 3.0 pF	±0.10 pF
	C	3.3 to 5.6 pF	±0.25 pF
0402	8	0.10 to 0.90 pF	±0.05 pF
	9	0.60 to 0.90 pF	±0.075 pF
	B	1.0 to 8.2 pF	±0.10 pF
	C	3.3 to 10.0 pF	±0.25 pF
	J	12 to 15 pF	±5 %

■ Specifications and Testing Methods

Characteristics	Specifications	Test Method
Operating Temperature Range	–55 to 125 °C	———
Dielectric Withstanding Voltage	No dielectric breakdown and/or damage	Test voltage: Rated voltage × 300 % Duration: 1 to 5 s Charge/discharge current: 50 mA max.
Insulation Resistance (IR)	10000 MΩ min.	Measuring voltage: Rated voltage Duration: 60±5 s Charge / Discharge current: 50 mA max.
Capacitance	Within the specified tolerance	Temperature: 20 +/–2 °C Measuring Frequency: 1 MHz +/–10 % Measuring Voltage: 0.5 to 5 Vrms
Dissipation Factor (tan δ)	tan $\delta \leqq$ 0.005 max.	
Temperature Characteristics	C0G : 0 +/-30 ppm/°C	Maximum capacitance change at stage 1 to 5

Stage	Temperature
Stage1	25±2 °C
Stage2	–25±2 °C
Stage3 (Reference Temperature)	25±2 °C
Stage4	85±2 °C
Stage5	25±2 °C

Adhesion	The terminal electrode shall be free from peeling or signs of peeling.	Applied force : Size : 0201 : 2N Size : 0402 : 5N Arrow direction for 10 seconds. 
Bending Strength	Appearance : no mechanical damage	Bending value : 1 mm Bending speed : 1 mm/s 
Resistance to Solder Heat	Appearance : no mechanical damage I.R. : initial value	Solder temperature : 270±5 °C Dipping period : 3.0±0.5 s Preheat condition :

Order	Temp. (°C)	Time (s)
1	80 to 100	120 to 180
2	150 to 200	120 to 180

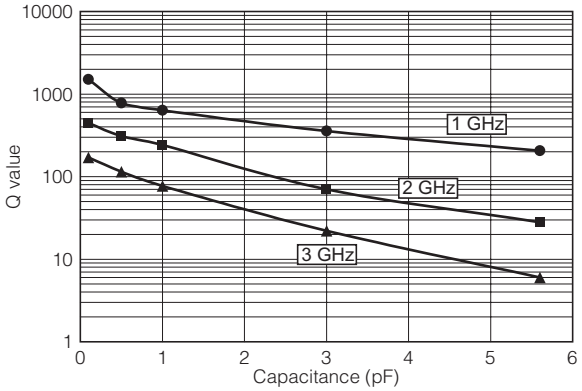
		Recovery (Standard condition) : 24 ±2 h
Solderability	More than 75 % of the soldered area of both terminal electrodes shall be covered with fresh solder .	Solder bath method Solder temperature : 230±5 °C Dipping period : 4±1 s Solder : H63A (JIS Z 3283)

✻ Standard condition: Temperature 15 to 35 °C, Relative humidity 45 to 75 %.

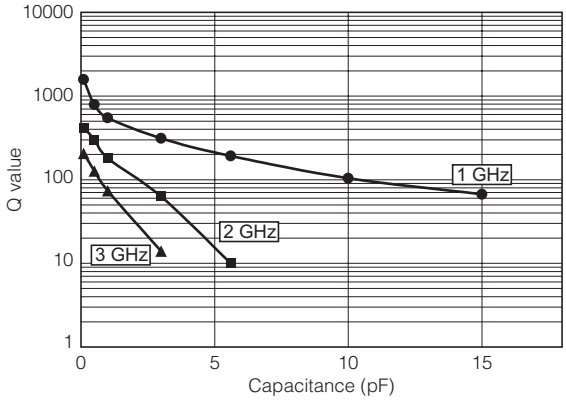
Characteristics	Specifications	Test Method
Temperature cycle	Appearance : no mechanical damage I.R. : 1000MΩ min.	Condition of one cycle Step1 : –55 ±3 °C 30±3 min. Step2 : Room temp 3 min. Step3 : 125±3 °C 30±3 min. Step4 : Room temp 3 min. Number of cycles : 5 cycles Recovery (Standard condition) : 24 ±2 h
Moisture Resistance	Appearance : no mechanical damage I.R. : 1000MΩ min. Capacitance Change: Within ±7.5 % or ±0.02 pF whichever is lager tan δ : 0.005 max.	Temperature : 40±2 °C Relative Humidity : 90 to 95 % Test period : 500 +24/0 h Recovery (Standard condition) : 24 ±2 h
Moisture Resistant Loading	Appearance : no mechanical damage I.R. : 1000MΩ min.	Temperature : 40±2 °C Relative Humidity : 90 to 95 % Applied voltage : Rated voltage Limit surge current : 50 mA max. Test period : 500 +24/0 h Recovery (Standard condition) : 24 ±2 h
Loading at high temperature	Appearance : no mechanical damage I.R. : 1000MΩ min.	Temperature: 125 °C±3 °C Applied voltage : Rated voltage ×200 % Limit surge current : 50 mA max. Test period : 1000 +48/0 h Recovery (Standard condition) : 24 ±2 h

■ Q value vs. Capacitance

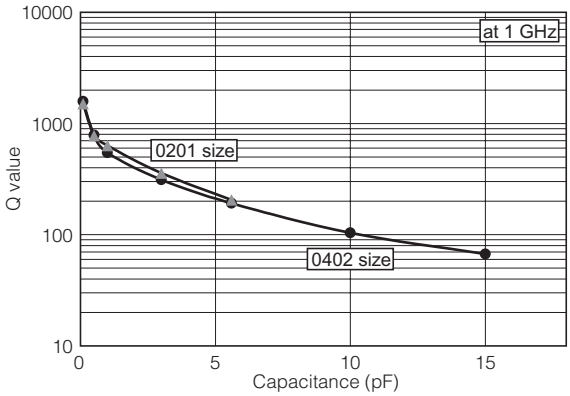
EIA 0201 size



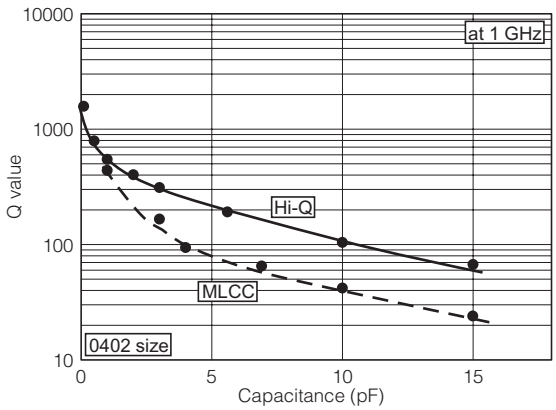
EIA 0402 size



■ Comparison data of Q value



■ Comparison data of Q value



Measurements performed Boonton34A Resonant Coaxial-Line and represent typical capacitor performance.

■ Standard Products for EIA Size "0201", Taped Version

● Temperature Characteristics C0G

Rated voltage		DC 25 V	
Capacitance (pF)	Capacitance Tolerance	Part No.	Dim. T (mm)
0.10	±0.05 pF (8)	ECDGZER108	0.3
0.20		ECDGZER208	0.3
0.30		ECDGZER308	0.3
0.40		ECDGZER408	0.3
0.50		ECDGZER508	0.3
0.60	±0.075 pF (9)	ECDGZER609	0.3
0.70		ECDGZER709	0.3
0.80		ECDGZER809	0.3
0.90		ECDGZER909	0.3
1.0	±0.1 pF (B)	ECDGZE1R0B	0.3
1.1		ECDGZE1R1B	0.3
1.2		ECDGZE1R2B	0.3
1.3		ECDGZE1R3B	0.3
1.5		ECDGZE1R5B	0.3
1.6		ECDGZE1R6B	0.3
1.8		ECDGZE1R8B	0.3
2.0		ECDGZE2R0B	0.3
2.2		ECDGZE2R2B	0.3
2.4		ECDGZE2R4B	0.3
2.7		ECDGZE2R7B	0.3
3.0		ECDGZE3R0B	0.3
3.3	±0.25 pF (C)	ECDGZE3R3C	0.3
3.9		ECDGZE3R9C	0.3
4.7		ECDGZE4R7C	0.3
5.6		ECDGZE5R6C	0.3

Packaging Style Code : "E" (T=0.3 mm) for Standard Packaging Quantity (15,000 pcs./reel)

■ Standard Products for EIA Size "0402", Taped Version

● Temperature Characteristics C0G

Rated voltage		DC 25 V	
Capacitance (pF)	Capacitance Tolerance	Part No.	Dim. T (mm)
0.10	±0.05 pF (8)	ECDG0ER108	0.5
0.20		ECDG0ER208	0.5
0.30		ECDG0ER308	0.5
0.40		ECDG0ER408	0.5
0.50		ECDG0ER508	0.5
0.60	±0.05 pF(8) or ±0.075 pF(9)	ECDG0ER60□	0.5
0.70		ECDG0ER70□	0.5
0.80		ECDG0ER80□	0.5
0.90		ECDG0ER90□	0.5
1.0	±0.1 pF (B)	ECDG0E1R0B	0.5
1.1		ECDG0E1R1B	0.5
1.2		ECDG0E1R2B	0.5
1.3		ECDG0E1R3B	0.5
1.5		ECDG0E1R5B	0.5
1.6		ECDG0E1R6B	0.5
1.8		ECDG0E1R8B	0.5
2.0		ECDG0E2R0B	0.5
2.2		ECDG0E2R2B	0.5
2.4		ECDG0E2R4B	0.5
2.7		ECDG0E2R7B	0.5
3.0		ECDG0E3R0B	0.5
3.3	±0.1 pF(B) or ±0.25 pF(C)	ECDG0E3R3□	0.5
3.9		ECDG0E3R9□	0.5
4.7		ECDG0E4R7□	0.5
5.6		ECDG0E5R6□	0.5
6.8		ECDG0E6R8□	0.5
8.2		ECDG0E8R2□	0.5
10.0	±0.25 pF	ECDG0E100C	0.5
12	±5 % (J)	ECDG0E120J	0.5
15		ECDG0E150J	0.5

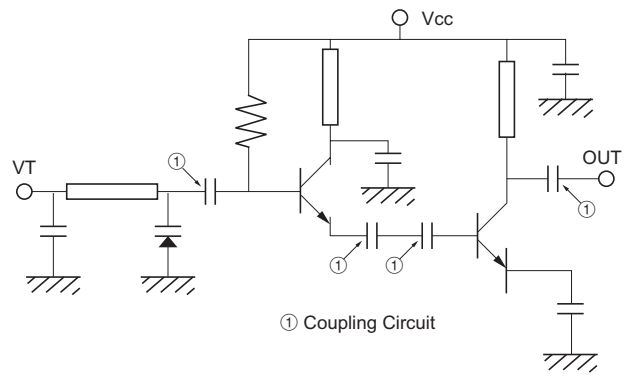
□ : Capacitance tolerance code.

Packaging Style Code : "E" (T=0.5 mm) for Standard Packaging Quantity (10,000 pcs./reel)

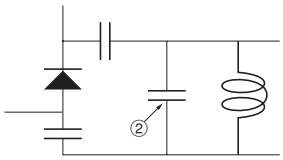
■ Application Examples

● RF Circuit

VCO

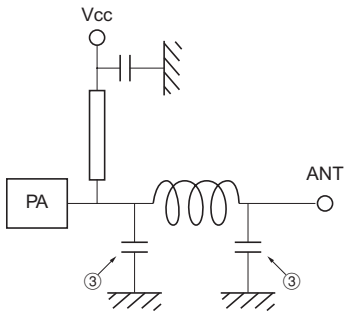


① Coupling Circuit



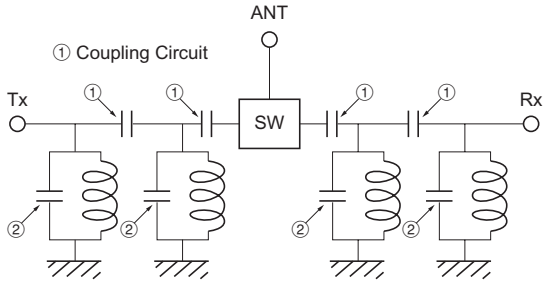
② Resonant Circuit

PA



③ Matching Circuit

Filter



② Resonant Circuit