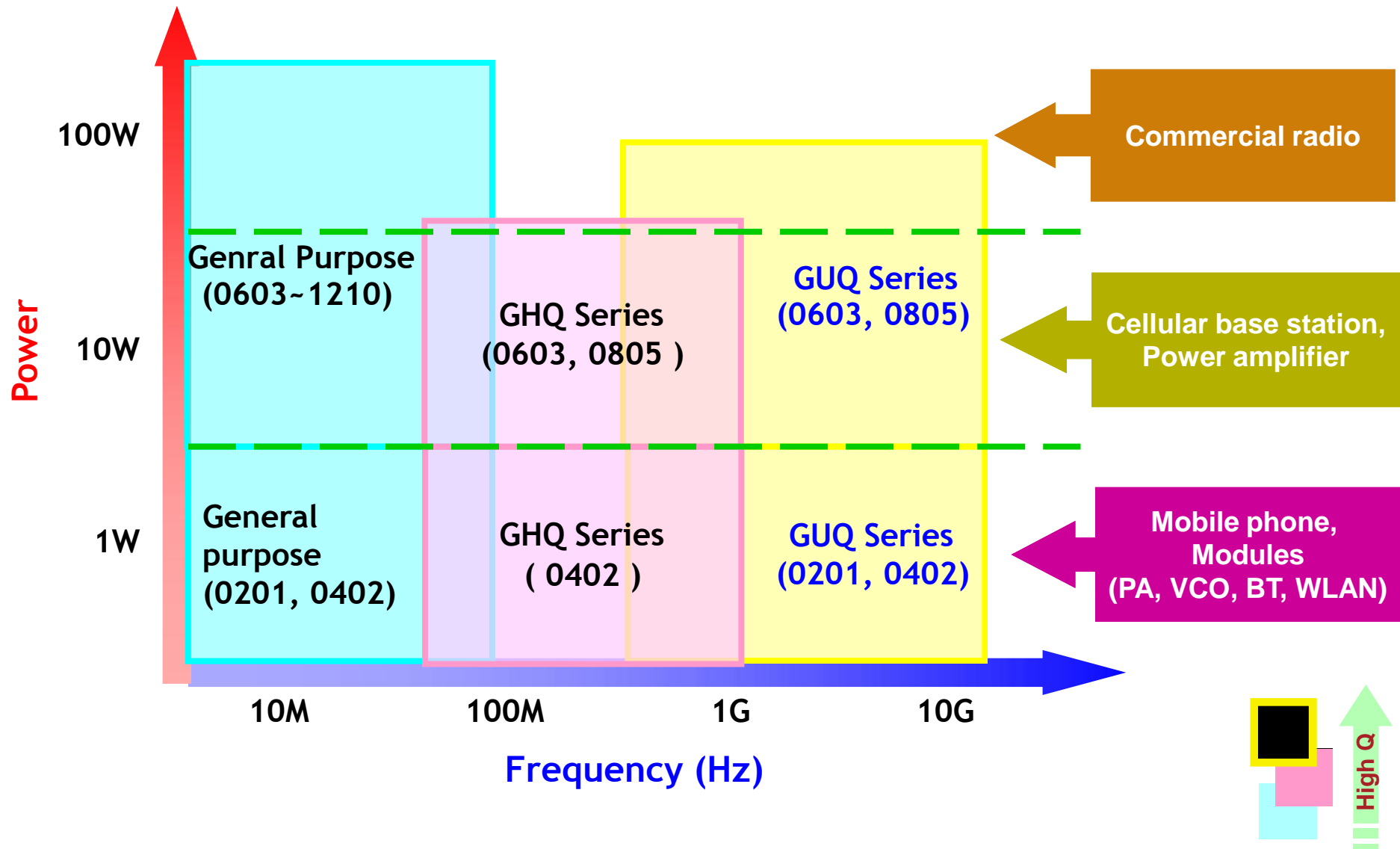


Introduces two new
High Q products

GHQ Series = High Q
GUQ Series = Ultra High Q

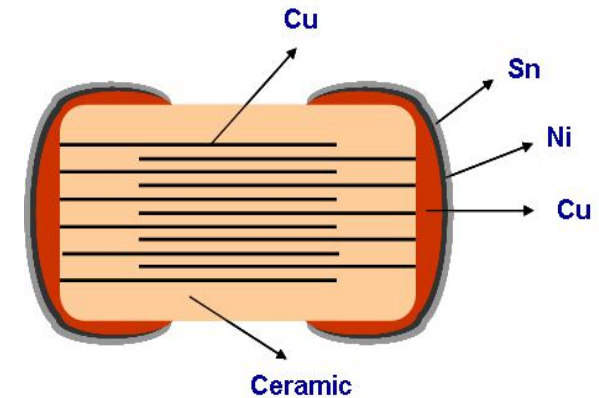
CALCHIP ELECTRONICS, INC.



Calchip Ultra-high Q/Low ESR (GUQ-MLCC)

Features:

- Made by BME technology with Cu inner electrodes.
- Excellent Q level at high frequency applications.
- Having high SRF characteristic.
- Offer ultra low capacitance to 0.1pF.
- Offer high precision capacitance tolerance to $\pm 0.05\text{pF}$

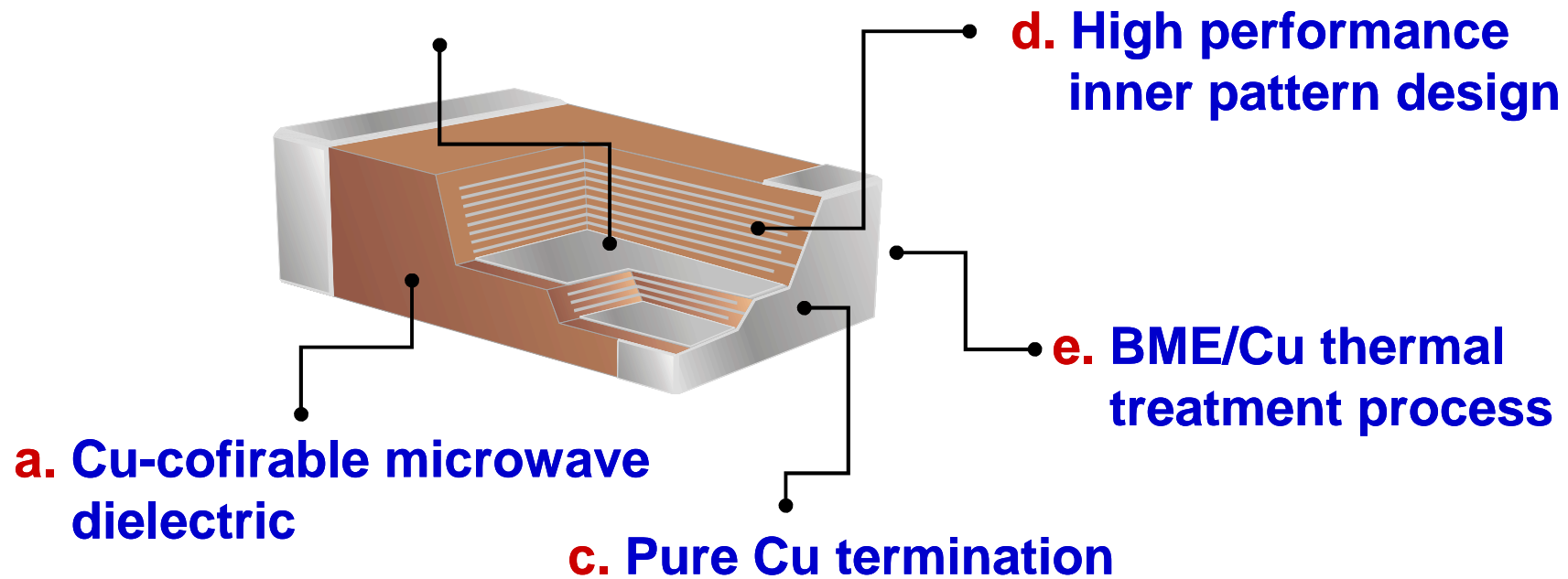


HOW TO ORDER

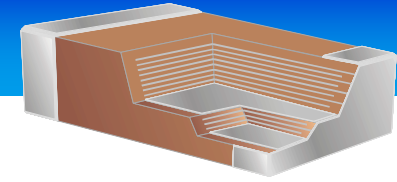
GUQ	10	CG	101	J	250	N	T
SERIES	SIZE	DIELECTRIC	CAPACITANCE	TOLERANCE	VOLTAGE	TERMINATION	PACKAGING
GUQ=Ultra High Q & Low ESR	02=0201 04=0402 10=0603 21=0805	CG = NP0 (C0G)	Two significant digits followed by no. of zeros. An R is in place of decimal point. eg.: 0R5=0.5pF 1R0=1.0pF 100=10pF	A= $\pm 0.05\text{pF}$ B= $\pm 0.1\text{pF}$ C= $\pm 0.25\text{pF}$ D= $\pm 0.5\text{pF}$ F= $\pm 1\%$ G= $\pm 2\%$ J= $\pm 5\%$	Two significant digits followed by no. of zeros. And R is in place of decimal point. 25=25 VDC 50=50 VDC 100=100 VDC 250=250 VDC	N=Cu/Ni/Sn	T = 7" reel TD = 13 reel

Core-technology of GUQ-MLCC

b. Pure Cu inner-electrode



Creativeness of CCE GUQ-MLCC



❑ **Copper co-firable dielectric recipe:**

**Copper electrode co-firable Ba-Ti-O microwave material
& its additives recipe**

❑ **Advanced Inner-electrode pattern design:**

Floating inner-electrode placement of MLCC

Modified T-type inner-electrode placement of MLCC

Precise capacitance control by electrode design of MLCC

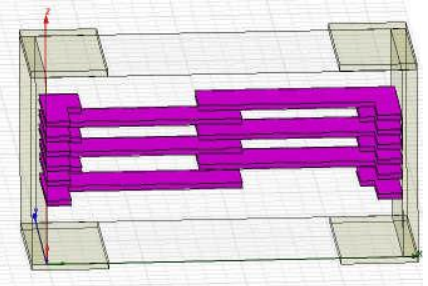
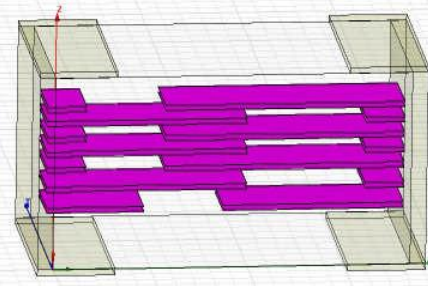
Advanced Floating inner-electrode placement of MLCC

❑ **Novel BME-Cu process**

**Novel BME process of MLCC Manufacture with
copper electrode**

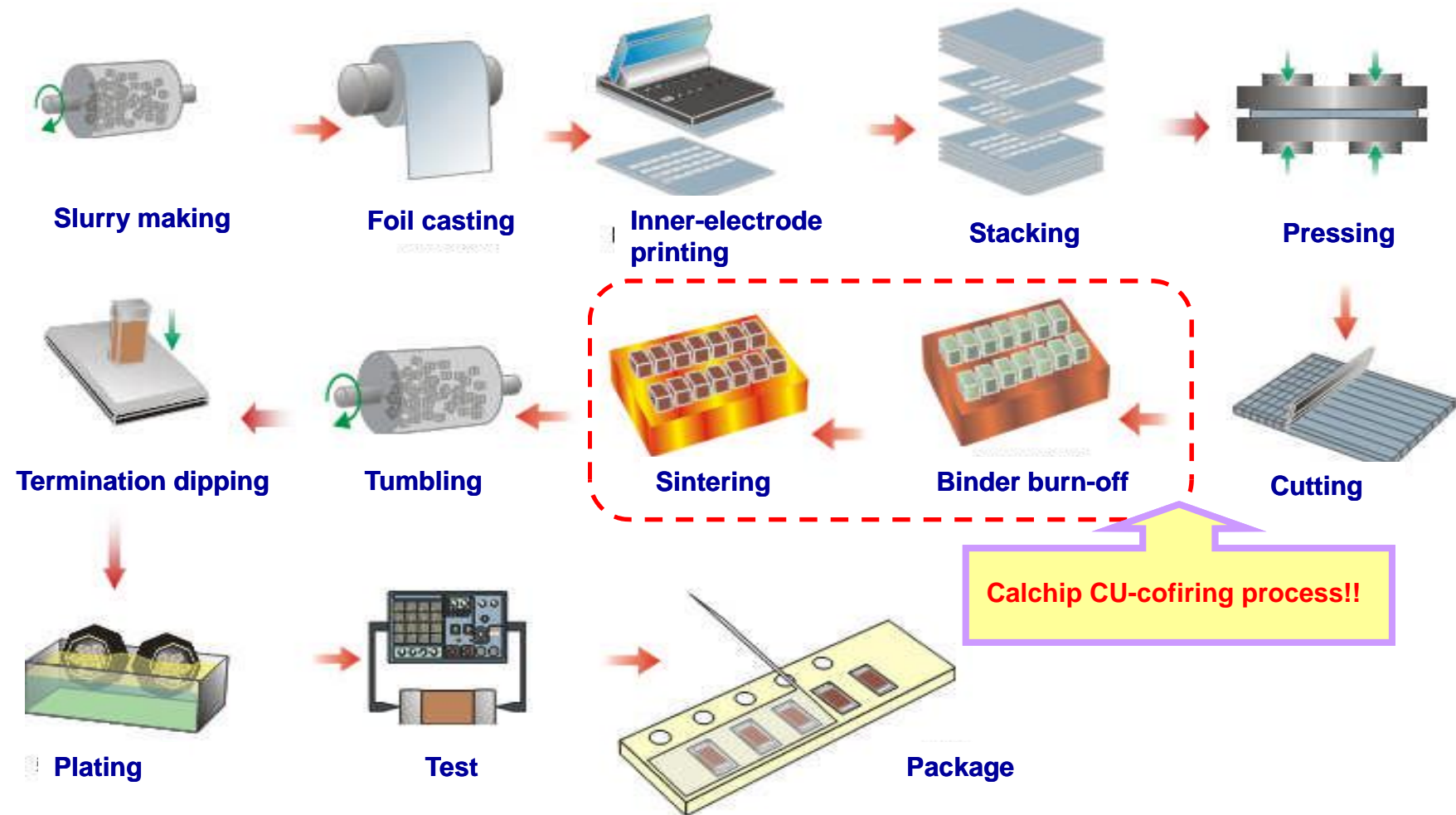
Creativeness of GUQ (Design & Material)

Product comparison (Calchip GUQ-type vs. Murata GJM-type)

Product	Inner-electrode Design	Ceramic composition	Inner-electrode composition
CCE-GUQ	<ol style="list-style-type: none"> 1. L-shape electrode 2. Stress balance design 3. Low-ESR design (for low cap) 	<p>Ba-Ti-O system with sintering aids* (H²-free protection sintering)</p>	Copper metal
			
Murata-GJM	<ol style="list-style-type: none"> 1. Cap-modified variable design 	<p>Ca-Zr-O system with Mn doped (H² reduction sintering)</p>	Copper metal
			

Creativeness of GUQ (Process)

❑ Process flow of Calchip GUQ-MLCC

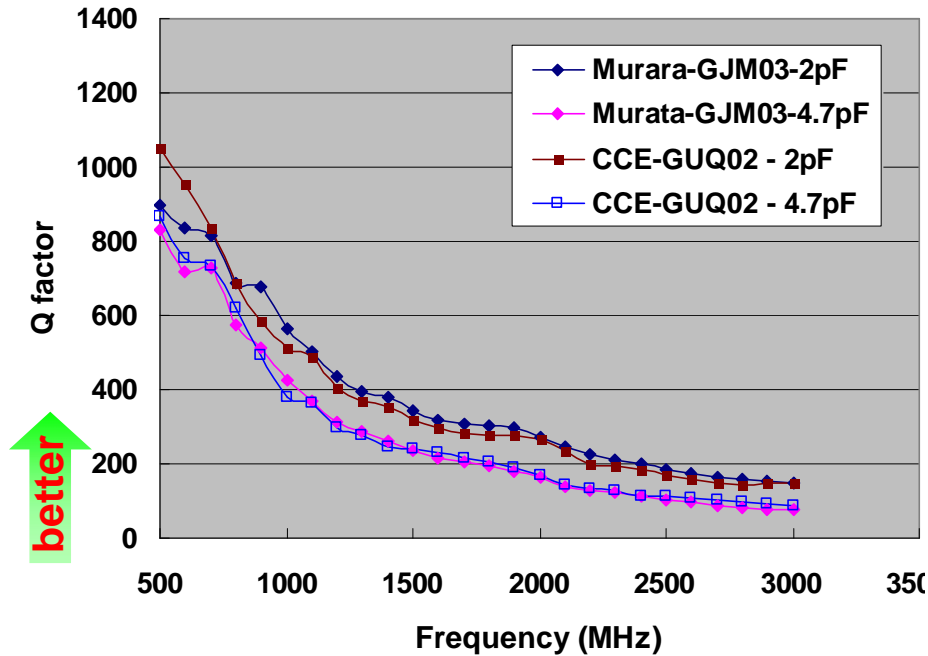


Product Range of GUQ-MLCC

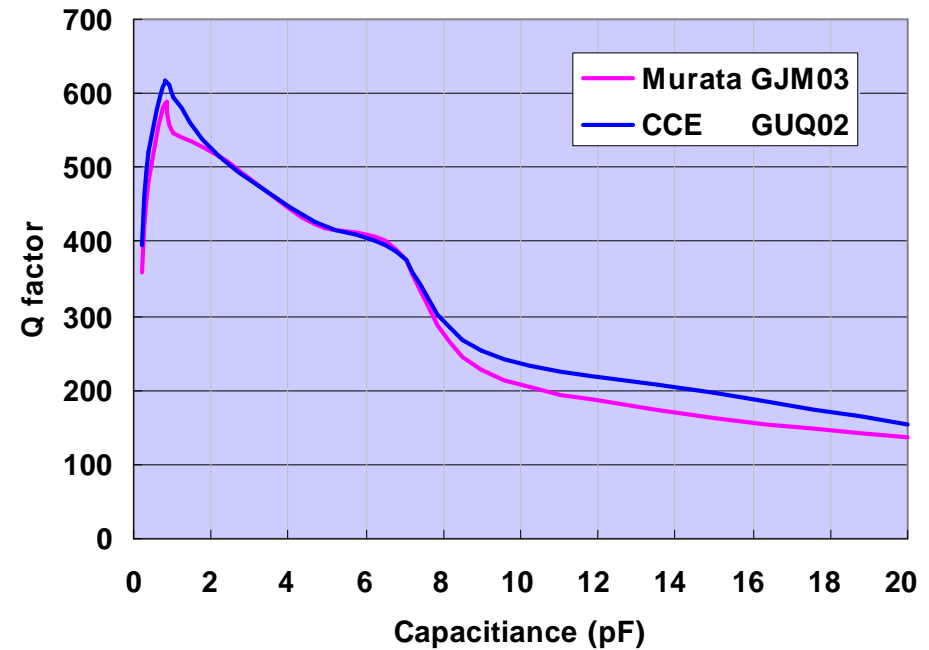
EIA size	0201					0402		0603					0805						
Product	GJM03		GUQ02		GJM15	GUQ04		GQM18			GUQ10		GQM21			GUQ21			
TC	COG/COH		COG/COH		COG	COG		COG			COG		COG			COG			
Rated Volt.	6.3V	25V	10V	25V	50V	50V	100V	50V	100V	250V	50V	100V	250V	50V	100V	250V	50V	100V	250V
Cap (pF)																			
0R1																			
1R0																			
10																			
20																			
40																			
100																			
Remark	22~ 33 pF	0R1~ 20 pF	22~ 33 pF	0R1~ 20 pF	0R1~ 20 pF	0R1~ 20 pF	0R1~ 10 pF	7R0~ 100 pF	0R2~ 6R8 pF	0R2~ 47 pF	0R2~ 100 pF	0R2~47 pF		20~ 100 pF	0R2~ 18 pF	0R2~ 100 pF	0R2~100 pF		

Q comparison (GUQ02 vs. GJM03, $\leq 3\text{GHz}$)

(a) 2pF & 4.7pF, 0.5~3GHz



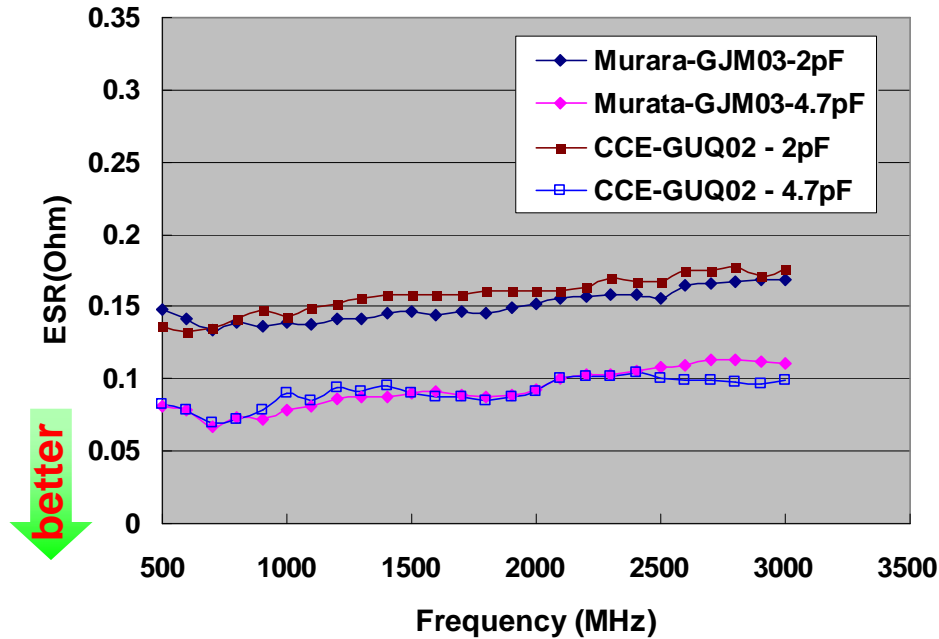
(b) Different capacitance at 1GHz



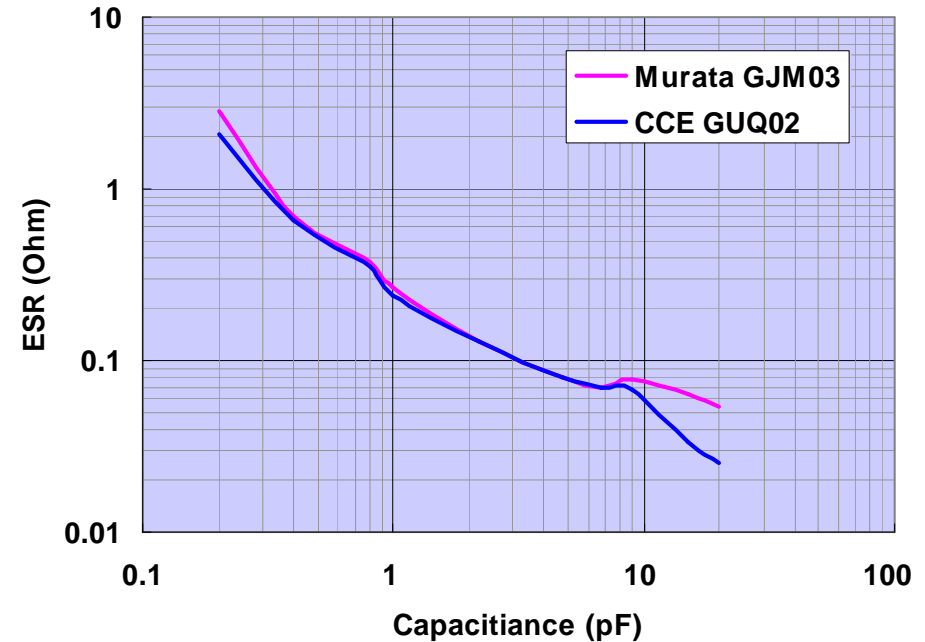
- Q factor of CCE-GUQ02's are similar or better levels than Murata-GJM03 products measured by LCR meter.

ESR comparison (GUQ02 vs. GJM03, $\leq 3\text{GHz}$)

(a) 2pF & 4.7pF, 0.5~3GHz



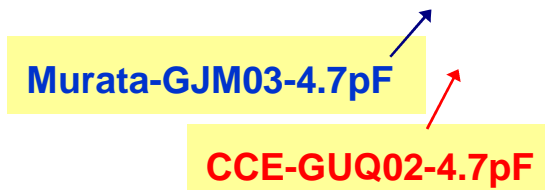
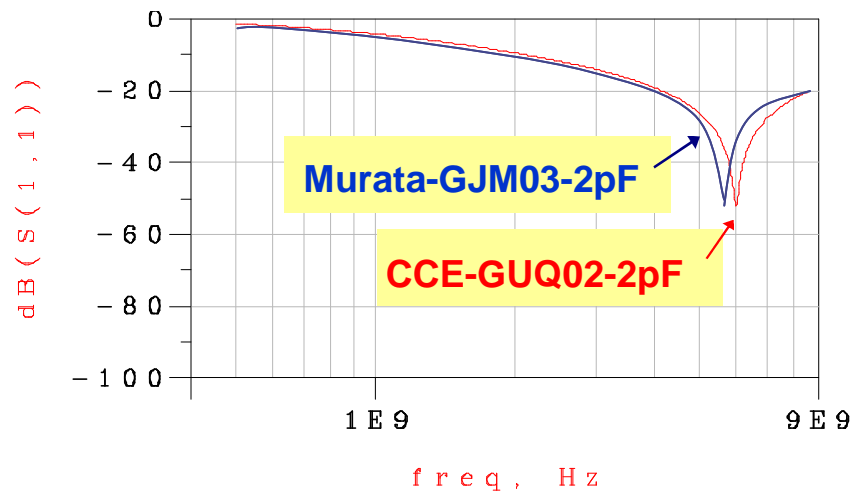
(b) Different capacitance at 1GHz



- ESR of CCE-GUQ02's are similar or better levels than Murata-GJM03 products measured by LCR meter.

SRF comparison (GUQ02 vs. GJM03, $\leq 8.5\text{GHz}$)

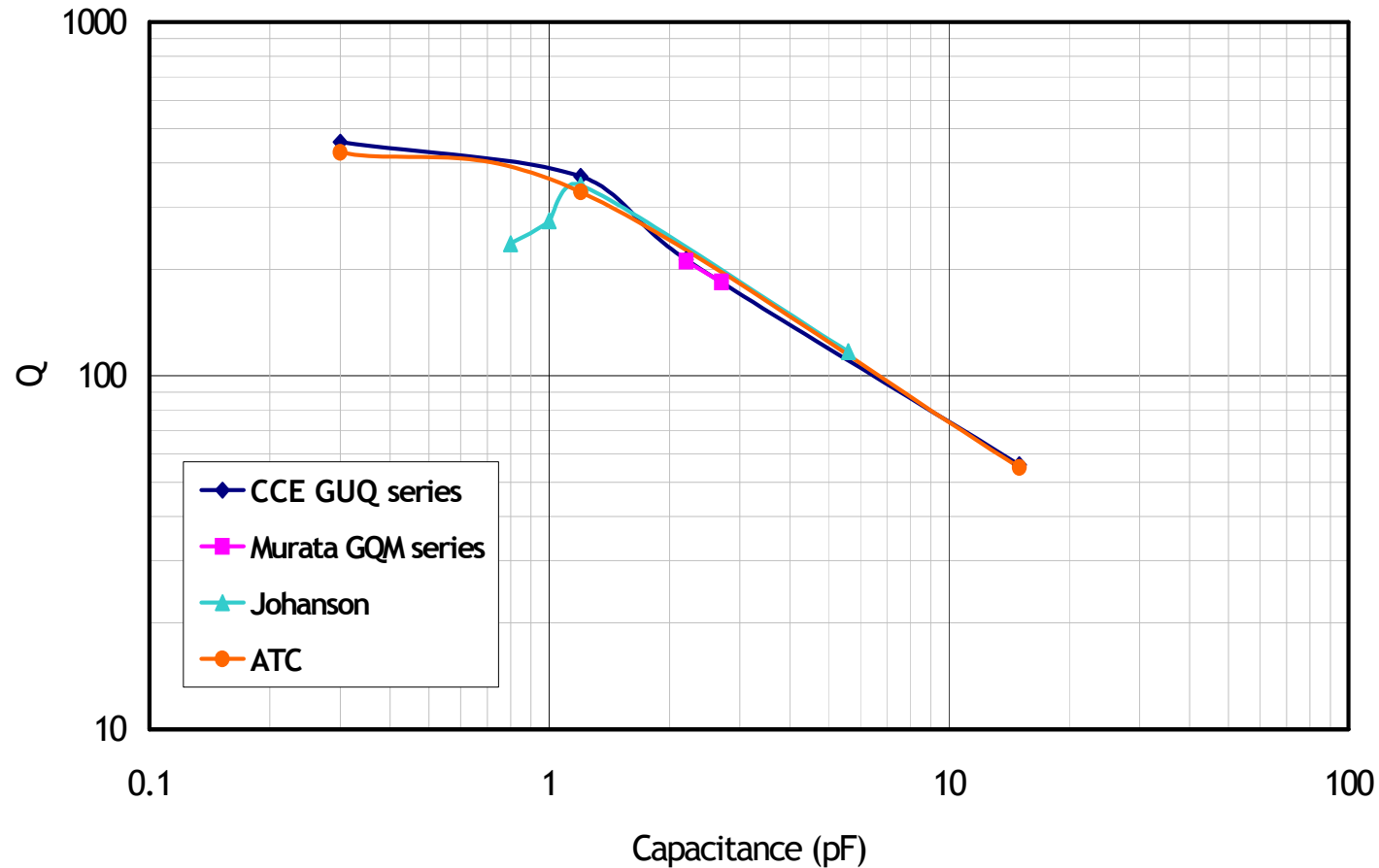
0201 size			
NO	Cap (pF)	SRF (MHz)	
		CCE	Murata
1	0.1	NA	NA
2	0.2	NA	NA
3	0.4	NA	NA
4	0.5	NA	NA
5	0.8	NA	NA
6	1	8150	7650
7	1.2	7400	6680
8	1.5	7280	6007
9	1.8	6630	5592
10	2	5990	5365
11	2.7	5350	4449
12	3.3	4550	4054
13	3.9	4210	3791
14	4	4070	3735
15	4.7	3690	3461
16	5.6	3210	1318
17	6.8	3040	2943
18	8.2	2610	2577
19	9	2570	2484
20	10	2480	2329
21	12	2030	2188
22	18	1830	1784



- The SRF level of CCE-GUQ02 & Murata-GJM03 are also close, but GUQ02 still slightly high.

Comparison of GUQ10/250V with competitors

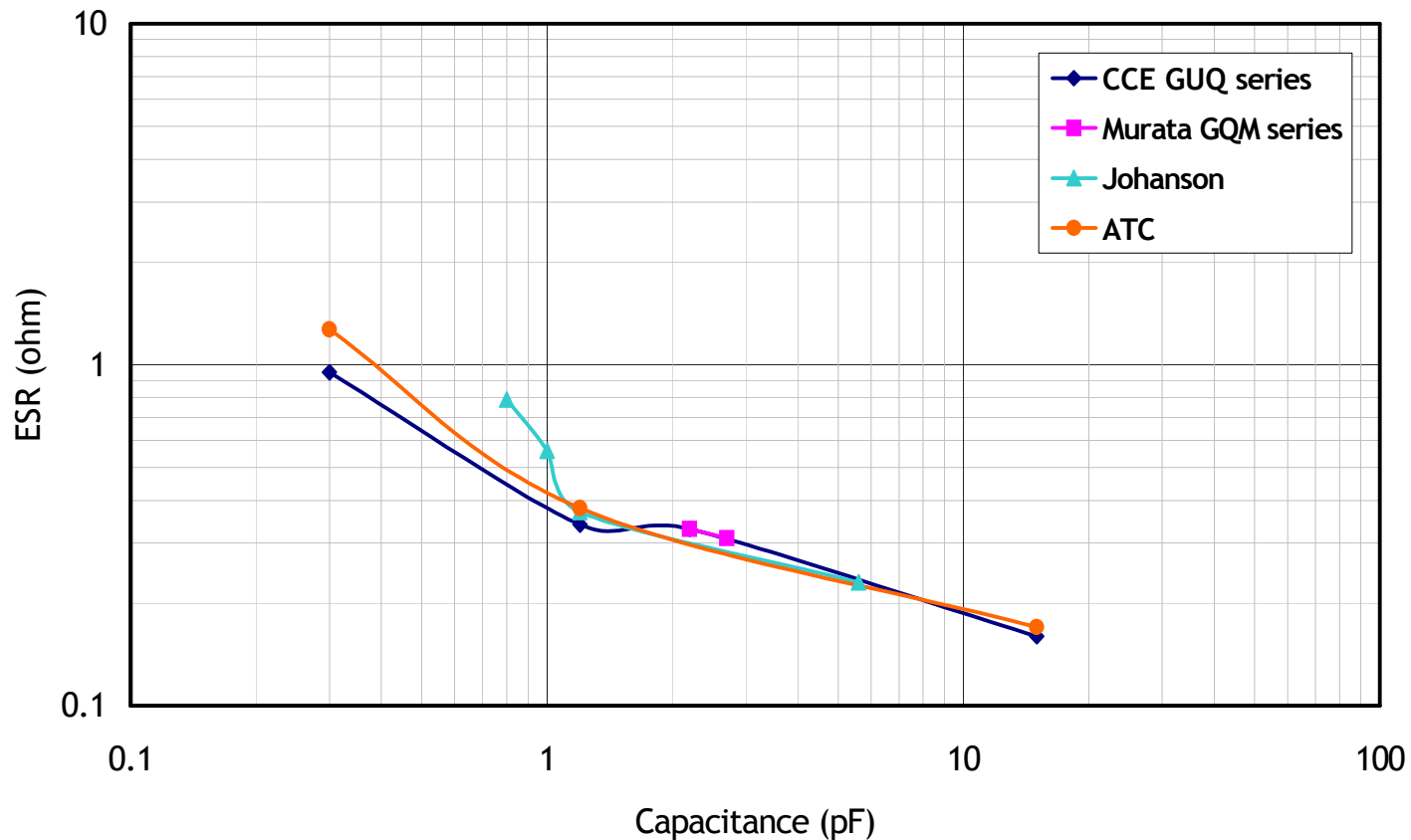
HQ 0603, NPO, 250V (@ 1GHz)



- CCE's high voltage "GUQ" series MLCC has similar Q performances to competitive products in high frequency performance.

Comparison of GUQ10/250V with competitors

HQ 0603, NPO, 250V (@ 1GHz)



- CCE's high voltage "GUQ" series MLCC has similar ESR performances to competitive products in high frequency performance.

Summary

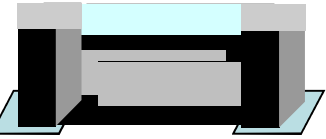


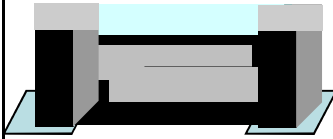
Product range & performance:

- CCE can provide same product range to replace muRata GJM/GQM series.
- CCE GUQ series perform similar HF property with muRata GJM series.

Key technology:

- COG dielectric ceramic (cofirable with Cu)
- Pure Cu Termination & Innerelectrode
- N² protection binder burn-out & sintering - Cu cofiring process

Capacitance Measurement with Different Directions

Size	0402		C (pF)	0201	
C (pF)	Vertical to Inner-electrode 	Parallel to Inner-electrode 		Vertical to Inner-electrode 	Parallel to Inner-electrode 
0.5	0.50	0.50	0.5	0.50	0.50
1	1.02	1.01	1	1.00	1.00
5	4.99	5.00	1.5	1.50	1.49
10	10.01	10.00	2	2.01	2.01
15	14.99	14.98	2.2	2.15	2.16
20	20.05	20.05	3	2.99	2.99

Balance design have been adopted

$\Delta C = 0.1 \text{ pF max}$

$$f_s = \frac{1}{2\pi\sqrt{L_s C}}$$

& $\Delta C = 0.1 \text{ pF max}$



$\Delta f_s = 0.01 \text{ GHz max}$

f_s : self-resonant frequency

◆ **Conclusion : No significant capacitance discrepancies between different measuring directions of GUQ-MLCC.**

CCE NPO-MLCC specifications in mid-high frequency

Product	GUQ series	GHQ series	General purpose
Dimension	0201~ 0805	0201~ 0805	0201~1812
Rated voltage	25~250V	25~100V	25~630V
Dielectric	BaTiO compound	BaTiO compound / BaNdTiO compound/ SrCaZrTiO compound	BaTiO compound / SrCaZrTiO compound
Inner electrode	Cu	Pd-Ag / Ni	Ni / Pd-Ag
Termination	Cu-Ni-Sn	Ag-Ni-Sn / Cu-Ni-Sn	Cu-Ni-Sn / Ag-Ni-Sn
Application frequency	500MHz~10GHz	100MHz~1GHz	1MHz~100MHz
Capacitance range	0.1~100pF	0.1~1000pF	0.1~10000pF