

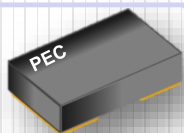


汎翊國際有限公司

FLYING888 INTERNATIONAL CO.,LTD



Wire-bondable Cap



High Frequency Cap



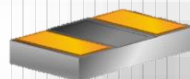
Ultra Broadband Cap



Variable Cap



Ultra Low ESL Cap



Varactor

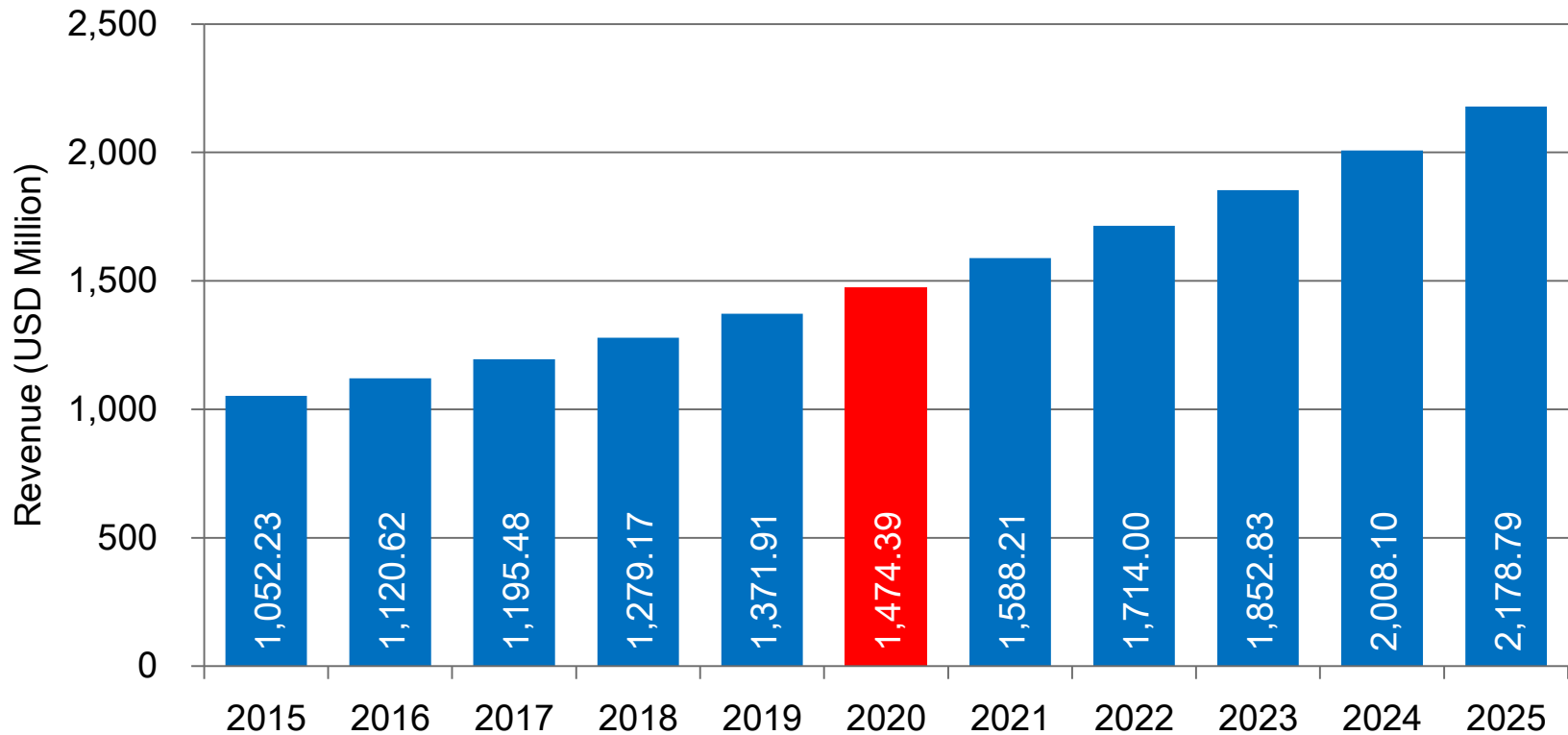
Aug.-2020

Agenda

- **Global Silicon Capacitors Market**
- **Silicon Capacitors Characteristic**
- **Broadband & High Frequency Characteristic**
- **Applications & Product Roadmap**

Global Silicon Capacitor Market

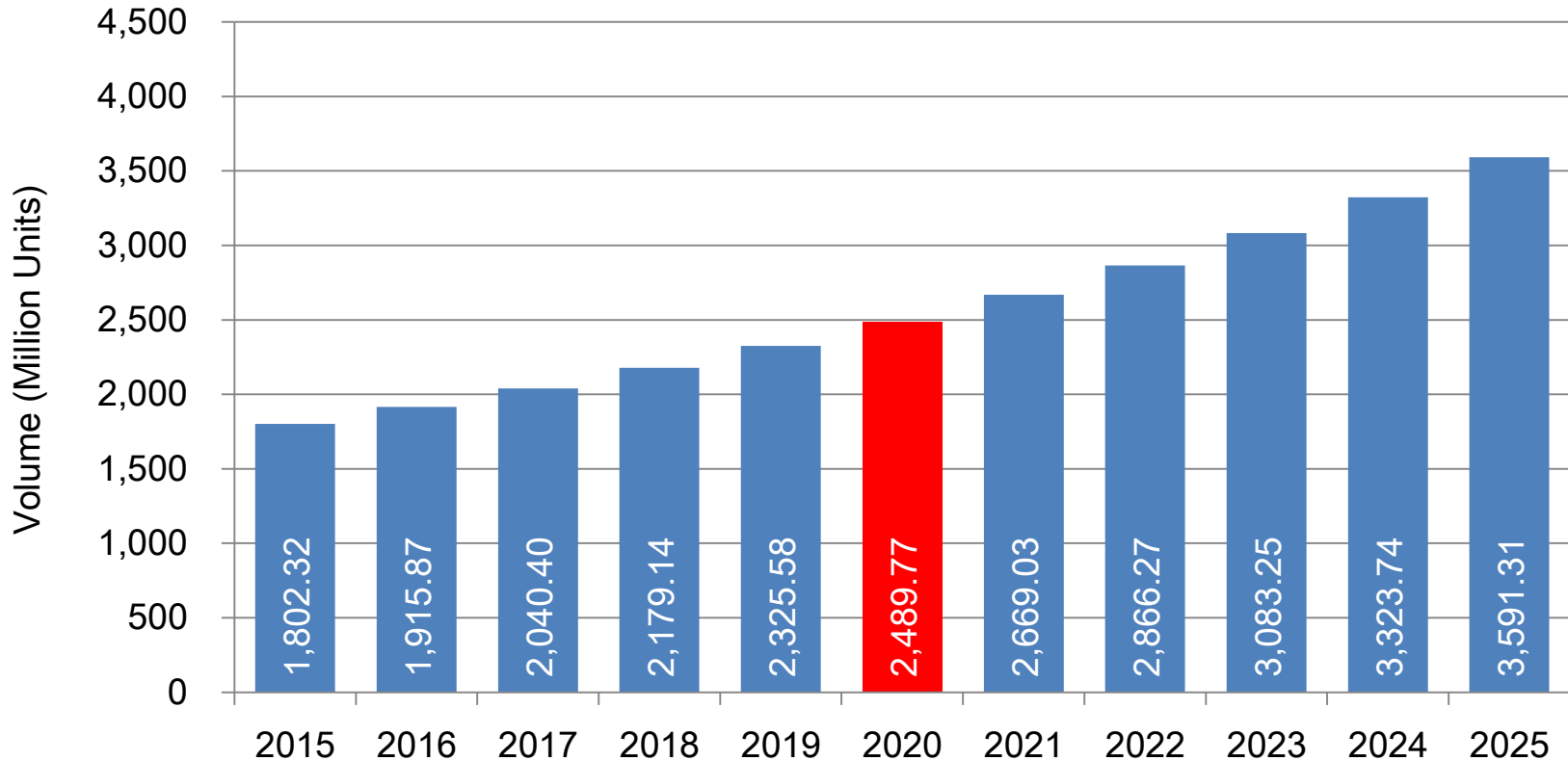
1.1 Global Silicon Capacitor Market Share, 2015-2025 (USD Million)



Source: Market Research Store, 2020

Global Silicon Capacitor Market

1.2 Global Silicon Capacitor Market Share, 2015-2025 (Million Units)



* ASP: USD\$0.592 @2020

Source: Market Research Store, 2020

Global Silicon Capacitor Market

2.1 Global Silicon Capacitor Market Share, by Structure 2015-2025 (USD Million)

	2015	2016	2017	2018	2019	2020
Deep-trench Capacitor	498.30	531.58	568.03	608.80	654.02	704.04
MNOS Capacitor	342.70	364.64	388.65	415.47	445.19	478.01
MIS Capacitor	211.23	224.41	238.81	254.89	272.70	292.34
Total	1,052.23	1,120.62	1,195.48	1,279.17	1,371.91	1,474.39

	2021	2022	2023	2024	2025	CAGR (20-25)
Deep-trench Capacitor	759.64	821.16	889.13	965.23	1,048.99	8.30%
MNOS Capacitor	514.44	554.68	599.06	648.66	703.16	8.02%
MIS Capacitor	314.13	338.16	364.64	394.20	426.64	7.85%
Total	1,588.21	1,714.00	1,852.83	2,008.10	2,178.79	8.12%

Source: Market Research Store, 2020

Global Silicon Capacitor Market

2.2 Global Silicon Capacitor Market Share, by Structure 2015-2025 (Million Units)

	2015	2016	2017	2018	2019	2020
Deep-trench Capacitor	854.11	909.43	970.15	1,037.84	1,109.42	1,189.71
MNOS Capacitor	586.45	623.96	665.12	711.00	759.46	813.82
MIS Capacitor	361.76	382.48	405.12	430.31	456.70	486.24
Total	1,802.32	1,915.87	2,040.40	2,179.14	2,325.58	2,489.77

	2021	2022	2023	2024	2025	CAGR (20-25)
Deep-trench Capacitor	1,277.47	1,374.14	1,480.59	1,598.70	1,730.23	7.78%
MNOS Capacitor	873.20	938.58	1,010.54	1,090.35	1,179.18	7.70%
MIS Capacitor	518.36	553.56	592.12	634.70	681.89	7.00%
Total	2,669.03	2,866.27	3,083.25	3,323.74	3,591.31	7.60%

ASP: @2020

- Deep-Trench: USD\$0.592
- MNOS: USD\$0.587
- MIS: USD\$0.601

Source: Market Research Store, 2020

Global Silicon Capacitor Market

3.1 Global Silicon Capacitor Market Share, by Sales Channel 2015-2025 (USD Million)

	2015	2016	2017	2018	2019	2020
Online	354.78	378.28	404.02	432.8	464.72	500.01
Offline	697.45	742.35	791.47	846.37	907.19	974.37
Total	1,052.23	1,120.62	1,195.48	1,279.17	1,371.91	1,474.39

	2021	2022	2023	2024	2025	CAGR (20-25)
Online	539.24	582.62	630.55	684.18	743.19	8.25%
Offline	1,048.97	1,131.37	1,222.28	1,323.92	1,435.60	8.06%
Total	1,588.21	1,714.00	1,852.83	2,008.10	2,178.79	8.12%

Source: Market Research Store, 2020

Global Silicon Capacitor Market

3.2 Global Silicon Capacitor Market Share, by Sales Channel 2015-2025 (Million Units)

	2015	2016	2017	2018	2019	2020
Online	607.61	646.64	689.48	737.22	787.68	844.27
Offline	1,194.71	1,269.22	1,350.92	1,441.92	1,537.91	1,645.50
Total	1,802.32	1,915.87	2,040.40	2,179.14	2,325.58	2,489.77

	2021	2022	2023	2024	2025	CAGR (20-25)
Online	906.11	974.2	1,049.16	1,132.30	1,224.86	7.73%
Offline	1,762.93	1,892.08	2,034.09	2,191.45	2,366.44	7.54%
Total	2,669.03	2,866.27	3,083.25	3,323.74	3,591.31	7.60%

Source: Market Research Store, 2020

Global Silicon Capacitor Market

4.1 Global Silicon Capacitor Market Share, by End User, 2015-2025 (USD Million)

	2015	2016	2017	2018	2019	2020
Automotive	218.49	232.8	248.47	265.99	285.4	306.87
Telecommunication	374.62	399.3	426.33	456.55	490.05	527.09
Healthcare	256.46	274.01	293.26	314.79	338.7	365.16
Aerospace & Defense	160.75	170.32	180.75	192.4	205.26	219.44
Others	41.92	44.2	46.68	49.44	52.49	55.83
Total	1,052.23	1,120.62	1,195.48	1,279.17	1,371.91	1,474.39

	2021	2022	2023	2024	2025	CAGR (20-25)
Automotive	330.72	357.08	386.18	418.74	454.55	8.17%
Telecommunication	568.25	613.77	664.03	720.27	782.13	8.21%
Healthcare	394.6	427.2	463.26	503.67	548.19	8.47%
Aerospace & Defense	235.13	252.4	271.38	292.55	315.7	7.55%
Others	59.51	63.55	67.97	72.88	78.21	6.98%
Total	1,588.21	1,714.00	1,852.83	2,008.10	2,178.79	8.12%

Source: Market Research Store, 2020

Global Silicon Capacitor Market

4.1 Global Silicon Capacitor Market Share, by End User, 2015-2025 (Million Units)

	2015	2016	2017	2018	2019	2020
Automotive	374.22	397.98	424.05	453.1	483.78	518.18
Telecommunication	641.62	682.6	727.58	777.69	830.64	890.02
Healthcare	439.14	468.31	500.36	536.1	573.96	616.44
Aerospace & Defense	275.48	291.33	308.66	327.93	348.13	370.75
Others	71.87	75.64	79.75	84.32	89.07	94.38
Total	1,802.32	1,915.87	2,040.40	2,179.14	2,325.58	2,489.77

	2021	2022	2023	2024	2025	CAGR (20-25)
Automotive	555.75	597.1	642.61	693.06	749.2	7.65%
Telecommunication	954.89	1,026.30	1,104.90	1,192.07	1,289.09	7.69%
Healthcare	662.93	714.17	770.66	833.39	903.31	7.94%
Aerospace & Defense	395.34	422.3	451.84	484.47	520.64	7.03%
Others	100.12	106.39	113.23	120.75	129.06	6.46%
Total	2,669.03	2,866.27	3,083.25	3,323.74	3,591.31	7.60%

Source: Market Research Store, 2020



Silicon Capacitors Characteristic

Silicon Capacitors Characteristic

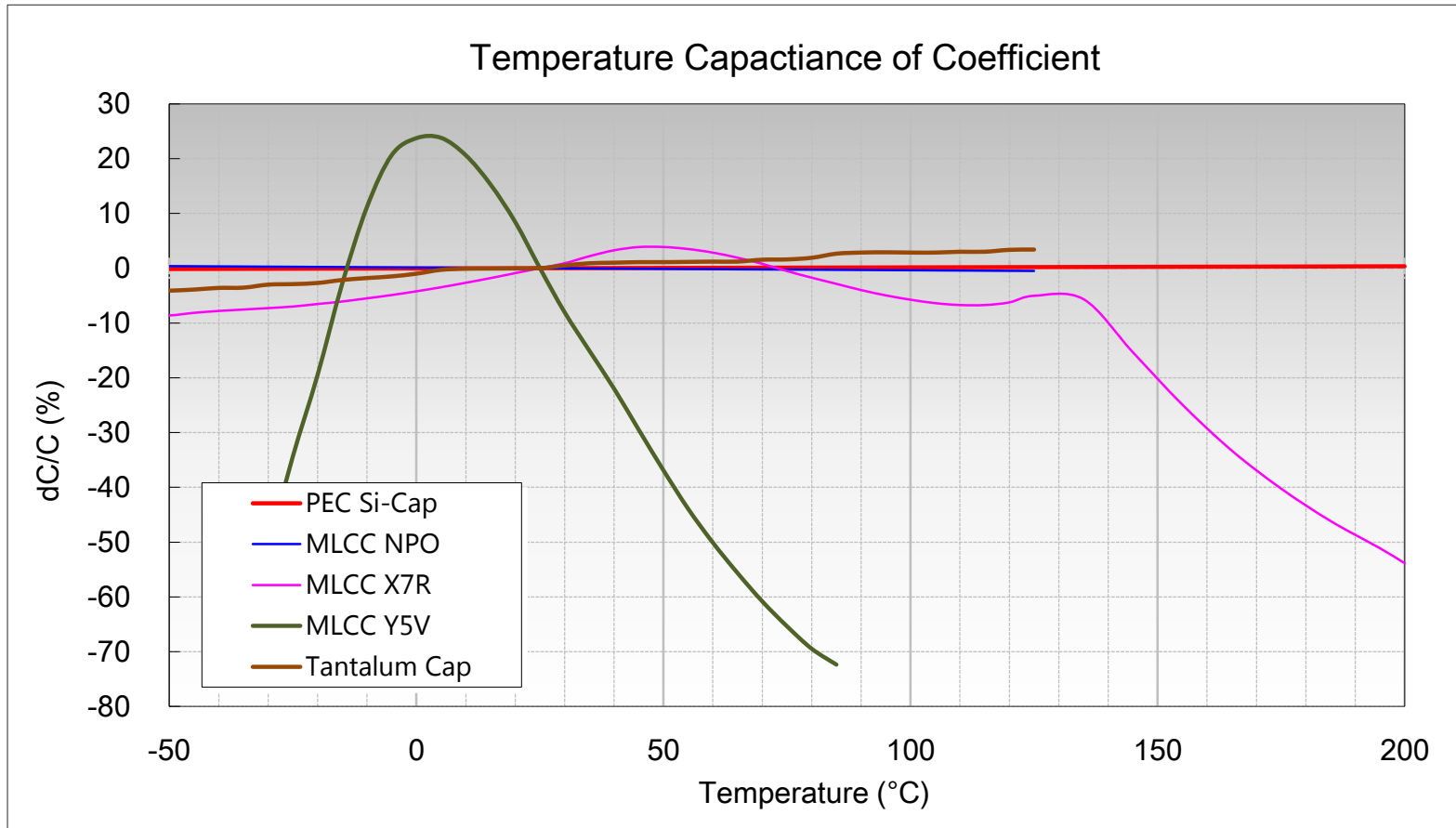
Features

- ✓ Ultra miniature size that less than **008004 (0.250x0.125mm)**
- ✓ High Stability Capacitance and Tight Tolerance
- ✓ MOS Process that for **High Reliability** Capacitors
- ✓ Automotive High/Extreme Temperature Capacitors - **UP to 200°C/250°C**
- ✓ Low Profile Capacitors -**80um** thickness (on request)
- ✓ Ultra Broadband SMD/Wire-Bondable Capacitors -**UP to 40GHz+**
- ✓ **Ultra Low ESR** and **Ultra Low ESL** Capacitors for high speed data systems
- ✓ Suitable for **Customer Design**



Silicon Capacitors Characteristic

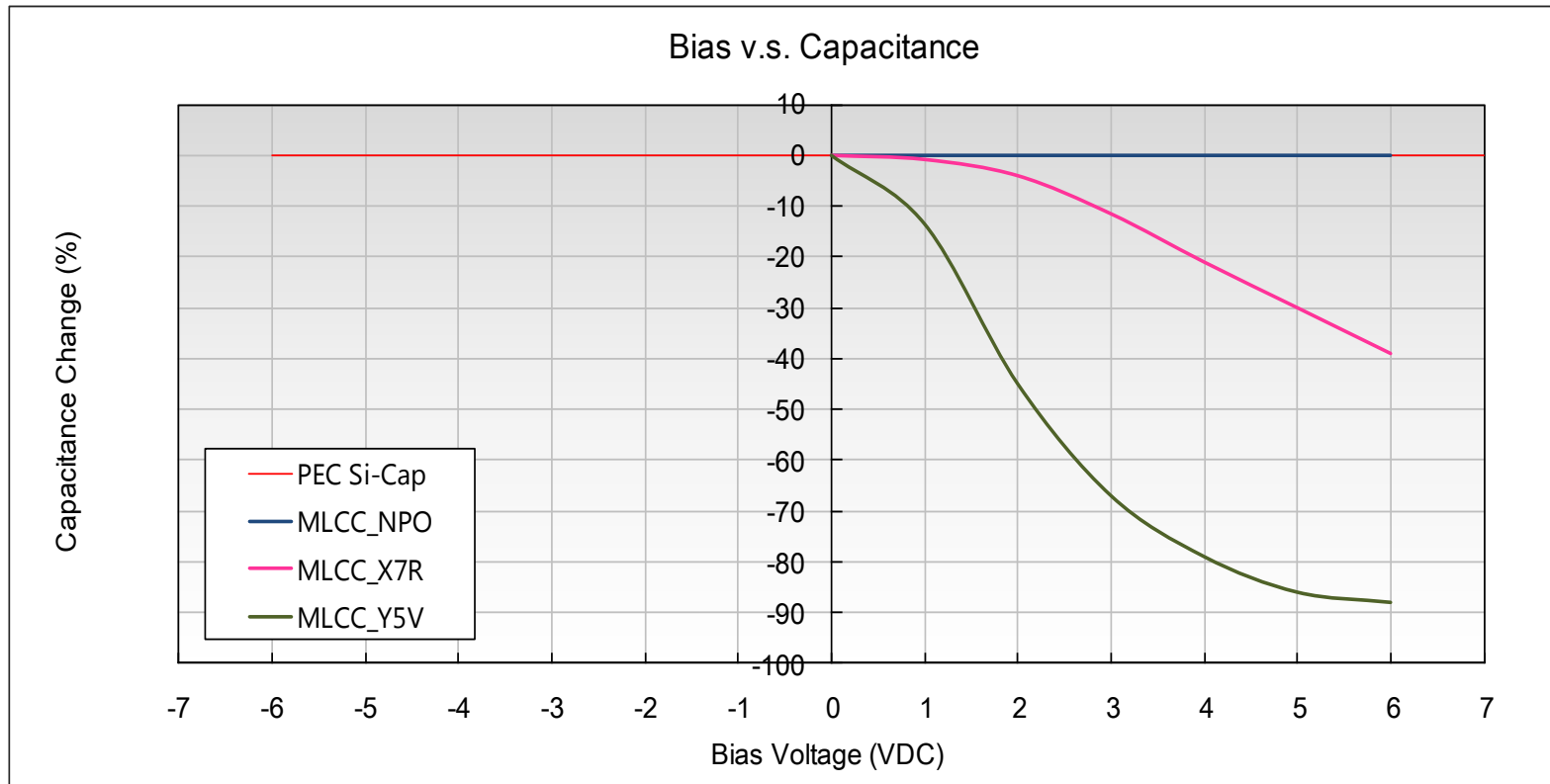
Temperature Coefficient



Temperature Coefficient performances comparisons

Silicon Capacitors Characteristic

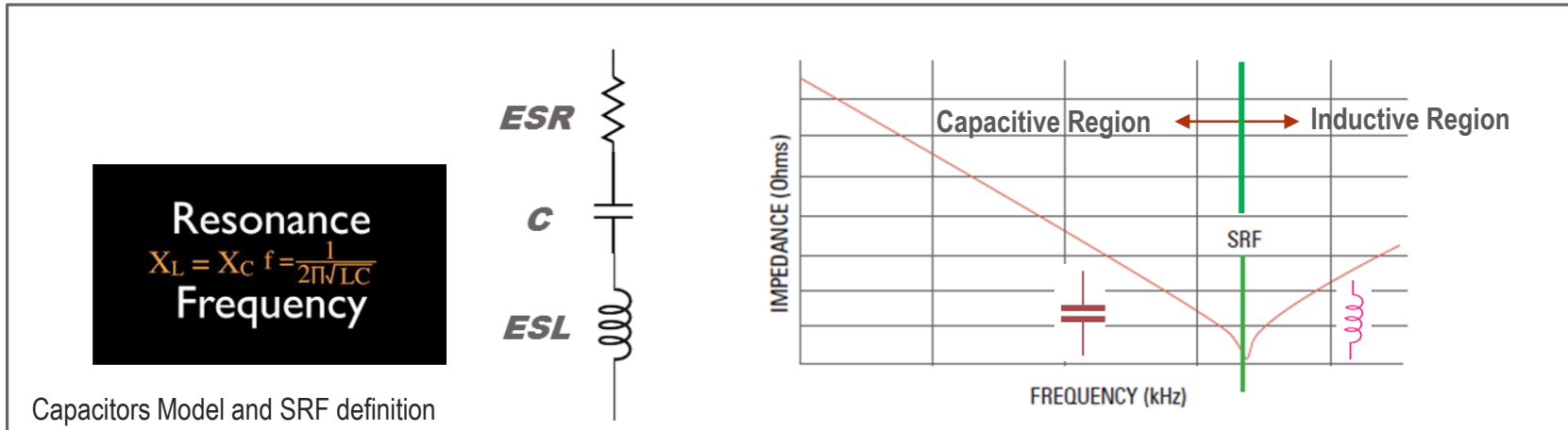
DC Bias Characteristic



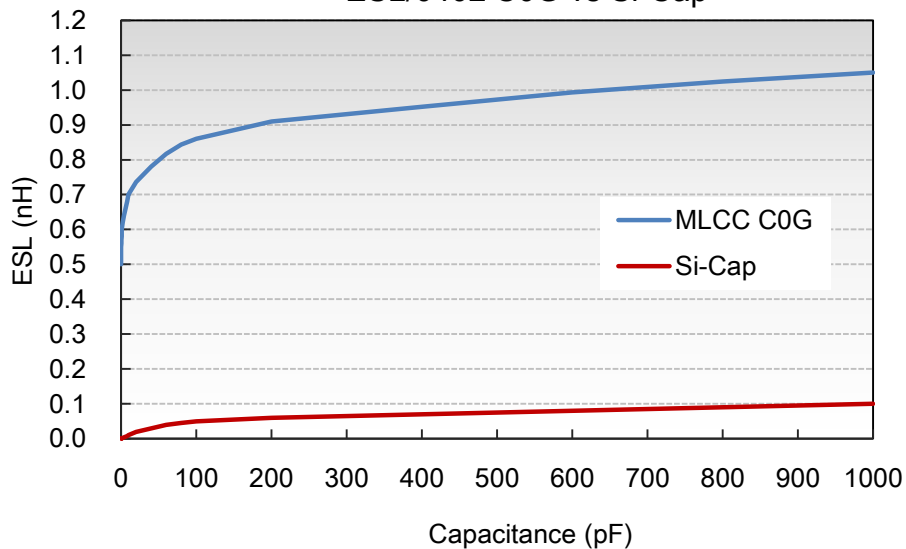
DC Bias stability performances comparisons

Silicon Capacitors Characteristic

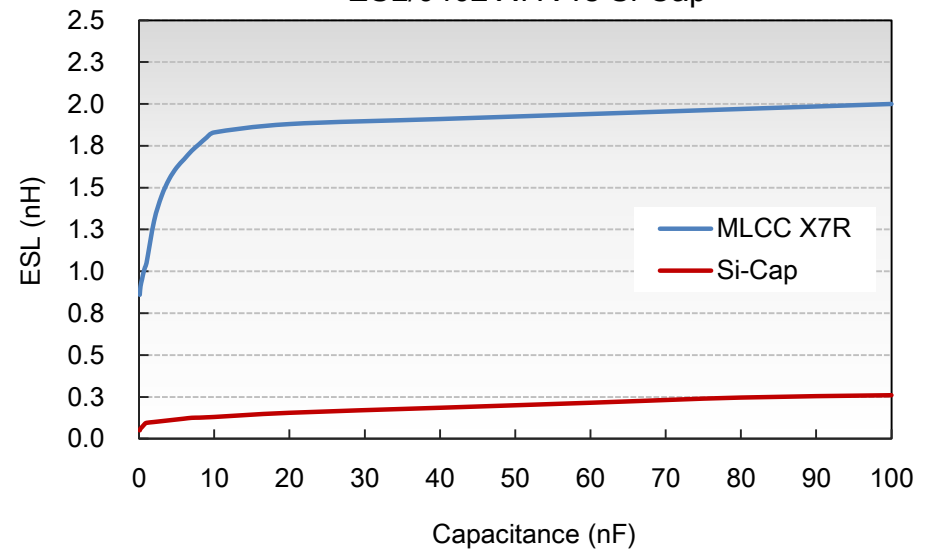
ESL Characteristic of MLCC vs Si-Cap



ESL/0402 C0G vs Si-Cap



ESL/0402 X7R vs Si-Cap

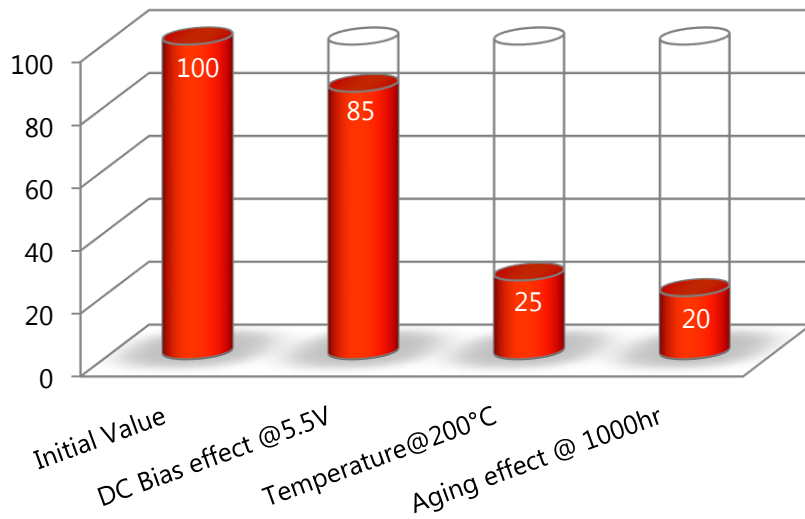


Silicon Capacitors Characteristic

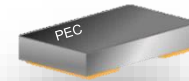
Si-Cap v.s. MLCC X8S Dielectric Capacitance Change



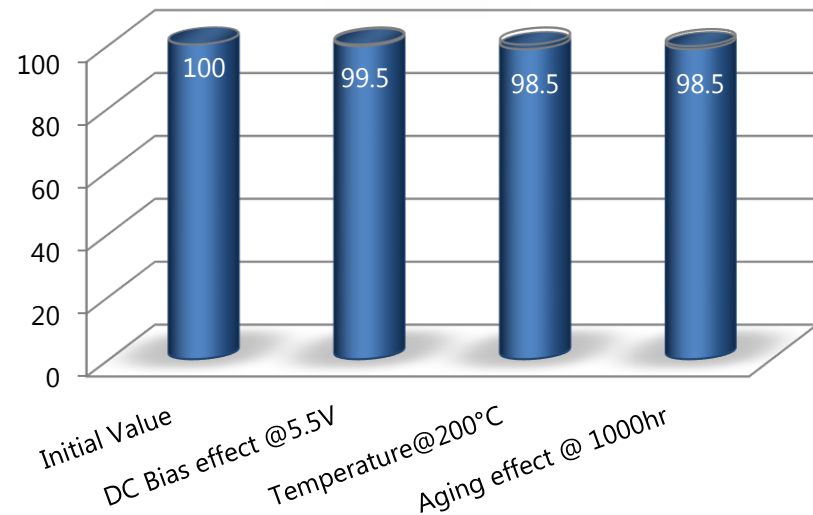
MLCC 0402/X8S/100nF



X8S 0402 100nF Capacitors the cumulate de-rating @200°C around -80%



Si-Cap 0402/100nF

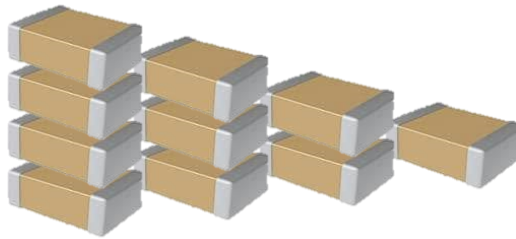


100nF Si-Cap in 0402 instead of
-470nF X8S in 0402 OR
-100nF NPO in 1206

Silicon Capacitors Characteristic

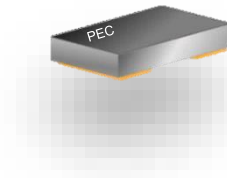
Space Saving Comparison

Space saving on boards thanks to PEC capacitors density



Class I ,NPO/COG MLCC
0603/10nF x10 pcs

=



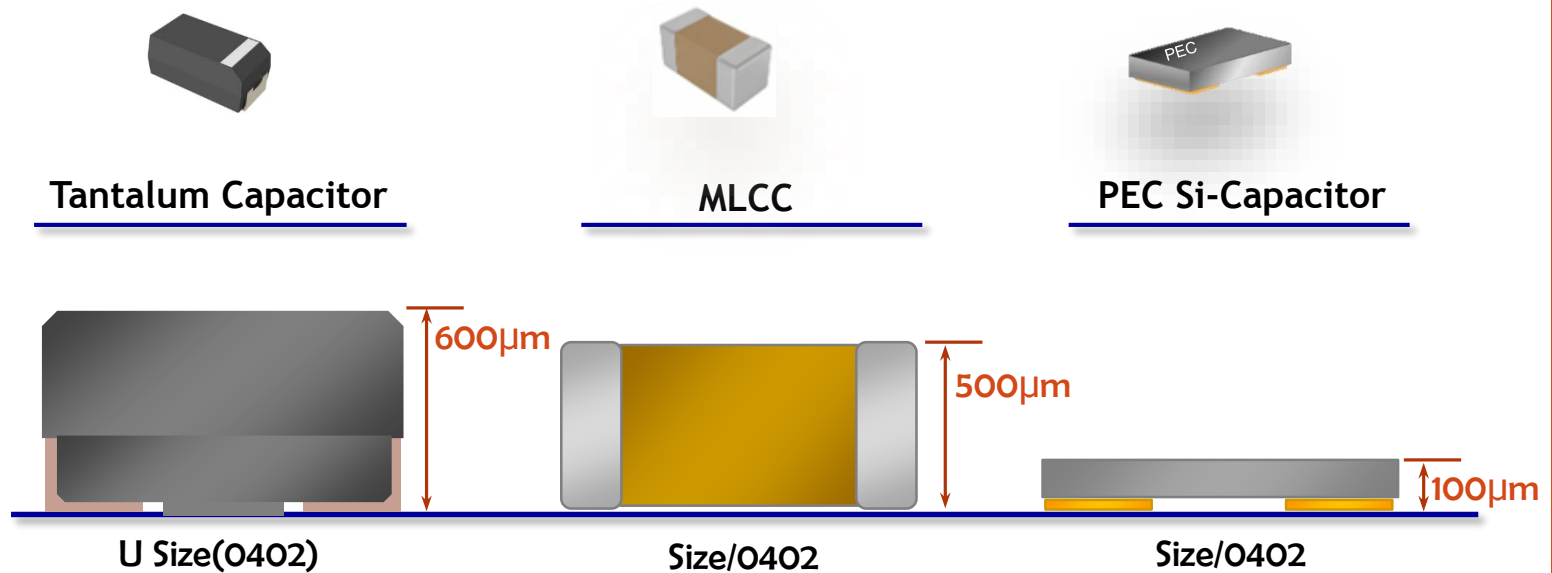
Si-Capacitors
0402/100nF x 1pcs

High density capacitance are space saving

Silicon Capacitors Characteristic

Tantalum, MLCC & Si-Capacitors of thickness comparison

The lowest profile: Si-Cap vs. MLCC and Tantalum capacitors

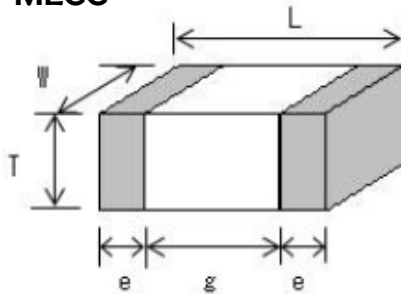


Si-Cap Thickness - 400um, 250um, 100um and below (**80um on request**)

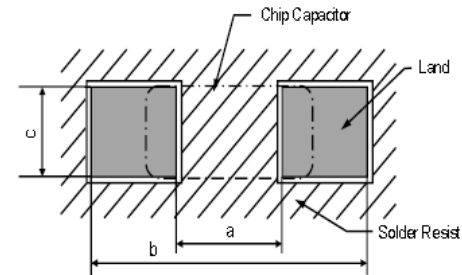
Silicon Capacitors Characteristic

JEDEC Compatible Land Design

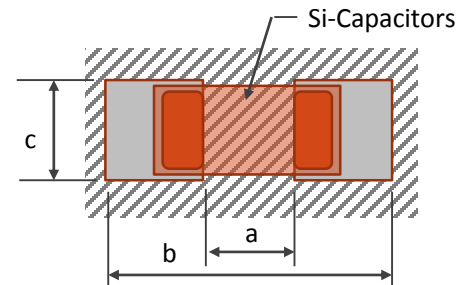
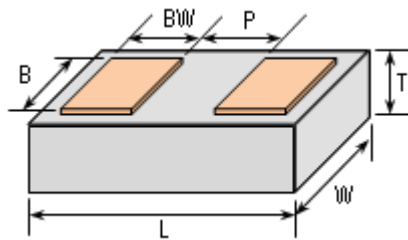
MLCC



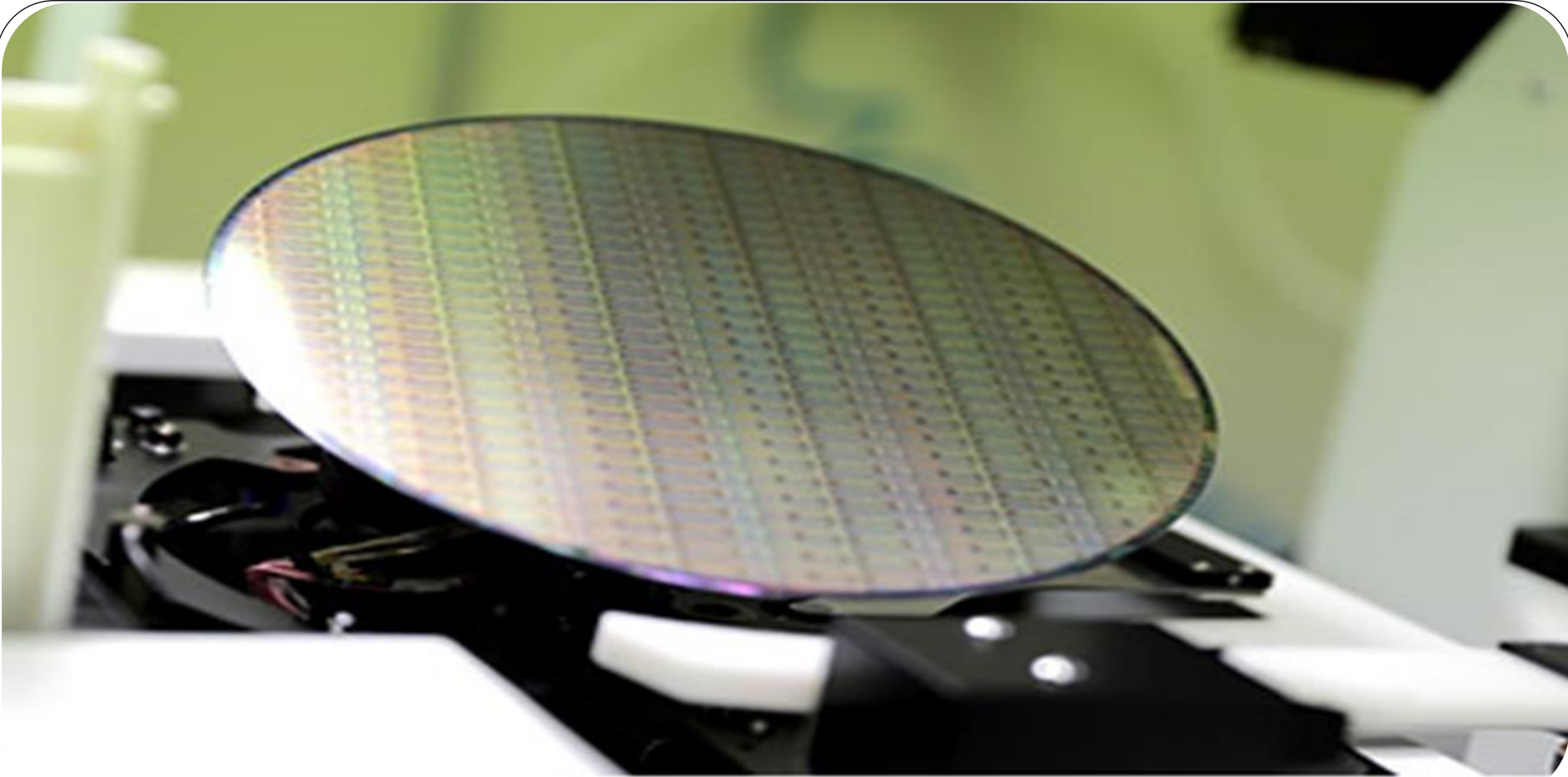
• Land Dimensions



Si-Cap



Si-Cap with SMD compatible pad layout



Broadband & High Frequency Characteristic

Characteristic Comparison

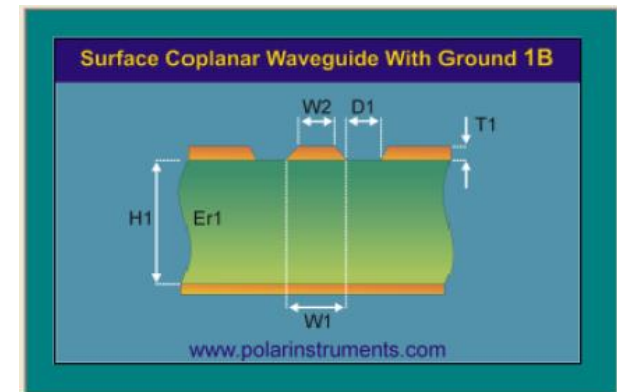
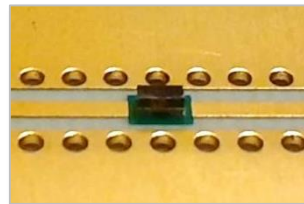
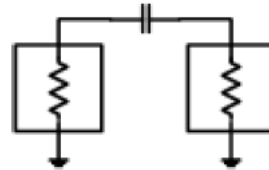
Broadband Characteristic - S Parameter (S_{21}/S_{11})

Test conditions :

PNA: Keysight N5227A

Frequency: 10MHz to 67GHz

Test Structure:



in Transmission Mode

- Substrate : Rogers 4350B
- Nominal 50 ohm characteristic impedance.

S_{21} : Insertion Loss

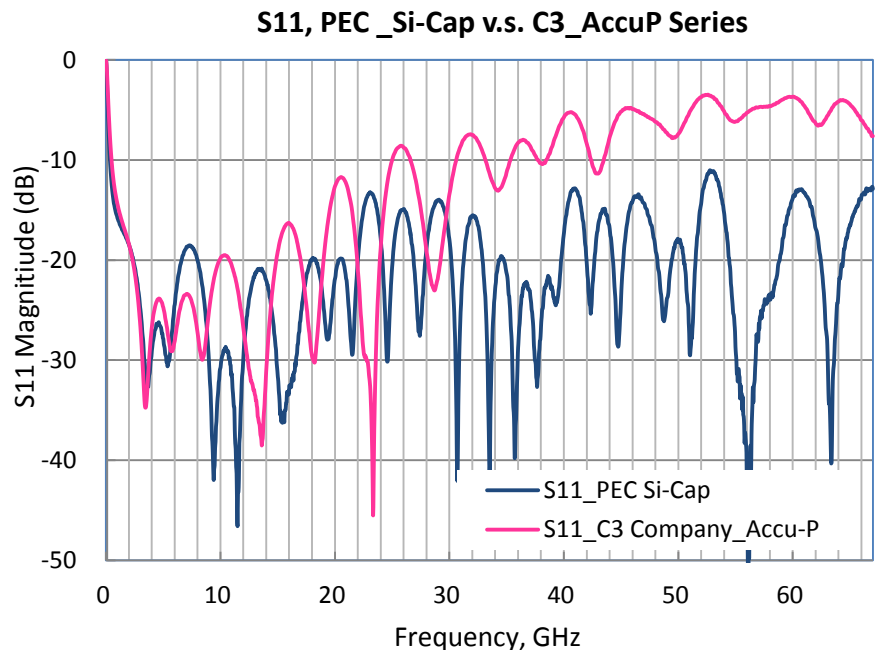
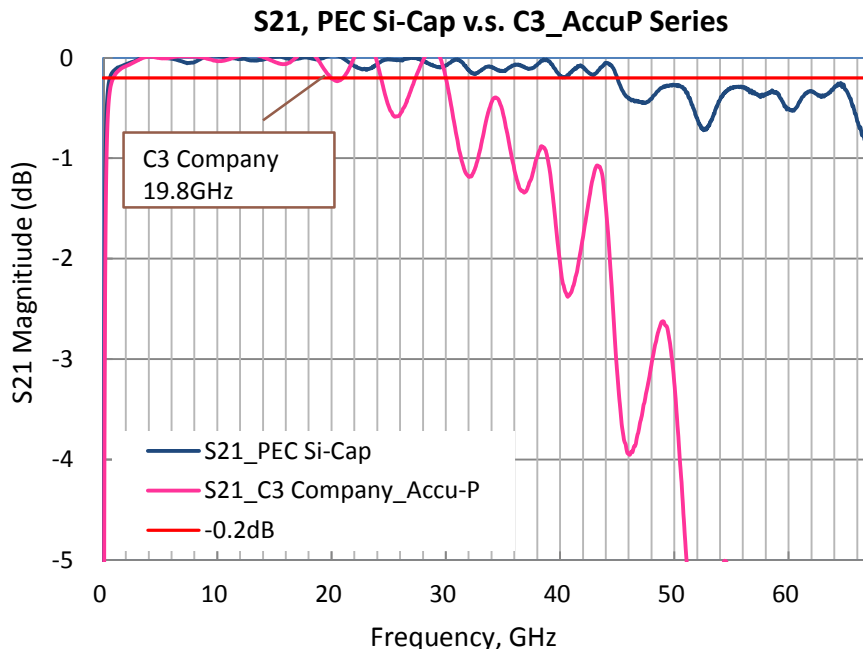
S_{11} : Return Loss

$S_{21}(\text{dB})$	Reflected Power (%)	Through Power (%)
2.99551	49.8295	50.17052
0.65817	14.0625	85.93750
0.58466	12.5954	87.40460
0.45414	9.9288	90.07120
0.30228	6.7236	93.27635
0.20087	4.5199	95.48012

Characteristic Comparison

Frequency Characteristic - S Parameter (S21/S11)

- PEC Si-Cap (0402/10pF) v.s. C3_Company AccuP (0402/10pF) comparison



Conclusion:

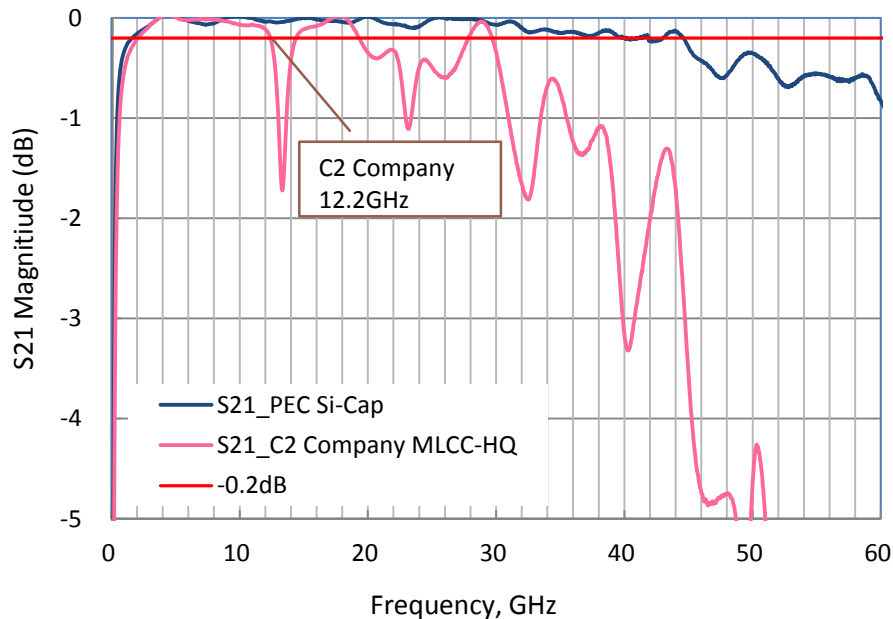
- * S21: The definition of criteria -0.2dB max.(95.48%), broadband application are up to 19.8GHz of C3_Company and more than 50GHz of PEC.
- * S11: PEC is better than C3 company.

Characteristic Comparison

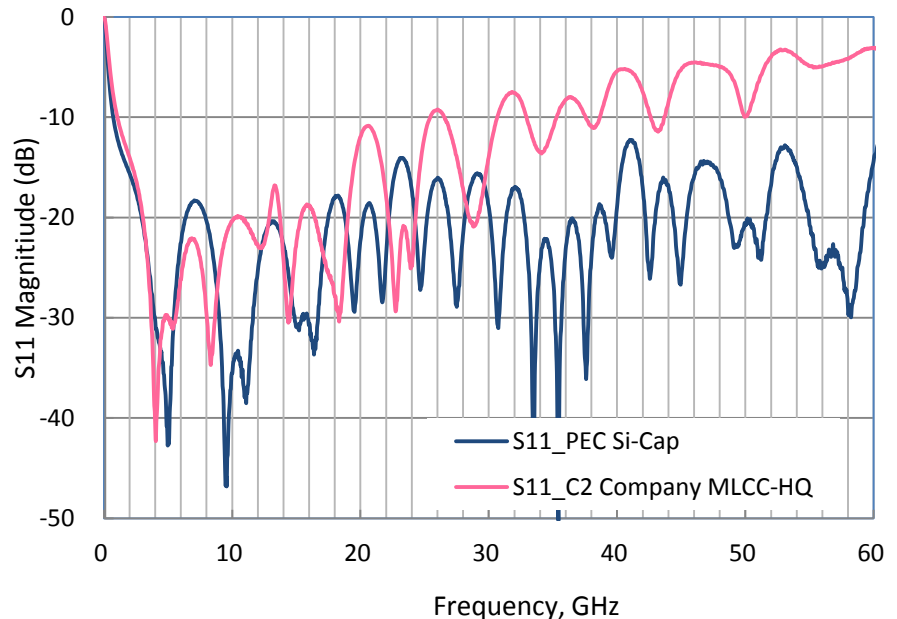
Frequency Characteristic - S Parameter (S21/S11)

- PEC Si-Cap (5.4pF) vs C2_Company MLCC-HQ(5.1pF) comparison

S21, PEC Si-Cap v.s. C2 MLCC-HQ



S11, PEC Si-Cap vs C2 MLCC-HQ



Conclusion:

- * S21: The definition of criteria -0.2dB max.(95.48%), broadband application are up to 12.2GHz of C2_Company and more than 40GHz of PEC.
- * S11: PEC Si-Cap is better than C2_Company .

Characteristic Comparison

Frequency Characteristic - High Frequency

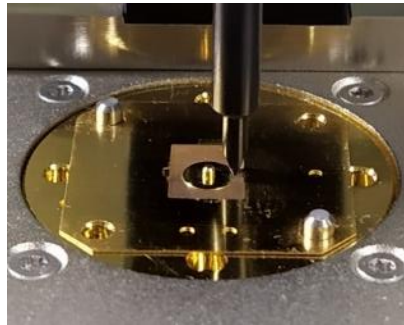
Test conditions :

Impedance Analyzer : Keysight E4991A+16197A

Frequency : 1MHz to 3GHz



Impedance Analyzer



Fixture

Compare Items

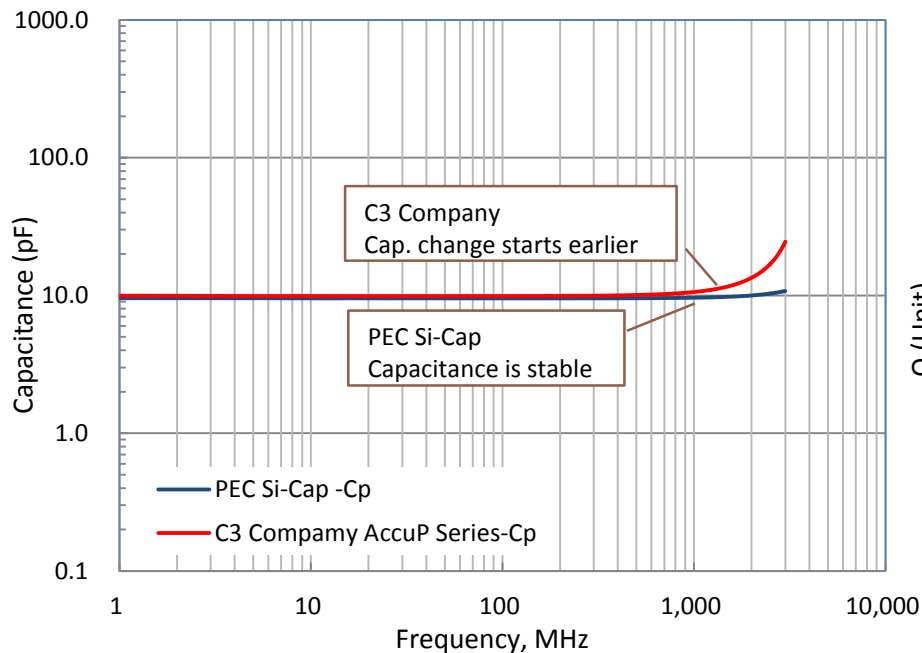
- **Change of capacitance in High Frequency (Capacitance Stability)**
- **Q Factor characteristics in High Frequency (900MHz, 1GHz, 1.9GHz, 2.4GHz)**

Characteristic Comparison

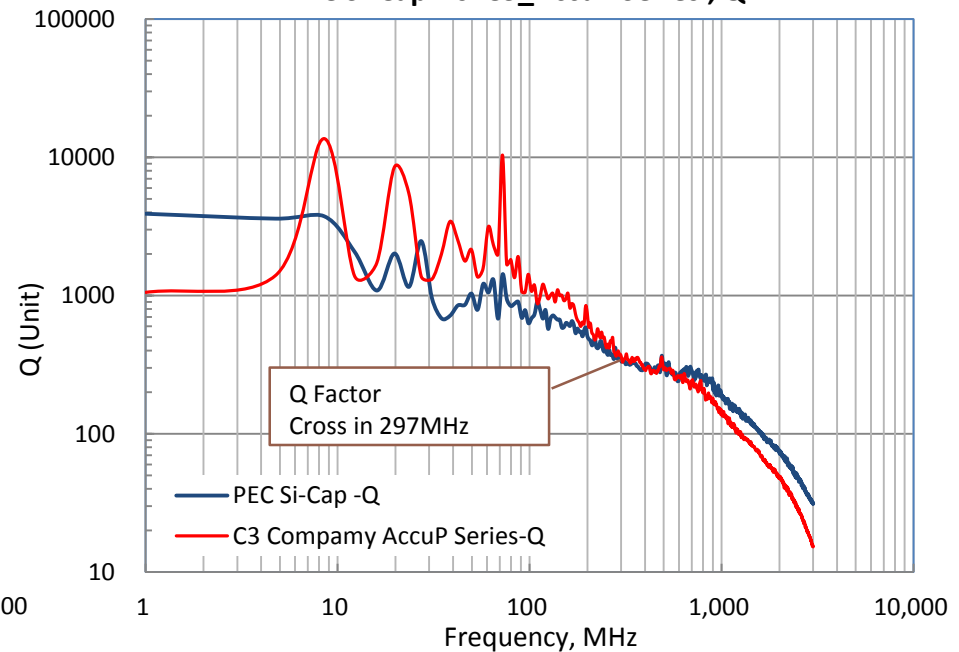
Frequency Characteristic - High Frequency

- PEC Si-Cap (0402/10pF) v.s. C3_Company AccuP (0402/10pF) comparison

PEC Si-Cap v.s. C3_AccuP Series , Cap



PEC Si-Cap v.s. C3_AccuP Series , Q



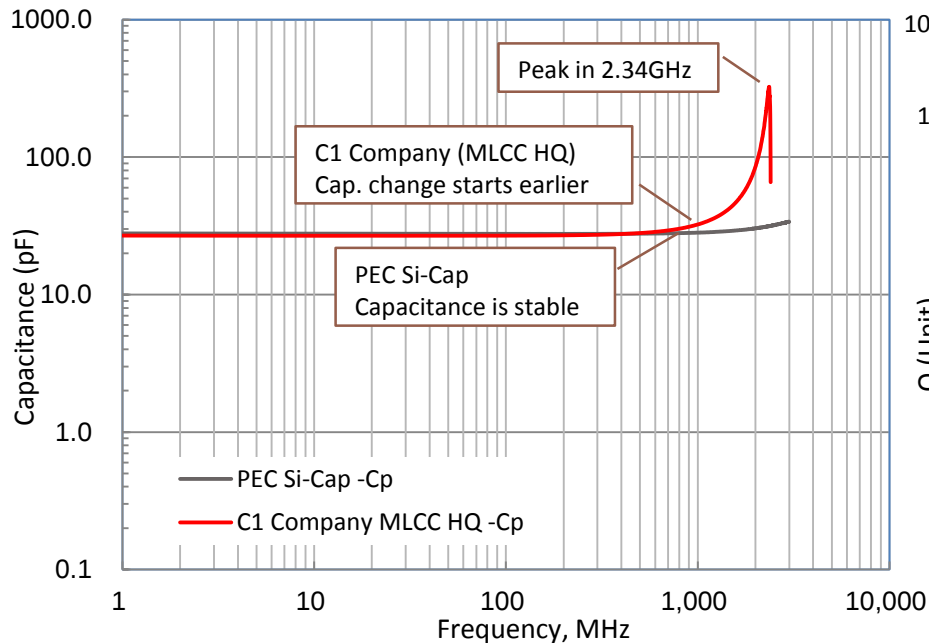
P/N	900MHz		1GHz		1.9GHz		2.4GHz	
	Cp (pF)	Q	Cp(pF)	Q	Cp(pF)	Q	Cp(pF)	Q
C3 Company_AccuP 0402/10pF	10.460	181.23	10.599	143.81	12.969	52.49	15.965	32.17
PEC_ Si-Cap 0402/10pF	9.659	214.57	9.632	188.38	9.947	81.83	10.260	50.41

Characteristic Comparison

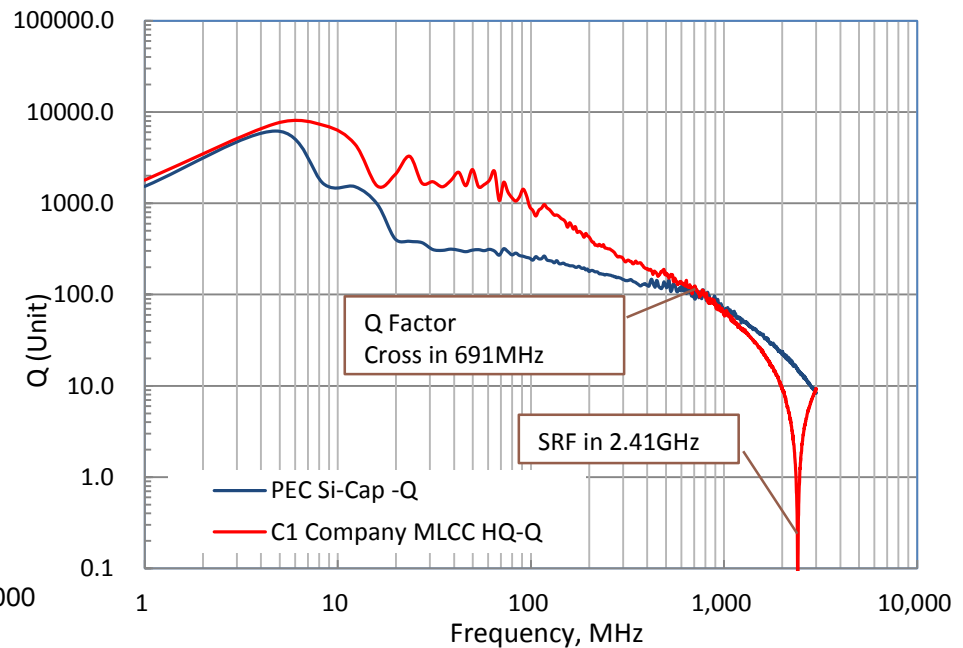
Frequency Characteristic - High Frequency

- PEC Si-Cap (0402/27pF) v.s. C1_Company MLCC HQ (0402/27pF) comparison

PEC Si-Cap v.s. C1_MLCC-HQ , Cap



PEC Si-Cap v.s. C1_MLCC-HQ , Q



P/N	900MHz		1GHz		1.9GHz		2.4GHz	
	Cp (pF)	Q	Cp(pF)	Q	Cp(pF)	Q	Cp(pF)	Q
C1 Company_MLCC HQ 0402/27pF	31.139	80.763	32.358	63.634	69.663	12.085	116.097	0.196
PEC_ Si-Cap 0402/27pF	28.093	90.309	28.209	62.571	30.062	25.019	31.557	15.418



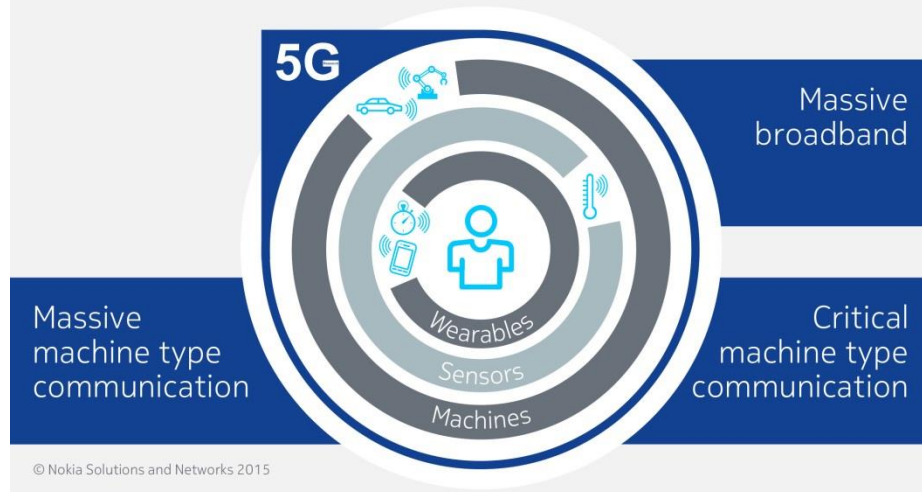
Applications & Product Roadmap

Applications

Si-Capacitor Target Applications

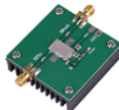
5G for people and things

Expanding the human possibilities of cellular technology



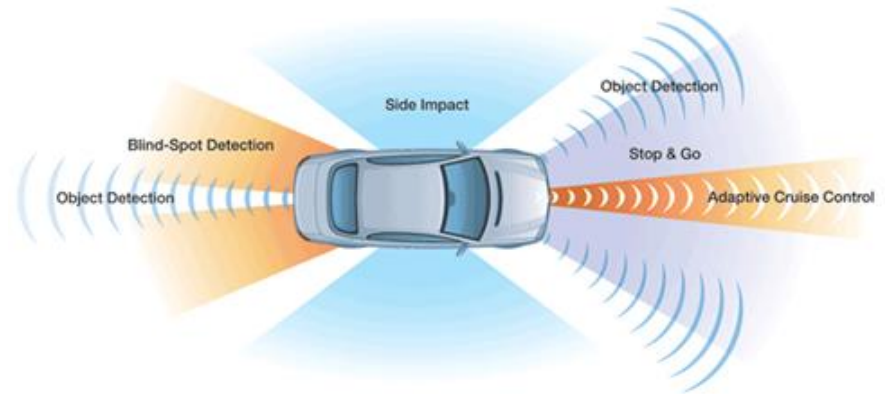
Communication

- APU(Application Processor Unit)
- HPC(High Performance Computer)
- Optical Network Ultra Broadband Communication
- RF-PA(Radio Frequency Power Amplifier)



FLYING888
INTERNATIONAL

Smart car



Electronics automotive sensor

Automotive

- LiDAR(Light Detection and Ranging)
- SiC-MOSFET Power Transistor Unit (Snubber)



Silicon Capacitors

Product Roadmap

• Variable Capacitors

Cap. Range : >10pF
Turning Range: 2:1 /5:1

• Varactor

Cap. Range : >10pF
Turning Range: 2:1 /5:1

• XLSC(Low ESL Cap)

Case Size: 0102-0404
Cap. Range : 390pF-1.0uF

• WSLC(Wire-Bondable Cap)

Case Size: 0101-0707
Cap. Range : 100pF-1nF

• BBSC(Broadband Cap)

Case Size: 0201-0402
Cap. Range : 390pF-0.1uF

• RFSC (Radio Frequency Cap)

Case Size: 01005-0402
Cap. Range : 0.1-47pF



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