

Surface Mount Multilayer Ceramic Capacitors (SMD MLCCs) for High Power Applications
Ultra HiQ-CBR Squared Series, C0G Dielectric, Low ESR
250 VDC, 1 MHz – 50 GHz (RF & Microwave)

Overview

KEMET's Ultra HiQ-CBR 0505 Series surface mount multilayer ceramic capacitors (MLCCs) in C0G dielectric feature a robust and exceptionally stable copper electrode dielectric system as well as a square case size that offers excellent low loss performance (ultra high Q). These devices provide extremely low ESR and high self-resonance characteristics, and are well-suited for higher power applications where minimal heating due to I²R losses are a factor. CBR Series capacitors exhibit no change in capacitance with respect to time and voltage, and boast a negligible change in capacitance with reference to

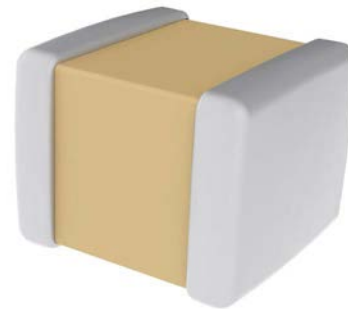


ambient temperature. Capacitance change is limited to ± 30 ppm/°C from -55°C to $+125^{\circ}\text{C}$.

CBR Series devices are suitable for many circuit applications including RF power amplifiers, mixers, oscillators, low noise amplifiers, filter networks, antenna tuning, timing circuits, delay lines, and MRI imaging coils.

Benefits

- Ultra high Q and extremely low ESR
- 0505 Square case size for higher SRF versus standard EIA case sizes
- High thermal stability
- 1 MHz to 50 GHz frequency range
- Operating temperature range of -55°C to $+125^{\circ}\text{C}$
- Base metal electrode (BME) dielectric system
- Pb-free and RoHS compliant
- DC voltage rating of 250 V
- Capacitance offerings ranging from 0.4 pF up to 100 pF
- Available capacitance tolerances of ± 0.05 pF, ± 0.1 pF, ± 0.25 pF, ± 0.5 pF, $\pm 1\%$, $\pm 2\%$, and $\pm 5\%$



Ordering Information

CBR	05	C	330	F	A	G	A	C	
Series	Case Size (L"x W")	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Dielectric	Termination Style	Termination Finish	Packaging/Grade (C-Spec) ¹
CBR	05 = 0505	C = Standard	Two significant digits + number of zeros Use 9 for 1.0 – 9.9 pF Use 8 for 0.1 – 0.99 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508	A = ± 0.05 pF B = ± 0.10 pF C = ± 0.25 pF D = ± 0.50 pF F = $\pm 1\%$ G = $\pm 2\%$ J = $\pm 5\%$	A = 250 V	G = C0G	A = N/A	C = 100% Matte Sn	Blank = 7" Reel Unmarked

¹ When ordering CBR Series devices, a "suffix" or "C-Spec" is not required to indicate a 7" reel packaging option. CBR devices are only available and shipped on 7" reels (paper tape). Bulk bag and cassette packaging options are not available. Please contact KEMET if you have a specific, non-standard packaging requirement.

Benefits cont'd

- No piezoelectric noise
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature
- No capacitance decay with time
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

Typical applications include critical timing, tuning, bypass, coupling, feedback, filtering, impedance matching and DC blocking.

Field applications include wireless and cellular base stations, wireless LAN, subscriber-based wireless services, wireless broadcast equipment, satellite communications, RF power amplifier (PA) modules, filters, voltage-controlled oscillators (VCOs), PAs, matching networks, RF modules, satellite communications and medical electronics.

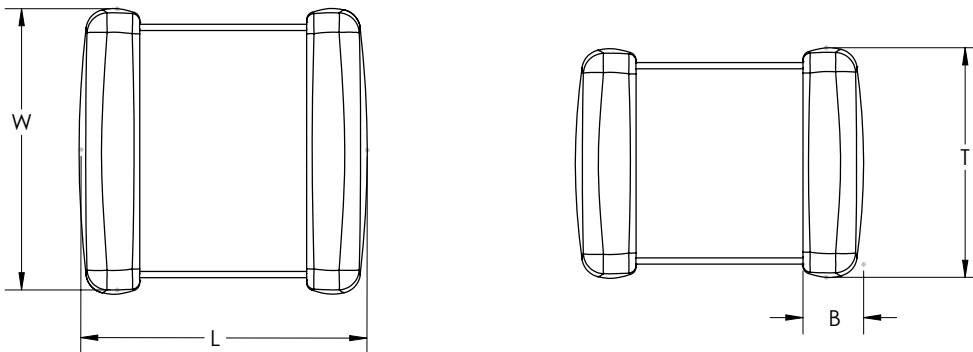
Qualification

RF and microwave products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Pb-free and RoHS compliant.

Dimensions – Millimeters (Inches)



Case Size (in.)	Case Size (mm)	L Length	W Width	T Thickness	B Bandwidth	Mounting Technique
0505	1414	1.40 +0.38 / -0.25 (0.055 +0.015 / -0.01)	1.40 ± 0.38 (0.055 ± 0.015)	1.15 ± 0.15 (0.045 ± 0.006)	0.25 + 0.25 - 0.13 (0.010 + 0.010 - 0.005)	Solder Reflow Only

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating Temperature Range:	-55°C to +125°C
Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC):	0 ±30 ppm/°C
Aging Rate (Maximum % Capacitance Loss/Decade Hour):	0%
¹ Dielectric Withstanding Voltage (DWV):	See Dielectric Withstanding Voltage Table (5 ±1 seconds and charge/discharge not exceeding 50 mA)
² Quality Factor (Q):	≥ 1,400 for capacitance values ≥30 pF ≥ 800 + 20°C for capacitance values < 30 pF
³ Insulation Resistance (IR) Limit @ 25°C:	10 GΩ minimum (rated voltage applied for 120 ± 5 seconds)

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and quality factor (Q) measured at 1 MHz ±100 kHz and 1.0 ±0.2 Vrms.

³ To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

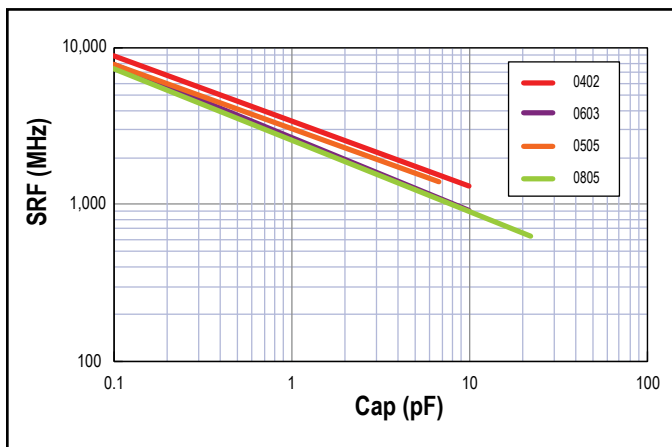
Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Dielectric Withstanding Voltage Table

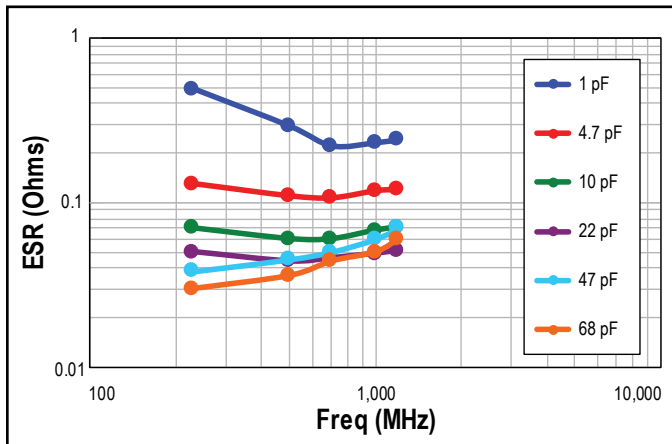
Rated Voltage (VDC)	250 V
DWV	200%

Electrical Characteristics

SRF (MHz) vs. Cap (pF)



ESR vs. Frequency 0505



Q vs. Frequency 0505

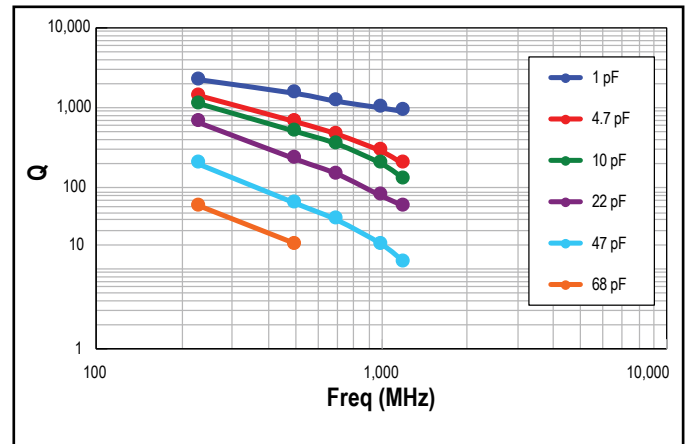


Table 1 – CBR Series, Capacitance Range Waterfall

Case Size – Inches (mm)		0505 (1414)
Length	mm (Inches)	1.40 +0.38 / -0.25 (0.055 +0.015 / -0.01)
Width	mm (Inches)	1.40 ± 0.38 (0.055 ± 0.015)
Thickness	mm (Inches)	1.15 ± 0.15 (0.045 ± 0.006)
Bandwidth	mm (Inches)	0.25 + 0.25 - 0.13 (0.010 + 0.010 - 0.005)
Rated Voltage (VDC)		250
Voltage Code		A
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)
0.4 pF	A = ±0.05pF B = ±0.10pF C = ±0.25pF D = ±0.50pF	408
0.5 pF		508
0.6 pF		608
0.7 pF		708
0.8 pF		808
0.9 pF		908
1.0 pF		109
1.1 pF		119
1.2 pF		129
1.3 pF		139
1.4 pF		149
1.5 pF		159
1.6 pF		169
1.7 pF		179
1.8 pF		189
1.9 pF		199
2.0 pF		209
2.1 pF		219
2.2 pF		229
2.3 pF		239
2.4 pF		249
2.5 pF		259
2.6 pF		269
2.7 pF		279
2.8 pF		289
2.9 pF		299
3.0 pF		309
3.1 pF		319
3.2 pF		329
3.3 pF		339
3.4 pF		349
3.5 pF	359	
3.6 pF	369	
3.7 pF	379	
3.8 pF	389	
3.9 pF	399	
4.0 pF	409	
4.1 pF	419	
4.2 pF	429	
4.3 pF	439	
4.4 pF	449	
4.5 pF	459	
4.6 pF	469	
4.7 pF	479	
4.8 pF	489	
4.9 pF	499	
5.0 pF	509	
Rated Voltage (VDC)		250
Voltage Code		A

* Available only in "B" (±0.1 pF) capacitance tolerance.

Table 1 – CBR Series, Capacitance Range Waterfall cont'd

Case Size – Inches (mm)		0505 (1414)
Length	mm (Inches)	1.40 +0.38 / -0.25 (0.055 +0.015 / -0.01)
Width	mm (Inches)	1.40 ± 0.38 (0.055 ± 0.015)
Thickness	mm (Inches)	1.15 ± 0.15 (0.045 ± 0.006)
Bandwidth	mm (Inches)	0.25 + 0.25 - 0.13 (0.010 + 0.010 - 0.005)
Rated Voltage (VDC)		250
Voltage Code		A
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)
5.1 pF	B = ±0.10pF C = ±0.25pF D = ±0.50pF	519
5.2 pF		529
5.3 pF		539
5.4 pF		549
5.5 pF		559
5.6 pF		569
5.7 pF		579
5.8 pF		589
5.9 pF		599
6.0 pF		609
6.1 pF		619
6.2 pF		629
6.3 pF		639
6.4 pF		649
6.5 pF		659
6.6 pF		669
6.7 pF		679
6.8 pF		689
6.9 pF		699
7.0 pF		709
7.1 pF		719
7.2 pF	729	
7.3 pF	739	
7.4 pF	749	
7.5 pF	759	
7.6 pF	769	
7.7 pF	779	
7.8 pF	789	
7.9 pF	799	
8.0 pF	809	
8.1 pF	819	
8.2 pF	829	
8.3 pF	839	
8.4 pF	849	
8.5 pF	859	
8.6 pF	869	
8.7 pF	879	
8.8 pF	889	
8.9 pF	899	
9.0 pF	909	
9.1 pF	919	
9.2 pF	929	
9.3 pF	939	
9.4 pF	949	
9.5 pF	959	
Rated Voltage (VDC)		250
Voltage Code		A

Table 1 – CBR Series, Capacitance Range Waterfall cont'd

Case Size – Inches (mm)		0505 (1414)
Length	mm (Inches)	1.40 +0.38 / -0.25 (0.055 +0.015 / -0.01)
Width	mm (Inches)	1.40 ± 0.38 (0.055 ± 0.015)
Thickness	mm (Inches)	1.15 ± 0.15 (0.045 ± 0.006)
Bandwidth	mm (Inches)	0.25 + 0.25 - 0.13 (0.010 + 0.010 - 0.005)
Rated Voltage (VDC)		250
Voltage Code		A
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)
9.6 pF	F = ±1% G = ±2% J = ±5%	969
9.7 pF		979
9.8 pF		989
9.9 pF		999
10 pF		100
11 pF		110
12 pF		120
13 pF		130
15 pF		150
16 pF		160
18 pF		180
20 pF		200
22 pF		220
24 pF		240
27 pF		270
30 pF		300
33 pF		330
36 pF		360
39 pF		390
43 pF		430
47 pF	470	
51 pF	510	
56 pF	560	
62 pF	620	
68 pF	680	
75 pF	750	
82 pF	820	
91 pF	910	
100 pF	101	
Rated Voltage (VDC)		250
Voltage Code		A

Table 2 – Chip Thickness/Reeling Quantities

Chip Size Inches (mm)	Chip Thickness (mm)	Reel Quantity	
		7" Paper	13" Paper
0505 (1414)	1.15 ±0.15	3,000	Contact KEMET for availability.

Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

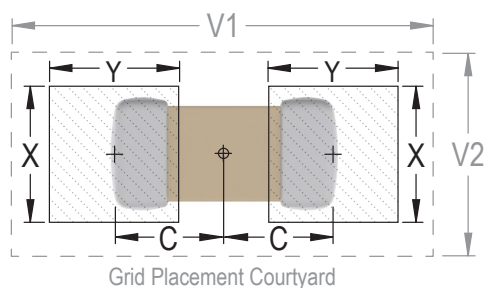
Case Size (Inches)	Case Size (mm)	Density Level A: Maximum (Most) Land Protrusion					Density Level B: Median (Nominal) Land Protrusion					Density Level C: Minimum (Least) Land Protrusion				
		C	Y	X	V1	V2	C	Y	X	V1	V2	C	Y	X	V1	V2
0505	1414	0.92	1.15	1.89	3.99	2.89	0.82	0.95	1.79	3.09	2.29	0.72	0.75	1.69	2.43	1.93

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of 0603(1608) and 0805 (2012) case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes.

Density Level C: For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1608 case size.



Soldering Process

Recommended Soldering Technique:

- 0505 case sizes are limited to solder reflow only

Recommended Soldering Profile:

- KEMET recommends following the guidelines outlined in IPC/JEDEC J–STD–020

Recommended Solder Alloys:

Alloy	Composition	Solidus	Liquidous
In50	50 In, 50 Pb	180°C	209°C
In52	52 In, 48 Sn	118°C	118°C
Sn62	62.5 Sn, 36.1 Pb, 1.4 Ag	179°C	179°C
Sn63	63 Sn, 37 Pb	183°C	183°C
Pb-Free	95.5 Sn, 3.8 Ag, 0.7 Cu	217°C	217°C
Hi-Temp	5 Sn, 93.5 Pb, 1.5 Ag	296°C	301°C
Sn5	5 Sn, 95 Pb	308°C	312°C

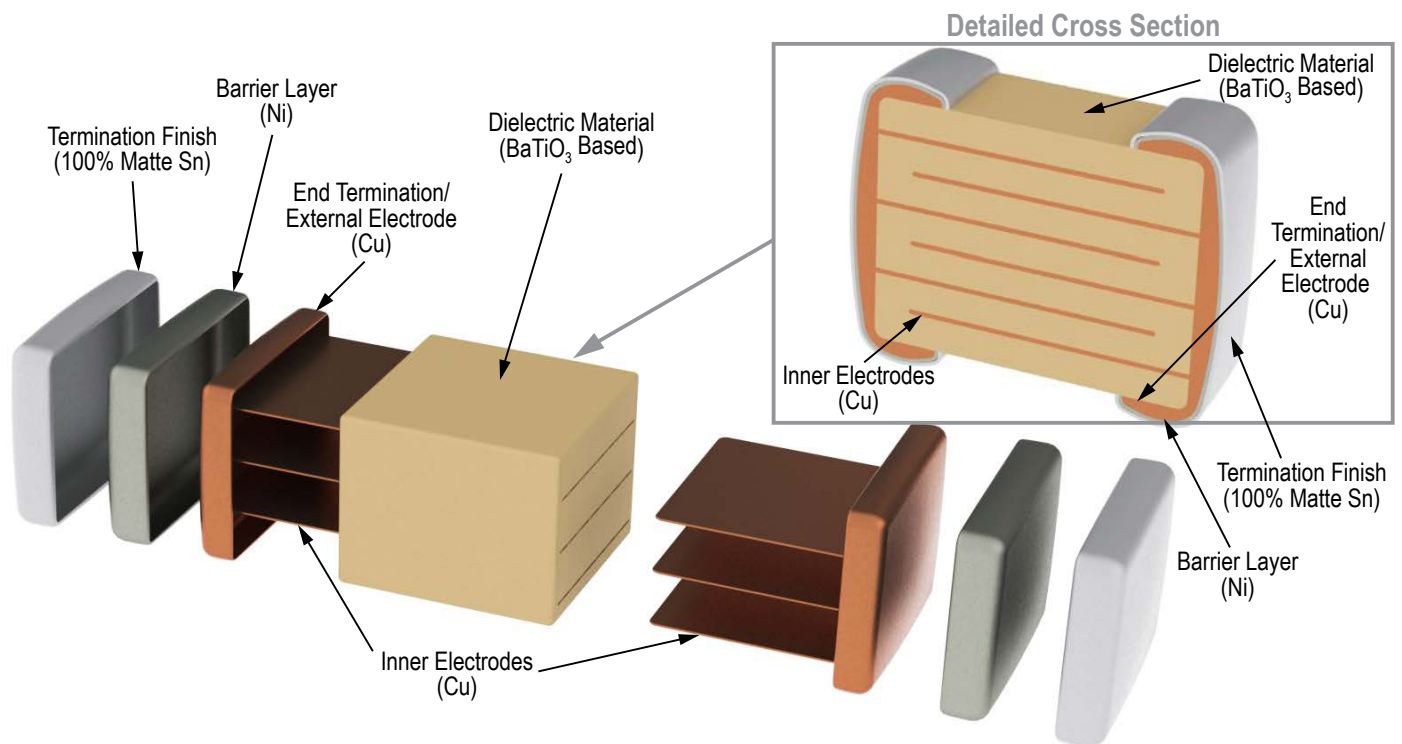
Table 4 – Performance & Reliability: Test Methods & Conditions

Stress	Test or Inspection Method	Requirements															
Terminal Strength	Pressurizing force: 0505 case sizes: 5N Test time: 10 ±1 second	No visible damage or separation of termination system.															
Vibration Resistance	Vibration frequency: 10 ~ 55 Hz/minimum Total amplitude: 1.5 mm Test time: 6 hours (Two hours each in three mutually perpendicular directions.)	No visible damage. Capacitance change and Q/DF: To meet initial specification															
Solderability	Solder temperature: 235 ± 5°C Dipping time: 2 ±0.5 seconds	95% minimum coverage of termination finish.															
Board Flex	Capacitor is mounted to a substrate which is flexed by means of ram at a rate of 1 mm per second until the deflection becomes 1 mm. (Deflection is maintained for 5 ±1 second) Store at room temperature for 24 ±2 hours before measuring electrical properties.	No visible damage. Capacitance change: within ±5.0% or ±0.5 pF, whichever is larger. (Capacitance change is monitored during flexure.)															
Resistance to Soldering Heat	Solder temperature: 260 ±5°C Dipping time: 10 ±1 second Preheating: 120 to 150°C for 1 minute before immerse the capacitor in a eutectic solder. Store at room temperature for 24 ±2 hours before measuring electrical properties.	No visible damage. Capacitance change: within ±2.5% or ±0.25 pF, whichever is larger. Q/DF, IR and dielectric strength: To meet initial requirements. 25% maximum leaching on each edge.															
Temperature Cycling	5 cycles of steps 1 - 4: <table border="1" data-bbox="370 1010 886 1203"> <thead> <tr> <th>Step</th> <th>Temp. (°C)</th> <th>Time (min.)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Minimum operating temp. +0/-3</td> <td>30 ±3</td> </tr> <tr> <td>2</td> <td>Room temp</td> <td>2 ~ 3</td> </tr> <tr> <td>3</td> <td>Maximum operating temp. +3/-0</td> <td>30 ±3</td> </tr> <tr> <td>4</td> <td>Room temp (25°C)</td> <td>2 ~ 3</td> </tr> </tbody> </table> Store at room temperature for 24 ± 2 hours before measuring electrical properties.	Step	Temp. (°C)	Time (min.)	1	Minimum operating temp. +0/-3	30 ±3	2	Room temp	2 ~ 3	3	Maximum operating temp. +3/-0	30 ±3	4	Room temp (25°C)	2 ~ 3	No visible damage. Capacitance change: within ±2.5% or ±0.25 pF, whichever is larger. Q/DF, IR and dielectric strength: To meet initial requirements.
Step	Temp. (°C)	Time (min.)															
1	Minimum operating temp. +0/-3	30 ±3															
2	Room temp	2 ~ 3															
3	Maximum operating temp. +3/-0	30 ±3															
4	Room temp (25°C)	2 ~ 3															
Humidity (Damp Heat) Steady State	Test temperature: 40 ±2°C Humidity: 90 ~ 95% RH Test time: 500 +24/-0 hours Store at room temperature for 24 ±2 hours before measuring electrical properties.	No visible damage. Capacitance change: within ±5.0% or ±0.5 pF, whichever is larger. Q/DF value: Capacitance ≥ 30 pF, Q ≥ 350, 10 pF ≤ Capacitance < 30 pF, Q ≥ 275 +2.5°C Capacitance < 10 pF; Q ≥ 200 +10°C IR: ≥ 1GΩ															
Humidity (Damp Heat) Load	Test temperature: 40 ±2°C Humidity: 90 ~ 95% RH Test time: 500 +24/-0 hours Applied voltage: rated voltage Store at room temperature for 24 ±2 hours before measuring electrical properties.	No visible damage. Capacitance change: within ±7.5% or ±0.75 pF, whichever is larger. Q/DF value: Capacitance ≥ 30 pF, Q ≥ 200, Capacitance < 30 pF, Q ≥ 100+10/3°C IR: ≥ 500MΩ															
High Temperature Life	Test temperature: 125 ±3°C Applied voltage: 200% of rated voltage (6.3 VDC - 250 VDC) Test time: 1,000 +24/-0 hours Store at room temperature for 24 ±2 hours before measuring electrical properties.	No visible damage. Capacitance change: within ±3.0% or ±0.3 pF, whichever is larger. Q/DF value: Capacitance ≥ 30 pF, Q ≥350, 10 pF ≤ Capacitance < 30 pF, Q ≥ 275 +2.5°C Capacitance <10 pF, Q ≥ 200 +10°C IR: ≥1 GΩ															
ESR	The ESR should be measured at room temperature and tested at frequency 1±0.1 GHz.	<table border="1" data-bbox="954 1801 1507 1948"> <thead> <tr> <th>0505 Case Size</th> </tr> </thead> <tbody> <tr> <td>0.4pF ≤Capacitance <1.0pF: < 1500mΩ</td> </tr> <tr> <td>1.0pF ≤Capacitance <10pF: < 250mΩ</td> </tr> <tr> <td>10pF ≤Capacitance ≤100pF: < 200mΩ</td> </tr> </tbody> </table>	0505 Case Size	0.4pF ≤Capacitance <1.0pF: < 1500mΩ	1.0pF ≤Capacitance <10pF: < 250mΩ	10pF ≤Capacitance ≤100pF: < 200mΩ											
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1.0pF ≤Capacitance <10pF: < 250mΩ																	
10pF ≤Capacitance ≤100pF: < 200mΩ																	

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C, and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts, and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability, chip stock should be used promptly, preferably within 1.5 years of receipt.

Construction



Marking

Hi CBR series devices are supplied unmarked. If you require marked product, please contact KEMET for availability of a laser-marked option.

Tape & Reel Packaging Information

KEMET offers RF and Microwave Multilayer Ceramic Chip Capacitors packaged in 8 mm tape on 7" reels. This packaging system is compatible with all tape-fed automatic pick and place systems.

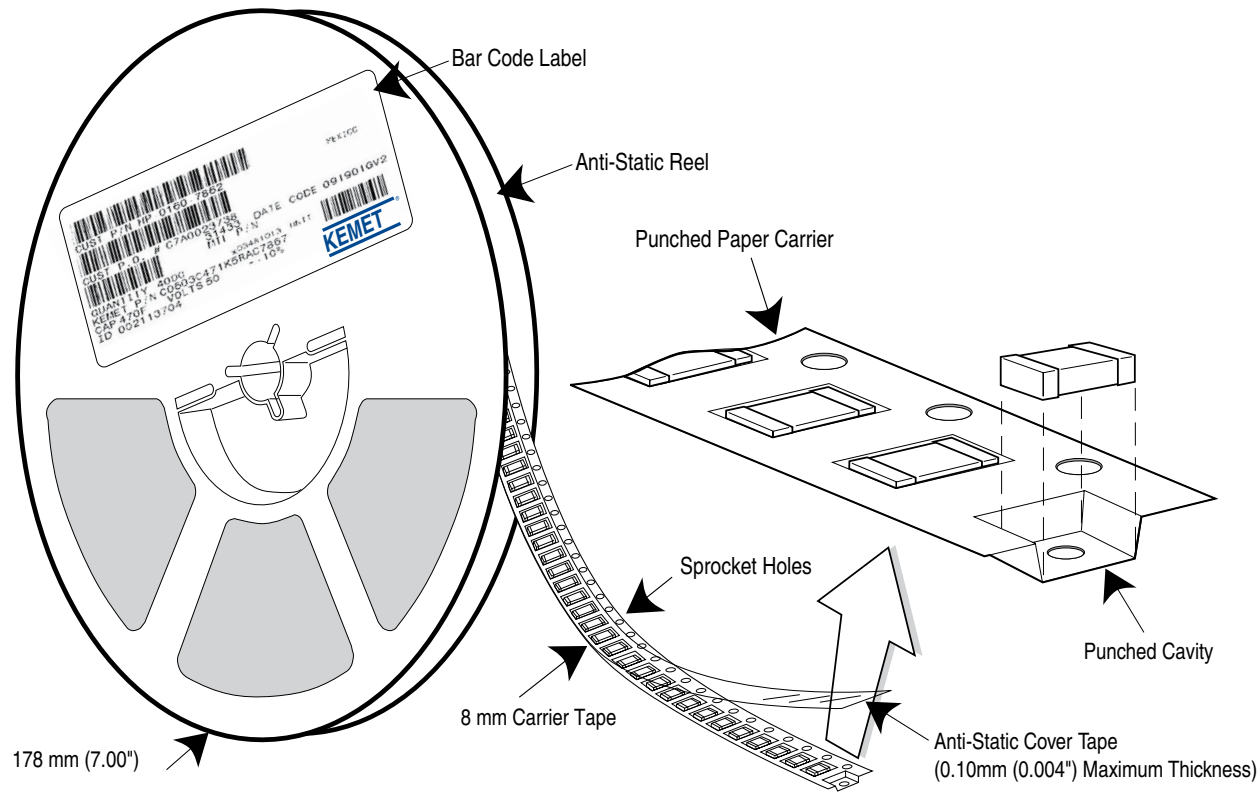


Table 5 – Carrier Tape Configuration (mm)

EIA Case Size	Tape Size (W)*	Pitch (P ₁)*
0505	8	4

*Refer to Figure 1 & 2 for W and P₁, carrier tape reference locations.

*Refer to Table 6 for tolerance specifications.

Figure 1 – Punched (Paper) Carrier Tape Dimensions

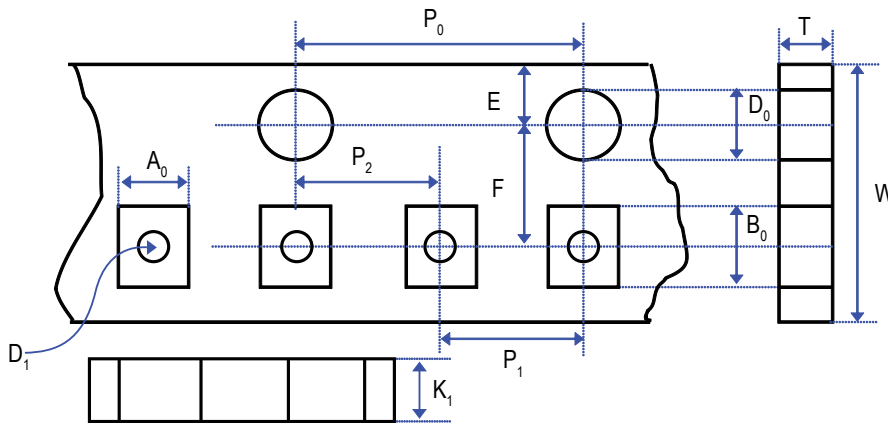


Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)								
Tape Size	D_0	E	P_0	P_2	R Reference Note 1	K_0		
8 mm	1.55 +0.10 (0.061 +0.004)	1.75 ±0.10 (0.069 ±0.004)	4.0 ±0.10 (0.157 ±0.004)	2.0 ±0.05 (0.079 ±0.002)	25.0 (0.984)	Maximum 1.5 (Maximum 0.060)		
Variable Dimensions — Millimeters (Inches)								
Tape Size	Pitch	A_0	B_0	F	P_1	T	W	D_1
8 mm	Single (4 mm)	Maximum 1.9 (Maximum 0.075)	Maximum 1.90 (Maximum 0.075)	3.5 ±0.05 (0.138 ±0.002)	4.0 ±0.1 (0.157 ±0.004)	0.23±0.1 (0.009 ±0.004)	8.0 ±0.2 (0.315 ±0.008)	1.00 ±0.1 (0.039 ±0.004)

1. The tape with or without components shall pass around R without damage (see Figure 3).

Packaging Information Performance Notes

- Cover Tape Break Force:** 1.0 Kg minimum.
- Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

Tape Width	Peel Strength
8 mm	0.1 to 1.0 Newton (10 to 100 gf)
12 and 16 mm	0.1 to 1.3 Newton (10 to 130 gf)

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

- Labeling:** Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. Refer to EIA Standards 556 and 624.

Figure 2 – Bending Radius

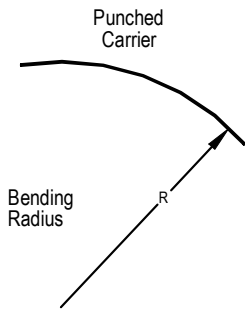


Figure 3 – Tape Leader & Trailer Dimensions

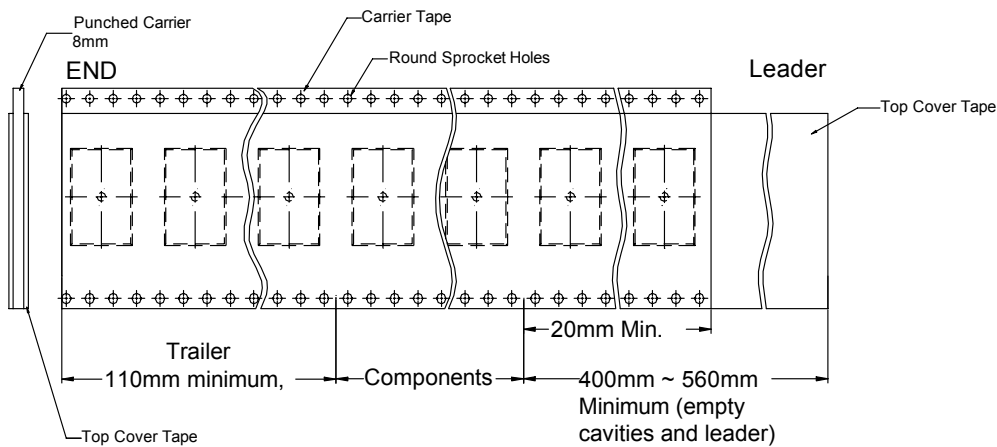


Figure 4 – Maximum Camber

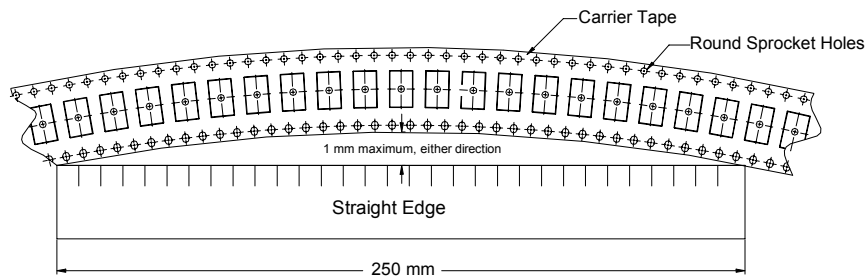


Figure 5 – Reel Dimensions

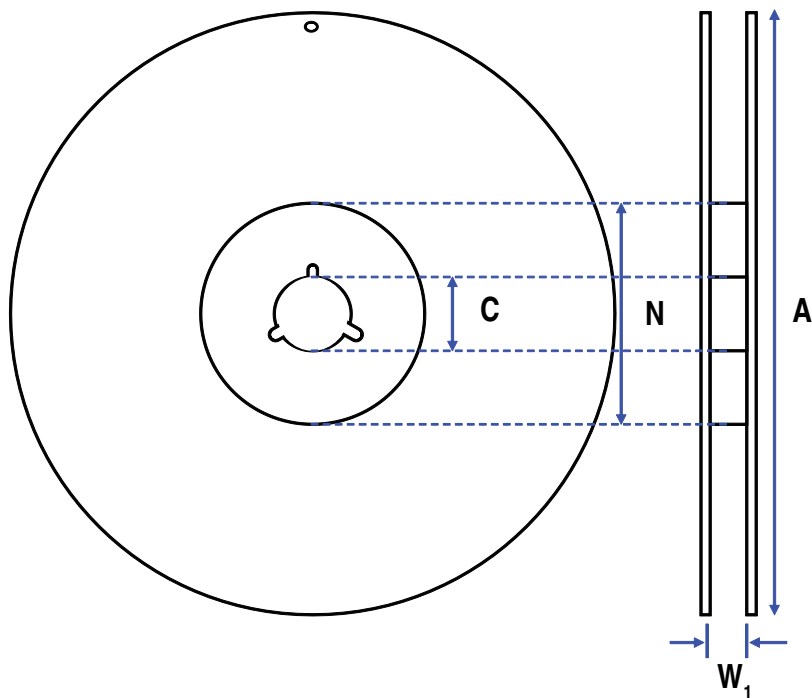


Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)			
Tape Size	Reel Size	A	C
8 mm	7	178 ±0.10 (7.008 ±0.004)	13.0 ±0.50 (0.512 ±0.02)
Variable Dimensions — Millimeters (Inches)			
Tape Size	N Minimum See Note 2, Table 6	W ₁	
8 mm	60 ±1.0 (2.362 ±0.04)	8.4 +1.5/ -0.0 (0.331 +0.059/ -0.0)	

KEMET Corporation World Headquarters

2835 KEMET Way
Simpsonville, SC 29681

Mailing Address:
P.O. Box 5928
Greenville, SC 29606

www.kemet.com
Tel: 864-963-6300
Fax: 864-963-6521

Corporate Offices
Fort Lauderdale, FL
Tel: 954-766-2800

North America

Northeast

Wilmington, MA
Tel: 978-658-1663

Southeast

Lake Mary, FL
Tel: 407-855-8886

Central

Novi, MI
Tel: 248-994-1030

Irving, TX
Tel: 972-915-6041

West

Milpitas, CA
Tel: 408-433-9950

Mexico

Guadalajara, Jalisco
Tel: 52-33-3123-2141

Europe

Southern Europe

Sasso Marconi, Italy
Tel: 39-051-939111

Skopje, Macedonia
Tel: 389-2-55-14-623

Central Europe

Landsberg, Germany
Tel: 49-8191-3350800

Kamen, Germany
Tel: 49-2307-438110

Northern Europe

Wyboston, United Kingdom
Tel: 44-1480-273082

Espoo, Finland
Tel: 358-9-5406-5000

Asia

Northeast Asia

Hong Kong
Tel: 852-2305-1168

Shenzhen, China
Tel: 86-755-2518-1306

Beijing, China
Tel: 86-10-5877-1075

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Tel: 86-21-6447-0707

Seoul, South Korea
Tel: 82-2-6294-0550

Taipei, Taiwan
Tel: 886-2-27528585

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Tel: 65-6701-8033

Penang, Malaysia
Tel: 60-4-6430200

Bangalore, India
Tel: 91-806-53-76817

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