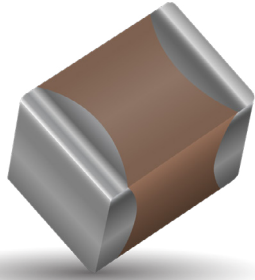


High Voltage MLC Chips

For 600V to 5000V Applications



High value, low leakage and small size are difficult parameters to obtain in capacitors for high voltage systems. AVX special high voltage MLC chip capacitors meet these performance characteristics and are designed for applications such as snubbers in high frequency power converters, resonators in SMPS, and high voltage coupling/dc blocking. These high voltage chip designs exhibit low ESRs at high frequencies.

Larger physical sizes than normally encountered chips are used to make high voltage MLC chip products. Special precautions must be taken in applying these chips in surface mount assemblies. The temperature gradient during heating or cooling cycles should not exceed 4°C per second. The preheat temperature must be within 50°C of the peak temperature reached by the ceramic bodies through the soldering process. Chip sizes 1210 and larger should be reflow soldered only. Capacitors may require protective surface coating to prevent external arcing.

For 1825, 2225 and 3640 sizes, AVX offers leaded version in either thru-hole or SMT configurations (for details see section on high voltage leaded MLC chips)

NEW 630V RANGE

HOW TO ORDER

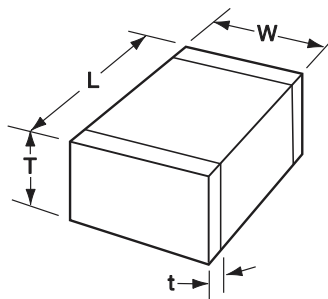
1808	A	A	271	M	A	T	2	A
AVX Style	Voltage	Temperature Coefficient	Capacitance Code	Capacitance Tolerance	Test Level	Termination*	Packaging	Special Code
0805 1206 1210 1808 1812 1825 2220 2225 3640 ***	C = 600V/630V A = 1000V S = 1500V G = 2000V W = 2500V H = 3000V J = 4000V K = 5000V	A = NPO (C0G) C = X7R	(2 significant digits + no. of zeros) Examples: 10 pF = 100 100 pF = 101 1,000 pF = 102 22,000 pF = 223 220,000 pF = 224 1 μF = 105	C0G: J = ±5% K = ±10% M = ±20% X7R: K = ±10% M = ±20% Z = +80%, -20%	A = Standard	T = Plated Ni and Sn (RoHS Compliant)	2 = 7" Reel** 4 = 13" Reel	A = Standard

Notes:

- Capacitors with X7R dielectrics are not intended for applications across AC supply mains or AC line filtering with polarity reversal. Contact plant for recommendations. Contact factory for availability of Termination and Tolerance options for Specific Part Numbers.
- *Terminations with 5% minimum lead (Pb) is available, see pages 100 and 101 for LD style. Leaded terminations are available, see pages 102-106.

**The 3640 Style is not available on 7" Reels.

*** AVX offers nonstandard chip sizes. Contact factory for details.



DIMENSIONS: millimeters (inches)

SIZE	0805	1206	1210*	1808*	1812*	1825*	2220*	2225*	3640*
(L) Length	2.10 ± 0.20 (0.083 ± 0.008)	3.30 ± 0.30 (0.130 ± 0.012)	3.30 ± 0.40 (0.130 ± 0.016)	4.60 ± 0.50 (0.181 ± 0.020)	4.60 ± 0.50 (0.181 ± 0.020)	4.60 ± 0.50 (0.181 ± 0.020)	5.70 ± 0.50 (0.224 ± 0.020)	5.72 ± 0.25 (0.225 ± 0.010)	9.14 ± 0.25 (0.360 ± 0.010)
(W) Width	1.25 ± 0.20 (0.049 ± 0.008)	1.60 ± 0.20 (0.063 ± 0.008)	2.50 ± 0.30 (0.098 ± 0.012)	2.00 ± 0.20 (0.079 ± 0.008)	3.20 ± 0.30 (0.126 ± 0.012)	6.30 ± 0.40 (0.248 ± 0.016)	5.00 ± 0.40 (0.197 ± 0.016)	6.35 ± 0.25 (0.250 ± 0.010)	10.2 ± 0.25 (0.400 ± 0.010)
(T) Thickness Max.	1.35 (0.053)	1.80 (0.071)	2.80 (0.110)	2.20 (0.087)	2.80 (0.110)	3.40 (0.134)	3.40 (0.134)	2.54 (0.100)	2.54 (0.100)
(t) terminal min. max.	0.50 ± 0.20 (0.020 ± 0.008)	0.60 ± 0.20 (0.024 ± 0.008)	0.75 ± 0.35 (0.030 ± 0.014)	0.75 ± 0.35 (0.030 ± 0.014)	0.75 ± 0.35 (0.030 ± 0.014)	0.75 ± 0.35 (0.030 ± 0.014)	0.85 ± 0.35 (0.033 ± 0.014)	0.85 ± 0.35 (0.033 ± 0.014)	0.76 (0.030) 1.52 (0.060)

*Reflow Soldering Only

High Voltage MLC Chips

For 600V to 5000V Applications



NP0 (C0G) CAPACITANCE RANGE – PREFERRED SIZES ARE SHADED

Case Size	1825												2220												2225												3640											
	Reflow Only												Reflow Only												Reflow Only												Reflow Only											
(L) Length	4.60 ± 0.50 (0.181 ± 0.020)												5.70 0.50 (0.224 0.020)												5.70 ± 0.50 (0.225 ± 0.010)												9.14 ± 0.25 (0.360 ± 0.010)											
(W) Width	6.30 ± 0.40 (0.248 ± 0.016)												5.00 0.40 (0.197 0.016)												6.30 0.40 (0.250 ± 0.010)												10.2 ± 0.25 (0.400 ± 0.010)											
(T) Thickness	3.40 (0.134)												3.40 (0.134)												3.40 (0.100)												2.54 (0.100)											
(t) Terminal	0.75 ± 0.35 (0.030 ± 0.014)												0.85 0.35 (0.033 ± 0.014)												0.85 ± 0.35 (0.033 ± 0.014)												0.76 (0.030) 1.52 (0.060)											
Voltage (V)	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000													
Cap (pF)	1.5	1R5																																														
	1.8	1R8																																														
	2.2	2R2																																														
	2.7	2R7																																														
	3.3	3R3																																														
	3.9	3R9																																														
	4.7	4R7																																														
	5.6	5R6																																														
	6.8	6R8																																														
	8.2	8R2																																														
	10	100	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																				
	12	120	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	15	150	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	18	180	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	22	220	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	27	270	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	33	330	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	39	390	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F																			
	47	470	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F					G														
	56	560	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F					G														
	68	680	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F					G														
	82	820	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F					G														
	100	101	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	120	121	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	150	151	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	180	181	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	220	221	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	270	271	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	330	331	E	E	G	E	F	E	F	F	F	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	390	391	E	E	G	E	F	E	F			E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	470	471	E	E	G	E	F	E	F			E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	560	561	E	E	G	E	F	E	F			E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	G					G														
	680	681	E	E	G	E	F	F	G			E	E	E	E	E	F	F																	G													
	750	751	E	E	G	E	F	F	G			E	E	E	E	E	F	F																	G													
	820	821	E	E	G	E	F	F	G			E	E	E	E	E	F	F																	G													
	1000	102	E	E	G	E	F	F	G			E	E	E	E	E	F	F																	G													
	1200	122	E	E	G	E	F	G	G			E	E	E	E	E	G	G																	G													
	1500	152	E	E	G	F	G	G	G			E	E	E	F	F	G	G																	G													
	1800	182	E	E	G	F	G	G	G			E	E	E	F	F	G	G																	G													
	2200	222	E	E	G	G	G		G			E	E	E	G	F																			G													
	2700	272	E	E	G	G	G		G			E	E	E	G	G																			G													
	3300	332	E	E	G	G	G					E	E	E	G	G																			G													
	3900	392	E	E	G	G	G					E	E	E	G	G																			G													
	4700	472	E	E	G	G	G					E	E	E	G	G																			G													
	5600	562	F	F	G	G	G					F	F	F	G	G																			G													
	6800	682	F	F	G		G					F	F	F																					G													
	8200	822	F	F	G		G					G	G	G																					G													
Cap (µF)	0.010	103	F	F	G							7	7	7																																		
	0.012	123	F	F	G																																											
	0.015	153	F	F																																												
	0.018	183	F	F																																												
	0.022	223	F	F																																												
	0.027	273	F	F																																												
	0.033	333	F	F																																												
	0.039	393	G	G																																												
	0.047	473	G	G																																												
	0.056	563	G	G																																												
	0.068	683	G	G																																												
	0.100	104																																														
Voltage (V)	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000													
Case Size	1825												2220												2225												3640											

Letter	A	C	E	F	G	X	7
Max. Thickness	0.813 (0.032)	1.448 (0.057)	1.8034 (0.071)	2.2098 (0.087)	2.794 (0.110)	0.940 (0.037)	3.30 (0.130)

NOTE: Contact factory for non-specified capacitance values

High Voltage MLC Chips

For 600V to 5000V Applications

X7R Dielectric

Performance Characteristics

Capacitance Range	10 pF to 0.82 μF (25°C, 1.0 ±0.2 Vrms at 1kHz)
Capacitance Tolerances	±10%; ±20%; +80%, -20%
Dissipation Factor	2.5% max. (+25°C, 1.0 ±0.2 Vrms, 1kHz)
Operating Temperature Range	-55°C to +125°C
Temperature Characteristic	±15% (0 VDC)
Voltage Ratings	600, 630, 1000, 1500, 2000, 2500, 3000, 4000 & 5000 VDC (+125°C)
Insulation Resistance (+25°C, at 500 VDC)	100K MΩ min. or 1000 MΩ - μF min., whichever is less
Insulation Resistance (+125°C, at 500 VDC)	10K MΩ min. or 100 MΩ - μF min., whichever is less
Dielectric Strength	Minimum 120% rated voltage for 5 seconds at 50 mA max. current

X7R CAPACITANCE RANGE – PREFERRED SIZES ARE SHADED

Case Size Soldering	0805			1206					1210					1808								1812							
	Reflow/Wave			Reflow/Wave					Reflow Only					Reflow Only								Reflow Only							
(L) Length	2.10 ±0.20 (0.085 ±0.008)			3.30 ±0.30 (0.130 ±0.012)					3.30 ±0.40 (0.130 ±0.016)					4.60 ±0.50 (0.181 ±0.020)								4.60 ±0.50 (0.177 ±0.012)							
W) Width	1.25 ±0.20 (0.049 ±0.008)			1.60 +0.30/-0.10 (0.063 +0.012/-0.004)					2.50 ±0.30 (0.098 ±0.012)					2.00 ±0.20 (0.079 ±0.008)								3.20 ±0.30 (0.126 ±0.008)							
(T) Thickness	1.35 (0.053)			1.80 (0.071)					2.80 (0.110)					2.20 (0.087)								2.80 (0.100)							
(t) Terminal	0.50 ±0.20 (0.020 ±0.008)			0.60 ±0.20 (0.024 ±0.008)					0.75 ±0.35 (0.030 ±0.014)					0.75 ±0.35 (0.030 ±0.014)								0.75 ±0.35 (0.030 ±0.014)							
Voltage (V)	600	630	1000	600	630	1000	1500	2000	600	630	1000	1500	2000	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000
Cap (pF) 100	101	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
120	121	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
150	151	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
180	181	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
220	221	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
270	271	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
330	331	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
390	391	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
470	471	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
560	561	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
680	681	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
750	751	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
820	821	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
1000	102	X	X	X	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
1200	122	X	X	X	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
1500	152	X	X	X	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
1800	182	X	X	C	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
2200	222	X	X	X	C	C	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E		
2700	272	C	C		C	C	E	E		E	E	E	F	E	E	E	E	F	F		F	F	F	F	F	G	G		
3300	332	C	C		C	C	E			E	E	E	F	E	E	E	E	F	F		F	F	F	F	F	G	G		
3900	392	C	C		C	C	E			E	E	E	F		E	E	E	F			F	F	F	F	F	G	G		
4700	472	C	C		C	C	E			E	E	E	F		E	E	E	F			F	F	F	F	F	G	G		
5600	562	C	C		C	C	E			E	E	E	F		E	E	E	F			F	F	F	F	G	G	G		
6800	682	C	C		C	C	E			E	E	E			E	E	E	F			F	F	F	G	G				
8200	822	C	C		C	C	E			E	E	E			E	E	E				F	F	F	G	G				
Cap (μF) 0.010	103	C	C		C	C	E			E	E	E			E	E	E				F	F	F	G	G				
0.015	153	C	C		E	E	E			E	E	E			F	F	F				F	F	F	G					
0.018	183	C	C		E	E				E	E	E			F	F	F				F	F	G						
0.022	223	C	C		E	E				E	E	F			F	F	F				F	F	G						
0.027	273				E	E				E	E				F	F					F	F	G						
0.033	333				E	E				E	E				F	F					F	F	G						
0.039	393									E	E				F	F					F	F	G						
0.047	473									E	E				F	F					F	F	G						
0.056	563									F	F				F	F					F	F							
0.068	683									F	F				F	F					F	F							
0.082	823									F	F										F	F							
0.100	104									F	F										F	F							
0.150	154																							G	G				
0.220	224																							G	G				
0.270	274																												
0.330	334																												
0.390	394																												
0.470	474																												
0.560	564																												
0.680	684																												
0.820	824																												
1.000	105																												
Voltage (V)	600	630	1000	600	630	1000	1500	2000	600	630	1000	1500	2000	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000
Case Size	0805			1206					1210					1808								1812							

Letter	A	C	E	F	G	X	7
Max. Thickness	0.813 (0.032)	1.448 (0.057)	1.8034 (0.071)	2.2098 (0.087)	2.794 (0.110)	0.940 (0.037)	3.30 (0.130)

NOTE: Contact factory for non-specified capacitance values

High Voltage MLC Chips

For 600V to 5000V Applications



X7R CAPACITANCE RANGE

PREFERRED SIZES ARE SHADED

Case Size	1825								2220								2225								3640										
Soldering	Reflow Only								Reflow Only								Reflow Only								Reflow Only										
(L) Length	4.60 ± 0.50 (0.181 ± 0.020)								5.70 ± 0.50 (0.224 ± 0.020)								5.70 ± 0.50 (0.225 ± 0.010)								9.14 ± 0.25 (0.360 ± 0.010)										
(W) Width	6.30 ± 0.40 (0.248 ± 0.016)								5.00 ± 0.40 (0.197 ± 0.016)								6.30 ± 0.40 (0.250 ± 0.010)								10.2 ± 0.25 (0.400 ± 0.010)										
(T) Thickness	3.40 (0.134)								3.40 (0.134)								3.40 (0.100)								2.54 (0.100)										
(t) Terminal max	0.75 ± 0.35 (0.030 ± 0.014)								0.85 ± 0.35 (0.033 ± 0.014)								0.85 ± 0.35 (0.033 ± 0.014)								0.76 (0.030) 1.52 (0.060)										
Voltage (V)	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000
Cap (pF)	100	101																																	
120	121																																		
150	151																																		
180	181																																		
220	221																																		
270	271																																		
330	331																																		
390	391																																		
470	471																																		
560	561																																		
680	681																																		
750	751																																		
820	821																																		
1000	102	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
1200	122	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
1500	152	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
1800	182	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
2200	222	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
2700	272	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
3300	332	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
3900	392	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
4700	472	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
5600	562	F	F	F	F	F	F	F	F	F	F	F	F	F	F	G	F	F	F	F	F	F	F	F	G	G	G	G	G	G	G	G	G		
6800	682	F	F	F	G	G	G	G	F	F	F	F	F	G	G	F	F	F	F	F	G	G	G	G	G	G	G	G	G	G	G	G			
8200	822	F	F	F	G	G	G	G	F	F	F	G	G	G	G	F	F	F	F	F	G	G	G	G	G	G	G	G	G	G	G	G			
Cap (uF)	0.010	103	F	F	F	G	G	G	F	F	F	G	G	G	F	F	F	F	F	G	G	G	G	G	G	G	G	G	G	G	G				
0.015	153	F	F	F	G	G	G	F	F	F	G	G	G	F	F	F	G	G	G	G	G	G	G	G	G	G	G	G	G						
0.018	183	F	F	F	G	G		F	F	F	G	G	G	F	F	F	G	G	G	G	G	G	G	G	G	G	G	G							
0.022	223	F	F	F	G	G		F	F	F	G	G		F	F	F	G	G		G	G	G	G	G	G										
0.027	273	F	F	F	G			F	F	F	G	G		F	F	F	G	G		G	G	G	G	G	G										
0.033	333	F	F	F	G			F	F	F	G			F	F	F	G	G		G	G	G	G												
0.039	393	F	F	F	G			F	F	F	G			F	F	F	G		G	G	G	G													
0.047	473	F	F	F	P			F	F	F	G			F	F	F	G		G	G	G	G													
0.056	563	F	F	F	G			F	F	F	G			F	F	F	G		G	G	G	G													
0.068	683	F	F	G				F	F	G				F	F	F	G		G	G	G	G													
0.082	823	F	F	G				F	F	G				F	F	G			G	G															
0.100	104	F	F	G				F	F	G				F	F	G			G	G															
0.150	154	F	F					F	F	G				F	F	G			G	G															
0.220	224	F	F					F	F	G				F	F				G	G															
0.270	274	F	F					F	F					F	F				G	G															
0.330	334	F	F					F	F					F	F				G	G															
0.390	394	F	F					F	F					F	F				G	G															
0.470	474	F	F					F	F					F	F				G	G															
0.560	564	G	G					G	G					F	F				G	G															
0.680	684							G	G					G	G																				
0.820	824													G	G																				
1.000	105													G	G																				
Voltage (V)	600	630	1000	1500	2000	2500	3000	4000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000	600	630	1000	1500	2000	2500	3000	4000	5000
Case Size	1825								2220								2225								3640										

Letter	A	C	E	F	G	X	7
Max. Thickness	0.813 (0.032)	1.448 (0.057)	1.8034 (0.071)	2.2098 (0.087)	2.794 (0.110)	0.940 (0.037)	3.30 (0.130)

NOTE: Contact factory for non-specified capacitance values