

# Goldmax, 300 Series, Conformally Coated, COG Dielectric, 25 – 250 VDC (Commercial Grade)

## Overview

KEMET's Goldmax conformally coated radial leaded ceramic capacitors in COG dielectric feature a 125°C maximum operating temperature. The Electronics Industries Alliance (EIA) characterizes COG dielectric as a Class I "stable" material. Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with

respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to  $\pm 30$  ppm/°C from -55°C to +125°C.

These devices meet the flame test requirements outlined in UL Standard 94V-0.

## Benefits

- Radial leaded form factor
- Conformally coated
- 0.100", 0.200", 0.250" and 0.400" lead spacing
- Operating temperature range of -55°C to +125°C
- Lead (Pb)-Free, RoHS and REACH compliant
- DC voltage ratings of 25 V, 50 V, 100 V, 200 V and 250 V
- Capacitance offerings ranging from 1.0 pF up to 0.47  $\mu$ F



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## Ordering Information

| C       | 320        |     |     | C                        | 153                                                                                                      | J                                                                                     | 5                                                 | G          | 5                 | T                                           | A               | 7301                                                                  |
|---------|------------|-----|-----|--------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------|------------|-------------------|---------------------------------------------|-----------------|-----------------------------------------------------------------------|
| Ceramic | Style/Size |     |     | Specification/<br>Series | Capacitance<br>Code (pF)                                                                                 | Capacitance<br>Tolerance <sup>1</sup>                                                 | Rated Voltage<br>(VDC)                            | Dielectric | Design            | Lead<br>Finish <sup>2</sup>                 | Failure<br>Rate | Packaging<br>(C-Spec)                                                 |
|         | 315        | 324 | 335 | C =<br>Standard          | First two digits<br>represent<br>significant<br>figures. Third<br>digit specifies<br>number of<br>zeros. | D = $\pm 0.5$ pF<br>F = $\pm 1\%$<br>G = $\pm 2\%$<br>J = $\pm 5\%$<br>K = $\pm 10\%$ | 3 = 25<br>5 = 50<br>1 = 100<br>2 = 200<br>A = 250 | G =<br>COG | 5 =<br>Multilayer | T = 100%<br>Matte Sn<br>H = SnPb<br>(60/40) | A =<br>N/A      | See<br>"Packaging<br>C-Spec<br>Ordering<br>Options<br>Table"<br>below |
|         | 316        | 325 | 336 |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |
|         | 317        | 326 | 340 |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |
|         | 318        | 327 | 346 |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |
|         | 320        | 328 | 350 |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |
|         | 321        | 330 | 356 |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |
|         | 322        | 331 |     |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |
|         | 323        | 333 |     |                          |                                                                                                          |                                                                                       |                                                   |            |                   |                                             |                 |                                                                       |

<sup>1</sup> Additional capacitance tolerance offerings may be available. Contact KEMET for details.

<sup>2</sup> Lead materials:

Standard: 100% matte tin (Sn) with nickel (Ni) underplate and steel core ("T" designation).

Alternative 1: 60% tin (Sn)/40% lead (Pb) finish with copper-clad steel core ("H" designation).

Alternative 2: 60% tin (Sn)/40% lead (Pb) finish with 100% copper core (available with "H" designation code with C-Spec). Contact KEMET for C-Spec details.

## Benefits cont'd

- Available capacitance Tolerances of  $\pm 0.5$  pF,  $\pm 1\%$ ,  $\pm 2\%$ ,  $\pm 5\%$ , and  $\pm 10\%$
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- No capacitance decay with time
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated lead finish allowing for excellent solderability
- SnPb-plated lead finish option available upon request (Sn60/Pb40)
- Encapsulation meets flammability standard UL 94V-0

## Applications

Typical applications include critical timing, tuning, circuits requiring low loss, circuits with pulse, high current, decoupling, bypass, filtering, transient voltage suppression, blocking and energy storage.

## Application Notes

These devices are not recommended for use in overmold applications and/or processes.

## Packaging C-Spec Ordering Options Table

| Packaging Type <sup>1</sup>                     | Packaging/Grade Ordering Code (C-Spec) |
|-------------------------------------------------|----------------------------------------|
| Bulk Bag                                        | Not required (Blank)                   |
| 12" Tape & Reel (16.0 $\pm$ 0.5 mm lead length) | 7301                                   |
| 12" Tape & Reel (18.0 mm minimum lead length)   | 7303 and TR                            |
| Ammo Pack (16.0 $\pm$ 0.5 mm lead length)       | 7305                                   |
| Ammo Pack (18.0 mm minimum lead length)         | 7317                                   |

<sup>1</sup> Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging. Bulk bag option is required for Size/Style C321 and C331.

<sup>1</sup> "Tape and Reel" packaging option is not available for Size/Style C321 and C331. For more information see "Packaging Quantities".

<sup>1</sup> "Ammo Pack" packaging option is not available for Size/Style C321, C331, C350, and C356. For more information see "Packaging Quantities".

<sup>1</sup> "Ammo Pack" and "Tape and Reel" packaging options have the same lead tape configuration. For more information see "Tape & Reel Packaging Information".

## Dimensions – Inches (Millimeters)



\* May be supplied in a "Shoulder Bend" or "Straight" Lead configuration. Please see Capacitance Range Waterfall section of this document to determine lead configuration availability by capacitance value.

| Series | Style / Size | S<br>Lead Spacing<br>±0.030 (0.78) | L<br>Length<br>Maximum | H<br>Height<br>Maximum | T<br>Thickness<br>Maximum | F<br>Lead Diameter<br>+0.004 (0.10),<br>-0.001 (0.025) | LL<br>Lead Length<br>Minimum |
|--------|--------------|------------------------------------|------------------------|------------------------|---------------------------|--------------------------------------------------------|------------------------------|
| C31X   | 315          | 0.100 (2.54)                       | 0.150 (3.81)           | 0.120 (3.14)           | 0.100 (2.54)              | 0.020 (0.51)                                           | 0.276 (7.00)                 |
|        | 316          |                                    | 0.150 (3.81)           | 0.230 (5.84)           | 0.100 (2.54)              |                                                        | 0.200 (5.08)                 |
| C32X   | 324          |                                    | 0.200 (5.08)           | 0.230 (5.84)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 320          | 0.200 (5.08)                       | 0.200 (5.08)           | 0.230 (5.84)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 326          |                                    | 0.200 (5.08)           | 0.300 (7.62)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.200 (5.08)                 |
| C31X   | 317          | 0.200 (5.08)                       | 0.150 (3.81)           | 0.200 (5.08)           | 0.100 (2.54)              |                                                        | 0.276 (7.00)                 |
|        | 318          |                                    | 0.150 (3.81)           | 0.235 (5.97)           | 0.100 (2.54)              |                                                        | 0.276 (7.00)                 |
| C32X   | 321          | 0.250 (6.35)                       | 0.200 (5.08)           | 0.260 (6.60)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 322          | 0.200 (5.08)                       | 0.200 (5.08)           | 0.260 (6.60)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 323          |                                    | 0.200 (5.08)           | 0.300 (7.62)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 325          |                                    | 0.200 (5.08)           | 0.300 (7.62)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 328          |                                    | 0.200 (5.08)           | 0.300 (7.62)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.276 (7.00)                 |
|        | 327          |                                    | 0.200 (5.08)           | 0.320 (8.13)           | 0.125 (3.18) <sup>1</sup> |                                                        | 0.200 (5.08)                 |
| C33X   | 330          | 0.250 (6.35)                       | 0.280 (7.11)           | 0.360 (9.14)           | 0.160 (4.07)              | 0.025 (0.64)                                           | 0.276 (7.00)                 |
|        | 331          |                                    | 0.280 (7.11)           | 0.360 (9.14)           | 0.160 (4.07)              |                                                        | 0.276 (7.00)                 |
|        | 333          | 0.200 (5.08)                       | 0.280 (7.11)           | 0.400 (10.16)          | 0.160 (4.07)              |                                                        | 0.276 (7.00)                 |
|        | 335          |                                    | 0.280 (7.11)           | 0.400 (10.16)          | 0.160 (4.07)              |                                                        | 0.276 (7.00)                 |
|        | 336          |                                    | 0.280 (7.11)           | 0.400 (10.16)          | 0.160 (4.07)              |                                                        | 0.200 (5.08)                 |
| C34X   | 340          | 0.400 (10.16)                      | 0.290 (7.36)           | 0.400 (10.16)          | 0.160 (4.07)              |                                                        | 0.276 (7.00)                 |
|        | 346          |                                    | 0.290 (7.36)           | 0.400 (10.16)          | 0.160 (4.07)              |                                                        | 0.200 (5.08)                 |
| C35X   | 350          | 0.400 (10.16)                      | 0.330 (8.38)           | 0.400 (10.16)          | 0.200 (5.08)              |                                                        | 0.276 (7.00)                 |
|        | 356          |                                    | 0.330 (8.38)           | 0.400 (10.16)          | 0.200 (5.08)              |                                                        | 0.200 (5.08)                 |

<sup>1</sup> Thickness maximum (T) = 0.160" (4.07 mm) for capacitance values greater than or equal to 4.7 µF

## Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 2, Performance & Reliability.

## Environmental Compliance

Lead (Pb)-free, REACH and RoHS compliant without exemptions when ordered with a 100% tin (Sn) wire lead finish. Product ordered with tin/ lead (Sn60/Pb40) wire lead finish do not meet RoHS criteria.

| Series     | Termination Finish (Wire Lead) | RoHS Compliant | RoHS Exemption Code | REACH Compliant <sup>1</sup> | Halogen Free |
|------------|--------------------------------|----------------|---------------------|------------------------------|--------------|
| 300 (C3XX) | 100% Matte Sn                  | Yes            | n/a                 | Yes                          | Yes          |
|            | Sn60/Pb40                      | No             | n/a                 | Yes                          | Yes          |

<sup>1</sup> REACH compliance indicates product does not contain Substance/s of Very High Concern (SVHC)

## 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) | ±30 ppm/°C                                                                              |
| Aging Rate (Maximum % Cap Loss/Decade Hour)                        | 0%                                                                                      |
| Dielectric Withstanding Voltage                                    | 250% of rated voltage<br>(5±1 second and charge/discharge not exceeding 50 mA at 25°C)  |
| Dissipation Factor (DF) Maximum Limit at 25°C                      | 0.1%                                                                                    |
| Insulation Resistance (IR) Limit at 25°C                           | 1,000 megohm microfarads or 100 GΩ<br>(Rated voltage applied for 120±5 seconds at 25°C) |

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

Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 V<sub>rms</sub> ±0.2 V if capacitance ≤ 1,000 pF

1 kHz ±50 Hz and 1.0 V<sub>rms</sub> ±0.2 V if capacitance > 1,000 pF

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

## Post Environmental Limits

| High Temperature Life, Biased Humidity and Storage Life |                  |                   |                                |                   |                       |
|---------------------------------------------------------|------------------|-------------------|--------------------------------|-------------------|-----------------------|
| Style/Size                                              | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| C0G                                                     | All              | All               | 0.5                            | 0.3% or ±0.25 pF  | 10% of Initial Limit  |

**Table 1A – C31X Style/Size, Capacitance Range Waterfall**

| C315, C316, C317, C318 Style/Size (0.100" and 0.200" Lead Spacing) |                                           |                                          |     |     |     |     |
|--------------------------------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|-----|-----|
| Rated Voltage (VDC)                                                |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                       |                                           | 3                                        | 5   | 1   | 2   | A   |
| Capacitance                                                        | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |     |     |
| 1pF                                                                | D = ±0.5pF                                | 109                                      | 109 | 109 | 109 | 109 |
| 1.1pF                                                              |                                           | 119                                      | 119 | 119 | 119 | 119 |
| 1.2pF                                                              |                                           | 129                                      | 129 | 129 | 129 | 129 |
| 1.3pF                                                              |                                           | 139                                      | 139 | 139 | 139 | 139 |
| 1.5pF                                                              |                                           | 159                                      | 159 | 159 | 159 | 159 |
| 1.6pF                                                              |                                           | 169                                      | 169 | 169 | 169 | 169 |
| 1.8pF                                                              |                                           | 189                                      | 189 | 189 | 189 | 189 |
| 2.0pF                                                              |                                           | 209                                      | 209 | 209 | 209 | 209 |
| 2.2pF                                                              |                                           | 229                                      | 229 | 229 | 229 | 229 |
| 2.4pF                                                              |                                           | 249                                      | 249 | 249 | 249 | 249 |
| 2.7pF                                                              |                                           | 279                                      | 279 | 279 | 279 | 279 |
| 3.0pF                                                              |                                           | 309                                      | 309 | 309 | 309 | 309 |
| 3.3pF                                                              |                                           | 339                                      | 339 | 339 | 339 | 339 |
| 3.6pF                                                              |                                           | 369                                      | 369 | 369 | 369 | 369 |
| 3.9pF                                                              |                                           | 399                                      | 399 | 399 | 399 | 399 |
| 4.3pF                                                              |                                           | 439                                      | 439 | 439 | 439 | 439 |
| 4.7pF                                                              |                                           | 479                                      | 479 | 479 | 479 | 479 |
| 5.1pF                                                              |                                           | 519                                      | 519 | 519 | 519 | 519 |
| 5.6pF                                                              |                                           | 569                                      | 569 | 569 | 569 | 569 |
| 6.2pF                                                              |                                           | 629                                      | 629 | 629 | 629 | 629 |
| 6.8pF                                                              |                                           | 689                                      | 689 | 689 | 689 | 689 |
| 7.5pF                                                              | 759                                       | 759                                      | 759 | 759 | 759 |     |
| 8.2pF                                                              | 829                                       | 829                                      | 829 | 829 | 829 |     |
| 9.1pF                                                              | 919                                       | 919                                      | 919 | 919 | 919 |     |
| 10pF                                                               | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 100                                      | 100 | 100 | 100 | 100 |
| 11pF                                                               |                                           | 110                                      | 110 | 110 | 110 | 110 |
| 12pF                                                               |                                           | 120                                      | 120 | 120 | 120 | 120 |
| 13pF                                                               |                                           | 130                                      | 130 | 130 | 130 | 130 |
| 15pF                                                               |                                           | 150                                      | 150 | 150 | 150 | 150 |
| 16pF                                                               |                                           | 160                                      | 160 | 160 | 160 | 160 |
| 18pF                                                               |                                           | 180                                      | 180 | 180 | 180 | 180 |
| 20pF                                                               |                                           | 200                                      | 200 | 200 | 200 | 200 |
| 22pF                                                               |                                           | 220                                      | 220 | 220 | 220 | 220 |
| 24pF                                                               |                                           | 240                                      | 240 | 240 | 240 | 240 |
| 27pF                                                               |                                           | 270                                      | 270 | 270 | 270 | 270 |
| 30pF                                                               |                                           | 300                                      | 300 | 300 | 300 | 300 |
| 33pF                                                               |                                           | 330                                      | 330 | 330 | 330 | 330 |
| 36pF                                                               |                                           | 360                                      | 360 | 360 | 360 | 360 |
| 39pF                                                               |                                           | 390                                      | 390 | 390 | 390 | 390 |
| 43pF                                                               |                                           | 430                                      | 430 | 430 | 430 | 430 |
| 47pF                                                               |                                           | 470                                      | 470 | 470 | 470 | 470 |
| 51pF                                                               |                                           | 510                                      | 510 | 510 | 510 | 510 |
| 56pF                                                               |                                           | 560                                      | 560 | 560 | 560 | 560 |
| 62pF                                                               |                                           | 620                                      | 620 | 620 | 620 | 620 |
| 68pF                                                               |                                           | 680                                      | 680 | 680 | 680 | 680 |
| 75pF                                                               | 750                                       | 750                                      | 750 | 750 | 750 |     |
| 82pF                                                               | 820                                       | 820                                      | 820 | 820 | 820 |     |
| 91pF                                                               | 910                                       | 910                                      | 910 | 910 | 910 |     |
| 100pF                                                              | 101                                       | 101                                      | 101 | 101 | 101 |     |
| 110pF                                                              | 111                                       | 111                                      | 111 | 111 | 111 |     |
| 120pF                                                              | 121                                       | 121                                      | 121 | 121 | 121 |     |
| 130pF                                                              | 131                                       | 131                                      | 131 | 131 | 131 |     |
| 150pF                                                              | 151                                       | 151                                      | 151 | 151 | 151 |     |
| 160pF                                                              | 161                                       | 161                                      | 161 | 161 | 161 |     |
| 180pF                                                              | 181                                       | 181                                      | 181 | 181 | 181 |     |
| 200pF                                                              | 201                                       | 201                                      | 201 | 201 | 201 |     |
| Rated Voltage (VDC)                                                |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                       |                                           | 3                                        | 5   | 1   | 2   | A   |

These products are protected under one or more of the following United States Patents and their non-US counterparts: US Pat. No. 7172985; U.S. Pat. No. 7670981.

**Table 1A – C31X Style/Size, Capacitance Range Waterfall cont'd**

| C315, C316, C317, C318 Style/Size (0.100" and 0.200" Lead Spacing) |                                           |                                          |     |     |     |     |
|--------------------------------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|-----|-----|
| Rated Voltage (VDC)                                                |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                       |                                           | 3                                        | 5   | 1   | 2   | A   |
| Capacitance                                                        | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |     |     |
| 220pF                                                              | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 221                                      | 221 | 221 | 221 | 221 |
| 240pF                                                              |                                           | 241                                      | 241 | 241 | 241 | 241 |
| 270pF                                                              |                                           | 271                                      | 271 | 271 | 271 | 271 |
| 300pF                                                              |                                           | 301                                      | 301 | 301 | 301 | 301 |
| 330pF                                                              |                                           | 331                                      | 331 | 331 | 331 | 331 |
| 360pF                                                              |                                           | 361                                      | 361 | 361 | 361 | 361 |
| 390pF                                                              |                                           | 391                                      | 391 | 391 | 391 | 391 |
| 430pF                                                              |                                           | 431                                      | 431 | 431 | 431 | 431 |
| 470pF                                                              |                                           | 471                                      | 471 | 471 | 471 | 471 |
| 510pF                                                              |                                           | 511                                      | 511 | 511 | 511 | 511 |
| 560pF                                                              |                                           | 561                                      | 561 | 561 | 561 | 561 |
| 620pF                                                              |                                           | 621                                      | 621 | 621 | 621 | 621 |
| 680pF                                                              |                                           | 681                                      | 681 | 681 | 681 | 681 |
| 750pF                                                              |                                           | 751                                      | 751 | 751 | 751 | 751 |
| 820pF                                                              |                                           | 821                                      | 821 | 821 | 821 | 821 |
| 910pF                                                              |                                           | 911                                      | 911 | 911 | 911 | 911 |
| 1000pF                                                             |                                           | 102                                      | 102 | 102 | 102 | 102 |
| 1100pF                                                             |                                           | 112                                      | 112 | 112 | 112 | 112 |
| 1200pF                                                             |                                           | 122                                      | 122 | 122 | 122 | 122 |
| 1300pF                                                             |                                           | 132                                      | 132 | 132 | 132 | 132 |
| 1500pF                                                             |                                           | 152                                      | 152 | 152 | 152 | 152 |
| 1600pF                                                             |                                           | 162                                      | 162 | 162 | 162 | 162 |
| 1800pF                                                             |                                           | 182                                      | 182 | 182 | 182 | 182 |
| 2000pF                                                             |                                           | 202                                      | 202 | 202 | 202 | 202 |
| 2200pF                                                             |                                           | 222                                      | 222 | 222 | 222 | 222 |
| 2400pF                                                             |                                           | 242                                      | 242 | 242 | 242 | 242 |
| 2700pF                                                             |                                           | 272                                      | 272 | 272 | 272 | 272 |
| 3000pF                                                             |                                           | 302                                      | 302 | 302 | 302 | 302 |
| 3300pF                                                             |                                           | 332                                      | 332 | 332 | 332 | 332 |
| 3600pF                                                             |                                           | 362                                      | 362 | 362 | 362 | 362 |
| 3900pF                                                             |                                           | 392                                      | 392 | 392 | 392 | 392 |
| 4300pF                                                             |                                           | 432                                      | 432 | 432 | 432 | 432 |
| 4700pF                                                             |                                           | 472                                      | 472 | 472 | 472 | 472 |
| 5100pF                                                             |                                           | 512                                      | 512 | 512 | 512 | 512 |
| 5600pF                                                             |                                           | 562                                      | 562 | 562 | 562 | 562 |
| 6200pF                                                             |                                           | 622                                      | 622 | 622 | 622 | 622 |
| 6800pF                                                             |                                           | 682                                      | 682 | 682 | 682 | 682 |
| 7500pF                                                             |                                           | 752                                      | 752 | 752 | 752 | 752 |
| 8200pF                                                             |                                           | 822                                      | 822 | 822 | 822 | 822 |
| 9100pF                                                             |                                           | 912                                      | 912 | 912 |     |     |
| 0.01μF                                                             |                                           | 103                                      | 103 | 103 |     |     |
| 0.012μF                                                            |                                           | 123                                      | 123 | 123 |     |     |
| 0.015μF                                                            |                                           | 153                                      | 153 | 153 |     |     |
| 0.018μF                                                            |                                           | 183                                      | 183 |     |     |     |
| 0.022μF                                                            |                                           | 223                                      | 223 |     |     |     |
| 0.027μF                                                            |                                           | 273                                      |     |     |     |     |
| 0.033μF                                                            |                                           | 333                                      |     |     |     |     |
| 0.039μF                                                            | 393                                       |                                          |     |     |     |     |
| 0.047μF                                                            | 473                                       |                                          |     |     |     |     |
| Rated Voltage (VDC)                                                |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                       |                                           | 3                                        | 5   | 1   | 2   | A   |

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**Table 1B – C32X Style/Size, Capacitance Range Waterfall**

| C320, C322, C323, C326, C328 Style/Size (0.100" and 0.200" Lead Spacing) |                                           |                                          |     |     |     |     |
|--------------------------------------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|-----|-----|
| Rated Voltage (VDC)                                                      |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                             |                                           | 3                                        | 5   | 1   | 2   | A   |
| Capacitance                                                              | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |     |     |
| 1pF                                                                      | D = ±0.5pF                                | 109                                      | 109 | 109 | 109 | 109 |
| 1.1pF                                                                    |                                           | 119                                      | 119 | 119 | 119 | 119 |
| 1.2pF                                                                    |                                           | 129                                      | 129 | 129 | 129 | 129 |
| 1.3pF                                                                    |                                           | 139                                      | 139 | 139 | 139 | 139 |
| 1.5pF                                                                    |                                           | 159                                      | 159 | 159 | 159 | 159 |
| 1.6pF                                                                    |                                           | 169                                      | 169 | 169 | 169 | 169 |
| 1.8pF                                                                    |                                           | 189                                      | 189 | 189 | 189 | 189 |
| 2.0pF                                                                    |                                           | 209                                      | 209 | 209 | 209 | 209 |
| 2.2pF                                                                    |                                           | 229                                      | 229 | 229 | 229 | 229 |
| 2.4pF                                                                    |                                           | 249                                      | 249 | 249 | 249 | 249 |
| 2.7pF                                                                    |                                           | 279                                      | 279 | 279 | 279 | 279 |
| 3.0pF                                                                    |                                           | 309                                      | 309 | 309 | 309 | 309 |
| 3.3pF                                                                    |                                           | 339                                      | 339 | 339 | 339 | 339 |
| 3.6pF                                                                    |                                           | 369                                      | 369 | 369 | 369 | 369 |
| 3.9pF                                                                    |                                           | 399                                      | 399 | 399 | 399 | 399 |
| 4.3pF                                                                    |                                           | 439                                      | 439 | 439 | 439 | 439 |
| 4.7pF                                                                    |                                           | 479                                      | 479 | 479 | 479 | 479 |
| 5.1pF                                                                    |                                           | 519                                      | 519 | 519 | 519 | 519 |
| 5.6pF                                                                    |                                           | 569                                      | 569 | 569 | 569 | 569 |
| 6.2pF                                                                    |                                           | 629                                      | 629 | 629 | 629 | 629 |
| 6.8pF                                                                    |                                           | 689                                      | 689 | 689 | 689 | 689 |
| 7.5pF                                                                    | 759                                       | 759                                      | 759 | 759 | 759 |     |
| 8.2pF                                                                    | 829                                       | 829                                      | 829 | 829 | 829 |     |
| 9.1pF                                                                    | 919                                       | 919                                      | 919 | 919 | 919 |     |
| 10pF                                                                     | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 100                                      | 100 | 100 | 100 | 100 |
| 11pF                                                                     |                                           | 110                                      | 110 | 110 | 110 | 110 |
| 12pF                                                                     |                                           | 120                                      | 120 | 120 | 120 | 120 |
| 13pF                                                                     |                                           | 130                                      | 130 | 130 | 130 | 130 |
| 15pF                                                                     |                                           | 150                                      | 150 | 150 | 150 | 150 |
| 16pF                                                                     |                                           | 160                                      | 160 | 160 | 160 | 160 |
| 18pF                                                                     |                                           | 180                                      | 180 | 180 | 180 | 180 |
| 20pF                                                                     |                                           | 200                                      | 200 | 200 | 200 | 200 |
| 22pF                                                                     |                                           | 220                                      | 220 | 220 | 220 | 220 |
| 24pF                                                                     |                                           | 240                                      | 240 | 240 | 240 | 240 |
| 27pF                                                                     |                                           | 270                                      | 270 | 270 | 270 | 270 |
| 30pF                                                                     |                                           | 300                                      | 300 | 300 | 300 | 300 |
| 33pF                                                                     |                                           | 330                                      | 330 | 330 | 330 | 330 |
| 36pF                                                                     |                                           | 360                                      | 360 | 360 | 360 | 360 |
| 39pF                                                                     |                                           | 390                                      | 390 | 390 | 390 | 390 |
| 43pF                                                                     |                                           | 430                                      | 430 | 430 | 430 | 430 |
| 47pF                                                                     |                                           | 470                                      | 470 | 470 | 470 | 470 |
| 51pF                                                                     |                                           | 510                                      | 510 | 510 | 510 | 510 |
| 56pF                                                                     |                                           | 560                                      | 560 | 560 | 560 | 560 |
| 62pF                                                                     |                                           | 620                                      | 620 | 620 | 620 | 620 |
| 68pF                                                                     |                                           | 680                                      | 680 | 680 | 680 | 680 |
| 75pF                                                                     | 750                                       | 750                                      | 750 | 750 | 750 |     |
| 82pF                                                                     | 820                                       | 820                                      | 820 | 820 | 820 |     |
| 91pF                                                                     | 910                                       | 910                                      | 910 | 910 | 910 |     |
| 100pF                                                                    | 101                                       | 101                                      | 101 | 101 | 101 |     |
| 110pF                                                                    | 111                                       | 111                                      | 111 | 111 | 111 |     |
| 120pF                                                                    | 121                                       | 121                                      | 121 | 121 | 121 |     |
| 130pF                                                                    | 131                                       | 131                                      | 131 | 131 | 131 |     |
| 150pF                                                                    | 151                                       | 151                                      | 151 | 151 | 151 |     |
| 160pF                                                                    | 161                                       | 161                                      | 161 | 161 | 161 |     |
| 180pF                                                                    | 181                                       | 181                                      | 181 | 181 | 181 |     |
| 200pF                                                                    | 201                                       | 201                                      | 201 | 201 | 201 |     |
| Rated Voltage (VDC)                                                      |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                             |                                           | 3                                        | 5   | 1   | 2   | A   |

These products are protected under one or more of the following United States Patents and their non-US counterparts: US Pat. No. 7172985; U.S. Pat. No. 7670981.

**Table 1B – C32X Style/Size, Capacitance Range Waterfall cont'd**

| C320, C322, C323, C326, C328 Style/Size (0.100" and 0.200" Lead Spacing) |                                           |                                          |     |     |     |     |
|--------------------------------------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|-----|-----|
| Rated Voltage (VDC)                                                      |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                             |                                           | 3                                        | 5   | 1   | 2   | A   |
| Capacitance                                                              | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |     |     |
| 220pF                                                                    | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 221                                      | 221 | 221 | 221 | 221 |
| 240pF                                                                    |                                           | 241                                      | 241 | 241 | 241 | 241 |
| 270pF                                                                    |                                           | 271                                      | 271 | 271 | 271 | 271 |
| 300pF                                                                    |                                           | 301                                      | 301 | 301 | 301 | 301 |
| 330pF                                                                    |                                           | 331                                      | 331 | 331 | 331 | 331 |
| 360pF                                                                    |                                           | 361                                      | 361 | 361 | 361 | 361 |
| 390pF                                                                    |                                           | 391                                      | 391 | 391 | 391 | 391 |
| 430pF                                                                    |                                           | 431                                      | 431 | 431 | 431 | 431 |
| 470pF                                                                    |                                           | 471                                      | 471 | 471 | 471 | 471 |
| 510pF                                                                    |                                           | 511                                      | 511 | 511 | 511 | 511 |
| 560pF                                                                    |                                           | 561                                      | 561 | 561 | 561 | 561 |
| 620pF                                                                    |                                           | 621                                      | 621 | 621 | 621 | 621 |
| 680pF                                                                    |                                           | 681                                      | 681 | 681 | 681 | 681 |
| 750pF                                                                    |                                           | 751                                      | 751 | 751 | 751 | 751 |
| 820pF                                                                    |                                           | 821                                      | 821 | 821 | 821 | 821 |
| 910pF                                                                    |                                           | 911                                      | 911 | 911 | 911 | 911 |
| 1000pF                                                                   |                                           | 102                                      | 102 | 102 | 102 | 102 |
| 1100pF                                                                   |                                           | 112                                      | 112 | 112 | 112 | 112 |
| 1200pF                                                                   |                                           | 122                                      | 122 | 122 | 122 | 122 |
| 1300pF                                                                   |                                           | 132                                      | 132 | 132 | 132 | 132 |
| 1500pF                                                                   |                                           | 152                                      | 152 | 152 | 152 | 152 |
| 1600pF                                                                   |                                           | 162                                      | 162 | 162 | 162 | 162 |
| 1800pF                                                                   |                                           | 182                                      | 182 | 182 | 182 | 182 |
| 2000pF                                                                   |                                           | 202                                      | 202 | 202 | 202 | 202 |
| 2200pF                                                                   |                                           | 222                                      | 222 | 222 | 222 | 222 |
| 2400pF                                                                   |                                           | 242                                      | 242 | 242 | 242 | 242 |
| 2700pF                                                                   |                                           | 272                                      | 272 | 272 | 272 | 272 |
| 3000pF                                                                   |                                           | 302                                      | 302 | 302 | 302 | 302 |
| 3300pF                                                                   |                                           | 332                                      | 332 | 332 | 332 | 332 |
| 3600pF                                                                   |                                           | 362                                      | 362 | 362 | 362 | 362 |
| 3900pF                                                                   |                                           | 392                                      | 392 | 392 | 392 | 392 |
| 4300pF                                                                   |                                           | 432                                      | 432 | 432 | 432 | 432 |
| 4700pF                                                                   |                                           | 472                                      | 472 | 472 | 472 | 472 |
| 5100pF                                                                   |                                           | 512                                      | 512 | 512 | 512 | 512 |
| 5600pF                                                                   |                                           | 562                                      | 562 | 562 | 562 | 562 |
| 6200pF                                                                   |                                           | 622                                      | 622 | 622 | 622 | 622 |
| 6800pF                                                                   |                                           | 682                                      | 682 | 682 | 682 | 682 |
| 7500pF                                                                   |                                           | 752                                      | 752 | 752 | 752 | 752 |
| 8200pF                                                                   |                                           | 822                                      | 822 | 822 | 822 | 822 |
| 9100pF                                                                   |                                           | 912                                      | 912 | 912 | 912 | 912 |
| 0.01μF                                                                   |                                           | 103                                      | 103 | 103 | 103 | 103 |
| 0.012μF                                                                  |                                           | 123                                      | 123 | 123 | 123 | 123 |
| 0.015μF                                                                  |                                           | 153                                      | 153 | 153 | 153 | 153 |
| 0.018μF                                                                  |                                           | 183                                      | 183 | 183 | 183 | 183 |
| 0.022μF                                                                  |                                           | 223                                      | 223 | 223 | 223 | 223 |
| 0.027μF                                                                  |                                           | 273                                      | 273 | 273 | 273 | 273 |
| 0.033μF                                                                  |                                           | 333                                      | 333 | 333 | 333 | 333 |
| 0.039μF                                                                  |                                           | 393                                      | 393 | 393 | 393 | 393 |
| 0.047μF                                                                  | 473                                       | 473                                      | 473 | 473 | 473 |     |
| 0.056μF                                                                  | 563                                       | 563                                      | 563 |     |     |     |
| 0.068μF                                                                  | 683                                       | 683                                      | 683 |     |     |     |
| 0.082μF                                                                  | 823                                       | 823                                      | 823 |     |     |     |
| 0.100μF                                                                  | 104                                       | 104                                      | 104 |     |     |     |
| 0.120μF                                                                  | 124                                       | 124                                      |     |     |     |     |
| 0.150μF                                                                  | 154                                       | 154                                      |     |     |     |     |
| 0.180μF                                                                  | 184                                       |                                          |     |     |     |     |
| Rated Voltage (VDC)                                                      |                                           | 25                                       | 50  | 100 | 200 | 250 |
| Voltage Code                                                             |                                           | 3                                        | 5   | 1   | 2   | A   |

These products are protected under one or more of the following United States Patents and their non-US counterparts: US Pat. No. 7172985; U.S. Pat. No. 7670981.

**Table 1C – C32X Style/Size, Capacitance Range Waterfall**

| C321, C324, C325, C327 Style/Size (0.100" and 0.200" Lead Spacing) |                                           |                                          |     |     |     |  |
|--------------------------------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|-----|--|
| Rated Voltage (VDC)                                                |                                           | 50                                       | 100 | 200 | 250 |  |
| Voltage Code                                                       |                                           | 5                                        | 1   | 2   | A   |  |
| Capacitance                                                        | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |     |  |
| 1pF                                                                | D = ±0.5pF                                | 109                                      | 109 | 109 | 109 |  |
| 1.1pF                                                              |                                           | 119                                      | 119 | 119 | 119 |  |
| 1.2pF                                                              |                                           | 129                                      | 129 | 129 | 129 |  |
| 1.3pF                                                              |                                           | 139                                      | 139 | 139 | 139 |  |
| 1.5pF                                                              |                                           | 159                                      | 159 | 159 | 159 |  |
| 1.6pF                                                              |                                           | 169                                      | 169 | 169 | 169 |  |
| 1.8pF                                                              |                                           | 189                                      | 189 | 189 | 189 |  |
| 2.0pF                                                              |                                           | 209                                      | 209 | 209 | 209 |  |
| 2.2pF                                                              |                                           | 229                                      | 229 | 229 | 229 |  |
| 2.4pF                                                              |                                           | 249                                      | 249 | 249 | 249 |  |
| 2.7pF                                                              |                                           | 279                                      | 279 | 279 | 279 |  |
| 3.0pF                                                              |                                           | 309                                      | 309 | 309 | 309 |  |
| 3.3pF                                                              |                                           | 339                                      | 339 | 339 | 339 |  |
| 3.6pF                                                              |                                           | 369                                      | 369 | 369 | 369 |  |
| 3.9pF                                                              |                                           | 399                                      | 399 | 399 | 399 |  |
| 4.3pF                                                              |                                           | 439                                      | 439 | 439 | 439 |  |
| 4.7pF                                                              |                                           | 479                                      | 479 | 479 | 479 |  |
| 5.1pF                                                              |                                           | 519                                      | 519 | 519 | 519 |  |
| 5.6pF                                                              |                                           | 569                                      | 569 | 569 | 569 |  |
| 6.2pF                                                              |                                           | 629                                      | 629 | 629 | 629 |  |
| 6.8pF                                                              |                                           | 689                                      | 689 | 689 | 689 |  |
| 7.5pF                                                              |                                           | 759                                      | 759 | 759 | 759 |  |
| 8.2pF                                                              |                                           | 829                                      | 829 | 829 | 829 |  |
| 9.1pF                                                              |                                           | 919                                      | 919 | 919 | 919 |  |
| 10pF                                                               | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 100                                      | 100 | 100 | 100 |  |
| 11pF                                                               |                                           | 110                                      | 110 | 110 | 110 |  |
| 12pF                                                               |                                           | 120                                      | 120 | 120 | 120 |  |
| 13pF                                                               |                                           | 130                                      | 130 | 130 | 130 |  |
| 15pF                                                               |                                           | 150                                      | 150 | 150 | 150 |  |
| 16pF                                                               |                                           | 160                                      | 160 | 160 | 160 |  |
| 18pF                                                               |                                           | 180                                      | 180 | 180 | 180 |  |
| 20pF                                                               |                                           | 200                                      | 200 | 200 | 200 |  |
| 22pF                                                               |                                           | 220                                      | 220 | 220 | 220 |  |
| 24pF                                                               |                                           | 240                                      | 240 | 240 | 240 |  |
| 27pF                                                               |                                           | 270                                      | 270 | 270 | 270 |  |
| 30pF                                                               |                                           | 300                                      | 300 | 300 | 300 |  |
| 33pF                                                               |                                           | 330                                      | 330 | 330 | 330 |  |
| 36pF                                                               |                                           | 360                                      | 360 | 360 | 360 |  |
| 39pF                                                               |                                           | 390                                      | 390 | 390 | 390 |  |
| 43pF                                                               |                                           | 430                                      | 430 | 430 | 430 |  |
| 47pF                                                               |                                           | 470                                      | 470 | 470 | 470 |  |
| 51pF                                                               |                                           | 510                                      | 510 | 510 | 510 |  |
| 56pF                                                               |                                           | 560                                      | 560 | 560 | 560 |  |
| 62pF                                                               |                                           | 620                                      | 620 | 620 | 620 |  |
| 68pF                                                               |                                           | 680                                      | 680 | 680 | 680 |  |
| 75pF                                                               |                                           | 750                                      | 750 | 750 | 750 |  |
| 82pF                                                               |                                           | 820                                      | 820 | 820 | 820 |  |
| 91pF                                                               |                                           | 910                                      | 910 | 910 | 910 |  |
| 100pF                                                              |                                           | 101                                      | 101 | 101 | 101 |  |
| 110pF                                                              |                                           | 111                                      | 111 | 111 | 111 |  |
| 120pF                                                              |                                           | 121                                      | 121 | 121 | 121 |  |
| 130pF                                                              |                                           | 131                                      | 131 | 131 | 131 |  |
| 150pF                                                              |                                           | 151                                      | 151 | 151 | 151 |  |
| 160pF                                                              |                                           | 161                                      | 161 | 161 | 161 |  |
| 180pF                                                              |                                           | 181                                      | 181 | 181 | 181 |  |
| 200pF                                                              |                                           | 201                                      | 201 | 201 | 201 |  |
| Rated Voltage (VDC)                                                |                                           | 50                                       | 100 | 200 | 250 |  |
| Voltage Code                                                       |                                           | 5                                        | 1   | 2   | A   |  |

These products are protected under one or more of the following United States Patents and their non-US counterparts: US Pat. No. 7172985; U.S. Pat. No. 7670981.

**Table 1C – C32X Style/Size, Capacitance Range Waterfall cont'd**

| C321, C324, C325, C327 Style/Size (0.100" and 0.200" Lead Spacing) |                                           |                                          |     |     |     |  |
|--------------------------------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|-----|--|
| Rated Voltage (VDC)                                                |                                           | 50                                       | 100 | 200 | 250 |  |
| Voltage Code                                                       |                                           | 5                                        | 1   | 2   | A   |  |
| Capacitance                                                        | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |     |  |
| 220pF                                                              | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 221                                      | 221 | 221 | 221 |  |
| 240pF                                                              |                                           | 241                                      | 241 | 241 | 241 |  |
| 270pF                                                              |                                           | 271                                      | 271 | 271 | 271 |  |
| 300pF                                                              |                                           | 301                                      | 301 | 301 | 301 |  |
| 330pF                                                              |                                           | 331                                      | 331 | 331 | 331 |  |
| 360pF                                                              |                                           | 361                                      | 361 | 361 | 361 |  |
| 390pF                                                              |                                           | 391                                      | 391 | 391 | 391 |  |
| 430pF                                                              |                                           | 431                                      | 431 | 431 | 431 |  |
| 470pF                                                              |                                           | 471                                      | 471 | 471 | 471 |  |
| 510pF                                                              |                                           | 511                                      | 511 | 511 | 511 |  |
| 560pF                                                              |                                           | 561                                      | 561 | 561 | 561 |  |
| 620pF                                                              |                                           | 621                                      | 621 | 621 | 621 |  |
| 680pF                                                              |                                           | 681                                      | 681 | 681 | 681 |  |
| 750pF                                                              |                                           | 751                                      | 751 | 751 | 751 |  |
| 820pF                                                              |                                           | 821                                      | 821 | 821 | 821 |  |
| 910pF                                                              |                                           | 911                                      | 911 | 911 | 911 |  |
| 1000pF                                                             |                                           | 102                                      | 102 | 102 | 102 |  |
| 1100pF                                                             |                                           | 112                                      | 112 | 112 | 112 |  |
| 1200pF                                                             |                                           | 122                                      | 122 | 122 | 122 |  |
| 1300pF                                                             |                                           | 132                                      | 132 | 132 | 132 |  |
| 1500pF                                                             |                                           | 152                                      | 152 | 152 | 152 |  |
| 1600pF                                                             |                                           | 162                                      | 162 | 162 | 162 |  |
| 1800pF                                                             |                                           | 182                                      | 182 | 182 | 182 |  |
| 2000pF                                                             |                                           | 202                                      | 202 | 202 | 202 |  |
| 2200pF                                                             |                                           | 222                                      | 222 | 222 | 222 |  |
| 2400pF                                                             |                                           | 242                                      | 242 | 242 | 242 |  |
| 2700pF                                                             |                                           | 272                                      | 272 | 272 | 272 |  |
| 3000pF                                                             |                                           | 302                                      | 302 | 302 | 302 |  |
| 3300pF                                                             |                                           | 332                                      | 332 | 332 | 332 |  |
| 3600pF                                                             |                                           | 362                                      | 362 | 362 | 362 |  |
| 3900pF                                                             |                                           | 392                                      | 392 | 392 | 392 |  |
| 4300pF                                                             |                                           | 432                                      | 432 | 432 | 432 |  |
| 4700pF                                                             |                                           | 472                                      | 472 | 472 | 472 |  |
| 5100pF                                                             |                                           | 512                                      | 512 | 512 | 512 |  |
| 5600pF                                                             |                                           | 562                                      | 562 | 562 | 562 |  |
| 6200pF                                                             |                                           | 622                                      | 622 | 622 | 622 |  |
| 6800pF                                                             |                                           | 682                                      | 682 | 682 | 682 |  |
| 7500pF                                                             |                                           | 752                                      | 752 | 752 | 752 |  |
| 8200pF                                                             |                                           | 822                                      | 822 | 822 | 822 |  |
| 9100pF                                                             |                                           | 912                                      | 912 | 912 | 912 |  |
| 0.01μF                                                             |                                           | 103                                      | 103 | 103 | 103 |  |
| 0.012μF                                                            |                                           | 123                                      | 123 | 123 | 123 |  |
| 0.015μF                                                            |                                           | 153                                      | 153 | 153 | 153 |  |
| 0.018μF                                                            |                                           | 183                                      | 183 | 183 | 183 |  |
| 0.022μF                                                            |                                           | 223                                      | 223 | 223 | 223 |  |
| 0.027μF                                                            |                                           | 273                                      | 273 | 273 | 273 |  |
| 0.033μF                                                            |                                           | 333                                      | 333 | 333 | 333 |  |
| 0.039μF                                                            |                                           | 393                                      | 393 | 393 | 393 |  |
| 0.047μF                                                            |                                           | 473                                      | 473 | 473 | 473 |  |
| 0.056μF                                                            |                                           | 563                                      | 563 | 563 |     |  |
| 0.068μF                                                            |                                           | 683                                      | 683 | 683 |     |  |
| 0.082μF                                                            |                                           | 823                                      | 823 | 823 |     |  |
| 0.100μF                                                            |                                           | 104                                      | 104 | 104 |     |  |
| 0.120μF                                                            |                                           | 124                                      | 124 |     |     |  |
| 0.150μF                                                            |                                           | 154                                      | 154 |     |     |  |
| 0.180μF                                                            |                                           | 184                                      |     |     |     |  |
| Rated Voltage (VDC)                                                |                                           | 50                                       | 100 | 200 | 250 |  |
| Voltage Code                                                       |                                           | 5                                        | 1   | 2   | A   |  |

These products are protected under one or more of the following United States Patents and their non-US counterparts: US Pat. No. 7172985; U.S. Pat. No. 7670981.

**Table 1D – C33X Style/Size, Capacitance Range Waterfall**

| C330, C331, C333, C335, C336 Style/Size (0.200" and 0.250" Lead Spacing) |                                           |                                          |      |      |      |  |
|--------------------------------------------------------------------------|-------------------------------------------|------------------------------------------|------|------|------|--|
| Rated Voltage (VDC)                                                      |                                           | 50                                       | 100  | 200  | 250  |  |
| Voltage Code                                                             |                                           | 5                                        | 1    | 2    | A    |  |
| Capacitance                                                              | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |      |      |      |  |
| 470pF                                                                    | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 471*                                     | 471* | 471* | 471* |  |
| 510pF                                                                    |                                           | 511*                                     | 511* | 511* | 511* |  |
| 560pF                                                                    |                                           | 561*                                     | 561* | 561* | 561* |  |
| 620pF                                                                    |                                           | 621*                                     | 621* | 621* | 621* |  |
| 680pF                                                                    |                                           | 681*                                     | 681* | 681* | 681* |  |
| 750pF                                                                    |                                           | 751*                                     | 751* | 751* | 751* |  |
| 820pF                                                                    |                                           | 821*                                     | 821* | 821* | 821* |  |
| 910pF                                                                    |                                           | 911*                                     | 911* | 911* | 911* |  |
| 1000pF                                                                   |                                           | 102*                                     | 102* | 102* | 102* |  |
| 1100pF                                                                   |                                           | 112*                                     | 112* | 112* | 112* |  |
| 1200pF                                                                   |                                           | 122*                                     | 122* | 122* | 122* |  |
| 1300pF                                                                   |                                           | 132*                                     | 132* | 132* | 132* |  |
| 1500pF                                                                   |                                           | 152*                                     | 152* | 152* | 152* |  |
| 1600pF                                                                   |                                           | 162*                                     | 162* | 162* | 162* |  |
| 1800pF                                                                   |                                           | 182*                                     | 182* | 182* | 182* |  |
| 2000pF                                                                   |                                           | 202*                                     | 202* | 202* | 202* |  |
| 2200pF                                                                   |                                           | 222*                                     | 222* | 222* | 222* |  |
| 2400pF                                                                   |                                           | 242*                                     | 242* | 242* | 242* |  |
| 2700pF                                                                   |                                           | 272*                                     | 272* | 272* | 272* |  |
| 3000pF                                                                   |                                           | 302*                                     | 302* | 302* | 302* |  |
| 3300pF                                                                   |                                           | 332*                                     | 332* | 332* | 332* |  |
| 3600pF                                                                   |                                           | 362*                                     | 362* | 362* | 362* |  |
| 3900pF                                                                   |                                           | 392*                                     | 392* | 392* | 392* |  |
| 4300pF                                                                   |                                           | 432*                                     | 432* | 432* | 432* |  |
| 4700pF                                                                   |                                           | 472*                                     | 472* | 472* | 472* |  |
| 5100pF                                                                   |                                           | 512*                                     | 512* | 512* | 512* |  |
| 5600pF                                                                   |                                           | 562*                                     | 562* | 562* | 562* |  |
| 6200pF                                                                   |                                           | 622*                                     | 622* | 622* | 622* |  |
| 6800pF                                                                   |                                           | 682*                                     | 682* | 682* | 682* |  |
| 7500pF                                                                   |                                           | 752*                                     | 752* | 752* | 752* |  |
| 8200pF                                                                   |                                           | 822*                                     | 822* | 822* | 822* |  |
| 9100pF                                                                   |                                           | 912*                                     | 912* | 912* | 912* |  |
| 0.01µF                                                                   |                                           | 103*                                     | 103* | 103* | 103* |  |
| 0.012µF                                                                  |                                           | 123*                                     | 123* | 123* | 123* |  |
| 0.015µF                                                                  |                                           | 153*                                     | 153* | 153* | 153* |  |
| 0.018µF                                                                  |                                           | 183*                                     | 183* | 183* | 183* |  |
| 0.022µF                                                                  |                                           | 223*                                     | 223* | 223* | 223* |  |
| 0.027µF                                                                  |                                           | 273*                                     | 273* | 273* | 273* |  |
| 0.033µF                                                                  |                                           | 333*                                     | 333* | 333* | 333* |  |
| 0.039µF                                                                  |                                           | 393*                                     | 393* | 393* | 393* |  |
| 0.047µF                                                                  |                                           | 473*                                     | 473* | 473* | 473* |  |
| 0.056µF                                                                  |                                           | 563*                                     | 563* | 563  | 563  |  |
| 0.068µF                                                                  |                                           | 683*                                     | 683* | 683  | 683  |  |
| 0.082µF                                                                  |                                           | 823*                                     | 823* | 823  | 823  |  |
| 0.100µF                                                                  |                                           | 104*                                     | 104* | 104  | 104  |  |
| 0.120µF                                                                  |                                           | 124*                                     | 124  | 124  |      |  |
| 0.150µF                                                                  |                                           | 154*                                     | 154  | 154  |      |  |
| 0.180µF                                                                  |                                           | 184                                      | 184  | 184  |      |  |
| 0.220µF                                                                  |                                           | 224                                      | 224  |      |      |  |
| 0.270µF                                                                  |                                           | 274                                      | 274  |      |      |  |
| 0.330µF                                                                  |                                           | 334                                      | 334  |      |      |  |
| 0.390µF                                                                  |                                           | 394                                      |      |      |      |  |
| 0.470µF                                                                  |                                           | 474                                      |      |      |      |  |
| Rated Voltage (VDC)                                                      |                                           | 50                                       | 100  | 200  | 250  |  |
| Voltage Code                                                             |                                           | 5                                        | 1    | 2    | A    |  |

These products are protected under one or more of the following United States Patents and their non-US counterparts: US Pat. No. 7172985; U.S. Pat. No. 7670981.

\* Capacitor is supplied with a "Shoulder-Bend" lead configuration in Style/Size C330 and C331.

**Table 1E – C34X Style/Size, Capacitance Range Waterfall**

| C340, C346 Style/Size (0.200" Lead Spacing) |                                           |                                          |      |     |
|---------------------------------------------|-------------------------------------------|------------------------------------------|------|-----|
| Rated Voltage (VDC)                         |                                           | 50                                       | 100  | 200 |
| Voltage Code                                |                                           | 5                                        | 1    | 2   |
| Capacitance                                 | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |      |     |
| 0.01μF                                      | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 103*                                     | 103* | 103 |
| 0.012μF                                     |                                           | 123*                                     | 123  | 123 |
| 0.015μF                                     |                                           | 153                                      | 153  | 153 |
| 0.018μF                                     |                                           | 183                                      | 183  | 183 |
| 0.022μF                                     |                                           | 223                                      | 223  | 223 |
| 0.027μF                                     |                                           | 273                                      | 273  | 273 |
| 0.033μF                                     |                                           | 333                                      | 333  | 333 |
| 0.039μF                                     |                                           | 393                                      | 393  | 393 |
| 0.047μF                                     |                                           | 473                                      | 473  | 473 |
| 0.056μF                                     |                                           | 563                                      | 563  |     |
| 0.068μF                                     |                                           | 683                                      | 683  |     |
| Rated Voltage (VDC)                         |                                           | 50                                       | 100  | 200 |
| Voltage Code                                |                                           | 5                                        | 1    | 2   |

\* Capacitor is supplied with a "Shoulder-Bend" lead configuration in Style/Size C340

**Table 1F – C35X Style/Size, Capacitance Range Waterfall**

| C350, C356 Style/Size (0.400" Lead Spacing) |                                           |                                          |     |     |  |
|---------------------------------------------|-------------------------------------------|------------------------------------------|-----|-----|--|
| Rated Voltage (VDC)                         |                                           | 50                                       | 100 | 200 |  |
| Voltage Code                                |                                           | 5                                        | 1   | 2   |  |
| Capacitance                                 | Capacitance Tolerance                     | Capacitance Code (Available Capacitance) |     |     |  |
| 4700pF                                      | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10% | 472                                      | 472 | 472 |  |
| 5100pF                                      |                                           | 512                                      | 512 | 512 |  |
| 5600pF                                      |                                           | 562                                      | 562 | 562 |  |
| 6200pF                                      |                                           | 622                                      | 622 | 622 |  |
| 6800pF                                      |                                           | 682                                      | 682 | 682 |  |
| 7500pF                                      |                                           | 752                                      | 752 | 752 |  |
| 8200pF                                      |                                           | 822                                      | 822 | 822 |  |
| 9100pF                                      |                                           | 912                                      | 912 | 912 |  |
| 0.01μF                                      |                                           | 103                                      | 103 | 103 |  |
| 0.012μF                                     |                                           | 123                                      | 123 | 123 |  |
| 0.015μF                                     |                                           | 153                                      | 153 | 153 |  |
| 0.018μF                                     |                                           | 183                                      | 183 | 183 |  |
| 0.022μF                                     |                                           | 223                                      | 223 | 223 |  |
| 0.027μF                                     |                                           | 273                                      | 273 | 273 |  |
| 0.033μF                                     |                                           | 333                                      | 333 | 333 |  |
| 0.039μF                                     |                                           | 393                                      | 393 | 393 |  |
| 0.047μF                                     |                                           | 473                                      | 473 | 473 |  |
| 0.056μF                                     |                                           | 563                                      | 563 | 563 |  |
| 0.068μF                                     |                                           | 683                                      | 683 | 683 |  |
| 0.082μF                                     |                                           | 823                                      | 823 | 823 |  |
| 0.100μF                                     |                                           | 104                                      | 104 | 104 |  |
| 0.120μF                                     |                                           | 124                                      | 124 | 124 |  |
| 0.150μF                                     |                                           | 154                                      | 154 | 154 |  |
| 0.180μF                                     |                                           | 184                                      | 184 | 184 |  |
| 0.220μF                                     |                                           | 224                                      | 224 | 224 |  |
| 0.270μF                                     |                                           | 274                                      | 274 |     |  |
| 0.330μF                                     |                                           | 334                                      | 334 |     |  |
| 0.390μF                                     |                                           | 394                                      |     |     |  |
| 0.470μF                                     |                                           | 474                                      |     |     |  |
| Rated Voltage (VDC)                         |                                           | 50                                       | 100 | 200 |  |
| Voltage Code                                |                                           | 5                                        | 1   | 2   |  |

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## Soldering Process

### Recommended Soldering Methods:

- Solder Wave
- Hand Soldering (Manual)

### Recommended Soldering Profile:

- Optimum Wave Solder Profile



### Mounting

All encased capacitors will pass the Resistance to Soldering Heat of MIL-STD-202, Method 210, Condition C. This test simulates wave solder topside board mount product. This demonstration of resistance to solder heat is in accordance with what is believed to be the industry standard. More severe treatment must be considered reflective of an improper soldering process.

The above figure is a recommended solder wave profile for both axial and radial leaded ceramic capacitors.

- Hand Soldering (Manual)

### Manual Solder Profile with Pre-heating



**Table 2 – Performance & Reliability: Test Methods and Conditions**

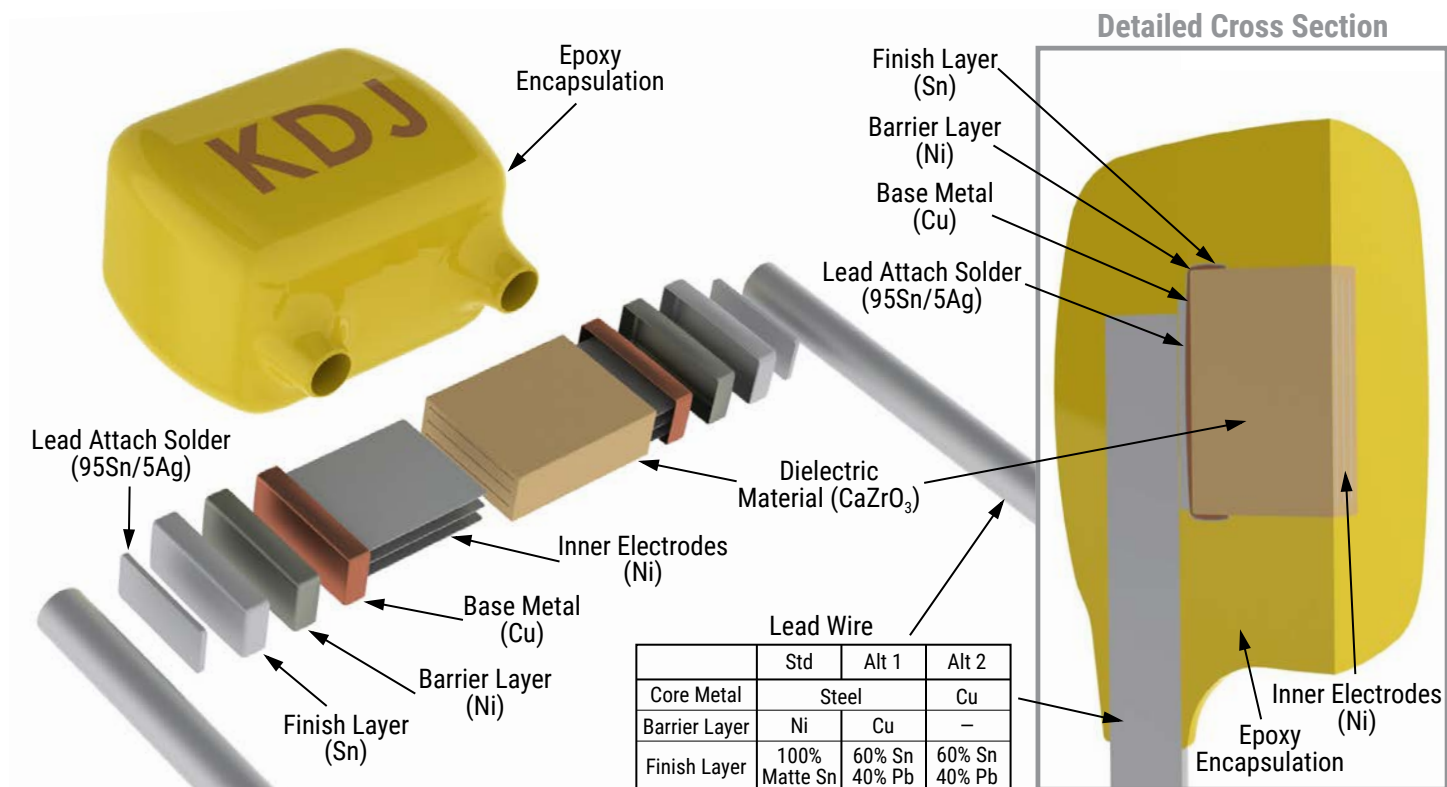
| Stress                       | Reference                         | Test or Inspection Method                                                                                                                                                                                                                        |
|------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Solderability                | J-STD-002                         | Magnification 50X. Conditions:<br>a) Method A, at 235°C, Category 3                                                                                                                                                                              |
| Temperature Cycling          | JESD22 Method JA-104              | 5 cycles (-55°C to +125°C), measurement at 24 hours ±4 hours after test conclusion.                                                                                                                                                              |
| Biased Humidity              | MIL-STD-202<br>Method 103         | Load humidity, 1,000 hours 85°C/85%RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion.                                                                                                         |
|                              |                                   | Low volt humidity, 1,000 hours 85°C/85%RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion.                                                                                                             |
| Moisture Resistance          | MIL-STD-202<br>Method 106         | t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours ±4 hours after test conclusion.                                                                                                                             |
| Thermal Shock                | MIL-STD-202<br>Method 107         | -55°C to +125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air.                                                                                                                  |
| High Temperature Life        | MIL-STD-202<br>Method 108/EIA-198 | 1,000 hours at 125°C (85°C for Z5U) with 1 X rated voltage applied.                                                                                                                                                                              |
| Storage Life                 | MIL-STD-202<br>Method 108         | 125°C, 0 VDC for 1,000 hours.                                                                                                                                                                                                                    |
| Vibration                    | MIL-STD-202<br>Method 204         | 5 g for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8"X5" PCB .031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz. |
| Resistance to Soldering Heat | MIL-STD-202<br>Method 210         | Condition B. No preheat of samples. Note: single wave solder – procedure 2.                                                                                                                                                                      |
| Terminal Strength            | MIL-STD-202<br>Method 211         | Conditions A (454g), Condition C (227g)                                                                                                                                                                                                          |
| Mechanical Shock             | MIL-STD-202<br>Method 213         | Figure 1 of Method 213, Condition C.                                                                                                                                                                                                             |
| Resistance to Solvents       | MIL-STD-202<br>Method 215         | Add aqueous wash chemical – OKEM Clean or equivalent.                                                                                                                                                                                            |

## Storage & Handling

The un-mounted storage life of a leaded ceramic capacitor is dependent upon storage and atmospheric conditions as well as packaging materials. While the ceramic chips enveloped under the epoxy coating themselves are quite robust in most environments, solderability of the wire lead on the final epoxy-coated product 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 and exposure to direct sunlight – reels may soften or warp, and tape peel force may increase.

KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably within 18 months of receipt. For applications requiring pre-tinning of components, storage life may be extended if solderability is verified. Before cleaning, bonding or molding these devices, it is important to verify that your process does not affect product quality and performance. KEMET recommends testing and evaluating the performance of a cleaned, bonded or molded product prior to implementing and/or qualifying any of these processes.

## Construction



## Marking



<sup>1</sup> To properly request the inclusion of the date code in the marking information provided on the component, ordering code C-SPEC 9207 must be added to the end of the ordering code.

| Date Code                        |                                                                |
|----------------------------------|----------------------------------------------------------------|
| 15                               | 20                                                             |
| Manufacturing Year:<br>15 = 2015 | Manufacturing Week:<br>20 = Week 20<br>(of mfg. calendar year) |

## Packaging Quantities

| Style/<br>Size | Standard Bulk<br>Quantity | Ammo Pack<br>Quantity<br>Maximum | Reel Quantity<br>Maximum<br>(12" Reel) |
|----------------|---------------------------|----------------------------------|----------------------------------------|
| 315            | 500/Bag                   | 2500                             | 2500                                   |
| 316            |                           |                                  |                                        |
| 317            |                           |                                  |                                        |
| 318            |                           |                                  |                                        |
| 320            |                           |                                  |                                        |
| 321            |                           | N/A                              | N/A                                    |
| 322            |                           | 2500                             | 2500                                   |
| 323            |                           |                                  |                                        |
| 324            |                           |                                  |                                        |
| 325            |                           |                                  |                                        |
| 326            |                           |                                  |                                        |
| 327            |                           |                                  |                                        |
| 328            |                           |                                  |                                        |
| 330            | 250/Bag                   | 1500                             | 1500                                   |
| 331            |                           | N/A                              | N/A                                    |
| 333            |                           | 1500                             |                                        |
| 335            |                           |                                  |                                        |
| 336            |                           |                                  |                                        |
| 340            | 100/Bag                   | 1000                             | 1000                                   |
| 346            |                           |                                  |                                        |
| 350            | 50/Bag                    | N/A                              | 500                                    |
| 356            |                           |                                  |                                        |

## Tape & Reel Packaging Information

KEMET offers standard reeling of Molded and Conformally Coated Radial Leaded Capacitors in accordance with EIA standard 468. Parts are taped to a tagboard carrier strip, and wound on a reel as shown in Figure 1. Kraft paper interleaving is inserted between the layers of capacitors on the reel. Ammopack is also available, with the same lead tape configuration and package quantities.



Figure 3: Standard Reel



Figure 2: Lead Tape Configuration (See Table Below)

## Ceramic Radial Tape and Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) |                       |                            |                  |                     |                |                                     |                  |                  |
|--------------------------------------------|-----------------------|----------------------------|------------------|---------------------|----------------|-------------------------------------|------------------|------------------|
| $D_0$<br>±0.2 (0.008)                      | $P_0$<br>±0.3 (0.012) | $\Delta H$<br>±0.2 (0.008) | $L_1$<br>Maximum | $t$<br>±0.2 (0.008) | $T$<br>Maximum | $W$<br>+1.0/-0.5<br>(+0.039/-0.020) | $W_0$<br>Minimum | $W_2$<br>Maximum |
| 4.00 (0.157)                               | 12.7 (0.500)          | 4.0 (0.157)                | 1.0 (0.039)      | 0.7 (0.051)         | 1.5 (0.059)    | 18.0 (0.709)                        | 5.0 (0.197)      | 3.0 (0.118)      |

## Ceramic Radial Tape and Reel Dimensions cont'd

Metric will govern

| Variable Dimensions – Millimeters (Inches) |                                              |                   |                               |                               |                         |                                        |                         |
|--------------------------------------------|----------------------------------------------|-------------------|-------------------------------|-------------------------------|-------------------------|----------------------------------------|-------------------------|
| F<br>±0.78 (0.030) <sup>1</sup>            | P <sub>1</sub><br>±0.30 (0.012) <sup>1</sup> | P<br>±0.3 (0.012) | P <sub>2</sub><br>±1.3 (0.51) | H                             |                         | H <sub>0</sub>                         |                         |
|                                            |                                              |                   |                               | Straight Lead Configuration   |                         | Formed Lead Configuration <sup>2</sup> |                         |
|                                            |                                              |                   |                               | Packaging C-Spec <sup>3</sup> |                         |                                        |                         |
|                                            |                                              |                   |                               | 7301/7305                     | 7303/7317               | 7301/7305                              | 7303/7317               |
| 2.54 (0.100)                               | 5.08 (0.200)                                 | 12.7 (0.500)      | 6.35 (0.250)                  | 16.0±0.5<br>(0.630±0.020)     | 18.0 (0.709)<br>Minimum | 16.0±0.5<br>(0.630±0.020)              | 18.0 (0.709)<br>Minimum |
| 4.32 (0.170)                               | 3.89 (0.153)                                 | 12.7 (0.500)      | 6.35 (0.250)                  |                               |                         |                                        |                         |
| 5.08 (0.200)                               | 3.81 (0.150)                                 | 12.7 (0.500)      | 6.35 (0.250)                  |                               |                         |                                        |                         |
| 5.59 (0.220)                               | 3.25 (0.128)                                 | 12.7 (0.500)      | 6.35 (0.250)                  |                               |                         |                                        |                         |
| 6.98 (0.275)                               | 2.54 (0.100)                                 | 12.7 (0.500)      | 6.35 (0.250)                  |                               |                         |                                        |                         |
| 7.62 (0.300)                               | 2.24 (0.088)                                 | 12.7 (0.500)      | 6.35 (0.250)                  |                               |                         |                                        |                         |
| 9.52 (0.375)                               | 7.62 (0.300)                                 | 12.7 (0.500)      | 6.35 (0.250)                  |                               |                         |                                        |                         |
| 10.16 (0.400)                              | 7.34 (0.290)                                 | 25.4 (1.000)      | N/A                           |                               |                         |                                        |                         |
| 12.06 (0.475)                              | 6.35 (0.250)                                 | 25.4 (1.000)      | N/A                           |                               |                         |                                        |                         |
| 14.60 (0.575)                              | 5.08 (0.200)                                 | 25.4 (1.000)      | N/A                           |                               |                         |                                        |                         |
| 17.14 (0.675)                              | 3.81 (0.15)                                  | 25.4 (1.000)      | N/A                           |                               |                         |                                        |                         |

<sup>1</sup> Measured at the egress from the carrier tape, on the component side.

<sup>2</sup> Formed lead configuration includes: "shoulder bend", "inside kink", "outside kink", and "snap-in". For more information regarding available lead configurations see "Dimensions" section of this document.

<sup>3</sup> The "Packaging C-Spec" is a 4 digit code which identifies the packaging type, lead length and/or lead material. When ordering, the proper code must be included in the 15th through 18th character positions of the ordering code. See "Ordering Information" section of this document for further details.

| Symbol Reference Table |                                               |
|------------------------|-----------------------------------------------|
| D <sub>0</sub>         | Sprocket Hole Diameter                        |
| P <sub>0</sub>         | Sprocket Hole Pitch                           |
| P                      | Component Pitch                               |
| F                      | Lead Spacing                                  |
| P <sub>1</sub>         | Sprocket Hole Center to Lead Center           |
| P <sub>2</sub>         | Sprocket Hole Center To Component Center      |
| H                      | Height to Seating Plane (Straight Leads Only) |
| H <sub>0</sub>         | Height to Seating Plane (Formed Leads Only)   |
| H <sub>1</sub>         | Component Height Above Tape Center            |
| ΔH                     | Component Alignment                           |
| L <sub>1</sub>         | Lead Protrusion                               |
| t                      | Composite Tape Thickness                      |
| W                      | Carrier Tape Width                            |
| W <sub>0</sub>         | Hold-Down Tape Width                          |
| W <sub>2</sub>         | Hold-Down Tape Location                       |

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Тел: +7 (812) 336 43 04 (многоканальный)

Email: [org@lifeelectronics.ru](mailto:org@lifeelectronics.ru)

[www.lifeelectronics.ru](http://www.lifeelectronics.ru)