# HS Series, Radial, Conformally Coated, 500 - 5,000 VDC (Space Grade)



#### **Overview**

KEMET's HS Series ceramic capacitors are designed with COG and X7R dielectrics which feature a 125°C maximum operating temperature and are screened to MIL-PRF-49467. These devices are made using robust designs and screened to MIL-PRF-49467 Group A to meet the demands of higher reliability applications. These devices are ideal for high voltage power supplies, DC/DC conversion and well suited for timing, resonant, bypass, and decoupling applications.

These high voltage capacitors are widely used in industries related to semiconductors, telecommunications, test/diagnostic equipment and power/grid.

The HS Series is part of KEMET's Harsh Environment PME (Precious Metal Electrode) portfolio which is ideal for industrial and high reliability applications.

#### **Benefits**

- Operating temperature range of -55°C to +125°C
- Capacitance range from 180 pF 5.6 μF in X7R
- Capacitance range from 12 pF 0.15 μF in COG
- DC voltage ratings of 500 V, 1 kV, 2 kV, 3 kV, 4 kV, 5 kV
- · High thermal stability



## **Applications**

- · Aerospace engine compartments
- · Switch mode power supplies
- · DC/DC Converters
- · Measuring equipment
- Inverters
- High voltage coupling



## **Ordering Information**

| 10   | HS     | 2                                      | 4                                | В                        | 102  | K                                     | С   | F                                    |
|--|--------|--|----------------------------------|--------------------------|--|---------------------------------------|---|--------------------------------------|
| Voltage  | Series | Style                                  | /Size                            | Dielectric               | Capacitance<br>Code (pF)                   | Capacitance<br>Tolerance <sup>1</sup> | Test Level <sup>3</sup>                         | Voltage<br>Conditioning <sup>3</sup> |
| 05 = 500V<br>10 = 1000V<br>20 = 2000V<br>30 = 3000V<br>40 = 4000V<br>50 = 5000V<br>75 = 7500V<br>100 = 10,000V | нѕ     | 20<br>21<br>22<br>23<br>24<br>25<br>26 | 30<br>31<br>33<br>34<br>35<br>36 | N = BP COG (NPO) B = X7R | Two significant digits and number of zeros | J = ±5%<br>K= ±10%<br>M = ±20%        | Blank = Standard Screening  C = CSAM (optional) | F = Burn In<br>(optional)            |

<sup>&</sup>lt;sup>1</sup> Additional capacitance tolerance offerings may be available. Contact KEMET for details. J= ±5% It is only applicable for COG dielectric

# **Environmental Compliance**

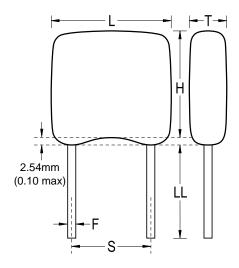
Industrial PME (precious metal electrode) part types are not RoHS compliant.

<sup>&</sup>lt;sup>2</sup> Please refer to the Construction section in the datasheet.

<sup>&</sup>lt;sup>3</sup> CSAM must be included if burn-in option is selected.



# **Dimensions - Inches (Millimeters)**



| Series | Style/<br>Size | Length<br>Maximum<br>(L) | Height<br>Maximum<br>(H) | Thickness<br>Maximum<br>(T) | Lead Spacing<br>±0.030 (S) | Lead<br>Diameter (F)                         | Lead Length<br>Minimum (LL) |
|--------|----------------|--------------------------|--------------------------|-----------------------------|----------------------------|--|-----------------------------|
|        | 20             | 0.250 (6.35)             | 0.220 (5.59)             | 0.200 (5.08)                | 0.170 (4.32)               |  |                             |
|        | 21             | 0.320 (8.13)             | 0.280 (7.11)             | 0.250 (6.35)                | 0.220 (5.59)               |  |                             |
|        | 22             | 0.370 (9.40)             | 0.300 (7.62)             | 0.250 (6.35)                | 0.250 (6.35)               |  |                             |
|        | 23             | 0.470 (11.94)            | 0.400 (10.16)            | 0.270 (6.89)                | 0.375 (9.53)               |  |                             |
|        | 24             | 0.570 (14.48)            | 0.500 (12.70)            | 0.270 (6.89)                | 0.475 (12.07)              |  |                             |
|        | 25             | 0.670 (17.02)            | 0.600 (15.24)            | 0.270 (6.89)                | 0.575 (14.61)              |  |                             |
| HS     | 26             | 0.770 (19.56)            | 0.720 (18.29)            | 0.270 (6.89)                | 0.675 (17.15)              | 0.025 +0.004/-0.002<br>(0.635 +0.102/-0.051) | 1.25 (31.75)                |
|        | 30             | 0.450 (11.43)            | 0.220 (5.59)             | 0.200 (5.08)                | 0.300 (7.62)               | (0.000 70.102/ 0.001)                        |                             |
|        | 31             | 0.550 (13.97)            | 0.280 (7.11)             | 0.250 (6.35)                | 0.400 (10.16)              |  |                             |
|        | 33             | 0.850 (21.59)            | 0.400 (10.16)            | 0.270 (6.89)                | 0.700 (17.78)              |  |                             |
|        | 34             | 1.050 (26.67)            | 0.500 (12.70)            | 0.270 (6.89)                | 0.975 (24.76)              |  |                             |
|        | 35             | 1.250 (31.75)            | 0.600 (15.24)            | 0.270 (6.89)                | 1.175 (29.84)              |  |                             |
|        | 36             | 1.450 (36.83)            | 0.720 (18.29)            | 0.270 (6.89)                | 1.375 (34.92)              |  |                             |



### Table 1A - HS X7R Waterfall

| Style/S              | Sizo                      | ŀ   | lS2                 | 0    | ŀ    | HS2  | 1    | ŀ        | <b>IS2</b> | 2                   |          | HS   | 23   |      |      | ŀ    | IS2  | 4    |      |     |      | HS   | 25   |      |      |     |      | HS   | 26   |          |      |
|----------------------|---------------------------|-----|---------------------|------|------|------|------|----------|------------|---------------------|----------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|-----|------|------|------|----------|------|
| Style/c              | JIZE                      |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      | Volt | age  |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| Capacitance          | Cap<br>Code               | 200 | 1000                | 2000 | 200  | 1000 | 2000 | 200      | 1000       | 2000                | 200      | 1000 | 2000 | 3000 | 200  | 1000 | 2000 | 3000 | 4000 | 200 | 1000 | 2000 | 3000 | 4000 | 2000 | 200 | 1000 | 2000 | 3000 | 4000     | 5000 |
| 270 pF               | 271                       | Х   | Χ                   | Χ    |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| 330 pF               | 331                       | Х   | Х                   | X    |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| 390 pF               | 391                       | Х   | Х                   | X    |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| 470 pF               | 471                       | Х   | X                   | X    | L ., |      |      |          |            |                     | _        |      |      |      |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      | $\vdash$ |      |
| 560 pF               | 561                       | X   | X                   | X    | X    | X    | X    | V        | V          | V                   |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| 680 pF<br>820 pF     | 681                       | X   | X                   | X    | X    | X    | X    | X        | X          | X                   |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| 1000 pF              | 821<br>102                | X   | X                   | X    | X    | X    | X    | X        | X          | X                   | Х        | Х    | Х    | Х    | Х    | Х    | Х    | Х    | Х    | Х   | Х    | Х    | Х    | Х    | Х    |     |      |      |      |          |      |
| 1200 pF              | 122                       | X   | X                   | X    | X    | X    | X    | Х        | X          | Χ                   | X        | Χ    | X    | X    | X    | X    | Χ    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |
| 1500 pF              | 152                       | X   | X                   | X    | X    | X    | X    | X        | X          | X                   | X        | X    | X    | X    | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |
| 1800 pF              | 182                       | X   | X                   | X    | Х    | X    | X    | X        | X          | X                   | X        | X    | X    | X    | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |
| 2200 pF              | 222                       | X   | X                   | X    | X    | X    | X    | X        | X          | X                   | X        | X    | X    | X    | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |
| 2700 pF              | 272                       | Х   | X                   | X    | X    | X    | X    | X        | X          | X                   | X        | X    | X    | X    | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |
| 3300 pF              | 332                       | Х   | Х                   | Х    | Х    | X    | X    | Х        | Х          | Х                   | Х        | Х    | Х    | Х    | Х    | X    | Х    | X    | X    | Х   | X    | Х    | X    | X    | Х    |     |      |      |      |          |      |
| 3900 pF              | 392                       | Х   | Х                   |      | Х    | Х    | Х    | Х        | Х          | Х                   | Х        | Х    | Х    | Х    | Х    | Х    | Х    | Х    | Х    | Х   | Х    | Х    | Х    | Х    | Х    | Х   | Х    | Х    | Х    | Х        | Х    |
| 4700 pF              | 472                       | Χ   | Χ                   |      | Χ    | Х    | Х    | Χ        | Χ          | Х                   | Х        | Х    | Х    | Х    | Х    | X    | Х    | Х    | Х    | Χ   | Х    | Х    | Х    | Х    | Х    | Χ   | Х    | Χ    | Χ    | Х        | Χ    |
| 5000 pF              | 502                       | Χ   | Χ                   |      | Χ    | X    | X    | Χ        | Χ          | Х                   | Х        | Х    | X    | X    | Х    | X    | Х    | X    |      | Χ   | X    | X    | X    | X    | X    | Χ   | X    | Х    | Χ    | Х        | Χ    |
| 5600 pF              | 562                       | Χ   | Х                   |      | Х    | X    | X    | Х        | Χ          | X                   | Х        | X    | X    | X    | Х    | X    | X    | X    |      | Х   | X    | X    | X    | X    | X    | Х   | X    | X    | Χ    | Х        | Χ    |
| 6800 pF              | 682                       | Χ   | Х                   |      | Х    | X    |      | Х        | Х          |                     | Х        | Х    | X    | X    | Х    | X    | Х    | X    |      | Х   | X    | X    | X    | X    | X    | Х   | X    | Χ    | Χ    | Χ        | Χ    |
| 8200 pF              | 822                       | Χ   | Х                   |      | Х    | X    |      | Х        | Х          |                     | Х        | X    | X    |      | Х    | X    | X    | X    |      | Х   | X    | X    | X    | X    | X    | Х   | X    | X    | Χ    | X        |      |
| 10000 pF             | 103                       | Х   | Х                   |      | X    | X    |      | Х        | X          |                     | Х        | X    | X    |      | X    | X    | X    | X    |      | X   | X    | X    | X    | X    | X    | X   | X    | Х    | X    | X        |      |
| 12000 pF             | 123                       | Х   |                     |      | X    | X    |      | X        | X          |                     | X        | X    | X    |      | X    | X    | X    | X    |      | X   | X    | X    | X    | X    |      | X   | X    | X    | X    | X        |      |
| 15000 pF             | 153                       | Х   |                     |      | X    | X    |      | X        | X          |                     | X        | X    | X    |      | X    | X    | X    |      |      | X   | X    | X    | X    | X    |      | X   | X    | X    | X    | Х        |      |
| 18000 pF             | 183                       | X   |                     |      | X    | X    |      | X        | X          |                     | X        | X    | Х    |      | X    | X    | X    |      |      | X   | X    | X    | X    | Х    |      | X   | X    | X    | X    | $\vdash$ |      |
| 22000 pF<br>27000 pF | 223<br>273                | X   |                     |      | Х    | X    |      | Х        | X          |                     | X        | X    |      |      | X    | X    | X    |      |      | X   | X    | X    | X    |      |      | Х   | X    | X    | X    |          |      |
| 33000 pF             | 333                       | ^   |                     |      | X    | X    |      | X        | X          |                     | X        | X    |      |      | X    | X    | X    |      |      | X   | X    | X    | ^    |      |      | X   | X    | X    | X    |          |      |
| 39000 pF             | 393                       |     |                     |      | X    | X    |      | X        | X          |                     | X        | X    |      |      | X    | X    | X    |      |      | X   | X    | X    |      |      |      | X   | X    | X    | X    |          |      |
| 47000 pF             | 473                       |     |                     |      | X    | X    |      | X        | X          |                     | X        | X    |      |      | X    | X    | X    |      |      | X   | X    | X    |      |      |      | X   | X    | X    |      |          |      |
| 56000 pF             | 563                       |     |                     |      | Х    |      |      | Х        | Х          |                     | Х        | Х    |      |      | Х    | Х    | Х    |      |      | Х   | Х    | Х    |      |      |      | Х   | Х    | Χ    |      |          |      |
| 68000 pF             | 683                       |     |                     |      | Х    |      |      | Х        | Х          |                     | Х        | Х    |      |      | Х    | Х    | Х    |      |      | Х   | Х    | Х    |      |      |      | Х   | Х    | Х    |      |          |      |
| 82000 pF             | 823                       |     |                     |      | Х    |      |      | Х        | Χ          |                     | Х        | Х    |      |      | Х    | Х    | Х    |      |      | Х   | Х    | Х    |      |      |      | Х   | Х    | Χ    |      |          |      |
| 0.10 uF              | 104                       |     |                     |      |      |      |      | Х        | Х          |                     | Х        |      |      |      | Х    | Х    | Х    |      |      | Х   | Х    |      |      |      |      | Х   | Х    | Χ    |      |          |      |
| 0.12 uF              | 124                       |     |                     |      |      |      |      |          |            |                     | Х        |      |      |      | Х    | X    |      |      |      | Х   | Х    |      |      |      |      | Х   | Х    |      |      |          |      |
| 0.15 uF              | 154                       |     |                     |      |      |      |      |          |            |                     | Х        |      |      |      | Х    | X    |      |      |      | Х   | Х    |      |      |      |      | Х   | X    |      |      |          |      |
| 0.18 uF              | 184                       |     |                     |      |      |      |      |          |            |                     | Х        |      |      |      | Х    | X    |      |      |      | Х   |      |      |      |      |      | Х   | X    |      |      |          |      |
| 0.22 uF              | 224                       |     |                     |      |      |      |      |          |            |                     | X        |      |      |      | X    | X    |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |
| 0.27 uF              | 274                       |     |                     |      |      |      |      |          |            |                     | Х        |      |      |      | X    | X    |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |
| 0.33 uF              | 334                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      | X    | X    |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |
| 0.39 uF<br>0.47 uF   | 394<br>474                |     |                     |      |      |      |      |          |            |                     |          |      |      |      | X    | X    |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |
| 0.47 uF<br>0.56 uF   | 564                       |     |                     |      |      |      |      | $\vdash$ |            |                     | $\vdash$ |      |      |      | ├^   | ^    |      |      |      | Х   |      |      |      |      |      | Х   | X    |      |      | $\vdash$ |      |
| 0.56 uF              | 684                       |     | _                   |      |      |      |      | $\vdash$ | _          |                     | $\vdash$ |      |      |      |      |      |      |      |      | X   |      |      |      |      |      | X   | X    |      |      | $\vdash$ |      |
| 0.82 uF              | 824                       |     |                     |      |      |      |      |          |            |                     | l -      |      |      |      |      |      |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |
| 1.0 uF               | 105                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |
| 1.2 uF               | 125                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      | Х   |      |      |      |          |      |
| 1.5 uF               | 155                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      | Х   |      |      |      |          |      |
| 1.8 uF               | 185                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      | Х   |      |      |      |          |      |
| 2.2 uF               | 225                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      | Х   |      |      |      |          |      |
| 2.7 uF               | 275                       |     |                     |      |      |      |      |          |            |                     |          |      |      |      |      |      |      |      |      |     |      |      |      |      |      | Х   |      |      |      |          |      |
| Capacitance          | Cap<br>Code               | 200 | 1000                | 2000 | 200  | 1000 | 2000 | 200      | 1000       | 2000 2000 2000 1000 |          |      | 2000 | 3000 | 200  | 1000 | 2000 | 3000 | 4000 | 200 | 1000 | 2000 | 3000 | 4000 | 2000 | 200 | 1000 | 2000 | 3000 | 4000     | 5000 |
|                      |                           |     |                     |      |      |      |      |          |            |                     |          |      |      | Vol  | tage |      |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |
| Style/Si             | ize                       |     | HS20 HS21 HS22 HS23 |      |      |      |      |          | HS24       |                     |          |      |      | н    | 25   |      |      |      |      | нс  | 26   |      |      |      |      |     |      |      |      |          |      |
|                      | H320   H321   H322   H323 |     |                     |      | L    |      | 4    |          |            |                     |          | 115  |      |      |      |      |      | 113  |      |     |      |      |      |      |      |     |      |      |      |          |      |



## Table 1A - HS X7R Waterfall cont.

| Style/S              | Sizo        |     | HS   | 30   |      |     |      | HS   | 31   |      |      |     |      | Н    | IS3  | 3        |      |      |      |      | Н    | IS3  | 4    |      |      |          |      | HS   | 35   |      |      |     |      | HS   | 36   |      |          |
|----------------------|-------------|-----|------|------|------|-----|------|------|------|------|------|-----|------|------|------|----------|------|------|------|------|------|------|------|------|------|----------|------|------|------|------|------|-----|------|------|------|------|----------|
| Style/s              | oize        |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      | ١    | /olt | ago  | е    |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| Capacitance          | Cap<br>Code | 200 | 1000 | 2000 | 3000 | 200 | 1000 | 2000 | 3000 | 4000 | 2000 | 200 | 1000 | 2000 | 3000 | 4000     | 2000 | 7500 | 200  | 1000 | 2000 | 3000 | 4000 | 2000 | 7500 | 200      | 1000 | 2000 | 3000 | 4000 | 2000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000     |
| 180 pF<br>220 pF     | 181<br>221  | X   | X    | X    | X    |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| 270 pF               | 271         | X   | X    | X    | X    |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| 330 pF               | 331         | Х   | Х    | Х    | Х    |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| 390 pF<br>470 pF     | 391<br>471  | X   | X    | X    | X    | Х   | X    | X    | Х    | Х    | Х    |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| 560 pF               | 561         | X   | X    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| 680 pF               | 681         | Х   | Х    | X    | Х    | Х   | Х    | Х    | Х    | Χ    | Χ    |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| 820 pF               | 821         | X   | X    | X    | X    | X   | X    | X    | X    | X    | X    | _   |      |      |      |          |      |      | V    | V    | V    | V    | V    | V    | V    | _        |      |      |      |      |      | _   |      |      |      |      |          |
| 1000 pF<br>1200 pF   | 102<br>122  | X   | X    | X    | X    | X   | X    | X    | X    | X    | X    |     |      |      |      |          |      |      | X    | X    | X    | X    | X    | X    | X    |          |      |      |      |      |      |     |      |      |      |      |          |
| 1500 pF              | 152         | Х   | Х    | Х    |      | Х   | Х    | Х    | Х    | Х    |      | Х   | Х    | Х    | Χ    | Х        | Χ    | Х    | Х    | Х    | Х    | Х    | Х    | Х    | Х    |          |      |      |      |      |      |     |      |      |      |      |          |
| 1800 pF              | 182         | Х   | X    | X    |      | Х   | X    | X    | X    | X    |      | X   | X    | X    | X    | X        | X    | X    | X    | X    | X    | X    | X    | X    | X    |          |      |      |      |      |      |     |      |      |      |      | <u> </u> |
| 2200 pF<br>2700 pF   | 222<br>272  | X   | X    | X    |      | X   | X    | X    | X    | Х    |      | X   | X    | X    | X    | X        | X    | X    | X    | X    | X    | X    | X    | X    | X    | $\vdash$ |      |      |      |      |      |     |      |      |      |      |          |
| 3300 pF              | 332         | X   | X    | X    |      | X   | X    | X    | X    |      |      | X   | X    | X    | X    | X        | X    | Χ    | X    | X    | X    | X    | X    | X    | Χ    |          |      |      |      |      |      |     |      |      |      |      |          |
| 3900 pF              | 392         | Х   | X    |      |      | X   | X    | X    | X    |      |      | Х   | X    | X    | X    | X        | X    | Χ    | Х    | X    | X    | X    | X    | X    | X    | ,,       |      | ١,   | ,,   | ,,   | ,,,  |     |      |      |      |      |          |
| 4700 pF<br>5000 pF   | 472<br>502  | X   | X    |      |      | X   | X    | X    | X    |      |      | X   | X    | X    | X    | X        | X    | X    | X    | X    | X    | X    | X    | X    | Χ    | X        | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X        |
| 5600 pF              | 562         | X   | X    |      |      | X   | X    | X    |      |      |      | X   | X    | X    | X    | X        |      |      | X    | X    | X    | X    | X    | X    |      | X        | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X        |
| 6800 pF              | 682         | Х   | X    |      |      | Х   | Х    | X    |      |      |      | Х   | Х    | Х    | X    | Χ        |      |      | Х    | Χ    | Χ    | Х    | Х    | Х    |      | Х        | Х    | Χ    | Χ    | Х    | X    | Х   | Х    | Х    | Χ    | Χ    | Χ        |
| 8200 pF<br>10000 pF  | 822<br>103  | X   | X    |      |      | X   | X    | X    |      |      |      | X   | X    | X    | X    |          |      |      | X    | X    | X    | X    | X    |      |      | X        | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X        |
| 12000 pF             | 123         | X   |      |      |      | X   | X    | ^    |      |      |      | X   | X    | X    | X    |          |      |      | X    | X    | X    | X    | X    |      |      | X        | X    | X    | X    | X    | X    | X   | X    | X    | X    | X    | X        |
| 15000 pF             | 153         | Х   |      |      |      | Х   | Х    |      |      |      |      | Х   | Х    | Χ    |      |          |      |      | Χ    | Χ    | Χ    | Х    | Х    |      |      | Х        | Χ    | Χ    | Χ    | Х    | Χ    | Х   | Χ    | Χ    | Χ    | Χ    | Χ        |
| 18000 pF<br>22000 pF | 183<br>223  | X   |      |      |      | X   | X    |      |      |      |      | X   | X    | X    |      |          |      |      | X    | X    | X    | X    |      |      |      | X        | X    | X    | X    | X    | Х    | X   | X    | X    | X    | X    | X        |
| 27000 pF             | 273         | X   |      |      |      | X   | X    |      |      |      |      | X   | X    | X    |      |          |      |      | Х    | X    | X    | X    |      |      |      | X        | Х    | X    | X    | X    |      | X   | Х    | X    | Х    | X    | ^        |
| 33000 pF             | 333         | Х   |      |      |      | Х   | Х    |      |      |      |      | Х   | Х    | Χ    |      |          |      |      | Χ    | Χ    | Χ    | Х    |      |      |      | Х        | Х    | Χ    | Χ    |      |      | Х   | Χ    | Χ    | Χ    | Χ    |          |
| 39000 pF<br>47000 pF | 393         | X   |      |      |      | X   |      |      |      |      |      | X   | X    | Х    |      |          |      |      | X    | X    | X    |      |      |      |      | X        | X    | X    | X    |      |      | X   | X    | X    | X    | Χ    |          |
| 56000 pF             | 473<br>563  | X   |      |      |      | X   |      |      |      |      |      | X   | X    |      |      |          |      |      | X    | X    | X    |      |      |      |      | X        | X    | X    | X    |      |      | X   | X    | X    | X    |      |          |
| 68000 pF             | 683         |     |      |      |      | Х   |      |      |      |      |      | Х   | Х    |      |      |          |      |      | Х    | Χ    | Χ    |      |      |      |      | Х        | Х    | Χ    |      |      |      | Х   | Χ    | Х    | Х    |      |          |
| 82000 pF             | 823         |     |      |      |      | Х   |      |      |      |      |      | X   | Х    |      |      |          |      |      | X    | X    | Χ    |      |      |      |      | X        | X    | X    |      |      |      | X   | X    | X    |      |      | _        |
| 0.10 uF<br>0.12 uF   | 104<br>124  |     |      |      |      | X   |      |      |      |      |      | X   |      |      |      |          |      |      | X    | X    |      |      |      |      |      | X        | X    | X    |      |      |      | X   | X    | X    |      |      |          |
| 0.15 uF              | 154         |     |      |      |      | Х   |      |      |      |      |      | Х   |      |      |      |          |      |      | Х    | X    |      |      |      |      |      | Х        | X    |      |      |      |      | Х   | Х    | Х    |      |      |          |
| 0.18 uF              | 184         |     |      |      |      | Х   |      |      |      |      |      | Х   |      |      |      |          |      |      | Х    | Χ    |      |      |      |      |      | Х        | X    |      |      |      |      | Х   | X    | Χ    |      |      |          |
| 0.22 uF<br>0.27 uF   | 224<br>274  | -   |      |      |      | X   |      |      |      |      |      | X   |      |      |      |          |      |      | X    |      |      |      |      |      |      | X        | X    |      |      |      |      | X   | X    |      |      |      |          |
| 0.27 uF              | 334         |     |      |      |      | X   |      |      |      |      |      | Х   |      |      |      |          |      |      | X    |      |      |      |      |      |      | Х        |      |      |      |      |      | X   | X    |      |      |      |          |
| 0.39 uF              | 394         |     |      |      |      | Х   |      |      |      |      |      | Х   |      |      |      |          |      |      | Х    |      |      |      |      |      |      | Х        |      |      |      |      |      | Х   | X    |      |      |      |          |
| 0.47 uF<br>0.56 uF   | 474<br>564  | -   |      |      |      |     |      |      |      |      |      | X   |      |      |      |          |      |      | X    |      |      |      |      |      |      | X        |      |      |      |      |      | X   | X    |      |      |      |          |
| 0.56 uF              | 684         |     |      |      |      |     |      |      |      |      |      | X   |      |      |      |          |      |      | X    |      |      |      |      |      |      | X        |      |      |      |      |      | X   | X    |      |      |      |          |
| 0.82 uF              | 824         |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      | Х    |      |      |      |      |      |      | Χ        |      |      |      |      |      | Х   | Х    |      |      |      |          |
| 1.0 uF<br>1.2 uF     | 105<br>125  |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      | Х    |      |      |      |      |      |      | X        |      |      |      |      |      | X   | X    |      |      |      |          |
| 1.5 uF               | 155         |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      | Χ        |      |      |      |      |      | X   | Х    |      |      |      |          |
| 1.8 uF               | 185         |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      | Χ        |      |      |      |      |      | Х   | Χ    |      |      |      |          |
| 2.2 uF<br>2.7 uF     | 225<br>275  |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      | Х        |      |      |      |      |      | X   | X    |      |      |      |          |
| 2.7 uF<br>2.9 uF     | 295         |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      | X   |      |      |      |      |          |
| 3.3 uF               | 335         |     |      |      |      |     |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      | Х   |      |      |      |      |          |
| 3.9 uF<br>4.7 uF     | 395<br>475  | -   |      |      |      | -   |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      | X   |      |      |      |      |          |
| 4.7 uF<br>5.6 uF     | 565         | f   |      |      |      | 1   |      |      |      |      |      |     |      |      |      |          |      |      |      |      |      |      |      |      |      |          |      |      |      |      |      | X   |      |      |      |      |          |
| Capacitance          | Can         | 200 | 1000 | 2000 | 3000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000 | 200 | 1000 | 2000 | 3000 | 4000     | 2000 | 7500 | 200  | 1000 | 2000 | 3000 | 4000 | 2000 | 7500 | 200      | 1000 | 2000 | 3000 | 4000 | 5000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000     |
| Style/S              | ize         |     |      |      |      | _   |      |      |      |      |      |     |      |      |      |          |      |      | Volt | age  |      |      |      |      |      |          |      |      |      |      |      |     |      |      |      |      |          |
| Style/3              |             |     | HS   | 30   |      |     |      | HS   | 31   |      |      |     |      |      | HS33 | <u> </u> |      |      |      |      |      | HS34 | 1    |      |      |          |      | HS   | 35   |      |      |     |      | HS   | 36   |      |          |



## Table 1B - HS COG Waterfall

| 12 pF  | Ctule/C     | ina | H   | IS2  | 0    | ŀ   | <b>HS2</b> | 1    | H        | IS2  | 2    |     | HS   | 23   |      |     |      | HS   | 24   |      |      |     |      | HS   | 25   |      |      |     |      | HS   | 26   |      |      |
|--|-------------|-----|-----|------|------|-----|------------|------|----------|------|------|-----|------|------|------|-----|------|------|------|------|------|-----|------|------|------|------|------|-----|------|------|------|------|------|
| 12 pf  | Style/S     | ize |     |      |      |     |            |      |          |      |      |     |      |      |      |     | Vo   | lta  | ge   |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| 15 pf  | Capacitance |     | 500 | 1000 | 2000 | 200 | 1000       | 2000 | 500      | 1000 | 2000 | 200 | 1000 | 2000 | 3000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000 | 200 | 1000 | 2000 | 3000 | 4000 | 2000 |
| 18 pf  | 12 pF       | 120 | Х   | Х    | Х    |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| 220 F 220 X X X X X X X X X X X X X X X X X X  | 15 pF       | 150 |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| 27 pF 270 X X X X X X X X X X X X X X X X X X X  |             |     |     | _    |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| 33 pF 330  |             |     |     |      |      |     | _          |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| 39 pF 390 N X X X X X X X X X X X X X X X X X X  |             |     |     |      |      | _   |            |      |          |      |      |     | _    |      |      | _   |      | _    | _    | _    | _    |     |      |      |      |      |      |     |      |      |      |      |      |
| ## ATP   A70   X   |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| S56 P   S60  |             |     |     |      |      |     |            |      |          |      | _    |     |      |      |      |     | _    |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| 68 pF 68 0   |             |     |     |      |      |     |            |      |          |      | _    |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      | X    |
| R2 pF  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     | _    |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      | Х    |
| 100 pF 101 X X X X X X X X X X X X X X X X X X   |             |     |     |      |      |     | _          |      |          |      | _    |     |      |      |      |     | _    |      | _    | -    |      |     |      |      | _    | _    | _    |     | _    | _    | _    |      | X    |
| 120 pF   |             |     |     | _    |      |     | _          | _    |          |      | _    |     | _    |      |      |     | _    |      |      | _    |      |     |      | _    | _    | _    | +    | _   |      | _    | _    |      | X    |
| 150 pF   |             |     |     | _    |      |     | _          | _    |          |      | _    |     | _    |      |      |     | _    | _    | _    | _    |      |     |      | _    | _    | _    | +    | _   | _    | _    | _    |      | Х    |
| 180 pF   |             |     |     | _    | _    |     | _          | _    |          |      |      |     |      | _    |      |     | _    | _    |      |      |      |     |      | _    | _    | _    | _    |     |      |      |      |      | Х    |
| 220 pF 221 X X X X X X X X X X X X X X X X X X   |             | 151 |     |      |      |     | _          | _    |          |      |      |     |      |      |      |     | _    |      |      |      |      |     |      |      | _    | _    | _    |     |      |      |      |      | X    |
| 270 pF 271 X X X X X X X X X X X X X X X X X X X   |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      | _    |      |      |     |      | _    |      |      | X    |
| 330 pF 391 X X X X X X X X X X X X X X X X X X X   |             | 221 |     |      |      | Х   | X          |      | Х        |      |      |     |      |      |      | Х   |      |      |      |      |      |     |      |      | X    | X    | X    | Х   |      |      |      |      | X    |
| 390 pF   |             |     |     |      |      |     |            |      |          |      | _    |     |      |      |      |     |      |      |      |      |      |     |      |      | _    |      |      |     |      |      |      |      | X    |
| ## A70 pF  |             | 331 | Х   |      | X    | Х   | X          |      | Х        |      | X    |     |      |      | X    | Х   | X    |      |      |      | X    | Х   |      | Х    | X    | X    | X    | Х   |      | X    |      |      | X    |
| 550 pF   |             | 391 | Х   |      |      | Х   | X          |      | Х        |      | X    | Χ   |      | X    |      | Х   | X    |      |      |      |      | Х   |      | Х    | X    | X    |      | Х   |      |      |      |      | X    |
| 680 pF 681 X X X X X X X X X X X X X X X X X X X   |             | 471 | Х   | X    |      | Χ   | X          | Х    | Х        |      | X    |     |      |      |      | Χ   | X    | X    | X    | X    | X    | Х   |      | Х    | X    | X    | X    | Х   | X    | X    | X    |      | X    |
| 820 pF 821 X   |             | 561 | Х   | X    |      | Х   | X          | Х    | Х        |      | X    | Χ   | X    |      |      | Х   | X    |      | X    |      |      | Х   | Х    | Х    | X    | X    | X    | Х   |      | X    | X    |      | X    |
| 1,000 pF 102   |             | 681 |     | X    |      | Х   | Х          | X    | Х        |      | Х    | Х   | _    |      | X    | Х   | X    | Х    | X    |      |      | Х   |      | Х    | X    | X    | X    | Х   | X    | X    | X    |      |      |
| 1.200 pF 122 X   |             | 821 | Х   |      |      | Х   | Х          | X    | Х        |      |      | Χ   | X    | X    |      | Х   | X    |      |      |      |      | Х   |      | Х    | X    | X    |      | Х   |      | X    |      |      |      |
| 1,500 pF   |             | 102 | Х   |      |      | Х   | Х          | Х    | Х        | Х    | Х    | Χ   | X    | X    |      | Х   | X    | Х    | X    | X    |      | Х   | X    | Х    | X    | X    |      | Х   | X    | X    | X    | Х    |      |
| 1,800 pF   |             | 122 | Х   |      |      | Х   | X          | X    | Х        | Х    | X    | Χ   | X    | X    |      | Х   | X    | Х    | X    |      |      | Х   | X    | Х    | X    | X    |      | Х   | X    | X    | X    | _    |      |
| 2,700 pF   |             | 152 | Х   |      |      | Х   | X          |      | Х        |      |      | Χ   |      |      |      | Х   |      |      | X    | X    |      | Х   |      |      | X    | X    |      | Х   |      | X    |      |      |      |
| 2,700 pF   |             | 182 | Х   |      |      | Х   | X          |      | Х        |      |      | Χ   | X    | X    |      | Х   | Х    |      |      |      |      | Х   | X    | Х    | X    | X    |      | Х   | X    | X    |      | Х    |      |
| 3,900 pF 332   |             | 222 | Х   |      |      | Х   | X          |      | Х        |      |      | Χ   |      | X    |      | Х   |      |      |      |      |      | Х   | X    |      | X    | X    |      | Х   | X    | X    |      |      |      |
| 3,900 pF 392   |             |     |     |      |      |     | X          | Х    |          |      |      |     |      |      |      |     | _    |      |      |      |      |     |      |      |      |      |      |     | _    |      |      |      |      |
| 4,700 pF   |             |     |     |      |      |     |            |      |          | Х    |      |     | _    |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     | _    | _    | _    |      |      |
| Style/Size   Sty   |             |     |     |      |      |     |            |      |          |      |      |     | _    |      |      |     | _    |      |      |      |      | _   |      | _    |      |      |      | _   |      |      | _    |      |      |
| 6,800 pF 682   |             |     |     |      |      |     |            |      |          |      |      |     | _    |      |      |     | _    | Х    |      |      |      | _   |      | _    |      |      |      | _   | _    | _    | X    |      |      |
| 7,500 pF 752   |             |     |     |      |      | Х   |            |      |          |      |      |     | X    |      |      |     | _    |      |      |      |      | _   |      | _    |      |      |      | _   | _    |      |      |      |      |
| 8,200 pF 822   |             |     |     |      |      |     |            |      | Х        |      |      |     |      |      |      |     | _    |      |      |      |      | _   |      |      |      |      |      | _   |      | _    |      |      |      |
| 10,000 pF 103  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      | _   | _    |      |      |      |      | _   |      | _    |      |      |      | _   | _    | _    |      |      |      |
| 12,000 pF 123  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      | _   |      |      |      |      |      |     |      |      |      |      |      |
| 15,000 pF 153  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     | X    |      |      |      |      | _   |      | Х    |      |      |      |     | _    |      |      |      |      |
| 18,000 pF 183  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      | _   |      |      |      |      |      |     | _    |      |      |      |      |
| 22,000 pF 223  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     | X    |      |      |      |      |     |      |      |      |      |      |
| 27,000 pF 273  |             |     |     |      |      |     |            |      |          |      |      | Х   |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     | _    |      |      |      |      |
| 33,000 pF 333  |             |     | L   |      |      |     |            |      | L        |      |      |     |      |      |      |     |      |      |      |      |      | _   |      |      |      |      |      | _   | X    | X    |      |      |      |
| 39,000 pF 393  |             |     |     |      |      |     |            |      | <u> </u> |      |      |     |      |      |      |     |      |      |      |      |      | _   |      |      |      |      |      |     |      |      |      |      |      |
| 47,000 pF  |             |     |     |      |      |     |            |      | <u> </u> |      |      |     |      |      |      |     |      |      |      |      |      | _   |      |      |      |      |      |     |      |      |      |      |      |
| 56,000 pF 563  |             |     |     |      |      |     |            |      | <u> </u> |      |      |     |      |      |      | _   |      |      |      |      |      | _   |      |      |      |      |      |     |      |      |      |      |      |
| 68,000 pF 683  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      | X   |      |      |      |      |      | X   |      |      |      |      |      |     |      |      |      |      |      |
| Capacitance   Cap   Code   Code   Cap   Code   Cap   Code   Cap   Capacitance   Cap   Capacitance   Cap   Code   Capacitance   Cap   Capacitance   Cap   Capacitance   Cap |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
| Style/ Size Voltage  | 68,000 pF   |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      |      |      |      |      |     |      |      |      |      |      | X   |      |      |      |      |      |
| Style/ Size Voltage  | Capacitance |     | 200 | 1000 | 2000 | 200 | 1000       | 2000 | 500      | 1000 | 2000 | 200 | 1000 | 2000 | 3000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000 | 200 | 1000 | 2000 | 3000 | 4000 | 5000 | 200 | 1000 | 2000 | 3000 | 4000 | 2000 |
| Style/ Size  |             |     |     |      |      |     |            |      |          |      |      |     |      |      |      |     |      | _    | _    |      |      |     |      |      |      |      |      |     |      |      |      |      |      |
|  | Style/ Si   | ze  |     | HS20 | )    |     | HS21       |      |          | HS22 | ·    |     | HS   | 23   |      |     |      |      |      |      |      |     |      | HS   | 25   |      |      |     |      | н    | 26   |      |      |



## **Table 1B - HS COG Waterfall cont.**

| Style/S                | izo         |          | HS   | 30   |      |          |      | HS   | 31    |          |        |     |        | HS   | 33       |      |      |          |      | Н    | <b>S</b> 3 | 4    |      |      |     |      |          | HS   | 35   |      |      |       |     |      |      | HS   | 36   |      |      |          |
|------------------------|-------------|----------|------|------|------|----------|------|------|-------|----------|--------|-----|--------|------|----------|------|------|----------|------|------|------------|------|------|------|-----|------|----------|------|------|------|------|-------|-----|------|------|------|------|------|------|----------|
| Style/S                | ize         |          |      |      |      |          |      |      |       |          |        |     |        |      |          |      |      |          |      | Vo   | lta        | ge   |      |      |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| Capacitance            | Cap<br>Code | 200      | 1000 | 2000 | 3000 | 200      | 1000 | 2000 | 3000  | 4000     | 5000   | 200 | 1000   | 2000 | 3000     | 4000 | 5000 | 200      | 1000 | 2000 | 3000       | 4000 | 5000 | 7500 | 500 | 1000 | 2000     | 3000 | 4000 | 5000 | 7500 | 10000 | 500 | 1000 | 2000 | 3000 | 4000 | 5000 | 7500 | 10000    |
| 15 pF                  | 150         | Х        | Х    | Х    | Χ    |          |      |      |       |          |        |     |        |      |          |      |      |          |      |      |            |      |      |      |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 18 pF                  | 180         | Х        | Χ    | Х    | X    |          |      |      |       |          |        |     |        |      |          |      |      |          |      |      |            |      |      |      |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 22 pF                  | 220         | X        | X    | X    | X    | X        | X    | X    | X     | X        | Х      | V   |        |      | . v      | V    | \ \  | _        |      |      |            |      |      |      | L   |      |          |      |      |      |      | -     | L   |      |      |      |      |      |      | _        |
| 27 pF<br>33 pF         | 270<br>330  | X        | X    | X    | X    | X        | X    | X    | X     | X        | X      | X   | X      | X    | X        | X    | X    |          |      |      |            |      |      |      |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 39 pF                  | 390         | X        | X    | X    | X    | X        | X    | X    | X     | X        | X      | X   | X      | X    | X        | X    | X    | Х        | Х    | Х    | Х          | Х    | Х    | Х    |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 47 pF                  | 470         | Х        | X    | X    | X    | X        | X    | X    | X     | Х        |        | X   | Х      | Х    | X        | Х    | X    | X        | X    | X    | X          | X    | Х    | X    |     |      |          |      |      |      | Х    | Х     |     |      |      |      |      |      |      |          |
| 56 pF                  | 560         | Х        | Χ    | Х    | Х    | Х        | Х    | Х    | Х     | Χ        |        | Χ   | Χ      | Χ    | Χ        | Х    | Х    | Х        | Х    | Х    | Χ          | Χ    | Χ    | Χ    |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 68 pF                  | 680         | Х        | Χ    | Х    | Х    | Х        | X    | Х    | Х     | Х        |        | Χ   | Χ      | Χ    | Χ        | Х    | Х    | Х        | Х    | Х    | Χ          | Х    | Х    | X    |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 82 pF                  | 820         | Х        | Х    | Х    | X    | Х        | X    | X    | X     | Х        |        | X   | Χ      | Χ    | X        | Х    | Х    | Х        | X    | X    | Х          | Х    | X    | X    |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| 100 pF                 | 101         | Х        | X    | X    | X    | X        | X    | X    | X     | X        |        | X   | X      | X    | X        | X    | X    | X        | X    | X    | X          | X    | X    | X    | _   |      |          |      |      |      |      |       | _   |      |      |      |      |      |      | -        |
| 120 pF                 | 121         | X        | X    | X    | X    | X        | X    | X    | X     | X        |        | X   | X      | X    | X        | X    | X    | X        | X    | X    | X          | X    | X    | X    | -   |      |          |      |      |      |      |       | -   |      |      |      |      |      |      |          |
| 150 pF<br>180 pF       | 151<br>181  | X        | X    | Х    |      | X        | X    | X    | X     | X        |        | Х   | Х      | Х    | Х        | Х    | Х    | Х        | Х    | X    | Х          | Х    | Х    | Х    |     |      |          |      |      |      |      |       | -   |      |      |      |      |      |      |          |
| 220 pF                 | 221         | X        | Χ    | X    |      | Χ        | X    | X    | X     | Х        |        | X   | Χ      | Χ    | Х        | X    | X    | X        | X    | X    | X          | X    | X    | X    | Х   | Х    | Х        | Х    | Х    | Х    |      |       |     |      |      |      |      |      |      |          |
| 270 pF                 | 271         | Х        | X    | X    |      | X        | X    | X    |       | ^        |        | X   | Х      | Χ    | X        | X    | X    | X        | X    | X    | X          | X    | X    | X    | Х   | X    | X        | X    | X    | X    |      |       | Х   | Х    | Х    | Х    | Х    | Х    |      |          |
| 330 pF                 | 331         | Х        | Χ    | Χ    |      | Х        | Х    | Х    |       |          |        | Χ   | Χ      | Χ    | Χ        | Χ    | Χ    | Х        | Х    | Χ    | Χ          | Χ    | Х    | Χ    | Х   | Х    | Х        | Χ    | Х    | Х    |      |       | Х   | Х    | Х    | Х    | Х    | Χ    |      |          |
| 390 pF                 | 391         | Х        | Χ    | Χ    |      | Х        | X    | X    |       |          |        | Χ   | Χ      | Χ    | X        | Χ    | X    | Х        | X    | X    | Χ          | Х    | Х    | X    | Х   | X    | X        | X    | X    | X    |      |       | Х   | Х    | X    | X    | X    | X    |      |          |
| 470 pF                 | 471         | Х        | Χ    | X    |      | Х        | X    | X    |       |          |        | X   | X      | Χ    | X        | X    | X    | Х        | X    | X    | X          | X    | X    | X    | Х   | X    | X        | X    | X    | X    |      |       | Х   | X    | X    | X    | X    | X    |      |          |
| 560 pF                 | 561         | Х        | X    | X    |      | X        | X    | X    |       |          |        | X   | X      | X    | X        | X    | X    | X        | X    | X    | X          | X    | X    | Х    | X   | X    | X        | X    | X    | X    |      | -     | X   | X    | X    |      | X    | X    |      | _        |
| 680 pF                 | 681         | X        | X    | Х    |      | X        | X    | X    |       |          |        | X   | X      | X    | X        | X    | X    | X        | X    | X    | X          | X    | X    |      | X   | X    | X        | X    | X    | X    |      |       | X   | X    | X    |      | X    | X    |      |          |
| 820 pF<br>1,000 pF     | 821<br>102  | X        | Х    |      |      | X        | X    | X    |       |          |        | Х   | Х      | X    | Х        | Χ    | Х    | X        | Х    | X    | Х          | Х    | X    |      | X   | Х    | Х        | X    | X    | X    | Х    | Х     | X   | Х    | X    |      | X    | Х    |      |          |
| 1,000 pf               | 122         | Х        | X    |      |      | X        | X    | X    |       |          |        | X   | X      | X    | X        | X    | ^    | X        | X    | X    | X          | X    | X    |      | X   | X    | X        | X    | X    | X    | ^    | ^     | X   | X    | X    |      | X    | X    |      |          |
| 1,500 pF               | 152         | Х        | X    |      |      | Х        | Ä    |      |       |          |        | X   | X      | Х    | X        | X    |      | X        | X    | X    | X          | X    | X    |      | Х   | X    | X        | X    | X    | X    |      |       | Х   | X    | X    | X    | X    | X    | Х    | Х        |
| 1,800 pF               | 182         | Х        | Χ    |      |      | Х        |      |      |       |          |        | Χ   | Χ      | Χ    |          |      |      | Х        | Х    | Х    | Χ          | Χ    | Х    |      | Х   | Х    | Х        | Х    | Χ    | Х    |      |       | Х   | Х    | Х    | Х    | Х    | Х    |      |          |
| 2,200 pF               | 222         | Х        |      |      |      | Х        |      |      |       |          |        | Χ   | Χ      | Χ    |          |      |      | Х        | X    | X    | Х          | Х    | Х    |      | Х   | Х    | Х        | X    | X    |      |      |       | Х   | Х    | Х    | Х    | X    | Х    |      |          |
| 2,700 pF               | 272         | Χ        |      |      |      | Х        |      |      |       |          |        | X   | Χ      | Χ    |          |      |      | Х        | X    | X    | Χ          | Х    |      |      | Х   | X    | X        | X    | X    |      |      |       | Х   | Х    | X    | X    | X    | X    |      |          |
| 3,300 pF               | 332         | X        |      |      |      | X        |      |      |       |          |        | X   | X      | X    |          |      |      | X        | X    | X    |            |      |      |      | X   | X    | X        | X    | X    |      |      |       | X   | X    | X    | X    | X    | Х    |      |          |
| 3,900 pF               | 392<br>472  | X        |      |      |      | X        |      |      |       |          |        | X   | X      | X    |          |      |      | X        | X    | X    |            |      |      |      | X   | X    | X        | X    | X    |      |      |       | X   | X    | X    |      | X    |      |      |          |
| 4,700 pF<br>5,600 pF   | 562         | X        |      |      |      | X        |      |      |       |          |        | X   | X      | X    |          |      |      | X        | X    | X    |            |      |      |      | X   | X    | X        |      |      |      |      |       | X   | X    | X    |      | X    |      |      |          |
| 6,800 pF               | 682         | Ĥ        |      |      |      | Х        |      |      |       |          |        | Х   | Х      |      |          |      |      | X        | X    | X    |            |      |      |      | Х   | X    | Х        |      |      |      |      |       | Х   | X    | X    | _    | X    |      |      |          |
| 7,500 pF               | 752         |          |      |      |      | Х        |      |      |       |          |        | Х   | Х      |      |          |      |      | Х        | Х    | Х    |            |      |      |      | Х   | Х    | Х        |      |      |      |      |       | Х   | Х    | Х    | _    |      |      |      |          |
| 8,200 pF               | 822         |          |      |      |      | Χ        |      |      |       |          |        | Χ   | Χ      |      |          |      |      | Х        | X    | Х    |            |      |      |      | Х   | X    | X        |      |      |      |      |       | Х   | Х    | Х    | X    |      |      |      |          |
| 10,000 pF              | 103         |          |      |      |      | Х        |      |      |       |          |        | Х   | Χ      |      |          |      |      | Х        | X    | X    |            |      |      |      | Х   | X    | X        |      |      |      |      |       | Х   | Х    | X    | Х    |      |      |      |          |
| 12,000 pF              | 123         |          |      |      |      | Х        |      |      |       |          |        | X   | X      |      |          |      |      | X        | X    | X    |            |      |      |      | X   | X    | X        |      |      |      |      |       | X   | X    | X    |      |      |      |      |          |
| 15,000 pF              | 153         |          |      |      |      |          |      |      |       |          |        | X   | X      |      |          |      |      | X        | X    | Х    |            |      |      |      | X   | X    | X        |      |      |      |      |       | X   | X    | X    |      |      |      |      |          |
| 18,000 pF<br>22,000 pF | 183<br>223  |          |      |      |      |          |      |      |       |          |        | Х   | ^      |      |          |      |      | Х        | X    |      |            |      |      |      | X   | X    | X        |      |      |      |      |       | Х   | X    | X    |      |      |      |      |          |
| 27,000 pF              | 273         | Н        |      |      |      |          |      |      |       |          |        | X   |        |      |          |      |      | X        | _    |      |            |      |      |      | X   | X    | <u> </u> |      |      |      |      |       | X   | X    | X    |      |      |      |      |          |
| 33,000 pF              | 333         |          |      |      |      |          |      |      |       |          |        | Х   |        |      |          |      |      | Х        |      |      |            |      |      |      | Х   | Х    |          |      |      |      |      |       | Х   | Х    |      |      |      |      |      |          |
| 39,000 pF              | 393         |          |      |      |      |          |      |      |       |          |        | Χ   |        |      |          |      |      | Х        |      |      |            |      |      |      | Х   | Х    |          |      |      |      |      |       |     | Х    |      |      |      |      |      |          |
| 47,000 pF              | 473         |          |      |      |      |          |      |      |       |          |        | Χ   |        |      |          |      |      | Х        |      |      |            |      |      |      | Х   | X    |          |      |      |      |      |       | Х   | Х    |      |      |      |      |      |          |
| 56,000 pF              | 563         |          |      |      |      | _        |      |      |       |          |        |     |        |      |          |      |      | Х        |      |      |            |      |      |      | X   |      |          |      |      |      |      |       | X   | Х    |      |      |      |      |      | <u> </u> |
| 68,000 pF              | 683         | $\vdash$ |      | -    |      | $\vdash$ | -    |      |       |          | _      |     | -      |      |          | -    |      | $\vdash$ |      |      | -          |      |      |      | X   |      |          |      |      |      | -    | -     | X   |      |      |      |      |      |      |          |
| 82,000 pF<br>0.1 uF    | 823<br>104  | $\vdash$ |      |      |      | $\vdash$ |      |      |       | $\vdash$ |        |     |        |      |          |      |      |          |      |      |            |      |      |      | X   |      |          |      |      |      |      |       | Х   |      |      |      |      |      |      |          |
| 0.1 uF<br>0.12 uF      | 124         |          |      |      |      |          |      |      |       | $\vdash$ |        |     | $\neg$ |      |          |      |      |          |      |      |            |      |      |      | X   |      |          |      |      |      |      |       | X   |      |      |      |      |      |      |          |
| 0.15 uF                | 154         |          |      |      |      |          |      |      |       |          |        |     |        |      |          |      |      |          |      |      |            |      |      |      | Х   |      |          |      |      |      |      |       | Х   |      |      |      |      |      |      |          |
| Capacitance            | Cap<br>Code | 200      | 1000 | 2000 | 3000 | 200      | 1000 | 2000 | 3000  | 4000     | 5000   | 200 | 1000   | 2000 | 3000     | 4000 | 2000 | 200      | 1000 | 2000 | 3000       | 4000 | 5000 | 7500 | 200 | 1000 | 2000     | 3000 | 4000 | 5000 | 7500 | 10000 | 200 | 1000 | 2000 | 3000 | 4000 | 2000 | 7500 | 10000    |
|                        |             |          |      |      |      |          |      |      |       |          |        |     |        |      |          |      |      |          |      |      | oltag      |      |      |      |     |      |          |      |      |      |      |       |     |      |      |      |      |      |      |          |
| Style/Siz              | ze          | $\vdash$ | —    | 30   |      | Г        |      | ш    | 31    | —        | $\neg$ |     | _      | HS   | 32       |      |      | Г        | _    |      | HS34       | _    |      |      |     |      |          | щ    | 35   |      |      |       |     |      | _    | щ    | 36   |      |      | _        |
| L                      |             |          |      | 30   |      |          |      | п    | , J I |          |        |     |        | пэ   | <u> </u> |      |      |          |      |      | 1004       |      |      |      |     |      |          | пә   |      |      |      |       |     |      |      | п    | ,,0  |      |      |          |



#### **Packaging Quantities**

| Style | Waffle Pack Quantity | Style | Waffle Pack Quantity |
|-------|----------------------|-------|----------------------|
| HS20  | 28                   | HS25  | 28                   |
| HS21  | 28                   | HS26  | 20                   |
| HS22  | 28                   | HS33  | 20                   |
| HS30  | 28                   | HS34  | 4                    |
| HS23  | 20                   | HS35  | 4                    |
| HS31  | 20                   | HS36  | 4                    |
| HS24  | 20                   | -     | -                    |

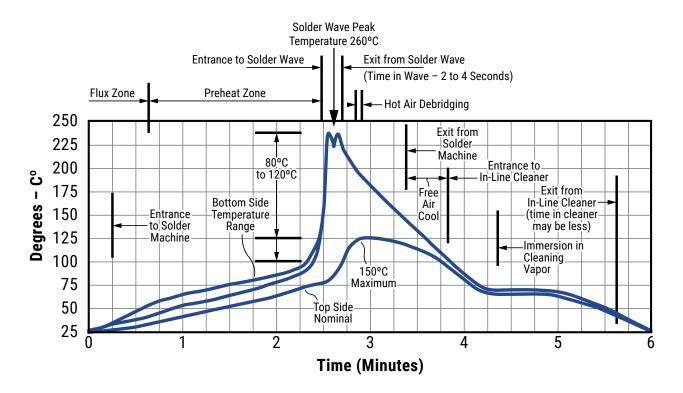
### **Soldering Process**

#### **Recommended Soldering Technique:**

- · Solder Wave
- Hand Soldering (Manual)

#### **Recommended Soldering Profile:**

· Optimum Wave Solder Profile

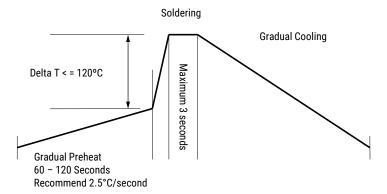




### **Soldering Process cont.**

Hand Soldering (Manual)

#### **Manual Solder Profile with Pre-heating**



KEMET recommends following the guidelines and techniques outlined in technical bulletins F2103 and F9207.

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

| Stress   | Reference                 | Test or Inspection Method   | Limits  |
|--|---------------------------|---|---|
| Visual and<br>Mechanical   | KEMET Internal            | No defects that may affect performance (10X)  | Dimensions according KEMET Spec Sheet   |
| Capacitance<br>(Cap)   | MIL-STD-202<br>Method 305 | C $\leq$ 100 pF: 1 MHz $\pm$ 100 kHz and 1.0 $\pm$ 0.2 Vrms C > 100 pF: 1 kHz $\pm$ 100 Hz and 1.0 $\pm$ 0.2 Vrms   | Dimensions according KEMET Spec Sheet   |
| Dissipation<br>Factor (DF)   | KEMET Internal            | C $\leq$ 100 pF: 1 MHz $\pm$ 100 kHz and 1.0 $\pm$ 0.2 Vrms C > 100 pF: 1 kHz $\pm$ 100 Hz and 1.0 $\pm$ 0.2 Vrms   | X7R: 2.5%<br>C0G: 0.15%   |
| Insulation<br>Resistance (IR)  | MIL-STD-202<br>Method 302 | Test potential: 500 V DC between capacitor element terminals Surge current: limited to 30mA Special condition: If failure at relative humidity of ≥ 50%, IR may be measured again at a relative humidity of less than 50% | Within Specification To obtain IR limit, divide $M\Omega$ - $\mu$ F value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.  At 25°C: 100,000 megohms or 1,000 Megohm-microfarad, whichever is less. At 125°C: 10,000 megohms or 100 Megohm-microfarad, whichever is less. |
| Temperature<br>Coefficient of<br>Capacitance (TCC)                           | KEMET Internal            | C0G: 0 ppm/°C ±30 ppm/°C<br>X7R: ±15%   | Within Specification  |
| Temperature<br>Coefficient of<br>Capacitance at<br>Applied Voltage<br>(TCVC) | KEMET Internal            | C0G: 0 ppm/°C ±30 ppm/°C<br>X7R: +15%/-70%  | COG: Within Specification<br>X7R: Within KEMET Specification limits   |



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

| Stress  | Reference                 | Test or Inspection Method   | Limits   |
|---|---------------------------|---|--|
| Dielectric<br>Withstanding<br>Voltage (DWV)                   | KEMET Internal            | 150% of rated voltage for voltage rating of<br>500 V ≤ V < 1,000 V<br>120% of rated voltage for voltage rating of ≥ 1,000 V<br>(5 ±1 seconds and charge/discharge not exceeding<br>50 mA at 25°C) | Withstand test voltage without insulation breakdown or damage.   |
| Aging Rate<br>(Maximum %<br>Capacitance Loss/<br>Decade Hour) | KEMET Internal            | Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details.                     | Please refer to a part number specification sheet for specific Aging rate  |
| Terminal<br>Strength  | MIL-STD-202<br>Method 211 | Applied force: 5 pounds (2.3 kg)  | No evidence of mechanical damage   |
| Solderability   | MIL-STD-202<br>Method 208 | Condition: 4 hours ± 15 minutes at 155°C dry bake apply all methods Test 245 ± 5°C  | Visual Inspection. 95% coverage on termination. No leaching  |
| Temperature<br>Cycling  | JESD22<br>Method JA-104   | 1,000 cycles (-55°C to +125°C)<br>2 - 3 cycles per hour<br>Soak Time: 1 or 5 minutes  | Measurement at 24 hours ±4 hours after test<br>conclusion.<br>Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit   |
| Moisture<br>Resistance  | MIL-STD-202<br>Method 106 | Number of cycles required 10, 24 hours per cycle.<br>Steps 7a and 7b not required   | Visual examination: No mechanical damage. Marking shall remain legible  Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: X7R: Change not to exceed ±10% of initial measured value Cap: C0G: ±0.5 percent or 5 pF, whichever is greater, of initial measured value IR: 10% of Initial Limit of the initial +25°C requirement |
| Thermal Shock   | MIL-STD-202<br>Method 107 | Number of cycles required 5, (-55°C to 125°C)<br>Dwell time 15 minutes.   | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit   |
| High Temperature<br>Life                                      | MIL-STD-202<br>Method 108 | 2,000 hours at +125°C, +4°C, -0°C.<br>With rated voltage, ±5 percent.   | Within Post Environmental Limits Visual examination: No mechanical damage. Marking shall remain legible. IR: (at +25°C): Shall not be less than 30 percent of the value specified IR: (at elevated ambient temperature): Shall not be less than 30 percent of the value  |
| Storage Life  |                           | 1,000 hours at 125°C, Unpowered   | specified  |
| Vibration   | MIL-STD-202<br>Method 204 | 20 g's for 8 hours, 3 orientations.<br>Test from 10 – 2,000 Hz  | Cap: X7R: Change not to exceed +/- 10% of initial measured value Cap: COG: ±0.5 percent or 5 pF, whichever is greater, of initial measured value DF: Initial Limit IR: Initial Limit   |
| Mechanical<br>Shock   | MIL-STD-202<br>Method 213 | 100 g's 6 ms Sawtooth, Velocity Change 9.7 feet/<br>second (Condition I)  | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit   |
| Resistance<br>to Solvents                                     | MIL-STD-202<br>Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents  | Capacitors shall be visually examined for evidence of mechanical damage and marking.   |

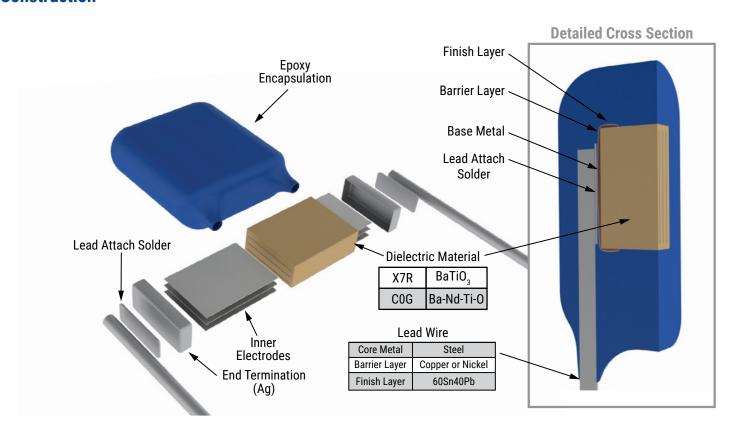


#### **Storage & Handling**

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.

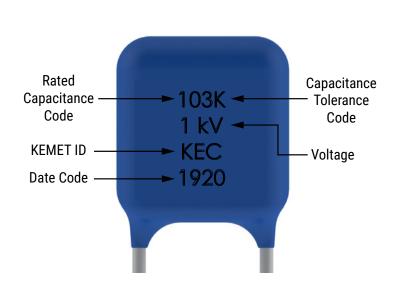
#### Construction

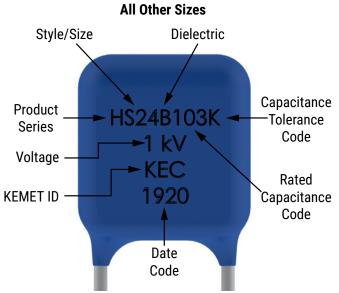




# **Marking**

HS20, HS21





| Date                             | Code  |
|----------------------------------|---|
| 19                               | 20  |
| Manufacturing Year:<br>19 = 2019 | Manufacturing Week:<br>20 = Week 20<br>(of manufacturing calendar year) |



#### **KEMET Electronics Corporation Sales Offices**

For a complete list of our global sales offices, please visit www.kemet.com/sales.

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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product-related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicated or that other measures may not be required.