

## Polypropylene film foil capacitors

KP 460 to 464

## KP AXIAL EPOXY LACQUERED TYPE

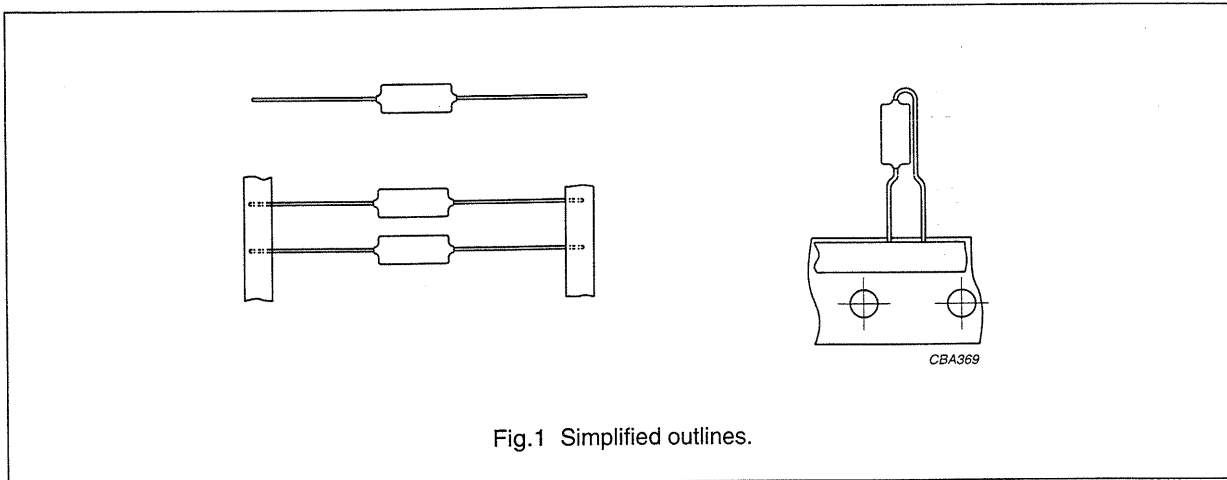


Fig.1 Simplified outlines.

## FEATURES

- Supplied loose in box, taped on reel or unidirectional.

## APPLICATIONS

- In circuits where close tolerance, reliability and low losses are of prime importance, for example: tuned circuits, filter and timing networks.

## DETAIL SPECIFICATION

For more detailed data and test requirements see "Type detail specification HQN-384-13/101".

## QUICK REFERENCE DATA

| DESCRIPTION                     | VALUE   |
|---------------------------------|---|
| Capacitance range (E12 series)  | 47 to 62000 pF  |
| Capacitance tolerance           | ±5% (E24 series);<br>±2% (E24, E48 series);<br>±1% (E24, E48, E96 series) |
| Rated (DC) voltage              | 63 V; 160 V; 250 V; 400 V; 630 V  |
| Climatic category               | 40/100/56   |
| Rated temperature               | 85 °C   |
| Maximum application temperature | 100 °C  |
| Reference specification         | IEC 60384-13  |
| Stability class for:            |   |
| 63; 160; 250 V versions         | class 1   |
| 400; 630 V versions             | class 2   |

Polypropylene film foil capacitors

KP 460 to 464

COMPOSITION OF CATALOGUE NUMBER

| TYPE AND VOLTAGES |       |
|-------------------|-------|
| 460               | 63 V  |
| 461               | 160 V |
| 462               | 250 V |
| 463               | 400 V |
| 464               | 630 V |

| MULTIPLIER (nF) |   |
|-----------------|---|
| 0.0001          | 9 |
| 0.001           | 1 |
| 0.01            | 2 |
| 0.1             | 3 |

**CAPACITANCE**  
(numerically)

**Example:**  
1003 = 100 × 0.1 = 10 nF

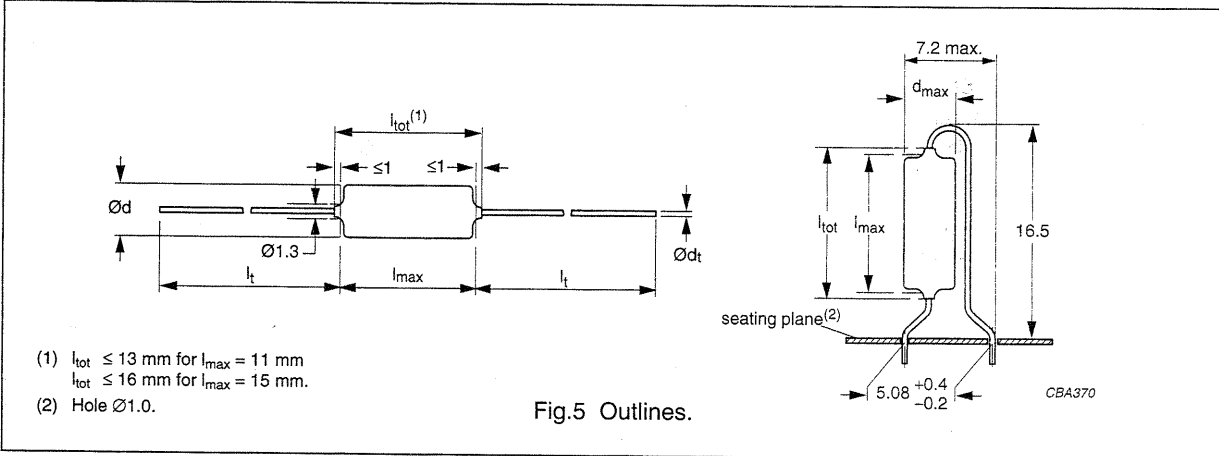
2222    XXX    X    XXX    X

| PACKAGING      | TAPE DISTANCE  | C-TOL |   |
|----------------|--|-------|---|
| Taped on reel  | tape distance = 63.5 mm  | ±1%   | 8 |
|                |  | ±2%   | 7 |
|                |  | ±5%   | 6 |
| Loose in box   | lead length 30.0 or 28.0 mm; see tables with catalogue numbers | ±1%   | 4 |
|                |  | ±2%   | 3 |
|                |  | ±5%   | 2 |
| Unidirectional | H = 16.5 mm  | ±1%   | 1 |
|                |  | ±2%   | 0 |

Polypropylene film foil capacitors

KP 462

KP 462 GENERAL DATA



Specific reference data for the 250 V DC capacitors

| DESCRIPTION   | VALUE   |  |
|---|---|--|
|   | at 1 kHz  | at 100 kHz   |
| Tangent of loss angle:<br>1 000 pF < C ≤ 5000 pF<br>5 000 pF < C ≤ 20000 pF<br>20 000 pF < C ≤ 22000 pF | ≤5 × 10 <sup>-4</sup><br>≤5 × 10 <sup>-4</sup><br>≤5 × 10 <sup>-4</sup> | ≤10 × 10 <sup>-4</sup><br>≤15 × 10 <sup>-4</sup><br>≤25 × 10 <sup>-4</sup> |
| Rated voltage pulse slope (dU/dt) <sub>R</sub> at 250 V (DC)  | 10000 V/μs  |  |
| R between leads; at 100 V; 1 minute   | >100 000 MΩ   |  |
| R between interconnected leads and case; 100 V; 1 minute  | >100 000 MΩ   |  |
| Withstanding (DC) voltage (cut off current 10 mA); rise time 100 V/s                                    | 500 V; 1 minute   |  |
| Withstanding (DC) voltage between leads and case  | 500 V; 1 minute   |  |

Available 250 V DC versions

| PACKAGING                     | C-tol | FIRST 8 DIGITS OF CATALOGUE NUMBER | ORDERING   |
|-------------------------------|-------|------------------------------------|------------|
| Taped on reel; notes 1 and 2  | ±1%   | 2222 462 8....                     | preferred  |
|                               | ±2%   | 2222 462 7....                     | preferred  |
|                               | ±5%   | 2222 462 6....                     | on request |
| Loose in box; note 1          | ±1%   | 2222 462 4....                     | on request |
|                               | ±2%   | 2222 462 3....                     | on request |
|                               | ±5%   | 2222 462 2....                     | on request |
| Unidirectional; notes 1 and 2 | ±1%   | 2222 462 1....                     | on request |
|                               | ±2%   | 2222 462 0....                     | on request |

Available on request

| PACKAGING        | TAPE DISTANCE (mm) |
|------------------|--------------------|
| Taped in ammpack | 52.5; note 2       |
|                  | 63.5; note 2       |
| Taped on reel    | 52.5; note 2       |

Notes

1. For SPQ refer to this handbook, chapter "Packaging information".
2. For detailed specifications refer to this handbook, chapter "Packaging information".

## Polypropylene film foil capacitors

KP 462

 $U_{Rdc} = 250 \text{ V}$ ;  $U_{Rac} = 125 \text{ V}$ 

| C <sup>(1)</sup><br>(E24)<br>(pF)  | DIMENSIONS<br>$d_{max} \times l_{max}$<br>(mm) | MASS<br>(g)    | CATALOGUE NUMBER                |                              |                |               |  |
|--|--|----------------|---------------------------------|------------------------------|----------------|---------------|--|
|  |  |                | TAPED ON REEL                   |                              | UNIDIRECTIONAL |               |  |
|  |  |                | TAPE DISTANCE 63.5 mm           |                              | C-tol = ±2%    | C-tol = ±1%   |  |
|  |  |                | C-tol = ±2%                     | C-tol = ±1%                  | C-tol = ±2%    | C-tol = ±1%   |  |
|  |  |                | catalogue number <sup>(2)</sup> | last 5 digits <sup>(2)</sup> | last 5 digits  | last 5 digits |  |
| <b><math>l_t = 30.0 \text{ mm}</math>; <math>d_t = 0.60 \pm 0.06 \text{ mm}</math></b> |  |                |                                 |                              |                |               |  |
| 1200   | 5.0 × 11.0                                     | 0.5            | 2222 462 71202                  | .. 81202                     | .. 01202       | .. 11202      |  |
| 1300   |  | 0.5            | 2222 462 71302                  | .. 81302                     | .. 01302       | .. 11302      |  |
| 1500   |  | 0.4            | 2222 462 71502                  | .. 81502                     | .. 01502       | .. 11502      |  |
| 1600   |  | 0.5            | 2222 462 71602                  | .. 81602                     | .. 01602       | .. 11602      |  |
| 1800   |  | 0.6            | 2222 462 71802                  | .. 81802                     | .. 01802       | .. 11802      |  |
| 2000   |  | 0.6            | 2222 462 72002                  | .. 82002                     | .. 02002       | .. 12002      |  |
| 2200   |  | 0.5            | 2222 462 72202                  | .. 82202                     | .. 02202       | .. 12202      |  |
| 2400   |  | 0.5            | 2222 462 72402                  | .. 82402                     | .. 02402       | .. 12402      |  |
| 2700   |  | 0.5            | 2222 462 72702                  | .. 82702                     | .. 02702       | .. 12702      |  |
| 3000   |  | 0.5            | 2222 462 73002                  | .. 83002                     | .. 03002       | .. 13002      |  |
| 3300   |  | 0.5            | 2222 462 73302                  | .. 83302                     | .. 03302       | .. 13302      |  |
| <b><math>l_t = 28.0 \text{ mm}</math>; <math>d_t = 0.60 \pm 0.06 \text{ mm}</math></b> |  |                |                                 |                              |                |               |  |
| 3600   |  | 6.0 × 15.0     | 0.5                             | 2222 462 73602               | .. 83602       |               |  |
| 3900   | 0.5  |                | 2222 462 73902                  | .. 83902                     |                |               |  |
| 4300   | 0.6  |                | 2222 462 74302                  | .. 84302                     |                |               |  |
| 4700   | 0.6  |                | 2222 462 74702                  | .. 84702                     |                |               |  |
| 5100   | 0.6  |                | 2222 462 75102                  | .. 85102                     | -              | -             |  |
| 5600   | 0.6  |                | 2222 462 75602                  | .. 85602                     |                |               |  |
| 6200   | 0.7  |                | 2222 462 76202                  | .. 86202                     |                |               |  |
| 6800   | 0.7  |                | 2222 462 76802                  | .. 86802                     |                |               |  |
| 7500   | 0.7  | 2222 462 77502 | .. 87502                        |                              |                |               |  |
| 8200   | 6.5 × 15.0                                     | 0.8            | 2222 462 78202                  | .. 88202                     |                |               |  |
| 9100   |  | 0.8            | 2222 462 79102                  | .. 89102                     | -              | -             |  |
| 10000  |  | 0.9            | 2222 462 71003                  | .. 81003                     |                |               |  |
| 11000  | 7.0 × 15.0                                     | 0.9            | 2222 462 71103                  | .. 81103                     |                |               |  |
| 12000  |  | 1.0            | 2222 462 71203                  | .. 81203                     | -              | -             |  |
| 13000  |  | 1.0            | 2222 462 71303                  | .. 81303                     |                |               |  |
| 15000  | 7.5 × 15.0                                     | 1.1            | 2222 462 71503                  | .. 81503                     |                |               |  |
| 16000  |  | 1.2            | 2222 462 71603                  | .. 81603                     |                |               |  |
| 18000  | 8.0 × 15.0                                     | 1.3            | 2222 462 71803                  | .. 81803                     |                |               |  |
| 20000  | 8.5 × 15.0                                     | 1.4            | 2222 462 72003                  | .. 82003                     |                |               |  |
| 22000  |  | 1.5            | 2222 462 72203                  | .. 82203                     |                |               |  |

## Notes

- In addition to the values of the E24 series as quoted, intermediate values are available of the E48 series (with a tolerance of ±2% or ±1%) and the E96 series (with a tolerance of ±1%). The specifications of these intermediate values are equal to the specifications of the next higher value of the E24 series.
- The shading indicates preferred types.

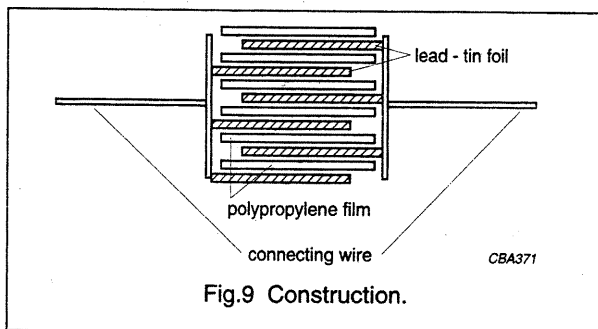
# Polypropylene film foil capacitors

KP 460 to 464

## CONSTRUCTION

### Description

- Low-inductive wound cell of metal foil and a polypropylene film
- Protected by a hard, water-repellent solvent-resistant blue epoxy lacquer
- Axial iron leads, solder-coated.



### SPECIFIC METHOD OF MOUNTING TO WITHSTAND VIBRATION AND SHOCK

The capacitors shall be mechanically fixed by the leads.

### SOLDERING CONDITIONS

The capacitance stability is dependent on the maximum temperature the capacitor reaches during soldering. Figure 10 shows the typical effect of  $\Delta C/C$  as a function of soldering time under the worst possible mounting conditions (horizontal on the PCB, minimum possible pitch) and with 80 °C preheating.

### Storage temperature

- Storage temperature:  $T_{stg} = -25$  to  $+40$  °C with RH maximum 80% without condensation.

### RATINGS AND CHARACTERISTICS REFERENCE CONDITIONS

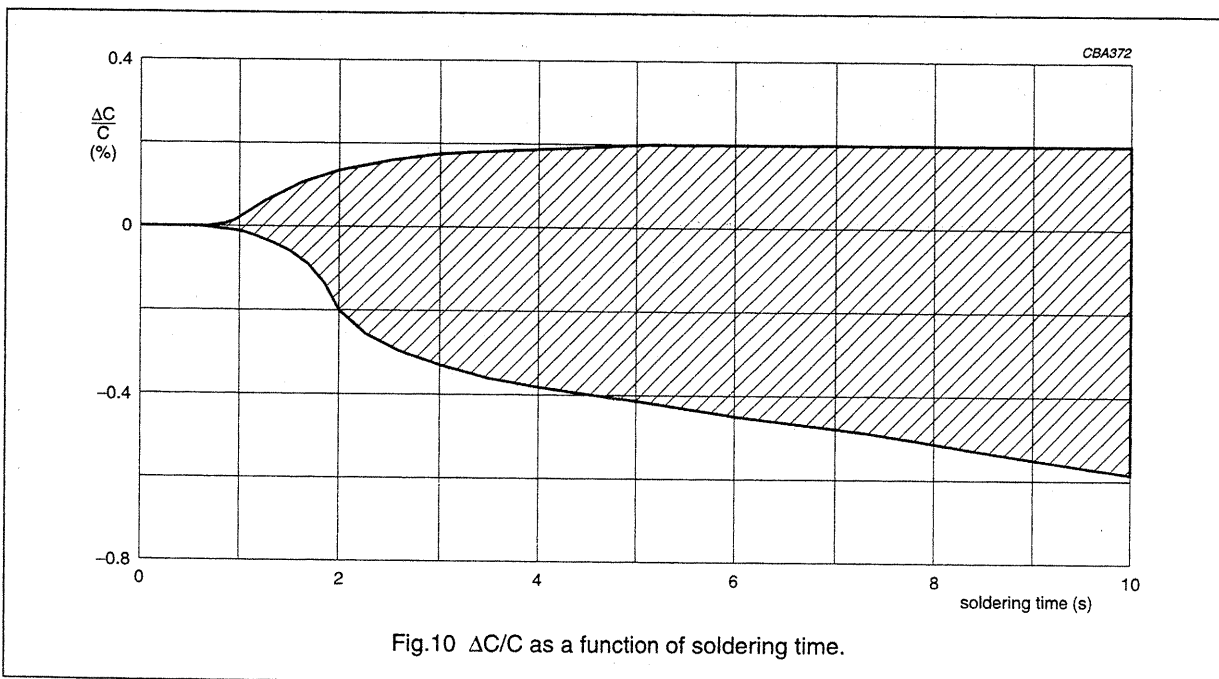
Unless otherwise specified, all electrical values apply to an ambient free air temperature of  $23 \pm 1$  °C, an atmospheric pressure of 86 to 106 kPa and a relative humidity of  $50 \pm 2\%$ .

For reference testing, a conditioning period shall be applied over  $96 \pm 4$  hours by heating the products in a circulating air oven at the rated temperature and a relative humidity not exceeding 20%.

## Mounting

### NORMAL USE

The capacitors are suitable for vertical or horizontal mounting on printed-circuit boards. The capacitors packed on bandoliers are designed for mounting on printed-circuit boards by means of automatic insertion machines.



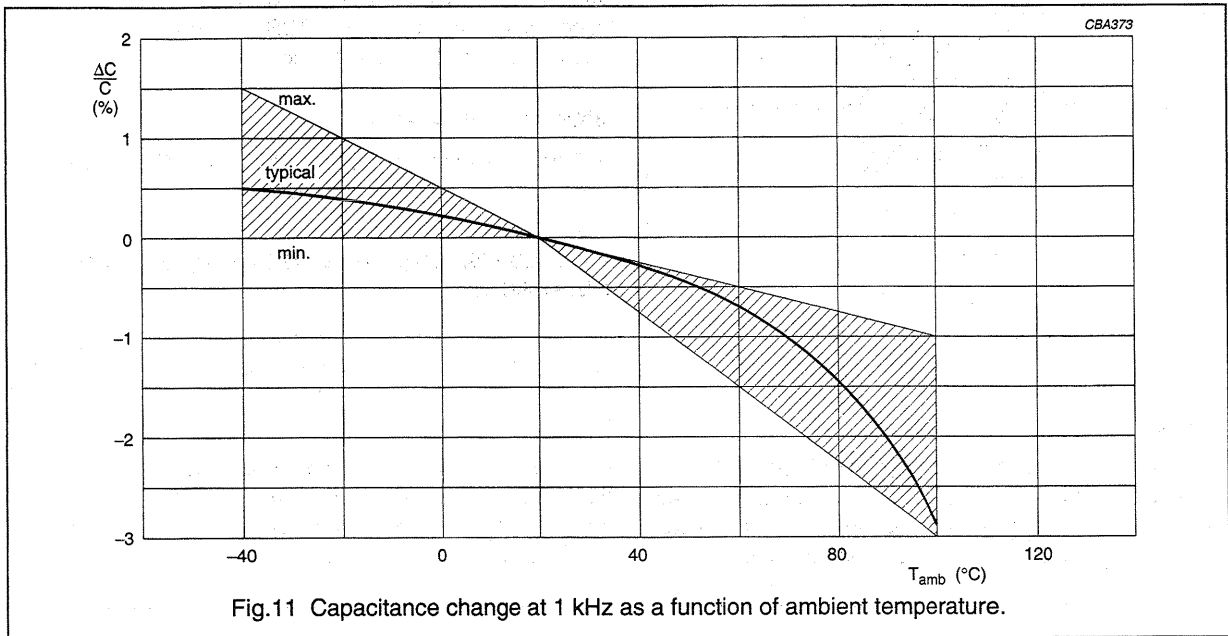
Polypropylene film foil capacitors

KP 460 to 464

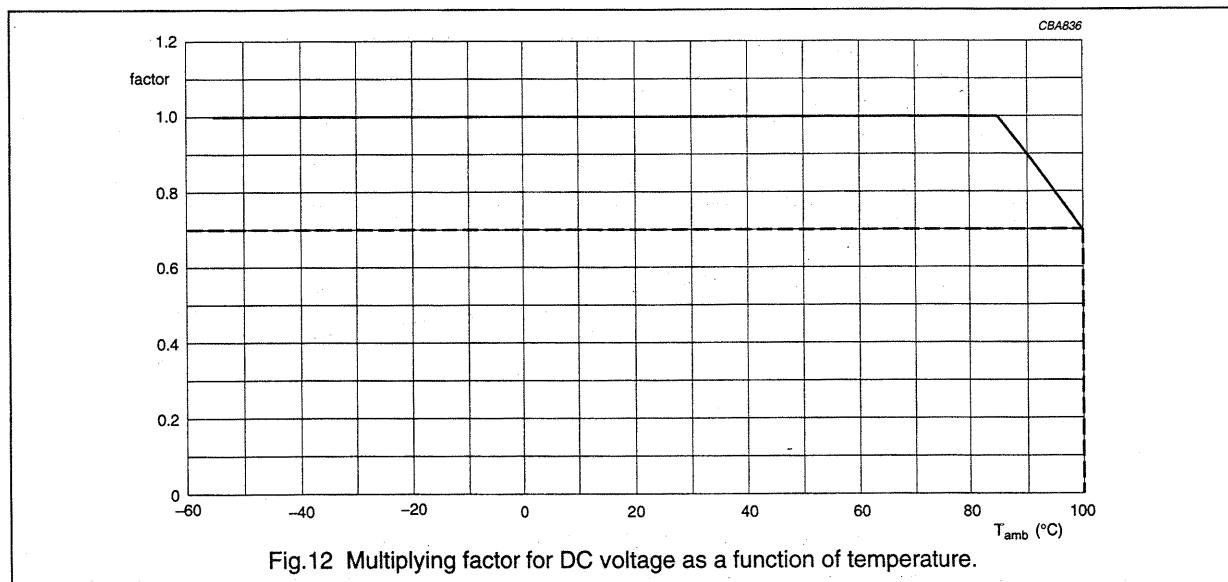
**CHARACTERISTICS**

**Capacitance**

- Temperature coefficient:
  - between -40 and +20 °C for  $C \leq 1000 \text{ pF}$ :  $-(125 \pm 125) \times 10^{-6}/\text{K}$
  - between -40 and +20 °C for  $C > 1000 \text{ pF}$ :  $-(125 \pm 60) \times 10^{-6}/\text{K}$
  - between +20 and +100 °C:  $-(250 \pm 120) \times 10^{-6}/\text{K}$ .



**Maximum DC voltage as a function of temperature**



Polypropylene film foil capacitors

KP 460 to 464

Maximum RMS voltage (sinewave) as a function of frequency

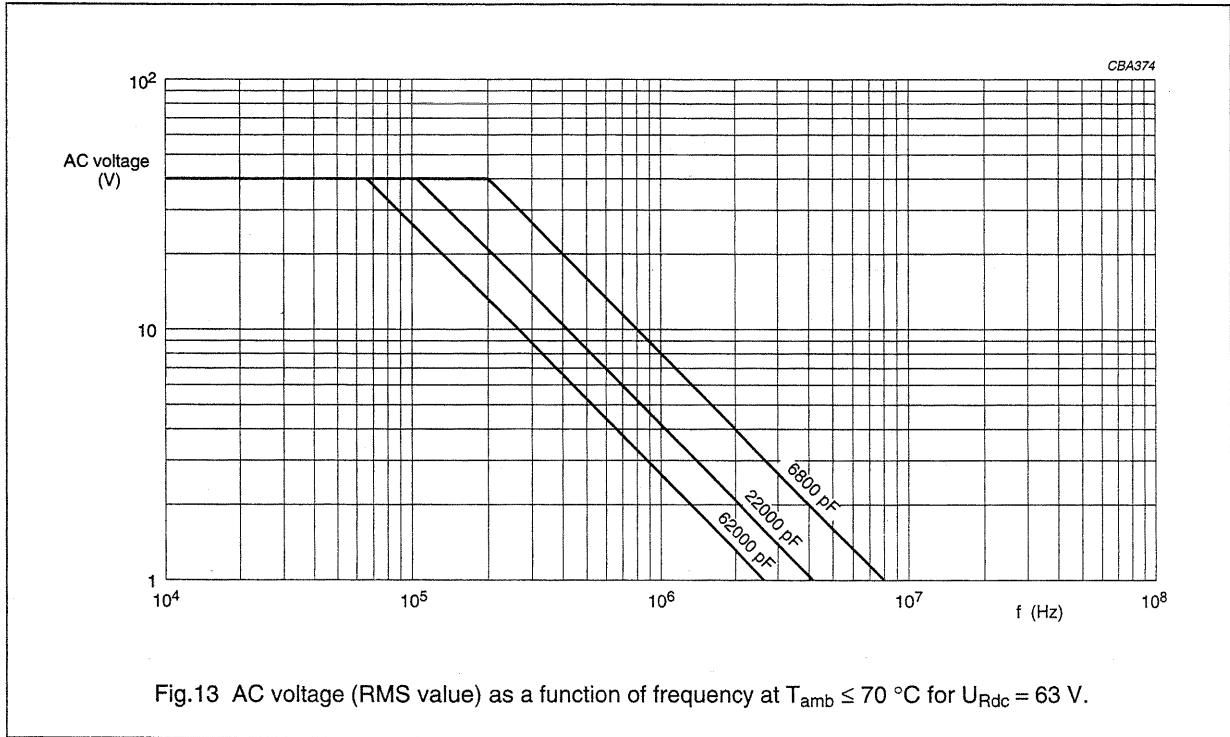


Fig.13 AC voltage (RMS value) as a function of frequency at  $T_{amb} \leq 70\text{ °C}$  for  $U_{Rdc} = 63\text{ V}$ .

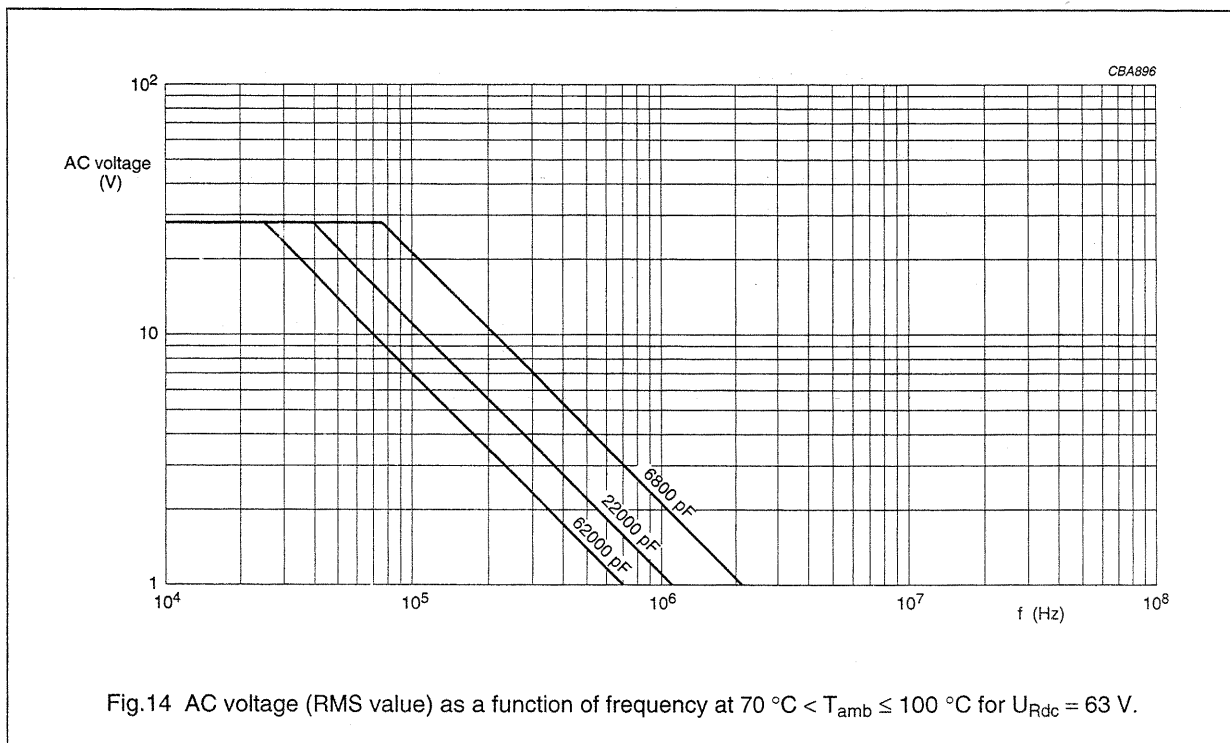
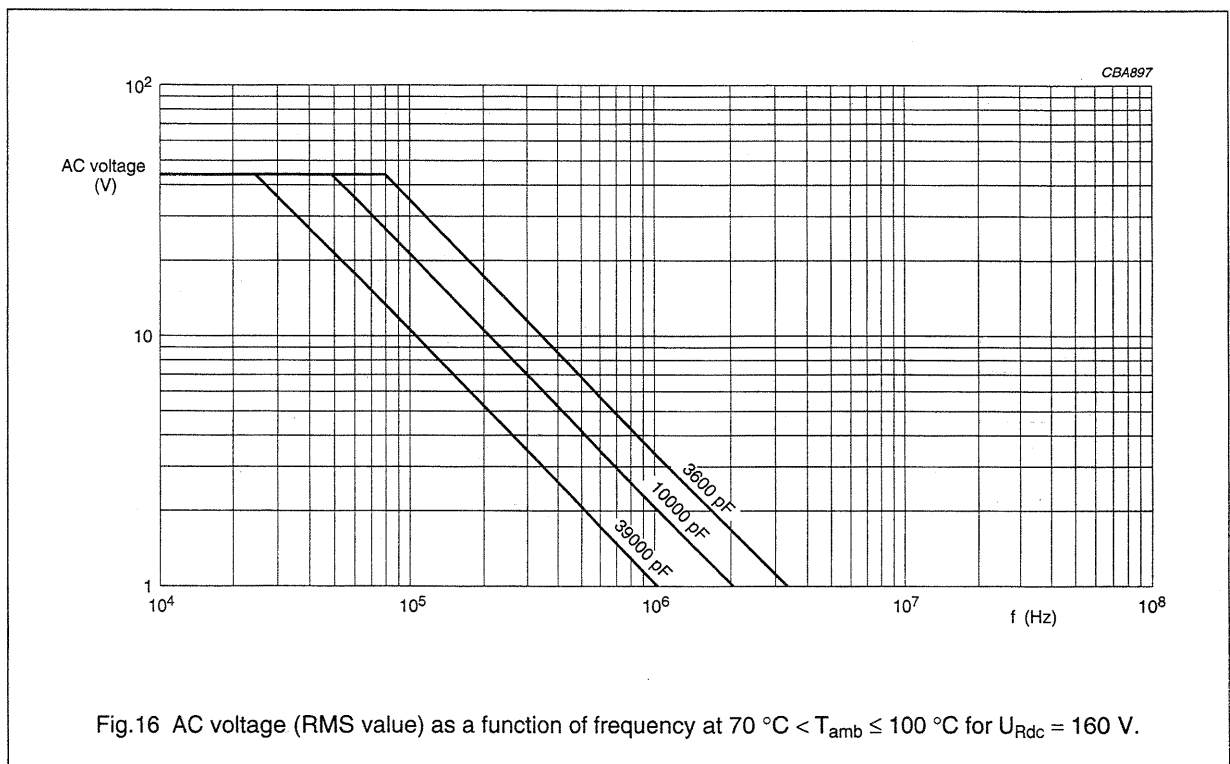
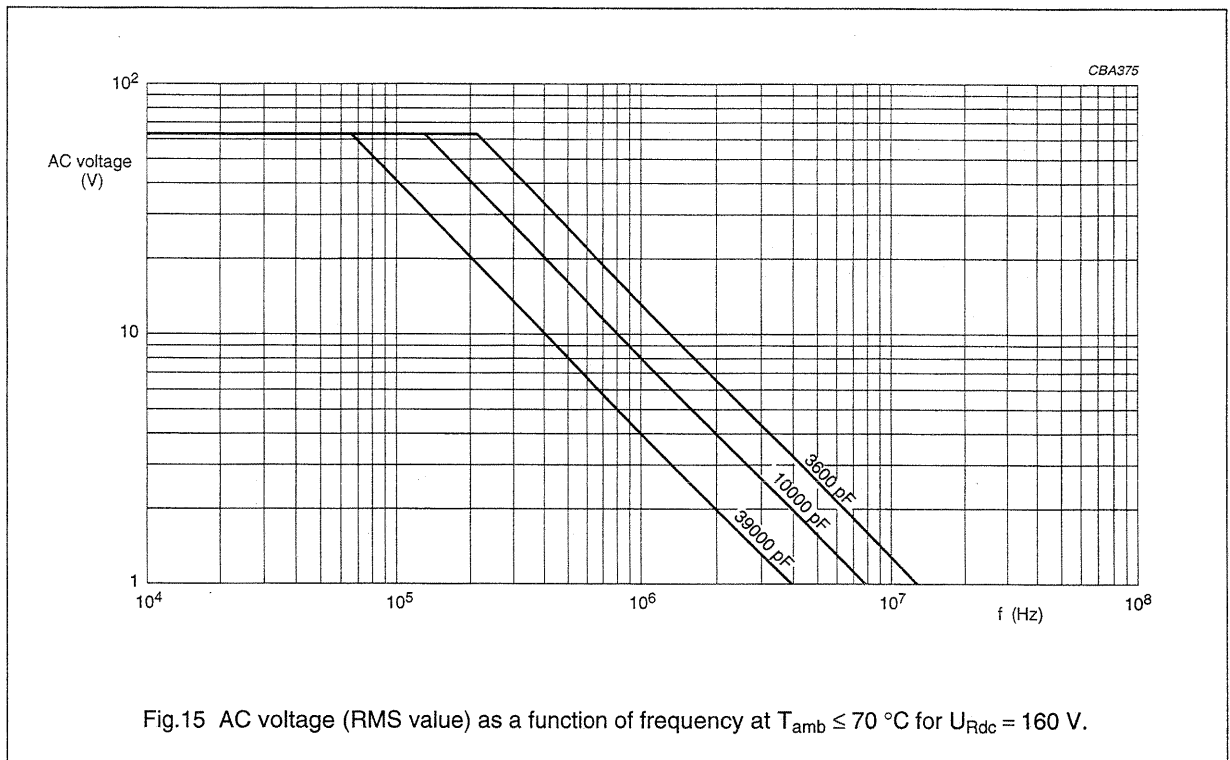


Fig.14 AC voltage (RMS value) as a function of frequency at  $70\text{ °C} < T_{amb} \leq 100\text{ °C}$  for  $U_{Rdc} = 63\text{ V}$ .

Polypropylene film foil capacitors

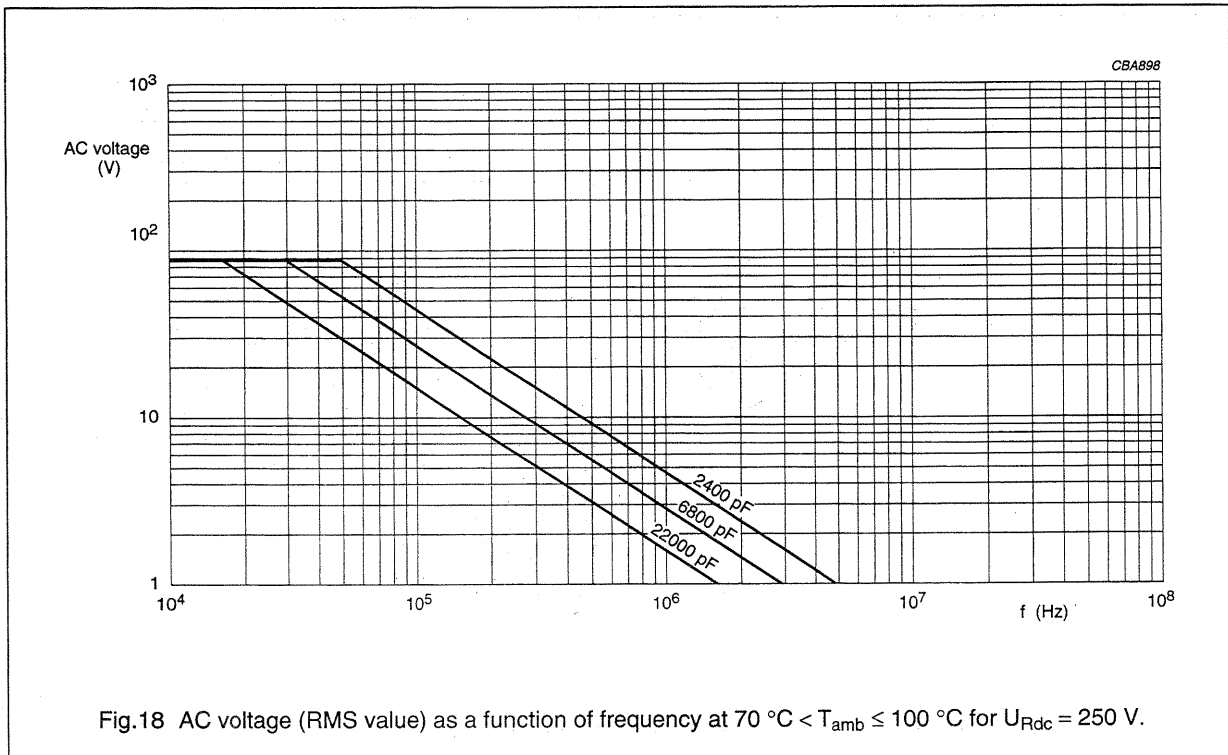
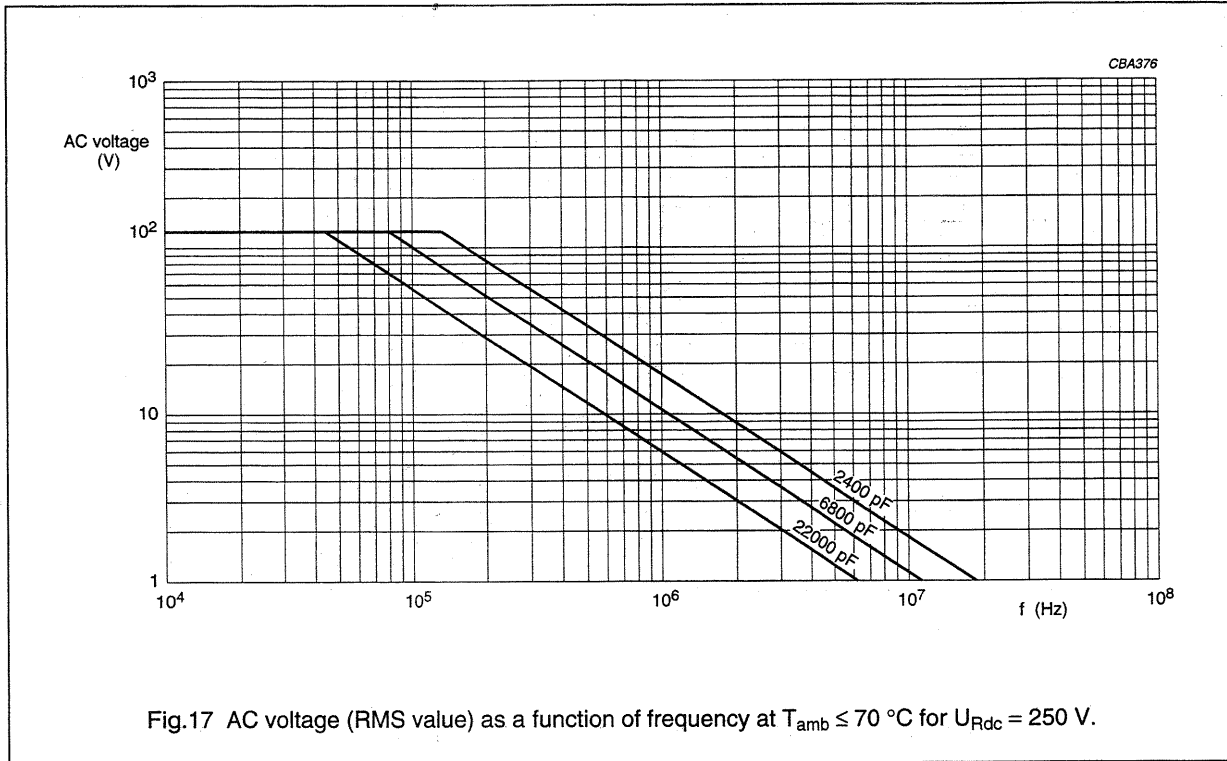
KP 460 to 464

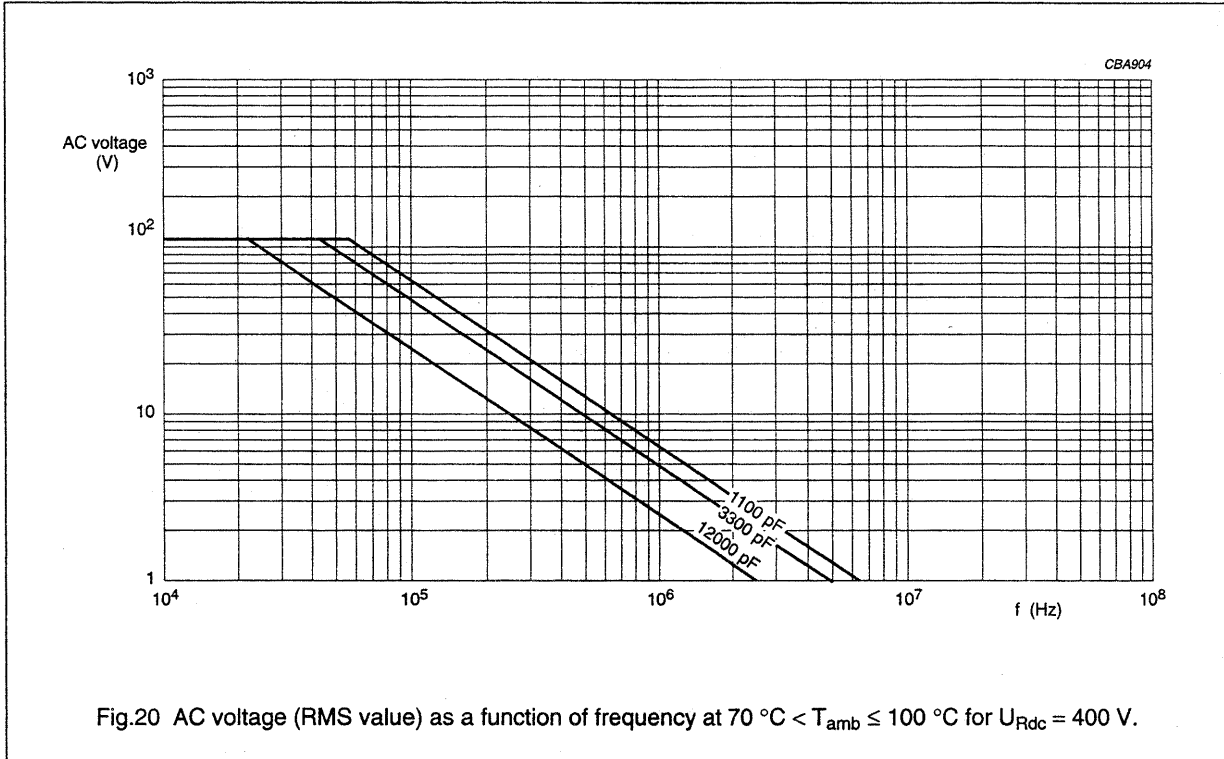
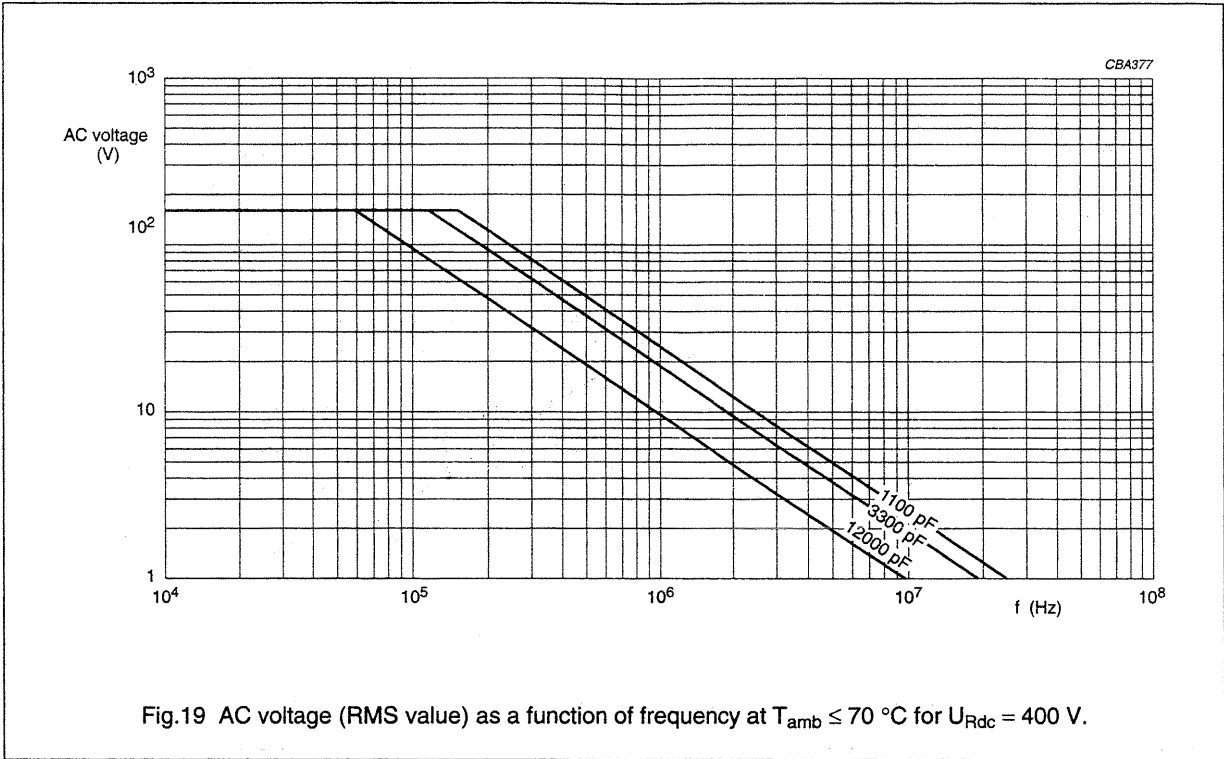




Polypropylene film foil capacitors

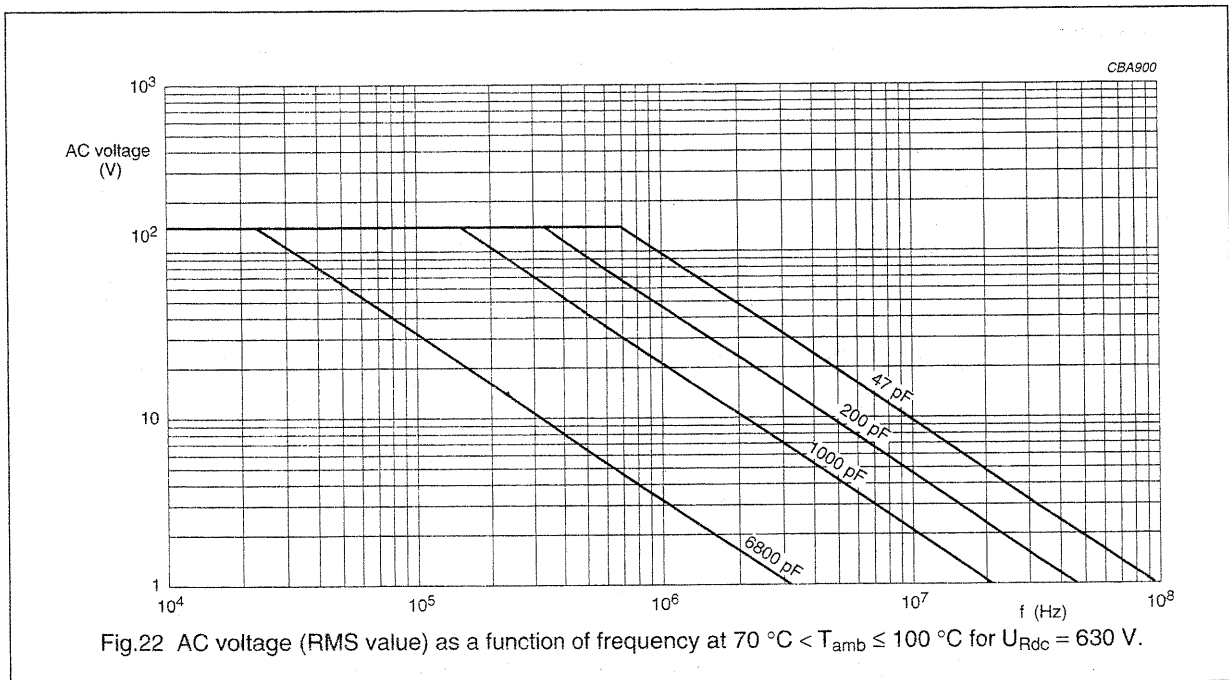
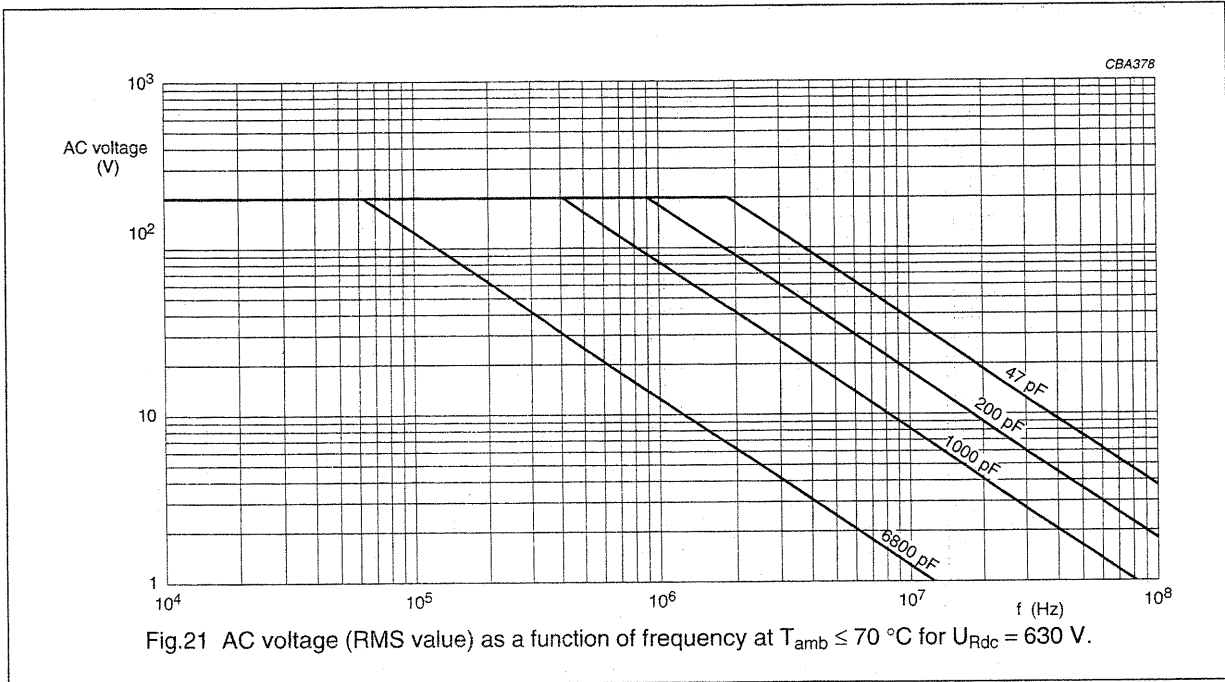
KP 460 to 464





Polypropylene film foil capacitors

KP 460 to 464



**Maximum RMS current (sinewave) as a function of frequency**

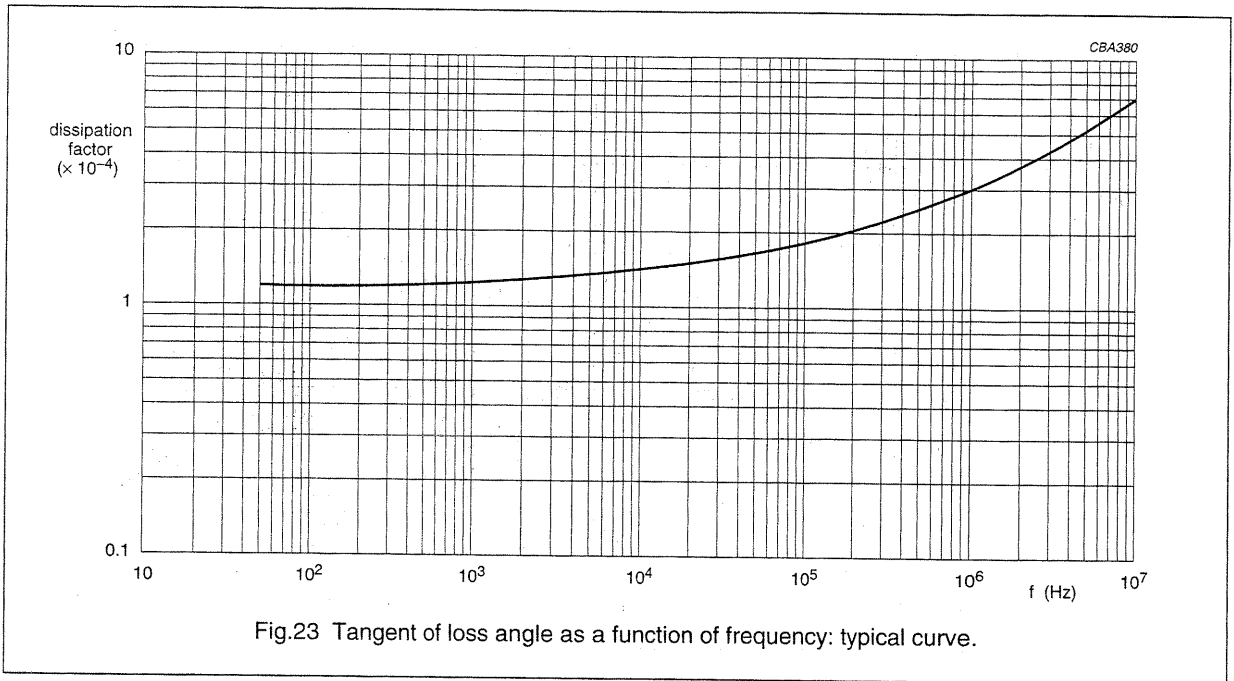
The maximum RMS current is defined by  $I_{ac} = \omega \times C \times U_{ac}$ .

$U_{ac}$  is the maximum AC voltage depending on the ambient temperature in Figs 13 to 22.

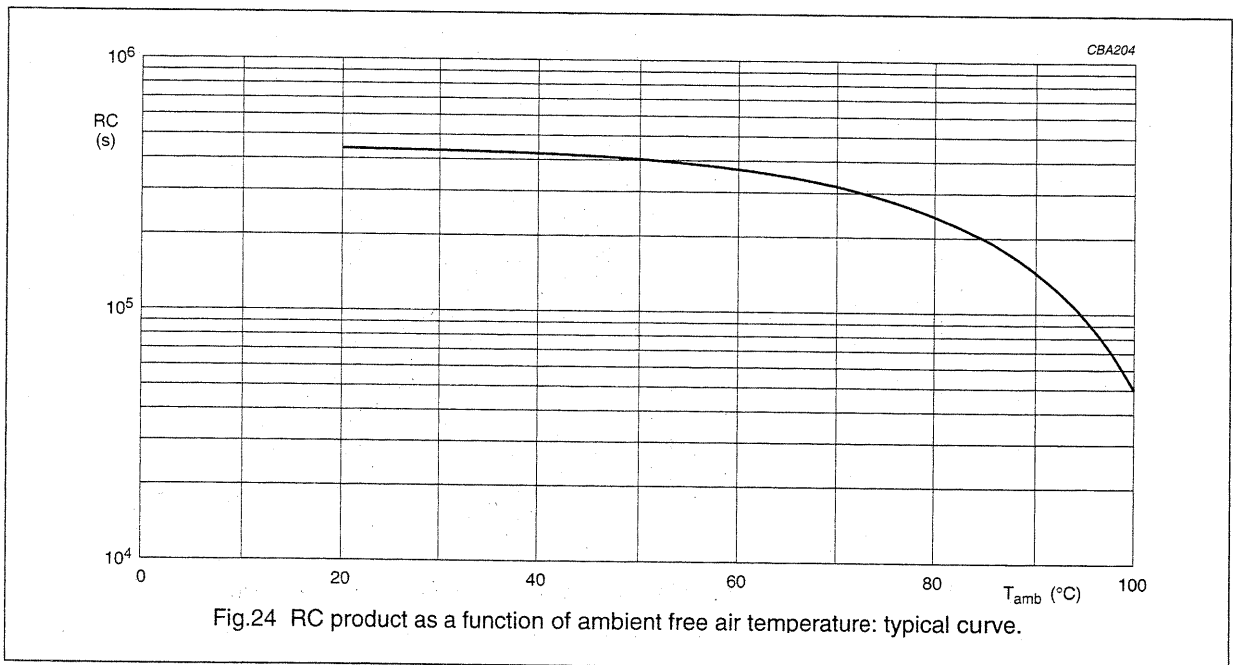
# Polypropylene film foil capacitors

KP 460 to 464

## Tangent of loss angle



## Insulation resistance



## Inductance

- L dependent on lead and capacitor length: ≤10 nH/cm.

Polypropylene film foil capacitors

KP 460 to 464

Maximum allowed component temperature rise ( $\Delta T$ ) as a function of the ambient temperature ( $T_{amb}$ )

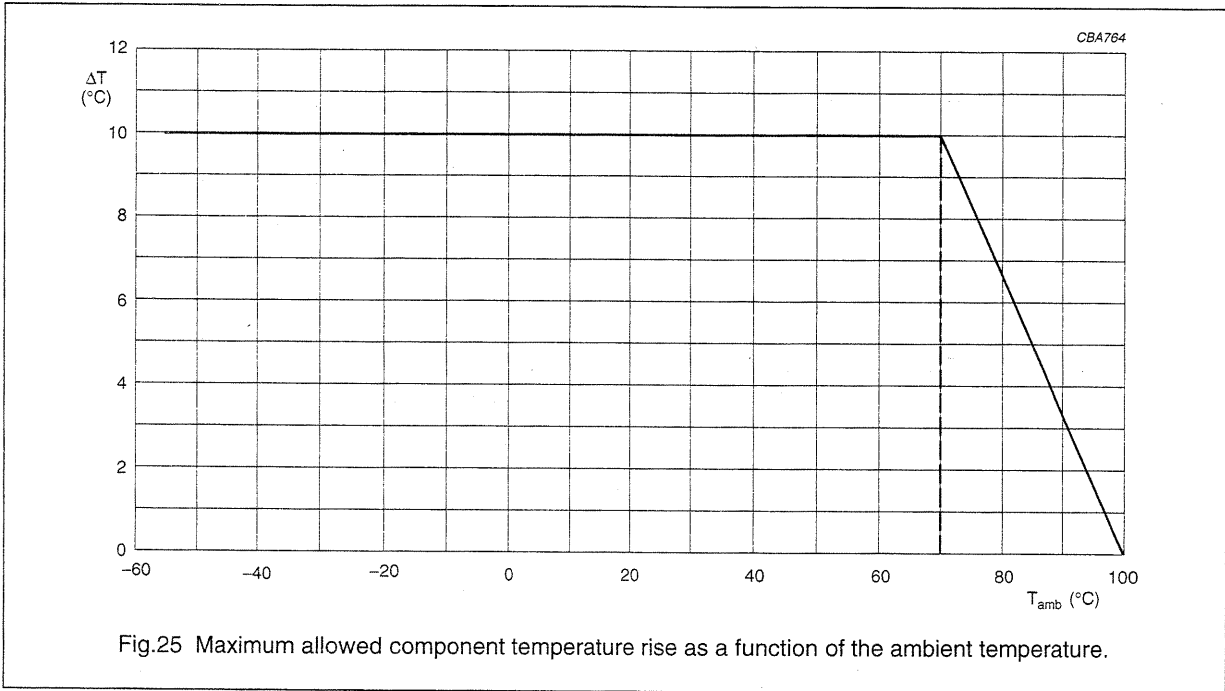


Fig.25 Maximum allowed component temperature rise as a function of the ambient temperature.

Heat conductivity (G) as a function of body dimensions in  $\text{mW}/^{\circ}\text{C}$

Table 1 Heat conductivity

| $d_{max} \times l_{max}$<br>(mm) | G<br>( $\text{mW}/^{\circ}\text{C}$ ) |
|----------------------------------|---------------------------------------|
| 5.0 × 11.0                       | 2.7                                   |
| 5.5 × 15.0                       | 4.3                                   |
| 6.0 × 15.0                       | 4.7                                   |
| 7.0 × 15.0                       | 5.3                                   |
| 7.5 × 15.0                       | 5.7                                   |
| 8.0 × 15.0                       | 6.3                                   |
| 8.5 × 15.0                       | 6.7                                   |

Power dissipation and maximum component temperature rise

The power dissipation must be limited in order not to exceed the maximum allowed component temperature rise as a function of the free air ambient temperature.

Power dissipation can be calculated in accordance with chapter "Introduction", section "Maximum power dissipation".

The component temperature rise ( $\Delta T$ ) can be measured (see section "Measuring the component temperature" for more details) or calculated by  $\Delta T = P/G$  :

- $\Delta T$  = component temperature rise ( $^{\circ}\text{C}$ ).
- P = power dissipation of the component (mW).
- G = heat conductivity of the component ( $\text{mW}/^{\circ}\text{C}$ ).

## Polypropylene film foil capacitors

KP 460 to 464

**Measuring the component temperature**

A thermocouple must be attached to the capacitor body as in Fig.26.

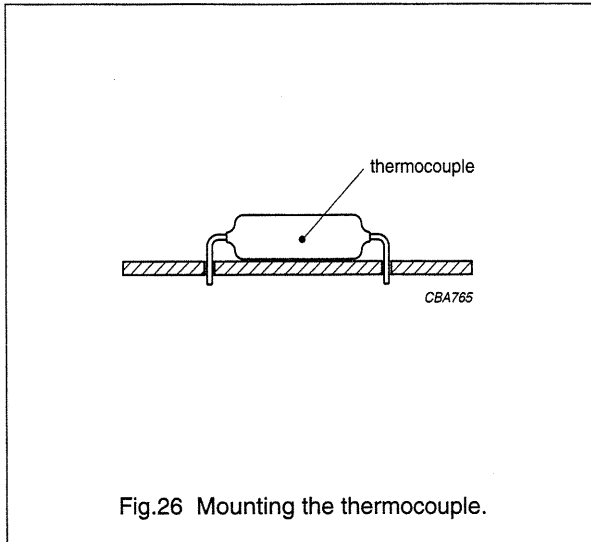


Fig.26 Mounting the thermocouple.

The temperature is measured in unloaded ( $T_{amb}$ ) and maximum loaded condition ( $T_c$ ).

The temperature rise is given by  $\Delta T = T_c - T_{amb}$ .

To avoid radiation or convection, the capacitor should be tested in a wind-free box.

**Application note and limiting conditions**

To select the capacitor for a certain application, the following conditions must be checked:

1. The peak voltage ( $U_p$ ) shall not be greater than the rated DC voltage ( $U_{Rdc}$ ).
2. The peak-to-peak voltage ( $U_{p-p}$ ) shall not be greater than the maximum  $U_{p-p}$  to avoid the ionisation inception level.
3. The voltage pulse slope ( $dU/dt$ ) shall not exceed the rated voltage pulse slope in an RC-circuit at rated voltage and without ringing. If the pulse voltage is lower than the rated DC voltage, the rated voltage pulse slope may be multiplied by  $U_{Rdc}$  and divided by the applied voltage.

For all other pulses following equation must be fulfilled:

$$2 \times \int_0^T \left( \frac{dU}{dt} \right)^2 \times dt < U_{Rdc} \times \left( \frac{dU}{dt} \right)_{rated}$$

T is the pulse duration.

4. The maximum component surface temperature rise must be lower than the limits in Fig.25.
5. The maximum component surface temperature must be lower than 100 °C.
6. The capacitance drift is influenced by the soldering conditions (see section "Soldering conditions" for more details).

## Polypropylene film foil capacitors

KP 460 to 464

**MARKING****Product marking**

The capacitors are marked in black ink with the following information:

1. Rated capacitance code in accordance with "IEC 60062"
2. Tolerance on rated capacitance: F =  $\pm 1\%$ ; G  $\pm 2\%$ ; J =  $\pm 5\%$
3. Rated (DC) voltage (e.g. 63 V)
4. Code for dielectric material (KP)
5. Production date code in accordance with "IEC 60062; clause 5"
6. Manufacturer.

**MARKING EXAMPLE**

8n2  
G 63  
KPK2 (see Table 2)  
PHILIPS

**Table 2** Letter codes for year and numbers for month of production

| YEAR | LETTER CODE | MONTH     | CODE |
|------|-------------|-----------|------|
| 1998 | K           | January   | 1    |
| 1999 | L           | February  | 2    |
| 2000 | M           | March     | 3    |
| 2001 | N           | April     | 4    |
| 2002 | P           | May       | 5    |
| 2003 | R           | June      | 6    |
| 2004 | S           | July      | 7    |
| 2005 | T           | August    | 8    |
| 2006 | U           | September | 9    |
| 2007 | V           | October   | O    |
| 2008 | W           | November  | N    |
| 2009 | X           | December  | D    |





## Polypropylene film foil capacitors

KP 460 to 464

## Package marking

The package containing the capacitors is marked as shown in Fig.27.

**Please note:**  
In due time BC COMPONENTS  
will replace PHILIPS COMPONENTS

|     |   |   |
|-----|---|---|
| 1.  | <b>PHILIPS COMPONENTS</b>   | <b>Barcode label marking</b><br><br><b>LINE MARKING EXPLANATION</b><br><br>1 Manufacturer's name<br>2 Country of origin<br>3 Sub-family<br>4 Type description<br>5 Capacitance value, tolerance, voltage and climatic category ("IEC 60068-1")<br>6 -<br>7 Preference origin code: A<br>Country of origin in code: 170 (Belgium)<br>Responsible production centre: HQ<br>Work order: WO<br>8 Product type description<br>9 Quantity and production period, year and week code<br>10 Product code (12NC) |
| 2.  | <b>MADE IN BELGIUM</b>  |   |
| 3.  | <b>DC FILM CAPACITOR</b>  |   |
| 4.  | <b>KP AXIAL EPOXY LACQUERED TYPE</b>  |   |
| 5.  | <b>47pF ±1% 630V= 40/100/56</b><br><b>U.L.C=0.7 X U.L.R</b>   |   |
| 6.  |   |   |
| 7.  |  <b>WO: 12345678</b><br><b>ORIG A170 RPC HQ</b><br> |   |
| 8.  | <b>TYPE KP 464</b>  |   |
| 9.  | <br><b>QTY 250 DATE 9904</b><br>                |   |
| 10. | <b>CODEND 2222 464 44709</b>  |   |

CCA346

Fig.27 Barcode label.



## Polypropylene film foil capacitors

KP 460 to 464

## QUICK REFERENCE TEST REQUIREMENTS (see note 1)

| TEST   | PROCEDURE<br>(quick reference)  | REQUIREMENTS   |
|--|---|--|
| <b>Robustness of leads</b>   |   |  |
| Tensile:<br>"IEC 60068-2-21"   | load 10 N; 10 s   | no visible damage<br>legible marking<br>$ \Delta C/C  \leq 2\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )           |
| Bending:<br>"IEC 60068-2-21"   | load 5 N; $4 \times 90^\circ$   |  |
| Torsion:   | $2 \times 180^\circ$  |  |
| Resistance to soldering heat:<br>"IEC 60068-2-20"                    | solder bath: $260^\circ\text{C}$ ; 5 s  |  |
| Component solvent resistance   | isopropyl alcohol; $23^\circ\text{C}$ ; 5 minutes   |  |
| <b>Robustness of component</b>                                       |   |  |
| Vibration:<br>"IEC 60068-2-6"  | 10 to 55 Hz; amplitude 0.75 mm or<br>acceleration $98 \text{ m/s}^2$ ; 6 hours  | $ \Delta C/C  \leq 2\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )   |
| Shock:<br>"IEC 60068-2-27"   | half sinewave; $490 \text{ m/s}^2$ ; 11 ms  | $R_{\text{ins}} \geq 50\%$ of specified value  |
| <b>Climatic sequence</b>   |   |  |
| Dry heat:<br>"IEC 60068-2-2"   | 16 hours; $100^\circ\text{C}$   | $ \Delta C/C  \leq 1\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )<br>$R_{\text{ins}} \geq 50\%$ of specified value  |
| Damp heat, cyclic, test Db,<br>first cycle:<br>"IEC 60068-2-30"      |   |  |
| Cold:<br>"IEC 60068-2-1"   | 2 hours; $-40^\circ\text{C}$  |  |
| Damp heat, cyclic, test Db,<br>remaining cycles:<br>"IEC 60068-2-30" |   |  |
| <b>Other applicable tests</b>  |   |  |
| Damp heat, steady state:<br>"IEC 60068-2-3"                          | 56 days; $40^\circ\text{C}$ ; 90 to 95% RH  | $ \Delta C/C  \leq 1\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )<br>$R_{\text{ins}} \geq 50\%$ of specified value  |
| Endurance (DC):<br>"IEC 60384-13"                                    | 1000 hours;<br>$1.5 \times U_{\text{Rdc}}$ ; $85^\circ\text{C}$<br>$1.05 \times U_{\text{Rdc}}$ ; $100^\circ\text{C}$ | $ \Delta C/C  \leq 2\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )<br>$R_{\text{ins}} \geq 100\%$ of specified value |
| Variation of capacitance with<br>temperature:<br>"IEC 60384-13"      | static method; one cycle  | $ \Delta C/C  \leq 2\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )<br>$R_{\text{ins}} \geq 10000 \text{ M}\Omega$    |
| Heat storage:<br>"IEC 60384-13"                                      | 1000 hours; $100^\circ\text{C}$   | $ \Delta C/C  \leq 2\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )   |
| Resistance to soldering heat with<br>preheating:<br>"IEC 60384-13"   | body temperature: $100^\circ\text{C}$ ;<br>bath temperature: $260^\circ\text{C}$ ;<br>dwell time: 5 s                 | $ \Delta C/C  \leq 2\% + 1 \text{ pF}$ ( $C \leq 1100 \text{ pF}$ )<br>$ \Delta C/C  \leq 1\%$ ( $C > 1100 \text{ pF}$ )   |

## Note

1. For detailed information: see "Type detail specification HQN-384-13/101".