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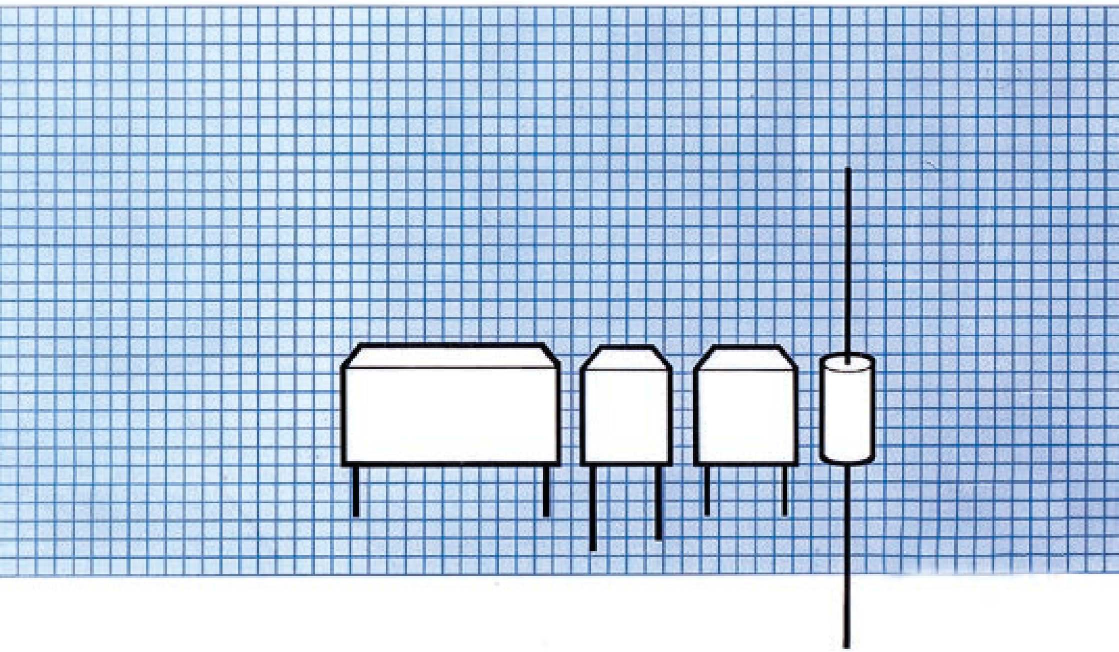

Polypropylene Capacitors
Film Capacitors

Data Book

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Polypropylene Capacitors
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Polypropylene capacitors

Type	Rated capacitance C_R pF	Rated voltage U_R V	Cap.-tolerances	Climatic category DIN 40 040 DIN IEC 68-1	Detail specs.	Features	Page
up to 85 °C/185°F: humidity category E							
B 33 063 	> 2 to 100000 2 to 22000	160 630	± 1pF ± 1 % ± 2.5 % ± 5 %	GPE 40/085/21	-	General purpose grade; available on tape	59

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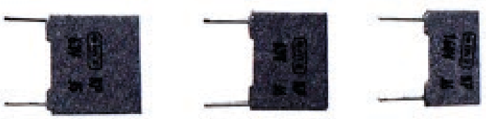
Polypropylene capacitors

Type	Rated capacitance C_R pF	Rated voltage U_R V	Cap.-[1] tolerances	Climatic category DIN 40 040 DIN IEC 68-1	Detail specs.	Features	Page
B 33 531 	25 pF bis 68100	63	± 1% ± 2.5 %	FPE 55/085/56	DIN 45 910	Long life grade; plastic case (flame-retardant in acc. with UL 94 V-0); especially suitable for a combined assembly with RM ferrite cores.	62
B 33 521 	100 to 130000 100 to 44200 100 to 6600	63 160 630	± 1% ± 2.5 %	FPE 55/085/56	DIN 45 910	Long life grade; plastic case (flame-retardant in acc. with UL 94 V-0); especially suitable for a combined assembly with RM ferrite cores.	60

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General Technical Information

Introduction

1.1 Type

This data book covers film/foil capacitors.
These capacitors are comprised of tubular capacitor windings in film/foil technology. The dielectric consists of flexible, biaxially-aligned electro-insulating films, made of polypropylene (PP). The capacitor electrodes consist of solid metal foils made of aluminum or tin.

The polypropylene dielectric used largely determines the properties of the capacitor and thus gives the capacitor type its name. The following abbreviation is used in this data book for describing the type of the capacitor:
KP = capacitors with polypropylene as dielectric

1.2 Construction

After the winding process the capacitors are heat-treated. Due to careful shrinking of the film the mechanical properties are strengthened and the electrical properties stabilized. Thus, even unprotected capacitors, i. e. capacitors without any additional enclosure reach a quality which makes them suitable for a wide variety of applications.

Since the thickness of the films varies depending on the manufacturing process, the diameters of the capacitors, which are wound for a close capacitance tolerance, also vary. The indicated maximum diameters of unprotecded capacitors are to be understood as the upper limit of deviations, met on the average by 98% of a batch. The diameter values refer to capacitance deviations.

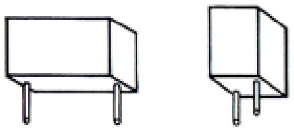
By incorporating the capacitor into a plastic case with epoxy resin sealing a capacitor type is obtained, that is true to size and thus particularly suitable for automatic insertion. Its radial leads are precisely spaced apart (lead spacing) and its axial leads precisely centered. As a result from incorporating the capacitors as described above, further enhancements such as resistance to soldering heat and solvents, mechanical ruggedness, flame retardance, low-inductive configuration, low losses, high packing density could be obtained. Thus a variety of new fields of application has been opened up.

In addition to keeping the capacitance tolerance and dielectric strength, the dissipation factor and the insulation resistance of long-life grade capacitors are subject to especially severe tests. Moreover, enhanced stability of the properties is obtained by increased pretreatment with temperature loops.

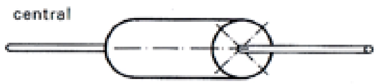
Depending on the type, the capacitor leads are brought out either on one or on both sides of the winding.

There are the following versios:

single-ended (radial)



double-ended (axial)



For details on the capacitor terminals refer to the outline drawings in the data sheets. Reliable contacts at the capacitor electrodes are provided by strip or wire terminals. Thus, a low electrical contact resistance is ensured even at very low voltages. The diameters of the leads comply with DIN IEC 301.

1.3 Application

Polypropylene capacitors are preferably used in circuits where special low-loss capacitors with high capacitance stability, close capacitance tolerance, and a constant temperature coefficient, are required. Due to low dielectric losses and a constant negative temperature coefficient, the capacitors are particularly suitable for use as resonant circuit capacitors. The advantages of polypropylene capacitors with a temperature coefficient of about $-200 \cdot 10^{-6}$/K are lower sensitivity to soldering heat and damp heat as well as better resistance to solvents.

If ferrite inductors with a corresponding positive temperature coefficient are used, the resonance frequency of a resonant circuit can be kept largely independent of temperature.

1.4 Choosing the right capacitor type

When selecting a certain type of capacitor the following aspects have to be taken into consideration:
- Dielectric (electrical properties),
- Construction (dimensions, leads, insertion method)
- Climatic category (DIN, IEC),
- General purpose (GP) grade or long life (LL) grade (service life, reliability).

The different capacitor types are listed according to the selector guide, i. e. first the unprotected types and then the protected types.

2 Capacitance

2.1 Rated capacitance C_R

The rated capacitance C_R of a capacitor is the value indicated upon it.
Unless otherwise agreed upon, the capacitance is measured in standard climate in accordance with DIN IEC 68-1, para. 5.3. In cases of doubt the capacitance has to be measured in a referee atmosphere in accordance with DIN IEC 68-1, para. 5.2.
The measuring frequency has to be selected in accordance with the sectional specifications CECC 31 800, para. 4.2.2.

	Standard conditions	Referee conditions
Temperature	15 °C to 35 °C	(23 ± 1) °C
Relative humidity	45 % to 75 %	(50 ± 2) %
Air pressure $C_R \leq 1$ nF	86 kPa to 106 kPa	86 kPa to106 kPa
$C_R \geq 1$ nF	100 kHz or 1 Mhz	1 MHz
Voltage	1 kHz or 10 kHz	1 kHz
	$0.03 \cdot V_R$ (max. 5 V)	$0.03 \cdot V_R$ (max. 5 V)

Before starting the measurements, the capacitors have to be stored in the measuring climate until the whole capacitor has adapted itself to this climate.

2.2 Capacitance and tolerance values available

For each type the available rated capacitances C_R as well as the tolerances and the pertinent preferred series are quoted (E series in accordance with DIN IEC 63). For rated capacitance values between 10 pF and 100pF only integral values from the corresponding E series are permitted. Below 10 pF any integral rated capacitance value can be delivered.

In the following the corresponding E series and capacitance tolerances are tabulated:

Capacitance tolerance	± 5 %	± 2.5 %	± 2 %	± 1 %	± 0.5 %
Code letter in acc. with DIN IEC 62	J	H	G	F	D
according to E series	E 12 E 24	E 12 E 24	E 12 E 24	E 12 E 24	E 12 E 24
according to E series (special version)		E 48	E 48	E 48 E 96	E 48 E 96 E 192
Threshold value [1]	20 pF	40 pF	50 pF	100 pF	200 pF
Tolerance below threshold value	± 1 pF ≙ F				

Capacitance tolerances and capacitance values deviating from the values tabulated above will be changed by us correspondingly. Special versions are available, but require specific agreement. In any case it should be taken into account that capacitance values with more than four digits must not have any other numbers but zeros behind the fourth digit.

[1]) Capacitance tolerances stated in per cent only apply to a low threshold value of the rated capacitance. Below this threshold value the standardized value of ±1 pF applies.

E series in accordance with DIN IEC 63

The following values of the E series have to be multiplied by the necessary integral positive or negative power of 10.

In any case the E series available have to be quoted from the individual data sheets.

Deviating values upon request.

E 12	E 24	E 48	E 96	E 192
100	100	100	100	100
				101
			102	102
				104
		105	105	105
				106
			107	107
				109
	110	110	110	110
				111
			113	113
				114
		115	115	115
				117
			118	118
120	120			120
		121	121	121
				123
			124	124
				126
		127	127	127
				129
	130		130	130
				132
		133	133	133
				135
			137	137
				138
		140	140	140
				142
			143	143
				145
		147	147	147
				149
150	150		150	150
				152
		154	154	154
				156
			158	158
	160			160
		162	162	162
				164
			165	165
				167
		169	169	169
				172
			174	174
				176

E 12	E 24	E 48	E 96	E 192
		178	178	178
180	180			180
			182	182
				184
		187	187	187
				189
			191	191
				193
		196	196	196
				198
	200		200	200
				203
		205	205	205
				208
			210	210
				213
		215	215	215
				218
220	220		221	221
				223
		226	226	226
				229
			232	232
				234
		237	237	237
	240			240
			243	243
				246
		249	249	249
				252
			255	255
				258
		261	261	261
				264
			276	267
270	270			271
		274	274	274
				277
			280	280
				284
		287	287	287
				291
			294	294
				298
	300	301	301	301
				305
			309	309
				312

E 12	E 24	E 48	E 96	E 192
		316	316	316
				320
			324	324
				328
330	330	332	332	332
				336
			340	340
				344
		348	348	348
				352
			357	357
	360			361
		365	365	365
				370
			374	374
				379
		383	383	383
				388
390	390		392	392
				397
		402	402	402
				407
			412	412
				417
		422	422	422
				427
	430		432	432
				437
		442	442	442
				448
			453	453
				459
		464	464	464
470	470			470
			475	475
				481
		487	487	487
				493
			499	499
				505
	510	511	511	511
				517
			523	523
				530
		536	536	536
				542
			549	549
				556

E 12	E 24	E 48	E 96	E 192
560	560	562	562	562
				569
			576	576
				583
		590	590	590
				597
			604	604
				612
	620	619	619	619
				626
			634	634
				642
		649	649	649
				657
			665	665
				673
680	680	681	681	681
				690
			698	698
				706
		715	715	715
				723
			732	732
				741
	750	750	750	750
				759
			768	768
				777
		787	787	787
				796
			806	806
				816
820	820	825	825	825
				835
			845	845
				856
		866	866	866
				876
			887	887
				898
	910	909	909	909
				920
			931	931
				942
		953	953	953
				965
			976	976
				988

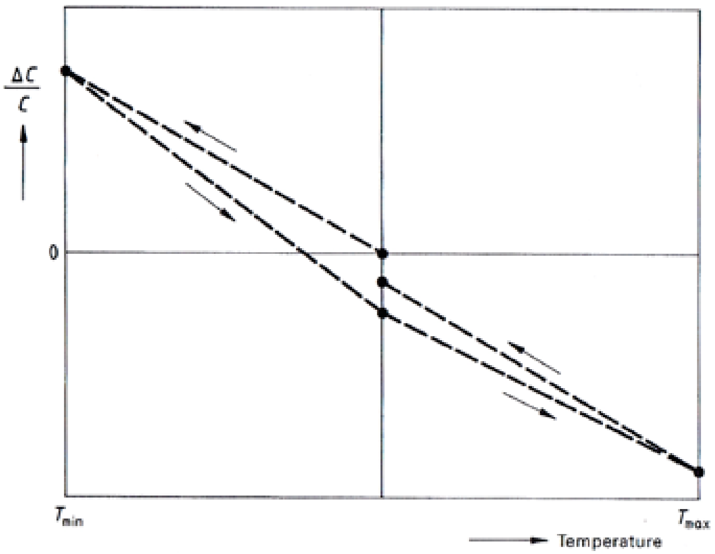
2.3 Temperature dependence of the capacitance

The capacitance of a KP capacitor changes reversibly and almost linearly in the temperature range between upper and lower category temperature, and that indirectly proportionally to the temperature. The steepness of the temperature variation is stated by the temperature coefficient α_c. The latter is mainly determined by the properties of the dielectric film and the electrode foil as well as by the capacitor construction and the manufacturing parameters. KP capacitors are characterized by a negative temperature coefficient, i. e. the measured capacitance values decrease with rising temperature.
The temperature coefficient α_c of the capacitance is the average capacitance variation within a certain temperature range T_1 and T_2 referred to 1 Kelvin and capacitance at (25 ± 10)°C:

$$\alpha_c = \frac{C_2 - C_1}{C_3 \cdot (T_2 - T_1)}$$

C_1 = capacitance at temperature T_1
C_2 = capacitance at temperature T_2
C_3 = reference capacitance at (25 ± 10) °C [1]
The temperature coefficient α_c is stated in the unit 10^{-6}/K.
The temperature coefficient α_c has to be measured in a temperature range between the lower and the upper category temperature:

$T_1 = T_{min}$; $T_2 = T_{max}$



Capacitance change versus temperature (schematic)

[1]) In accordance with IEC 384-1 and CECC 30 000, para. 4.24.1, the reference capacitance C_3 has to be measured at the temperature of (20 ± 2) °C.

In the specific data sheets the temperature coefficients α_c between T_{min} and T_{max} are indicated and are to be understood as typical values. Measurements in shorter temperature intervals may lead to deviating α_c values.

By passing a complete temperature cycle, starting at ambient temperature, continuing via T_{min} and T_{max} and returning to ambient temperature, small differences between initial capacitance and final capacitance (return value) may occur (see diagram, page 20).

In accordance with IEC 384-1 and CECC 30 000, para. 4.24.3, such a variation of capacitance with temperature is called capacitance drift.

Corresponding to the different stability categories, the sectional specifications IEC 384-13 as well as CECC 31 800 specify close limits for the capacitance drift.

When measuring it has to be taken into account that each temperature change also causes a change in humidity, which influences the performance of the capacitor, depending on the type of capacitor and the time constant of the humidity condition (cf para. 2.4.). Under standard conditions and provided that the temperature cycles are not too slow, the deteriorations of α_c caused by superimposed humidity remain within the stated α_c limits of variation.

2.4 Humidity dependence of the capacitance

The capacitance of a KP capacitor changes reversibly in dependence on the humidity. Both the dielectric and the effective air gap between film and foil react, depending on the type, to the changes of the surrounding humidity and thus influence the capacitance values measured.

The humidity coefficient β_c is defined as the average capacitance change at a change of the relative humidity by 1% (within the range of the relative humidity F_2 to F_1) at a constant temperature and measuring frequency of a capacitor being in a state of balance with the relevant ambient climate:

$$\beta_c = \frac{2 \cdot (C_2 - C_1)}{(C_2 + C_1) \cdot (F_2 - F_1)}$$

C_1 = capacitance at a relative humidity F_1
C_2 = capacitance at a relative humidity F_2

The following typical values apply:

Type	Range of relative humidity	Humidity coefficient β_c
Polypropylene	50 % to 95 %	+ (40 to 100) · 10^{-6} per % rel. humidity

Corresponding to the humidity diffusion the moisturing and drying process is time-dependent, the time constant varying between 1/2 day (e. g. for unprotected capacitors) and several weeks (e. g. for protected capacitors).

At relative humidities below 30%, the humidity coefficient is relatively low. Wide variations are to be expected at relative humidities above 85%.

Should unprotected capacitors be additionally encased and sealed the following must be observed: Thus, a capacitor can only be considered as sealed, if it is soldered or welded in a metal, glass or ceramic case. Organic materials used as sealing agents or the use of stuffing boxes for rotary axes provide only insufficient sealing. Even in the case of protected capacitors traces of vapor can be found in the capacitor and in the case. When the temperature falls below the dew point, the vapor condenses. Therefore, changes of capacitance or insulation resistance may under certain circumstances be higher than with unprotected capacitors.

2.5 Frequency dependence of the capacitance

The capacitance of the capacitors is virtually independent of the frequency. Close to the self-resonance of the capacitors (see para. 7) the self inductance causes an additional decrease in impedance, thus causing the same effects as an increase in capacitance (refer to equivalent circuit diagram, para. 5).

2.6 Capacitance drift i_z

The drift values

$$i_z = \left| \frac{\Delta C}{C} \right|$$

stated for the individual capacitor types are typical values. They are quoted in per cent of the rated capacitance, mostly accompanied by an additive part in pF. The vertical lines on the right and left hand position of $\left| \frac{\Delta C}{C} \right|$ indicate that absolute values are being dealt with, i. e. the capacitance change can either be positive or negative. The drift values apply to rated capacitances ≥ 100 pF. The reversible influences of the temperature and the humidity variations (α_c and β_c) are not contained in the i_z value.

The value refer to +40°C and to the operating time that is stated for long life grade versions in the special data sheets. No operating time is stated for general purpose grade capacitors; here the capacitance drift refers to a period of two years. Frequent and large changes at the upper limit of the category temperature and the relative humidity may increase the indicated drift values.

If one capacitance value is available at two different rated voltages U_R, the capacitors type being the same, the capacitors with the higher rated voltage generally shows a more favorable drift, since its dielectric´s part of the total volume is higher.

The drift, which is caused by operation at changing temperatures, is enhanced by specific temperature cycles performed during the manufacturing process (number and temperature limit values being dependent on capacitor type and climatic category).

3 Voltage and current

3.1 Rated voltage U_R

The rated voltage U_R is the maximum dc voltage which may continuously be applied to the terminals of a capacitor at any temperature between the lower category temperature T_{min} and the upper category temperature T_{max}.

Within the entire temperature range the category voltage of all KP capacitors listed in this data book is equal to the rated voltage U_R.
The rated dc voltage U_R is indicated on the terminal side of the outer layer by means of a clear text or a color ring.

Rated voltage U_R	63 V	160 V	630 V
Color ring	yellow	red	black

3.2 Alternating voltage U_{ac}

In addition to a dc voltage the capacitors may also be operated at superimposed ac voltage. The permissible rms U_{ac} of the superimposed alternating voltage is indicated in the individual data sheets. Make sure that the sum of dc voltage and peak value of the superimposed ac voltage does not exceed the rated voltage.

3.3 Category current I_c

In the data sheets for the different types the category current I_c is stated as the rms value with which the capacitor can be operated throughout the entire temperature range. It should be taken into account that -if a max. permissible frequency $f_{max. perm.}$ is exceeded-the permissible ac voltage U_{ac} is limited by the category current I_c

$$U_{ac\ reduced} = \frac{I_c}{2\pi \cdot f \cdot C}$$

The max. permissible frequency $f_{max. perm.}$, up to which the stated permissible alternating voltage V_{ac} may fully be applied, is calculated by means of the following equation:

$$f_{max.\ perm.} = \frac{I_c}{2\pi \cdot C \cdot V_{ac}}$$

3.4 Pulse handling capability

Generally, KP capacitors may also be operated with pulses and non-sinusoidal alternating voltages. Normally, this pulse handling capability (permissible rate of voltage rise dU/dt) is not limited as long as the inherent heating is negligible. The permissible rate of voltage rise is about 1000 V/µs.

3.5 Voltage strength at low air pressure

With reduced air pressure the dielectric strength at the terminals of the capacitor decreases. Without any voltage derating the capacitors can be used down to 40 kPa, this corresponds to an altitude of 7000 m (approx. 23 000 ft) above sea level.
Capacitors for applications at altitudes above 7000 m are available upon request.

4 Temperature

4.1 Ambient temperature

The ambient temperature is defined as the temperature of the air in the immediate environment of the capacitor.

4.2 Lower category temperature T_{min}

In CECC 30 000 and IEC 384-1, para. 2.2.15, the lower category temperature is defined as the minimum ambient temperature for which the capacitor has been designed to operate continuously.

4.3 Upper category temperature T_{max}

In CECC 30 000 and IEC 384-1, para. 2.2.14, the upper category temperature is defined as the maximum ambient temperature for which the capacitor has been designed to operate continuously.

4.4 Category temperature range

As defined by CECC 30 000 and IEC 384-1, para. 2.2.13, the category temperature range is the range of ambient temperatures for which the capacitor has been designed to operate continuously; it is defined by the temperature limits of the appropriate category.

4.5 Rated temperature T_R

In CECC 30 000 and IEC 384-1, para. 2.2.16, the rated temperature is defined as the maximum ambient temperature at which the rated voltage V_R may be applied continuously.

The following formula applies to all KP capacitors listed in this data book:

$$T_R = T_{max}$$

Thus, the rated voltage V_R may fully be applied throughout the entire temperature range between T_{min} and T_{max} (see para. 3.1).

4.6 Reference temperature for reliability data

The reference determines an ambient temperature of 40°C as reference temperature for data on reliability (see chapter "Quality").

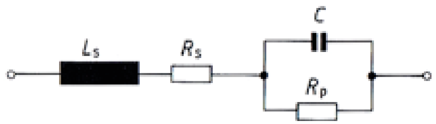
4.7 Storage temperature

KP capacitors may be stored throughout the entire temperature range between T_{min} and T_{max}.

5 Dissipation factor tan δ

The dissipation factor tan δ is the ratio of ESR to capacitive resistance in the equivalent series circuit or of effective power (power dissipation) to reactive power when a sinusoidal voltage is applied.

Equivalent circuit diagram



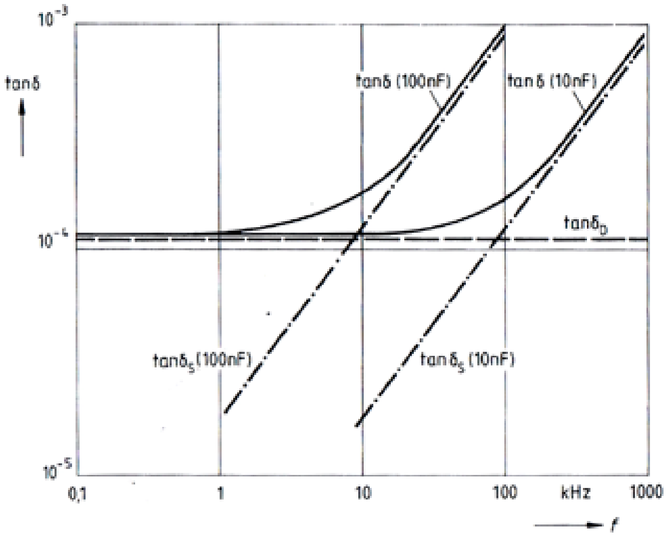
L_s Series inductance
R_s Series resistance (supply lines)
R_p Parallel resistance (insulation resistance)
C Capacitance

5.1 Frequency dependence of the dissipation factor

Neglecting the inductance L_S, the dissipation factor tan δ for frequencies $f \ll f_r$ [$f_r = 1/(2\pi\sqrt{L_S \cdot C})$ being the self resonance frequency] is composed of a parallel portion tan δ_p, a series portion tan δ_s and a constant portion tan δ_D:

$$\tan\delta = \tan\delta_P + \tan\delta_S + \tan\delta_D \qquad \begin{cases} \tan\delta_P = \dfrac{1}{R_P \cdot 2\pi f \cdot C} \\ \tan\delta_S = R_S \cdot 2\pi f \cdot C \\ \tan\delta_D \approx 1 \cdot 10^{-4} \end{cases}$$

The parallel portion tan δ_P can be neglected in the entire frequency range. Due to its extremly high insulating resistance (parallel resistance R_P) it does not contribute to the total dissipation factor, even for very low frequencies ($f \ll 1$ kHz) . Thus, in the lower frequency range the dissipation factor tan δ is solely determined by the dielectric component tan δ_D which is independent of the frequency far into the MHz range and results in a measuring value of about 10^{-4}, being characteristic for KP capacitors.



Dissipation factor versus measuring frequency (schematic drawing showing the example of two capacitance values)

With increasing measuring frequency (f >1 kHz) however, the series portion tan δ_s of the dissipation factor, corresponding to the capacitance, becomes increasingly noticeable and finally dominates the dissipation factor characteristic. Its measuring value is determined by the series resistance R_S, being the sum of the contact resistances and the lead resistances (connecting wires and electrode foils).

5.2 Moisture, temperature and voltage dependence

When the capacitor is exposed to moisture the measuring values for the dissipation factor may increase. The influence of temperature, however, is negligible. Nevertheless, when starting an appliance or equipment the moisture may decrease due to an increased operating temperature which may result in reducing the measured dissipation factor value.

The dissipation factor of KP capacitors is voltage-independent.

5.3 Measuring conditions

The measurement of the dissipation factor is subject to the same measuring conditions as the capacitance (see para. 2.1), but partly with additional measuring frequencies.

The dissipation factors are indicated with the measuring frequencies for the individual capacitor types. The tabulated values of the dissipation factor may be exceeded up to a factor of 1.5 by 10% of the capacitors.

6 Insulation resistance R_i

KP capacitors are outstanding for very high insulation resistance values in the TΩ range. The measurement of such values requires exact measuring conditions and reproducible measuring setups (shielded measurements).

6.1 Measuring conditions

The insulation resistance is the ratio of an applied dc voltage to the current flowing through the capacitor after a defined period of time.
In accordance with CECC 30 000 and IEC 384-1, para. 4.5.2, the measuring voltage is as follows:

Rated voltage V_R of the capacitor	Measuring voltage
$10\ V \le V_R < 100\ V$	$(10 \pm 1)\ V$[1)]
$100\ V \le V_R < 500\ V$	$(100 \pm 15)\ V$
$500\ V \le V_R$	$(500 \pm 50)\ V$

The insulation resistance shall be measured 1 min ± 5 s after the voltage has been applied.

If the temperature at which the measurement is made differs from 20°C the measuring value shall be converted into the value at 20°C. For this purpose, the measuring result has to be multiplied by the corresponding correction factor.

Measuring temperature in °C	Correction factors (average values) in acc. with CECC 31 800/IEC 384-13, para. 4.2.4
15	0.75
20	1.00
23	1.25
27	1.50
30	1.75
35	2.00

In cases of dispute the measurement at 20°C and at air humidity of (50 ± 2)% applies.
With the individual types the insulation resistance is quoted as minimum as-delivered value R_i and as limit value R_{iF} after the test "Damp heat, steady state" (each in GΩ $\hat{=}$ 10^9Ω).

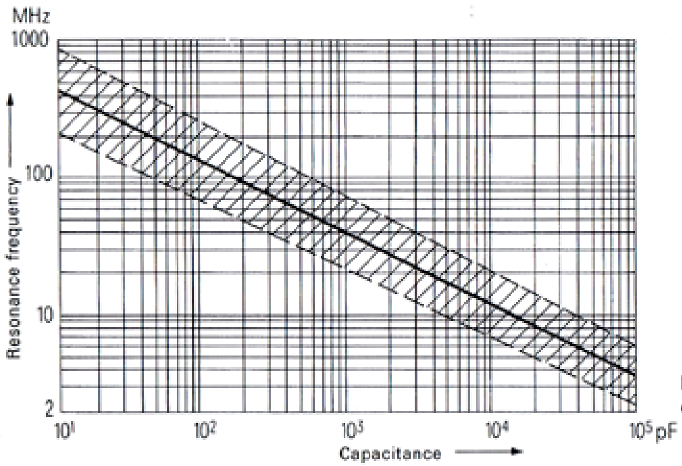
6.2 Influences on the insulation resistance

As the table containing the correction factors shows (para. 6.1), the insulation resistance is temperature dependent. Additionally, it is also influenced by humidity (negative humidity coefficient).
With increasing the temperature and keeping the absolute humidity stable, the relative humidity decreases, the capacitor becomes drier and its insulation resistance increases.

[1)] When it can be demonstrated that the voltage has no influence on the measuring result, or that a known relationship exists, measurement can be performed at voltages up to the rated voltage (10 V shall be used in case of dispute).

7 Self inductance

At high frequencies polypropylene capacitors are subject to self resonance caused by self inductance. This self resonance may disturb the circuit design. The self inductance is influenced by the kind of supply lines to the electrodes and by the winding construction. Due to bifilar layer currents and face contacting all capacitors described here feature low inductance and low attenuation.
The typical value for the self inductance is:
A maximum of 1 nH per 1 mm lead or capacitor length.
With the aid of special measures the self inductance can be decreased.
The frequency range of self resonance versus capacitance is shown in the diagram below.



Resonance frequency versus capacitance (typical values)

8 Shielding (outer layer)

The outer layer is marked by a color ring or a symbol. Whenever the outer layer of the capacitor is grounded, this layer serves as a shielding.

In cases when a low capacitance of the outer layer towards ground or adjacent components (coupling capacitance) is essential, unprotected small types are recommended. Furthermore, the coupling capacitance can be reduced by design measures when inserting the capacitor.

9 Non-electrical stress

9.1 Mechanical robustness of terminations

As per CECC 30 000 and IEC 384-1, para. 4.13, the mechanical robustness of terminations shall be tested in accordance with DIN IEC 68-2-21:

Test Ua1: Tensile strength
Tensile stress in the direction of the leads with a tensile force as tabulated below (duration10 s).

Test Ub: Bending strength
Bending stress in compliance with method 1: Two consecutive bends in opposite direction with a bending force as tabulated below.

Terminations		Test Ua 1	Test Ub
Strips	Round wires		
Rated cross section s mm²	Rated diameter d mm	Tensil force N	Bending force N
$0.05 < s \leq 0.07$	$0.25 < d \leq 0.3$	2.5	1.25
$0.07 < s \leq 0.20$	$0.30 < d \leq 0.5$	5.0	2.50
$0.20 < s \leq 0.50$	$0.50 < d \leq 0.8$	10.0	5.00

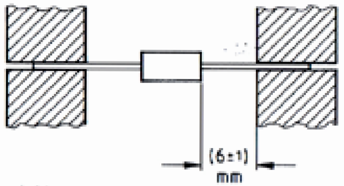
The test Ub only applies to types with axial leads.
After the stress, the capacitance and the dissipation factor of the specimens shall be measured and the specimens shall be visually examined. There shall be no visible damage.

9.2 Vibration

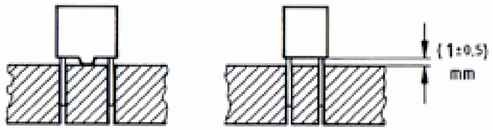
The ability of capacitors to withstand mechanical stress (such as vibration and shock), as may occur in rotating machinery (land vehicles, ships, planes etc.), is tested in accordance with DIN IEC 68-2.6.
The test procedure comprises endurance tests at variable frequency.
The following degrees of severity are employed:

Test F_c: Vibration, sinusoidal	Test conditions
Displacement amplitude (below cross-over-frequency)	0.75 mm
Acceleration amplitude (above cross-over-frequency)	98 m/s² (≙10 g)
Frequency range	10 Hz to 500 Hz
Endurance duration (in three mutually perpendicular axes)	3 · 120 min.

During the test the capacitors have to be mounted as shown below:



axial leads



single-ended leads

After the stress, the capacitance and the dissipation factor of the specimens shall be measured and the specimens shall be visually examined. There shall be no visible damage.

9.3 Soldering

Solderability

As per CECC 30 000 and IEC 384-1, para. 4.15, the solderability of the terminations is to be tested in accordance with DIN IEC 68-2-20, test Ta, method 1.

This solder bath method is the one which simulates most closely the soldering procedures that are generally used in practice. Before applying the soldering test, the leads have to be subjected to accelerated ageing:

Accelerated ageing: 4 hours, dry heat at 155 °C
(in acc. with DIN IEC 68-2-2, test Ba)

Note:
Since the ageing temperature exceeds the upper category temperature of the capacitors, the leads should be detached from the capacitor. Thereby it is avoided that the solderability is impaired by decomposition processes which may occur at the capacitor body.

Solder bath: (235 ± 5) °C
Immersion time: (2.0 ± 0.5) s
Immersion depth: to within (2.0 + 0 / -0.5) mm from the component or seating plane
Evaluation: The terminations shall be examined for good tinning evidenced by free flowing of the solder with wetting of more than 90% of the wire surface with new solder.

Soldering heat resistance

As per CECC 30 000 and IEC 384-1, para. 4. 14, the soldering heat resistance of the capacitors is measured in accordance with DIN IEC 68-2-20, test Tb, method 1A.

Solder bath temperature: (260 ±5) °C

Shielding: Thermally insulating plate between capacitor body and melted solder, (1.5 ±0.5) mm in thickness

Soldering time: (5 ± 1) s
Immersion depth: to within (2 + 0 / -0.5) mm from the component or seating plane

Evaluation	Unprotected types KP capacitors	Protected types
$\lvert\Delta C/C\rvert$	≤ (0.5% + 0.5 pF)	≤ (0.3 % + 0.3 pF)
tan δ	≤ tabulated value	
Visual inspection	no visible damage	

General information on soldering

The capability of KP capacitors to withstand thermal load is characterized by the upper category temperature T_{max}. Exceeding this type-specific category temperature may influence the plastic dielectric and can thus cause irreversible changes of the electrical data of the capacitor.

Apart from the solder bath temperature and the actual soldering time the efficiency of the thermal stability also depends on the initial temperature (preheating) and the follow-up temperature (cooling). Shading and persistent heating effects of adjacent components produce different effects.

Since the major part of the soldering heat flows via the leads into the extended foils and thus into the capacitor winding, the heat resistance of the connecting elements (wire diameter, length of wires, material-specific thermal conductivity, cross-section of point of contact between lead and electrode foil) substantially determines the heat supply.

The therefore desired bad heat conduction is in opposition to the requirement for a high electrical conductivity with a correspondingly low dissipation factor (series resistance R_s in para. 5.1), because the electrical conductivity is always directly proportional to the thermal conductivity.

Generally, a soldering temperature of max. 265°C and soldering time of max. 6 seconds are usually adequate for soldering if appropriate measures, such as
– keeping as much distance from the solder bath as possible,
– fan cooling,
– application of solder resist, etc.
are provided for. If preheating is absolutely necessary, the soldering conditions have to be adapted accordingly (especially cooling immediately after the soldering process).

Note:
The solvents contained in the flux may have an effect on the capacitors and thus lead to a (reversible) change of capacitance.

It is thus recommended:
1) to remove the vapor during the soldering process
2) not to adjust a resonant circuit immediately after the soldering process.

9.4 Cleaning

When selecting suitable solvents to remove flux residues and similar substances from the KP capacitors which are soldered on a PCB, the following items have to be considered:

Type \ Solvent	Ethanol Isopropanol	Solvent from table A	Solvent from table B
Unprotected KP capacitors	suitable	relatively suitable	unsuitable
Protected KP capacitors		suitable	

Table A

Designation of solvents based on trifluor trichloroethane (selection)

Trifluor trichloro - ethane	Mixtures of trifluor trichloroethanes with ethanol and isopropanol	Manufacturer
Freon TF	Freon TE 35; Freon TP 35; Freon TES	Du Pont
Frigen 113 TR	Frigen 113 TR-E; Frigen 113 TR-P; Frigen 113 TR-E 35	Hoechst
Arklone P	Arklone A; Arklone L; Arklone K	ICI
Kaltron 113 MDR	Kaltron 113 MDA; Kaltron 113 MDI; Kaltron 113 MDI 35	Kali - Chemie
Flugene 113	Flugene 113 E; Flugene 113 IPA	Rhône - Progil

Table B

Designation of solvents which must not be applied (selection)

Mixtures of chlorinated hydrocarbons and ketones with fluorinated hydrocarbons	Manufacturer
Freon TMC; Freon TA; Freon TC	Du Pont
Arklone E	ICI
Kaltron 113 MDD; Kaltron 113 MDK	Kali - Chemie
Flugene 113 CM	Rhône - Progil

With unprotected types, a reversible change of electrical characteristics may occur immediately after the cleaning process even after having used a suitable solvent.

9.5 Flammability

Passive flammability of KP capacitors

The tests for passive flammability ensure that accordingly qualified components contribute less to the risk of fire in their environment than is necessary for their own flammation. This is to prevent a possible fire from spreading.

The following test methods are in use:

Specification	Height of flame in mm	Severity Duration of flaming in sec.				Per-sistence of burning in sec.
UL 1414	19	1st period: 15				15
7. Enclosure Test		2 nd period: 15				15
		3 rd period: 15				60
DIN IEC 695-2-2	12 ± 1	Preferred values: 5, 10, 20, 30, 60, 120				30
IEC 384		Capacitor volume in mm^3				
		≤ 250	> 250	> 500	> 1750	
Category A	12 ± 1	15	30	60	120	3
Category B		10	20	30	60	10
Category C		5	10	20	30	30
Category D		None of the above-mentioned categories attained				

In these tests specified test flames are applied to the capacitors in order to evaluate their flammability properties. The assessment criterion is the persistence of burning: a max. permissible duration must not be exceeded.

In accordance with DIN IEC 695-2-2 the specimen is arranged for the test in its most unfavorable position of normal use. The test flame is applied to that part of the surface of the specimen which is likely to be affected by flames resulting from any source of ignition.

The severity is primarily determined by the size of the test flame and particularly the duration of flaming. A small capacitor will burn more easily than a big one.

DIN IEC 695-2-2 offers a variety of preferred values for the test severity (duration of flamming) at a fixed duration of persistent burning.

UL 1414 requires a three-step flammation with defined test parameters (as partial test of a safety standard for across-the-line, antenna-coupling, and line-by-pass capacitors for radio- and television-type appliances).

Flammability of materials

In addition to the tests for flammability of the capacitor, often data on flammability of material in accordance with UL 94 are required. The safety standard UL 94 describes a material test for the classification of the flammability of plastic materials.

In the test according UL 94 V the test flame (19 mm / 10s) is twice applied to the vertically arranged specimens (127 mm in length / 12.7 mm in width). On the basis of the results the materials are classified according to the flammability categories UL 94 V-0, UL 94 V-1 and UL 94 V-2:

Flammability category	UL 94 V-O	UL 94 V-1	UL 94 V-2
Persistance of burning in sec.: Individual flame application Total of ten flame applications (5 specimens)	 ≤ 10 ≤ 50	 ≤ 30 ≤ 250	 ≤ 30 ≤ 250
Flammation of underlying layer by flaming particles	not permitted		permitted

For an evaluation of the flammability categories indication of the thickness of the specimen is indispensable !

Example: UL 94 V-0 (3.2 mm)

Attention: UL 94 V-0 (3.2 mm) does not imply that UL 94 V-1 (1.6 mm) will also be passed.

The importance of the safety standard UL 94 lies in the relative comparability of the flammability of one material with different specimen thicknesses or of different materials with the same specimen thickness. The standard makes no statements on the flammability properties of the capacitor.

10 Climatic stress

10.1 Climatic category in acc. with DIN IEC 68-1

The climatic category is indicated by a combination of three numbers separated by slanted strokes.

Example: 40 / 085 / 56

-40 °C (-40°F)

+85 °C (+185°F)

56 days

1 st number
Absolute value of lower category temperature T_{min} as test temperature for
Test Aa (cold) in accord with DIN IEC 68-2-1

2 nd number
Upper category temperature T_{max} as test temperature for
Test Ba (dry heat) in accord with DIN IEC 68-2-2
Test duration: 16 h

3 rd number
Number of days as test duration for
Test Ca (damp heat, steady state) in accord with DIN IEC 68-2-3
at (93 + 2 / -3) % rel. humidity and 40 °C/104°F ambient temperature

The permissible test limits after damp heat, steady state are specified for the individual types in the data sheets. Variations caused by humidity are reversible.

10.2 Climatic category

The climatic category specifies the range of climatic stresses for which the component has been designed.

According to the table below three code letters are used:

1 st code letter	Lower category temperature T_{min}
F	- 55 °C (-67°F)
G	- 40 °C (-40°F)
H	- 25 °C (-13°F)

2 nd code letter	Upper category temperature T_{max}
M	100 °C (212°F)
P	85 °C (185°F)
S	70 °C (158°F)

3 rd code letter	Limits of relative humidity Max. values				Remarks
	Annual average	for 30 days per year continuously [1]	for 60 days per year continuously [1]	for the remaining days occasionally [2]	
E	≤ 75 %	≤ 95 %	-	≤ 85 %	Rare and slight dew precipitation [3]
G	≤ 65 %	-	≤ 85 %	≤ 75 %	No dew precipitation

Example given: **GPE**

Lower category temperature T_{min}	**G**	-40 °C	
Upper category temperature T_{max}	**P**	+85 °C	
Humidity category:	**E**		
Relative humidity (annual average)		≤75 %	rare and
30 days per year		95 %	slight dew
on the remaining days occasionally		85 %	precipitation

[1] These days should reasonably be distributed over the year.
[2] Keeping the annual average.
[3] May, for example, occur in the case of short openings of devices that are installed outdoors.

11 Standards and specifications

KP capacitors largely comply with German and international standards and specifications. The specifications quoted in this data book (DIN, CECC, IEC) refer to the editions valid from March 1, 1997.

11.1 Generic specifications for fixed capacitors

CECC 30 000	Generic specification: Fixed capacitors September 1985
IEC 384-1	Fixed capacitors for use in electronic equipment Part 1: Generic specification 1982

11.2 Sectional specifications

KP capacitors

CECC 31 800	Fixed polypropylene film dielectric metal foil d. c. capacitors 1 st edition 1985
IEC 384-13	Fixed capacitors for use in electronic equipment Part: 13 Sectional specification: Fixed polypropylene film dielectric metal foil capacitors for direct current Selection of methods of test and general requirements 1 st edition 1980

12 Marking

The following data is stamped on the component:

Rated capacitance in pF or coded in acc. with DIN IEC 62

Capacitance tolerance (code letter in acc. with DIN IEC 62)

The outer layer of an unprotected capacitor is designated by color ring or by a bar. The rated voltage can either be marked by the color of the ring or in clear. A certain color of the ring is assigned to each rated voltage (see para. 3.1).

Depending on the size of the capacitor, the following information may also be imprinted:

Climatic category
Date of manufacture (sometimes coded in acc. with DIN IEC 62)
Rated voltage (for encased types) in Volt
Type (KP)
Ordering code (part number)

Example for the coding of capacitance and tolerance values (in acc. with DIN IEC 62):

Capacitance		Abbreviated indication
1	pF	1 p0
5	pF	5 p0
10	pF	10 p
47	pF	47 p
100	pF	100 p
332	pF	332 p
1	nF	1 n0
3.32	nF	3 n 32
10	nF	10 n
33.2	nF	33 n 2
100	nF	100 n
332	nF	332 n

Capacitance tolerance	Code letter
± 1 pF	F[1)]
± 0.5 %	D
± 1.0 %	F
± 2.0 %	G
± 2.5 %	H[2)]
± 5.0 %	J

[1)] see para. 2.2

Two-digit codes for the date of manufacture (year/month) in acc. with DIN IEC 62:

year	letter
2015	F
2016	H
2017	J
2018	K
2019	L
2020	M
2021	N
2022	P
2023	R
2024	S
2025	T

Month	Letter	Month	Letter
January	1	July	7
February	2	August	8
March	3	September	9
April	4	October	O
May	5	November	N
June	6	December	D

Example: March 1996 ≙ H3, November 1996 ≙ HN

13 Construction of the ordering (part number)

The coding system is dealt with in the following sections.

Should however, the coding system remain unclear, it is better to place the order uncoded (clear text). Since the coded designation is necessary for the internal handling the coding will then be performed by EMZ, so that all types are supplied according to a coded part number.

In order to facilitate the legibility, the part number comprising 15 digits, has been seperated into 3 blocks of 6, 5 and 4 digits, the blocks being linked by a hyphen. Each of the three blocks begins with a letter, whereas all other digits are Arabic figures. In case of collecting numbers, the letter are replaced by the special sign " + " and figures by " * " :

Digit position	1	2	3	4	5	6		7	8	9	10	11		12	13	14	15
	B						-						-				
	1 st block							2 nd block						3 rd block			

Digit 1 to 6 (type number)

The first block is called "type number" or "B-number".

Digit 7 (revision status)

The first letter of the second block - the 7th digit position of the type number- indicates the revision status. Upon variation of the revision status, the code letter can be changed into the next following letter of the alphabet.
The letters necessary for identifying the revision status are devided into 3 groups:

A. . . H; J. . . R; S. . . Z

There are different reasons for changing the revision status code letter: in most cases these are either enhanced electrical characteristics or changed (reduced) dimensions.

As far as enhanced electrical characteristics are concerned, the previous version can always be replaced by the revised one. If the dimensions are subject to changes, the replacement depends on certain conditions. The former applicability will normally not be impaired if the diameter and/or the length are scaled down, provided that the mounting conditions are kept the same. In both cases (properties, size reduction) the previous letter of the revision status is changed into the following, e. g. a version with the code letter A can be replaced by one with the code letter B. For this purpose the letters A to H are used.

Quite a different situation is given, when a volume reduction has been attained at the expense of scaled up dimensions (diameter or length) which may be necessary for reasons of standardization. Here, difficulties in the replacement may arise when the mounting conditions are changed as well. In these cases, the changed component is designated by a letter between J and R. This means that interchangeability is possible as far as the electrical properties are concerned, but the dimensions are to be checked.

The letters S to Z serve to identify special versions. Therefore, they are to be found in the data letter only in particular cases, e. g. when a special version advances to standard type.

A certain period of time is generally necessary to perform the change of the revision status. If after this period of time capacitors of the former revision status are ordered, automatically those of the new one will be delivered.

Digit 8 (rated voltage)

The code figures for capacitor voltage ratings are not systematized. The meaning of the code figure of the rated voltage is indicated in the individual data sheets.

Digits 9 to 14 (rated capacitance and tolerance)

When ordering capacitors it is necessary to code the desired rated capacitance as well as the appropriate tolerance values.

a) The value will be converted into the form $a \times 10^b$ pF; the μF values must, therefore, be converted into the basic unit "pF". The factor *a* is the unchanged figure sequence of the value, with the decimal point behind the second figure. The exponent b of the multiplier 10^b is clearly specified by this position of the decimal point and the basic unit "pF", and can admit values from 0 to 9. The lowest value to be represented is therefore 0.01 pF, the highest 99 990 μ F.

b) The 2 figures before the point are contained in the 9th and 10th digit; thus the decimal point must always be imagined as being behind digit 10.

c) The exponent *b* which designates the number of naughts of the multiplier (see the following code table for a capacitance values) is the code number in digit position 11.

d) 2 figures max. behind the decimal point are contained in digit position 13 and 14.

If only the digit position 13 is held by a figure (except of "0"), position 14 and position 15 must also be designated with "0" or any other value. In case, all positions behind data position 12 are only "0" they will be omitted.

The following apply to coding the capacitance values in the 2nd and 3rd date block:

Coding:→	Decoding:←
6.30 pF =	= 06.30 · 10^0 pF = - + *060 - + 30*
12.50 pF =	= 12.50 · 10^0 pF = - + *120 - + 50*
160 pF =	= 16 · 10^1 pF = - + *161 - + *
137.50 pF =	= 13.75 · 10^1 pF = - + *131 - + 75 *
3.15 nF =	3 150 pF = 31.50 · 10^2 pF = - + *312 - + 50 *
8765 pF =	= 87.65 · 10^2 pF = - + *872 - + 65 *
0.01 µF =	10 000 pF = 10 · 10^3 pF = - + *103 - + *
45.50 nF =	45 000 pF = 45.50 · 10^3 pF = - + *453 - + 50 *
0.33 µF =	330 000 pF = 33 · 10^4 pF = - + *334 - + *

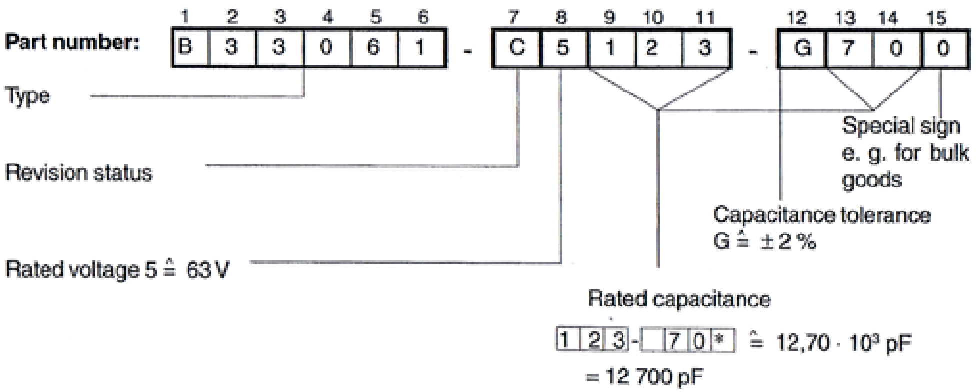
In accordance with the EMZ regulations an "*" is used to mark a variable figure, in this case the code figure for the rated voltage, or a special sign. A code letter is replaced by "+", coding in this example the 7th data position, i. e. the revision status, or the 12th data position, the tolerance.

For tolerance code letters refer to para. 12. Furthermore, they are indicated with the individual types.

Digit 15 (special version)

By means of this code figure different versions or special characteristics of the types are distinguished. The meaning of this code figure is stated for the actual types. A "6" in this digit position designates types packaged on continuous tapes (reel packing), a "7" is provided for packing in cardboard boxes (AMMO pack). Refer to chapter "Packaging".

Example for the compiling of part numbers (ordering code example)



Zeroes immediately after the tolerance code letters may be omitted (abbreviated writing).

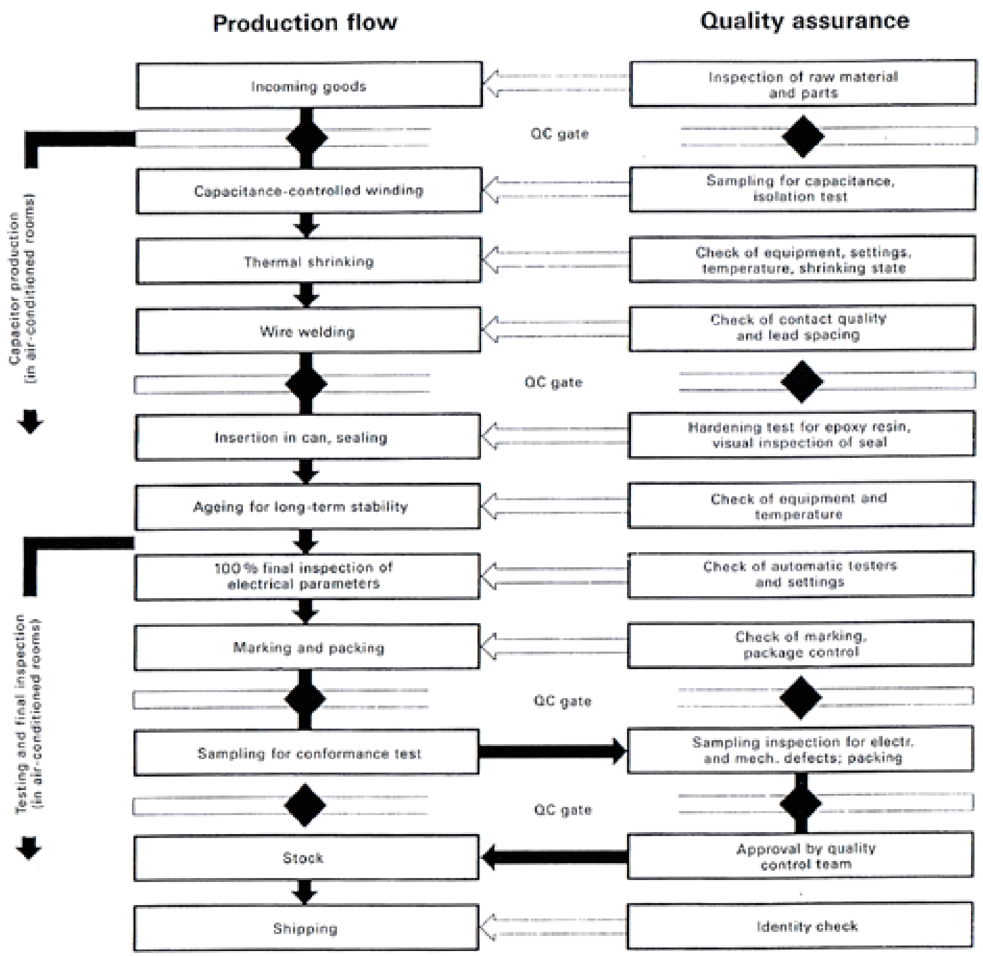
Quality

1 Introduction

To meet the high technical requirements in an open international market EMZ provides various specific quality assurance systems. The individual systems are matched to general-purpose or high rel requirements.
The EMZ system of quality assurance is laid down in the quality management manual.

Manufacturing processes and quality assurance

Example: KP capacitors in a tubular plastic case



2 Sequence of quality assurance measures

The quality department tested and released the capacitors described in this data book taking into account the criteria compliance with type specification, long-term reliability, process capability of production equipment as well as measuring and test methods and equipment.

To ensure a constantly high quality level the following tests are carried out:

2.1 Incoming inspection

In the incoming inspection the parts and materials required for production are checked for dimensional accuracy and material properties in a prescribed sequence. The results are stored and evaluated by an EDP system.

2.2 Product assurance

All important manufacturing stages are subject to routine monitoring. Each manufacturing stage is followed by a socalled "quality control gate", i. e. the product is only relased for the next stage after passing a corresponding test. The test results are constantly monitored and evaluated and are then used to assess the quality of the manufacturing process itself.

2.3 Final inspection

All capacitors are subject to a final inspection in accordance with the relevant specification, where they are checked for capacitance tolerance, voltage strength, dissipation factor, insulation resistance and finish.

2.4 Product monitoring

During standard production random sampling inspections are periodically carried out to check climatic resistance, operational reliability as well as solderability and resistance to soldering heat in accordance with DIN, CECC and IEC specifications.

3 Delivery quality

The term "delivery quality" designates the conformance with agreed data at the time of delivery.

3.1 Random sampling

The given AQL values (AQL = acceptable quality level) are based on the sampling inspection regulation DIN ISO 2859 level 1 (contents correspond to MIL-STD 105 D and IEC 410), single sampling plan for normal inspection, inspection level II.

3.2 Classification of defects

A defect exists if a component characteristic does not correspond to the specifications stated in the data sheets or in an agreed delivery specification. Defects which generally exclude the functional use of the component (inoperatives) are classified separately from less significant defects.

Inoperatives:

- short circuit or open circuit
- encapsulation or leads broken
- missing or incorrect marking of rated capacitance, rated voltage or type number
- mixing with other types

Other defects:

- exceeding of limiting values of electrical parameters
- mechanical defects, e. g. incorrect dimensions, damaged housing, illegible marking, bent leads

3.3 AQL values

The following AQL values apply to the quoted defects:

- for inoperatives (electrical and mechanical)	0.065
- for the total number of electrical defectives	0.25
- for the total number of mechanical defectives	0.25

4 Reliability

Data on long-term reliability under severe or moderate operating conditions are gained from continuously performed endurance tests. Basis are the failures registered under a defined load. The long-term reliability of the individual types tested is based on a confidence level of 60%. Our reliability data result from a very large number of component hours.

4.1 Reference reliability

The reference reliability describes the component-defined fraction failure which will not be exceeded under a defined load (the socalled reference load) within a defined period of time. The reference reliability given for film/foil capacitors refers to 40°C/104°F ambient temperature and to 30% relative humidity. The electrical reference load is the rated dc voltage.

4.2 Failure rate (long-term failure rate)

The failure rate is the fraction failure divided by the specified time of duty. The failure rate is expressed in fit.

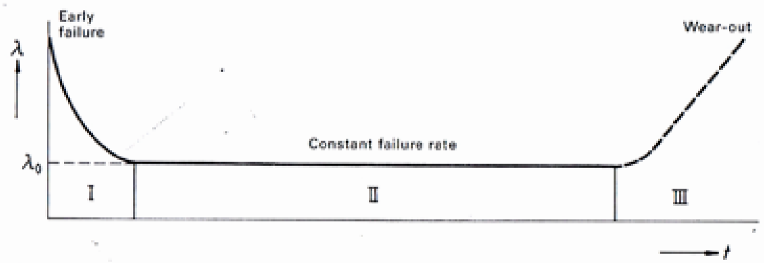
1 fit = $1 \cdot 10^{-9}$/h (fit = failure in time)

Example for a failure rate λ_{test} determined in a service life test:

1) Number of tested components	N = 8 000
2) Test duration	t_b = 25 000 h
3) Number of failures	n = 2

$$\lambda test = \frac{n}{N} \cdot \frac{1}{t_b} = \frac{2}{8000} \cdot \frac{1}{25\,000\text{ h}} = 10\text{ fit}$$

The failure rate curve for components can be represented by an idealized graph called bathtub curve.



Component failure periods versus operating hours

The three regions identified on the curve are:

I: Early failure period
II: Service period
III: Wear-out period

For components the existence of a service period is assumed that includes random failures with a virtually constant failure rate λ_0. Thus, stating the constant failure rate in this phase is considered to be sufficient.

The failures rates given in this data book apply to the reference load at the relevant operating time. For long life grade capacitors failure rates and the relevant operating time are explicitly specified in the individual data sheets.

4.3 Failure criteria

Unless otherwise specified in the data sheets, the failure criteria are defined as follows:

Total failure:	Short circuit, open circuit
Failure due to variation:	Capacitance $\lvert\Delta C/C\rvert > 3 \cdot i_z$
	Dissipation factor $\tan\delta > 2 \cdot$ tabulated value
	Insulation resistance R_i <10 % of minimum as-delivered value

4.4 Typical failure rate

Refered to the above mentioned reference load the following failure rates apply:

a) General purpose grade capacitors	15 fit
b) Long life grade capacitors	8 fit

5 Supplementary information

Quality data, which always refer to a large number of components, do not assure characteristics in a legal sense. Conversely, an agreement as regards such data does not exclude the possibility of the customer being able to claim replacement for individual defective capacitors within the framework of the terms of delivery. However, we are not able to assume any further liability, in particular as regards the consequences of component failure.

Furthermore, it must be taken into consideration that information on the service life and failure rate refers to an average production situation and that such information must thus be considered as average values (statistical anticipated values) based upon a large number of delivery lots of identical capacitors. They are based upon experience gained during use of the components and on data obtained from preceding tests under normal or severe conditions (for the purpose of accelerating the test).

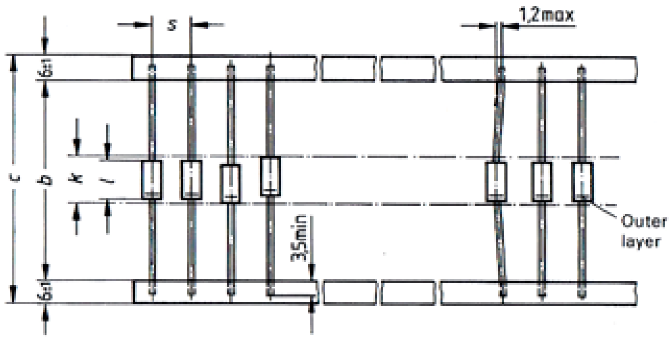
Tape Packaging

Film/foil capacitors with axial or radial leads are ideally suitable for automatic insertion. Most of the types contained in this data book are, therefore, available on tape.

1 KP capacitors with axial leads

Tape packaging is in accordance with DIN IEC 286-1.
The following types are available on tape:

B 33063



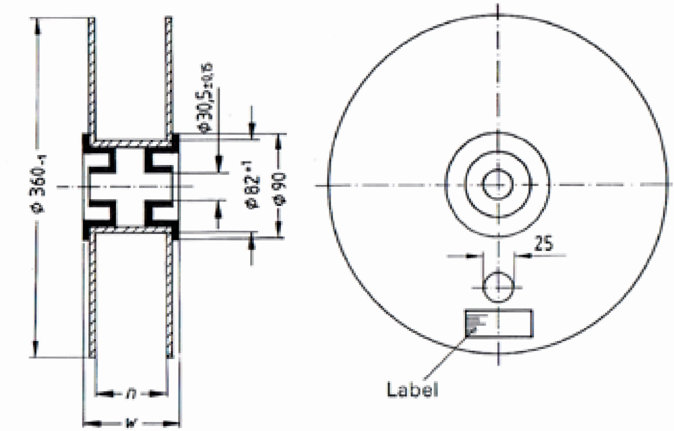
Spacing of components s mm	5 ± 0.5	10 ± 0.5	15 ± 0.5	20 ± 1.0
Perm. deviation over 10 spacings Δ s mm	± 1	± 2	± 3	± 4

Type	B 33 063		
Length l_{max} mm	11.0	16.5	21.5
Body location k mm	l_{max} + 1.4		
Inner tape spacing b ± 2 mm	63	68	73
Total tape width c mm	75	80	85

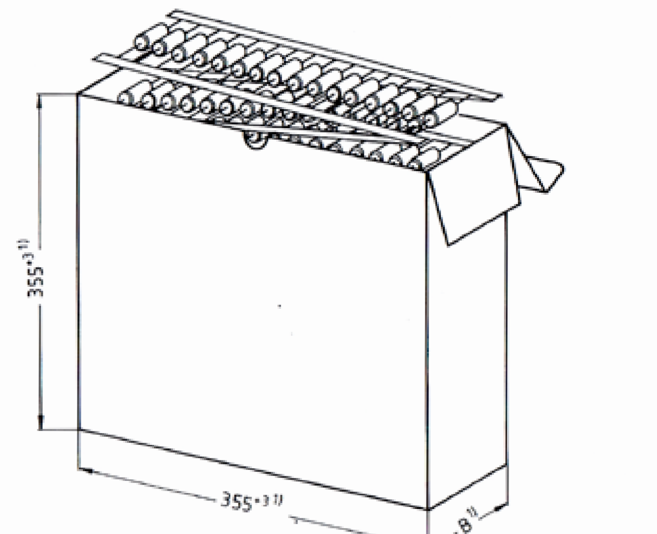
1.1 Modes of packing

According to your order we will deliver the components either on reels or in a meandershaped packing (AMMO pack) in a cardboard box.

Reel packing
Tape wound on reel with separation paper between the layers



AMMO-pack
Meander-shaped packing in card-board box



[1]) Outline dimensions

Dimensions in mm

Total tape width c	Reel packing Dimensions w	Reel packing Dimensions n	AMMO-pack Width of card-board box B
75	87^{+1}	78^{+1}	appr. 87^{+1}
80	92^{+1}	83^{+1}	appr. 87^{+1}
85	100^{+1}	91^{+1}	appr. 91^{+1}

1.2 Packing units / Minimum order quantities

The use of taped components in small quantities would not be economical, since the share of the taping and packing costs would then be to high. Automatic insertion is, moreover, only profitable if larger quantities are to be processed. Therefore, minimum quantities for ordering polypropylene capacitors have been determined, corresponding to the size of the reel or the box.

B 33 063- B 1
Packing units

U_R U_{eff}	C_R pF	Dimensions (max.) d x l mm	Packing units (items) AMMO pack	 Reel	
Ordering number: B 33 063-B1 *** -+*					compo-nent spacing mm
160 V-	Capacitance tolerance: ± 1 % ≙ F; ± 2.5 % ≙ H; ± 5 % ≙ J				
(65 V~)	330 to 1 200	4.5 x 11.0	6000	4000	5
	> 1 200 to 2 400	5.2 x 11.0	4600	1800	10
	> 2 400 to 3 500	5.8 x 11.0	4000	1600	10
	> 3 500 to 5 000	6.6 x 11.0	2800	1400	10
	> 5 000 to 6 500	7.3 x 11.0	2300	1300	10
	> 6 500 to 8 000	8.0 x 11.0	1900	1200	10
	> 8 000 to 10 000	8.7 x 11.0	1700	1100	10
	> 10 000 to 15 000	8.0 x 16.5	1900	1200	10
	> 15 000 to 17 000	8.5 x 16.5	1700	1100	10
	> 17 000 to 24 000	9.8 x 16.5	1400	900	10
	> 24 000 to 27 000	10.2 x 16.5	1100	600	15
	> 27 000 to 33 000	9.8 x 21.5	1400	900	10
	> 33 000 to 45 000	11.4 x 21.5	900	500	15
	> 45 000 to 60 000	13.0 x 21.5	700	500	15
	> 60 000 to 82 000	14.9 x 21.5	600	400	15
	> 82 000 to 100 000	16.5 x 21.5	400	300	20

B 33 063- B 6
Packing units

U_R $U_{(eff)}$	C_R pF	Dimensions (max.) d x l mm	Packing units (items) AMMO pack	 Reel	
Ordering number: B33063-B6***-+*					compo-nent spacing mm
630 V-	Capacitance tolerance: ± 1 pF ≙ F				
(210 V~)	2 to 20	4.0 x 11.0	7000	4700	5
	Capacitance tolerance: ± 1 pF ≙ F; ± 5 % ≙ J				
	> 20 to 40	4.0 x11.0	7000	4700	5
	Capacitance tolerance: ± 1 pF ≙ F; ± 2.5 % ≙ H; ± 5 % ≙ J				
	> 40 to 47	4.0 x 11.0	7000	4700	5
	> 47 to 100	4.5 x 11.0	6000	4000	5
	Capacitance tolerance: ± 1 pF ≙ F; ± 2.5 % ≙ H; ± 5 % ≙ J				
	> 100 to 330	4.5 x 11.0	6 000	4 000	5
	> 330 to 500	5.2 x 11.0	4 600	1 800	10
	> 500 to 1 000	6.0 x 11.0	3 600	1 600	10
	> 1 000 to 1 500	6.6 x 11.0	2 600	1 400	10
	> 1 500 to 2 200	7.9 x 11.0	2 000	1 200	10
	> 2 200 to 3 300	7.6 x 16.5	2 100	1 200	10
	> 3 300 to 4 500	8.6 x 16.5	1 700	1 100	10
	> 4 500 to 6 500	9.8 x 16.5	1 400	900	10
	> 6 500 to 7 500	10.4 x 16.5	1 100	600	15
	> 7 500 to 8 200	9.6 x 21.5	1 400	1 000	10
	> 8 200 to 8 500	9.8 x 21.5	1 400	900	10
	> 8 500 to 10 000	10.4 x 21.5	1 100	600	15
	> 10 000 to 12 500	11.4 x 21.5	900	500	15
	> 12 500 to 15 000	12.3 x 21.5	800	500	15
	> 15 000 to 17 000	13.0 x 21.5	700	500	15
	> 17 000 to 22 000	14.5 x 21.5	600	400	15

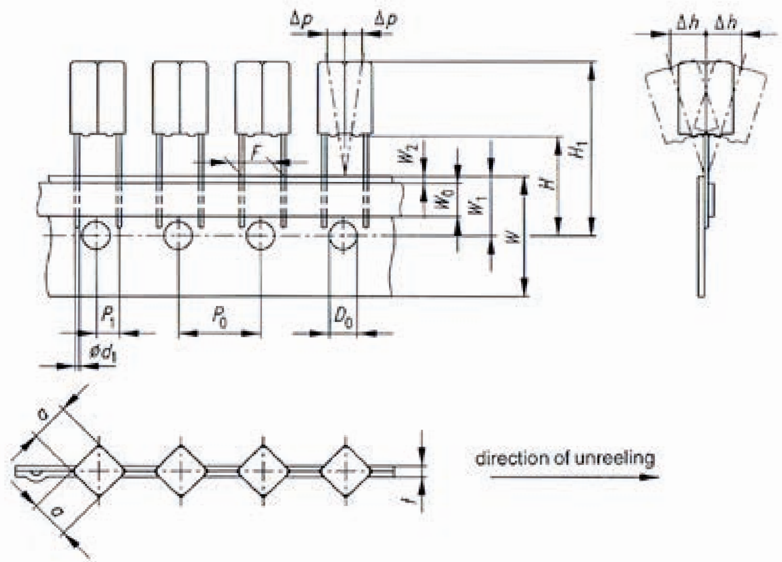
1.3 Ordering code

Reel packing	The code figure "6" has to be inserted in the last, i. e. the 13th or 15th digit position of the ordering code (refer to individual data sheets).
AMMO pack	The code figure "7" has to be inserted in the last, i. e. the 13th or 15th digit position of the ordering code (refer to individual data sheets).

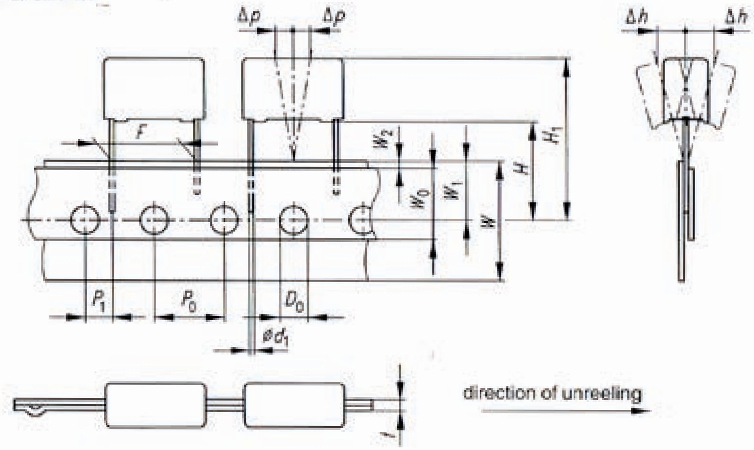
2 KP capacitors with unidirectional (radial) leads

Taping is in accordance with DIN IEC 286-2.
The following types are available on tape: B 33 531 (≤ 43 000 pF) und B 33 521 (≤ LS 10) .

B 33 531



B 33 521



Types	B 33 531	B 33 521	
Dimensions (mm)	width of capacitor a ≤ 7.5	lead spacing 10.0	tolerance (mm)
$\varnothing d_1$	0.6	0.6	+ 0.06/-0.05
F	7.2	10.0	+ 0.6/-0.1
P_1	3.6	7.7	± 0.7
H_1	32.2		max.
H	16.5 (Panasert); 18.5 (Avisert)		± 0.5
P_0	12.7		± 0.2 ± 1 pro 20 · P_0
D_0	4.0		± 0.2
W	18.0		± 0.5
W_0	6.0	12.0	± 0.5
W_1	9.0		± 0.5
W_2	0.5		+ 2.5
t	0.7		± 0.2
Δh	0		± 2.0
Δp	0		± 1.3

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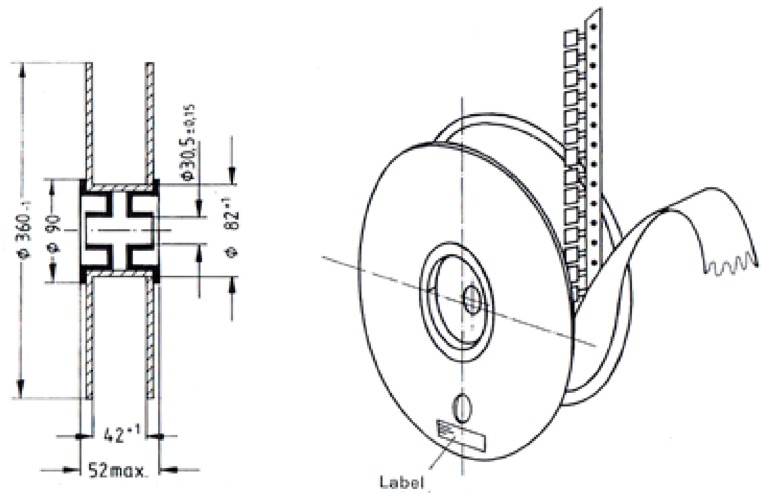
2.1 Modes of packing

The tape is wound on a reel with separation paper between the layers according to the following illustration:

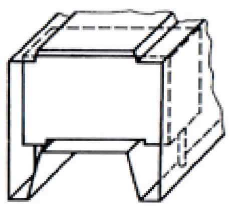


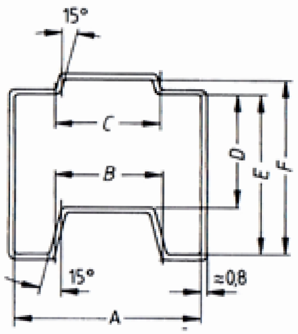
2.2 Ordering code

The code figure "6" (H=18.5 mm) or "8" (H=16.5 mm) has to be inserted in the last, i. e. 13th or 15 th digit of the ordering code (refer to individual data sheets).

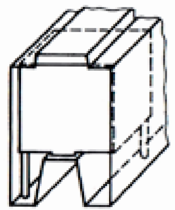
Magazine packing

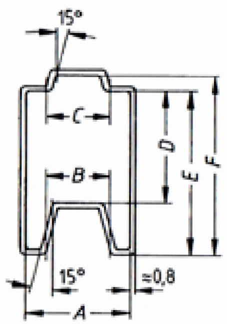
B 33 521





B 33 531





Type	Dimensions of capacitor	lead spacing	Dimensions of magazine (mm)						
	b x *h* x *l* (mm)	mm	*A*	*B* + 0.5	*C* - 0.5	*D* ± 0.2	*E* ± 0.2	*F*	length
B 33 521	5.0 x 7.2 x 12.5	10	13.2	6.0	6.0	7.2	14.2	16.2	580
	7.5 x 10.0 x 12.5	10	13.2	6.0	6.0	10.2	17.2	19.2	
	10.0 x 11.5 x 12.5	10	13.2	6.0	6.0	13.7	20.7	22.7	
	10.0 x 11.5 x 17.5	15	18.2	10.0	10.0	12.2	19.2	21.2	
	11.5 x 12.5 x 22.5	20	23.2	15.0	15.0	13.2	20.2	22.2	
	11.5 x 12.5 x 27.5	25	28.2	20.0	20.0	13.2	20.2	22.2	
	a x *h*	*r*							
B 33 531	6.3 x 11.0	7.2	7.2	2.7	2.7	11.5	18.5	20.5	580
	7.5 x 13.0	7.2	8.2	3.2	3.2	13.7	20.7	22.7	
	10.0 x 13.0	10.8	10.7	4.0	4.0	13.7	20.7	22.7	
	12.5 x 13.0	14.4	13.2	6.0	6.0	13.7	20.7	22.7	

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Polypropylene Capacitors up to 85 °C (185° F)

GP Grade and LL Grade

Humidity Category E

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GP grade

Construction

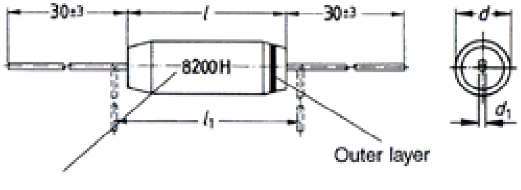
- Wound capacitor
- Central axial leads
- Available on tape

Features

- Stabilized mechanical and electrical characteristics due to a special heat treatment

Application

- RF and IF filters
- Timing circuits
- Resonant circuits



Legend: Rated capacitance (pF)
Tolerance (code letter)
Rated voltage (uncoded or color ring)

Outer layer: Bar or color ring

Length l_2	$l_{1\,min}$	d_1
11.0	15.0	0.6
16.5	20.0	0.8
21.5	25.0	0.8

Rated dc voltage U_R Color ring		160 V red	630 V black
Type with marking of revision status and rated voltage		B 33063-B1	B 33063-B6
Rated capacitance C_R		Dimensions (mm)	
Tolerance	pF	d_{max} x l_{max}	d_{max} x l_{max}
± 1 pF ≙ F	2 to 20		4.0 x 11.0
± 1 pF; ± 5 %	> 20 to 40		4.0 x 11.0
± 1 pF; ± 2.5 %; ± 5 %	> 40 to 47		4.0 x 11.0
	> 47 to 100		4.5 x 11.0
	> 100 to 330		4.5 x 11.0
	> 330 to 1 000	4.5 x 11.0	6.0 x 11.0
	> 1 000 to 1 500	4.5 x 11.0	6.9 x 11.0
	> 15 00 to 2 200	5.0 x 11.0	7.9 x 11.0
	> 2 200 to 3 300	5.7 x 11.0	7.6 x 16.5
	> 3 300 to 7 500	7.8 x 11.0	10.4 x 16.5
± 1 % ≙ F	> 7 500 to 8 200	8.1 x 11.0	9.6 x 21.5
± 2.5 % ≙ H	> 8 200 to 10 000	8.7 x 11.0	10.4 x 21.5
± 5 % ≙ J	> 10 000 to 15 000	8.0 x 16.5	12.3 x 21.5
	> 15 000 to 22 000	9.5 x 16.5	14.5 x 21.5
	> 22 000 to 27 000	10.2 x 16.5	
	> 27 000 to 33 000	10.0 x 21.5	
	> 33 000 to 47 000	11.7 x 21.5	
	> 47 000 to 82 000	15.0 x 21.5	
	> 82 000 to 100 000	16.5 x 21.5	

The dimensions apply to the highest capacitance value.
Diameters for lower capacitance values can be interpolated.
These capacitors are preferably available on tape. Please refer to chapter "Tape packaging".

Technical data

Type		B 33063-B1	B 33063-B6
Rated dc voltage U_R AC voltage $U_{\sim}$ Category current I_C	 l = 11.0 mm l = 16.5 mm l = 21.5 mm	160 V 65 V 1.0 A 1.2 A 1.5 A	630 V 210 V 1.0 A 1.2 A 1.5 A
IEC climatic category (DIN IEC 68-1) Lower category temperature T_{min} Upper category temperature T_{max} Test duration Category values after damp heat test: Capacitance change $\lvert \Delta C/C \rvert$ Dissipation factor tan δ_F Insulation resistance R_F		 40/085/21 - 40 °C + 85 °C 21 days ≤ (0.75 % + 0.5 pF) ≤ 1.4 · tabulated value ≥ 50 GΩ	
Climatic category DIN 40 040		GPE	
Capacitance drift i_C [1]		≤ (0.3 % + 0.4 pF)	
Temperature coefficient α_C of capacitance [1]		- (100 to 300) · 10^{-6}/ K	

Dissipation factor tan δ (10^{-3})	≤ 100 pF	... 1000 pF	... 4 700 pF	... 22 000 pF	... 100 000 pF
≤ 1 kHz	-	-	0.2	0.3	0.5
10 kHz	0.2	0.3	0.3	0.4	-
100 kHz	0.3	0.4	0.5	-	-
1000 kHz	0.4	0.7	-	-	-

Insulation resistance R_i (minimum as-delivered value)	100 GΩ

Ordering code example

B33063-B1823-H 7

Code figure for taping (AMMO pack)
Capacitance tolerance: H ≙ ± 2.5%
Rated capacitance: 823 ≙ 82 · 10^3 pF = 82000 pF
Type
Revision status, rated voltage
1 ≙ 160 V

For ordering information refer to page 38.

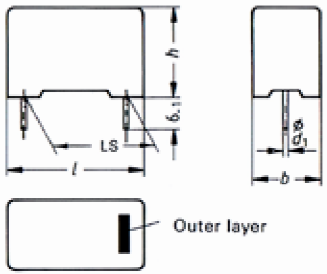
[1] for C_R ≥ 100 pF

LL grade

Construction
- Wound capacitor
- Plastic case (flame-retardant in acc. with UL 94 V-0), sealed
- Face-end contacts
- Radial leads in the lead spacing

Features
- Low self inductance
- Low failure
- Low power dissipation
- Operating time 200 000 hours

Application
- For professional equipment in measurement technique and telecommunications
- RF and IF filters
- Timing circuits
- Resonant circuits



Legend: Manufacturer´s logo
Design symbol (KP)
Rated capacitance (pF)
Tolerance (code letter)
Rated voltage (uncoded)
Date of manufacture

Length l_{max}	12.5	17.5	22.5	27.5
Lead spacing LS ±0.25	10.0	15.0	20.0	25.0
∅ d_1	0.6	0.6	0.8	0.8

Rated dc voltage U_R		63 V			160 V			630V		
Type with marking of revision status and rated voltage		B 33 521-C5			B 33 521-B1			B 33 521-A 6		
Rated capacitance C_R		Dimensions (mm)								
Tolerance	pF	b_{max}	h_{max}	l_{max}	b_{max}	h_{max}	l_{max}	b_{max}	h_{max}	l_{max}
	100 to 1 300	5.0	7.2	12.5	5.0	7.2	12.5	7.5	10.0	12.5
	> 1 300 to 1 500	5.0	7.2	12.5	5.0	7.2	12.5	10.0	11.5	12.5
	> 1 500 to 3 320	5.0	7.2	12.5	7.5	10.0	12.5	10.0	11.5	12.5
	> 3 320 to 4 700	5.0	7.2	12.5	7.5	10.0	12.5	10.0	11.5	17.5
	> 4 700 to 6 040	7.5	10.0	12.5	7.5	10.0	12.5	10.0	11.5	17.5
± 1 % ≙ F	> 6 040 to 6 600	7.5	10.0	12.5	10.0	11.5	12.5	10.0	11.5	17.5
± 2 .5 % ≙ H	> 6 600 to 12 000	7.5	10.0	12.5	10.0	11.5	12.5			
	> 12 000 to 12 100	7.5	10.0	12.5	10.0	11.5	12.5			
	> 12 100 to 16 000	7.5	10.0	12.5	10.0	11.5	17.5			
	> 16 000 to 25 500	10.0	11.5	12.5	10.0	11.5	17.5			
	> 25 500 to 40 200	10.0	11.5	17.5	11.5	12.5	22.5			
	> 40 200 to 44 200	11.5	12.5	22.5	11.5	12.5	27.5			
	> 44 200 to 68 100	11.5	12.5	22.5						
	> 68 100 to 130 000	11.5	12.5	27.5						

Technical data

Type	B 33521-C5	B 33521-B1	B 33521-A6
Rated dc voltage U_R AC voltage U_{ac} Category current I_c	63 V 25 V 1.0 A	160 V 65 V 1.0 A	630 V 210 V 1.0 A
IEC climatic category (DIN IEC 68-1) Lower category temperature T_{min} Upper category temperature T_{max} Test duration Category values after damp heat test: Capacitance change |ΔC/C| Dissipation factor tan δ_p Insulation resistance R_{is}	55/085/56 - 55 °C + 85 °C 56 days		after 56 days damp heat test: ≤ (0.75 % + 0.75 pF) ≤ 1.4 · tabulated value ≥ 100 GΩ
Climatic category (DIN 40 040)	FPE		
Realibility Failure rate Operating time	8 fit 200 000 hours		
Capacitance drift i_c [1]	≤ (0.3 % + 0.4 pF)		
Temperature coefficient α_c of capacitance [1]	- (80 to 360) · 10^{-6}/ K		
Insulation resistance R_i (minimum as-delivered value)	200 GΩ		

Dissipation factor tan δ (10^{-3})	p 1000 pF...	4700 pF...	10 000 pF...	22 000 pF..	40 000 pF	..130 000pF
p 10 kHz	0.3	0.3	0.3	0.4	0.4	0.5
100 kHz	0.4	0.4	0.4	0.5	0.6	-
1000 kHz	0.5	-	-	-	-	-

Ordering code example

B 33521-C5 124-F

Type
Revision status, rated voltage
5 ≙ 63 V
Capacitance tolerance: F ≙ ± 1%
Rated capacitance:
124 ≙ 12 · 10^4 pF = 120000pF

[1] for C_R > 460pF

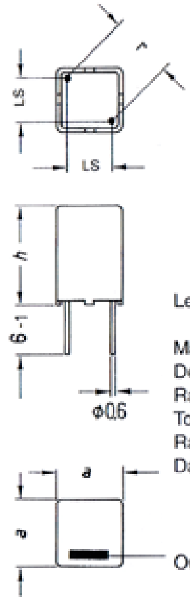
LL grade

Construction

- Wound capacitor
- Plastic case (flame-retardant in acc. with UL 94 V-0), sealed
- Face-end contacts
- Design suitable for matching with RM ferrite cores
- Single-ended leads complying with standardized lead spacings

Features
- Low self inductance
- Low failure rate
- Operating time 200 000 hours

Application
- For professional equipment in measurement technique and telecommunications
- RF and IF filters
- Timing circuits
- In combination with ferrite inductors ideal temperature compensation for resonant circuits



Legend:

Manufacturer´s logo
Design symbol (KP)
Rated capacitance (pF)
Tolerance (code letter)
Rated voltage (uncoded)
Date of manufacture

Outer layer (bar)

Rated dc voltage U_R		63 V			
Type with marking of revision status and rated voltage		B 33531-A5			
Rated capacitance C_R		Dimensions (mm)			
Tolerance	pF	$a_{\pm 0.3}$	$h_{\pm 0.5}$	$RM_{\pm 0.25}$	$r_{\pm 0.35}$
± 1 % ≙ F ± 2.5% ≙ H	100 to 9 200	6.3	11.0	5.08	7.20
	> 9 200 to 21 000	7.5	13.0	5.08	7.20
	> 21 000 to 43 000	10.0	13.0	7.62	10.75
	> 43 000 to 68 100	12.5	13.0	10.16	14.35

E 24 series
Taping upon request.

Technical data

Type	B 33531			
Rated dc voltage U_R AC voltage current U_{ac} Category current I_c	63 V 25 V 1.0 A			
IEC climatic category (DIN IEC 68-1) Lower category temperature T_{min} Upper category temperature T_{max} Test duration Category values after damp heat test: Capacitance change $\lvert \Delta C/C \rvert$ Dissipation factor tan δ Insulation resistance R_{is}	 55/085/56 - 55 °C + 85 °C 56 days ≤ (0.5 % + 0.5 pF) for C_R ≥ 330 pF ≤ (0.75 % + 0.75 pF) for C_R < 330 pF ≤ 1.4 ·tabulated value ≥ 50 GΩ			
Climatic category DIN 40 040	FPE			
Reliability Failure rate Operating time	 8 fit 200 000 hours			
Capacitance drift i_c [1]	≤ (0.3 % + 0.4 pF)			
Temperature coefficient α_c of capacitance [1]	- (80 to 360) · 10^{-6}/ K			
Dissipation factor tan δ (10^{-3})	≤ 100 pF	… 4700 pF	… 22000 pF	… 68000 pF
≤ 1 kHz	0.3	0.3	0.3	0.4
10 kHz	0.3	0.3	0.4	0.5
100 kHz	0.4	0.4	0.6	0.9
1000 kHz	0.6	-	-	-
Insulation resistance R_i (minimum as-delivered value)	100 GΩ			

Ordering code example

B 33531- A5 683 -F

Type — B 33531
Revision status, rated voltage — A5: 5 ≙ 63 V
Rated capacitance: 683 ≙ 68 · 10^3 pF = 68000 pF
Capacitance tolerance: F ≙ ± 1%

For ordering information refer to page 38.

[1] for C_R > 460 pF

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