

# Medium Power Film Capacitors

FPG/FPH (RoHS Compliant)

## PROTECTION



Metallized polypropylene dielectric capacitor with controlled self-healing.

Reinforced metallization on margins developed for high impulse currents.

Axial connections specially developed to reduce series inductance and to provide rigid mechanical mounting.

## APPLICATIONS

Protection of gate turn-off thyristor (G.T.O.).

Medium frequency tuning.

## HOT SPOT TEMPERATURE CALCULATION

See *Hot Spot Temperature* page 3.

$$\theta_{\text{hot spot}} = \theta_{\text{terminals}} + (P_d + P_t) \times R_{th}$$

with

$$P_d \text{ (Dielectric losses)} = Q \times \text{tg} \delta_0 \\ \Rightarrow \left[ \frac{1}{2} \times C_n \times (V_{\text{peak to peak}})^2 \times f \right] \times (2 \times 10^{-4})$$

$$P_t \text{ (Thermal losses)} = R_s \times (I_{\text{rms}})^2$$

where

- $C_n$  in Farads
- $V$  in Volts
- $I_{\text{rms}}$  in Amperes
- $R_s$  in Ohms
- $f$  in Hertz
- $\theta$  in °C
- $R_{th}$  in °C/W

Due to the design of the capacitor and its technology, the thermal impedance between the terminations and the core of the capacitor is low, it is necessary to take care that the capacitor is never overheated by use of incorrect sized connections.

In the case where the series diodes are screwed to the capacitor, cooling of the diodes must be taken in account.

Do not use the capacitor as a heat sink.

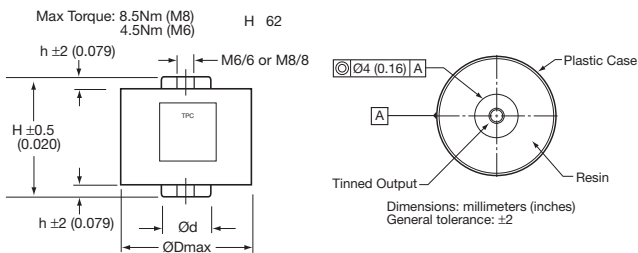
Due to the complexity of the diode/capacitor thermal exchanges, we recommend that thermal measurements shall be made on the different components. We would be pleased to advise you on specific problems.

## WORKING TEMPERATURE

(according to the power to be dissipated) -40°C to +85°C

## DIMENSIONS

millimeters (inches)



## MARKING

Logo

Withstanding surge voltage

Capacitance and tolerance in clear

Nominal DC voltage in clear

RMS current in clear

Date of manufacture (IEC coding)

## PACKAGING MATERIAL

Cylindrical in plastic case filled with thermosetting resin.

Outputs: threaded inserts either M6 or M8.

## HOW TO ORDER

| FPG                                    | 8                | 6                 | R                                                                                       | 0105                                                                | J                             | --                   |
|----------------------------------------|------------------|-------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------|----------------------|
| <b>Series</b>                          | <b>Case Size</b> | <b>Dielectric</b> | <b>Voltage Code</b>                                                                     | <b>Capacitance Code</b>                                             | <b>Capacitance Tolerances</b> | <b>Terminal Code</b> |
| FPG = Standard<br>FPH = RoHS Compliant | Case Size 8      | 6 = Polypropylene | R = 1500V<br>N = 2000V<br>P = 2500V<br>W = 2600V<br>X = 3500V<br>Z = 4500V<br>Y = 4600V | 0 + pF code<br>0105 = 1.0µF<br>0405 = 4.0µF<br>0604 = 0.6µF<br>etc. | J = ±5%                       | -- = Standard        |

# Medium Power Film Capacitors



FPG/FPH (RoHS Compliant)

## ELECTRICAL CHARACTERISTICS

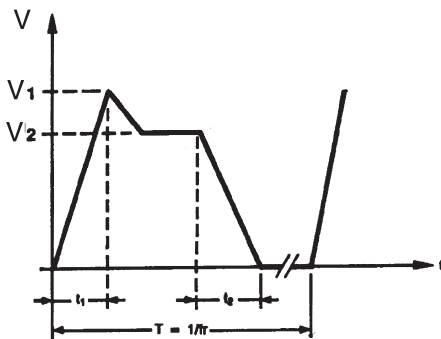
|                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Capacitance range $C_n$                                                                                                                                                                                                   | 0.12μF to 6μF                                                                                                                                                                                                                                                                                                                                                                  |
| Tolerance on $C_n$                                                                                                                                                                                                        | ±5%                                                                                                                                                                                                                                                                                                                                                                            |
| Rated DC voltage $V_{n\text{dc}}$                                                                                                                                                                                         | 800 to 3000 V                                                                                                                                                                                                                                                                                                                                                                  |
| Peak voltage $V_{\text{peak}}$                                                                                                                                                                                            | 1200 to 4000 V                                                                                                                                                                                                                                                                                                                                                                 |
| Allowable overvoltage $V_s$ (for 10 s/day)                                                                                                                                                                                | 1500 to 4600 V                                                                                                                                                                                                                                                                                                                                                                 |
| Nominal RMS voltage $V_{n\text{dc}}$                                                                                                                                                                                      | 500 to 1400 V                                                                                                                                                                                                                                                                                                                                                                  |
| Stray inductance                                                                                                                                                                                                          | ≈ 10 nH                                                                                                                                                                                                                                                                                                                                                                        |
| RMS current                                                                                                                                                                                                               | $I_{\text{rms max.}}$ = up to 80 A<br>The currents shown in the tables are maximum.<br>It is necessary to respect the thermal limits of the dielectric 85°C<br>see "Hot spot temperature calculation"                                                                                                                                                                          |
| Insulation resistance                                                                                                                                                                                                     | $R_i \times C \geq 30,000 \text{ s}$                                                                                                                                                                                                                                                                                                                                           |
| Impulse current                                                                                                                                                                                                           | $I^2.t$ max. given in the tables<br>Spikes or peak currents in the capacitors may cause a deterioration of the bonding between the metallization and the connections. These bonds are capable of withstanding only a limited amount of energy for each spike. The table shows the maximum energy permitted in the form ( $I^2.t$ ), where I is in Ampere, and t is in seconds. |
| <b>Note:</b> The formula ( $I^2.t$ ) replaces $dV/dt$ which is less easy to use as it is not an expression of energy ( $I = C.dV/dt$ ).<br>This type of capacitor has been designed to withstand high ( $I^2.t$ ) values. |                                                                                                                                                                                                                                                                                                                                                                                |
| Variation of capacitance with temperature                                                                                                                                                                                 | $\frac{\Delta C}{C} \leq \pm 2\%$ between -40 and 85°C                                                                                                                                                                                                                                                                                                                         |
| Climatic category                                                                                                                                                                                                         | 40/085/56 (IEC 60068)                                                                                                                                                                                                                                                                                                                                                          |
| Test voltage between terminals @ 25°C                                                                                                                                                                                     | $V_s$ during 10s                                                                                                                                                                                                                                                                                                                                                               |
| Test voltage between terminals and case @ 25°C (Type test)                                                                                                                                                                | @ 4 kVrms @ 50 Hz during 1 min.                                                                                                                                                                                                                                                                                                                                                |
| Dielectric                                                                                                                                                                                                                | Polypropylene                                                                                                                                                                                                                                                                                                                                                                  |

PROTECTION

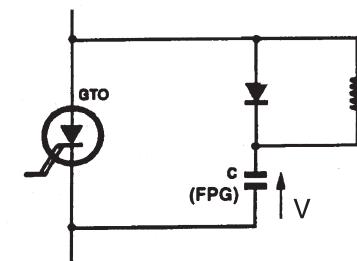
## PROTECTION

### APPLICATION NOTES

#### G.T.O. PROTECTION



Choice of voltage:  $V_1 \leq V_{\text{peak}}$   
 $V_2 \leq V_{n\text{dc}}$   
 Maximum overvoltage  $\leq V_s$  (10 s/day)



FPG: Snubber capacitor

Nominal DC voltage ( $V_{n\text{dc}}$ ) and peak voltage ( $V_{\text{peak}}$ ) are given in the table of values.

# Medium Power Film Capacitors



## FPG/FPH (RoHS Compliant) Table of Values

### PROTECTION

Dimensions: millimeters (inches)

| Part Number                                                                                                                        | Cn<br>(μF) | Case<br>Style     | Dimensions             |                     |            |                       | I <sup>2</sup> t<br>max.<br>(A <sup>2</sup> .s) | I <sub>rms</sub><br>max.<br>(A) | Rs<br>(mΩ) | Rth<br>(°C/W) | Typical<br>Weight (g) |
|------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------|------------------------|---------------------|------------|-----------------------|-------------------------------------------------|---------------------------------|------------|---------------|-----------------------|
|                                                                                                                                    |            |                   | H*<br>±0.5<br>(±0.020) | h<br>±2<br>(±0.079) | D<br>max.  | d<br>±0.5<br>(±0.020) |                                                 |                                 |            |               |                       |
| FPG 1500V V <sub>ndc</sub> = 800V V <sub>peak</sub> = 1200V V <sub>rms</sub> = 500V V <sub>s</sub> = 1500V (Voltage Code R)        |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66R0105J--                                                                                                                      | 1          | Plastic Case M6/6 | 52 (2.047)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 2                                               | 15                              | 2.4        | 14            | 120                   |
| FPG66R0155J--                                                                                                                      | 1.5        | Plastic Case M6/6 | 52 (2.047)             | 5 (0.197)           | 55 (2.165) | 18(0.709)             | 4.6                                             | 20                              | 1.6        | 10.5          | 160                   |
| FPG86R0205J--                                                                                                                      | 2          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 60 (2.362) | 22 (0.866)            | 8                                               | 30                              | 1.2        | 6.1           | 190                   |
| FPG86R0305J--                                                                                                                      | 3          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 18                                              | 45                              | 0.9        | 4.5           | 260                   |
| FPG86R0355J--                                                                                                                      | 3.5        | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 25                                              | 50                              | 0.85       | 4.5           | 260                   |
| FPG86R0405J--                                                                                                                      | 4          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 82 (1.575) | 22 (0.866)            | 32                                              | 60                              | 0.75       | 3.5           | 320                   |
| FPG86R0505J--                                                                                                                      | 5          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 82 (3.622) | 22 (0.866)            | 50                                              | 70                              | 0.65       | 2.5           | 320                   |
| FPG86R0605J--                                                                                                                      | 6          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 73                                              | 75                              | 0.6        | 2.5           | 400                   |
| FPG 2000V V <sub>ndc</sub> = 1000V V <sub>peak</sub> = 1600V V <sub>rms</sub> = 600V V <sub>s</sub> = 2000V (Voltage Code N)       |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66N0504J--                                                                                                                      | 0.5        | Plastic Case M6/6 | 52 (2.047)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 1                                               | 15                              | 3          | 14            | 120                   |
| FPG86N0105J--                                                                                                                      | 1          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 60 (2.362) | 22 (0.866)            | 3                                               | 20                              | 2.3        | 10.5          | 190                   |
| FPG86N0155J--                                                                                                                      | 1.5        | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 60 (2.362) | 22 (0.866)            | 7                                               | 30                              | 1.5        | 6.1           | 190                   |
| FPG86N0205J--                                                                                                                      | 2          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 12.7                                            | 40                              | 1.1        | 4.5           | 260                   |
| FPG86N0255J--                                                                                                                      | 2.5        | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 20                                              | 60                              | 0.89       | 3.7           | 260                   |
| FPG86N0305J--                                                                                                                      | 3          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 28                                              | 60                              | 0.85       | 3.2           | 320                   |
| FPG86N0355J--                                                                                                                      | 3.5        | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 39                                              | 65                              | 0.78       | 2.9           | 320                   |
| FPG86N0405J--                                                                                                                      | 4          | Plastic Case M8/8 | 52 (2.047)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 50                                              | 70                              | 0.7        | 2.5           | 400                   |
| FPG 2500V V <sub>ndc</sub> = 1300V V <sub>peak</sub> = 2000V V <sub>rms</sub> = 700V V <sub>s</sub> = 2500V (Voltage Code P)       |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66P0474J--                                                                                                                      | 0.47       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 0.7                                             | 15                              | 6          | 25            | 160                   |
| FPG66P0105J--                                                                                                                      | 1          | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 55 (2.165) | 18 (0.709)            | 2                                               | 18                              | 3          | 13            | 180                   |
| FPG66P0155J--                                                                                                                      | 1.5        | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 60 (2.362) | 22 (0.866)            | 4.5                                             | 25                              | 2          | 10            | 220                   |
| FPG86P0205J--                                                                                                                      | 2          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 8                                               | 35                              | 1.5        | 6.5           | 310                   |
| FPG86P0255J--                                                                                                                      | 2.5        | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 12.5                                            | 40                              | 1.3        | 4.8           | 310                   |
| FPG86P0305J--                                                                                                                      | 3          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 18                                              | 50                              | 1.15       | 4.4           | 410                   |
| FPG86P0405J--                                                                                                                      | 4          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 32                                              | 65                              | 0.95       | 3.4           | 475                   |
| FPG 2600V V <sub>ndc</sub> = 1750V V <sub>peak</sub> = 2000V V <sub>rms</sub> = 800V V <sub>s</sub> = 2600V (Voltage Code W)       |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66W0474J--                                                                                                                      | 0.47       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 1.4                                             | 12                              | 4.04       | 28            | 160                   |
| FPG66W0105J--                                                                                                                      | 1          | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 55 (2.165) | 18 (0.709)            | 5.7                                             | 21                              | 2.17       | 10.9          | 180                   |
| FPG66W0155J--                                                                                                                      | 1.5        | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 60 (2.362) | 18 (0.709)            | 12.9                                            | 31                              | 1.55       | 7.7           | 220                   |
| FPG86W0205J--                                                                                                                      | 2          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 23                                              | 41                              | 1.24       | 6.1           | 310                   |
| FPG86W0255J--                                                                                                                      | 2.5        | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 36                                              | 51                              | 1.05       | 4.5           | 410                   |
| FPG86W0305J--                                                                                                                      | 3          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 50                                              | 62                              | 0.92       | 3.9           | 475                   |
| FPG86W0355J--                                                                                                                      | 3.5        | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 70                                              | 72                              | 0.83       | 3.4           | 475                   |
| FPG86W0395J--                                                                                                                      | 3.9        | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 85                                              | 80                              | 0.78       | 3.1           | 475                   |
| FPG 3500V V <sub>ndc</sub> = 2000V V <sub>peak</sub> = 2400V V <sub>rms</sub> = 1000V V <sub>s</sub> = 3500V (Voltage Code X)      |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66X0334J--                                                                                                                      | 0.33       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 2                                               | 15                              | 2.5        | 28            | 160                   |
| FPG66X0504J--                                                                                                                      | 0.5        | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 55 (2.165) | 18 (0.709)            | 5                                               | 19                              | 2.5        | 11.2          | 180                   |
| FPG86X0105J--                                                                                                                      | 1          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 15                                              | 38                              | 1.4        | 6.2           | 310                   |
| FPG86X0155J--                                                                                                                      | 1.5        | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 40                                              | 56                              | 1.03       | 3.9           | 410                   |
| FPG86X0205J--                                                                                                                      | 2          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 70                                              | 75                              | 0.85       | 3.1           | 475                   |
| FPG 4500V V <sub>ndc</sub> = 2500V V <sub>peak</sub> = 3200V V <sub>rms</sub> = 1200V V <sub>s</sub> = 4500V (Voltage Code Z)      |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66Z0224J--                                                                                                                      | 0.22       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 1.5                                             | 15                              | 3.8        | 25            | 160                   |
| FPG66Z0474J--                                                                                                                      | 0.47       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 60 (2.362) | 18 (0.709)            | 7                                               | 24                              | 2.16       | 8.5           | 220                   |
| FPG86Z0684J--                                                                                                                      | 0.68       | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 14                                              | 35                              | 1.59       | 6.2           | 310                   |
| FPG86Z0105J--                                                                                                                      | 1          | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 30                                              | 52                              | 1.18       | 4             | 410                   |
| FPG86Z1254J--                                                                                                                      | 1.25       | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22 (0.866)            | 50                                              | 65                              | 1          | 3.3           | 475                   |
| FPG 4600 V V <sub>ndc</sub> = 3000 V V <sub>peak</sub> = 4000 V V <sub>rms</sub> = 1400 V V <sub>s</sub> = 4600 V (Voltage Code Y) |            |                   |                        |                     |            |                       |                                                 |                                 |            |               |                       |
| FPG66Y0124J--                                                                                                                      | 0.12       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 40 (1.575) | 18 (0.709)            | 0.8                                             | 15                              | 6          | 28            | 160                   |
| FPG66Y0224J--                                                                                                                      | 0.22       | Plastic Case M6/6 | 62 (2.441)             | 5 (0.197)           | 60 (2.362) | 18 (0.709)            | 3                                               | 20                              | 3.48       | 11            | 220                   |
| FPG86Y0334J--                                                                                                                      | 0.33       | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 72 (2.835) | 22 (0.866)            | 6.8                                             | 25                              | 2.42       | 7.7           | 310                   |
| FPG86Y0474J--                                                                                                                      | 0.47       | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 82 (3.228) | 22 (0.866)            | 13.8                                            | 35                              | 1.79       | 5.2           | 410                   |
| FPG86Y0604J--                                                                                                                      | 0.60       | Plastic Case M8/8 | 62 (2.441)             | 5 (0.197)           | 92 (3.622) | 22(0.866)             | 22                                              | 45                              | 1.47       | 4.2           | 475                   |

PROTECTION

