

## 4. Operational technique of Gold Capacitor

### 4-1 Life design

#### 4-1-1 Useful life

Gold Capacitors have a limited life the same as aluminum electrolytic capacitors. It is greatly different depending on use conditions. Therefore, the useful life of Gold Capacitors can be considered the time that is satisfied with back-up time set by customers in their use conditions.

#### 4-1-2 Example of expected life

Generally, the Arrhenius law (Double-speed acceleration at 10°C) is applied to similar aluminum electrolytic capacitor. The guaranteed life time of Gold Capacitors is

After 1000 hours at 70°C (SD/SE/SG/NF)

Capacitance change: ±30% of initial value

Internal resistance: 4 times or less of initial spec value

(Refer to the SPEC sheet or catalog for details)

When assuming that this capacitor is used at 30°C, the expected life becomes following.

$$\begin{aligned} T_{30} &= 1000 \times 2^{\frac{70-30}{10}} \\ &= 16000 \quad [\text{hours}] \end{aligned}$$

Please have the margin in initial capacitance, when you use Gold Capacitors. As a result, there is a possibility to be able to back up even if the capacitance becomes over the minus 30%. In this case, please refer to Chapter 5 in this book "Gold capacitor characteristic data" and Panasonic web for the reliability test data for the typical value of the characteristic change of our Gold Capacitors.

Example of calculating backup time

The case to use the SG series Gold Capacitor EECS5R5V155 in the following conditions is calculated.

Applied voltage ; 5.5V

Cut-off voltage ; 2V

Current during back-up ; 10uF

The backup time after 70°C2000 hour is forecast from data. (The item of the leakage current is disregarded. )

The characteristic after 70°C2000 hour(reference to data of Chapter 5)

Capacitance change about -32%, Internal resistance 120Ω

The Initial capacitance 1.2[F] (1.5[F] about -20%)

$$t = CV/I$$

$$= C \times (V_0 - i_x R - V_1) / (I + i_L)$$

$$= 1.2 \times 0.68 \times (5.5 - 0.0012 - 2) / (10 \times 10^{-6})$$

t: Back-up time (s)

C: Capacitance of Gold capacitor (F)

V<sub>0</sub>: Applied voltage (V)

=280000s

=79hours

 $V_1$ : Cut-off voltage (V)

i: Current during back-up (A)

 $i_L$ : Leakage current(A)R: Internal resistance ( $\Omega$ ) at 1kHz

70°C2000 hour is converted by applied the Arrhenius law (Double-speed acceleration at 10°C) and the calculation shows the backup time to be 79 hours after 3.6 years.

Even if the endurance change rate is exceeded with room in initial capacitance on the real use, with room in initial capacitance, Gold Capacitor can be still used (It is possible to back up). It seems that the life time is postponed. However the characteristic change has not been decreased in this case and the life of the Gold Capacitor has not been postponed. The circuit of each equipment will be designed on the condition that can be used even if the life of the Gold Capacitor is exceeded.

Generally, to decrease the capacitance change in the Gold Capacitor please refer to the following.

- ① The use temperature (ambient temperature) is lowered

As for the characteristic change in the Gold Capacitor, the Arrhenius law (Double-speed acceleration at 10°C) is applied generally as previously mentioned. The expected life becomes double by lowering the temperature at 10°C.

- ② The 85°C guarantee products are used.

The expected life increases to about 2.8 times that of 70°C guarantee products when using it at the same temperature.

- ③ The applied voltage to the Gold Capacitor (charge voltage) is lowered.

The applied voltage influences the characteristic change in the Gold Capacitor. The acceleration calculation like the temperature acceleration is not clear now.

However, in the case 5.5V products are used by 5.0V: about 1.3 times. In the case 5.5V product are used by 3.3V: about 2.8 times. This kind of level can be expected. (The RF/F series is excluded.)

- ④ The electrical charge and discharge is intermittent and the charging time is shortened.

The characteristic change of Gold Capacitor is not influenced from electrical charge and discharge cycle number but from the time that the voltage is applied. Therefore, please design for the electrical charge and discharge when it is necessary. The characteristic change can be suppressed at time that is not charged.

The result that a very long term backup can be expected in calculation might be obtained by use conditions. However, please consider checking regularly and exchanging it when using it for the set that long-term reliability is basically demanded from the Gold Capacitor.

## 4-2 Notes in using Electric Double Layer Capacitors

### 4-2-1 Circuit design

#### 4-2-1.1 Product Life

**Electric Double-Layer Capacitors (Gold Capacitors, hereafter referred to as capacitors) have a limited life.**

The life of an electric double layer capacitor is limited. Its capacitance will decrease and its internal resistance will increase over time.

The life of a capacitor greatly depends on the ambient temperature, humidity, applied voltage and discharging currents. Capacitor life can be extended when these parameters are set well below the ratings.

The guaranteed durability of electric double-layer capacitors is between 500 hours at 60°C and 2000 hours at 85°C. Generally, it is 1000 hours at 70°C. The life of the capacitor is guaranteed to be 16000 hours at a normal temperature (30°C) by applying the acceleration double for every 10°C.

If your application incorporates this capacitor over a long period of time then check it periodically and replace it when necessary.

#### 4-2-1.2 Polarity and voltage

**Capacitors have polarities**

Do not apply a reverse or AC voltage. If a reversed voltage is applied to a capacitor for a long period of time, then its life will be reduced and critical failures such as electrolyte leakage may occur.

**Do not apply an over-voltage (a voltage exceeding the rated voltage).**

If voltage exceeding the rating is applied to the capacitor for a long time, then its life will be reduced and critical failures such as electrolyte leakage or physical damage due to gas generated by electrochemical reaction or explosion may occur.

#### 4-2-1.3 Circuits through which ripple currents pass

When using a capacitor in a circuit through which ripple currents pass, monitor the allowable temperature range.

The internal resistance of electric double-layer capacitors is higher than that of electrolytic capacitors. Electric double-layer capacitors may generate heat due to ripple currents.

The allowable temperature rise due to ripple currents is 3°C measured on the surface of the capacitor.

#### 4-2-1.4 Ambient temperature and product life

Capacitor life is affected by usage temperatures. Generally speaking, capacitor life is approximately doubled when the temperature is decreased by 10°C. Therefore, lower the usage temperature as much as possible.

Using capacitors beyond the guaranteed range may cause rapid deterioration of their characteristics and cause them to break down.

The temperature referred to here includes the ambient temperature within the equipment, the heat

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produced by heat generating devices (power transistor, resistors, etc.), self-heating due to ripple currents, etc. Take all of these factors into consideration when checking the capacitor's temperature.

Do not place any heat generating devices on the back of the capacitors.

Life acceleration can be calculated with the following equation:

$$L_2 = L_1 \times 2^{\frac{T_1 - T_2}{10}}$$

$L_1$ : Life at temperature  $T_1$  (°C)(h)  
 $L_2$ : Life at temperature  $T_2$  (°C)(h)  
 $T_1$ : Category's upper limit temperature (°C)  
 $T_2$ : Ambient temperature to calculate the life + heat generation due to ripple current (°C)

Humidity also affects the capacitor's life. When using capacitors outside the following conditions, please contact Panasonic.

A temperature at +55°C and a relative humidity of 90% to 95% for 500 hours.

### 4-2-1.5 Voltage drop

Pay particular attention to the instantaneous working current and the voltage drop due to the capacitor's internal resistance when used in backup mode. The discharging current level is different depending on the capacitor's internal resistance. Use a capacitor with a discharging current below what is specified as the corresponding capacitor.

Series	Max. Discharging Current				
	0.047F or less	0.1 to 0.33F	0.47 to 1.5F	3.3 to 4.7F	10F to 50F
SG/SD/SE/NF/F	200μA	300μA	1mA	—	—
RF/RG	—	—	Ref. P**	—	—
EN/EP	5μA	10μA	—	—	—
HW/HZ	—	—	100mA	300mA	1A

### 4-2-1.6 Series connection

When connecting capacitors in series, add a bleeder resistor in parallel with each capacitor by taking the leak current into consideration so that the balanced of voltages is not disrupted.

### 4-2-1.7 Electrolyte is used in the products

Electrolyte is used in the capacitors. Therefore, misuse can result in rapid deterioration of characteristics and functions of each product. Electrolyte leakage will damage printed circuit boards and can affect their performance, characteristics, and functions.

### 4-2-1.8 External sleeve

The external sleeve is not electrical insulation, and thus capacitors should not be used in an environment that requires electrical insulation.

## 4-2-2 Mounting

## 4-2-2.1 Heat stress due to soldering

When soldering a capacitor to a printed circuit board, excessive heat stress could cause the deterioration of the capacitor's electrical characteristics. For example, the integrity of the seal can be compromised causing the electrolyte to leak, and short circuits could occur in addition to failure of appearance.

Please observe the following guidelines:

## (1) Reflow soldering

- 1) Only two series (EP & EN) can be reflow soldered in current products. (There are some products that can not be reflow soldered in these series). The other series can not be reflow soldered.
- 2) Please do not solder under conditions that exceed the referenced soldering profile. (Refer to "Mounting Specifications" .)
- 3) Do not solder when the voltage of the capacitor is 0.3V or more.

Please discharge the product according to the following process when soldering the product at that applied voltage.

At first short circuit the capacitor for 12 hours or more then stop shorting circuit. After 24 hours, check its voltage. Please repeat this process until the residual voltage becomes 0.3V or less.

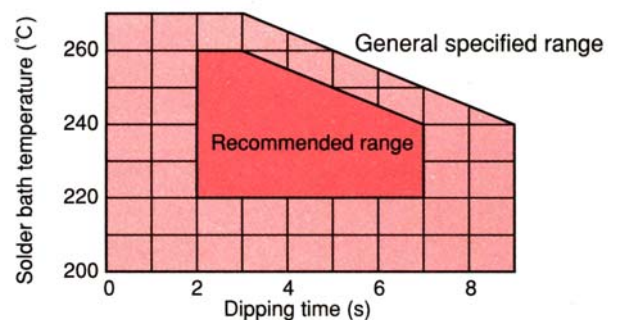
## (2) Manual soldering

Do not touch the capacitor body with a soldering iron. Solder the capacitor using a soldering tip temperature of 350°C or less for 4 seconds or less. Solder the capacitor three times or less at intervals of 15 seconds or more.

## (3) Flow soldering

- 1) Do not dip the body of the products into a soldering bath.
- 2) Use the general reference chart (Right chart) to set soldering temperature and time.
- 3) Do not flow solder the EN&EP series.
- 4) The terminals of the NF/F type are designed so the bottom of the product floats from the PCB. This is to protect against heat stress during soldering. Do not touch the bottom of the product directly to the PCB.

## Flow soldering



Pre-heating temperature : 110°C or under (on the surface of circuit board)  
 100°C or under (on the surface of capacitor)  
 Pre-heating time : 60 seconds or under  
 Board thickness : 0.8 mm or more

## (4) Other heat stress

- 1) Keep the product's surface temperature at or below 100°C for no more than 60 seconds (the peak 105°C) when applying heat to bake the PCB or fixing resin, etc.  
 The capacitor voltage must be 0.3V or less.

- 2) Do not use a product more than once after it has been mounted on the PCB. Excessive heat stress is applied when detaching it from the PCB. Please observe "(2) Manual soldering" when adjusting it.

3) Be sure that excessive heat stress is not applied to the Gold Capacitor when other parts in its surroundings are detached or adjusted.

(5) Others

1) The lead wires and terminals are plated for solderability. Rasping lead wires or terminals may damage the plating layer and degrade the solderability.

2) Do not apply a large mechanical force to the lead wires or terminals. Otherwise, they may break or come off or the capacitor characteristics may be damaged.

4-2-2.2 Circuit Design

Do not set wiring pattern directly to the mounted capacitor, and pass between terminals. If the electrolyte leaks, short circuit may occur and tracking or migrations are anticipated.

If a capacitor is directly touching a PCB, then the bottom of the capacitor and the circuit pattern may short-circuit. On PCBs, blowing flux or solder may cause the capacitor's external sleeve to break or shrink, potentially affecting the internal structure.

4-2-2.3 Residual voltage

Gold Capacitors can hold a large charge and could have residual voltage. Therefore, some electronic components with a low withstand voltage, such as semi-conductors, may be damaged.

Since Gold Capacitors can hold great charge, there may be residual electric charge that could damage other low-withstanding voltage parts such as semiconductors.

4-2-2.4 Circuit board cleaning

Apply the following conditions for flux cleaning after soldering. (Excepted for NF,F and RF series)

Temperature: 60°C or less

Duration: 5minutes or less

Rinse sufficiently and dry the boards.

[Recommended cleaning solvents include]

Pine Alpha ST-100s, Sunelec B-12, DK be-clear CW-5790, Aqua Cleaner 210SEP, Cold Cleaner P3-375, Cllear-th-ru 750H, Clean-thru 750L, Clean-thru 710M, Techno Cleaner219, Techno Care FRW-17, Techno Care FRW-1, Techno Care FRV1

◆Consult Panasonic if you are using a solvent other than any of those listed above.

◆The use of ozone depleting cleaning agents is not recommended in the interest of protecting the environment.

**4-2-3 Precautions for using equipment**

Avoid using mounting equipment in environments where:

(1) Capacitors are exposed to water, salt water or oil.

(2) Capacitors are exposed to direct sunlight.

(3) Capacitors are exposed to high temperature and humidity where water can condense on the capacitor surface.

(4) Capacitors are subject to various active gases.

(5) Capacitors are exposed to acidic or alkaline environments.

(6) Capacitors are subject to high-frequency induction.

(7) Capacitors are subject to excessive vibrations or mechanical impact.

A brown excretion might be caused around the sealing, depending on the conditions of use. This excretion is insulation and does not have influence on the electrical characteristics.

#### **4-2-4 Maintenance Precautions**

Periodically check capacitors used in industrial equipment. When checking and maintaining capacitors, turn off the equipment and discharge the capacitors beforehand. Do not apply stress to the capacitor lead terminals.

Periodically check the following items.

(1) Significant appearance abnormalities (deformation, electrolyte leakage, etc.)

(2) Electrical characteristics (described in the catalog or delivery specifications)

If any abnormalities are found, then replace the capacitors or take appropriate actions.

#### **4-2-5 Emergency procedures**

If the capacitors generate heat, then smoke may come out of the exterior resin. Under these conditions turn off the equipment immediately and stop using it.

Do not place your face or hands close to the capacitor, burns may be caused.

#### **4-2-6 Storage**

Do not store capacitors in a high-temperature or high-humidity environment. Store capacitors at a room temperature of 5°C to 35°C and a relative humidity of 85% or less.

Store capacitors in their packaging as long as possible.

Avoid storing capacitors under the following conditions.

(1) Exposed to water, high temperatures or humidity, or when condensation can occur.

(2) Exposed to oil or in environments filled with gaseous oil contents.

(3) Exposed to salt water or environments filled with saline substances.

(4) In environments filled with harmful gases (hydrogen disulfide, sulfurous acid, nitrous acid, chlorine, bromine, bromomethane, etc.)

(5) In environments filled with harmful alkaline gases such as ammonia.

(6) Exposed to acid or alkaline solvents.

(7) Exposed to direct sunlight, ozone, ultraviolet or radial rays.

(8) Exposed to vibrations or mechanical impact.

#### **4-2-7 Discarding**

Dispose of capacitors as industrial waste. They are comprised of various metals and resin.

#### **4-2-8 Others**

4-2-8.1 The purpose of these specifications is to ensure the quality of components as individual

components. Before use, check and evaluate their operation when mounted on your products.

4-2-8.2 Do not use our components outside of the corresponding specifications.

4-2-8.3 When using this capacitor in a product where safety is critical

We take great care in the quality of this product. However, performance may deteriorate and short-circuiting or open-circuiting may occur. If it will be used in transportation equipment (e.g. trains, cars, traffic lights), airborne equipment, aerospace equipment, electric heating appliances, combustion/gas equipment, rotating equipment, disaster/crime prevention equipment, or other equipment where a defect in this component may cause the loss of human life or other significant damage. Ensure that the target equipment has a failsafe design and is provided with the following systems to guarantee adequate safety.

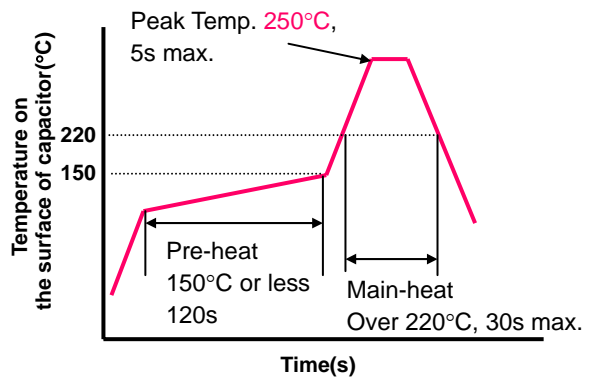
- (1) Ensure the safety of the whole system by installing a protection circuit and a protection device.
- (2) Redundant circuits, etc. to maintain the safety of the entire system so that a single independent failure will not lead to unsafe conditions.

4-2-8.4 Conditions of use

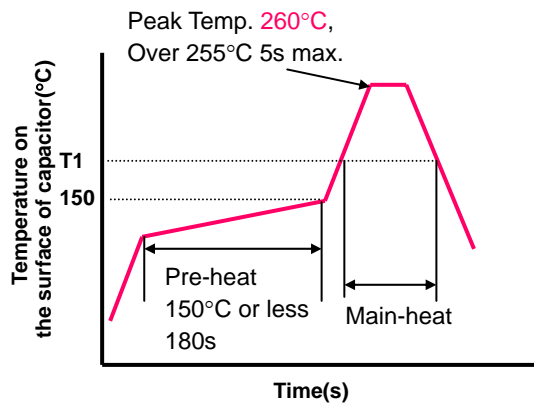
This products is intended to be use in electronic equipment for general-purpose standard applications and is not designed for use in any special environments. When this capacitor is used in a special environment or under special conditions, its performance may be affected. Before use, verify the performance and reliability of the capacitor.

### Mounting specifications

EN-series
P/N
EECEN0F204RK
EECEN0F204AK
EECEN0F204J2



EP-series
P/B
EECEP0F333A
EECEP0E333A



Main heat T1[°C]	Soak time t[s]
230	50
217	60

Please contact us about other part number products.

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The precautions for the use of Electric Double Layer Capacitors (Gold Capacitor ) follow the “Precautionary guidelines for the use of fixed Electric Double Layer Capacitors for electronic equipment”, RCR-2380A issued From EIAJ in March, 2002.

### 4-3 When making an order

When ordering Gold Capacitors, please provide information on the items below,  
Inquiry check list

<b>Gold Capacitor / Check sheet</b>	
Application	
Condition of Charging	
Charging Voltage	
Charging Time (Max.Min.)	
Charging Current (Balanced Resister, If any)	
Condition of Discharging	
Back Up Current (Max. Min. Typical.)	
Minimum Holding Voltage	
Required Back Up Time	
Back up for xxx (RTC, SRAM Etc.)	
Operating Condition	
Expected Life	
Ambient Temperature	