San Ace

SANYO DENKI Cooling Fans

Understanding Fan Life

Cooling Systems Division

Sanyo Denki America, Inc.

How To Define The Life Of A Fan

- One of the most common questions we get on fans is “how long will your fan operate?” or “what is the fan life?”
- There are multiple ways to define this value in electronic and mechanical components. So which one is best?

Mean Time Between Failure (MTBF):

- Primarily used for electronics
- Predicts life for large volume not individual part
- Based on the average life of electronics
- Not very accurate for fans

Weibull Curves:

- Quantifies failure rate throughout it’s life cycle
- Can be estimated but isn’t accurate for new products.
- Best when generated from return and RMA data
- Accurate when in the market for an extended time

L10 Life:

- Based on the bearing grease life within the fan
- The number of hours that 90% of a group of fans will complete or exceed.
- Usually the most accurate measurement for fans

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MTBF and Weibull

MTBF:

Defined as: $\frac{\text{total operating time}}{\text{total number of failures}}$

Primarily used as a statistical model for average life of any product. The down side is that it requires accurate data of total operating time and reporting from customers. Since this is difficult to enforce, MTBF should only be used as a reference.

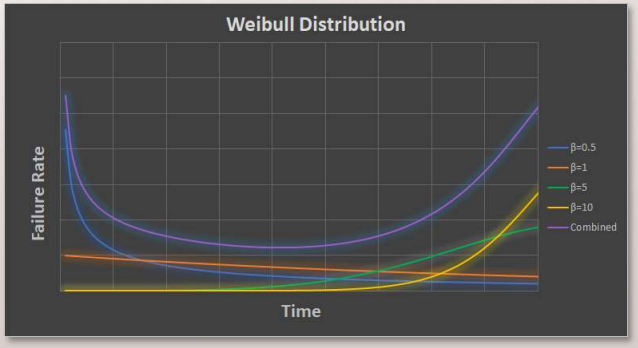
Sanyo Denki estimates our product MTBF rage anywhere from 1 million to 3 million hours depending on the model.

Weibull:

Usually defined as a “bath curve” as shown below. Commonly you can see three different sections of the curve: Infant mortality, Normal life, and End of life

In the below diagram you can see the 3 different failure curves combined to produce a combined failure curve

As you can see, this requires a lot of long term data to produce so it is difficult to use as a metric



L10 Life

Focuses on the life of the bearing to give an accurate estimate for a small group of products.

Why do we focus on the bearing?

The most common failure mode of a fan will be the bearing since this is the only moving component within the assembly.

Is L10 only based on bearing life?

On a pure definition yes, but Sanyo Denki uses our experience to more accurately model an L10 life.

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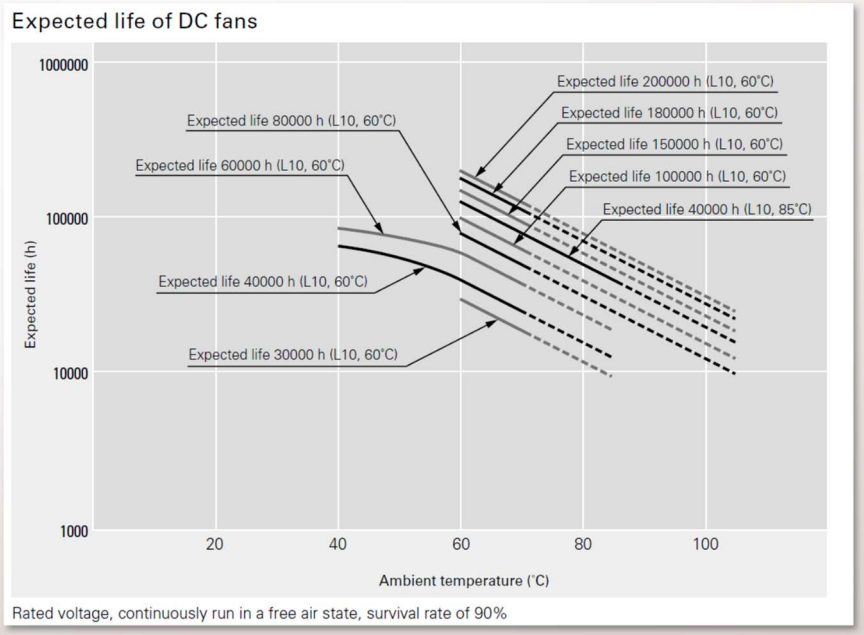
How to measure L10 Life

- Measuring L10 life is done with lab testing.
  - 10 samples of a fan are placed in a standard operating environment and run for an extended period of time.
  - Samples are run continuously at 100% PWM input duty cycle.
  - Our standard L10 life is 40,000hrs @ 60°C (4.5 years) but some go up to 200,000hrs @ 60°C (22.8 years).
  - We utilize an accelerated test method using higher temperature. For standard fans we test up to 85°
  - All fans must meet minimum test hours criteria without failing.
- Temperature is the primary limiting factor for bearing life.



Rule of Thumb: every 15°C increase reduces life by half

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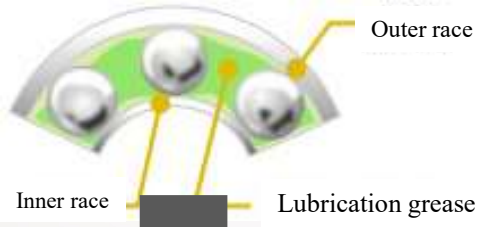
Service Life of Cooling Fans

The service life of the cooling fan is determined by the bearing.



Degradation of the lubrication grease in the bearing slows down rotation.

Decreased cooling fan speed

A drop to 70% or less of the rated speed

End of the cooling fan's service life

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Ball vs. Sleeve Bearings

When choosing a fan, it can be important to understand the pros and cons of different bearing options. This is particularly evident when reviewing the impact on product life.

Ball Bearings:

- Longer Life
- Higher temperature range
- Lower noise at later stages of life
- Higher Reliability
- More Costly

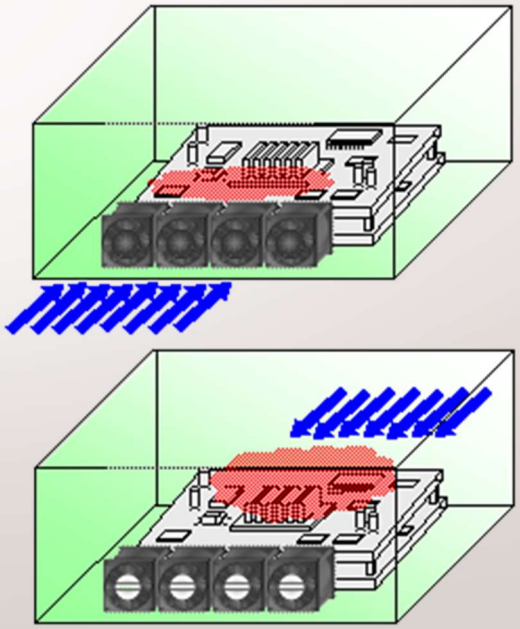
Sleeve Bearings:

- Shorter life
- Lower noise at beginning of product life but noisier as product ages
- Lower cost
- Restricted to mounting fan in vertical orientation

How to Increase life

In order to increase the product life, there are a couple options:

1. Decrease the temperature on the fan
   - Relocate fans to setup fans as intake air instead of ventilation
   - Reduce ambient air temperature
   - Reduce temperature rise of system
2. Use a long life fan alternative
   - Sanyo Denki offers multiple sizes of long life fan alternatives that are designed for 100khrs+
   - These fans are designed with an aluminum frame and special bearing housing to dissipate heat from the bearing
3. Reduce operating time or speed of the fan
   - When the fan is not needed, use PWM control to reduce the speed or entirely turn off the fan



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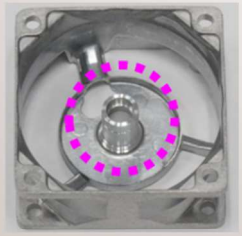
Long Life Fans

Aluminum frame

- Long life fans make use of an aluminum frame instead of a standard plastic frame.
- The aluminum frame allows heat dissipation directly from the bearings by turning the fan frame into a large heat sink.

Long Life Fan



- Aluminum frame
- Aluminum bearing house

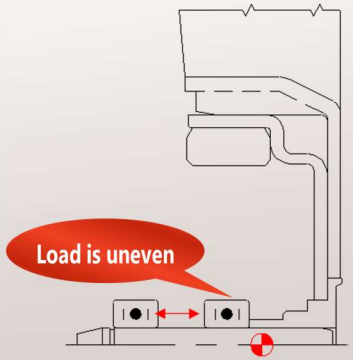
Standard fan

- Plastic frame
- Brass bearing house

Reduced bearing load

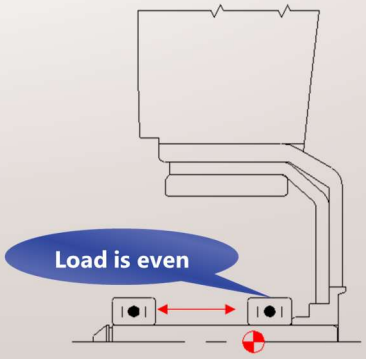
- By optimizing rotor's centroid position over bearings, the accuracy of balance is improved, so the load that is unevenly applied to one of the two bearings will be even.

Standard fan



Interval between the two bearings is narrow.

Long Life Fan



Interval between the two bearings is wide.

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Environmental Impact on Fan Life

When choosing a fan, it's important to factor in the location where a fan will be used.

Will the fan be exposed to:

- Humid or Wet Environment
- Dust
- Vibration
- High or Low Temperature
- Electromagnetic Interference (EMI)
- Oil Rich Environment
- Accessible by Tools or Fingers

Ingress Protection

Temperature Rating

Human Error

Vibration

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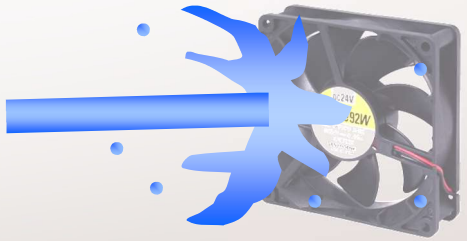
How to Protect From Moisture or Dust

Devices operate in very **humid environment** or may be in contact with minor water splashing.

Conformal Coating on PCB

Devices operate in environments where **some direct water spray** may occur. Alternatively **heavy dust** environment



IP55

Devices operate in harsh environment where potential **submersion** or **frequent direct water exposure** occurs

IP68

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Splash-Proof Fans

- The splash-proof fan is a type of cooling fan that provides protection against water.

1. SANYO DENKI splash-proof fans are rated up to IP68.
2. The live electrical parts (the coil and base) are protected with a resin having superior waterproofing properties.
3. A magnetic material with superior waterproofing is also used.

- Ideal for cooling devices installed outdoors and in environments with water

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High or Low Temperature Environments

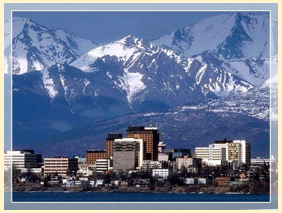
- Why do we need wide temperature?
  - Often times equipment is required to operate in non-climate controlled applications which could be mounted anywhere in the world. This means that equipment will need to be designed for operation no matter what climate.

City: Phoenix, AZ

Yearly High Temperature Avg: 47°C

Equipment operating with 30°C temp rise will be at 77 °C!

City: Anchorage, AK



Yearly Low Temperature Avg: -22°C

Most standard fans will only be rated down to -10°C or -20 °C

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Wide Temperature Fans

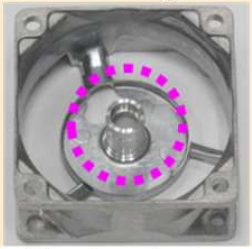
- Wide temp fans use specialty Ceramic bearings which are meant to operate over the wide temperature range

Aluminum frame

With an aluminum frame, the rise of bearings' surrounding temperature can be reduced, so the fan can have a longer life.

For the prevention of rust, Splash Proof Long Life Fans have cation electrodeposition coating.

Wide Temp Fan



- Aluminum frame
- Aluminum bearing house

Conventional standard fan

- Plastic frame
- Brass bearing house

Wide temp fans are all rated to -40°C to +85°C

Wide temp fans have a life from 40,000hrs @ 85°C

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How to Protect From Oil

Plastic coating

Fully protect electrically active parts with plastic coating.

Oil resistant material is used

Plastic material used for impeller and fan frame is oil resistant and has less chemical reactions.

Prevent fan locking

By widening the gap between impeller and fan frame, fan locking due to stuck-on oil can be prevented.

Standard fan

No protection

Oil proof fan

Plastic coating

Gap is narrow

Gap is wide

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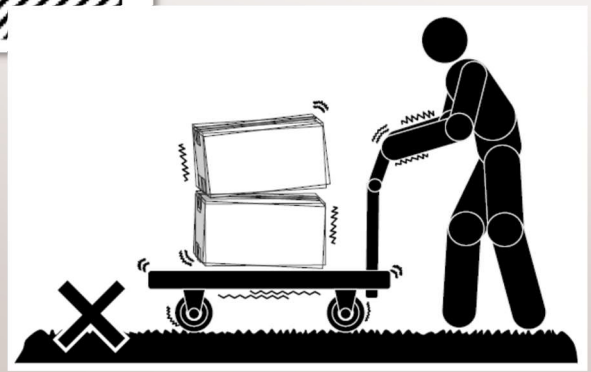
Proper Handling



- When handling a box of fans, be careful not to drop or jostle the fans.
- Dropping box from a height of 30cm or higher may cause permanent damage to the fans inside
- When transporting fans, make sure to prevent excessive vibration

- Dropping or excessive vibration may cause reduced life or increased noise due to bearing damage

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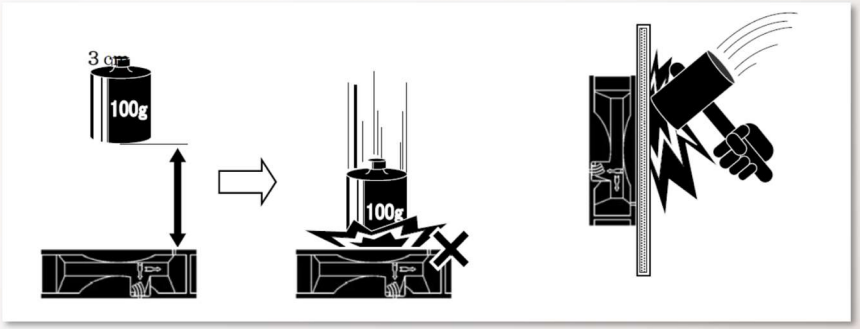
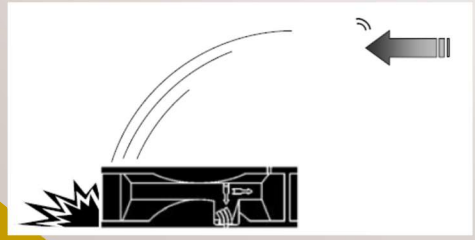
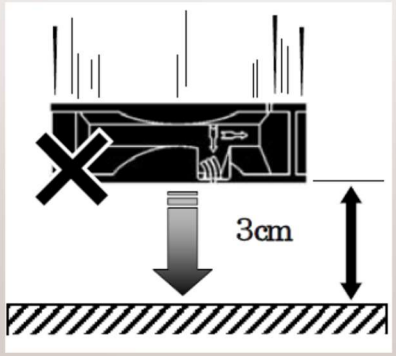
Proper Handling

- Proper handling of the fans is crucial to guarantee their peak operating
- Some examples of improper handling are as follows:
  - Dropping or knocking over a fan onto a hard surface
  - Applying excessive force to the external frame of a fan.
  - Handling the impeller of a fan







Summary

- L10 Life:
  - The primary method for defining product life of fans
  - Based on the bearing life.
  - Defined the number of hours that 90% of a group of fans will complete or exceed without failure.
- How to increase life:
  - Decrease the temperature on the fan
  - Use a long life fan alternative
  - Reduce operating time or speed of the fan
- Make sure your fan choice is appropriate for the environmental impacts
  - In dust or water environments → Use an IP68 rated splash proof fan
  - In high or low temperature environments → Use a wide temperature rated fan
  - In oil rich environments → Use oil proof fans
- Make sure to properly handle a fan during shipping, installation, and operation