References for Application of MF-Series iButtons

Regarding the protection class, MF-series iButtons are an improved version of the iButton Temperature Loggers. They provide effective protection against surface moisture, various chemicals and are suited for continuous immersion. MF-series iButtons are covered by a rugged and permanent resin coating. Top and bottom provide a notch to enable electrical contact to the iButton.

The protection class was determined within a self-certifcation to IPX8 according to DIN EN 60529. As per definition, water shall not penetrate if the enclosure is continuously immersed in water. The test conditions are subject to agreement between the manufacturer and user but they all shall be more severe than those prescribed in the second characteristic numeral 7 of the IP–standard (IPX7).

Short Explanation: Protection Class according to IPX7

For a class IPX7 protection no water shall penetrate the enclosure to a harmful amount if the enclosure or equipment is located 1,000 mm below the surface of water. The duration of the test is 30 min. Data and details about the test conditions can be found in Standard DIN EN 60529.

Short Explanation: Protection Class according to IPX8

The second characteristic numeral 8 of the IP standard requires the suitability of continuous immersion of the product enclosure. Under which conditions (temperature, pressure) this has to be achieved, is not defined by the standard as well as the definition of "permanent". Thus the manufacturer has to assume the responsibility to stipulate the test parameters for the product.

In our opinion, the test conditions should be selected in such a way as to conform to the product's possible conditions of application. Regarding the MF-series iButton an effective protection from water and surface moisture has to be ensured if the equipment is regularly exposed to extreme temperature changes. The life span of the battery determines the time frame for how long the protection class has to be met.

Requirements to the Protection Class

The temperature range is fixed by the measuring range of the iButton. With the popular types this range is from -40°C to +85°C. The manufacturer of iButtons however advises against a permanent use near the limits of the measuring range.

The iButton's battery life span determines the time frame over which the protection class has to be ensured. Depending on the external conditions, the expected life span can be more than 10 years but also considerably less. For example, temperatures beyond 50°C will significantly shorten the life span of the battery.

The iButton has no given water pressure limit to which a protected iButton should resist. Here we fixed the maximum water pressure to 3 bar which is equivalent to (about) 30 m of water column.

How is the Test Performed?

To simulate the requirements, as a first step the test pieces are aged artificially. That is achieved by a temperature cycle study. Subsequent to the temperature cycle study the test pieces are placed into a pressure vessel. With a final examination it will be determined if the protection class of the test pieces has degraded.

Short Explanation: Temperature Cycle Study

In a temperature cycle study, the test pieces are exposed to periodic temperature changes. For example: The test pieces are heated up to +80°C within 20 minutes, after a hold period of some minutes, the test pieces are cooled down to -35°C within 40 minutes. After a short hold time, the cycle starts anew. After going through a defined amount of cycles the temperature cycle study is completed. If the time spans for heating up and cooling down are shortened to only a few minutes, then it is considered to be a temperature shock study.

Selection of Tests

The influence on the material, thus on the protection class, strongly depends on how often and in which time span the temperature change happens. During more than 10 years of countless counseling interviews we have gained very interesting insights into the various scopes of application of iButtons.
Whereas iButtons in applications outdoors or for monitoring the soil temperature are subjected to slow temperature changes, for monitoring and optimizing of industrial processes, there can arise, numerous and fast (shock) temperature changes.

To realistically cater for different scopes of application in the tests, varied temperature cycle and temperature shock studies were carried out. The target of all these tests is not only to gain an idea of the possible scopes of application, but also to identify the material's limits.

Please use the results of this study to ponder the suitability of iButtons of the MF-series for your application. If in doubt, we will gladly help you with our advice.

Test 1: Temperature Cycle Study with Subsequent Pressure Test

For the temperature cycle study, 12 new iButtons of the MF-Series from different batches were tested. The test pieces were cooled down to -35°C with subsequent heating up to +80°C for 1,000 times. The test cycles were conducted continuously. The time period for heating up was 20 minutes and for cooling down 40 minutes. After 100, 250 and 500 cycles the test pieces were examined for external deficiencies.

Subsequent to the temperature cycle study (1,000 cycles) the test pieces were exposed to water pressure of 3 bar for 24 hours. To check the impact of various chemicals on the protection class, the test pieces were exposed for 24 hours and 3 bar pressure to cola, wine and sea water respectively. The environmental temperature on all pressure tests was 23°C.

Result

All test pieces were free of external deficiencies. There were no traces of water or moisture found inside the iButton. It can be assumed, that within the test conditions an effective and lasting protection can be guaranteed.

Test 2: Temperature Shock Study with Subsequent Pressure Test

For the temperature shock study, 12 new iButtons of the MF-Series from different batches were tested. The test pieces were cooled down to -35°C with subsequent heating up to +80°C for 100 times. The test cycles were conducted continuously. The time period for heating up was three minutes, for cooling down six minutes. The fast temperature change was made possible by a two container system with cold and hot liquids. A transport system is transferring the test pieces between the two containers within 20 seconds.

Subsequent to the temperature shock study (100 cycles) the test pieces were exposed to water pressure of 3 bar for 24 hours. To check the impact of various chemicals on the protection class, the test pieces were exposed for 24 hours and 3 bar pressure to cola, wine and sea water respectively. The environmental temperature on all pressure tests was 23°C.

Result

All test pieces showed external defects. However, inside the iButton there were no traces of water or moisture found. Due to the materials differing expansion coefficients and the extremely fast temperature changes, the bond between the resin and the stainless steel enclosure of the iButton already detached during the temperature shock study. The bond detaches, starting at the notch on top and bottom. During the subsequent pressure tests, the detaching process developed even further with some of the test pieces.

The protection class however is not effected by these defects due to the tests. Nevertheless, it has to be assumed, that continuous application under such conditions will have an adverse effect to the protection class.

Summary

The studies prove, the protection class for MF-series iButtons cannot be guaranteed for all theoretically possible fields of application. That, however, is also true for other such products on the market which promise an effective protection against water and moisture.

The MF-Series iButtons can be employed without hesitation in all applications without fast temperature changes. Usage fields are, for example, temperature monitoring in surface water or running water, monitoring of soil temperature, all outdoor applications or in high humidity environments.

Applications with very high and fast temperature changes lead to a deterioration of the protection class. The specification therefore stipulates a maximum change in temperature of 4°C per minute.