Keywords: DS1922L, DS1922T, DS1921G, DS1923, DS9107, DS1921H, DS1921Z, IP, ingress protection, IP56, IP68, iButton, capsule, waterproof, immersion, water resistant, submerge, water, steam, liquid, dust, IEC 60529

APPLICATION NOTE 4126

Understanding the IP (Ingress Protection) Ratings of iButton Data Loggers and Capsule

Oct 31, 2007

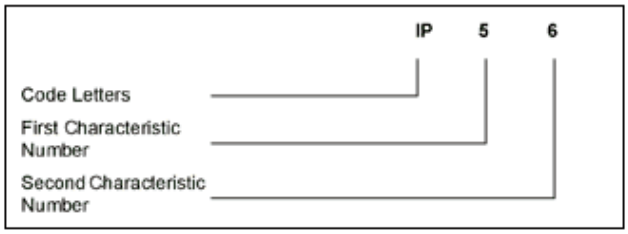
Abstract: The Thermochron® (DS1922L, DS1922T, DS1921G) and Hygrochron™ (DS1923) iButton® data loggers are ideal for a diverse range of applications. Because of their stainless steel casing, these devices are especially useful in harsh environments. Care must be taken, however, not to subject the units to environmental forces that exceed their specified level of protection. This application note defines and discusses the IP (Ingress Protection) ratings. It also explains that Thermochron and Hygrochron iButtons are certified to IP56 (dust and strong water jets), but should not be submerged. For a submerged application a waterproof enclosure such as the DS9107 iButton Capsule must be used.

What Are IP Ratings?

IP is an acronym for "Ingress Protection" against objects that intrude into the enclosure of any type of equipment. The IP ratings are defined in the IEC standard 60529, which was developed by the International Electrotechnical Commission. Specifically, IEC 60529 defines an enclosure as, "a part providing protection of equipment against certain external influences and in any direction protection against direct contact."[1]

The scope of IEC 60529 does not include corrosion resistance, construction requirements, and the effects of icing and coolants. These and additional aspects are addressed in the NEMA 250 product standard, developed by the National Electrical Manufacturers Association. With its more limited scope, an IP rating can be regarded as a supplement to a NEMA rating, but not as its equivalent. Consequently, caution is advised when using any IP/NEMA rating cross-reference tables published on the Internet. For more details refer to the NEMA publication, *A Brief Comparison of NEMA 250—Enclosures for Electrical Equipment (1000 Volts Maximum) and IEC 60529—Degrees of Protection Provided by Enclosures (IP Code)*.[2]

The IP rating is formatted as "IP" followed by two digits. The first digit indicates a protection level against solids such as dust, and the second digit indicates a protection level against liquids. **Figure 1** illustrates the IP formats and uses IP56 as an example.



First Characteristic Number			Second Characteristic Number	
	Protection of Person	Protection of Equipment		Protection of Equipment
0	No protection	No protection (sometimes X)	0	No protection (sometimes X)
1	Protected against contact with large areas of the body (e.g., back of hand)	Protected against solid objects up to 50mm³	1	Protection against vertically falling drops of water (e.g., condensation)
2	Protected against contact with fingers	Protected against solid objects up to 12mm in diameter	2	Protection against direct sprays of water up to 15 degrees from vertical
3	Protected against tools and wires over 2.5mm in diameter	Protected against solid objects up to 2.5mm in diameter	3	Protection against direct sprays of water up to 60 degrees from vertical
4	Protected against tools and wires over 1mm in diameter	Protected against solid objects up to 1mm in diameter	4	Protection against water sprayed from all directions, limited ingress permitted
5	Protected against tools and wires over 1mm in diameter	Protected against dust: limited ingress (i.e., no harmful deposit)	5	Protected against low-pressure jets of water from all directions, limited ingress permitted
6	Protected against tools and wires over 1mm in diameter	Totally protected against dust	6	Protected against strong jets of water from all directions, limited ingress permitted (e.g., a ship's deck)
			7	Protected against the effect of "temporary" immersion between 15cm and 1m
			8	Protected against long periods of immersion under pressure
			9	Protected against high pressure, high-temperature jets of water from multiple directions*

*IP69K is defined in DIN 40050-9

Figure 1. IP rating format.

iButton Data Logger Enclosure

The iButton data loggers, which include the Thermochron temperature loggers and the Hygrochron temperature and relative humidity loggers, represent a significant advancement in miniaturization and reliability. The single-contact 1-Wire® communication protocol that each data logger employs is robust and simple. The iButton stainless-steel package is durable and resistant to intrusions from both solids and liquids. For the iButton to function reliably in an application, however, it is important that the limitations of this enclosure be understood.

DS1921G, DS1922L, DS1922T, DS1923 Are Certified IP56

For a general introduction to iButton data loggers, their features, and how they are used see application note 3892, "Overview of iButton® Sensors and Temperature/Humidity Dataloggers." While iButton data loggers are water-resistant, they are not waterproof. An independent testing lab³ has certified several data loggers to be IP56 compliant: DS1921G (2kB memory, ±1°C accuracy, -40°C to 85°C); DS1922L (8kB memory, ±0.5°C accuracy, -40°C to 85°C); DS1922T (8kB memory, ±0.5°C accuracy, 0°C to 125°C); and the DS1923 (8kB memory, ±0.5°C/5%RH accuracy, -20°C to 85°C).

The initial sealing level of the DS1921G, DS1922L, and DS1922T Thermochrons at time of manufacture achieves IP56. From Figure 1 above, IP56 translates to "Protection against dust" and "Protection against strong jets of water." Aging and use conditions can, however, degrade the integrity of the seal over time.

Therefore, for applications with significant exposure to liquids, sprays, or similar environments, it is recommended that the Thermochron devices be placed in the DS9107 iButton capsule.

The DS1923 Hygrochron logs humidity, so it should not be placed inside a waterproof container that will prevent it from functioning as intended. Therefore, consider mounting the Hygrochron where it is exposed to the air, but not to direct water. A shield housing is recommended.

While the DS1921H and DS1921Z did not formally go through the IP56 testing, they are constructed identical to the DS1921G and should perform similarly.

The DS9107 Is Self-Certified to IP68

It is important to note that the data loggers are not recommended for any type of fluid immersion. If the application requires submersion in a liquid, then the device should first be placed in a waterproof container. An example of a suitable waterproof container is the DS9107 (iButton Capsule) (**Figure 2**) that is certified to IP68. IP68 indicates an extended immersion under pressure. The DS9107's IP68 rating has been defined as 100ft (30.5m) equivalent pressure for 24 hours (**Table 1**).

Figure 2. DS9107 iButton Capsule.

IP68 classifies any enclosure that can withstand liquid under pressure for "long periods." Additional specific parameters are then defined by, and for the device's individual enclosure characteristics. Maxim has performed a self-certification of IP68 for the DS9107, defined with the following specifics:

1. Simulated 100ft. (30.5m) of water by using a pressure vessel for 24 hours with no leakage noted
2. Simulated 100ft. (30.5m) of cola, wine, and ocean water for 24 hours with no leakage or corrosion noted
3. Temperature cycle study was at -40°C to 85°C for 1000 cycles followed by 100ft. (30.5m) of water simulation for one hour with no leakage noted

Maxim confirms leakage protection on each DS9107 with an air-leak test when each capsule is received from the supplier.

Table 1. DS9107 IP68 Self-Certification Results

Temperature Cycle					
Description	**Date Code**	**Condition (°C)**	**Readpoint**	**Qty**	**Fails**
Temp Cycle	0618	-40 to 85	1000 cys	77	0
		-40 to 85	1000 cys	77	0
		-40 to 85	1000 cys	77	0
			Total:		**0**
Unbiased Moisture Resistance					
Description	**Date Code**	**Condition**	**Readpoint**	**Qty**	**Fails**
Moisture Cycling	0618	+121°C, 2atm[4] steam, unbiased	100 cys	80	0
		+121°C, 2atm steam, unbiased	100 cys	80	0
		+121°C, 2atm steam, unbiased	100 cys	80	0
Liquid Submersion—Water	0618	100ft (30.5m) pressure, +25°C	24 hrs	77	0
		100ft. (30.5m) pressure, +25°C	24 hrs	77	0

		100ft. (30.5m) pressure, +25°C	24 hrs	77	0
Liquid Submersion—Wine	0618	100ft. (30.5m) pressure, +25°C	24 hrs	22	0
		100ft. (30.5m) pressure, +25°C	24 hrs	22	0
		100ft. (30.5m) pressure, +25°C	24 hrs	22	0
Liquid Submersion—Cola	0618	100ft. (30.5m) pressure, +25°C	24 hrs	22	0
		100ft. (30.5m) pressure, +25°C	24 hrs	22	0
		100ft. (30.5m) pressure, +25°C	24 hrs	22	0
Liquid Submersion—Salt Water	0618	100ft. (30.5m) pressure, +25°C	24 hrs	22	0
		100ft. (30.5m) pressure, +25°C	24 hrs	22	0
		100ft. (30.5m) pressure, +25°C	24 hrs	22	0
			Total:		**0**

References:

[1] IEC 60529 standard quoted in, *A Brief Comparison of NEMA 250—Enclosures for Electrical Equipment (1000 Volts Maximum) and IEC 60529—Degrees of Protection Provided by Enclosures (IP Code)*, published by NEMA in 2002. To download this document, see note 2. The IEC60529 standard is available for sale at: www.techstreet.com/cgi-bin/detail?product_id=861222.

[2] This comparison of NEMA 250 and IEC 60529 can be found at: https://www.nema.org/Standards/Pages/A-Brief-Comparison-of-NEMA-250-and-IEC-60529.aspx

[3] IP56 certification for iButton data loggers can be found at: www.maximintegrated.com/products/ibutton/images/ip56_loggers_cert.pdf

All iButton and iButton accessories' certifications can be found here.

[4] For more information on pressure measurements, measurement units, and the phase diagram of water, see Stephen R. Turns, *Thermal-Fluid Sciences, An Integrated Approach*, Chapter 2, "Thermodynamic Properties, Property Relationships, and Processes." Go to: www.cambridge.org/us/engineering/turns/assets/0521850436c02_p046-171.pdf

Related Parts	
DS1921G	Thermochron iButton
DS1921H	High Resolution Thermochron iButton Range H: +15°C to +46°C; Z: -5°C to +26°C
DS1921Z	High Resolution Thermochron iButton Range H: +15°C to +46°C; Z: -5°C to +26°C
DS1922L	Temperature Logger iButton with 8KB Datalog Memory
DS1922T	Temperature Logger iButton with 8KB Datalog Memory

DS1923	Hygrochron Temperature/Humidity Logger iButton with 8KB Data-Log Memory
DS9107	iButton Capsule

More Information
For Technical Support: http://www.maximintegrated.com/support
For Samples: http://www.maximintegrated.com/samples
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Application Note 4126: http://www.maximintegrated.com/an4126
APPLICATION NOTE 4126, AN4126, AN 4126, APP4126, Appnote4126, Appnote 4126