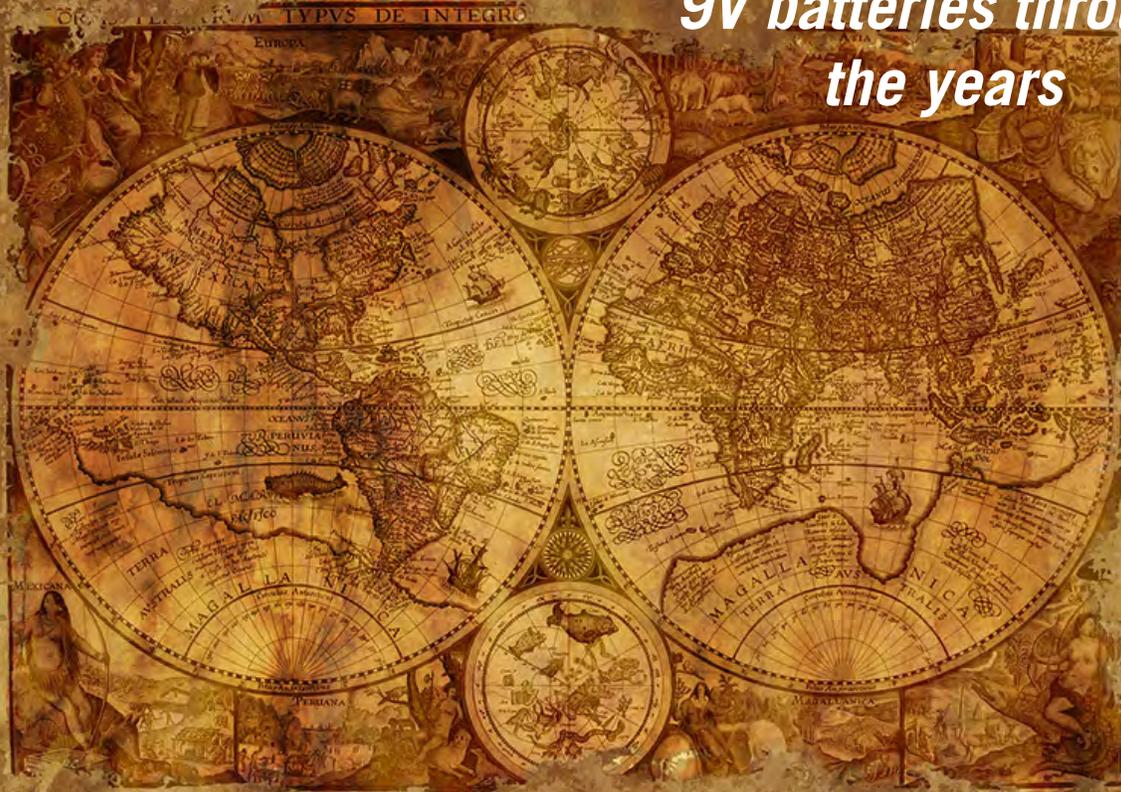




Alkaline 9V or ULTRALiFE[®] Lithium 9V

The chemistry conundrum

9V batteries through the years



50s

In 1956, the introduction of alloy transistors meant radios that had previously been powered by 22.5V were able to operate from lower voltages. Although originally marketed for vacuum tube hearing aids, the 9V battery found its first home.

dioxide chemistry to provide high energy density and voltage that remains very stable throughout discharge.

Proving an instant success, during this fiscal year alone, Ultralife manufactured between 100 to 400K every month.

The combination of low weight and high energy resulted in the highest energy density among all brand name 9V batteries.

Since the initial launch, there have been over 100 million units sold worldwide.

90s

Fast forward to the 90s and our story with the 9V begins; as Ultralife Batteries Inc was formed from the Ultra Technologies Battery Division of Kodak. Extensive tests on Kodak's 9-volt battery indicated the need for design improvements, which resulted in the first Ultralife 9-volt.

The world's longest lasting lithium 9V battery, it utilized lithium manganese

Production continued until 2012 when the design came under scrutiny from Ultralife's engineers who realized that using cylindrical cells in a square formation wasted vital space. As a result, they developed the thin cell battery as a pouch with square cells.

This innovative design gave the Ultralife Lithium 9V the highest energy available from leading brand names - 1200mAh. It also weighed 12% lighter than its predecessor (37 grams), making it ideal for incorporation into next-gen devices.

00s

THE FUTURE

Ultralife has been producing lithium 9V batteries for critical and hard to service applications for over 20 years - and this looks set to continue.

Looking to the future, the 9V looks set to power even more applications, with OEMs finding this voltage well-suited for the latest wearable and IoT devices, remote monitoring systems, security sensors and more.

ALKALINE 9V

Alkaline batteries were invented in 1949 and quickly came to replace early zinc-carbon batteries, offering double the energy density with capacity ranging from 500mAh to 800mAh.

Mass production of alkaline batteries is often inexpensive, which resulted in common household usage and wide retail store availability.

However, with the emergence of lithium battery technology, alkaline has acquired a rival that has a lower service life and does not need replacing as frequently.

Alkaline is also less suited than lithium to modern applications that require small and light batteries with excellent energy density; or those that are used in extreme environments subject to high and low temperatures.

ULTRALIFE® LITHIUM 9V

The requirement for batteries with a longer service life led to the development of the ULTRALIFE® 9V battery.

Achieving a 10-year service/shelf life, Ultralife's product proved well-suited for use in smoke alarms, medical instruments and security devices.

15 years ago, the next-gen of the Ultralife 9V was developed, using thin cell technology. When used together, the three, individual thin foil-cased cells achieve a capacity of 1200mAh; roughly 50% more than leading brand-named lithium competitors.

Lithium 9V also offers superior performance to alkaline 9V, providing 50% more energy.

THE WORLD'S LONGEST LASTING

Long Storage Life

The lithium technology used in the Ultralife Lithium 9V has been shown to offer a shelf life greater than 10 years with little loss of performance. The new lithium 9V has improved construction

and technology that assures the battery survives even the harshest of environments. Actual 5-year shelf life data at various capacities and rates is given in figure 1a.

A comparison between fresh and 5-year aged Ultralife Lithium 9V batteries impedance and closed-circuit voltage is contained in figure 1b (40 samples).

DISCHARGE TEMP	DISCHARGE RATE	TEMP/LOAD	DATA TO 5.4V CUTOFF			
			DO (Ahrs)		DWO (Whrs)	LOAD TIME (hours)
			AVG	% RATED	AVG	AVG
(-20C)	900Ω	(-20C) / 900Ω	0.8	70%	5.7	110.3
	300Ω	(-20C) / 300Ω	0.6	47%	3.6	26.5
23C	900Ω	23C / 900Ω	1.2	98%	9.8	128.3
	300Ω	23C / 300Ω	1.1	94%	9.2	42.2
	60Ω	23C / 60Ω	1.0	85%	7.7	8.2
60C	900Ω	60C / 900Ω	1.2	101%	10.5	126.7
	300Ω	60C / 300Ω	1.2	98%	10.2	42.1
	60Ω	60C / 60Ω	1.1	94%	9.3	8.4

Figure 1a: Actual 5 Year Storage Capacity Retention

	OCV	CCV 5.1Ω / 3Sec	1kHz IMPEDANCE
FRESH BATTERIES SUMMARY FROM QTR-E3668			
MIN	9.335	5.714	1.615
MAX	9.424	6.606	2.132
AVERAGE	9.36866	6.34318	1.89049
StDEV	0.022214	0.111529	0.0998112
AGED BATTERIES SUMMARY			
MIN	9.418	6.032	2.049
MAX	9.562	6.389	2.583
AVERAGE	9.5503	6.2118	2.312675
StDEV	0.0217	0.0894	0.1239016

Figure 1b: Fresh and 5 Year OCV, CCV, Impedance

Long Service Life

The Ultralife Lithium 9V easily outlasts the world's most advanced alkaline batteries. Depending on use and device cut-off voltage, the Ultralife Lithium 9V

battery can offer up to five times the capacity of a leading alkaline 9V. A test was conducted to show the service life of Ultralife's 9V in alarm simulation

when compared to alkaline competitors (results shown in figure 2). The test uses continuous discharge of 1200 ohms at 23°C with regular 20mA pulses.

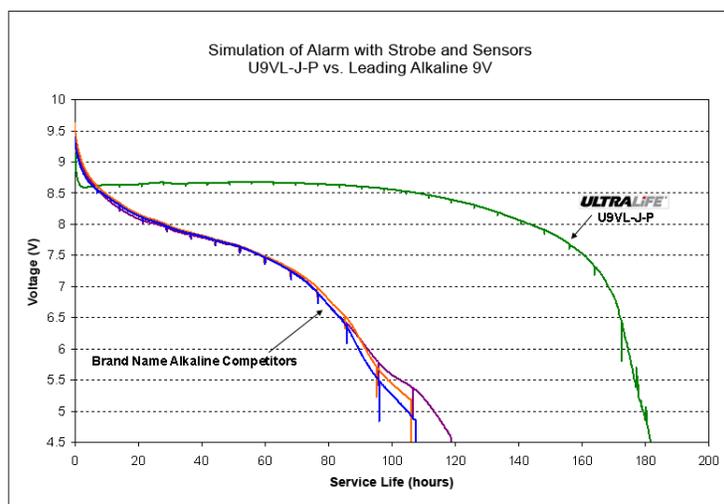


Figure 2

50% MORE ENERGY

High Performance

In addition to outperforming alkaline 9V batteries, the Ultralife Lithium 9V is also superior to other lithium competitors. Where the competition offers lithium 9V

products that boast 800mAh of capacity, the Ultralife Lithium 9V battery offers 1200mAh or 50% more energy. A test compared Ultralife 9V to other lithium

9V performances (figure 3), using continuous discharge of 1200 ohms at 23°C with regular 20mA pulses.

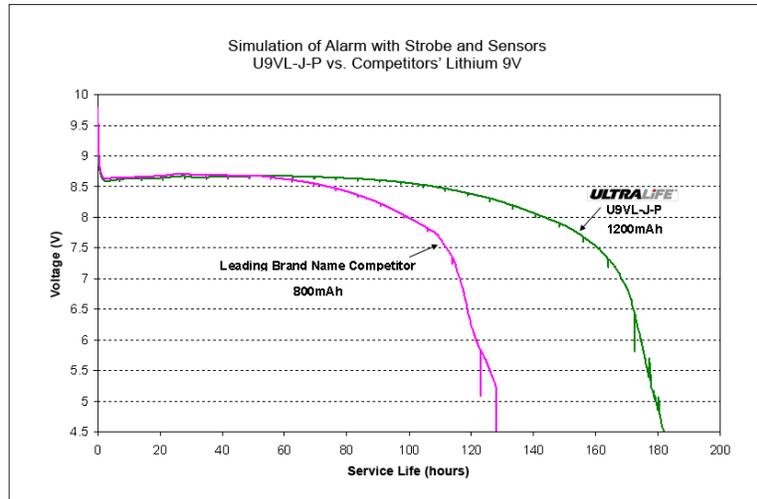


Figure 3

Wide Operating Temperature Range

Alkaline batteries have a recommended operating temperature range of -18°C to 55°C. However, the Ultralife 9V offers improved operational performance

versus temperature. The test shows how the battery can be discharged from -40°C to 60°C at the 900 Ohm rate, making it the ideal choice for a variety of

outdoor applications, including security sensors and invisible fence applications (results in figure 4).

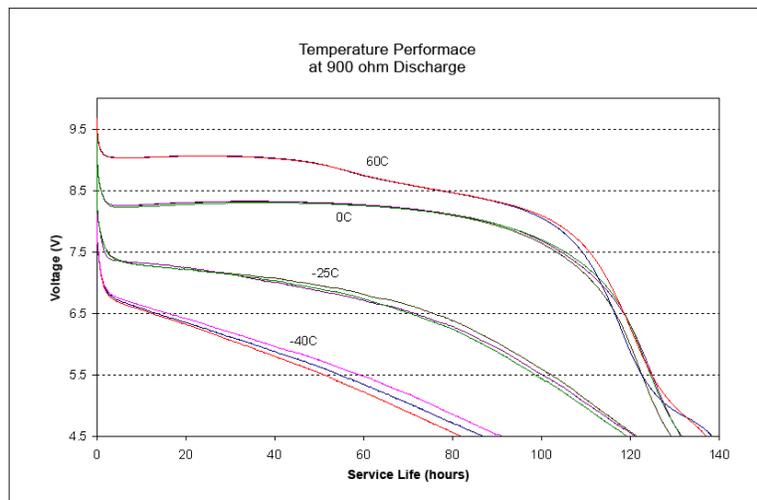


Figure 4

Wide Storage Temperature Range

One major alkaline 9V manufacturer recommends storing their batteries

between 5°C to 30°C, whereas lithium 9V can be stored between -40°C to 60°C.

PERFORMANCE BY DESIGN

Size and Weight

Understanding the demand for lithium 9V batteries to be consumer replaceable, like their alkaline alternatives, Ultralife matched the 9 volt's dimensions to those of a standard alkaline or carbon zinc battery (figure 5), also conforming to the ANSI 1604 specification.

Extremely lightweight, the Ultralife Lithium 9V weighs 37g, approx. 18% less than the average alkaline 9V. The combination of low weight and high energy results in the highest energy density among all brand name 9V batteries.

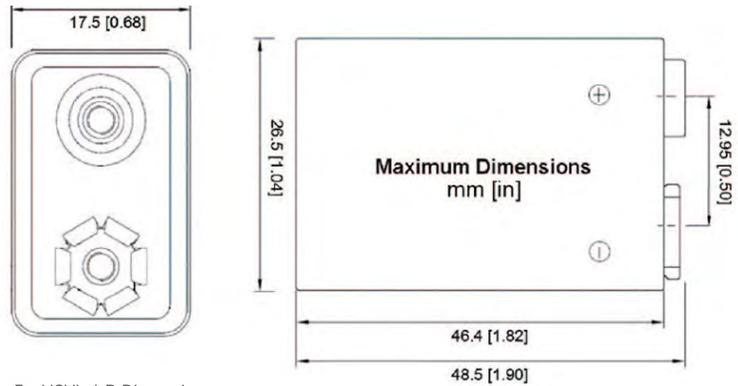


Figure 5 - U9VL-J-P Dimensions

Design Enhancements

The internal impedance of the battery was reduced by enhancing the design characteristics, increasing the ability for the battery to supply higher power output with a stable voltage for demanding applications.

The new lithium 9V has very little magnetic signature, with the outer container being constructed of stainless steel and the cells having non-magnetic construction.

Safety Features

Alkaline batteries left in storage or used infrequently are more susceptible to leak and damage the device in which they are used, so lithium can be safer.

To further enhance safety, Ultralife's Lithium 9V is constructed with a shutdown separator internal to each of the 3 cells. Should internal temperature of the cell become excessive, the normally porous separator closes the pores, permanently disabling the battery.

Ongoing Support

Ultralife has a technical staff available to help with applications development, specialized testing, or general questions. Call us today on +1-315-332-7100.

Attribute Comparison

The table below compares alkaline 9V and ULTRALIFE® Lithium 9V across ten performance attributes. Those seeking a low-cost battery that is widely available on the high street should consider alkaline 9V. For applications that require a long service life or high performance, Ultralife Lithium 9V offers the best option.

ATTRIBUTE	ALKALINE 9V	ULTRALIFE 9V
Shelf Life	✘	✓✓
Size	✓✓	✓✓
Weight	✘	✓✓
Service Life	✘	✓✓
High Performance	✘	✓✓
Temperature Range	✓	✓✓
Safety	✘	✓✓
Aftermarket Availability	✓✓	✓
Cost	✓✓	✓
Customization Options	✘✘	✓✓

✓✓ Very Good ✓ Good ✘ Poor ✘✘ Very Poor

Potential Applications

- Smoke alarms / carbon-monoxide detectors
- Music / audio devices
- Walkie-Talkies
- Wearable medical devices
- Rugged handheld devices
- Telematics
- Security systems / sensors
- and many more...



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DOWNLOAD OUR 9V INFOGRAPHIC

ULTRALIFE
**MORE THAN 20 YEARS
OF MISSION-CRITICAL
POWER**

1991  The first Ultralife Lithium 9V battery was launched as a solution to several industry issues

SECURITY

Security equipment is used in indoor and outdoor environments, operating in a range of conditions.

The battery performs well under varying temperatures, with an effective 900 Ohm discharge rate from -40°C to +60°C. That's why the original 9V was a perfect fit for outdoor security alarms and emergency location transmitters.

