

Panasonic battery for IoT devices with LPWA

27th November 2019

Industrial Energy Business Unit Energy Device Business Division

Industrial Solutions Company

Panasonic Corporation

Suggestion of Battery for IoT Devices with LWPA

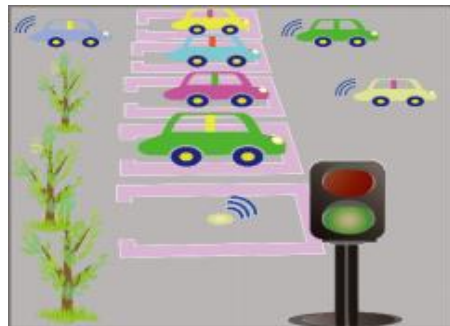
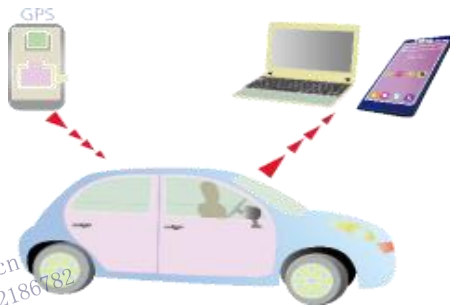
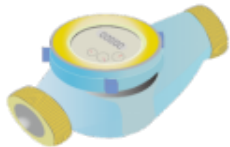
Expected max current and cut off voltage depend on the design of IoT device.

	NB-IoT		LoRa	Sigfox
Max communication distance	50 Km		15 Km	20 Km
Communication speed	≐ 100 Kbps		≐ 0.25 Kbps	≐ 0.1 Kbps
Expected max current	220mA~		~100mA	20~60mA
Expected cut off voltage	3.1V	2.1V	2.0V	1.9V
Battery	ER + Capacitor			
	CR +DC/DC	CR		

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IoT device examples using CR cylindrical batteries



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IoT device actual examples using CR cylindrical batteries

Amount of IoT applications is growing in recent years.

Our battery has been installed in a lot of products.

Traffic / Asset Management

Smart Parking



Telematics



GPS Tracker



Smart metering

Oil tank monitoring



Water Meter



Gas Meter



Infrastructure

Bridge deterioration monitoring



Smart Manhole



Water level monitoring



Security / Smart building

Smart Lock



Fire Alarm



Water level sensor



Global legislation situation of fire alarm

Global legislation trend of fire alarm

Installation deadline

USA

Indiana New York Washington Wisconsin California



APC

Japan

Australia

Taiwan

UK

France

EU

Rhineland-Palatinate & Saarland, Germany

Saarland, Germany

Saxony, Hasse, Bremen, Germany

North Rhine-Westphalia & Bayern, Germany

Thuringen, Germany

Accelerate legislation to install residential fire alarm system around the world



Fire alarm legislation Country Overview

Region	Country	Scope	Deadline	Building coverage	Standard warranty	Remarks
NA	USA	State	Done by some states	Private and public	10 years	Fire alarms in 35 states, smoke alarms in 25 states. Gradually warrants for 10 years.
	Canada	State	Done by some states	Private and public	10 years	Ontario, Fine system
EU	UK	Country	Done 2006	Private and public	10 years	Done by 13 out of 16 states
	Germany	State	Done by some states	Private and public	10 years	
	France	Country	Done in 2015	New private and public	10 years	Private by 2016. No enforceable (Since 1998)
	Sweden	Country	Done in 2006	Private and public	10 years	
	Spain	Country	TBD	Only public	10 years	
	Italy	TBD	TBD			
	Turkey			New private and public		No enforceable
	Russia			New private and public		No enforceable
APC	Poland	Country	Done in 2010	Only public		
	Japan	Country	Done in 2011	Private and public	10 years	
	Australia	Country	Done in 2006	Private and public	10 years	
	HK	All	Done in 2006			No enforceable
	China	Province				Shandong province, Shanghai
	Taiwan		Done in 2017			



Presence or absence of fire alarm system in the USA

Mandatory 10-year smoke alarm States/City

- Mandatory smoke alarm States are 39,
- Mandatory 10-year smoke alarm States/City are 18,
- But specifically set a deadline, and it is past States/City are 5.

Population : as of 2015,

Wikipedia

State / City	Statue	Law Effective date	Switching deadline	population	Note
Washington State	HB1824		July 1, 2017	6.2 million	
Connecticut	SB1012 & HB1012		No effective date yet	3.6 million	
Massachusetts	S 1249 & H 2109		No effective date yet	6.7 million	
Florida	SB704 & HB 535		No effective date yet	19.6 million	
New York	S6383	April 1, 2014		20.0 million	Cleanup bill for the 2015 bill
Milwaukee, WI		June 1, 2013	Oct 1, 2017	1.0 million	
Madison, WI		Aug. 1 2010		0.3 million	
Indianapolis, IN			July 1, 2014	0.9 million	
Frederick, ML			Apr 1, 2018	0.07 million	Built on or after Jan 1, 2008
California	SB745	Aug, 2013	Jan 1, 2015	38.4 million	
Oregon		Jan. 1998		3.9 million	
Louisiana		Jan. 1 2011		4.6 million	
North Carolina		Jan. 1, 2013		9.8 million	
Georgia		Jan. 30, 2014		10.0 million	
Maryland		July 1, 2013		5.9 million	
Phoenix		April 18, 2014		4.7 million	
Philadelphia		Nov. 27, 2012		6.1 million	
Louisville		April 10, 2013		0.6 million	

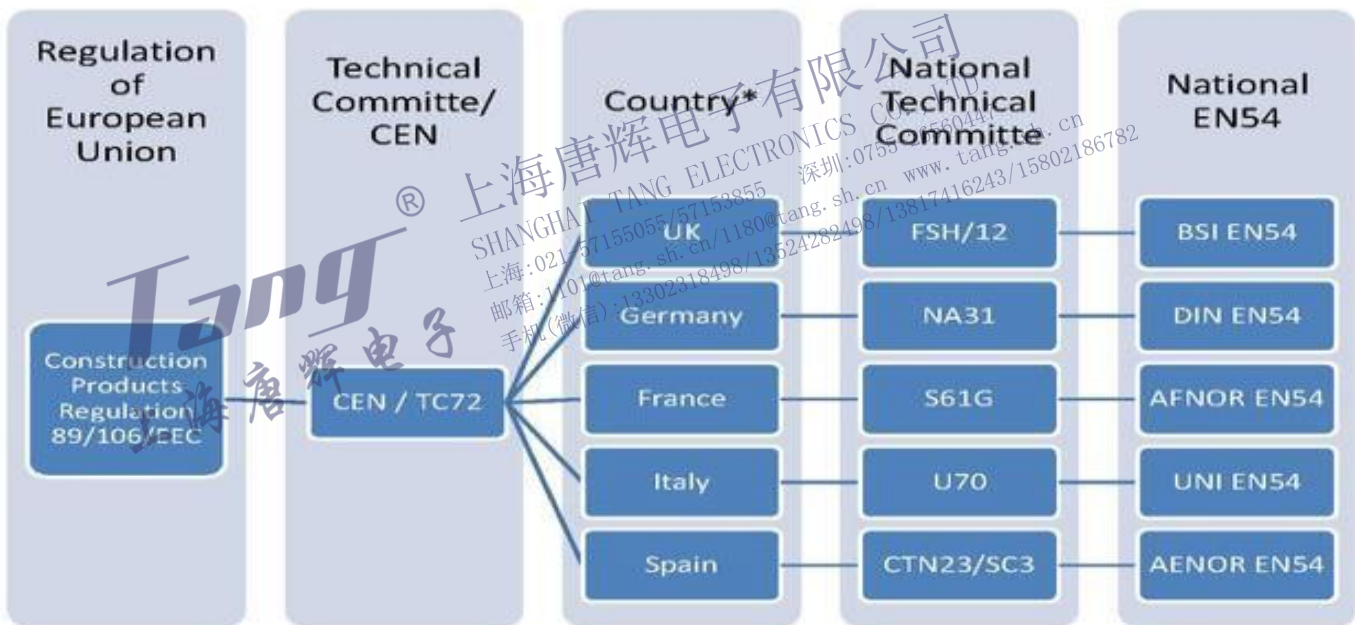
US Dry battery company against to change 10-years non-replaceable, non-removable battery.
 But Mandatory 10-year smoke alarm States/City are gradually expanding.



Europe Promotion Country & Framework

Promotion of examination of equipment specifications in Europe, centering on UK, Germany, France, Italy

How EN54 are made?



*Each country of the European Union has its own committee with its EN54 following directives of CEN/TC72

European directive compliance countries

Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK.



German state legislation / implementation deadline

We expect replacement demand of 7.5 million fire alarms in 2018-2019
 (= 4.5 million people / 3 people in a household * 5 fire alarms in a household)

population rank	State	lagislation	implementation term for existent house	population	ratio	amount
9	Schleswig-Holstein	2005/1/1	2008/12/12	2,832,950	3.4%	3.4%
14	Mecklenburg-Vorpommern	2006/4/18	2009/12/31	1,707,266	2.1%	5.5%
13	Hamburg	2005/12/7	2010/12/31	1,743,627	2.1%	7.6%
7	Rhineland-Palatinate	2003/12/22	2012/7/12	4,058,843	4.9%	12.5%
15	Saarland	2004/2/18	2014/12/31	1,050,293	1.3%	13.8%
5	Hesse	2005/6/24	2015/12/31	6,092,354	7.4%	21.2%
11	Saxony-Anhalt	2009/12/21	2015/12/31	2,469,716	3.0%	24.2%
4	Lower Saxony	2012/11/1	2015/12/31	7,993,946	9.7%	33.9%
16	Bremen	2015/12/31	2015/12/31	663,467	0.8%	34.7%
1	North Rhine-Westphalia	2013/4/1	2017/1/1	18,058,105	21.9%	56.6%
2	Bayern	2014/12/31	2017/12/31	12,468,726	15.1%	71.7%
12	Thuringen	2008/2/5	2018/12/31	2,334,575	2.8%	74.6%
3	Baden - Wurttemberg	<n/a>	<n/a>	10,735,701	13.0%	87.6%
6	The State of Sachsen	<n/a>	<n/a>	4,273,754	5.2%	92.8%
10	The State of Brandenburg	<n/a>	<n/a>	2,559,483	3.1%	95.9%
8	Berlin	2014/12/31	not decided	3,395,189	4.1%	100.0%
total				82,437,995		

Metering

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Electricity

Gas

Water

Heat

Heat cost allocator

and so on

Opportunity of industrial battery

Battery is required for each functions of smart meters



Electricity meter

- Battery usage
 - RTC back-up
- Required specification to battery
 - over 10 years life time
 - low rate continuous current discharge



Gas meter

- Battery usage
 - Measurement of gas flow
 - Valve running
 - RF transmission
- Required specification to battery
 - No resistance increase for a long time usage
 - high rate pulse current discharge
 - over 10 years life time

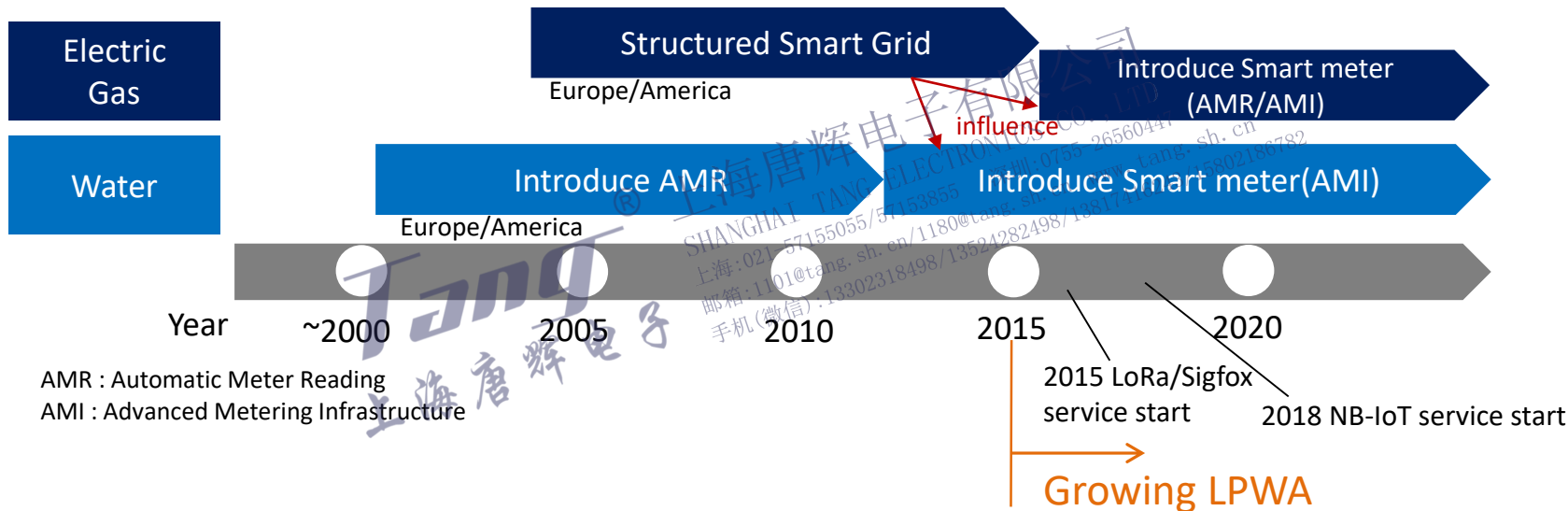


Water meter

- Battery usage
 - Measurement of water passing
 - RF transmission
- Required specification to battery
 - No resistance increase for a long time usage
 - high rate pulse current discharge
 - over 10 years life time

Growth of Smart meter

Electric, gas and water meter are developing as smart meter recent years.
Battery's demand for communicating data is expanding.



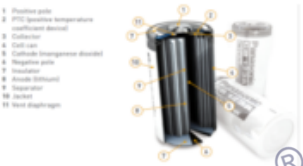

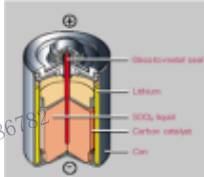
By smart metering

- Realize the accurate measurement
- Reduction of labor cost for reading a meter
- Analyze big data from collected reading data

Requirements of lithium metal cylinder battery for IoT devices

- Long term reliability (more than 10 years)
- Detection for residual capacity of battery
- Safe and environmental friendly

Cell chemistry comparison of Lithium primary battery

Chemistry	Panasonic CR	General CR	ER
Construction	Spiral Electrodes Crimping 	Spiral or Inside-out Electrodes Crimping or Laser welding 	Spiral or Bobbin Electrodes Glass Metal Seal 
Reaction	$MnO_2 + Li \rightarrow LiMnO_2$	$MnO_2 + Li \rightarrow LiMnO_2$	$2SOCl_2 + 4Li \rightarrow 4LiCl + S + SO_2$
Nominal Voltage	3.0V	3.0V	3.6V
Characteristics	Good discharge performance Stable and low internal resistance Good pulse capability -40°C to 70°C(85°C)	Good discharge performance Unstable internal resistance Good pulse capability -40°C to 70°C	High Voltage Stable discharge (flat) Unstable internal resistance (Passivation problems) -40°C to 85°C
Reliability	Very Good Over 15years actual operation	Poor Internal resistance increase reduces pulse capability	Poor Internal resistance increase reduces pulse capability
Safety & Environment	Safe Environmental friendly	Safe Environmental friendly	Unsafe $SOCl_2$ is toxic substance



- Long term reliability

- Detection for residual capacity of battery

- Eco friendly

- Advantage summary of Panasonic CR battery

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Superior long term reliability

Panasonic CR Cylinder Batteries can be used for over 15 years

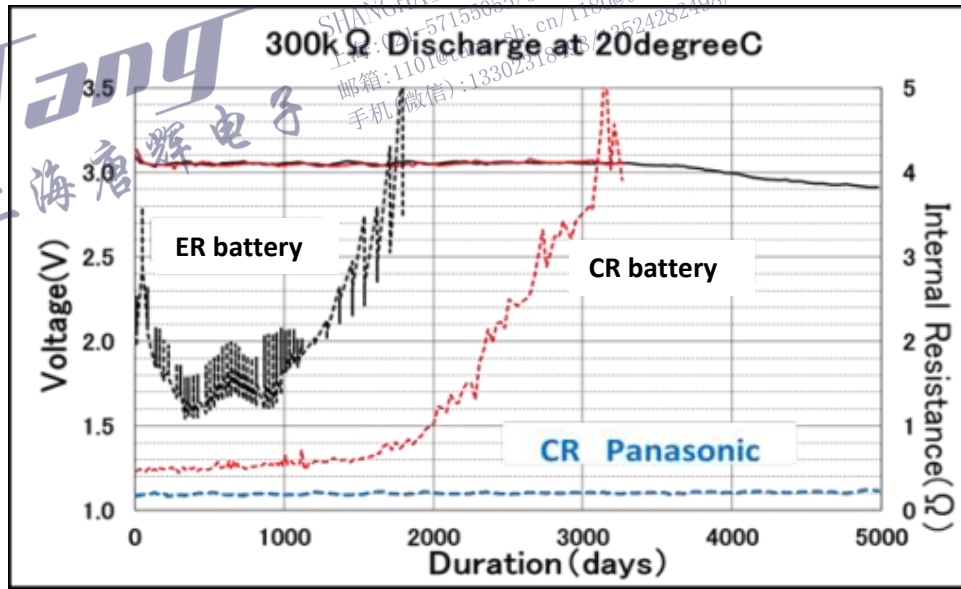
CR batteries are known as

- High drain capability
- Light weight (High density)
- Quite small self discharge

But...,



Normal CR cylinder batteries have impedance increasing after 3~5 years from starting to use.



Actual record of application required long term reliability

Fire alarm have to be performed 10 years that established by law.

Battery must be ready for immediate discharge whole 10 years.



Strength of Panasonic battery

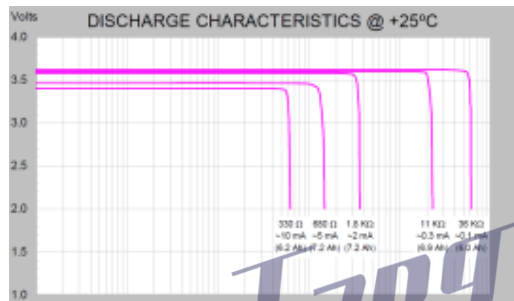
- Long term reliability
- **Detection for residual capacity of battery**
- Eco friendly
- Advantage summary of Panasonic CR battery

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Difference of discharge curve between Li-MnO₂ and Li-SOCl₂

CR battery can be checked remaining capacity after DOD 50%

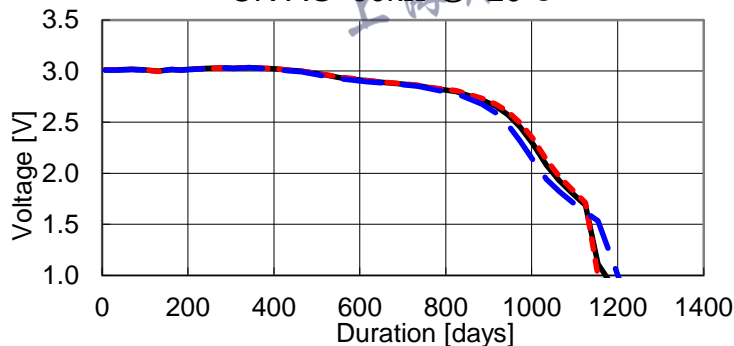
A company's battery discharge curve
3.6V Primary lithium-thionyl chloride [Li-SOCl₂]



Discharge curve of Li-SOCl₂ is flat to end of discharge.

It is difficult to check the remaining battery capacity.

Panasonic CR-AG discharge curve
3.0V Primary lithium-manganese dioxide [Li-MnO₂]
CR-AG 30kΩ @+20°C (N=3)



Discharge curve of Li-MnO₂ falls down gently after DOD*50% toward end of discharge.

It is possible to check the remaining battery capacity by detecting the voltage.

*DOD : Depth of discharge

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

Strength of Panasonic battery

- Long term reliability
- Detection for residual capacity of battery
- Eco friendly
- Advantage summary of Panasonic CR battery

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Toxicity of ER battery

In case the container is damaged, toxic gas could come out and lead to death.

Texas jury awards \$29 million in death of oilfield services worker

Jackson Lewis PC



USA | February 26 2015

A Houston jury has returned a \$29 million verdict against Professional Directional Enterprises, Inc. (PDE), an oil and gas drilling services, for the death of a Texas oilfield services worker killed in an industrial battery explosion at a Conroe, Texas, facility.

Garland Rickie Kelley died when a lithium thionyl chloride battery he was testing exploded on July 30, 2011. He ultimately died from injuries sustained in the explosion. Kelley, 38, was married and had three children.

The victim's family contended the battery was improperly heated to extend its life for use in an oilfield downhole drilling tool and was known to be defective, according to the *Houston Press*. The lawsuit, filed on behalf of Kelley's wife and children, included claims of gross negligence and allegations that company officials did not collect much evidence from the site following the explosion. Much of what the company collected was destroyed, according to the lawsuit, the media source reported.

Company officials claimed during a federal investigation of the incident that all its employees, including Kelley, had been given training materials for their work. The company also implied Kelley was to blame because he did not follow the alleged written instructions, according to court documents as reported by the *Houston Press*.

A separate federal investigation by OSHA led to about \$19,000 in proposed penalties against the company after the agency wrote multiple serious and other citations. The company contested the violations, and the case was settled after the Secretary of Labor filed a lawsuit, with a reduced penalty.

The \$29 million award, rendered on February 3 by a Harris County state court jury after a day of deliberations, consisted of \$4 million in compensatory damages and \$25 million in punitive damages. Eighty percent of the blame was ascribed to PDE and the remaining 20 percent to the other defendant, Excell, which produced the battery. Excell settled before closing arguments.

Jackson Lewis PC - Bradford T. Hammock, Henry Chajet and Mark Savit

He died when a lithium thionyl chloride battery he was testing exploded on July 30, 2011. He ultimately died from injuries sustained in the explosion.

<Thionyl Chloride>

- * Restricted materials by Chemical Weapon Treaty. Classified as "2nd type material". It could be used for chemical weapon as well as civil purpose.

<https://www.lexology.com/library/detail.aspx?g=b8ea46c6-d836-46b1-a4cc-139cdcd33401>

Toxicity of ER battery

Europe Water Meter Supplier decided not to use ER which has toxicity.

- Chinese water meter supplier can not export the products installed ER to Europe.





氯化亚砷 亚硫酸二氯 二氯化硫 亚硫酸氯	ICSC: 1409 10月 2001
CAS登记号: 7719-09-7 UN编号: 1836 EINECS编号: 231-748-8	

	急性危害	预防	消防
火灾与爆炸	不可燃。许多反应可能引起火灾或爆炸。在火焰中释放出刺激性或有毒烟雾（或气体）。	禁止与水接触。	周围环境着火时，可使用任何可得到的灭火剂进行灭火。禁止用水。着火时，喷雾状水保持料桶等冷却。禁止与水直接接触。

防止产生烟云！避免一切接触！一切情况均向医生咨询！			
	症状	预防	急救
吸入	喉咙痛。咳嗽。灼烧感。呼吸短促。呼吸困难。症状可能推迟显现。见注解。	采取通风、局部排气通风或呼吸防护。	新鲜空气，休息。半直立位。必要时进行人工呼吸。给与医疗护理。
皮肤接触	疼痛。发红。严重皮肤灼伤。	防护手套。防护服。	脱掉污染的衣服。用大量水冲洗皮肤或淋浴。给与医疗护理。
眼睛接触	疼痛。发红。严重深度烧伤。	戴面罩或眼镜防护结合呼吸防护。	先用大量水冲洗几分钟(如可能易行，取下隐形眼镜)，然后就医。
食入	有灼烧感。腹痛。休克或虚脱。	工作时不得进食，饮水或吸烟。进食前洗手。	漱口。不要催吐。就医。



Toxicity of ER battery

泄漏处置	分类与标签
通风。尽可能将泄漏和洒液体收集在可密封的容器中。用沙子或惰性吸收剂吸收残液。然后按照当地规定储存和处置。个人防护：全套防护服，包括自给式呼吸器。	按照联合国GHS标准 运输 57153855 深圳:0755-26560447 上海:021-57111010 邮箱: 1101@tang.sh.cn www.tang.sh.cn 手机(微信): 133025182498/13817416243/15802186782 联合国危险性类别 联合国危险性类别：8; 联合国包装类别：I
储存 沿地面通风。与食品和饲料分开存放。见化学危险性。干燥。严格密封。	
包装 不易碎包装。 将易碎包装放在密封的不易碎容器中。 不得与食品和饲料一起运输。	
不易碎包装。 将易碎包装放在密封的不易碎容器中。 不得与食品和饲料一起运输。	
<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="display: flex; align-items: center;">   <div style="margin-left: 10px;"> 英文版由EU（欧盟）财政支持，代表ILO（国际劳工组织）和WHO（世界卫生组织）的专家组编写。©ILO和WHO 2018 </div> </div> <div style="display: flex; align-items: center;">   </div> </div>	



Toxicity of ER battery

氯化亚砷		ICSC: 1409
物理与化学性质		
物理状态、外观 具有刺鼻气味的无色至黄色 或 微红色 发烟液体。	分子式: SOCl ₂ 分子量: 118.97 沸点: 76°C 熔点: -104.5°C 相对密度 (水=1): 1.64 水中溶解度: 反应	
物理危险性 蒸汽比空气重。	蒸汽压: 25°C时16kPa 蒸汽相对密度 (空气=1): 4.1 蒸汽、空气混合物相对密度 (20°C, 空气=1): 1.49	
化学危险性 高于140°C时, 分解。生成的有毒、腐蚀性烟雾。与水急剧地发生反应。生成二氧化硫和氯化氢有毒烟雾。与许多物质, 如可燃物质、胺类、碱类和金属发生反应。产生着火和爆炸的危险。		
接触与健康影响		
接触途径 该物质可经吸入和经食入吸收到体内。	吸入危险性 20°C时该物质蒸发 非常快地达到空气中有害污染浓度。	
短期接触的影响 该物质 对眼睛、皮肤和呼吸道具有 高腐蚀性。食入有腐蚀性。吸入可能导致肺水肿。见注解。该物质可能对肺造成影响。可能导致呼吸道发炎和堵塞。远高于职业接触限值接触能够造成死亡。影响可能推迟显现。需进行医疗观察。	长期或反复接触的影响	



Toxicity of ER battery

THIONYL CHLORIDE Sulfurous oxychloride Sulfurous dichloride Sulfinyl chloride Sulfur chloride oxide (Cl ₂ SO) Thionyl dichloride	ICSC: 1409 October 2001
CAS #: 7719-09-7 UN #: 1836 EC Number: 231-748-8	

	ACUTE HAZARDS	PREVENTION	FIRE FIGHTING
FIRE & EXPLOSION	Not combustible. Many reactions may cause fire or explosion. Gives off irritating or toxic fumes (or gases) in a fire.	NO contact with water.	In case of fire in the surroundings, use appropriate extinguishing media. NO water. In case of fire: keep drums, etc., cool by spraying with water. NO direct contact with water.

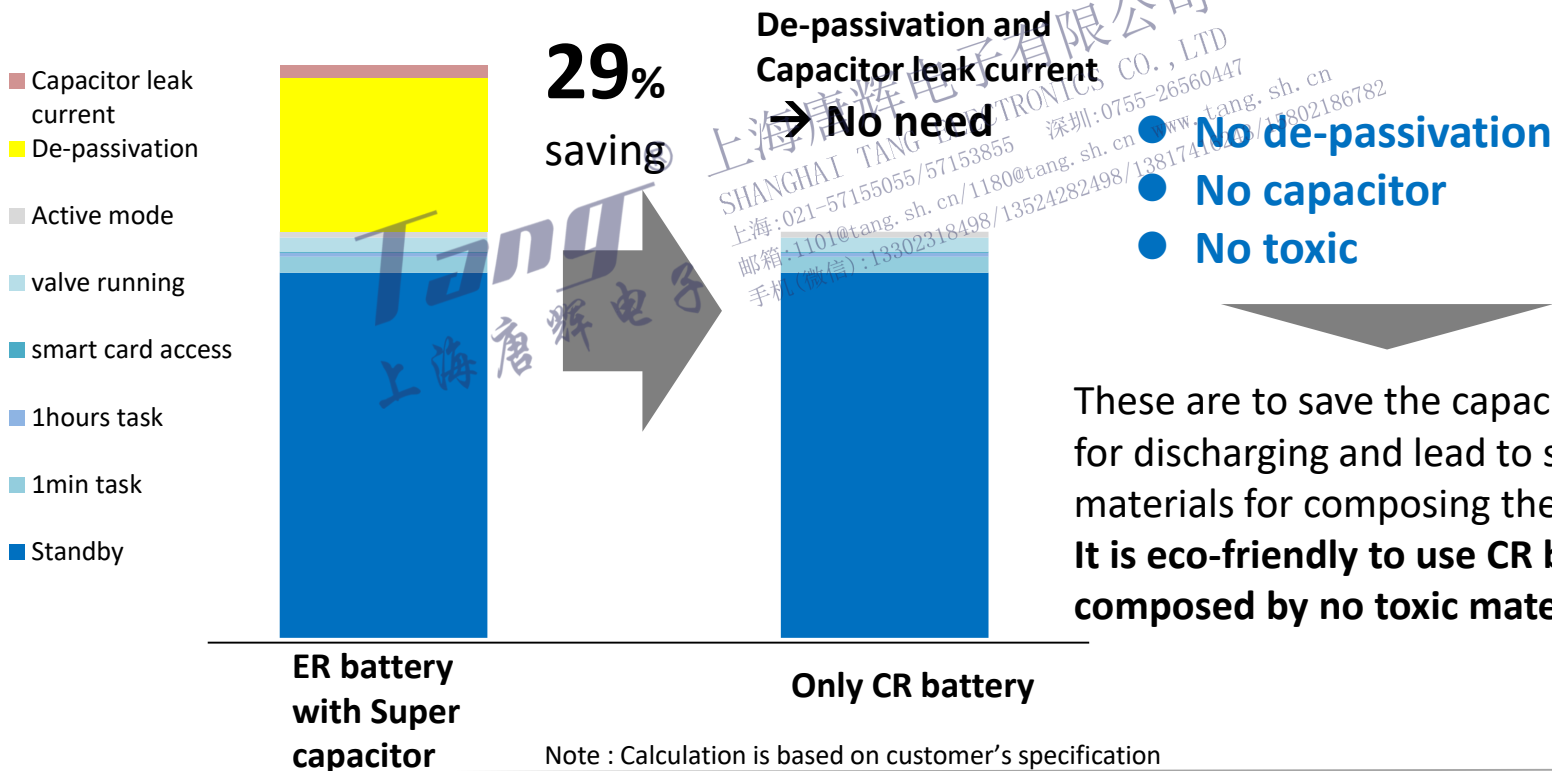
PREVENT GENERATION OF MISTS! AVOID ALL CONTACT! IN ALL CASES CONSULT A DOCTOR!			
	SYMPTOMS	PREVENTION	FIRST AID
Inhalation	Sore throat. Cough. Burning sensation. Shortness of breath. Laboured breathing. Symptoms may be delayed. See Notes.	Use ventilation, local exhaust or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
Skin	Pain. Redness. Serious skin burns.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention .
Eyes	Pain. Redness. Severe deep burns.	Wear face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then refer for medical attention.
Ingestion	Burning sensation. Abdominal pain. Shock or collapse.	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Do NOT induce vomiting. Refer for medical attention .



CR battery leads eco-friendly

It realizes to save the capacity and to use the green product by using no toxic CR battery

10 years current consumption at gas meter



Strength of Panasonic battery

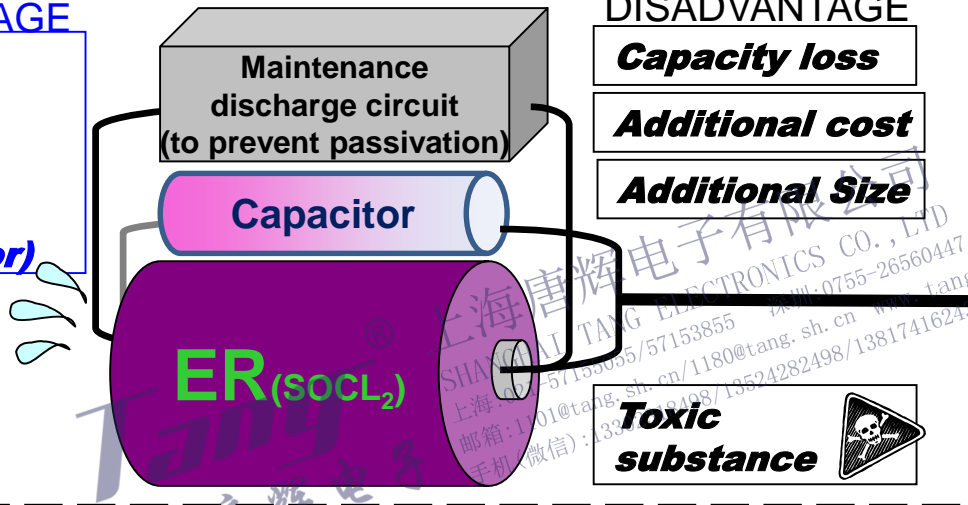
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What is advantage of CR battery?

ADVANTAGE

Higher Voltage Range
(with capacitor)



DISADVANTAGE

Capacity loss

Additional cost

Additional Size



Toxic substance

ADVANTAGE

No Passivation

Nontoxic

High Capacity Retention

High Stability Performance



DISADVANTAGE

Lower Voltage Range (than ER)

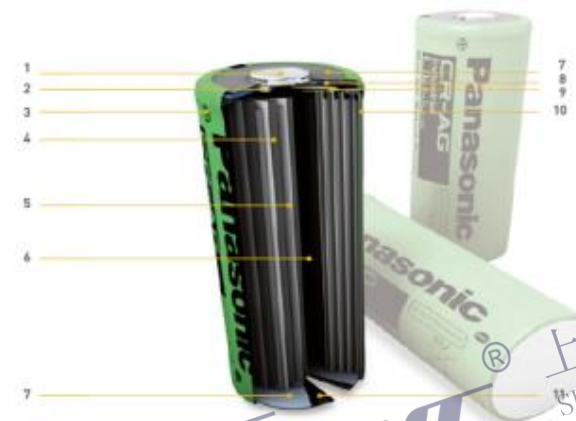


Discharge Performance of Long-life CR Cylinder

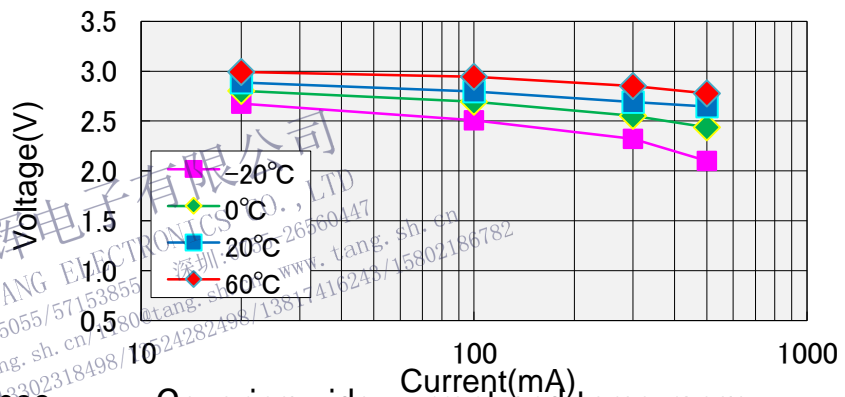
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3D ILLUSTRATION

- 1 Positive pole
- 2 Vent diaphragm
- 3 Tube
- 4 Anode (Lithium)
- 5 Separator
- 6 Cathode (Manganese Dioxide)
- 7 Insulator
- 8 PTC (Positive Temperature Coefficient Device)
- 9 Collector
- 10 Cell can
- 11 Negative pole

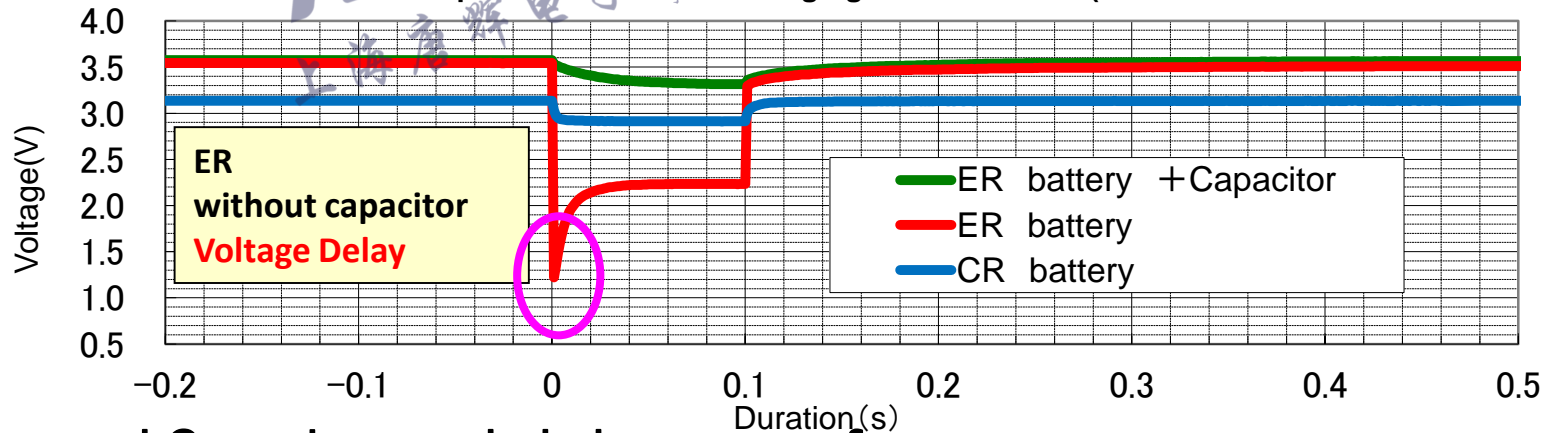


Panasonic CR-AG voltage/current correlation



“Spiral Structure” provides high drain discharge performance

Comparison of Pulse Discharging 100mA-100ms(-20°C)



No need Capacitors to help battery performance



Panasonic lithium metal battery highlight

Tang
上海唐辉电子

上海唐辉电子有限公司
SHANGHAI TANG ELECTRONICS CO., LTD
上海: 021-57155055/57138118 苏州: 0512-6770447
邮箱: 1101@tang.sh.cn/1101@tang.sh.cn
手机(微信): 13302318498/13524282498/13817111111

Panasonic industrial CR cylinder battery line up

- **Superior Long Term Reliability**
 No impedance increasing and keeps long operating life and No passivation
- **Good Pulse Capability**
 Stable and low Impedance can provide voltage at high drain
- **Good safety and Environmental Friendly**
 PTC device included. No toxic material content.

Model	Electrical spec				Operating temperature range [°C]	Dimensions		Mass weight [g]	Remarks
	Nominal voltage [V]	Nominal capacity [mAh]	Std discharge drain (continuous) [mA]	Max current drain (continuous) [mA]		Diameter [mm]	Height [mm]		
<i>CR-AGZ</i>	3	2,700	2.5	1000	-40 to +70	17.0	45.5	22	
CR-AG	3	2,400	2.5	1000	-40 to +70	17.0	45.5	22	
CR-AAU	3	1,800	2.5	1000	-40 to +85	14.5	50.5	19	
CR-2/3AZ	3	1,600	2.5	1000	-40 to +70	17.0	33.5	17	
CR2Z	3	1000	2.5	1000	-40 to +75	15.6	27.0	11	long term reliability
CR2U	3	1000	2.5	1000	-40 to +70	15.6	27.0	11	Low temp. discharge

Panasonic industrial CR cylinder battery line up

Model	CR-AGZ	CR-AG	CR-AAU	CR-2/3AZ	CR2Z	CR2U
Capacity	2.7Ah	2.4Ah	1.8Ah	1.6Ah	1.0Ah	1.0Ah
Diameter /mm	17.0	17.0	14.5	17.0	15.6	15.6
Height /mm	45.0	45.0	50.5	33.5	27.0	27.0
Operating Temp.	-40°C~70°C		-40°C~85°C	-40°C~70°C	-40°C~75°C	-40°C~70°C



CR-AGZ

Specifications and features

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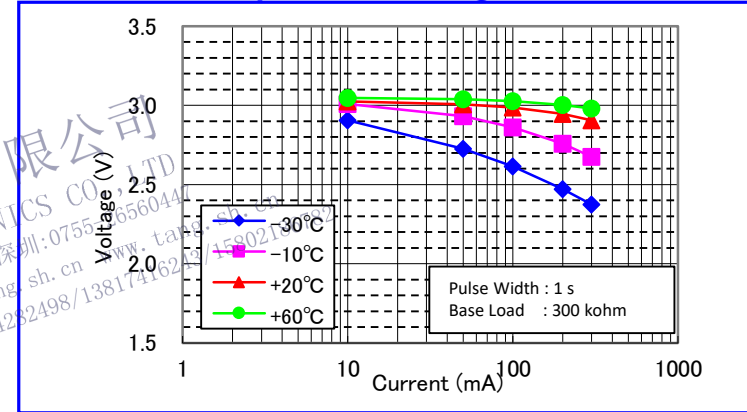
- Nominal Voltage 3V
- Nominal Capacity 2700mAh
- Standard Discharge Current 2.5mA
- Maximum Continuous Discharge Current 1A
- Operating Temperature Range -40~70°C
- Diameter 17.0mm
- Height 45.5mm
- Weight 23g



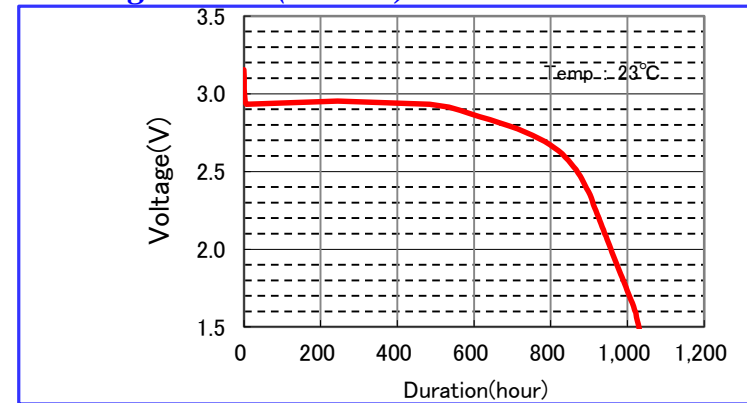
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- Higher capacity
12.5% additional cap than CR-AG.
- Good Pulse Capability
Stable Impedance keeps high pulse voltage.
- Good safety and Environmental Friendly
PTC device is included. No toxic materials are included and no passivation.

Pulse Discharge Characteristics - Depth of Discharge : 50%



Discharge Curve (1kohm)



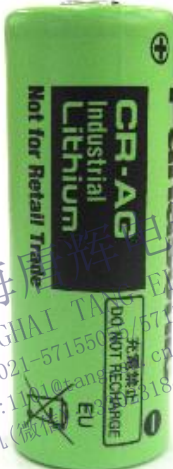
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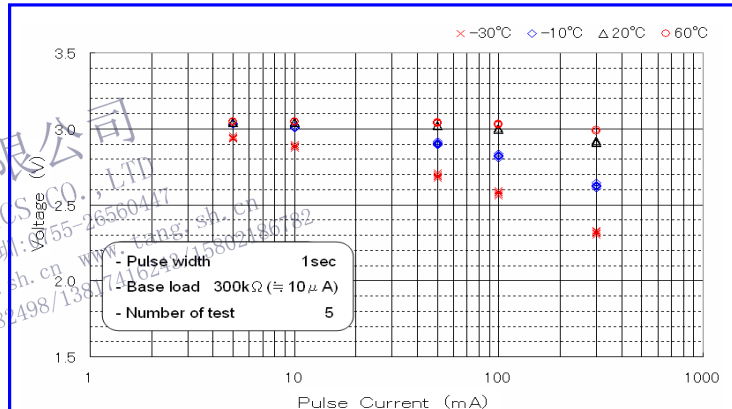
CR-AG Specifications and features

Specifications

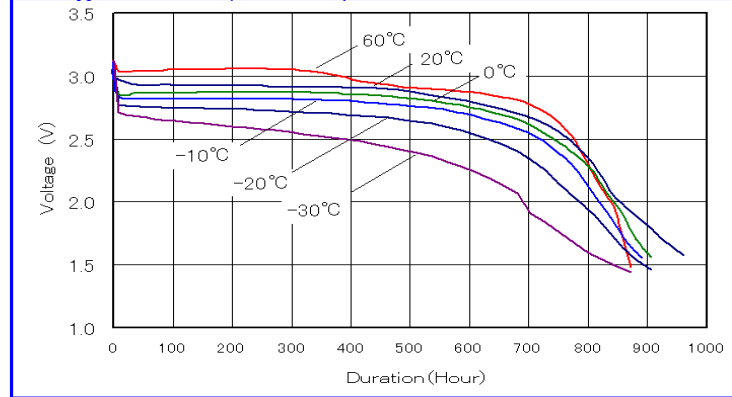
- Nominal Voltage 3V
- Nominal Capacity 2400mAh
- Standard Discharge Current 2.5mA
- Maximum Continuous Discharge Current 1A @20degC
- Operating Temperature Range -40~70degC
- Diameter 17.0mm
- Height 45.5mm
- Weight 22g
- Superior Long Term Reliability
 Internal resistance remains low during long term discharge such as memory-back-up. "Wake-up-pulse discharge" not required. More than 10years have passed since CR-AG were installed in gas meters.
- Good Pulse Capability
 Stable Impedance can provide high pulse voltage.
- Wide Operational Temperature Range
 -40degreeC to +70degreeC
- Good safety and Environmentally Friendly
 UL recognized. PTC device is included. No toxic materials are included.



Pulse Discharge Characteristics - Depth of Discharge : 50%



Discharge Curve (1kohm)

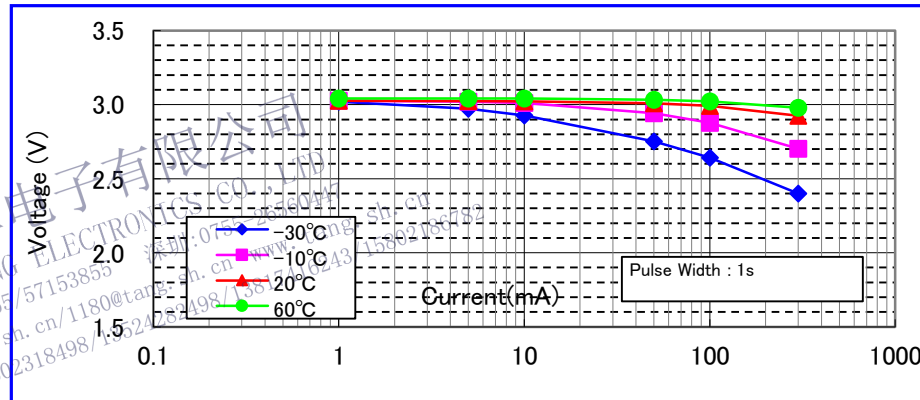


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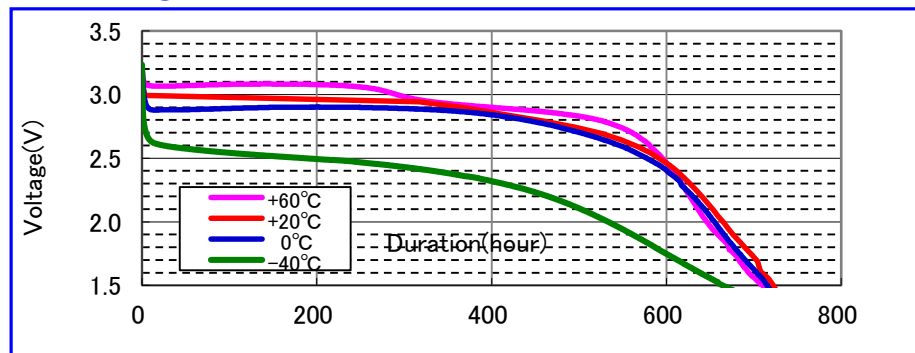


- Nominal Voltage 3V
- Nominal Capacity 1800mAh
- Standard Discharge Current 2.5mA
- Maximum Continuous Discharge Current 1A @20degC
- Operating Temperature Range -40~85degC
- Diameter 14.5mm
- Height 50.5mm
- Weight 18g
- Superior Long Term Reliability
 - No impedance increasing and keeps long operating life
 - No passivation
- Good Pulse Capability
 - Stable and low Impedance can provide voltage at high drain
- Wide Operational Temperature Range
 - 40degreeC to +85degreeC
- Good safety and Environmental Friendly
 - PTC device included. No toxic material content.

Pulse discharge (D.O.D: 50%)



Discharge Curve (1kohm)



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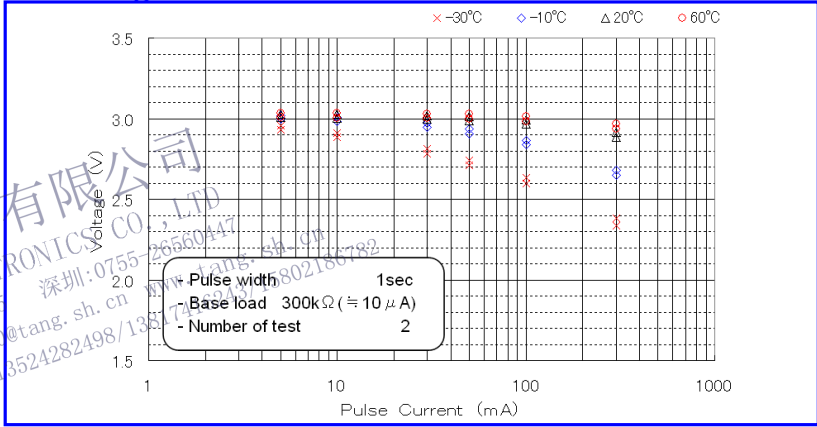
CR-2/3AZ Specifications and features

Specifications

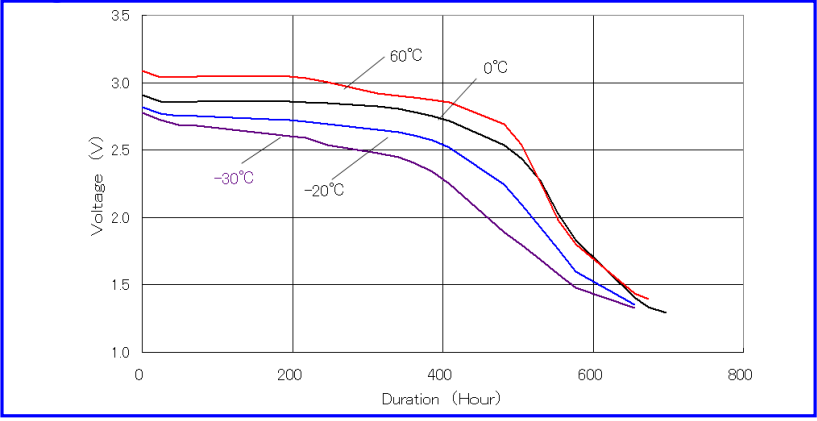
- Nominal Voltage 3V
- Nominal Capacity 1600mAh
- Standard Discharge Current 2.5mA
- Maximum Continuous Discharge Current 1A @20degC
- Operating Temperature Range -40~70degC
- Diameter 17.0mm
- Height 33.5mm
- Weight 16g



Pulse discharge (D.O.D: 50%)



Discharge Curve (1kohm)



- Superior Long Term Reliability
 Internal resistance remains low during long term discharge such as memory-back-up. "Wake-up-pulse discharge" not required. More than 10years have passed since CR-2/3AZ were installed in smoke detectors.
- Good Pulse Capability
 Stable Impedance can provide high pulse voltage.
- Wide Operational Temperature Range
 -40degreeC to +70degreeC
- Good safety and Environmentally Friendly
 UL recognized. PTC device is included. No toxic materials are included.

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CR-2Z

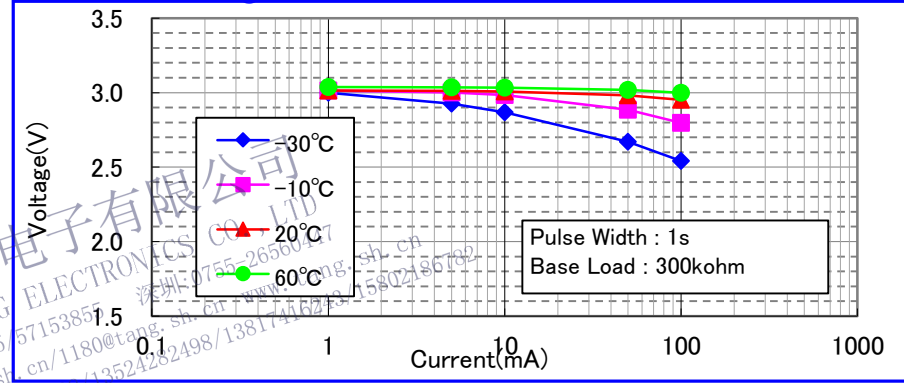
Specifications and features

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Until:2023.12.31
Submitted to 唐辉电子

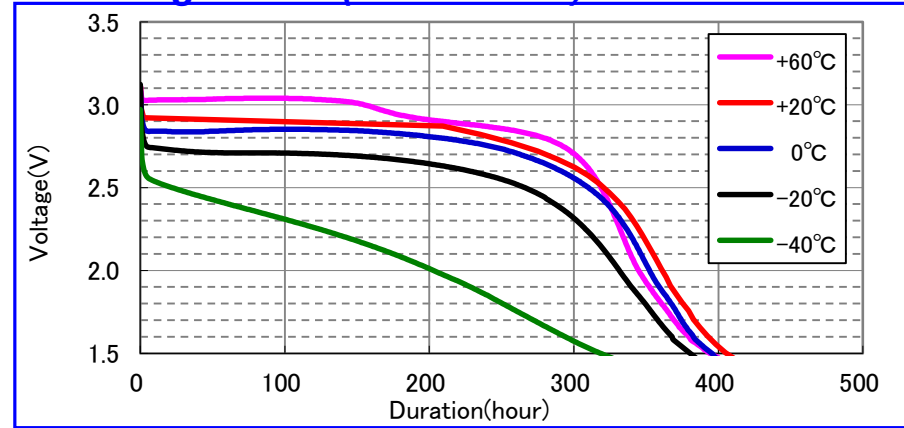
- Nominal Voltage 3V
- Nominal Capacity 1000mAh
- Standard Discharge Current 2.5mA
- Maximum Continuous Discharge Current 1A
- Operating Temperature Range -40~75°C
- Diameter 15.6mm
- Height 27.0mm
- Weight 11g
- Superior Long Term Reliability
No impedance increasing and keeps long operating life
No passivation
- Good Pulse Capability
Stable and low Impedance can provide voltage at high drain
- Wide Operational Temperature Range
-40degreeC to +75degreeC
- Good safety and Environmental Friendly
PTC device included. No toxic material content.



Pulse discharge (D.O.D: 50%)



Discharge Curve (1k ohm load)



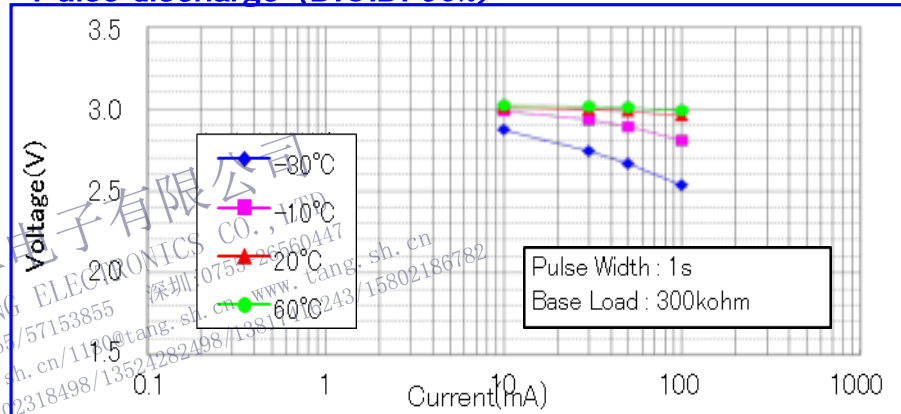
The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

- Nominal Voltage 3V
- Nominal Capacity 1000mAh
- Standard Discharge Current 2.5mA
- Maximum Continuous Discharge Current 1A
- Operating Temperature Range -40~70°C
- Diameter 15.6mm
- Height 27.0mm
- Weight 11g

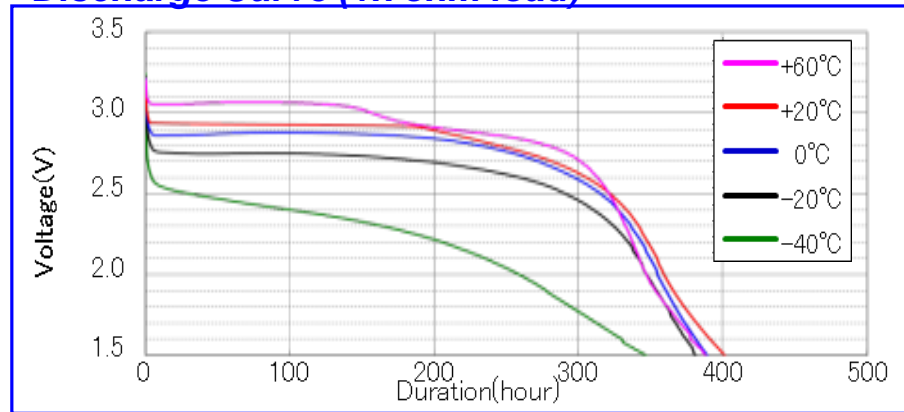


- Superior Long Term Reliability
Internal resistance keeps low during long term discharge such as memory-back-up without "wake-up-pulse discharge".
- Good Pulse Capability
Stable Impedance can provide high pulse voltage.
- Wide Operational Temperature Range
-40degreeC to +70degreeC
- Good safety and Environmental Friendly

Pulse discharge (D.O.D: 50%)



Discharge Curve (1k ohm load)



PTC device is included. No toxic materials are included.

The data in this document are for descriptive purposes only and are not intended to make or imply any guarantee or warranty.

Panasonic lithium metal battery all line up including pin type lithium ion battery

CR Cylinder Batteries Lineup

Model	Electrical Characteristics			Operating Temp. Range [°C]	Dimensions		Approx. Weight [g]
	Nominal Voltage [V]	Nominal Capacity [mAh]	Standard Continuous Drain [mA]		Diameter [mm]	Height [mm]	
CR123A	3.0	1,400	20	-40 to +70	17.0	34.5	18
CR2	3.0	850	20	-40 to +70	15.6	27.0	11
CR-V3	3.0	3,300	200	-40 to +70	L28.4 W14.4	52.0	39
2CR5	6.0	1,400	20	-40 to +70	L34.0 W17.0	45.0	38
CR-P2	6.0	1,400	20	-40 to +70	L35.0 W19.5	36.0	37
CR-AG	3.0	2,400	20	-40 to +70	17.0	45.5	22
CR-AAU	3.0	1,650	20	-40 to +70	14.5	50.5	19
CR-2/3AZ	3.0	1,600	20	-40 to +70	17.0	33.5	17
CR2Z/CR2U	3.0	1,000	20	-40 to +70	15.6	27.0	11

※ CR123A,CR2,CR-V3,2CR5 and CR-P2 are for consumer retail market..

※ CR-AG,CR-AAZ and CR-2/3AZ are only for industrial market.



BR Cylinder Batteries Lineup

Model	Electrical Characteristics			Operating Temp. Range [°C]	Dimensions		Approx. Weight [g]
	Nominal Voltage [V]	Nominal Capacity [mAh]	Standard Continuous Drain [mA]		Diameter [mm]	Height [mm]	
BR-C	3.0	5,000	5.0	-40 to +85	26.0	50.5	42
BR-AG	3.0	2,200	2.5	-40 to +85	17.0	45.5	18
BR-A	3.0	1,800	2.5	-40 to +85	17.0	45.5	18
BR-2/3AG	3.0	1,450	2.5	-40 to +85	17.0	33.5	13.5
BR-2/3A	3.0	1,200	2.5	-40 to +85	17.0	33.5	13.5
BR-1/2AA	3.0	1,000	2.5	-40 to +100*	14.5	25.5	8

※ BR batteries are only in industrial market

※ If operating temp. range is over 85 °C, Preliminary consultation is needed.

CR coin battery line up

Part#	OCV	Capacity	Std. Discharge Current	Diameter	Height	Weight	Temp. Range
CR	CR1025	3V	30mAh	0.1mA	10.0mm	2.5mm	0.7g
	CR1216	3V	25mAh	0.1mA	12.5mm	1.6mm	0.7g
	CR1220	3V	35mAh	0.1mA		2.0mm	1.2g
	CR1616	3V	55mAh	0.1mA	16.0mm	1.6mm	1.2g
	CR1620	3V	75mAh	0.1mA		2.0mm	1.3g
	CR1632	3V	140mAh	0.1mA	20.0mm	3.2mm	1.8g
	CR2012	3V	55mAh	0.1mA		1.2mm	1.4g
	CR2016	3V	90mAh	0.1mA		1.6mm	1.6g
	CR2025	3V	165mAh	0.2mA		2.5mm	2.3g
	CR2032	3V	225mAh	0.2mA		3.2mm	2.9g
	CR2330	3V	265mAh	0.2mA	23.0mm	3.0mm	3.8g
	CR2354	3V	560mAh	0.2mA		5.4mm	5.8g
	CR2412	3V	100mAh	0.2mA	24.5mm	1.2mm	2.0g
	CR2450	3V	620mAh	0.2mA		5.0mm	6.3g
	CR2477	3V	1000mAh	0.2mA		7.7mm	10.5g
CR3032	3V	500mAh	0.2mA	30.0mm	3.2mm	6.8g	



CR coin battery High-Temp. Ver. line up



14 year Broad experience in US, EU and Asian market

High reliability substantiated by zero claim

Continuous improvement for **optimization and for cost**

Remarkable **performance in low temperature** condition



	Model name	Diameter	Height	Capacity	Temperature range	Weight (bare cell)	Remark
Current model	CR-2032A	20 mm	3.2 mm	210 mAh	-40 ~ 125°C	2.8 g	Low temp performance improved
	CR-2032B	20 mm	3.2 mm	210 mAh	-40 ~ 120°C	2.8 g	Low temp performance improved
	CR-2050A	20 mm	5.0 mm	345 mAh	-40 ~ 125°C	4.1 g	Low temp performance improved
	CR-2050B2	20 mm	5.0 mm	345 mAh	-40 ~ 120°C	4.1 g	Low temp performance improved
	CR-2450A	24.5 mm	5.0 mm	560 mAh	-40 ~ 105°C	6.3 g	
	BR-2450A	24.5 mm	5.0 mm	550 mAh	-40 ~ 125°C	5.0 g	



BR coin battery line up

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Part #		Open Circuit Voltage	Capacity	Std Discharge Current	Diameter	Height	Weight	Temperature Range
BR	BR1220	3 V	35 mAh	0.03 mA	12.5 mm	2 mm	0.7 g	-30 – +80
	BR1225	3 V	48 mAh	0.03 mA	12.5 mm	2.5 mm	0.8 g	-30 – +80
	BR1632	3 V	120 mAh	0.03 mA	16 mm	3.2 mm	1.5 g	-30 – +80
	BR2032	3 V	190 mAh	0.03 mA	20 mm	3.2 mm	2.5 g	-30 – +80
	BR2325	3 V	165 mAh	0.03 mA	23 mm	2.5 mm	3 g	-30 – +80
	BR2330	3 V	255 mAh	0.03 mA	23 mm	3 mm	3.2 g	-30 – +80
	BR3032	3 V	500 mAh	0.03 mA	30 mm	3.2 mm	5.5 g	-30 – +80

High Temp Version

Part #		Open Circuit Voltage	Capacity	Std Discharge Current	Diameter	Height	Weight	Temperature Range
BR-A	BR1225A	3 V	48 mAh	0.03 mA	12.5 mm	2.5 mm	0.8 g	-40 – +125
	BR1632A	3 V	120 mAh	0.03 mA	16 mm	3.2 mm	1.5 g	-40 – +125
	BR2330A	3 V	255 mAh	0.03 mA	23 mm	3 mm	3.2 g	-40 – +125
	BR2450A	3 V	550 mAh	0.03 mA	24.5 mm	5 mm	5 g	-40 – +125
	BR2477A	3 V	1,000 mAh	0.03 mA	24.5 mm	7.7 mm	8 g	-40 – +125



ML·VL Coin Batteries Lineup

Part#	Model	Nominal Voltage (V)	Nominal Capacity (mAh)	Continuous Drain (uA)	Dimension		Weight (g)	Charge Voltage (V)	Average Discharge Voltage(V)
					Diameter (mm)	Thickness (mm)			
ML	ML2020	3	45	120	20	2.0	2.2	2.8-3.2	Approx. 2.45
	ML1220		17	30	12.5	2.0	0.8		
	ML920		11	30	9.5	2.0	0.4		
	ML621		5.0	10	6.8	2.1	0.23		
	ML614		3.4	10	6.8	1.4	0.16		
	ML421		2.3	5.0	4.8	2.1	0.11		
VL	VL3032		100	200	30	3.2	6.2	3.25-3.55	Approx. 2.85
	VL2330		50	100	23	3.0	3.5		
	VL2020		20	70	20	2.0	2.2		
	VL1220		7.0	20	12.5	2.0	0.8		
	VL621		1.5	10	6.8	2.1	0.27		

More back up time can be achieved than Condensers.

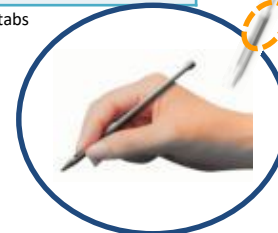


Pin-type Li-ion battery

Features & Benefits

- 1) Super small and slim battery realizes not only stylish designs but also high output.
- 2) A high-strength stainless exterior case provides excellent safety and reliability.
- 3) Rapid charging makes your portable devices more user-friendly.

Part #		CG-320A	CG-425A	CG-420A (Under development)
Size*	Diameter(max.)	3.65mm	4.7mm	4.7mm
	Height(max.)	20mm	25mm	20mm
Weight* (Approx.)		0.5g	0.8g	1.0g
Typical capacity		15mAh	32mAh	23mAh
Nominal voltage		3.8V		
Max charging voltage		4.35V		
Max charging current		11.2mA(0.75C)	90mA(3C)	66mA(3C)



* Without tabs

Thank you very much !

上海唐辉电子有限公司
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