	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	1 / 10




Battery Shelf Life Test

Product Name: Battery Pack


Model Name: BT-303 R

Tested by Changdeok Kim and Approved by Beom-ki KIM

Tested on August 6, 2020

	PREPARE	REVIEW	APPROVE
Signature			
Department	HW manager in R&D CENTER	R&D Director	CEO
Name	Chang deok Kim	Youngjin Lee	Beom-ki KIM
Date	6/August/2020	6/August/2020	6/August/2020

Test result : The shelf life of BT-303 R is 4 years.

	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	2 / 10

1. Test Purpose

- By measuring the current consumption of the battery, the shelf life of the battery is predicted by an arithmetic expression.

2. Specification of BT-303 R


- (1) The battery pack constructed with 12pcs primary lithium cells (4S3P), and equipped with protective circuit.
- (2) The main features of BT-303 R are shown as below:


Model	Nominal capacity	Nominal voltage	Maximum discharge current	Discharge cut-off voltage	Dimensions
BT-303 W, BT-303 R, BT-303 O	4200mAh	12.0V	3000mA	10.4V	24.6mm*59.2mm*181.58


- (3) Picture of BT-303 R



3. Test equipment

Equipment	Model Name	Serial Number
Defibrillator	HR-501 Plus	
Digit Multimeter	34465A (Control No.: RD-ME-23)	.S/N: MY54501043 .Calibrated on Sep. 09, 2019 .Frequency of calibration: 2 years . Annex 1. Calibration report

	Battery Shelf Life Test Automated External Defibrillator (Heart Guardian HR-501 Series)	File No.	RDHW-200910
		Rev No.	1
		Rev. Date	1/Oct./2021
		Page No.	3 / 10

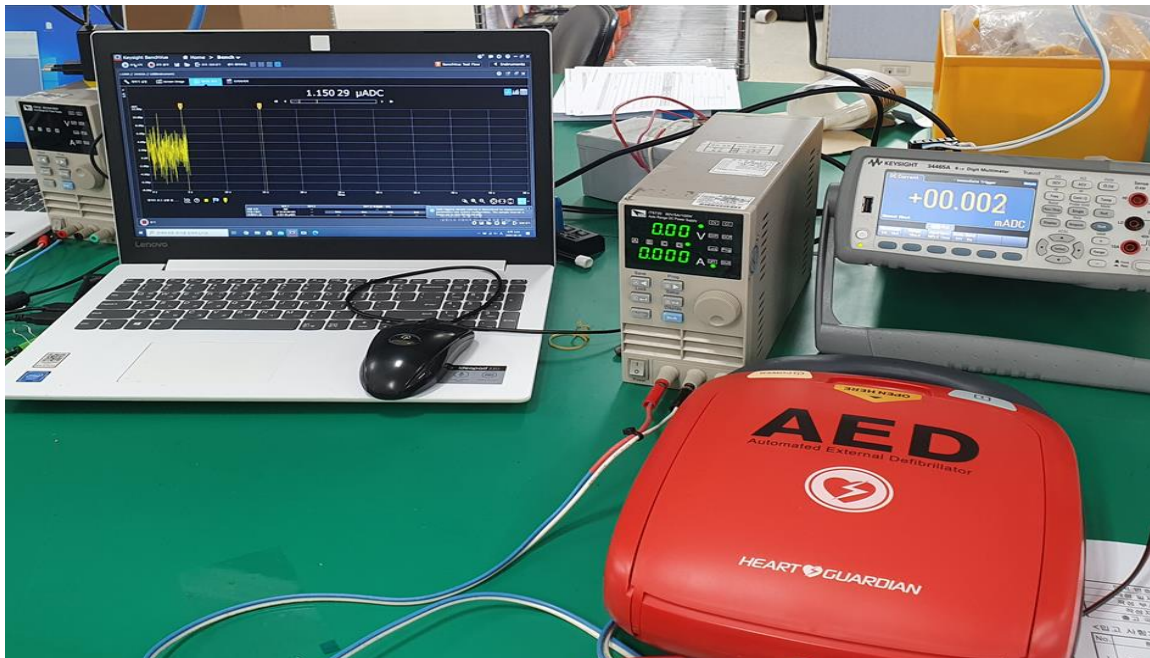
Laptop	.Lenove Notebook .Used software: BenchVue is multimeter compatible.	
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4. Testing method

- A. Connect the battery of HR-501 and multimeter
- B. Connect Multimeter to PC and run BenchVue
- C. Measurement of current consumption
 - a. A Test measures the amount of current consumed for 1 second in sleep mode.
 - b. B Test measures the amount of current consumed for LED flickering.
 - c. C Test measures the amount of current consumed for self-diagnosis in administrator mode.

5. Testing environment

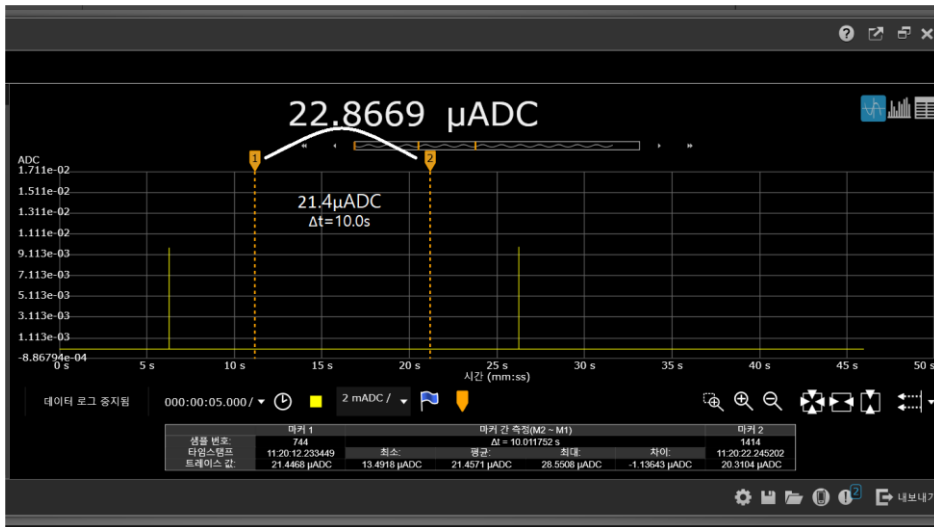
- Testing place: R&D Lab
- Temperature and humidity at the place: $23 \pm 5^{\circ}\text{C}$, 40~70%



5. Test result

A. Test

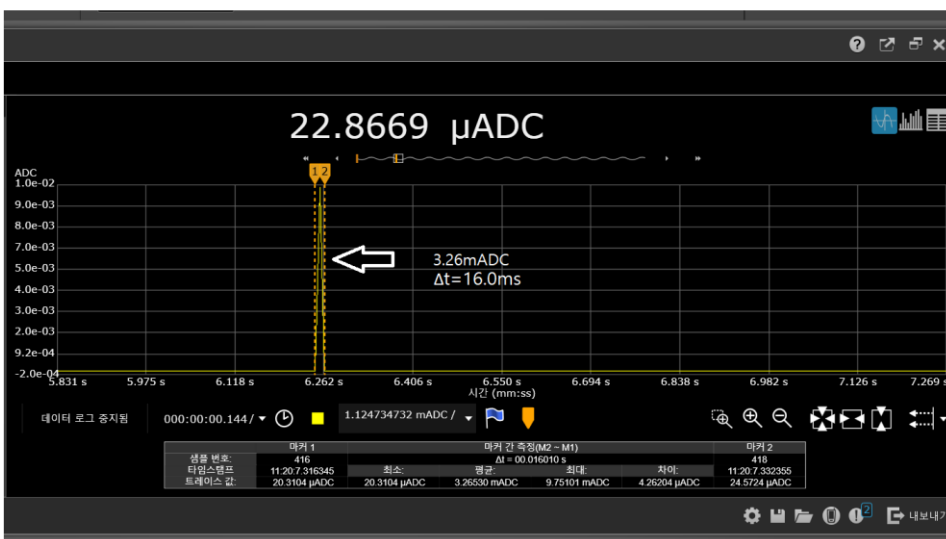
- The product checks the battery level per 10 second in sleep mode.
- The average of battery level is 21.4uA/sec.




마커 간 측정(M2 ~ M1)		
Δt = 10.011752 s		
최소:	평균:	최대:
13.4918 µADC	21.4571 µADC	28.5508 µADC

B. Test

- The LED flickering conducts for 16ms per 20 seconds.
 - The average of battery level while LED flickering is 3.26mA
 - Therefore, the average of battery level is 2.61uA/sec.
- $3260\mu A(3.26mA) * 0.016sec(16msec) / 20sec = 2.61\mu A$



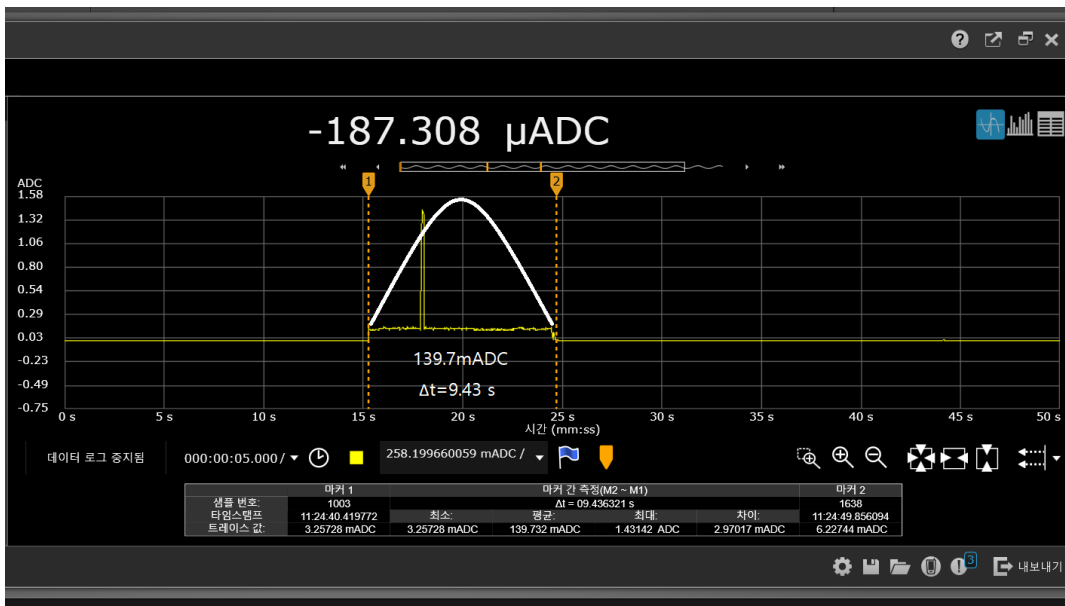
마커 간 측정(M2 ~ M1)		
Δt = 00.016010 s		
최소:	평균:	최대:
20.3104 µADC	3.26530 mADC	9.75101 mADC

	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	5 / 10

C. Test

- The self-diagnosis conducts for 10 seconds only once per month.
- The average of battery level is 140mA/sec and maximum of battery level is 1.43A.
- Therefore, the average of battery level is 2.61uA/sec.

$$140000\mu\text{A}(140\text{mA}) * 20 \text{ sec} / (30 \text{ day} * 24 \text{ hours} * 60\text{min} * 60\text{s}) = 0.51\mu\text{A}$$



마커 간 측정(M2 ~ M1)		
Δt = 09.436321 s		
최소	평균	최대
3.25728 mADC	139.732 mADC	1.43142 ADC

6. Formula

A. Current consumption per second


- $21.4\mu\text{A}(\text{A test}) + 2.61\mu\text{A}(\text{B test}) + 0.51\mu\text{A} = 24.5\mu\text{A}$

However instant maximum consumption current is 1.43A, as for it calculation 50uA.

B. Battery capacity

- $1400 * 3 = 4200\text{mAh}$

Calculate to discharge rate 0.7 base on 4200mAh is 3360mAh.

	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	6 / 10


C. Operating period

- $3360\text{mAh} / 0.05\text{mA} = 67200$ hours

However, calculate to discharging rate 20% on the basis of 1 time monthly charging & discharging is 53760 hours. ($67200 * 0.8$)

Therefore, the current amount consumed per year

- 53760 hour = 2240 day = 6.1 year

	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	7 / 10

. Annex 1. Calibration report



교 정 성 적 서

CALIBRATION CERTIFICATE



성적서 번호 : 1919147-7

서울 금천 서부셋길 606 대성-디폴리스 B동 8층
TEL : 02-869-1600 / FAX : 02-861-8585

Page 1 / 4 Pages

1. 의뢰자 (Client)

기관명 (Name) : 주식회사 라디안큐바이오
주소 (Address) : 서울특별시 금천구 가산디지털2로 53 (가산동, 한라시그마밸리1609호,1610호,1611호)

2. 측정기 (Calibration Subject)

기기명 (Description) : 디지털 멀티미터
제조회사 및 형식 (Manufacturer & Model Name) : KEYSIGHT / 34465A
기기번호 (Serial Number) : MY54501043

3. 교정일자 (Date of Calibration)

: 2019년 09월 09일

4. 교정환경 (Environment)

온도 (Temperature) : (22.8 ± 0.3) °C 습도 (Humidity) : (47 ± 4) % R.H.
교정장소 (Location) : 고정표준실 (CLAB Lab) 이동교정 (Mobile Lab) 현장교정 (On Site cal.)

5. 측정표준의 소급성 (Traceability)

교정방법 및 소급성 서술 (Calibration method and/or brief description)

상기 기기는 아날로그/디지털 멀티미터 교정업무표준서(CLAB-TM-40419-116)에 따라 국가측정표준기관으로부터 측정의 소급성이 확보된 아래의 표준장비를 이용하여 교정되었습니다.

교정에 사용한 표준장비 명세 (List of used standards / specifications)

기기명	제조회사 및 형식	기기번호	차기교정 예정일자	교정기관
Calibrator	Fluke / 5500A	1636004	2020.07.24	한국캘랩㈜
Calibrator	Fluke / 5730A	2808502	2020.06.22	한국표준과학연구원

6. 교정결과 (Calibration Results) : 교정결과 참조

7. 측정불확도 (Measurement uncertainty) : 교정결과 참조

확인 (Affirmation) 작성자 (Measurements performed by) : 정진영
성명 (Name) 정진영

승인자 (Approved by) : 임승호
직위 (Title) 기술책임자 (정부) : 임승호
성명 (Name) 임승호

위 성적서는 국제시험기관인정협력체(International Laboratory Accreditation Cooperation) 상호인정협정(Mutual Recognition Arrangement)에 서명한 한국인정기구(KOLAS)로부터 공인받은 분야의 교정결과입니다.

한국인정기구 인정
Accredited by KOLAS, Republic of KOREA

2019년 09월 09일


한국캘랩(주) 대표이사



(*) 성적서는 측정기의 정밀정확도에 영향을 미치는 요소(과부하, 온도, 습도 등)의 급격한 변화가 발생한 경우에는 무효가 됩니다.

F-QP022-001/A4P (REV.08)



	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	8 / 10



교 정 결 과

CALIBRATION RESULTS



성적서 번호 : **1919147-7**

Page 2 / 4 Pages

1. DC Voltage Calibration.

Range	STD. Value	Measured Value	Correction Value	Measurement uncertainty
100 mV	100.000 00 mV	99.998 9 mV	0.001 1 mV	0.001 4 mV
1 V	1.000 000 0 V	1.000 008 V	-0.000 008 V	0.000 007 V
10 V	2.000 000 V	2.000 00 V	0.000 00 V	0.000 03 V
	4.000 000 V	4.000 04 V	-0.000 04 V	0.000 03 V
	6.000 000 V	6.000 02 V	-0.000 02 V	0.000 04 V
	8.000 000 V	8.000 00 V	0.000 00 V	0.000 05 V
	10.000 000 V	9.999 99 V	0.000 01 V	0.000 05 V
100 V	100.000 00 V	100.000 6 V	-0.000 6 V	0.000 7 V
1 000 V	1 000.000 0 V	999.994 V	0.006 V	0.009 V

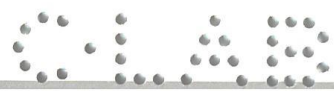
2. DC Current Calibration.

Range	STD. Value	Measured Value	Correction Value	Measurement uncertainty
100 μA	100.000 0 μA	100.009 1 μA	-0.009 1 μA	0.011 6 μA
1 mA	1.000 000 mA	1.000 043 mA	-0.000 043 mA	0.000 049 mA
10 mA	10.000 00 mA	10.000 04 mA	-0.000 04 mA	0.000 46 mA
100 mA	100.000 0 mA	99.999 3 mA	0.000 7 mA	0.006 1 mA
1 A	1.000 000 A	0.999 930 A	0.000 070 A	0.000 107 A
3 A	3.000 0 A	2.999 5 A	0.000 5 A	0.005 0 A
10 A	10.000 0 A	9.998 7 A	0.001 3 A	0.008 5 A


3. Resistance Calibration. (4 wire)

Range	STD. Value	Measured Value	Correction Value	Measurement uncertainty
100 Ω	99.998 7 Ω	99.993 5 Ω	0.005 2 Ω	0.001 3 Ω
1 kΩ	1.000 005 kΩ	0.999 931 kΩ	0.000 074 kΩ	0.000 010 kΩ
10 kΩ	9.999 90 kΩ	9.999 83 kΩ	0.000 07 kΩ	0.000 10 kΩ
100 kΩ	99.998 3 kΩ	100.000 1 kΩ	-0.001 8 kΩ	0.001 5 kΩ
1 MΩ	0.999 946 MΩ	0.999 986 MΩ	-0.000 040 MΩ	0.000 019 MΩ

F-QP022-002/A4P (REV.03)



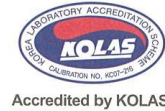
Hankeek Cal Lab Co., Ltd

	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	9 / 10



교 정 결 과

CALIBRATION RESULTS



성적서 번호 : 1919147-7

Page 3 / 4 Pages


4. AC Voltage Calibration.

Range	STD. Value	Measured Value	Correction Value	Measurement uncertainty
100 mV	100.000 mV , 40 Hz	99.998 mV	0.002 mV	0.019 mV
	100.000 mV , 1 kHz	100.001 mV	-0.001 mV	0.016 mV
	100.000 mV , 20 kHz	100.006 mV	-0.006 mV	0.016 mV
	100.000 mV , 50 kHz	100.015 mV	-0.015 mV	0.024 mV
1 V	1.000 00 V , 40 Hz	1.000 02 V	-0.000 02 V	0.000 13 V
	1.000 00 V , 1 kHz	1.000 04 V	-0.000 04 V	0.000 08 V
	1.000 00 V , 20 kHz	1.000 10 V	-0.000 10 V	0.000 08 V
	1.000 00 V , 50 kHz	1.000 12 V	-0.000 12 V	0.000 10 V
10 V	10.000 0 V , 40 Hz	10.000 0 V	0.000 0 V	0.001 3 V
	10.000 0 V , 1 kHz	10.000 2 V	-0.000 2 V	0.000 7 V
	10.000 0 V , 20 kHz	10.000 8 V	-0.000 8 V	0.000 7 V
	10.000 0 V , 50 kHz	10.001 9 V	-0.001 9 V	0.001 0 V
100 V	100.000 V , 40 Hz	99.998 V	0.002 V	0.013 V
	100.000 V , 1 kHz	99.999 V	0.001 V	0.009 V
	100.000 V , 20 kHz	100.002 V	-0.002 V	0.009 V
	100.000 V , 50 kHz	100.006 V	-0.006 V	0.012 V
750 V	750.00 V , 1 kHz	750.03 V	-0.03 V	0.08 V

F-QP022-002/A4P (REV.03)



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	Battery Shelf Life Test	File No.	RDHW-200910
		Rev No.	1
	Automated External Defibrillator (Heart Guardian HR-501 Series)	Rev. Date	1/Oct./2021
		Page No.	10 / 10



교 정 결 과

CALIBRATION RESULTS



성적서 번호 : 1919147-7

Page 4 / 4 Pages

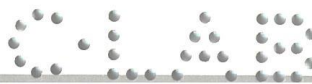
5. AC Current Calibration.

Range	STD. Value	Measured Value	Correction Value	Measurement uncertainty
1 mA	1.000 00 mA , 40 Hz	1.000 01 mA	-0.000 01 mA	0.000 24 mA
	1.000 00 mA , 1 kHz	1.000 08 mA	-0.000 08 mA	0.000 18 mA
10 mA	10.000 0 mA , 40 Hz	10.001 4 mA	-0.001 4 mA	0.002 4 mA
	10.000 0 mA , 1 kHz	10.001 2 mA	-0.001 2 mA	0.001 8 mA
100 mA	100.000 mA , 40 Hz	100.004 mA	-0.004 mA	0.025 mA
	100.000 mA , 1 kHz	100.010 mA	-0.010 mA	0.018 mA
1 A	1.000 00 A , 40 Hz	0.999 91 A	0.000 09 A	0.000 35 A
	1.000 00 A , 1 kHz	0.999 90 A	0.000 10 A	0.000 35 A
3 A	3.000 A , 100 Hz	2.998 A	0.002 A	0.019 A
	3.000 A , 1 kHz	2.999 A	0.001 A	0.019 A
10 A	10.000 A , 100 Hz	9.998 A	0.002 A	0.043 A
	10.000 A , 1 kHz	9.999 A	0.001 A	0.043 A

※ Measurement uncertainty : 신뢰수준 약 95 %, $k = 2$. 끝.

※ 국가교정기관 지정제도 운영요령 제40조에서 고시한 교정주기 : 12 개월

F-QP022-002/A4P (REV.03)



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