Lab Report on Battery Test of Oppo A16

Capacity test of the 4890 battery with cadex 8000 instrument

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***Abstract*—Lithium ion battery are the most predominant energy storage system in mobile handsets available in the market today. As per the type approval procedure TAP-04, NTA aims to validate the specification provided by the manufacturer on the battery cover for the benefit of the customers. The battery is tested with the battery testing equipment, CADEX 8000, wherein battery is run through a sequence of charge-discharge cycle all the while measuring the charge and discharge current to determine its actual capacity. The actual capacity is compared to its manufacturer designated design capacity. The battery is concluded as "passing" if the test determines its capacity to be equal or above 85 percent of the design capacity. The Oppo A16 (CPH2269)model has *passed* the test with its capacity determined to be at 86%.**

***Index Terms*—keywords, battery, lithium ion, capacity, temperature, etc.**

I. Introduction

NEPAL Telecommunication Authority (NTA) is an autonomous telecommunication regulatory body established in February 1998 pursuant to Telecommunication Act, 1997 and Telecommunication Regulation 1998. As per the provision of clause(f) of section 13 and section 14 of Act of the Authority determines and/or approves the standard of the plant and equipment in relation to the telecommunications and telecommunications service. In order to standardize the CPE radio terminal, NTA has issued a Type approval procedure (TAP-04) [1]. As per the TAP-04, the manufacturers/authorized representatives have to get a type approval certificate to import and/or sale of any types of radio telecommunication CPEs in Nepal. Each and every model of mobile handset shall meet some technical specifications adherent to safety standards like Radiation safety, battery safety, etc. of mobile phones in order to get the device approved.

Cell phone manufacturers have produced a wide variety of cell phones with wide price ranges. Every such cell phone must meet the minimum standard set by NTA in TAP-04. For the type approval of hand sets, the applicant will provide the relevant data for them. In the case of battery, the applicant shall state value of capacity of the battery (in mAH) in its application document to get the type approval certificate. The battery metrics with its chemistry (Li/ Li-polymer), nominal voltage (in Volts) and capacity are provided in the battery cover. The parameters are verified with the battery testing system (BTS) CADEX 8000 in order to validate the data supplied by the applicant.

Battery capacity(mAH) is defined as a product of the current that is drawn from the battery while the battery is able to supply the load until its voltage is dropped to lower than a certain minimum value ($2.9V$ in our case) for each cell. [7]

CADEX 8000 is a programmable BTS, that runs a pre-programmed testing algorithm where it runs charging and discharging cycles on the battery. During those cycles, current and temperature of the battery are measured which is used to determine the percentage of actual capacity of the battery against the designed capacity.The battery is considered to have passed the test if it has a capacity equal to or above 85 percent of its designed capacity. [2]

II. Materials and Methods

The experimental setup shown in Fig. 4 consisted of the C8000 advanced programmable BTS, C8000 SnapLock^{TM} Adapter Unit (PN 07-510-0000), RigidArm^{TM} Universal Battery Adapter (PN 07-110-0192) and Auxiliary data and Power port cables. The setup was then, connected to a PC via Ethernet cable with Battery lab software in Fig. 1. The battery tested today was the 4890 battery of Oppo A16 (CPH2269)model with imei number 865466058298339 The experiment was conducted in following steps.

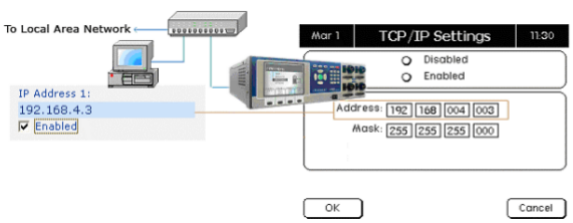

Fig. 1. Cadex 8000 connected to PC

A. Connect C8000 to BatteryLab

After the C8000 is connected to the PC via Ethernet, an IP address was assigned to the C8000 in BatteryLab program

as show in Fig. 1. Then, we pressed the connect button to complete the connection. On successful connection, we get a success message.

B. Add C-code for the battery

C-code is a set of parameters that is unique to battery being tested. C code with the same name as the model name of the mobile phone (Oppo A16) is created using the Battery Lab app as shown in Fig. 2.

C-Code Name	oppo_a16	
Chemistry	Li	
Number of cells	1	Cell
Rating	4.890	Ah
Charge rate	3.000	A
Discharge rate	3.000	A
Low temperature limit	0	degC
High temperature limit	45	degC
Delta T (dT)	1	degC/min
Maximum charge voltage	4.300	V
End of discharge	2.900	V
Standby voltage	4.050	V
Charge termination point	0.244	A
Rapid charge voltage	3.000	V
Target capacity	85	percent(%)
Perform automatic ohmtest	No	
Charge timeout (0 = off)	200	C-minute
Discharge timeout (0 = off)	200	C-minute
milli-ohms pass/fail point	150	mOhms
Min. safe operating voltage	1.000	V
Max. safe operating voltage	4.500	V
Max. safe operating charge current	9.780	A
Max. safe operating discharge current	9.780	A
Max. safe operating temperature	60	degC

Fig. 2. Cadex 8000 ccode interface

The relevant parameters changed in the experiment here are the *Chemistry* which is selected to be Li for lithium ion battery in our case and *Rating* at 4.89AH. All other parameters are left as default. Specifically, the *Maximum charge voltage* and *End of discharge* are set at $4.3V$ and $2.9V$ respectively by default. The above values must be obtained from the battery datasheet but is unavailable at this time from the manufacturer. The values will vary by the virtue of the particular batteries chemistry specifically the OCP of its positive electrode material. Neither the values are provided nor the chemistry could be determined, thus, the values are assumed as given above as per the standard convention for the safe charge disharge in lithium ion batteries. [4], [9] Also, both the charge and discharge rate are set at $3.0A$. All parameters are set according to the specification provided in the battery cover as in Fig. 7

C. Run the Auto Test

Auto is a factory default program provided by C8000. It exercises the battery to provide optimum performance. The battery is first cycled (charged and then discharged) to determine its true capacity. The charging is done via CC-CV method wherein, a constant charge current is applied to the cell until the cell reaches some predetermined maximum voltage($4.3V$). The cell's terminal voltage is then held at this maximum value until charging current becomes negligibly small($0.244A$). [8] During discharge, a constant current ($3.0AA$) of 1C rate is disharged until the end of dishcharge voltage ($2.9V$) is reached. There is a recondition step for NiMH chemistry but is not performed for Li-ion and SLA batteries. SLA and Li-ion batteries are cycled once. If the target capacity is not reached in the first cycle, it is cycled again [5]. Both charging and discharging are done at the rate of $3.0A$ as in Fig. 2.

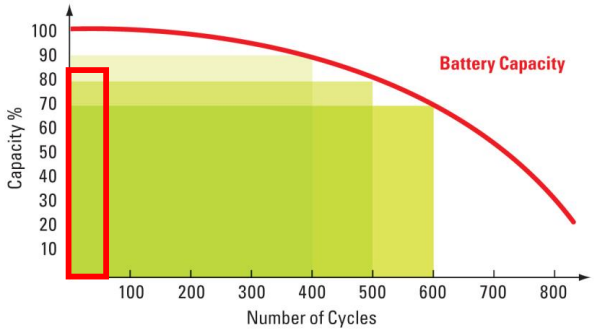

Fig. 3. The area covered by the red rectangle shows the expected battery capacity below 100 charge discharge cycles

Finally, the battery is determined to have passed the test if its capacity is $>= targetcapacity$. *target capacity* is set at 85% taking in reference from [2], [3] in Fig. 3. Since the battery is assumed to be brand new same as the cell phone, the battery clearly should a charge-discharge cycle less than 100,thus, it should at least meet the target capacity.

While selecting the target capacity (85%), a slightly less conservative approach is preferred so as to provide ample margin of tolerence for errors in the experiment, experimental setup and manufacture data. Although a battery should deliver 100 percent capacity during the first year of service, it is common to see lower than specified capacities, and shelf life may contribute to this loss. In addition, manufacturers tend to overrate their batteries, knowing that very few users will do spot-checks and complain if low. Not having to match single cells in mobile phones and tablets, as is required in multi-cell packs, opens the floodgates for a much broader performance acceptance. Cells with lower capacities may slip through cracks without the consumer knowing. [3]

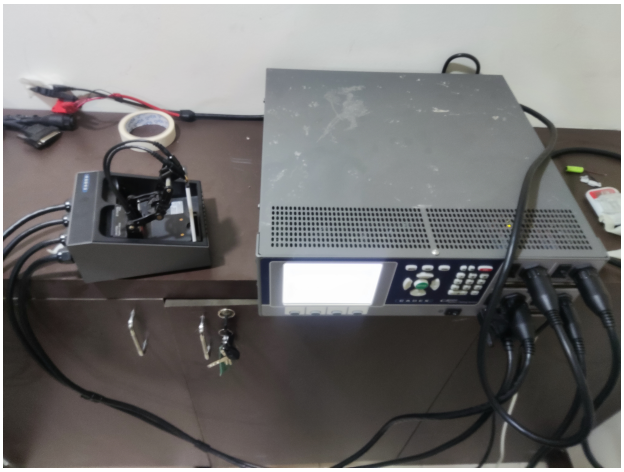

Fig. 4. Experimental setup with cadex 8000

III. Results and Discussion

The resulting graph from the *Auto* test are shown in Fig. 5. In the fig, the quantities$Voltage(V)$ in green, $Amperage(A)$ in blue and $Temprature(T)$ in red are plotted from top to bottom order in the vertical axis against $Time(minutes)$ in the horizontal axis. Initially, the battery is charged till $4.3V$ at max charge rate of $3.0A$. The charge cycle ensures battery is at full capacity before the actual measurement. Then it is discharged at a similar max rate of $3.0A$.

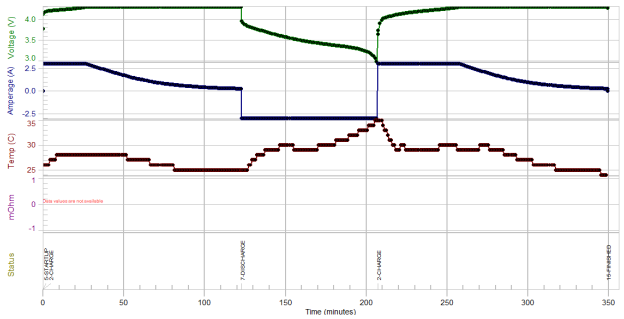

Fig. 5. Graph of voltage, ampere and temperature against time shows the real-time status of battery during the experiment

During discharge, the true capacity is computed by C8000 and compared to the designated capacity $4.89AH$. Also, the temperature reading shows normal behaviour which is $25 \pm 10°C$(room temperature). The true battery capacity is compared to design capacity $(4.89AH)$ set in the C-Code which is found to be at 86% which is greater than our target capacity and hence, the battery has passed the test. If the battery had failed this phase of the test, it would be subjected to another charge-discharge cycle. Finally, the battery which is now assumed to be at 0% is charged to 100% at the end of the test. This completes the six steps of the *Auto* test although only four steps: **STARTUP, CHARGE, DISCHARGE, CHARGE, FINISHED** are the only steps executed as per needed with our current battery sample.

Unit#	1
Firmware Version	2.10
Channel#	1
Battery ID	N/A
C-Code	oppo_a16
C-Code Charge Rate	3.000
C-Code Dchg Rate	3.000
Test ID	49
Program	Auto
Start	03/31/2022 6:07:31 AM
End	03/31/2022 11:57:31 AM
Duration	5 hour(s) 50 min(s)
Result	PASS
Capacities	86%
Fail Step#	N/A
Fail Message	N/A
mOhm	N/A
Status Code(s)	STARTUP, CHARGE, DISCHARGE, CHARGE, FINISHED
Charge Count	2
Discharge Count	1
Custom Waveform	N/A
Playback Waveform	N/A
LoadCapture Waveform	N/A
Remark	N/A

Fig. 6. Result provided by the C8000 for the Oppo A16 sample

Fig. 6 shows the result generated by the C8000. Notably, the amount of time for this test of this sample was 5 hours and 50 minutes.

Fig. 7. Phone sample Oppo A16 with battery

IV. Conclusion

The battery sample of the mobile phone *Oppo A16* has passed the capacity test. Since, 86% is greater than our target capacity (85%), the specification provided by the manufacturer is clearly valid. It is worth mentioning that the results provided by the experiment are only as valid as the parameters set in the C-code which should be accurately copied by the experimenter. The above experiment only validates the capacity at the beginning of the battery lifecycle and doesn't hold true for rest of its lifecycle during its active use. An interesting parameter can be the number of cycles until which the battery reaches below 80% of its actual capacity. Further, tests like *OhmTest, Life cycle* test can be performed to provide more

accurate analysis of the battery performance on the mobile phone during its overall lifetime.

A. Abbreviation

Li - Lithium ion
LiPo - Lithium Polymer
NTA - Nepal Telecommunication Authority
mAH - Milli Ampere Hour
CPE - Customer Premise Equipment
OCP - Open Circuit Potential

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