MBRT v2.1

Mac Battery Repair Tool

The device is designed to work with batteries based on bq20z451 and bq40z651 controllers.

Nowadays, many clients bring their Mac laptops with discharged or faulty batteries for repair.

MBRT programmer is the perfect assistant to revive such batteries.

Contents:

1. Package content, appearance of the device, description of control buttons.
2. List of supported batteries.
3. Battery connectors' pinouts.
4. Device powering, connecting the battery, using the tool for the first time.
5. Menu and device functionality.
6. Battery repair example.
7. FAQ

1. Package Content

The device comes with 6 cables:

1. Data cable for connecting battery series: A1713, A1820, A2113, A2519...
2. Universal cable (for soldering to i2c data bus).
3. Power connector for battery series: A1713, A1820, A2113, A2519...
4. Micro-USB cable for connecting power to the device
5. Cable for connecting the A2669 battery used in MacBook Air M2 (A2681), MacBook Air M3 (A3113)
6. Cable for connecting the A2797 battery used in MacBook Air 15" (A2941, A3114, A3241)

Appearance of the device:

1. Device power connector (micro USB)
2. Battery connector
3. Display
4. Control buttons (moving through the device menu)

2. Supported Models:

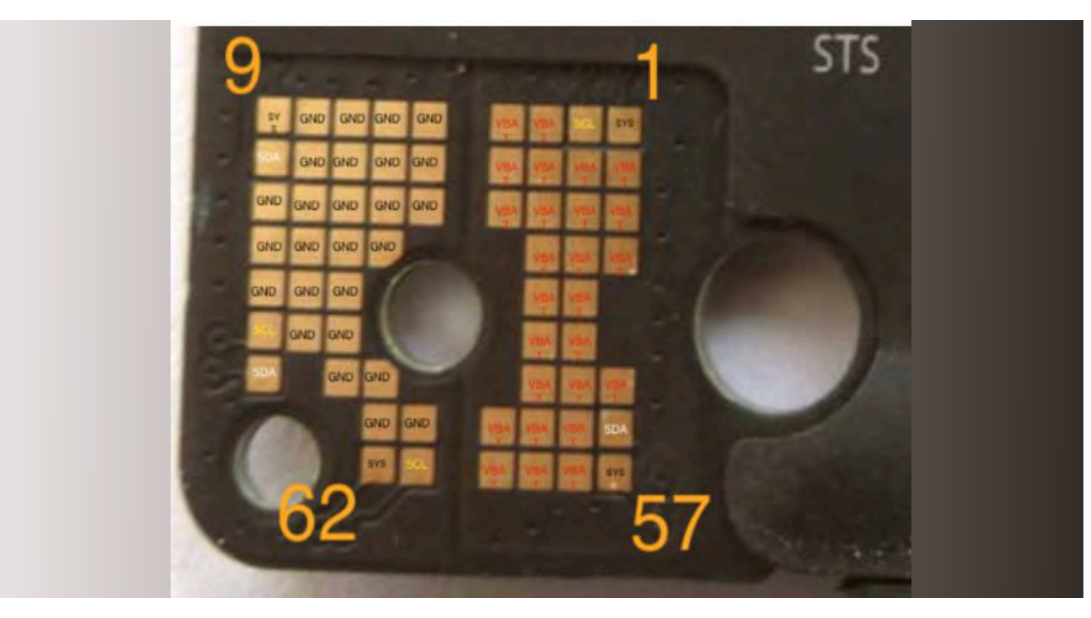
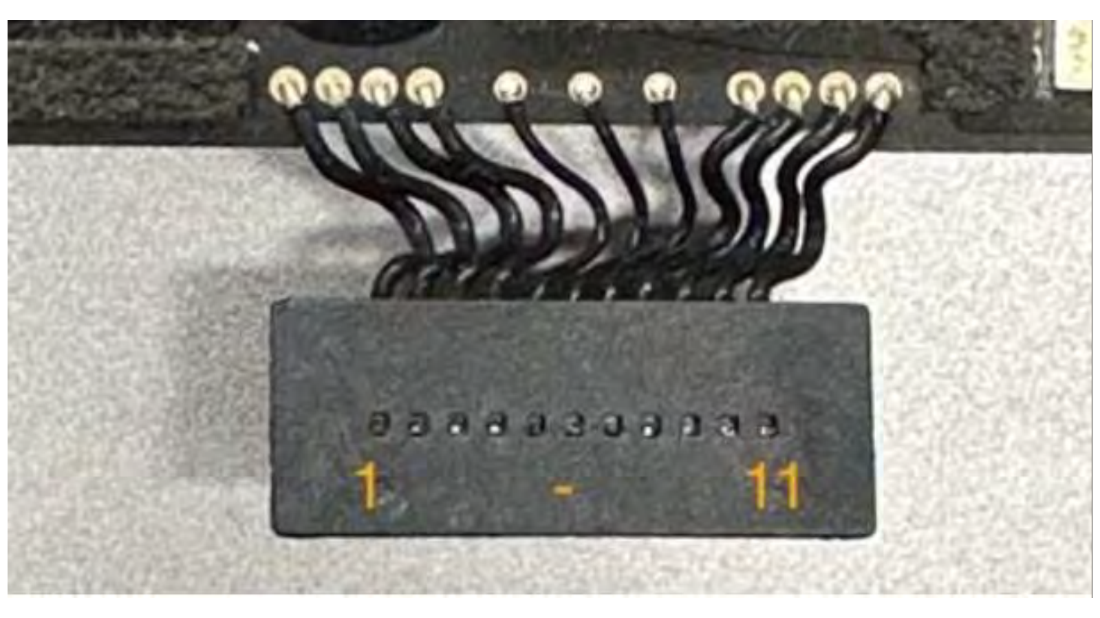
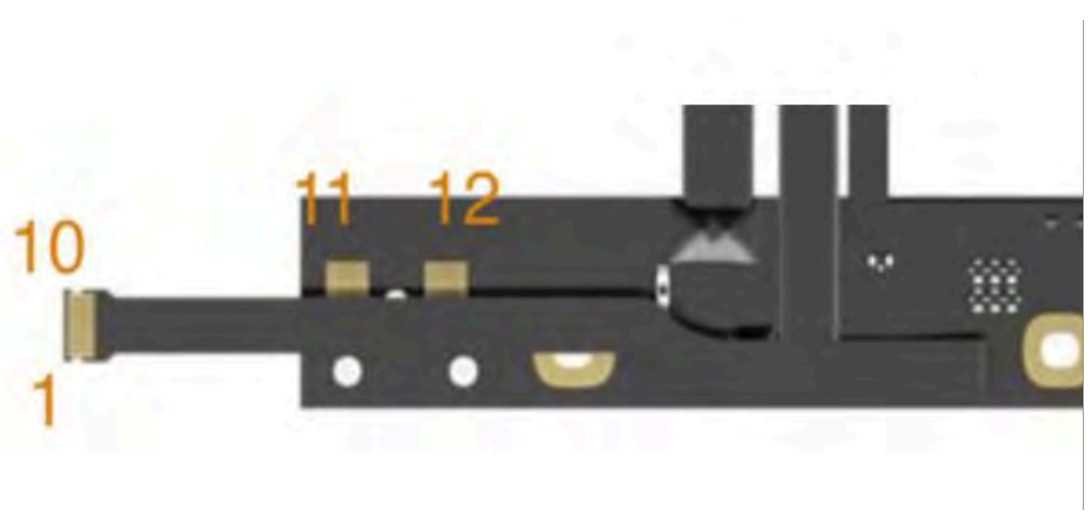
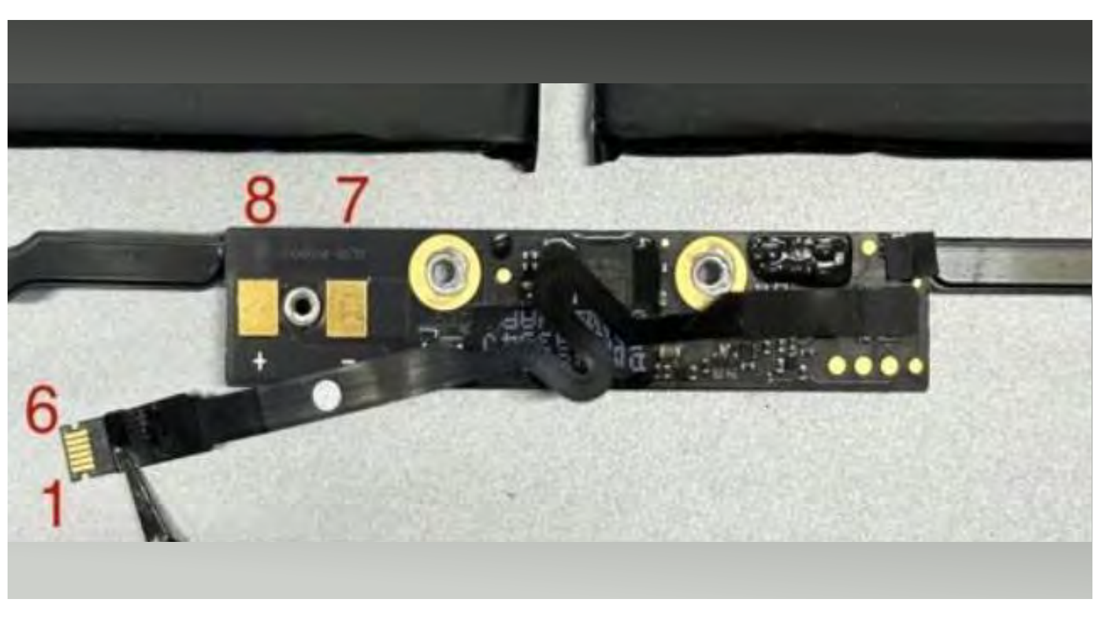
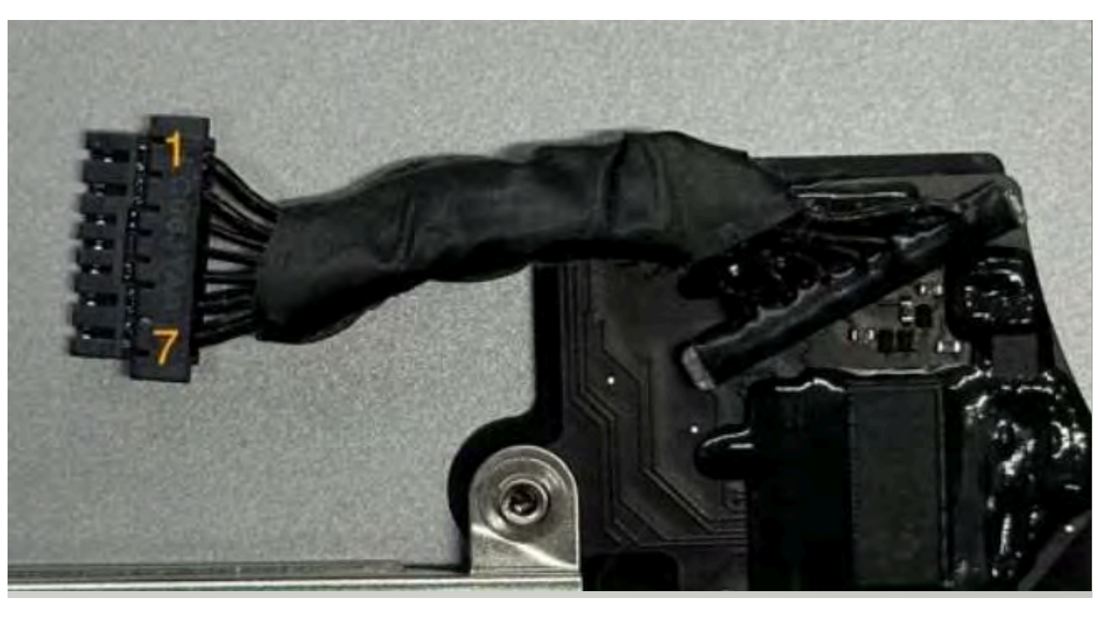
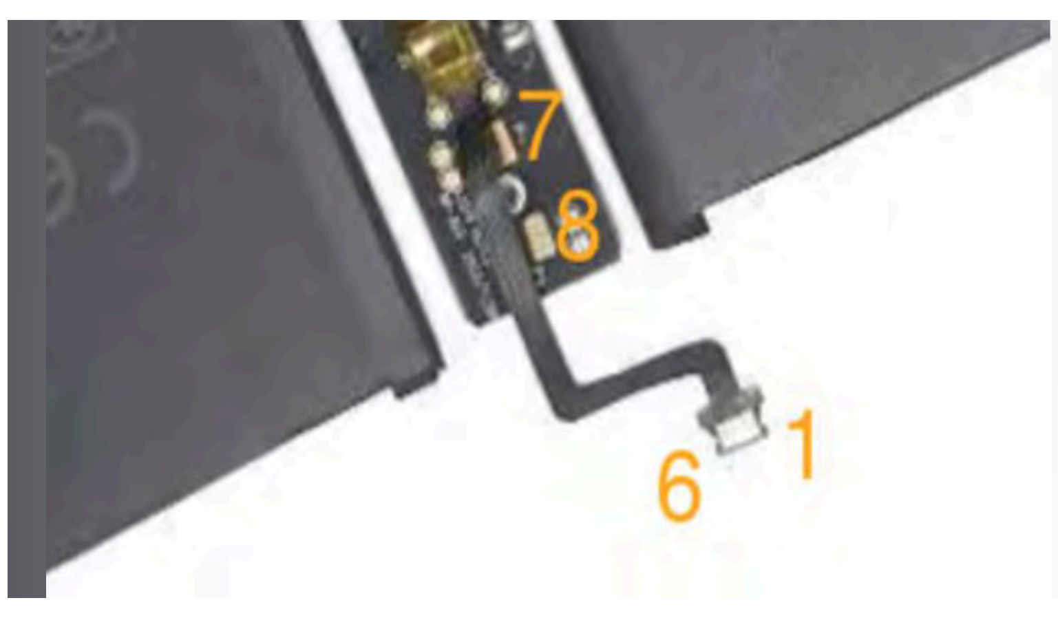
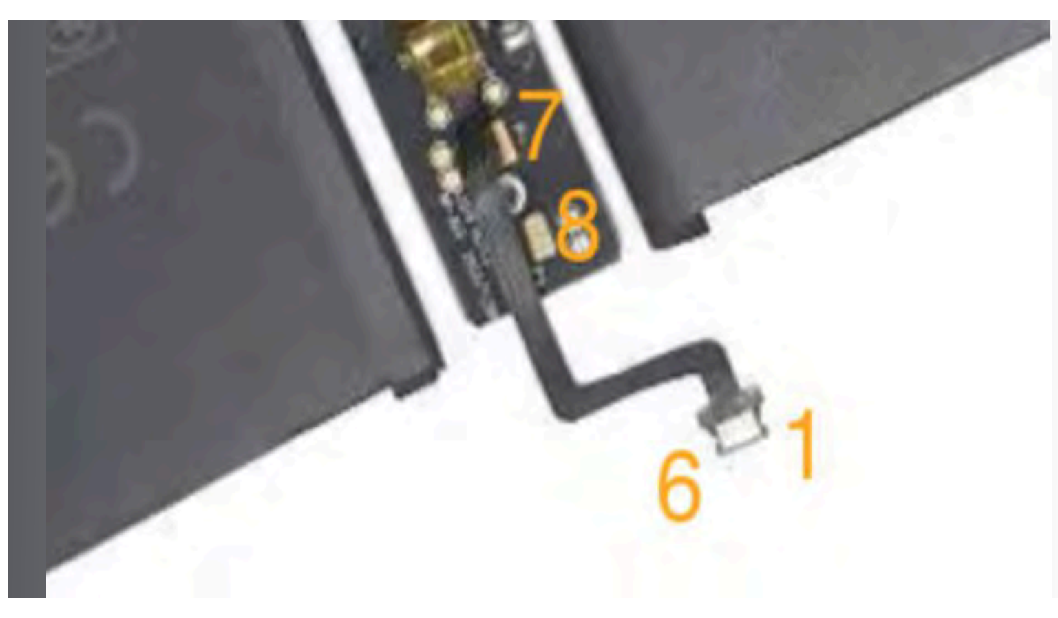
Battery Pack Model:	MacBook model:	Firmware:	Cells:	Controller:
A1309	PRO17 (A1297) 2009-2010 year	fw:0301	3	BQ20Z451
A1321	PRO15 (A1286) 2010-2010 year	fw:0201	3	BQ20Z451
A1322	PRO13 (A1278)	fw:0201	3	BQ20Z451
A1382	PRO15 (A1286) 2011 year	fw:0406	3	BQ20Z451
A1383	PRO17 (A1297) 2011 year	fw:0406	3	BQ20Z451
A1405	AIR13 (A1369)	fw:0301	2	BQ20Z451
A1406	AIR11 (A1370)	fw:0301	2	BQ20Z451
A1417	PRO15 (A1398) 2012-2013 year	fw:0511	3	BQ20Z451
A1437	PRO13 (A1425)	fw:0511	3	BQ20Z451
A1493	PRO13 (A1502) 2013-2014 year	fw:0702	3	BQ20Z451
A1494	PRO15 (A1398) 2013-2014 year	fw:0702	3	BQ20Z451
A1495	AIR11 (A1465)	fw:0511	2	BQ20Z451
A1496	AIR13 (A1466)	fw:0511	2	BQ20Z451
A1527	12 (A1534) 2015 year	fw:0702	2	BQ20Z451
A1582	PRO13 (A1502) 2015 year	fw:0702	3	BQ20Z451
A1618	PRO15 (A1398) 2015 year	fw:0702	3	BQ20Z451
A1705	12 (A1534) 2016-2017 year	fw:0702	2	BQ20Z451
A1713	PRO13 (A1708)	fw:0901	3	BQ20Z451
A1819	PRO13 (A1706)	fw:0901	3	BQ20Z451
A1820	PRO15 (A1707)	fw:0702	3	BQ20Z451
A1953	PRO15 (A1990)	fw:0901	3	BQ20Z451
A1964	PRO13 (A1989), PRO13 (A2251)	fw:0901	3	BQ20Z451
A1965	AIR13 (A1932), AIR13 (A2179)	fw:1002	3	BQ20Z451
A2171	PRO13 (A2159), PRO13 (A2289), PRO13 M1(A2338), PRO13 M2(A2338)	fw:1002	3	BQ20Z451
A2113	PRO16 (A2141)	fw:1100	3	BQ40Z651
A2389	AIR13 M1 (A2337)	fw:1002	3	BQ20Z451
A2519	PRO14 M1 (A2442), PRO14 M2 (A2779), PRO14 M3 (A2918)	fw:1100	3	BQ40Z651
A2527	PRO16 M1 (A2485), PRO16 M2 (A2780)	fw:1100	3	BQ40Z651
A2669	AIR M2 (A2681) 2022 year*	fw:1100	3	BQ40Z651
A2797	AIR 15 (A2941, A3114, A3241)*	fw:1100	3	BQ40Z651

*These cables are included in this kit, but not in the previous versions. If you have the older kit, you can buy them separately.

3. Battery connection

Below is a table with pinouts for all supported batteries:

Note: for the correct operation of the battery, the SYS_DETECT signal must be connected to the ground (GND)

Battery pack model:	Connector picture:	Pinout:
MBRT Pinout		1- NC, 2 - SDA, 3 - SCL, 4 - GND
A1309, A1321, A1322, A1382, A1383		1, 2, 3 - GND(-) 6 - SDA 5 - SYS_DETECT 4 - SCL 7, 8, 9 - VBAT(+)
A1405, A1496		1, 2, 3 - VBAT(+) 4 - SCL 5 - SDA 6 - SYS_DETECT 7, 8, 9 - GND(-)
A1406, A1495		1, 2, 3 - VBAT(+) 4 - SCL 5 - SDA 6 - SYS_DETECT 7, 8, 9 - GND(-)
A1437		1,9,57,62 - SYS_DETECT 2, 44, 61 - SCL 18, 50, 51 - SDA
A1493, A1582		1, 2, 3 - VBAT(+) 4 - SCL 5 - SDA 6 - SYS_DETECT 7, 8, 9 - GND(-)
A1417, A1494, A1618		1,2,3,4 - VBAT(+) 5 - SCL 6 - SDA 7 - SYS_DETECT 8,9,10,11 - GND(-)
A1527, A1705		4 - VBAT(+) 1 - SCL 2 - SYS_DETECT 3 - SDA 5 - GND(-)
A1713, A2171		1,4,10,12 - GND 2 - SCL 3 - SDA 7 - SYS_DETECT 11 - VBAT (+)
A1819, A1820, A1953, A1964, A2113		1 - SYS_DETECT 2 - SCL 3 - SDA 5, 6, 7 - GND(-) 8 - VBAT (+)
A1965		1, 2 - VBAT(+) 3 - SCL 4 - SDA 5 - SYS_DETECT 6, 7 - GND(-)
A2389		1, 2 - VBAT(+) 3 - SCL 4 - SDA 5 - SYS_DETECT 6, 7 - GND(-)
A2519		1 - SYS_DETECT 2 - SCL 3 - SDA 5, 6, 7 - GND(-) 8 - VBAT (+)
A2527		1 - SYS_DETECT 3 - SCL 4 - SDA 5, 6, 7 - GND(-) 8 - VBAT (+)

4. Let’s start

Connect the micro USB cable and apply power. The device will turn on automatically and enter standby mode.

When you connect the battery, the programmer will automatically detect the chip used in the battery and enter the main menu.

Note: You may need to power the controller board (12V for 3-cell batteries) or (8V for 2-cell batteries) from an external lab power supply (limit current to 200mA)

5. Main menu and device functionality

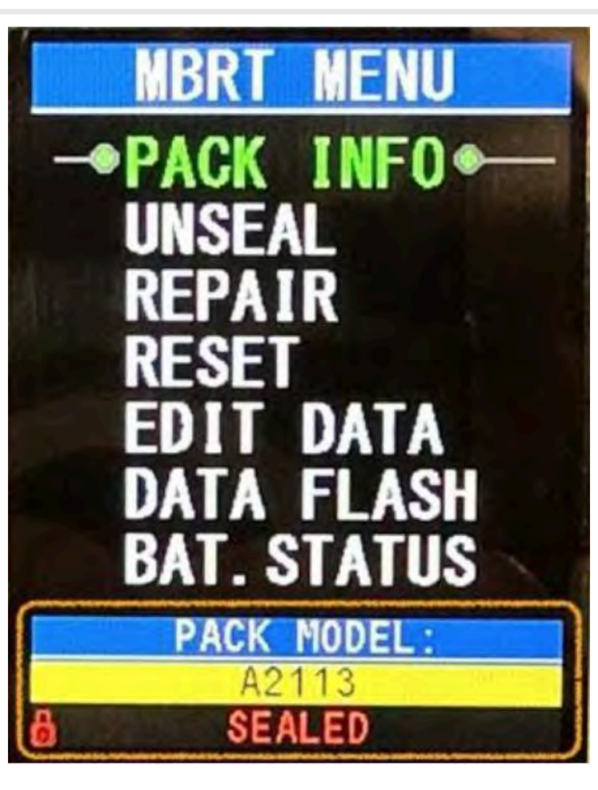
After you have connected the battery and determined its model, go to the main menu.

Battery pack model: | **Connector picture:**

The main menu of the device consists of seven items:
1) pack info
2) unseal
3) repair
4) reset
5) edit data
6) data flash
7) bat.status

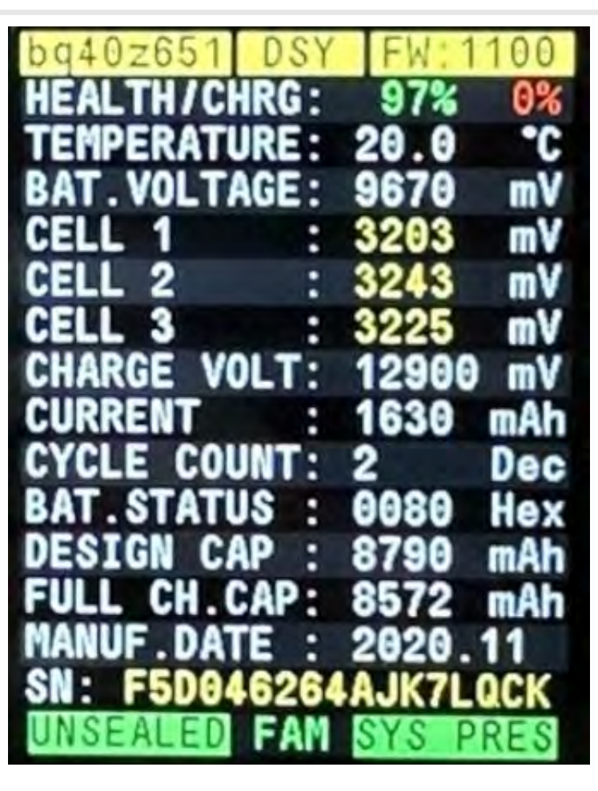
At the bottom of the main screen, you can see the model number of the connected battery pack and the seal status.

...you can change the battery in this menu. Just disconnect battery and connect another one. MBRT will detect a new battery and show the pack model. But please – don't play with this function😌



1 PACK INFO screen displays basic battery information:

Controller name	Pack manufacturer | Firmware version
HEALTH/CHRG	(Battery pack Health / Charge in percent)
TEMPERATURE	(Battery pack temperature in Celsius)
BAT.VOLTAGE	(Battery pack voltage in mV)
CELL 1	(Voltage on cell group 1 in mV)
CELL 2	(Voltage on cell group 2 in mV)
CELL 3	(Voltage on cell group 3 in mV)
CHARGE VOLT	(Desired charging voltage in mV)
CURRENT	(Current of charge or discharge -negative values mean discharging)
CYCLE COUNT	(The number of cycles the battery has experienced)
BAT.STATUS	(Battery status register)
DESIGN CAP	(Design capacity of battery pack)
FULL CH.CAP	(Full charge capacity of a battery pack)
MANUF DATE	(Date of manufacture)
SN	(Pack serial number)
UNSEALED	(Seal status - SEALED or UNSEALED with lock icon)
FAM	(Factory Access Mode - enabled/disabled)
SYS_PRES	(SYS_DETECT pin on the battery connector connected to GND)



```
bq40z651  DSY  FW:1100
HEALTH/CHRG:  97%   0%
TEMPERATURE:  20.0  °C
BAT.VOLTAGE:  9670  mV
CELL 1     :  3203  mV
CELL 2     :  3243  mV
CELL 3     :  3225  mV
CHARGE VOLT:  12900 mV
CURRENT    :  1630  mAh
CYCLE COUNT:  2     Dec
BAT.STATUS :  0080  Hex
DESIGN CAP :  8790  mAh
FULL CH.CAP:  8572  mAh
MANUF.DATE :  2020.11
SN: F5D046264AJK7LQCK
UNSEALED FAM SYS PRES
```

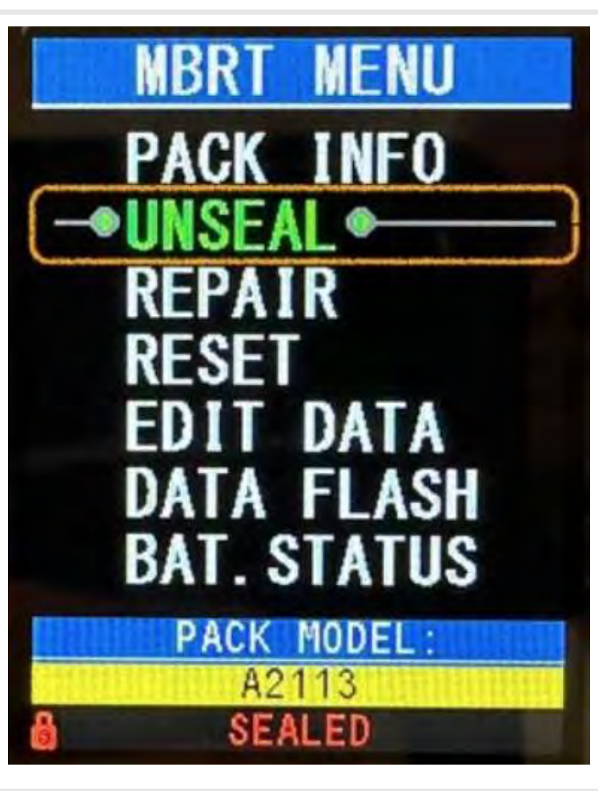
(This screenshot is an example of connected battery pack)

...if you want you can change
The battery on this screen. Just disconnect the battery and connect another one.

2 UNSEAL function

Unsealing the controller for memory access (errors reset, edit configuration data, data-flash operation)

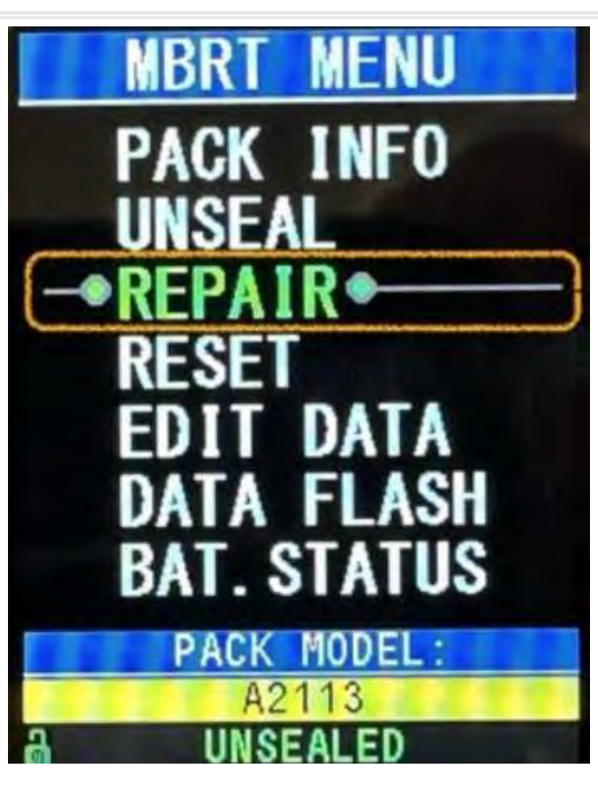
...this is the most important function of the device for working with battery pack



3 REPAIR function

This function will clear all permanent errors stored in the chip memory.

...battery pack needs to be UNSEALED first!



4 RESET function

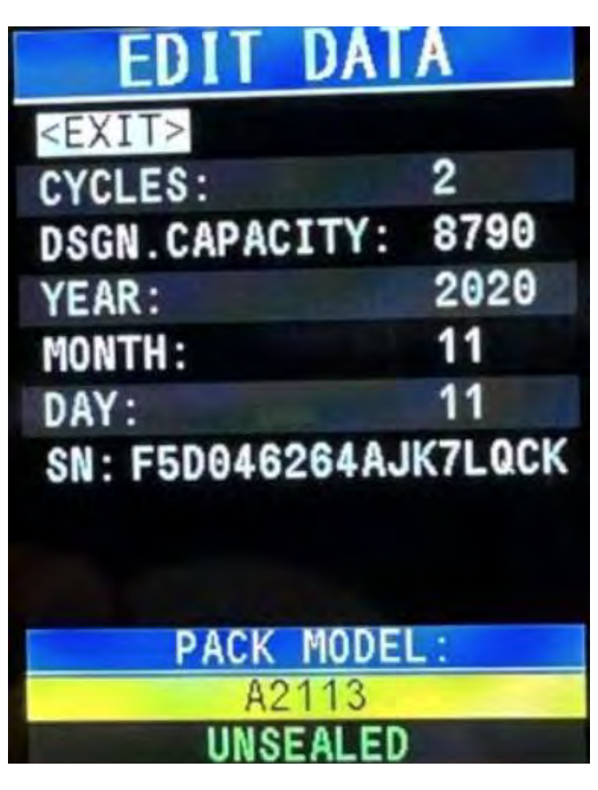
This function will Reset (reboot) the battery controller and set it to SEALED mode.

...if the battery was disconnected from MBRT – this function will reboot the device (no need to disconnect mini-USB cable for rebooting)

5 EDIT DATA menu:

When the battery is in UNSEALED mode you can change some data:
1) CYCLES counter (we do not recommend reducing it too much)
2) DESIGN CAPACITY (influences the remaining capacity in percent)
3) YEAR
4) MONTH
5) DAY (year, month, day of manufacture)
6) SN (pack's serial number)

... serial number must be changed if the operating system remembers the previous state of the battery and continues to write "service battery" even after the battery has been repaired.



```
EDIT DATA
<EXIT>
CYCLES:                 2
DSGN.CAPACITY:       8790
YEAR:                2020
MONTH:                 11
DAY:                   11
SN: F5D046264AJK7LQCK

PACK MODEL:
A2113
UNSEALED
```

6 DATA FLASH menu (BATTERY GURUS ONLY!!!)

- In this menu, you can back up all calibration data (for example, from a partially faulty controller with correct calibration data) and transfer to another good one (with the same firmware).

- Or you can flash factory default calibration data (from new battery pack). Default calibration profiles are stored in MBRT.

...everything that happens in this menu - happens at your own peril and risk! Please remember that you can kill your battery!

By entering this menu, in the top of the screen you will see the controller type, firmware version and cell revision.

DATA FLASH menu is a smart menu.

This menu may change depending on whether you read data into the buffer or not, if the MBRT has default data for your battery, then the corresponding item will appear in the menu.

If you still decide to flash the default data, then we recommend that you read data from your chip into the device buffer first (after that, do not turn off power from the programmer)

```
DATA OF FIRMWARE:1100
SAVED IN MBRT BUFFER
```

So, if you want to read data from your chip into MBRT buffer – choose READ TO BUFFER and select YES.
Programmer will read, verify and save data into buffer.

...when you use write function, please use the shortest cable to connect to the battery to avoid errors when read or write.

...bq20z451 need to be UNSEALED each time after each procedure.

```
ARE YOU SURE? NO YES
Reading data flash...
```

```
ARE YOU SURE? NO YES
Verifying...
```

If you want to write data from MBRT into your chip – choose WRITE FROM BUFFER and choose YES.
Programmer will write and verify data from a buffer.

... Please connect the same controller with the same firmware version for writing.

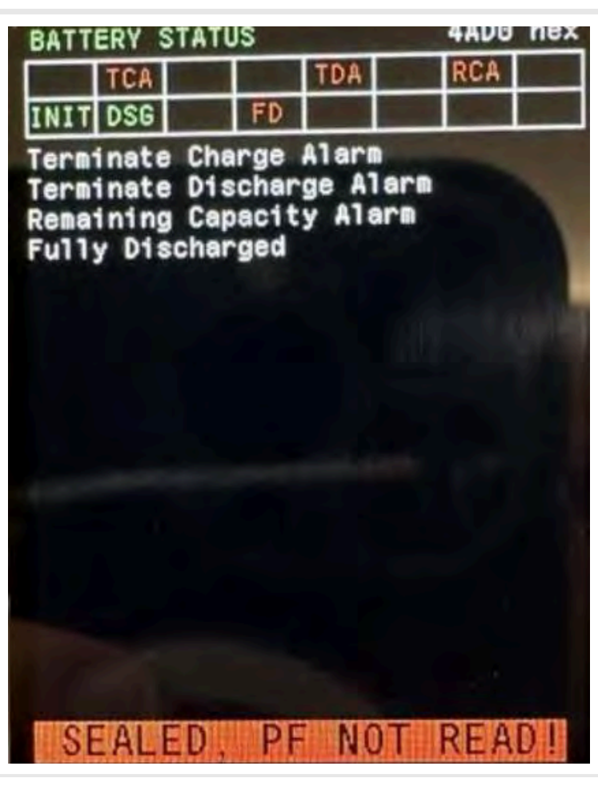
```
ARE YOU SURE? NO YES
Write data flash...
DATA OF FIRMWARE:1100
SAVED IN MBRT BUFFER
```

7 BAT.STATUS screen

On this screen, you can see the decoding of status registers (error codes), which will facilitate your next steps.
You can see an example with bad battery status 4AD0 and problems list.

...more data can be showed in UNSEAL mode.

...please study the datasheet for the controller BQ20Z45 and BQ40Z60 attentively.



```
Terminate Charge Alarm
Terminate Discharge Alarm
Remaining Capacity Alarm
Fully Discharged
SEALED, PF NOT READ!
```

6. Repair example

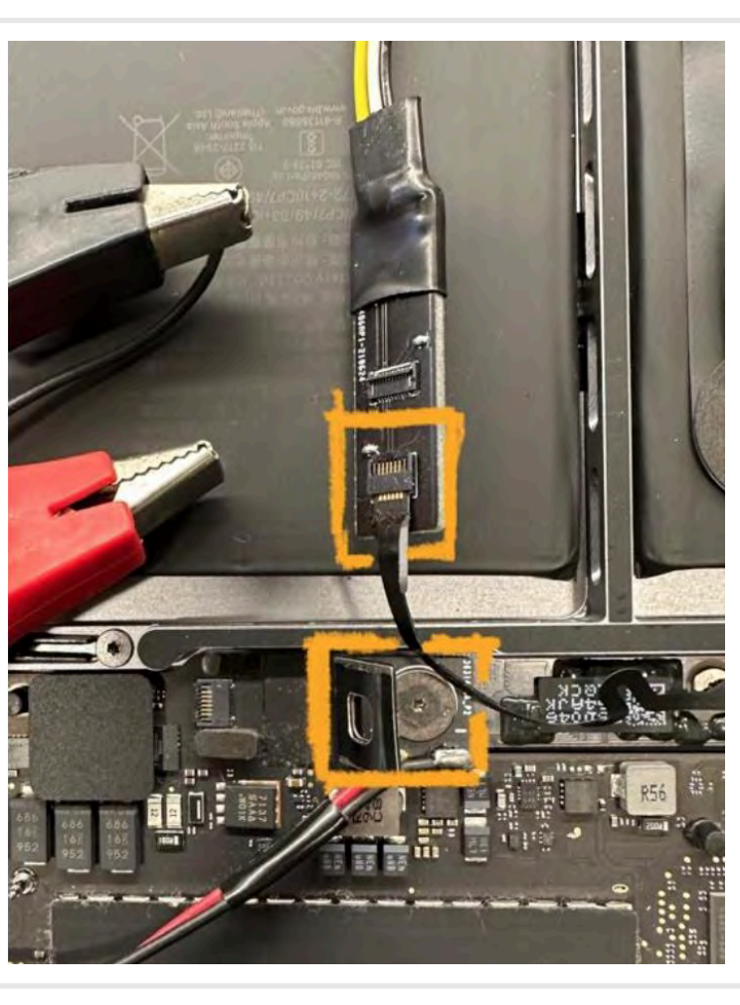
This is an example of reviving the A2113 battery for model 16" A2141.
A2113 – unseal and repair in case of deep discharge (a common problem with these models)
WARNING! All work can be done directly in the laptop. No need to remove the battery!

① Disconnect the battery flex cable and unscrew the screw that holds the power contacts.

② Install the power terminal (connector) supplied with the programmer.

WARNING! Observe polarity!

Connect the battery flex cable to the programmer's connector (supplied with the programmer).



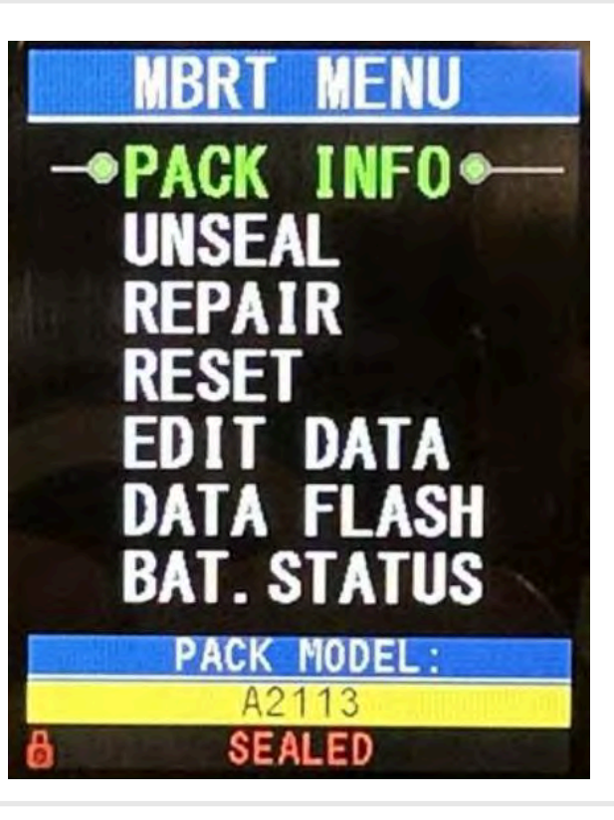
③ Turn on the programmer, and plug in the battery connector.

The programmer should automatically detect the controller-chip (40Z651 in this case) and enter the main menu screen.

!If the controller does not respond – set the voltage to 12V on your laboratory power supply with a current limitation of ~ 200-500 mA and connect to the battery pack.

After successfully reading data from the battery, the display will show MAIN MENU with information about the battery pack model and seal status.

Choose "PACK INFO" menu and press "OK"



PACK INFO MENU:

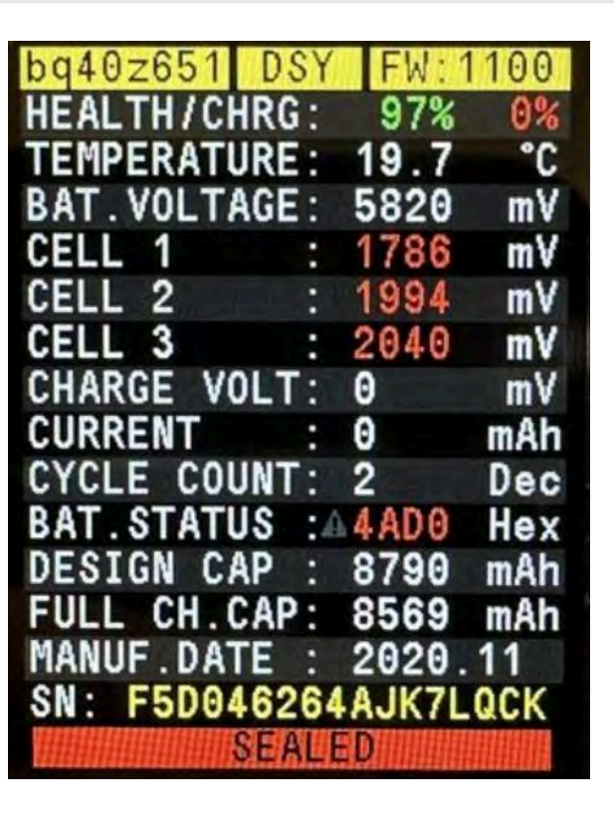
On this screen, you will see basic information about the battery pack (cell voltages, temperature, status, serial number, etc.)

Battery status 4AD0😟

As you can see in the picture, the residual voltage on the cells is very low (average value 2000 mV instead of 3500-4100 mV) – this is the main problem!

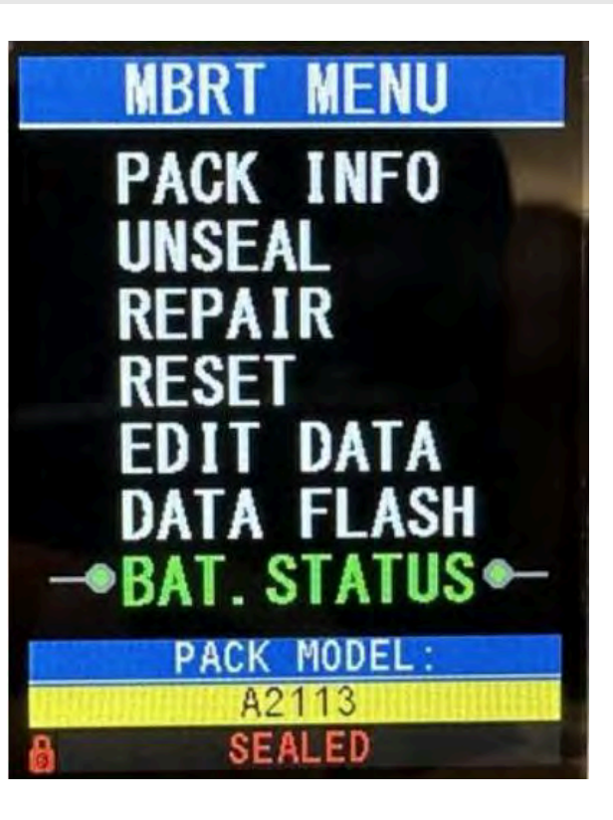
CHARGE VOLTAGE is also set to 0!

Press "OK" and go to MAIN MENU



```
bq40z651  DSY  FW:1100
HEALTH/CHRG:   97%   0%
TEMPERATURE:  19.7   °C
BAT.VOLTAGE:  5820   mV
CELL 1     :  1786   mV
CELL 2     :  1994   mV
CELL 3     :  2040   mV
CHARGE VOLT:  0      mV
CURRENT    :  0      mAh
CYCLE COUNT:  2      Dec
BAT.STATUS : 4AD0    Hex
DESIGN CAP :  8790   mAh
FULL CH.CAP:  8569   mAh
MANUF.DATE :  2020.11
SN: F5D046264AJK7LQCK
SEALED
```

Choose "BAT.STATUS" MENU

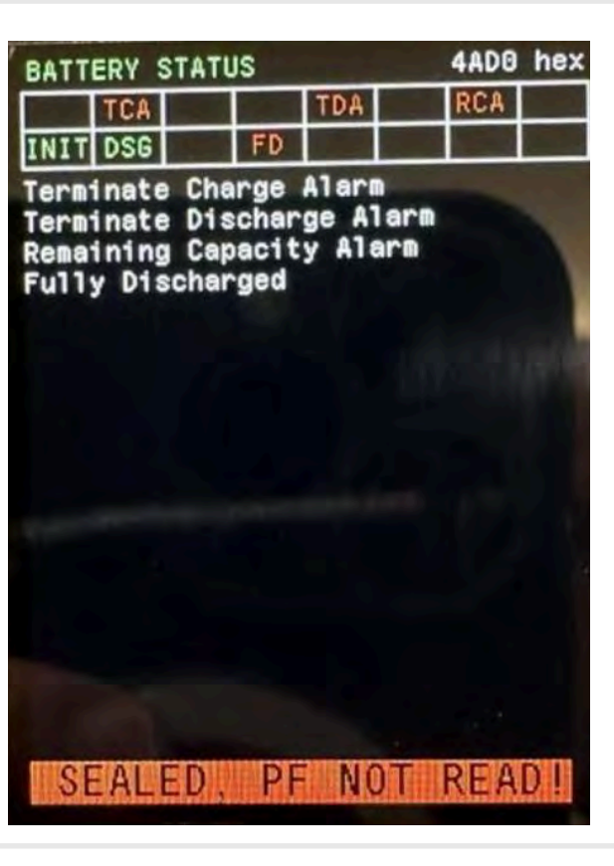


In this menu, you will find decoded info of the battery status register.

PF (Permanent Failure Register) – can't be read in SEALED mode – if you want to see detailed info about Permanent Failures – please UNSEAL pack first.

Press "OK" and go to MAIN MENU

...For detailed info, please explore the datasheet for this chip.

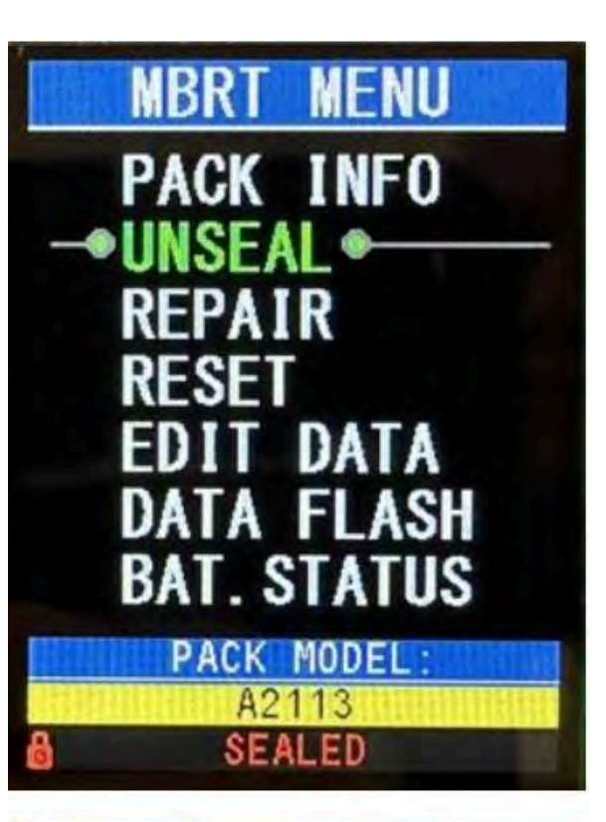


```
BATTERY STATUS                4AD0 hex
     TCA              TDA    RCA
INIT DSG       FD
Terminate Charge Alarm
Terminate Discharge Alarm
Remaining Capacity Alarm
Fully Discharged

SEALED, PF NOT READ!
```

Now the pack is "SEALED"

Select "UNSEAL"

if everything goes well - you will see the "UNSEALED" status



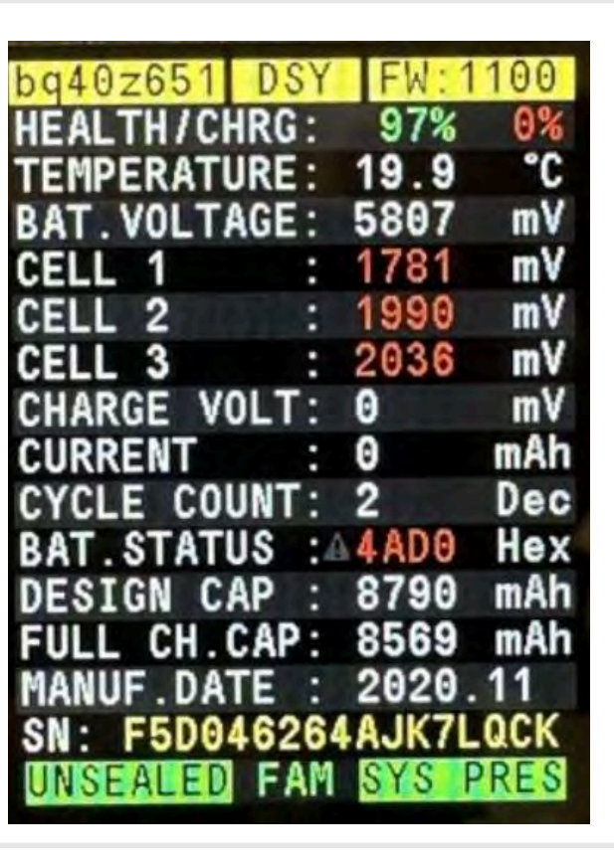
Go to "PACK INFO" screen.

You will see "UNSEALED, FAM, SYS_PRES" on the bottom of the screen.

FAM - Factory Access Mode enabled.

SYS_PRES - System present pin is connected to GND and the controller thinks it is connected to the laptop.

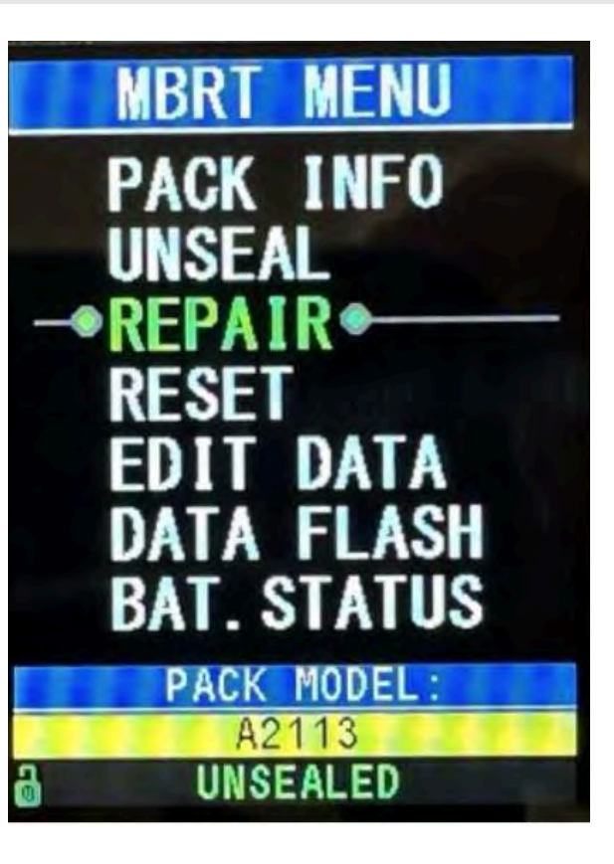
Press "OK" and go to MAIN MENU

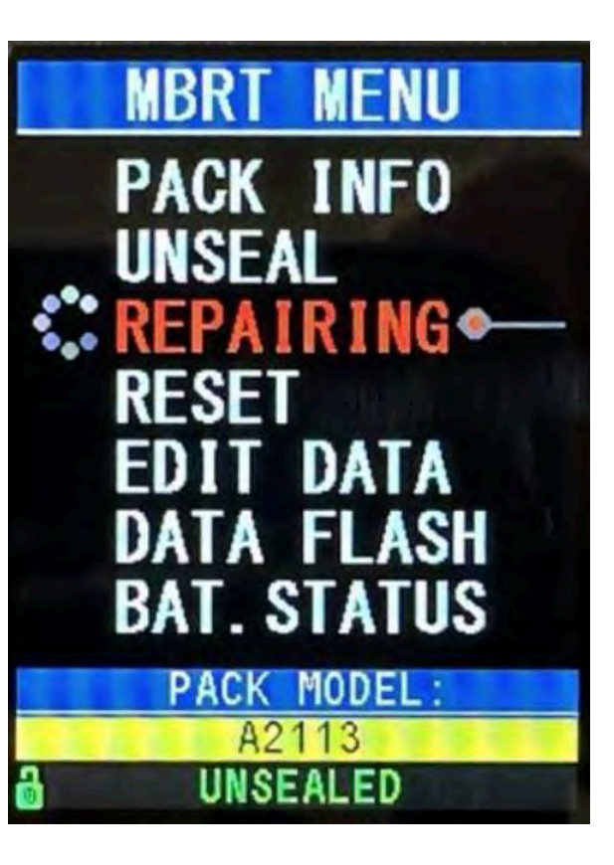


```
bq40z651  DSY  FW:1100
HEALTH/CHRG:   97%   0%
TEMPERATURE:  19.9   °C
BAT.VOLTAGE:  5807   mV
CELL 1     :  1781   mV
CELL 2     :  1990   mV
CELL 3     :  2036   mV
CHARGE VOLT:  0      mV
CURRENT    :  0      mAh
CYCLE COUNT:  2      Dec
BAT.STATUS : 4AD0    Hex
DESIGN CAP :  8790   mAh
FULL CH.CAP:  8569   mAh
MANUF.DATE :  2020.11
SN: F5D046264AJK7LQCK
UNSEALED FAM SYS PRES
```

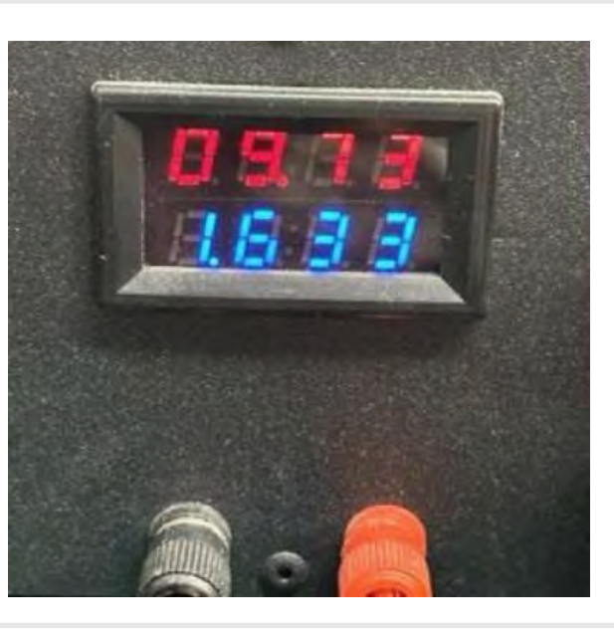
Next step - connect the laboratory power supply to the battery terminal (if you have not connected it before) and set the voltage to 12,9V with a current limitation of ~ 1000 mA.

Choose "REPAIR"





The battery should start charging and you will see the current consumption on the laboratory power supply (1633 mA in our example)



Look at the PACK INFO screen

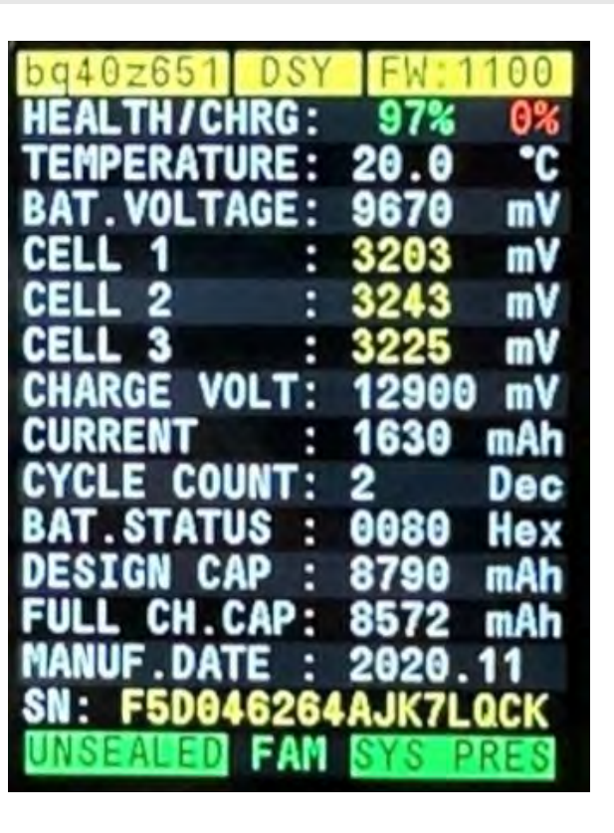
CHARGE VOLTAGE is set to 12900 mV now (means the battery can accept charge now)

CURRENT is the same as your laboratory power supply.

And voltage on each cell is rising now.

Also, you can look in BAT.STATUS menu – it is fine now (all permanent errors have been erased!)

Now you need to wait until the battery charges minimum to 1-2%



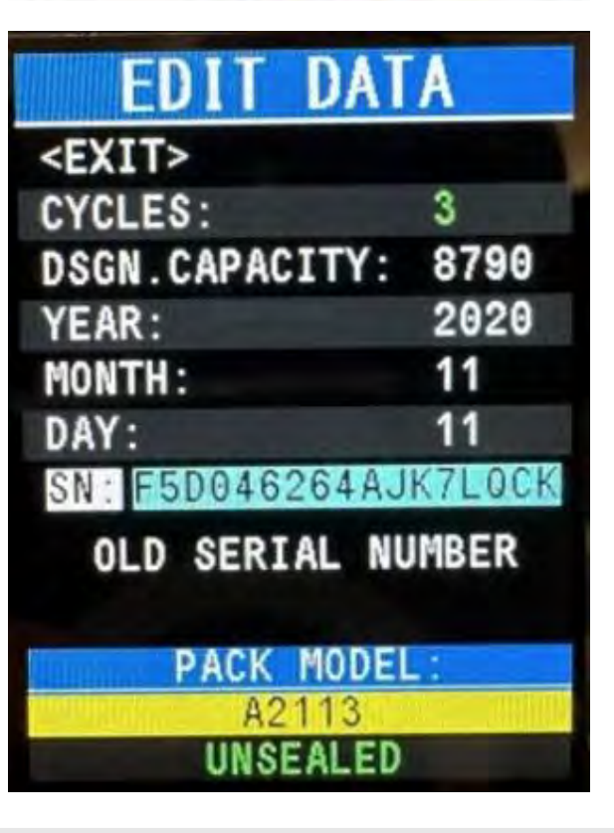
```
bq40z651  DSY  FW:1100
HEALTH/CHRG:   97%   0%
TEMPERATURE:  20.0   °C
BAT.VOLTAGE:  9670   mV
CELL 1     :  3203   mV
CELL 2     :  3243   mV
CELL 3     :  3225   mV
CHARGE VOLT:  12900  mV
CURRENT    :  1630   mAh
CYCLE COUNT:  2      Dec
BAT.STATUS :  0080   Hex
DESIGN CAP :  8790   mAh
FULL CH.CAP:  8572   mAh
MANUF.DATE :  2020.11
SN: F5D046264AJK7LQCK
UNSEALED FAM SYS PRES
```

```
BATTERY STATUS                0080 hex
INIT
PF STATUS                     0000 hex
```

Now you need to change the serial number of the battery pack, because all new macOS systems will know about the problem with this pack and in some cases will write "service recommended" in the battery menu.
So.
Choose "EDIT DATA" menu:

Choose "SN" and click "OK"
This is your "Old serial number from the factory"

```
EDIT DATA
<EXIT>
CYCLES:              3
DSGN.CAPACITY:    8790
YEAR:             2020
MONTH:              11
DAY:                11
SN: F5D046264AJK7LQCK

PACK MODEL:
A2113
UNSEALED
```

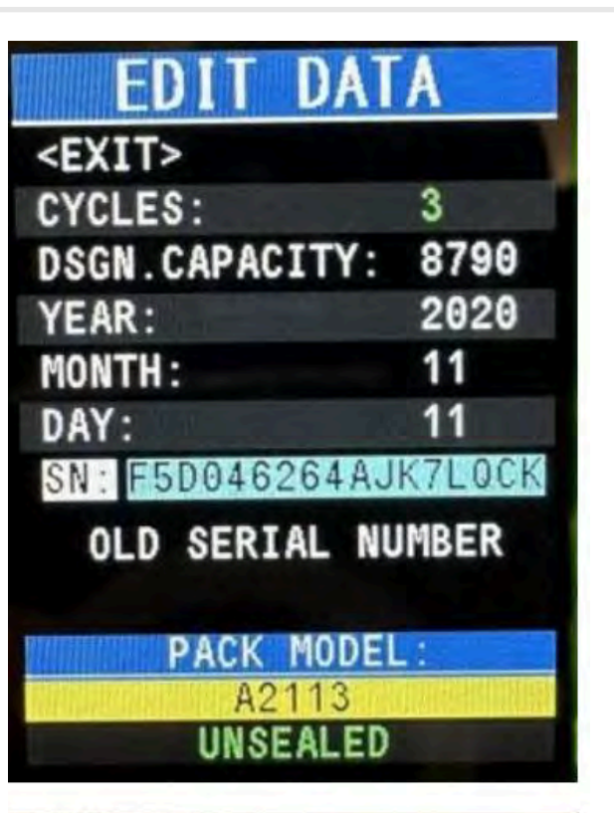


```
EDIT DATA
<EXIT>
CYCLES:              3
DSGN.CAPACITY:    8790
YEAR:             2020
MONTH:              11
DAY:                11
SN: F5D046264AJK7LQCK
OLD SERIAL NUMBER

PACK MODEL:
A2113
UNSEALED
```

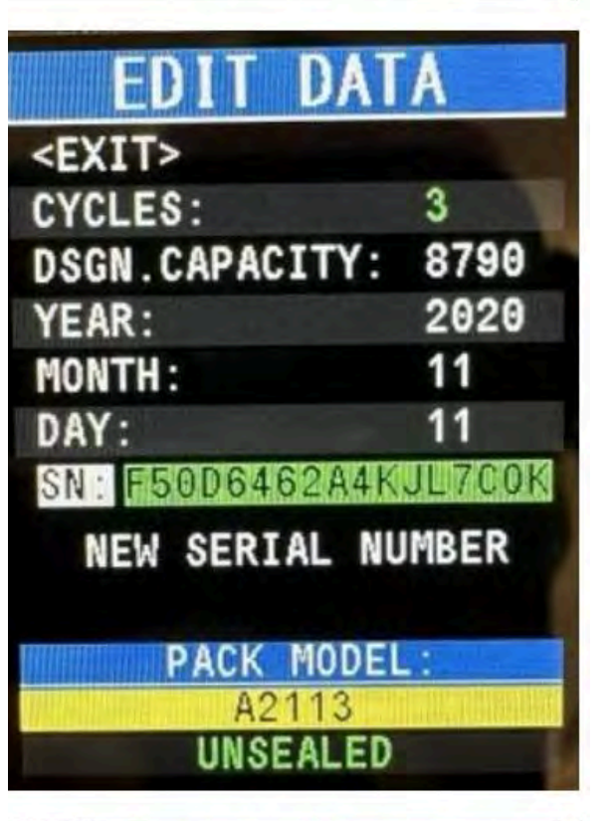
By clicking UP or DOWN buttons, you can choose the OLD or a NEW serial number.

Press "OK" for Saving data.

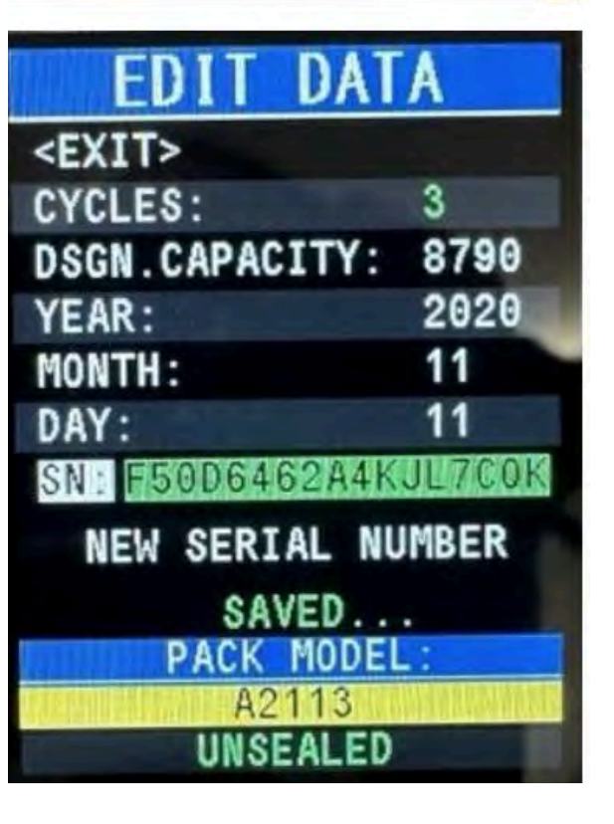
Choose "EXIT"



```
EDIT DATA
<EXIT>
CYCLES:              3
DSGN.CAPACITY:    8790
YEAR:             2020
MONTH:              11
DAY:                11
SN: F5D046264AJK7LQCK
OLD SERIAL NUMBER

PACK MODEL:
A2113
UNSEALED
```

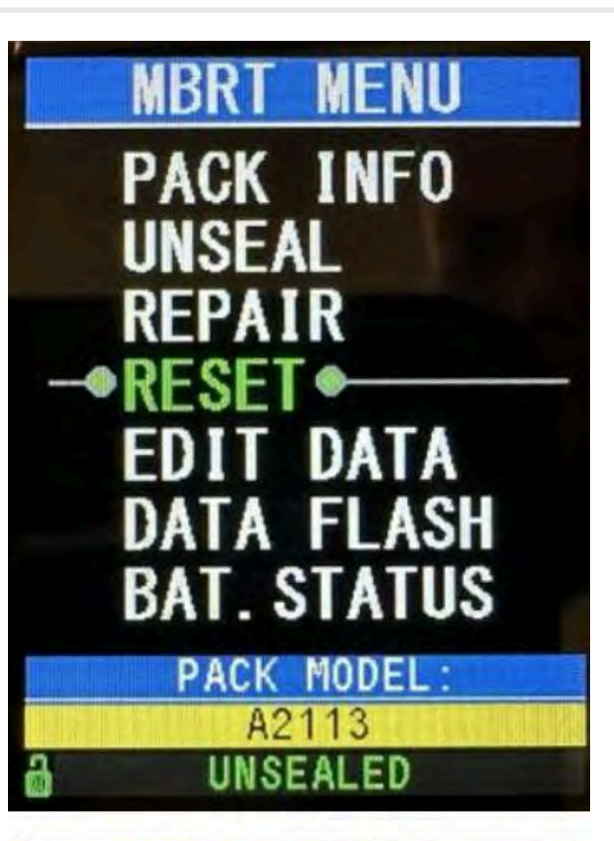


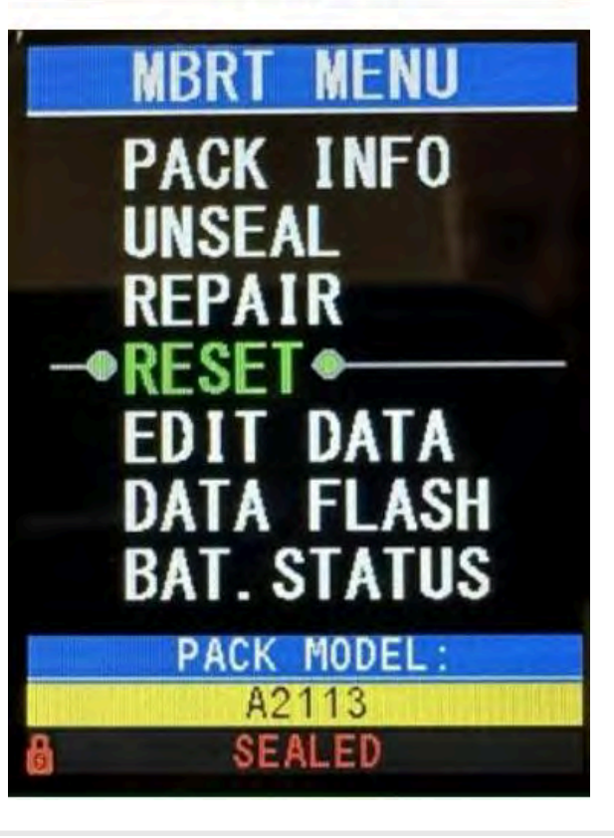
```
EDIT DATA
<EXIT>
CYCLES:              3
DSGN.CAPACITY:    8790
YEAR:             2020
MONTH:              11
DAY:                11
SN: F50D6462A4KJL7COK
NEW SERIAL NUMBER

PACK MODEL:
A2113
UNSEALED
```



```
EDIT DATA
<EXIT>
CYCLES:              3
DSGN.CAPACITY:    8790
YEAR:             2020
MONTH:              11
DAY:                11
SN: F50D6462A4KJL7COK
NEW SERIAL NUMBER
SAVED...
PACK MODEL:
A2113
UNSEALED
```

Choose "RESET"
The charging process will stop for 2-5 sec and after that will start again.





Now you can disconnect data flex from battery pack (charging process will stop) and unscrew Power cable.

Reconnect the battery to the motherboard and plug in the original 96w charger to the laptop.

7. FAQ

Q: Is MBRT regularly updated?
A: No. This device does not support firmware updates.

Q: Only two battery connectors are included in the kit. Where can I buy the other connectors?
A: We are working on it. For now, you can unsolder connectors from motherboards and make your own.

Q: I connected the battery to the programmer but nothing happens.
A: 1. Check the correct connection of the SDA, SCL line (if you use a wire for soldering)
2. Power the battery (12V for 3-cell batteries) or (8V for 2-cell batteries) from an external lab power supply (limit current to 200mA)
3. If this does not help, inspect the battery controller board carefully (for example, it may be damaged by liquid corrosion).
4. There may be a blown fuse on the controller board - check it!

Q: What should I do if the programmer incorrectly detects my battery, although I am completely sure that it is original?
A: The programmer has a built-in manual battery detection mode. To do this, you need to turn off the power from the programmer, then press the UP (for bq20z451) or DOWN (for bq40z651) button, and, without releasing, apply power to the programmer. The automatic battery detection system will be off for one time.

Q: Does the programmer support Chinese copies of batteries (for example, on A2168 chip)?
A: The programmer does not support Chinese copies of batteries, although some functions are available for A2168 (try it at your own risk).

Q: Is it possible to change (reconnect) the battery while the programmer is on?
A: Yes. The programmer constantly checks battery availability. You can change the batteries while working with the programmer.

Q: After I revived a deeply discharged battery, the system still writes – “service battery”...
A: You need to change the serial number of the battery (edit data menu)

Q: Data writing to the bq20z451 controller was accidentally interrupted and now it is not detected.
A: Most likely, the controller is stuck in data download mode. Try turning off the programmer, press the UP button, and, while still holding this button, turn on the programmer (the battery must be connected).

Q: Sometimes when transferring data from one battery to another I get a few verification errors - why?
A: 1) It is desirable to transfer data to exactly the same board (controller) with the same firmware version.
2) Use the shortest possible cable for writing.
3) Try writing data again.

Download links:

BQ20Z45 – datasheet (schematic diagram)
https://www.ti.com/lit/ds/symlink/bq20z45-r1.pdf

BQ20Z45 – Technical reference manual
https://www.ti.com/lit/ug/sluu387a/sluu387a.pdf

BQ40Z60 – datasheet (schematic diagram)
https://www.ti.com/lit/ds/symlink/bq40z60.pdf

BQ40Z60 – Technical reference manual
https://www.ti.com/lit/ug/sluua04d/sluua04d.pdf