CEDV Algorithm And Its Data Flash parameters

Data Flash Configuration

For detail parameter description, please refer to the Technical Reference Manual (sluu319)

Data Flash Configuration

1st Level Safety	2nd Level Safety	Charge Control	SBS Confi
Calibration			
Configuration	Power	**Gas Gauging**	OCV Tabl

Name	Value	Unit
CEDV Cfg	-	-
CEDV Config	00	flg
EMF	3743	mV
C0	149	num
R0	867	num
T0	4030	num
R1	316	num
TC	9	num
C1	0	num
Age Factor	0	num
Fixed EDV 0	3031	mV
Fixed EDV 1	3385	mV
Fixed EDV 2	3501	mV
Low Temp	119	0.1 degC
Overload Current	5000	mA
Self Discharge Rate	20	.01%/da

Name	Value	Unit
Electronics Load	0	3uA
Battery Low %	18	%/2.56
Near Full	200	mAH
Current Thresholds	-	-
Dsg Current Threshold	100	mA
Chg Current Threshold	50	mA
Quit Current	10	mA
Dsg Relax Time	1	Sec
Chg Relax Time	60	Sec
State	-	-
Qmax Cell 0	4400	mAh
Qmax Cell 1	4400	mAh
Qmax Cell 2	4400	mAh
Qmax Cell 3	4400	mAh
Qmax Pack	4400	mAh

Charge Control	SBS Configuration	
Name	Value	Unit
DOD at EDV2	15232	num

For detail parameter description, please refer to the Technical Reference Manual (sluu319)

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Current Integration Based Fuel-gauging
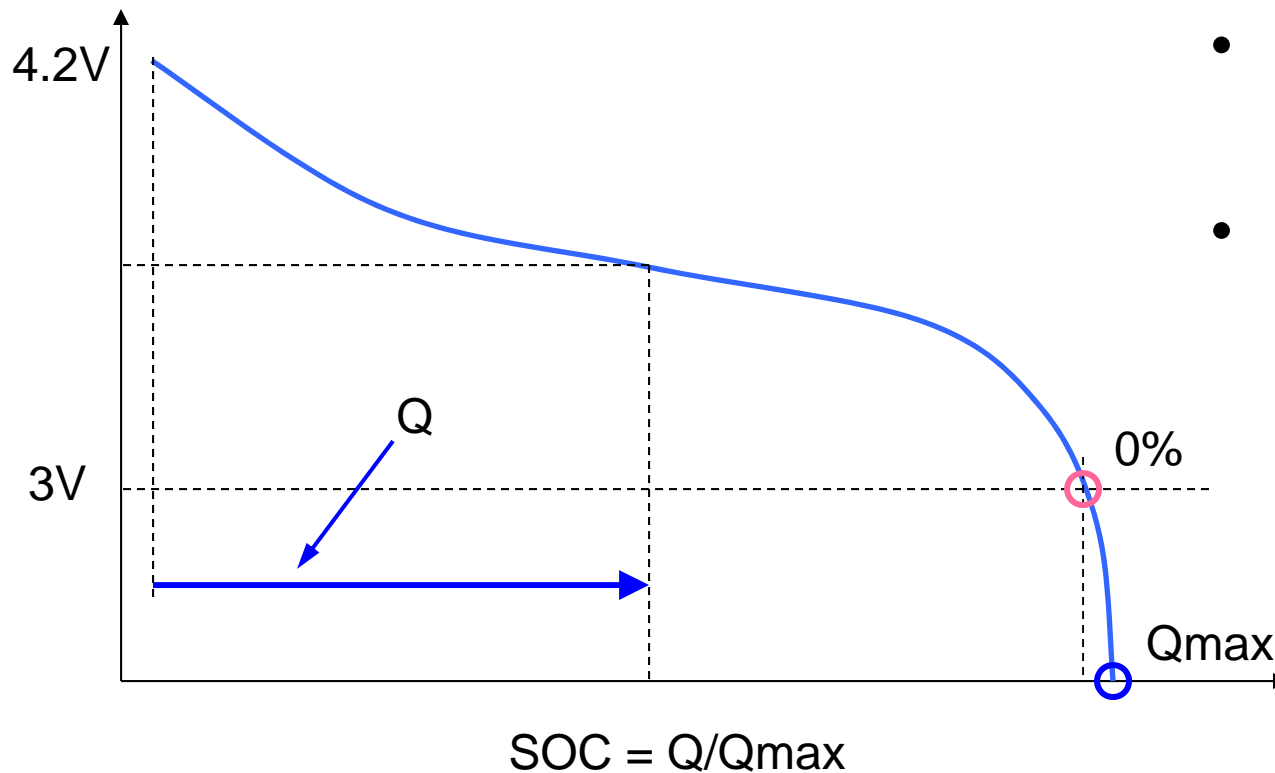
- Battery is fully charged
- During discharge capacity is integrated
- State of charge (SOC) at each moment is Q/Q_{max}
- Q_{max} is updated every time full discharge occurs

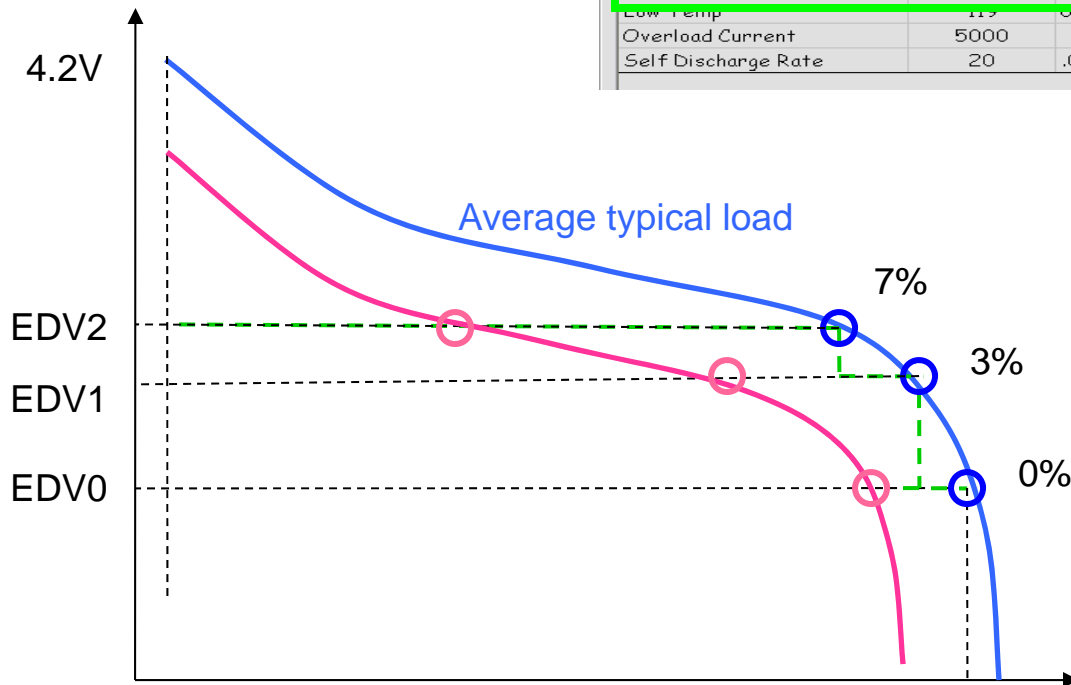Chart labels: 4.2V, 3V, Q, 0%, Qmax

$$SOC = Q/Qmax$$

Learning Before Fully Discharged
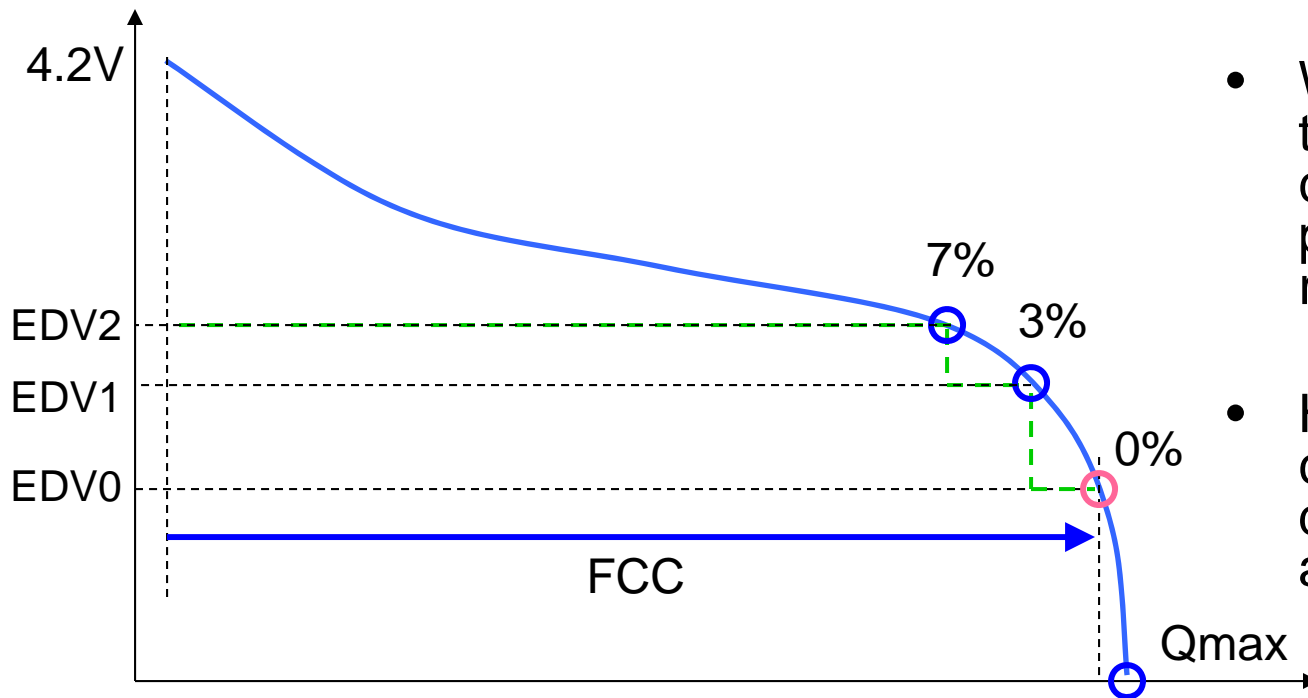
- It is too late to learn when 0% capacity is reached → Learning FCC before 0%

- We can set voltage threshold that correspond to given percentage of remaining capacity

- However, true voltage corresponding to 7% depends on current and temperature

Using bq3060 with Fix EDV Algorithm

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Qmax Cell 3	4400	mAh
Qmax Pack	4400	mAh

4.2V

Average typical load
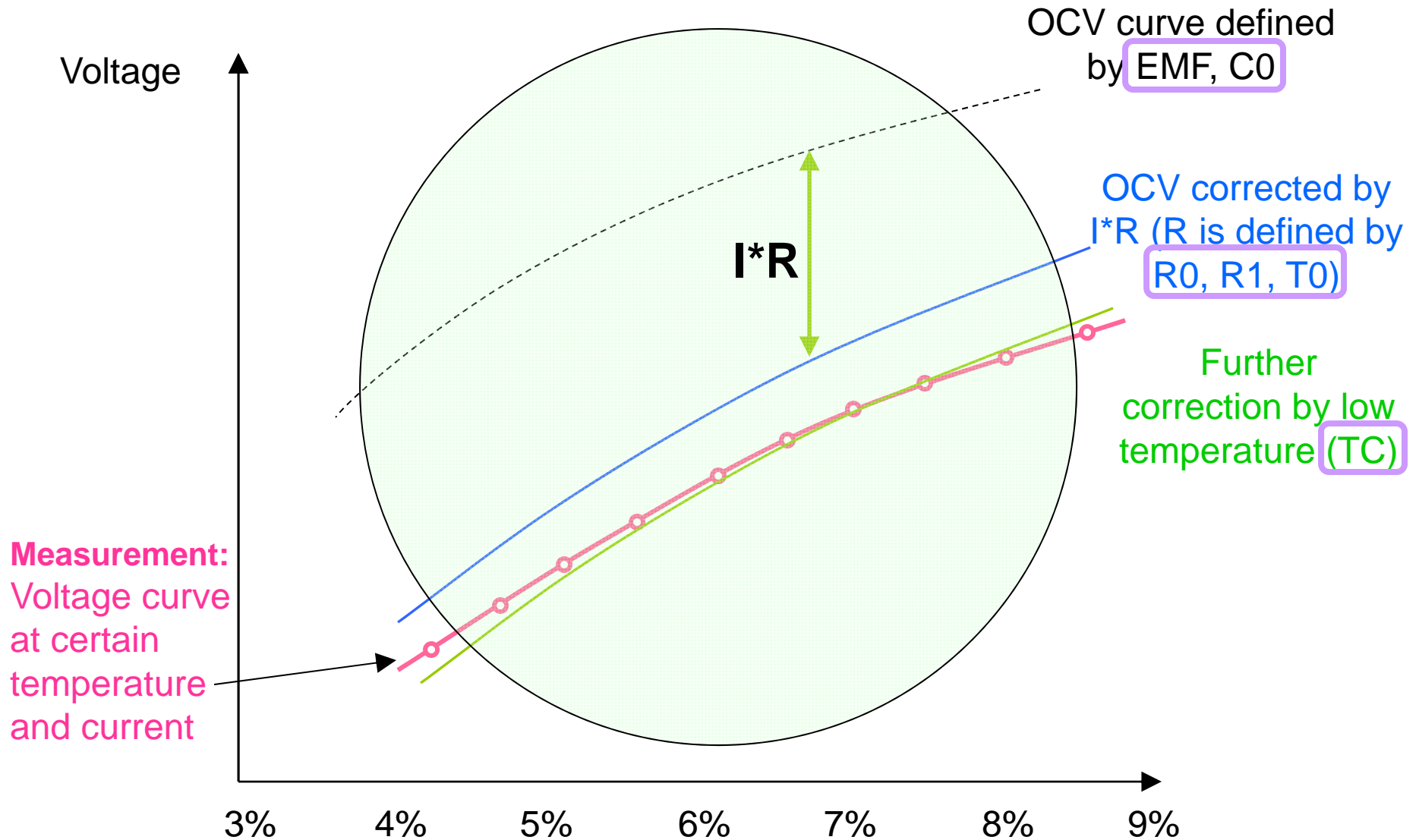
EDV2   7%

EDV1   3%

EDV0   0%

- Discharge curve will change according to different current, temperature, and the age of the battery

- By using Fix EDV setting, not all the useable capacity is being utilized, or worse, the system is running too low on capacity.

Learning before fully discharged with current and temperature compensation

CEDV Model:
Predict V(SOC) under any current and temperature

OCV

4.2V

EDV2 (I1)
EDV2 (I2)
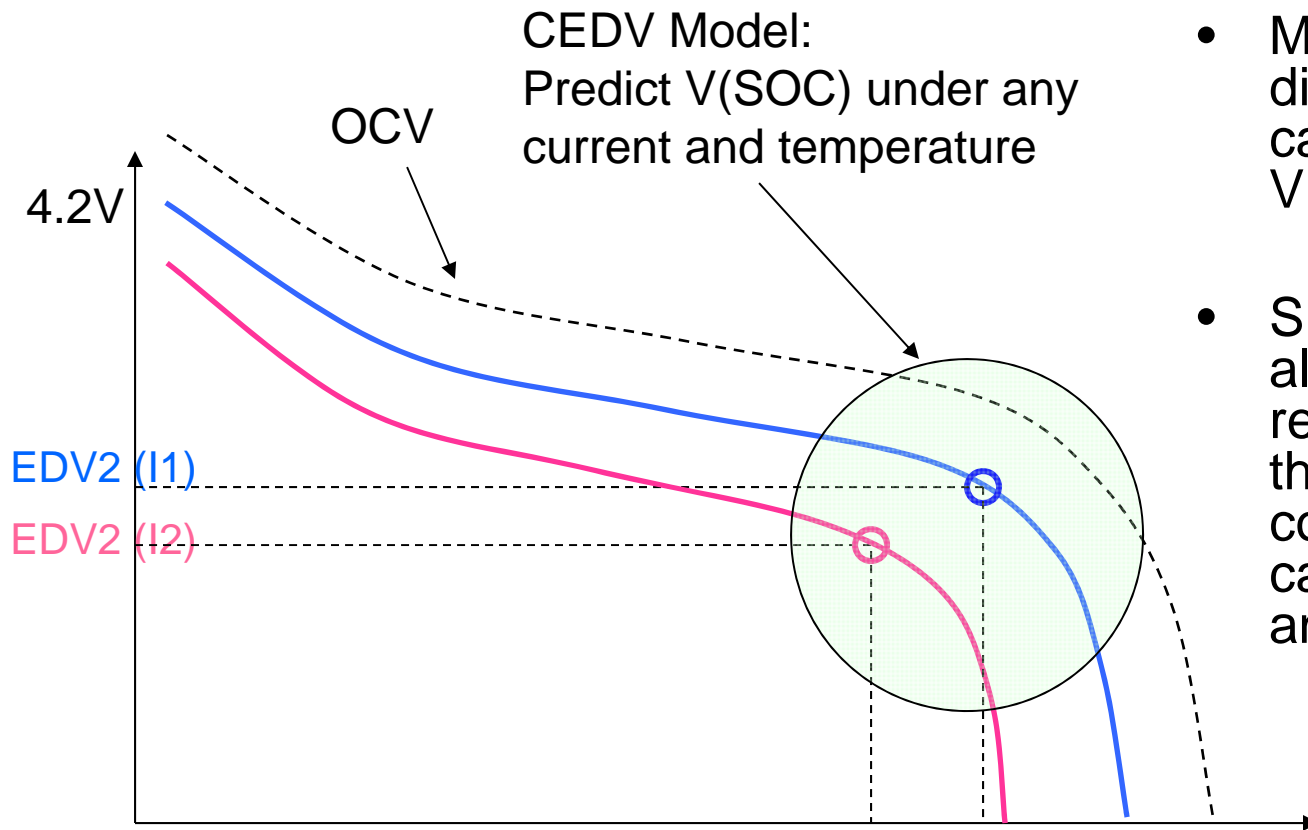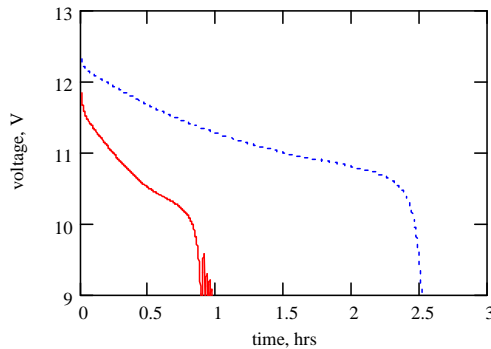
- Modeling last part of discharge allows to calculate function V(SOC, I, T)

- Substituting SOC=7% allows to calculate in real time CEDV2 threshold that corresponds to 7% capacity at any current and temperature

CEDV Model Visualization

OCV curve defined by EMF, C0

OCV corrected by I*R (R is defined by R0, R1, T0)

Further correction by low temperature (TC)

I*R

Voltage

Measurement: Voltage curve at certain temperature and current

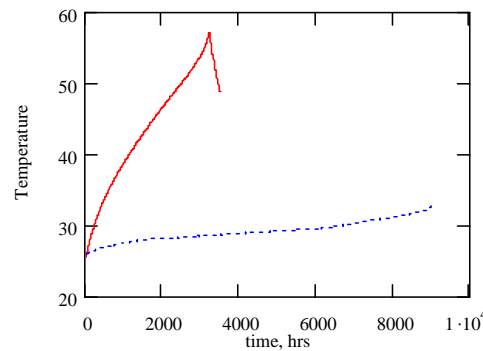3% 4% 5% 6% 7% 8% 9%

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Required Cell Test
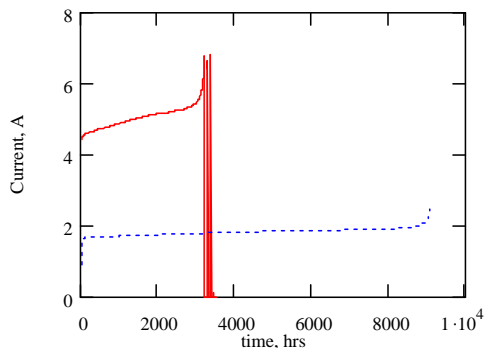
Voltage

Temperature

Current

- Continuous discharge at 2 different rates, from fully charged state until termination voltage is reached.
- First rate should be <u>average typical</u>, and second should be <u>average high</u> for your application. Note that high rate should NOT be maximal peak current, but maximal average sustained rate that can practically occur in the application.
- Test at both rates has to be performed at 3 different temperatures. Typical temperatures for the test are 5, 30, 50 ^{o}C.
- Make sure to set over-temperature limits in the fuel-gauge higher then expected cell temperature during the test. Note that cells heat-up during high rate discharge
- Discharge does not have to be constant current. It can be any load pattern typical for your application, including constant power.
- Battery should be fully charged prior to application of test pattern.
- If temperature was changed, battery should be left for reaching thermal equilibrium for at least 2 hrs prior to testing

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Required Data for MathCAD Input

- As result of all tests you will obtain **6 files**:
  2 different rates at 3 different temperatures

- Time, voltage, current and temperature
  (directly on the cells) has to be recorded and
  stored as separate columns. Any header text
  should be removed from files prior to
  calculations.

- Easy recording method is to use our EV
  software that is reading data directly from
  our fuel-gauge.

Search "sluc042" as a keyword from TI Website:

Download the associated zip file, which includes:

Advanced guide to MathCad_CEDVs calculations.ppt

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TEXAS INSTRUMENTS

Data Flash Configuration

Name	Value	Unit
CEDV Cfg	-	-
CEDV Config	00	flg
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Fixed EDV 2	3501	mV
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Qmax Cell 0	4400	mAh
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Qmax Cell 2	4400	mAh
Qmax Cell 3	4400	mAh
Qmax Pack	4400	mAh

Name	Value	Unit
DOD at EDV2	15232	num

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Low Temp	119	0.1 degC
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Tabs: 1st Level Safety, 2nd Level Safety, Charge Control, SBS Confi, Calibration, Configuration, Power, **Gas Gauging**, OCV Tabl

Name	Value	Unit
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Qmax Pack	4400	mAh

BatteryLow% =
EDV2 * 2.56 * 256

Initialize to design capacity from battery datasheet

Tabs: Charge Control, **SBS Configuration**

Name	Value	Unit
DOD at EDV2	15232	num

DODatEDV2 =
(1-BatteryLow%) * 16385

For detail parameter description, please refer to the Technical Reference Manual (sluu319)

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TEXAS INSTRUMENTS
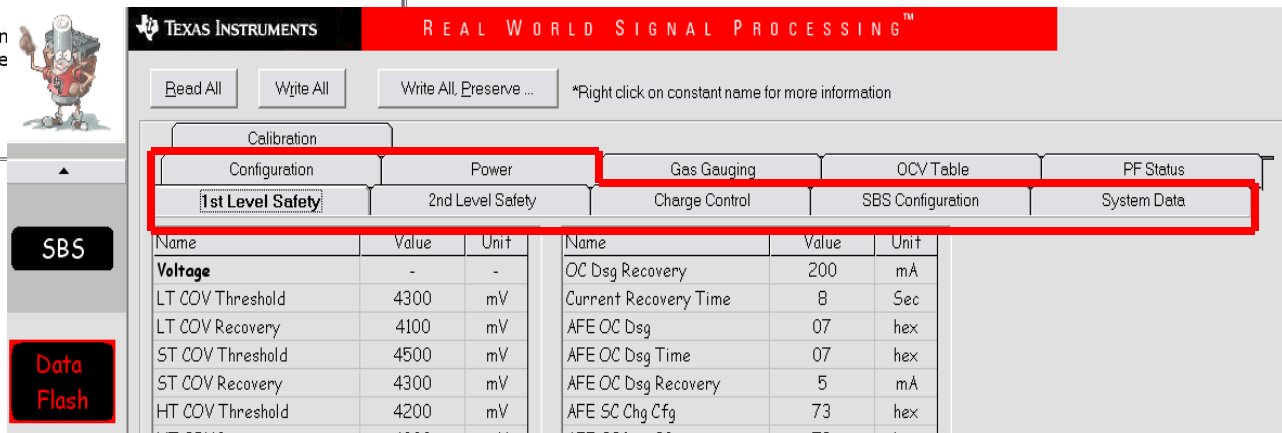
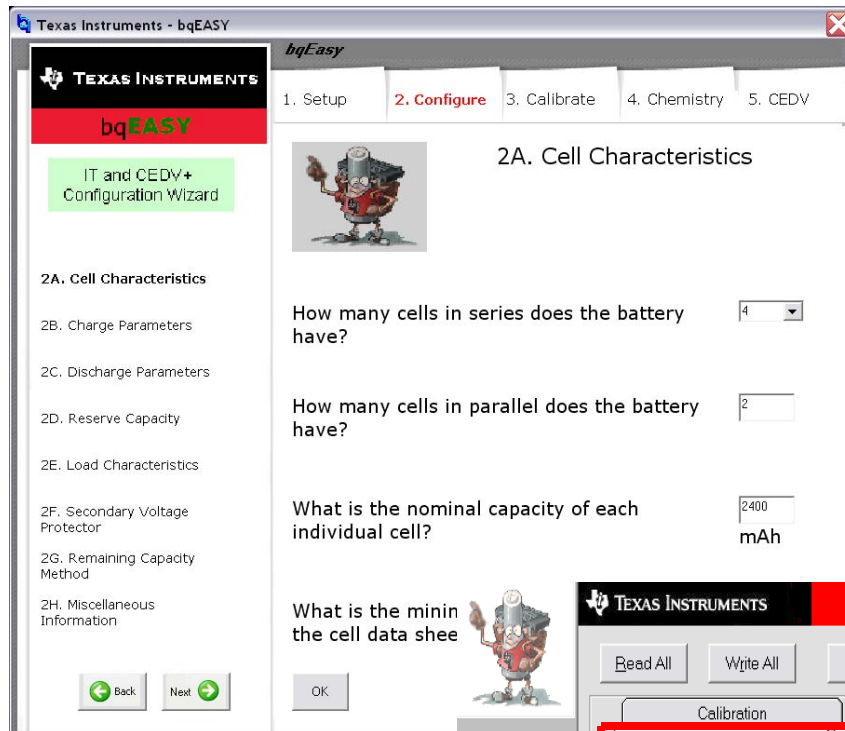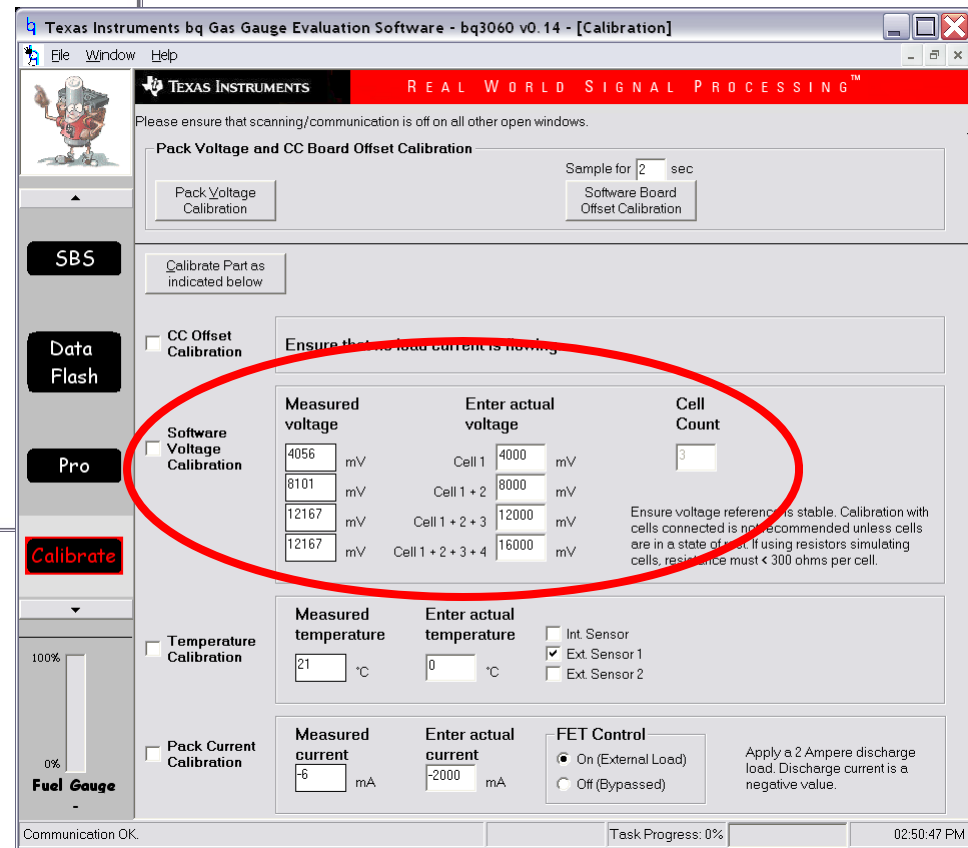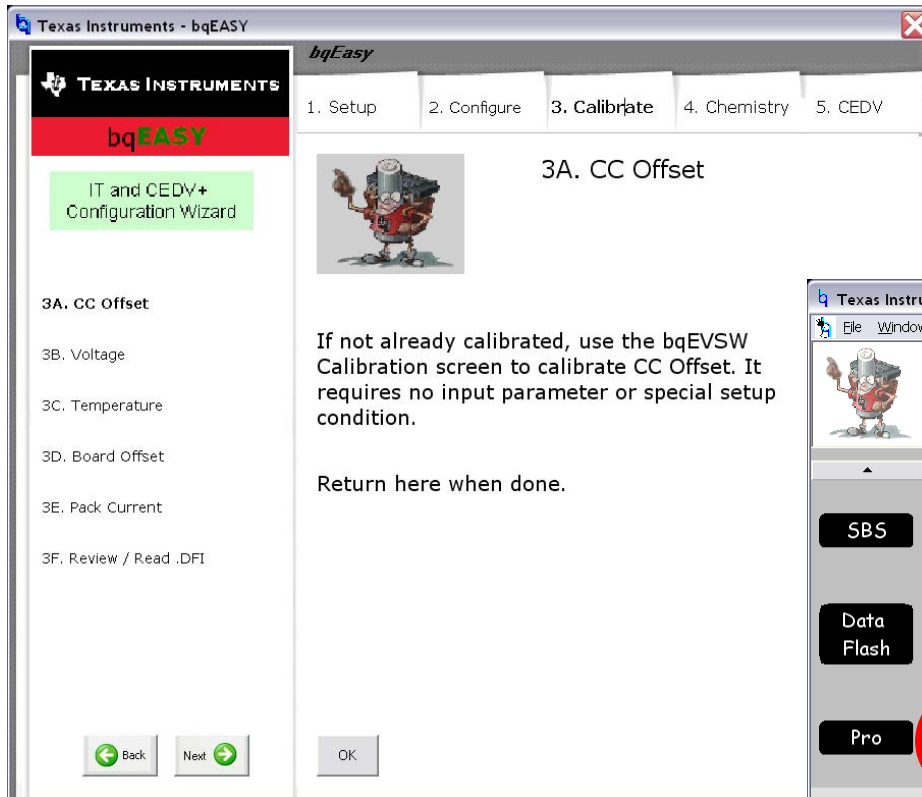# bqEASY for bq3060 (coming soon)

bqEASY for bq3060
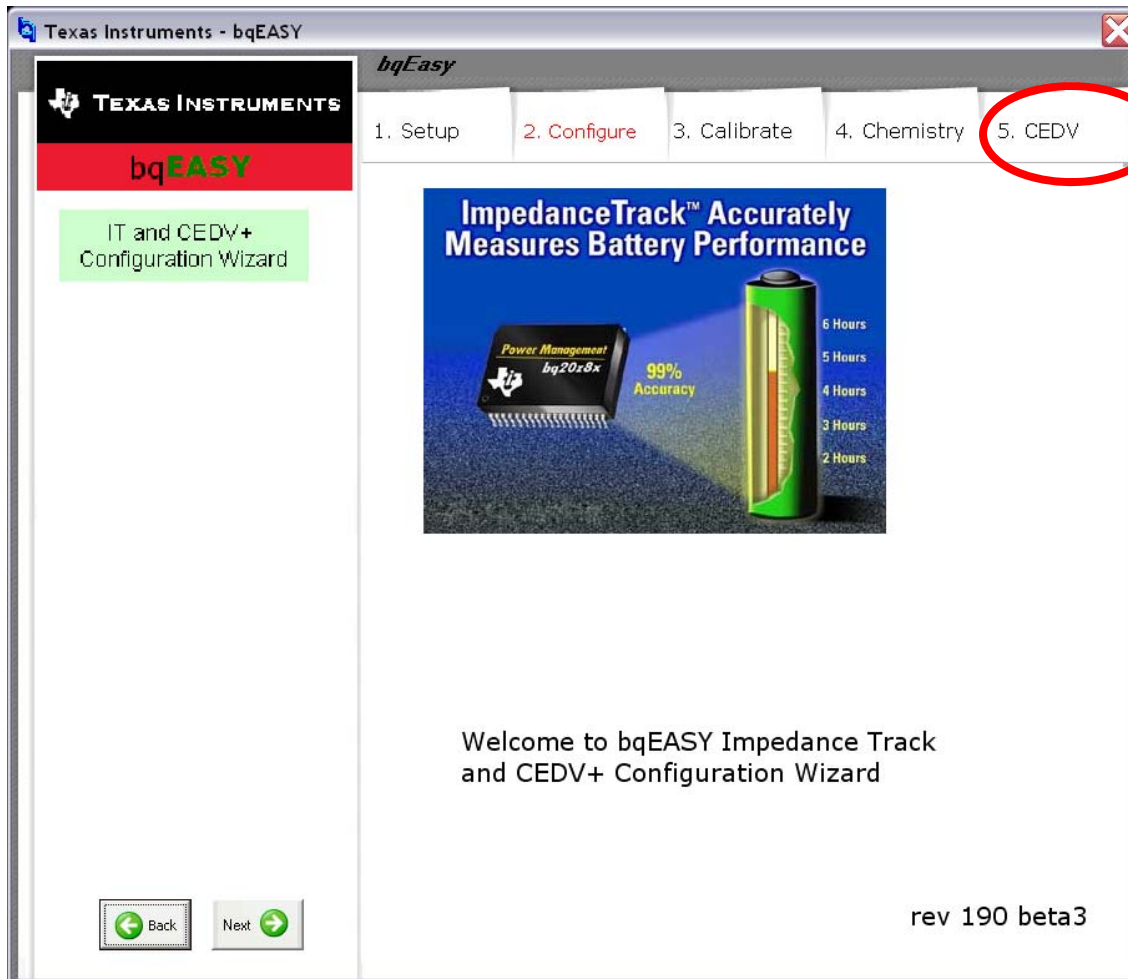
- Similar to bqEASY for z-track devices

- The Learning Cycle tab is replaced with a CEDV tab

bqEASY for bq3060: Configuration
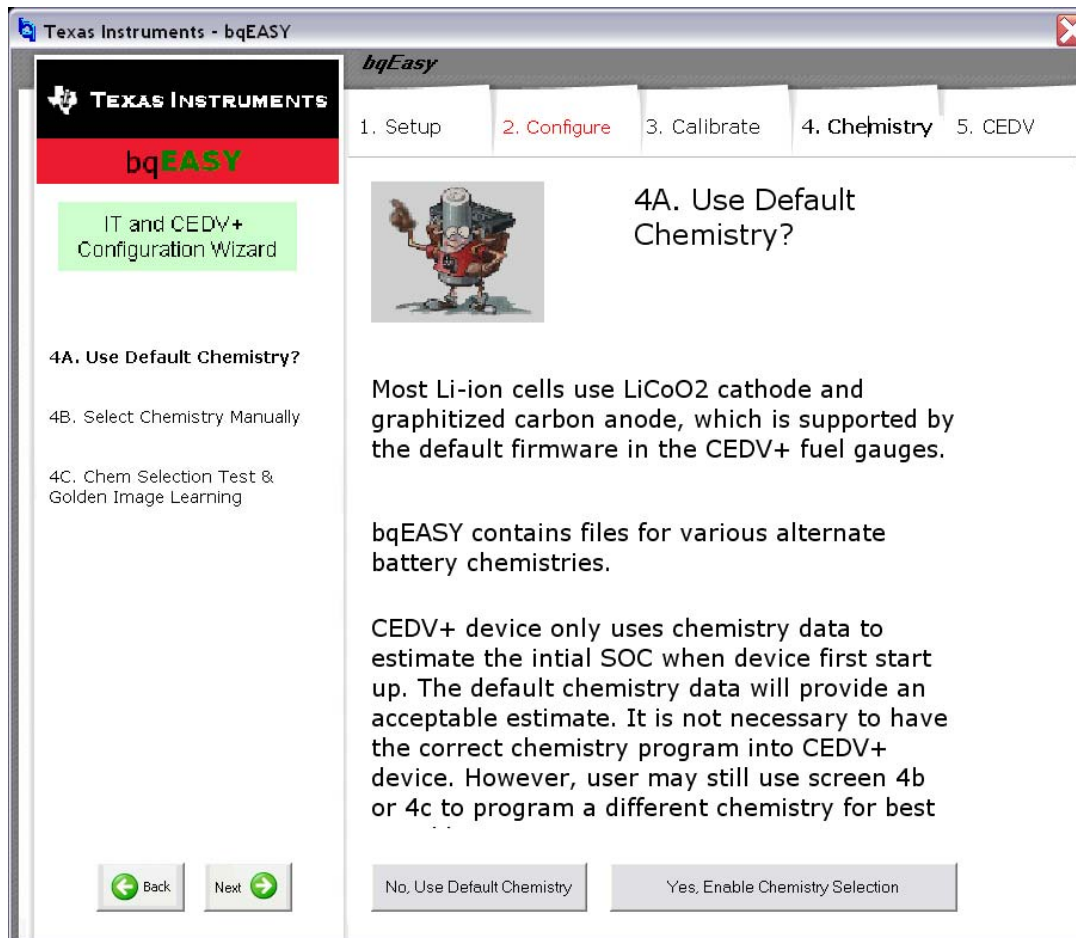

- Configure basic parameter settings

bqEASY for bq3060: Calibration

- Calibration is done through EVSW

- Voltage calibration needs to be done for each cell

bqEASY for bq3060: Chemistry

- Only the OCV profile from the chemistry is used

- This information is used to estimate initial capacity when the device is reset

- ChemID 100 is the default chemistry data programmed to bq3060

Determination of Initial Capacity

- In bq2084 and bq2060A, the initial capacity of a battery pack is estimated by a crude, midrange correction: 25%, 50%, and 75% by reading voltage at device reset

- In bq3060 and bq28300/400, the initial capacity of a battery pack is determined by the following method:
  - Reading the voltage of the cells
  - Calculate SOC based on chemistry data
  - Calculate RemCap based on the data flash values of Qmax and FCC

TEXAS INSTRUMENTS

bqEASY for bq3060: CEDV

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Calibration						

Configuration		Power		Gas Gauging		OCV Tabl

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		num
		num
		num
		num
		num
		num
		num
		mV
		mV
		mV
		0.1 degC
		mA
		.01%/da

Name	Value	Unit
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Qmax Cell 3	4400	mAh
Qmax Pack	4400	mAh

Texas Instruments - bqEASY

bqEasy

TEXAS INSTRUMENTS

bqEASY

IT and CEDV+ Configuration Wizard

1. Setup   2. Configure   3. Calibrate   4. Chemistry   5. CEDV

5A. CEDV

5A. CEDV

1. Enable CEDV or use Fix EDV? [CEDV ▼]

2. Terminate EDV based on stack voltage? [Yes ▼]

3. What is the Battery Low %? [7] %

[Config Device]

In order to use CEDV algorithm, the following paramters need to be configured:

EMF , C0, R0, T0, R1, TC, C1

Please refer to app. note sluc049 and the device TRM for detail.

We recommand to review the cell balancing threshold. bqEASY set it to 300mV below the max charge voltage

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Charge Control		SBS Configuration	

Name	Value	Unit
DOD at EDV2	15232	num

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TEXAS INSTRUMENTS