

bq20zxx EVM Data Flash Settings for Number of Serial Cells and Pack Capacity

PMP Portable Power

ABSTRACT

This application report describes the configuration changes in the data flash constants in the Texas Instruments bq20z80 Gas Gauging Evaluation Software required for a variety of battery-pack configurations.

The factors affecting the settings include the number of cells in series and the pack capacity. The pack capacity is determined by the cell capacity and the number of cells are in parallel.

Configurations are described (for example) as 3s2p, which stands for 3 cells in series and 2 in parallel. All changes must be done before enabling the Impedance Track™ feature in the bq20z80.

[Section 1](#) describes the changes required when changing series-cell count, and [Section 2](#) explains settings for varying the pack capacity. Illustrations are provided showing the specific locations in the data flash screens of the evaluation software.

1 Changes to Default 4-Series Cell Configuration

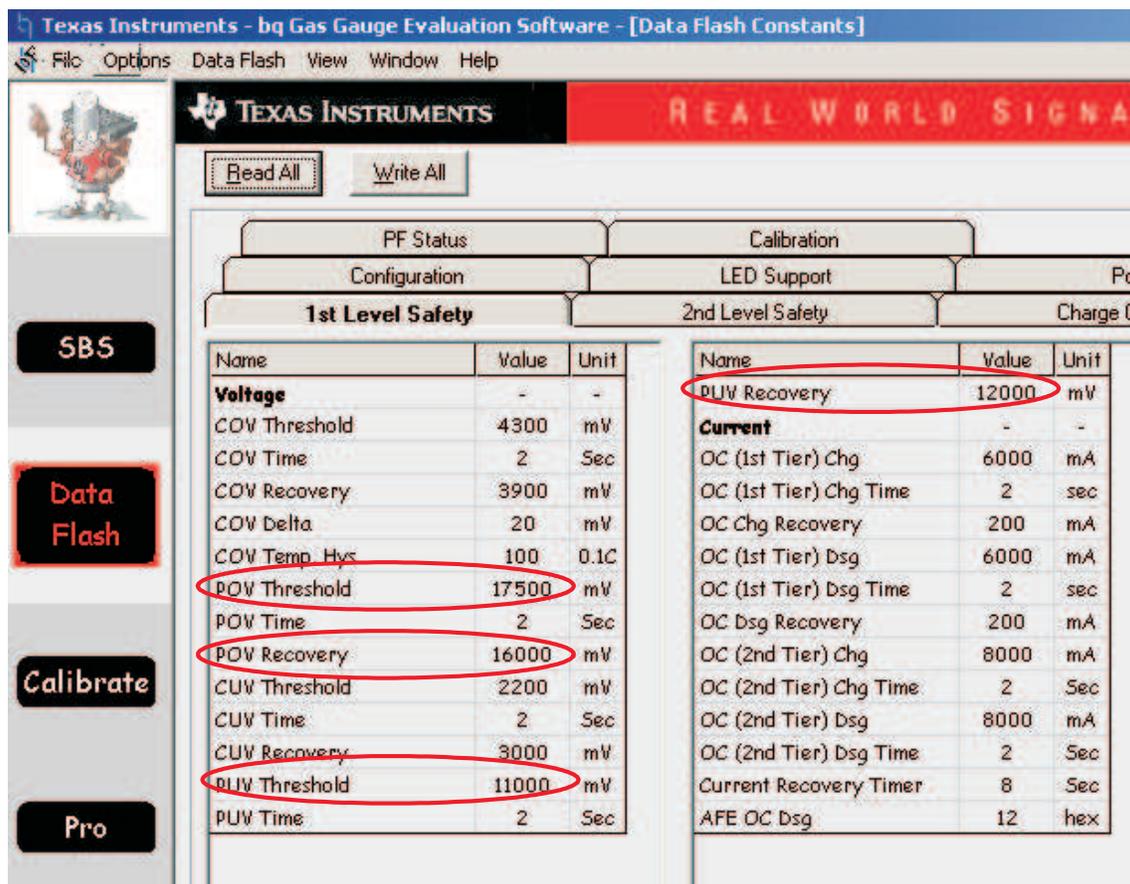
The following changes from the default settings must be made to enable a 2-series or 3-series cell pack before enabling the Impedance Track™ feature in the EVM. If a 4-series cell pack is connected, the EVM can be used in the default setting.

In addition to the serial configuration, the design capacity of the cells must be considered. This information is found on the cell-manufacturer data sheet and must be set in the data flash. This is described in [Section 2](#) of this application note.

Table 1. First Level Safety

Setting ⁽¹⁾	2-Cell	3-Cell	4-Cell (Default)
POV Threshold	8700	13000	17500
POV Recovery	8400	12600	16000
PUV Threshold	5400	8100	11000
PUV Recovery	5700	8500	12000

⁽¹⁾ This section does not apply to bq20z70.



The screenshot shows the 'Data Flash Constants' window of the Texas Instruments bq Gas Gauge Evaluation Software. The '1st Level Safety' section is expanded, showing a table of parameters. Several parameters are circled in red, indicating they are not present in the bq20z70 device:

Name	Value	Unit
Voltage	-	-
COV Threshold	4300	mV
COV Time	2	Sec
COV Recovery	3900	mV
COV Delta	20	mV
COV Temp. Hys	100	0.1C
POV Threshold	17500	mV
POV Time	2	Sec
POV Recovery	16000	mV
CUV Threshold	2200	mV
CUV Time	2	Sec
CUV Recovery	3000	mV
PUV Threshold	11000	mV
PUV Time	2	Sec

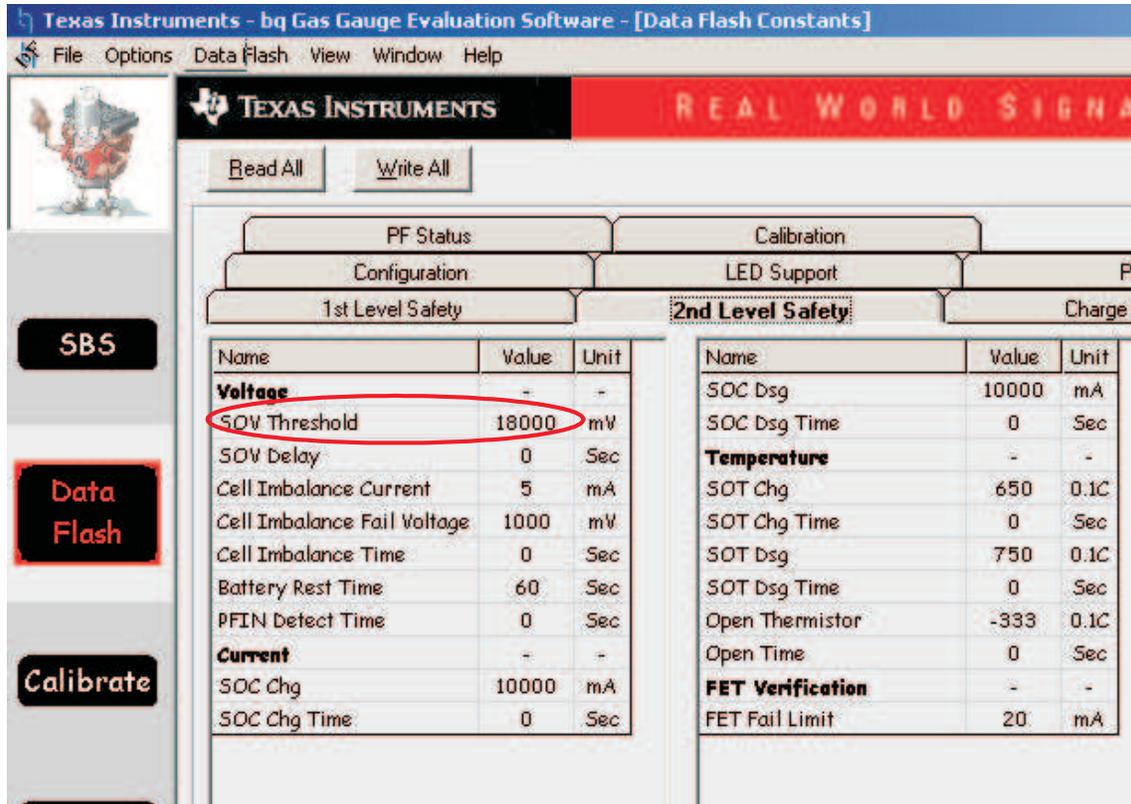
Additional parameters shown in the '2nd Level Safety' section include:

Name	Value	Unit
PUV Recovery	12000	mV
Current	-	-
OC (1st Tier) Chg	6000	mA
OC (1st Tier) Chg Time	2	sec
OC Chg Recovery	200	mA
OC (1st Tier) Dsg	6000	mA
OC (1st Tier) Dsg Time	2	sec
OC Dsg Recovery	200	mA
OC (2nd Tier) Chg	8000	mA
OC (2nd Tier) Chg Time	2	Sec
OC (2nd Tier) Dsg	8000	mA
OC (2nd Tier) Dsg Time	2	Sec
Current Recovery Timer	8	Sec
AFE OC Dsg	12	hex

This and other illustrations contain some parameters that are absent in the bq20z70.

Table 2. Second Level Safety

Setting	2-Cell	3-Cell	4-Cell (Default)
SOV Threshold	9000	13500	18000



The screenshot shows the 'Data Flash Constants' window in the Texas Instruments bq Gas Gauge Evaluation Software. The window is divided into several sections: 'PF Status', 'Calibration', 'Configuration', 'LED Support', '1st Level Safety', '2nd Level Safety', and 'Charge C'. The '2nd Level Safety' section is currently active and contains two tables of settings.

Name	Value	Unit
Voltage		
SOV Threshold	18000	mV
SOV Delay	0	Sec
Cell Imbalance Current	5	mA
Cell Imbalance Fail Voltage	1000	mV
Cell Imbalance Time	0	Sec
Battery Rest Time	60	Sec
PFIN Detect Time	0	Sec
Current		
SOC Chg	10000	mA
SOC Chg Time	0	Sec

Name	Value	Unit
SOC Dsg	10000	mA
SOC Dsg Time	0	Sec
Temperature		
SOT Chg	650	0.1C
SOT Chg Time	0	Sec
SOT Dsg	750	0.1C
SOT Dsg Time	0	Sec
Open Thermistor	-333	0.1C
Open Time	0	Sec
FET Verification		
FET Fail Limit	20	mA

Table 3. Charge Control

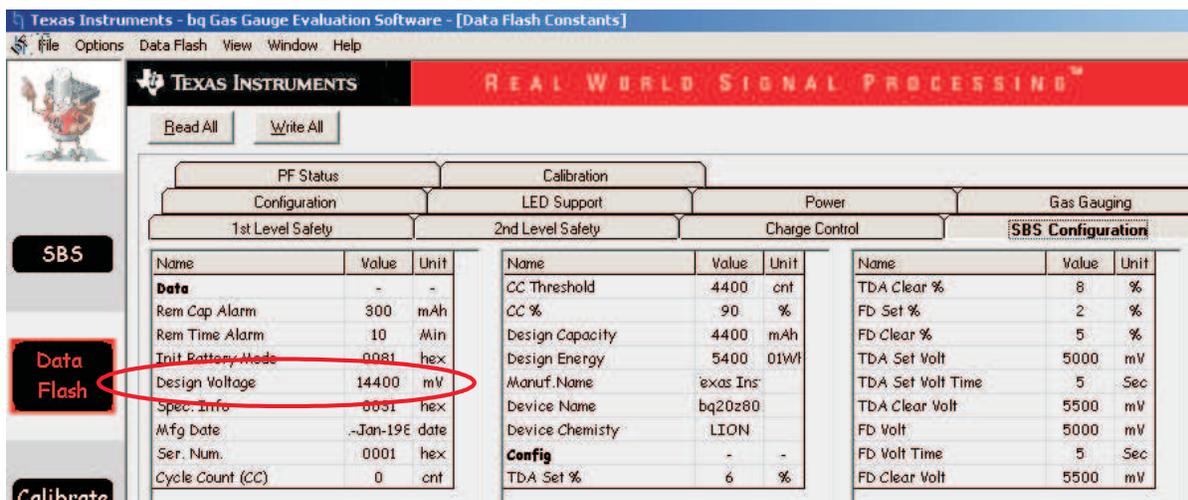
Setting	2-Cell	3-Cell	4-Cell (Default)
Charging voltage	8400	12600	16800
Depleted voltage	5000	8000	11000
Depleted recovery	5500	8500	11500

R_b Table			Ra Table			PF Status			Calibration		
Configuration			LED Support			Power			Gas Gauging		
1st Level Safety			2nd Level Safety			Charge Control			SBS Configuration		
Name	Value	Unit	Name	Value	Unit	Name	Value	Unit			
Charge Inhibit Cfg	-	-	Pulse Charge Cfg	-	-	Min Cell Deviation	1750	sec/mAh			
Chg Inhibit Temp Low	0	0.1C	Turn ON Voltage	4150	mV	Charging Faults	-	-			
Chg Inhibit Temp High	450	0.1C	Turn OFF Voltage	4250	mV	Over Charging Voltage	500	mV			
Temp Hys	10	0.1C	Max ON Pulse Time	240	S/4	Over Charging Volt Time	2	Sec			
Pre-Charge Cfg	-	-	Min OFF Pulse Time	0	S/4	Over Charging Current	500	mA			
Pre-chg Current	250	mA	Max OFF Voltage	4270	mV	Over Charging Curr Time	2	Sec			
Pre-chg Temp	120	0.1C	Termination Cfg	-	-	Over Charging Curr Recov	100	mA			
Pre-chg Voltage	3000	mV	Maintenance Current	0	mA	Depleted Voltage	8000	mV			
Recovery Voltage	3100	mV	Taper Current	250	mA	Depleted Voltage Time	2	Sec			
Fast Charge Cfg	-	-	Termination Voltage	300	mV	Depleted Recovery	8500	mV			
Fast Charge Current	4000	mA	Current Taper Window	40	Sec	Over Charge Capacity	300	mAh			
Charging Voltage	16800	mV	TCA Set %	-1	%	Over Charge Recovery	2	mAh			
Over Charging Voltage	500	mV	TCA Clear %	95	%	FC-MTO	10800	Sec			
Delta Temp	50	0.1C	FC Set %	-1	%	PC-MTO	3600	Sec			
Suspend Low Temp	-50	0.1C	FC Clear %	98	%	Charge Fault Cfg	0000	flg			
Suspend High Temp	550	0.1C	Cell Balancing Cfg	-	-						

Table 4. SBS Configuration

Setting	2-Cell	3-Cell	4-Cell (Default)
Design voltage	7200	10800	14400

Also see the description of the Design Energy setting in [Section 2](#).



PF Status			Calibration			Configuration			LED Support			Power			Gas Gauging		
1st Level Safety			2nd Level Safety			Charge Control			SBS Configuration								
Name	Value	Unit	Name	Value	Unit	Name	Value	Unit									
Data	-	-	CC Threshold	4400	cnt	TDA Clear %	8	%									
Rem Cap Alarm	300	mAh	CC %	90	%	FD Set %	2	%									
Rem Time Alarm	10	Min	Design Capacity	4400	mAh	FD Clear %	5	%									
Init Battery Mode	0081	hex	Design Energy	5400	01Wh	TDA Set Volt	5000	mV									
Design Voltage	14400	mV	Manuf. Name	exas Ins		TDA Set Volt Time	5	Sec									
Spec. Info	0051	hex	Device Name	bq20z80		TDA Clear Volt	5500	mV									
Mfg Date	--Jan-19E	date	Device Chemistry	LION		FD Volt	5000	mV									
Ser. Num.	0001	hex	Config	-	-	FD Volt Time	5	Sec									
Cycle Count (CC)	0	cnt	TDA Set %	6	%	FD Clear Volt	5500	mV									

Table 5. Typical Configuration Settings for bq20z80 and bq20z90

Setting	2-Cell	3-Cell	4-Cell (Default)
Operation CfgA	2d29	2e29	2f29
	CC1	0	1
	CC0	1	0

Number of serial cells is defined in CC1 and CC0 bits in Operation CfgA, bit mask 0x0300.

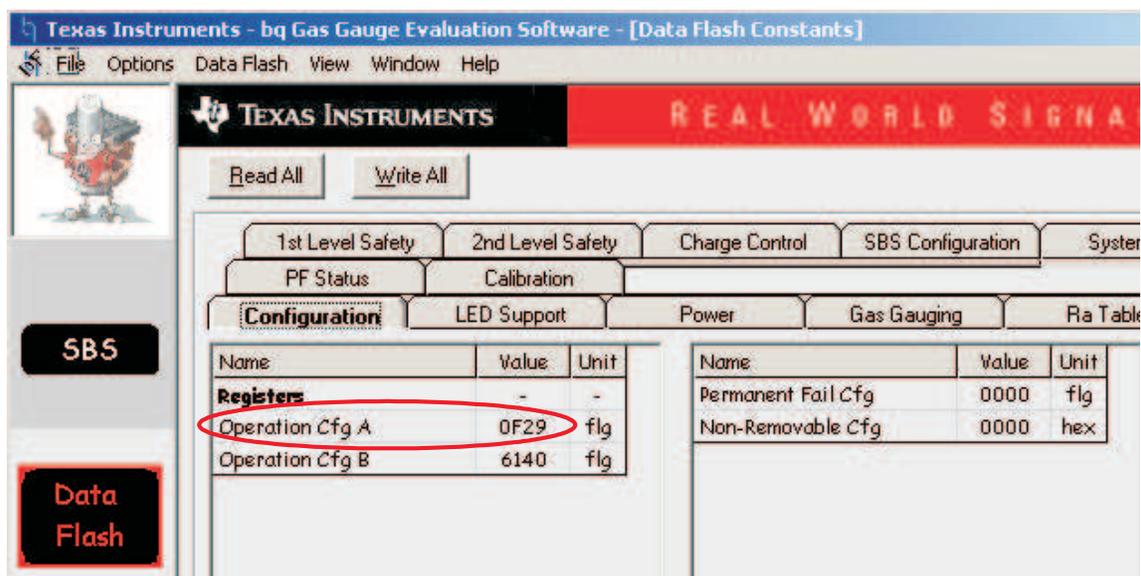


Table 6. Typical Configuration Settings for bq20z70

Setting	2-Cell	3-Cell	4-Cell (Default)
Operation CfgA	0129	0229	0329

Table 7. Power

Setting	2-Cell	3-Cell	4-Cell (Default)
Flash Update OK Voltage	6000	7500	7500
Charger Present Threshold	3000	3000	3000
Shut Down Voltage	5000	7000	7000

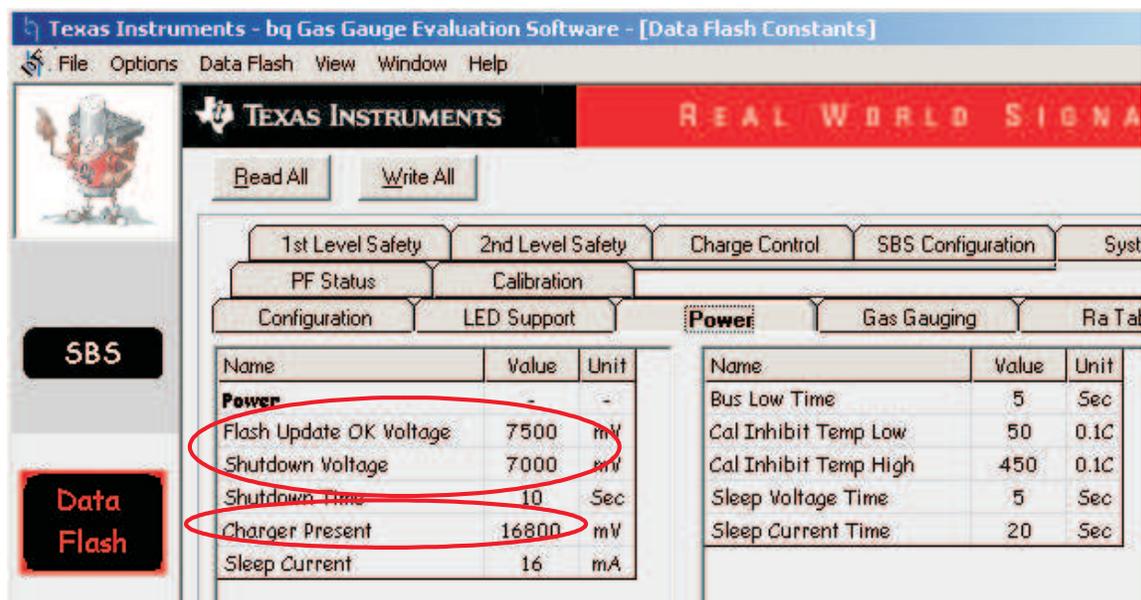
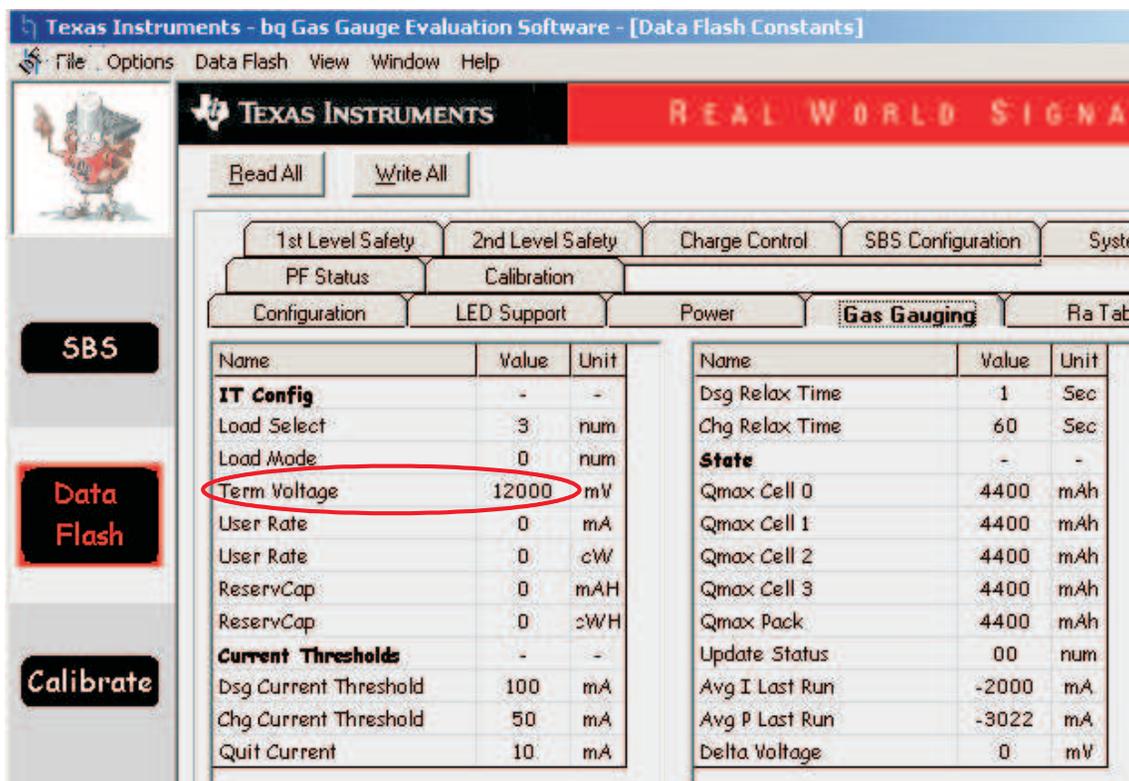


Table 8. Gas Gauging

Setting	2-Cell	3-Cell	4-Cell (Default)
Term Voltage	6000	9000	12000



The screenshot shows the 'Gas Gauging' configuration window in the Texas Instruments software. The window title is 'Texas Instruments - bq Gas Gauge Evaluation Software - [Data Flash Constants]'. The menu bar includes File, Options, Data Flash, View, Window, and Help. The interface features a sidebar with buttons for 'SBS', 'Data Flash', and 'Calibrate'. The main area has several tabs: '1st Level Safety', '2nd Level Safety', 'Charge Control', 'SBS Configuration', 'System', 'PF Status', 'Calibration', 'Configuration', 'LED Support', 'Power', 'Gas Gauging', and 'Ra Table'. The 'Gas Gauging' tab is active, displaying two tables of parameters. The 'Term Voltage' parameter in the left table is circled in red.

Name	Value	Unit
IT Config	-	-
Load Select	3	num
Load Mode	0	num
Term Voltage	12000	mV
User Rate	0	mA
User Rate	0	cW
ReservCap	0	mAH
ReservCap	0	cWH
Current Thresholds	-	-
Dsg Current Threshold	100	mA
Chg Current Threshold	50	mA
Quit Current	10	mA

Name	Value	Unit
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
Update Status	00	num
Avg I Last Run	-2000	mA
Avg P Last Run	-3022	mA
Delta Voltage	0	mV

2 Changes to Capacity Settings

The pack capacity depends on the individual cell capacity and on the number of parallel cells. The cell-capacity value found in the cell-manufacturer data sheet is used only as an initial estimate for the gas-gauging algorithm, and is updated during operation.

2.1 Gas Gauging

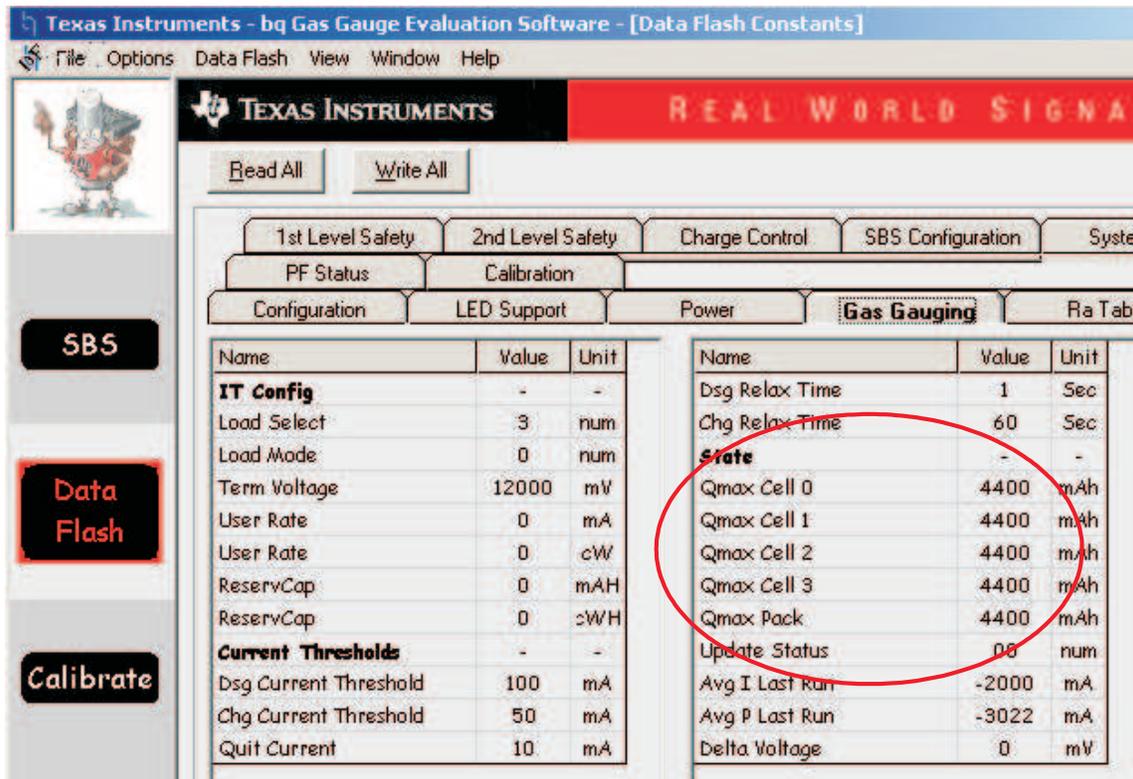
The Qmax of all serial cells (Qmax Cell 0 to 3) is set initially to equal values. The same value is assigned to Qmax Pack. The value to be assigned is calculated as

$$Q_{max} = \text{Data sheet Cell Capacity} \times \text{Number_parallel_cells.}$$

Example: The default assumes 2200-mAh cells. Following are the required changes to the 4s2p default values if 2400-mAh cells are actually used..

Table 9. Gas Gauging

Setting	1p with 2400 mAh	2p with 2200 mAh (Default)	3p with 2400 mAh
Qmax Cell 0	2400	4400	7200
Qmax Cell 1	2400	4400	7200
Qmax Cell 2	2400	4400	7200
Qmax Cell 3	2400	4400	7200
Qmax Pack	2400	4400	7200



The screenshot shows the 'Texas Instruments - bq Gas Gauge Evaluation Software - [Data Flash Constants]' window. The 'Gas Gauging' tab is active, displaying a table of configuration parameters. A red circle highlights the 'Qmax' values for cells 0-3 and the pack, which are all set to 4400 mAh.

Name	Value	Unit
IT Config	-	-
Load Select	3	num
Load Mode	0	num
Term Voltage	12000	mV
User Rate	0	mA
User Rate	0	cW
ReservCap	0	mAH
ReservCap	0	cWH
Current Thresholds	-	-
Dsg Current Threshold	100	mA
Chg Current Threshold	50	mA
Quit Current	10	mA
State	-	-
Dsg Relax Time	1	Sec
Chg Relax Time	60	Sec
Qmax Cell 0	4400	mAh
Qmax Cell 1	4400	mAh
Qmax Cell 2	4400	mAh
Qmax Cell 3	4400	mAh
Qmax Pack	4400	mAh
Update Status	06	num
Avg I Last Run	-2000	mA
Avg P Last Run	-3022	mA
Delta Voltage	0	mV

2.2 SBS Configuration

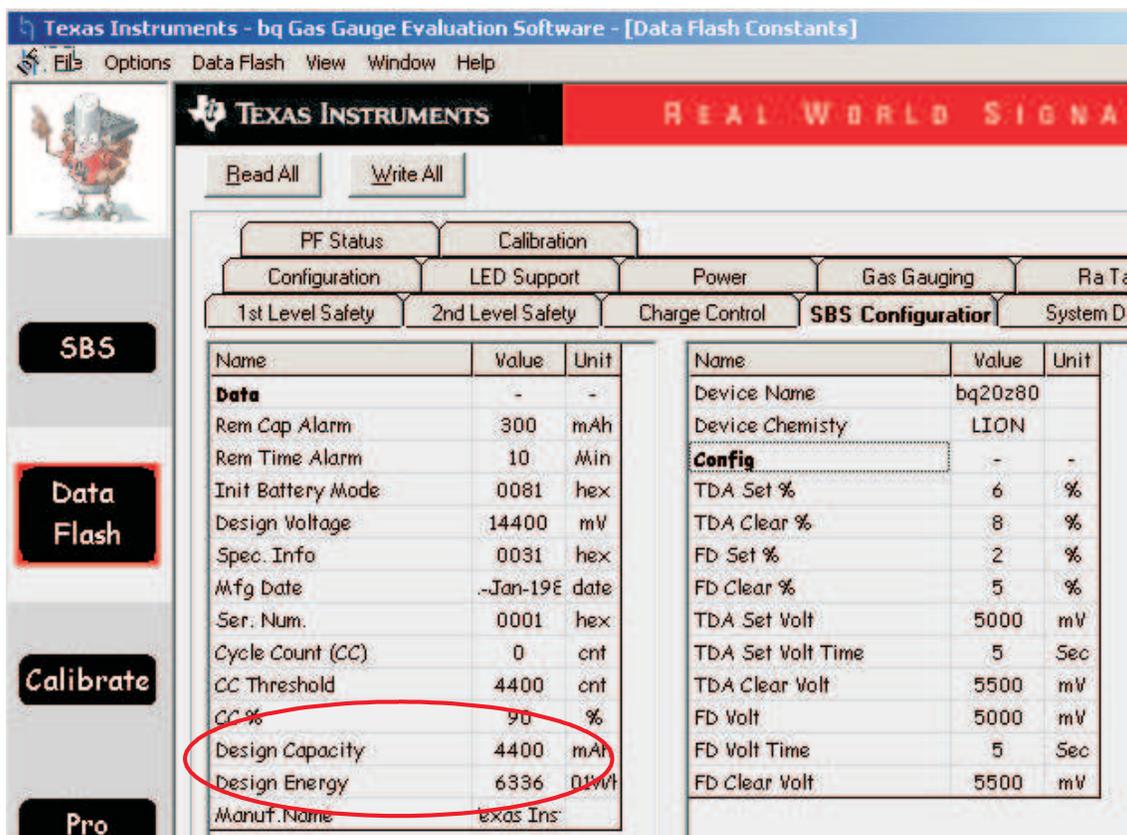
Design Capacity is set to the same number as Qmax or lower. Design energy (centi-Watt) is calculated as

$$\text{Design Energy} = \text{Design Capacity} \times \text{Number_Serial_Cells} \times 3.6 \text{ V} \div 10$$

Example: The default assumes 2200-mAh cells. Following are the required changes to the 4s2p default if 2400-mAh cells are actually used.

Table 10. Gas Gauging

Setting	1p with 2400 mAh	2p with 2200 mAH (Default)	3p with 2400 mAH
Design Capacity	2400	4400	7200
Design Energy	3456	6336	10368



The screenshot shows the 'SBS Configurator' tab in the software. The 'Data' table on the left has the following entries:

Name	Value	Unit
Rem Cap Alarm	300	mAh
Rem Time Alarm	10	Min
Init Battery Mode	0081	hex
Design Voltage	14400	mV
Spec. Info	0031	hex
Mfg Date	.-Jan-19E	date
Ser. Num.	0001	hex
Cycle Count (CC)	0	cnt
CC Threshold	4400	cnt
CC %	90	%
Design Capacity	4400	mAh
Design Energy	6336	mWh
Manuf. Name	exas Ins	

The 'Config' table on the right shows various settings for the device (bq20z80, LION chemistry):

Name	Value	Unit
Device Name	bq20z80	
Device Chemistry	LION	
Config	-	-
TDA Set %	6	%
TDA Clear %	8	%
FD Set %	2	%
FD Clear %	5	%
TDA Set Volt	5000	mV
TDA Set Volt Time	5	Sec
TDA Clear Volt	5500	mV
FD Volt	5000	mV
FD Volt Time	5	Sec
FD Clear Volt	5500	mV

Design Capacity is used to calculate the amount of discharge that is sufficient for a Qmax update. Therefore, it should be set to less than or equal to Qmax. Design Energy is not used in the gas-gauging algorithm, except for reporting absolute state of charge (ASOC) and state of health; so, it does not influence gas-gauging accuracy. Actual capacity depends on the rate of discharge. If a more-accurate setting of design capacity and energy is desired, it should be measured at a discharge rate typical for the target application. The learned FCC value from gas-gauging of a new battery pack at a typical rate can be used as a good estimate of design capacity.

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