

bq20z40/45 and bq20z60/65 EVM Data Flash Settings for Number of Serial Cells and Pack Capacity

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ABSTRACT

This application report describes the configuration changes in the data flash constants in the Texas Instruments bq20z40/45 and bq20z60/65 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 that 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 bq20z40/45 or bq20z60/65.

[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 report.

Table 1. Charge Control

Setting	2-Cell	3-Cell	4-Cell (Default)
LT Chg Voltage	6000	9000	12000
ST1 Chg Voltage	8400	12600	16800
ST2 Chg Voltage	8400	12600	16800
HT Chg Voltage	8380	12570	16760
Depleted Voltage ⁽¹⁾	5000	8000	11000
Depleted Recovery ⁽¹⁾	5500	8500	11500

⁽¹⁾ This parameter does not apply to the bq20z40/45.

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	Name	Value	Unit
Charge Temp Cfg	-	-	ST1 Chg Current3	4000	mA	FC Set %	-1	%	FC Clear %	98	%
JT1	0.0	degC	ST2 Chg Voltage	16800	mV	Cell Balancing Cfg	-	-	Min Cell Deviation	1750	s/mAh
JT2	12.0	degC	ST2 Chg Current1	4000	mA	Charging Faults	-	-	Over Charging Voltage	500	mV
JT2a	30.0	degC	ST2 Chg Current2	4000	mA	Over Charging Volt Time	2	s	Over Charging Current	500	mA
JT3	45.0	degC	ST2 Chg Current3	4000	mA	Over Charging Curr Time	2	s	Over Charging Curr Recov	100	mA
JT4	55.0	degC	HT Chg Voltage	16760	mV	Depleted Voltage	8000	mV	Depleted Voltage Time	2	s
Temp Hys	1.0	degC	HT Chg Current1	3800	mA	Depleted Recovery	8500	mV	Over Charge Capacity	300	mAh
Pre-Charge Cfg	-	-	HT Chg Current2	3800	mA	Over Charge Recovery	2	mAh	CMTO	10800	s
Pre-chg Voltage Threshold	3000	mV	HT Chg Current3	3800	mA	PCMTO	3600	s	Charge Fault Cfg	00	-
Pre-chg Recovery Voltage	3100	mV	Cell Voltage Threshold1	3900	mV						
Pre-chg Current	250	mA	Cell Voltage Threshold2	4000	mV						
Charge Cfg	-	-	Cell Voltage Thresh Hys	10	mV						
LT Chg Voltage	12000	mV	Termination Cfg	-	-						
LT Chg Current1	250	mA	Maintenance Current	0	mA						
LT Chg Current2	250	mA	Taper Current	250	mA						
LT Chg Current3	250	mA	Taper Voltage	75	mV						
ST1 Chg Voltage	16800	mV	Current Taper Window	40	s						
ST1 Chg Current1	4000	mA	TCA Set %	-1	%						
ST1 Chg Current2	4000	mA	TCA Clear %	95	%						

This and other illustrations contain some parameters that are absent in the bq20z40/45.

Table 2. SBS Configuration

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

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

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	Name	Value	Unit
Data	-	-	CC %	90	%	TDA Set %	6	%	TDA Set %	6	%
Rem Cap Alarm	300	mAh	CF MaxError Limit	100	%	TDA Clear %	8	%	TDA Clear %	8	%
Rem Energy Alarm	4320	mWh	Design Capacity	4400	mAh	FD Set %	2	%	FD Set %	2	%
Rem Time Alarm	10	Min	Design Energy	63360	mWh	FD Clear %	5	%	FD Clear %	5	%
Init Battery Mode	0081	-	Manuf Name	xas Instrumer	-	TDA Set Volt Threshold	5000	mV	TDA Set Volt Threshold	5000	mV
Design Voltage	14400	mV	Device Name	bq20z60	-	TDA Set Volt Time	5	s	TDA Set Volt Time	5	s
Spec Info	0031	-	Device Chemistry	LION	-	TDA Clear Volt	5500	mV	TDA Clear Volt	5500	mV
Manuf Date	01-Jan-1980	date	Deterioration Warn Limit	50	%	FD Set Volt Threshold	5000	mV	FD Set Volt Threshold	5000	mV
Ser. Num.	0001	-	Deterioration Fault Limit	30	%	FD Volt Time	5	s	FD Volt Time	5	s
Cycle Count	0	-	Cell Life Limit	20	%	FD Clear Volt	5500	mV	FD Clear Volt	5500	mV
CC Threshold	4400	mAh	Configuration	-	-						

Table 3. Typical Configuration Settings for bq20z60/65

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

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

PF Status			Calibration			Power			Gas Gauging		
Configuration			LED Support			Power			Gas Gauging		
Name	Value	Unit	Name	Value	Unit	Name	Value	Unit	Name	Value	Unit
Registers	-	-	Operation Cfg C	0130	-	Non-Removable Cfg	0000	-	AFE	-	-
Operation Cfg A	0F29	-	Permanent Fail Cfg	0000	-	AFE.State_CTL	00	-			
Operation Cfg B	6440	-	Permanent Fail Cfg 2	0000	-						

Table 4. Typical Configuration Settings for bq20z40/45

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

Table 5. Power

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

PF Status			Calibration			Power			Gas Gauging		
Configuration			LED Support			Power			Gas Gauging		
Name	Value	Unit	Name	Value	Unit	Name	Value	Unit	Name	Value	Unit
Power	-	-	Cell Shutdown Time	10	s	Cal Inhibit Temp High	45.0	degC	Sleep Voltage Time	5	s
Flash Update OK Voltage	7500	mV	Charger Present	3000	mV	Sleep Current Time	20	s	Sleep Current Reg	00	-
Shutdown Voltage	7000	mV	Sleep Current	10	mA	Wake Current Delay	5	s	Sealed Ship Delay	5	s
Shutdown Time	10	s	Bus Low Time	5	s						
Cell Shutdown Voltage	1750	mV	Cal Inhibit Temp Low	5.0	degC						

Table 6. Gas Gauging

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

PF Status			Calibration			Power			Gas Gauging		
Configuration			LED Support			Power			Gas Gauging		
Name	Value	Unit	Name	Value	Unit	Name	Value	Unit	Name	Value	Unit
IT Cfg	-	-	Chg Current Threshold	50	mA	Update Status	00	-	Cell 0 Chg dod at EoC	0	-
Load Select	7	-	Quit Current	10	mA	Cell 1 Chg dod at EoC	0	-	Cell 2 Chg dod at EoC	0	-
Load Mode	0	-	Dsg Relax Time	1	s	Cell 3 Chg dod at EoC	0	-	Avg I Last Run	-2000	mA
Term Voltage	12000	mV	Chg Relax Time	60	s	Avg P Last Run	-3022	10mW	Delta Voltage	0	mV
User Rate-mA	0	mA	State	-	-	Max Avg I Last Run	-2000	mA	Max Avg P Last Run	-3022	10mW
User Rate-mW	0	mW	Qmax Cell 0	4400	mAh						
Reserve Cap-mAh	0	mAh	Qmax Cell 1	4400	mAh						
Reserve Cap-mWh	0	mWh	Qmax Cell 2	4400	mAh						
Current Thresholds	-	-	Qmax Cell 3	4400	mAh						
Dsg Current Threshold	100	mA	Qmax Pack	4400	mAh						

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. [Table 7](#) and the accompanying illustration show the required changes to the 4s2p default values if 2400-mAh cells are actually used..

Table 7. 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

PF Status			Calibration			Power			Gas Gauging		
Configuration			LED Support			Power			Gas Gauging		
Name	Value	Unit	Name	Value	Unit	Name	Value	Unit	Name	Value	Unit
IT Cfg	-	-	Chg Current Threshold	50	mA	Update Status	00	-	Cell 0 Chg dod at EoC	0	-
Load Select	7	-	Quit Current	10	mA	Cell 1 Chg dod at EoC	0	-	Cell 1 Chg dod at EoC	0	-
Load Mode	0	-	Dsg Relax Time	1	s	Cell 2 Chg dod at EoC	0	-	Cell 2 Chg dod at EoC	0	-
Term Voltage	12000	mV	Chg Relax Time	60	s	Cell 3 Chg dod at EoC	0	-	Cell 3 Chg dod at EoC	0	-
User Rate-mA	0	mA	State	-	-	Avg I Last Run	-2000	mA	Avg I Last Run	-2000	mA
User Rate-mW	0	mW	Qmax Cell 0	4400	mAh	Avg P Last Run	-3022	10mW	Avg P Last Run	-3022	10mW
Reserve Cap-mAh	0	mAh	Qmax Cell 1	4400	mAh	Delta Voltage	0	mV	Max Avg I Last Run	-2000	mA
Reserve Cap-mWh	0	mWh	Qmax Cell 2	4400	mAh	Max Avg I Last Run	-2000	mA	Max Avg P Last Run	-3022	10mW
Current Thresholds	-	-	Qmax Cell 3	4400	mAh						
Dsg Current Threshold	100	mA	Qmax Pack	4400	mAh						

2.2 SBS Configuration

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

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

Example: The default assumes 2200-mAh cells. [Table 8](#) and the accompanying illustration show the required changes to the 4s2p default if 2400-mAh cells are actually used.

Table 8. Gas Gauging

Setting	1p with 2400 mAh	2p with 2200 mAh (Default)	3p with 2400 mAh
Design Capacity	2400	4400	7200
Design Energy	34560	63360	103680

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	Name	Value	Unit
Data	-	-	CC %	90	%	TDA Set %	6	%	TDA Set %	6	%
Rem Cap Alarm	300	mAh	CF MaxError Limit	100	%	TDA Clear %	8	%	TDA Clear %	8	%
Rem Energy Alarm	4320	mWh	Design Capacity	4400	mAh	FD Set %	2	%	FD Set %	2	%
Rem Time Alarm	10	Min	Design Energy	63360	mWh	FD Clear %	5	%	FD Clear %	5	%
Init Battery Mode	0081	-	Manuf Name	xas Instrumer	-	TDA Set Volt Threshold	5000	mV	TDA Set Volt Threshold	5000	mV
Design Voltage	14400	mV	Device Name	bq20z60	-	TDA Set Volt Time	5	s	TDA Set Volt Time	5	s
Spec Info	0031	-	Device Chemistry	LION	-	TDA Clear Volt	5500	mV	TDA Clear Volt	5500	mV
Manuf Date	01-Jan-1980	date	Deterioration Warn Limit	50	%	FD Set Volt Threshold	5000	mV	FD Set Volt Threshold	5000	mV
Ser. Num.	0001	-	Deterioration Fault Limit	30	%	FD Volt Time	5	s	FD Volt Time	5	s
Cycle Count	0	-	Cell Life Limit	20	%	FD Clear Volt	5500	mV	FD Clear Volt	5500	mV
CC Threshold	4400	mAh	Configuration	-	-						

Design Capacity is used to calculate the amount of discharge that is sufficient for a Qmax update. Therefore, it must 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 must 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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