bq78350-R1 TRM Addendum for the bq78350-R2 Device

This document is an addendum to the *bq78350-R1 Technical Reference Manual* (TRM, SLUUBD3) and discusses modifications relating to the bq78350-R2 device. Items not discussed in this addendum have not changed.

Notational Conventions

Information Type	Formatting Convention	Example
Commands	*Italics* with parentheses and no breaking spaces	*RemainingCapacity()* command
Data Flash (DF)	*Italics*, **bold**, and breaking spaces	***Design Capacity*** data
Register bits and flags	Brackets and *italics*	*[TDA]* bit
Data flash bits	Brackets, *italics*, and **bold**	***[LED1]*** bit
Modes and states	ALL CAPITALS	UNSEALED mode

Related Documentation from Texas Instruments

The following is related documentation:

1. *bq78350-R1 Technical Reference Manual* (SLUUBD3)
2. *bq78350-R1 CEDV Li-Ion Gas Gauge and Battery Management Controller Companion to the bq769x0 Battery Monitoring AFE Data Sheet* (SLUSCD0)
3. *bq78350 Data Memory Programming for Mass Production Application Report* (SLUA742)

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Glossary

TI Glossary —This glossary lists and explains terms, acronyms, and definitions.

Overview

Contents

1 General Description

The bq78350-R2 device is a modified version of the catalog bq78350-R1 device, which modifies selected functionality as well as adding new features. This document details the changes regarding the bq78350-R2 device with respect to the bq78350-R1 device.

2 Production Plans

To use the bq78350-R2 device, customers must order the catalog bq78350-R1 device from TI.com, and program the device with the TI-provided bq78350-R2 firmware. Thus, the package and pinout will remain the same as the bq78350-R1 device, with the exception of some modified functionality associated with the GPIO_B pin.

3 Added Features

3.1 PRE-DISCHARGE Mode

The bq78350-R2 device includes new functionality to provide pre-discharge control functionality on the GPIO_B pin (pin 28) for use with a high-side PFET. This pin functions as an open-drain output pin, which is expected to drive the gate of an NFET with source at ground. When the NFET is turned on, it will pull down the PFET gate and enable pre-discharge. When the NFET is turned off, the PFET gate will be pulled up and turn off the PFET, disabling pre-discharge.

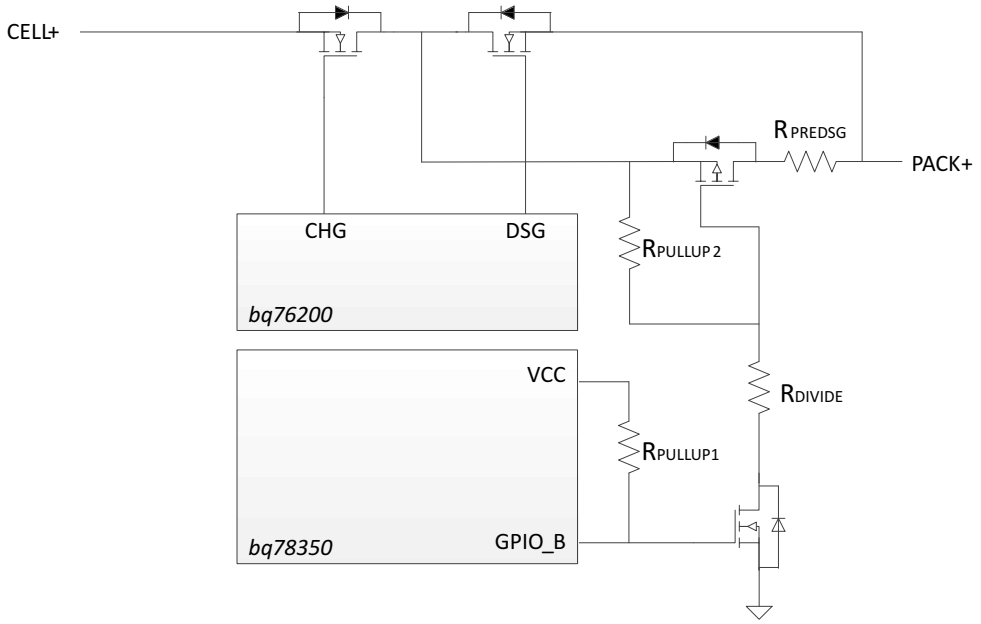

Figure 1. PRE-DISCHARGE

If the DSG FET is off and the bq78350-R2 device receives a request to turn it on, and if the bq78350 does not detect a charging current above a level of ***Charge Current Threshold***, the bq78350-R2 device will first enter a pre-discharge phase for a length of time given by Pre-Discharge:***[FET ON Time]***. After this time expires, the bq78350-R2 device will disable the pre-discharge phase and turn on the DSG FET.

If the DSG FET is off and the bq78350-R2 device receives a request to turn it on, and if the bq78350-R2 device detects a charging current above a level of ***Charge Current Threshold***, the bq78350-R2 device will immediately turn on the DSG FET and not first implement a pre-discharge phase.

While the bq78350-R2 device is in the pre-discharge phase, if any fault or issue occurs that would normally cause the DSG FET to be disabled (such as ACSD, AOLD, OTD, UTD), then the bq78350-R2 device will immediately disable the pre-discharge phase but keep the DSG FET off until all such faults are cleared.

3.1.1 Flash Changes for PRE-DISCHARGE Mode

Data flash bits to enable/disable the pre-discharge functionality and control the polarity of the signaling used on GPIO_B are included in the ***FET Options*** register.

Class	Subclass	Name	Format	Size in Bytes	Min	Max	Default	Unit
Settings	Configuration	FET Options	Hex	2	0x0000	0xFFFF	0x0021	—

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
High byte	RSVD	RSVD	RSVD	RSVD	PDSG_POL	PDSG_EN	KEY_POL	PCHG_POL
Low Byte	RSVD	SLEEPCHG	CHGFET	CHGIN	CHGSU	OTFET	KEY_EN	PCHG_EN

RSVD (Bits 7–4): Reserved

PDSG_POL: Configures the bq78350-R2 device GPIO_B pin output polarity when used for PRE-DISCHARGE mode. If PDSG_EN = 0, then this bit has no influence.

0 = The bq78350-R2 device configures the GPIO_B as active low (default).

1 = The bq78350-R2 device configures the GPIO_B as active high, requiring an external pull up.

PDSG_EN: This bit enables the bq78350-R2 device to use the GPIO_B pin during PRE-DISCHARGE mode.

0 = The bq78350-R2 device does not use GPIO_B for PRE-DISCHARGE mode (default)

1 = The bq78350-R2 device controls GPIO_B under normal charge control algorithm.

KEY_POL: This bit configures the KEYIN input detection polarity.

0 = KEYIN detection is active low (default).

1 = KEYIN detection is active high.

PCHG_POL: Configures the bq78350-R2 device PRECHG pin output polarity. If PCHG_EN = 0, then this bit has no influence.

0 = The bq78350-R2 device configures the PRECHG as active low (default).

1 = The bq78350-R2 device configures the PRECHG as active high, requiring an external pull up.

SLEEPCHG: CHG FET is enabled during SLEEP.

0 = CHG FET is off during SLEEP (default).

1 = CHG FET remains on during SLEEP.

CHGFET: FET action on valid charge termination

0 = FET active

1 = Charging and precharging disabled, FET off (default)

CHGIN: FET action in CHARGE INHIBIT mode

0 = FET active (default)

1 = Charging and precharging disabled, FETs off

CHGSU: FET action in CHARGE SUSPEND mode

0 = FET active (default)

1 = Charging and precharging disabled, FETs off

OTFET: FET action in OVERTEMPERATURE mode

0 = No FET action for overtemperature condition (default)

1 = CHG and DSG FETs will be turned off for overtemperature conditions.

KEY_EN: Enables the bq78350-R2 device to use the KEYIN pin function.

0 = The bq78350-R2 device never uses KEYIN (default).

1 = The bq78350-R2 device KEYIN is used to control the DSG FET.

PCHG_EN: This bit enables the bq78350-R2 device to use the PRECHG pin during PRECHARGE mode.

0 = The bq78350-R2 device never uses PRECHG.

1 = The bq78350-R2 device controls PRECHG under normal charge control algorithm (default).

The Pre-Discharge:***[FET ON Time]*** setting is included in the following data flash:

Class	Subclass	Name	Type	Min	Max	Default	Unit
Power	Pre-Discharge	FET ON Time	U2	0	65535	10	s

3.1.2 Command Changes for PRE-DISCHARGE Mode

3.1.2.1 ManufacturerAccess() 0x0057 ManufacturingStatus

This command returns the *ManufacturingStatus()* flags on *ManufacturerBlockAccess()* or *ManufacturerData()*. A new *[PDSG_TEST]* bit was added here for the bq78350-R2 device.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
High byte	CAL_EN	LT_TEST	CB_TEST	AFE_DD _TEST	RSVD	RSVD	LED_EN	SAFE_EN
Low Byte	BBR_EN	PF_EN	LF_EN	FET_EN	PDSG _TEST	DSG_TEST	CHG_TEST	PCHG _TEST

PDSG_TEST: Pre-Discharge FET Test

0 = Disabled

1 = Pre-discharge FET test activated

3.1.2.2 ManufacturerAccess() 0x001A PRE-DSG FET

This command turns on/off the pre-discharge FET drive function (which uses GPIO_B) to ease testing during manufacturing. When 0x001A is written to *ManufacturerAccess()* when *ManufacturingStatus()[FET_EN,PDSG_TEST]* = 0, 0, then GPIO_B turns the pre-discharge function ON and *ManufacturingStatus()[PDSG_TEST]* is set to 1. If 0x001A is written to *ManufacturerAccess()* once again, then GPIO_B turns the pre-discharge function OFF and *ManufacturingStatus()[PDSG_TEST]* is cleared to 0.

NOTE: The GPIO mode should not be used on GPIO_B while the PRE-DISCHARGE mode is used.

3.2 JEITA Charge Control

The existing bq78350-R1 device does not include JEITA charge control. This functionality is added in the bq78350-R2 device.

NOTE: Some existing data flash addresses were modified from bq78350-R1 device to accommodate the extra address space required for this feature.

The class name is changed from ***Charge Algorithm*** to ***Advanced Charge Algorithm***.

3.2.1 Temperature Ranges

Temperature Ranges ≥ values are changed from:

- ***Charge Inhibit/Suspend Low Temp***
- ***Precharge Temp***
- ***Charge Inhibit High Temp***
- ***Charge Suspend High Temp***

To:

- ***T1 Temp***
- ***T2 Temp***
- ***T5 Temp***
- ***T6 Temp***
- ***T3 Temp***
- ***T4 Temp***

See further details on these changes below:

3.2.1.1 T1 Temp

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	T1 Temp	I1	–128	127	0	°C

Description: T1 low temperature range lower limit

3.2.1.2 T2 Temp

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	T2 Temp	I1	–128	127	12	°C

Description: T2 low temperature range to standard temperature range

3.2.1.3 T5 Temp

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	T5 Temp	I1	–128	127	20	°C

Description: T5 recommended temperature range lower limit

3.2.1.4 T6 Temp

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	T6 Temp	I1	–128	127	25	°C

Description: T6 recommended temperature range upper limit

3.2.1.5 T3 Temp

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	T3 Temp	I1	–128	127	30	°C

Description: T3 standard temperature range to high temperature range

3.2.1.6 T4 Temp

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	T4 Temp	I1	–128	127	55	°C

Description: T4 high temperature range upper limit

3.2.1.7 Hysteresis

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Temperature Ranges	Hysteresis Temp	I1	–128	127	1	°C

Description: Temperature Hysteresis, applied when temperature is decreasing.

3.2.2 Fast Charging

Fast Charging → Voltage and Current is replaced with:

- Low Temp Charging → ***Voltage***
- Low Temp Charging → ***Current Low***
- Low Temp Charging → ***Current Med***
- Low Temp Charging → ***Current High***
- Standard Temp Charging → ***Voltage***
- Standard Temp Charging → ***Current Low***
- Standard Temp Charging → ***Current Med***
- Standard Temp Charging → ***Current High***
- High Temp Charging → ***Voltage***

- High Temp Charging → ***Current Low***
- High Temp Charging → ***Current Med***
- High Temp Charging → ***Current High***
- Rec Temp Charging → ***Voltage***
- Rec Temp Charging → ***Current Low***
- Rec Temp Charging → ***Current Med***
- Rec Temp Charging → ***Current High***

See further description on these changes below:

3.2.3 Low Temp Charging

3.2.3.1 Voltage

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Low Temp Charging	Voltage	I2	0	32767	4000	mV

Description: Low temperature range *ChargingVoltage()*.

3.2.3.2 Current Low

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Low Temp Charging	Current Low	I2	0	32767	132	mA

Description: Low temperature range low voltage range *ChargingCurrent()*

3.2.3.3 Current Med

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Low Temp Charging	Current Med	I2	0	32767	352	mA

Description: Low temperature range medium voltage range *ChargingCurrent()*

3.2.3.4 Current High

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Low Temp Charging	Current High	I2	0	32767	264	mA

Description: Low temperature range high voltage range *ChargingCurrent()*

3.2.4 Standard Temp Charging

3.2.4.1 Voltage

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Standard Temp Charging	Voltage	I2	0	32767	4200	mV

Description: Standard temperature range *ChargingVoltage()*

3.2.4.2 Current Low

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Standard Temp Charging	Current Low	I2	0	32767	1980	mA

Description: Standard temperature range low voltage range *ChargingCurrent()*

3.2.4.3 Current Med

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Standard Temp Charging	Current Med	I2	0	32767	4004	mA

Description: Standard temperature range medium voltage range *ChargingCurrent()*

3.2.4.4 Current High

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Standard Temp Charging	Current High	I2	0	32767	2992	mA

Description: Standard temperature range high voltage range *ChargingCurrent()*

3.2.5 High Temp Charging

3.2.5.1 Voltage

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	High Temp Charging	Voltage	I2	0	32767	4000	mV

Description: High temperature range *ChargingVoltage()*

3.2.5.2 Current Low

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	High Temp Charging	Current Low	I2	0	32767	1012	mA

Description: High temperature range low voltage range *ChargingCurrent()*

3.2.5.3 Current Med

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	High Temp Charging	Current Med	I2	0	32767	1980	mA

Description: High temperature range medium voltage range *ChargingCurrent()*

3.2.5.4 Current High

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	High Temp Charging	Current High	I2	0	32767	1496	mA

Description: High temperature range high voltage range *ChargingCurrent()*

3.2.6 Recommended Temp Charging

3.2.6.1 Voltage

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Rec Temp Charging	Voltage	I2	0	32767	4100	mV

Description: Recommended temperature range *ChargingVoltage()*

3.2.6.2 Current Low

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Rec Temp Charging	Current Low	I2	0	32767	2508	mA

Description: Recommended temperature range low voltage range *ChargingCurrent()*

3.2.6.3 Current Med

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Rec Temp Charging	Current Med	I2	0	32767	4488	mA

Description: Recommended temperature range medium voltage range *ChargingCurrent()*

3.2.6.4 Current High

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Rec Temp Charging	Current High	I2	0	32767	3520	mA

Description: Recommended temperature range high voltage range *ChargingCurrent()*

3.2.7 Pre-Charging

Pre-Charging → ***Current*** is retained, while ***Start Voltage*** and ***Recovery Voltage*** are removed.

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Pre-Charging	Current	I2	0	32767	100	mA

Description: Pre-charge *ChargingCurrent()*

3.2.8 Maintenance Charging

Maintenance Charging → ***Current*** is added.

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	MCHG	Current	I2	0	32767	44	mA

Description: Maintenance *ChargingCurrent()*

3.2.9 Voltage Range

The following dataflash are added:

- Voltage Range → ***Pre-charge Start Voltage***
- Voltage Range → ***Charging Voltage Low***
- Voltage Range → ***Charging Voltage Med***
- Voltage Range → ***Charging Voltage High***
- Voltage Range → ***Charging Voltage Hysteresis***

3.2.9.1 Pre-Charge Start Voltage

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Voltage Range	Pre-charge Start Voltage	I2	0	32767	2500	mV

Description: Minimum cell voltage to enter PRECHARGE mode

3.2.9.2

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Voltage Range	Charging Voltage Low	I2	0	32767	2900	mV

Description: Pre-charge Voltage range to ***Charging Voltage Low*** range

3.2.9.3 Charging Voltage Med

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Voltage Range	Charging Voltage Med	I2	0	32767	3600	mV

Description: ***Charging Voltage Low*** range to ***Charging Voltage Med*** range.

3.2.9.4 Charging Voltage High

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Voltage Range	Charging Voltage High	I2	0	32767	4000	mV

Description: ***Charging Voltage Med*** range to ***Charging Voltage High*** range

3.2.9.5 Charging Voltage Hysteresis

Class	Subclass	Name	Type	Min	Max	Default	Unit
Advanced Charging Algorithms	Voltage Range	Charging Voltage Hysteresis	U1	0	255	0	mV

Description: ***Charging Voltage Hysteresis*** applied when voltage is decreasing.

4 Changed and Removed Features

4.1 IPScale Feature

The IPScale feature in the existing bq78350-R1 device was optimized further in this release.

4.2 Static DF Checksum

The Static DF Checksum feature in the existing bq78350-R1 device incorrectly includes some special DF values which can vary from device to device. This causes the checksum to return different values on different devices even when the same srec is loaded. This feature is fixed in this release, such that different devices will all return the same checksum when the same srec is loaded.

4.3 LPEN Functionality Modified

The existing bq78350-R1 device includes the ***[LPEN]*** feature, which causes the CHG FET to be disabled whenever a fault is determined that would cause the DSG FET to be disabled. After a time given by ***Recovery*** is completed OR if the load is removed (as determined by the LOAD_PRESENT signal from the bq769x0), the CHG and DSG FETs are turned back on.

This functionality is modified in this release to provide an additional recovery mechanism. A new data flash control bit ***[DIS_AFE_TIME_RECOV]*** is introduced.

If ***[LPEN]*** is set and ***[DIS_AFE_TIME_RECOV]*** is cleared, then the CHG and DSG FETs will be turned back on after the time given by ***Recovery*** OR when LOAD_PRESENT is cleared. This case is the same as the existing bq78350-R1 device.

If ***[LPEN]*** is set and ***[DIS_AFE_TIME_RECOV]*** is also set, then the CHG and DSG FETs will be turned back on only when the LOAD_PRESENT signal is detected.

If ***[LPEN]*** is cleared, then the DSG FET will be turned back on after the time given by ***Recovery***. The CHG FET will not have been disabled simply because the DSG FET was disabled, so will typically still be on. This case is the same as the existing bq78350-R1 device operation.

NOTE: An important restriction: When ***[LPEN]*** is cleared, then the ***[DIS_AFE_TIME_RECOV]*** should be cleared.

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
February 2018	*	Initial Release

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