

CMOS IC Application Note

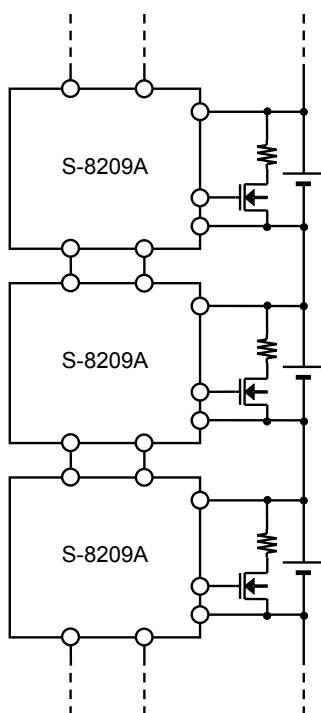
S-8209A Series Usage Guidelines Rev.1.3_00

The S-8209A Series is a battery protection IC with the cell-balance function. This application note is guideline on the typical connection examples when using the S-8209A Series for applications. See the datasheet for details and spec of this IC.

It is possible to configure the following applications with the S-8209A Series.

- A protection circuit with series multi-cell; 2 cells or more
- A battery protection circuit with cell-balance function

- Protection circuit with S-8209A Series for series multi-cells



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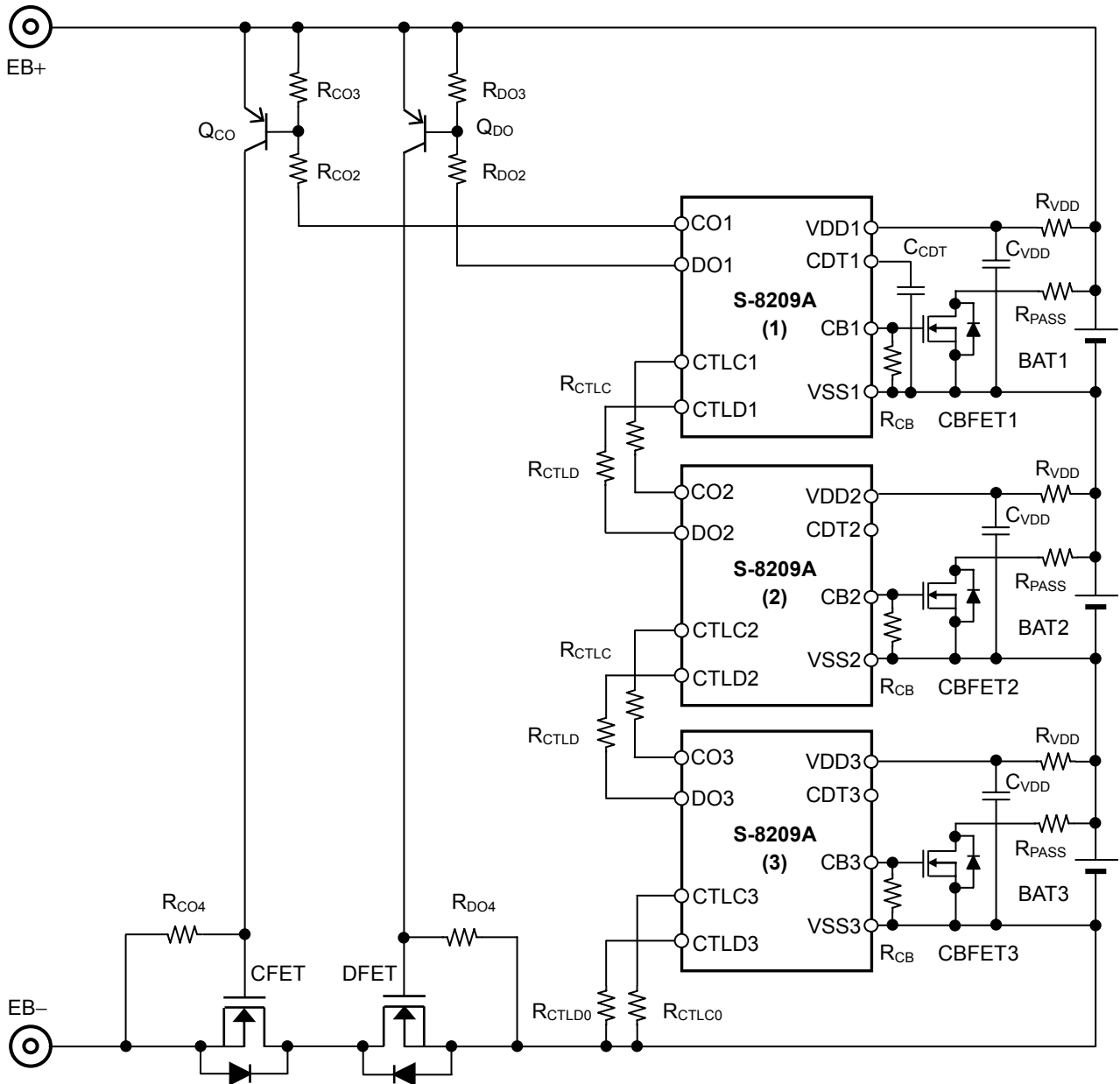
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1. Protection circuit with S-8209A Series for multi-cells

In the connection of S-8209A Series, connecting the CTLC, CTLD pins to the CO, DO pins allows to configure a protection circuit for series-connected batteries.

1.1 Connection example of battery protection IC

Figure 1 shows the example of protection circuit with S-8209A for series multi-cells.



Remark Refer to “3.5 External parts list” for constants of external parts.

Figure 1

- Caution 1.** The above constants may be changed without notice.
- 2.** The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

1.2 Operation

Following is about the operation of protection circuit with S-8209A for series multi-cell shown in **Figure 1**.

1.2.1 Normal status

Following is about the operation of S-8209A Series in the normal status.

The S-8209A goes in the normal status;

In the S-8209A (3), The CTLC3, CTLD3 pins are pulled down to the level of VSS3 pin, BAT3 is more than the overdischarge detection voltage (V_{DL}) and less than the overdischarge detection voltage (V_{CU}). The CO3, DO3 pins get the level of VSS3 pin.

In the S-8209A (2), The CTLC2, CTLD2 pins are pulled down to the level of VSS3 pin by the CO3, DO3 pins, BAT2 is more than V_{DL} and less than V_{CU} . The CO2, DO2 pins get the level of VSS2 pin.

In the S-8209A (1), The CTLC1, CTLD1 pins are pulled down to the level of VSS2 pin by the CO2, DO2 pins, BAT1 is more than V_{DL} and less than V_{CU} . The CO1, DO1 pins get the level of VSS1 pin.

The status of each pin in the normal status is shown in **Table 1**.

Table 1

CTLC pin	CTLD pin	Status of battery	CO pin	DO pin
CTLC3 = VSS3	CTLD3 = VSS3	$V_{DL} < BAT3 < V_{CU}$	CO3 = VSS3	DO3 = VSS3
CTLC2 = VSS3	CTLD2 = VSS3	$V_{DL} < BAT2 < V_{CU}$	CO2 = VSS2	DO2 = VSS2
CTLC1 = VSS2	CTLD1 = VSS2	$V_{DL} < BAT1 < V_{CU}$	CO1 = VSS1	DO1 = VSS1

The S-8209A (1) in the normal status turns on the charge control FET (CFET) and the discharge control FET (DFET) via bipolar transistors (Tr1, Tr2) externally set to each CO1 and DO1 pin. Therefore it is possible to charge/discharge by a charger or a load connected between EB+ and EB-.

1. 2. 2 Status to inhibit charge

Following is about the status to inhibit charge, for example, the S-8209A (3) detects overcharge, the S-8209A (2) and (1) are in the normal status.

The S-8209A (3) goes in the overcharge status when BAT3 gets V_{CU} or more by charging. The CO3 pin is set in high impedance.

The CTLC2 pin of the S-8209A (2) is pulled up to the level of VDD2 pin by the CTLC pin source current (I_{CTLCH}). The CTLC2 pin gets the level of VDD2 pin by the high impedance CO3 pin. Thus the S-8209A (2) goes in the overcharge status after the level of CTLC2 pin gets the CTLC pin H voltage (V_{CTLCH}) or more. The CO2 pin is set in high impedance.

The CTLC1 pin of the S-8209A (1) is pulled up to the level of VDD1 pin by I_{CTLCH} as well. The CTLC1 pin gets the level of VDD1 pin by the high impedance CO2 pin. The S-8209A (1) also goes in the overcharge status after the level of CTLC1 pin gets V_{CTLCH} or more.

The status of each pin in this case is shown in **Table 2**.

Table 2

CTLC pin	CTLD pin	Status of battery	CO pin	DO pin
CTLC3 = VSS3	CTLD3 = VSS3	$V_{CU} \leq BAT3$	CO3 = High-Z	DO3 = VSS3
CTLC2 = VDD2	CTLD2 = VSS3	$V_{DL} < BAT2 < V_{CU}$	CO2 = High-Z	DO2 = VSS2
CTLC1 = VDD1	CTLD1 = VSS2	$V_{DL} < BAT1 < V_{CU}$	CO1 = High-Z	DO1 = VSS1

The S-8209A (1) in the overcharge status turns off the CFET via a bipolar transistor (Tr1) set externally to the CO1 pin. In this case, charging via a charger connected between EB+ and EB- is inhibited.

By this operation the overcharge status is transmitted from the bottom (S-8209A (3)) to the top (S-8209A (1)), from the CO pin to the CTLC pin.

Charging is also inhibited; BAT1 or BAT2 gets V_{CU} or more.

S-8209A Series Usage Guidelines**1. 2. 3 Status to inhibit discharge**

Following is the status to inhibit discharge, for example, the S-8209A (3) detects overdischarge, the S-8209A (2) and (1) are in the normal status.

The S-8209A (3) goes in the overdischarge status when BAT3 gets V_{DL} or less by discharging. The DO3 pin is set in high impedance.

The CTLD2 pin of the S-8209A (2) is pulled up to the level of VDD2 pin by the CTLD pin source current (I_{CTLDH}). The CTLD2 pin gets the level of VDD2 pin by the high impedance DO3 pin. Thus the S-8209A (2) goes in the overdischarge status after the level of CTLD2 pin gets the CTLD pin H voltage (V_{CTLDH}) or more. The DO2 pin is set in high impedance.

The CTLD1 pin of the S-8209A (1) is pulled up to the level of VDD1 pin by I_{CTLDH} as well. The CTLD1 pin gets the level of VDD1 pin by the high impedance DO2 pin. The S-8209A (1) also goes in the overdischarge status after the level of CTLD1 pin gets V_{CTLDH} or more.

The status of each pin in this case is shown in **Table 3**.

Table 3

CTLC pin	CTLD pin	Status of battery	CO pin	DO pin
CTLC3 = VSS3	CTLD3 = VSS3	$BAT3 \leq V_{DL}$	CO3 = VSS3	DO3 = High-Z
CTLC2 = VSS3	CTLD2 = VDD2	$V_{DL} < BAT2 < V_{CU}$	CO2 = VSS2	DO2 = High-Z
CTLC1 = VSS2	CTLD1 = VDD1	$V_{DL} < BAT1 < V_{CU}$	CO1 = VSS1	DO1 = High-Z

The S-8209A (1) in the overdischarge status turns off the DFET via a bipolar transistor (Tr2) externally set to the DO1 pin. In this case, discharging to a load connected between EB+ and EB- is inhibited.

By this operation the overdischarge status is transmitted from the bottom (S-8209A (3)) to the top (S-8209A (1)), from the DO pin to the CTLD pin.

Discharging is also inhibited; BAT1 or BAT2 gets V_{DL} or less.

1. 2. 4 Cell-balance function

The S-8209A Series has two types of cell-balance function.

(1) Charge cell-balance function

In **Figure 1**, The S-8209A (3) sets the CB3 pin at the level of VDD3 pin when BAT3 gets the cell-balance detection voltage (V_{BU}) or more by charging. By this operation, the cell-balance control FET (CBFET3) is turned on so that the cell-balance control FET bypasses the charge current which flows into BAT3.

At this point, if BAT1, BAT2 are less than V_{BU} , the speed to charge BAT3 gets slower than to charge BAT1, BAT2. This is the charge cell-balance function. Even if any of battery voltages reaches V_{BU} , the cell-balance control FET which corresponds to each battery turns on and the cell-balance is adjusted.

The S-8209A Series turns off the cell-balance control FET when the battery voltage decreases to the cell-balance release voltage (V_{BL}) or less by discharging again.

(2) Discharge cell-balance function

As seen in “1. 2. 3 Status to inhibit discharge”, the S-8209A (3) goes in the overdischarge status when BAT3 gets V_{DL} or less by discharging. After that, the S-8209A (2) also goes in the overdischarge status via the DO3 pin and the CTLD2 pin.

At this point, if BAT2 is more than V_{DL} , the S-8209A (2) turns on the cell-balance control FET (CBFET2). This is the discharge cell-balance function. The S-8209A (1) also goes in the overdischarge status via the DO2 pin and the CTLD1 pin. As well in case that BAT1 is more than V_{DL} , the S-8209A (1) turns on the cell-balance control FET (CBFET1).

By this operation after BAT3 has reached V_{DL} , BAT1 and BAT2 which have the higher voltage than BAT3 start discharge; via the cell-balance control FETs (CBFET1, CBFET2) which correspond to each battery. Thus the cell-balance is adjusted after a certain period.

The S-8209A Series turns off the cell-balance control FET which corresponds to each battery when the voltages of BAT1, BAT2 decrease to V_{DL} or less.

Caution The cell-balance control FET may turn on immediately after connected the battery; a battery having the voltage V_{BL} or more, or a battery having the voltage overdischarge release voltage (V_{DU}) or less is included among batteries, in composing a protection circuit shown in **Figure 1**.

1. 2. 5 Delay circuit

Connecting a delay capacitor only to the CDT1 pin of the S-8209A (1), as seen in **Figure 1**, allows to gain the detection delay time (t_{DET}) and the release delay time (t_{REL}). In detecting by any of batteries, each delay time is the same length.

(1) Detection delay time (t_{DET})

BAT3 gets V_{CU} or more by charging, the CTLC2 pin gets the level of VDD2 pin because a capacitor is not connected to the CDT3 pin so that the CO3 pin is set in high impedance after delay of several hundred μ s.

After that in the S-8209A (2), the level of CTLC2 pin gets V_{CTLCH} or more, after delay of several hundred μ s the CO2 pin is set in high impedance.

In the S-8209A (1), after delay of $10.0 \text{ [M}\Omega\text{] (Typ.)} \times 0.01 \text{ [\mu F]} = 0.1 \text{ [s] (Typ.)}$, the CO1 pin is set in high impedance because connected C_{CDT} to the CDT1 pin.

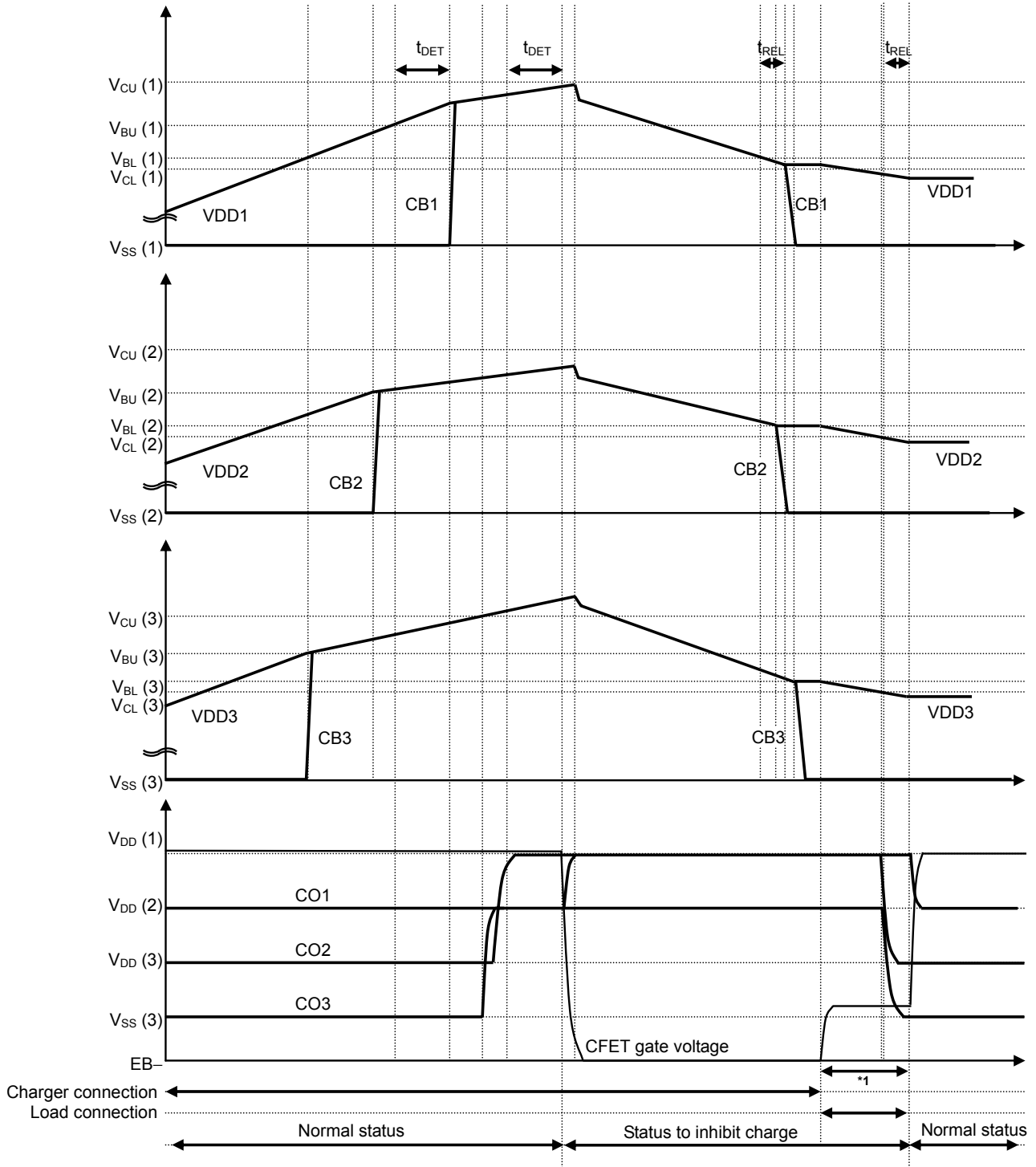
Even if any of batteries detects, by this operation, users are able to gain the detection delay time almost the same to delay time of the S-8209A (1), because it defines the whole delay time in the S-8209A Series.

(2) Release delay time (t_{REL})

The S-8209A Series also has the release delay time (t_{REL}), and this delay time is set its length as approx. 1/10 of the detection delay time. Connecting a delay capacitor only to the CDT1 pin of the S-8209A (1) allows having the same release delay time, as well as in the detection delay time.

1.3 Timing chart

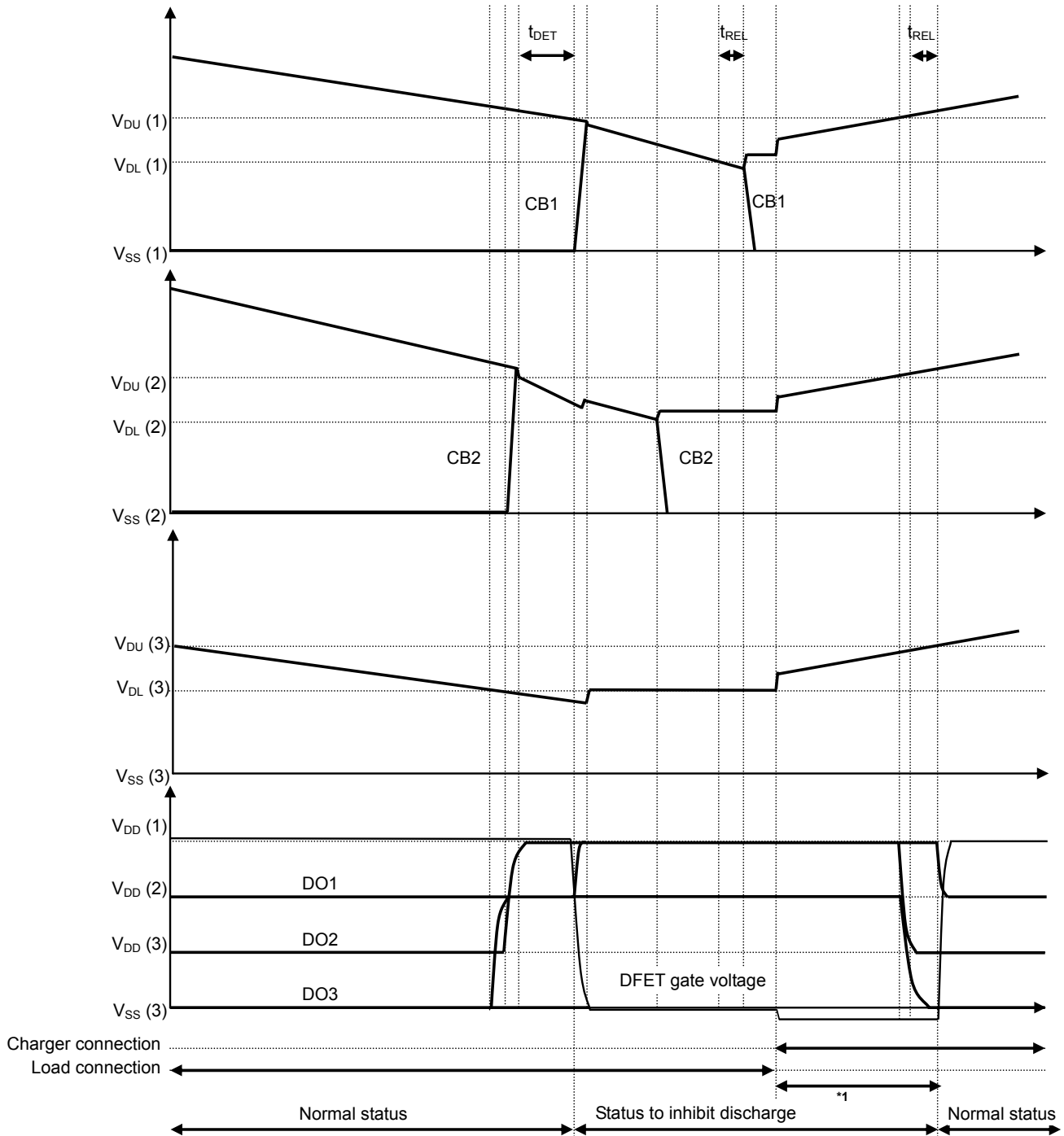
1.3.1 Overcharge detection



*1. In this period, the discharge current flows via a parasitic diode in the CFET.

Figure 2

1.3.2 Overdischarge detection



*1. In this period, the charge current flows via a parasitic diode in the DFET.

Figure 3

1.4 Demonstration data of charge cell-balance detection

The demonstration data shows cell-balance for 3-series lithium ion secondary battery using the S-8209AAA.

1.4.1 High ratio of bypass current to charge current

Charger: a constant current charger (0.05 C = 145 mA)

S-8209AAA charge cell-balance, 0.05 C constant current charger

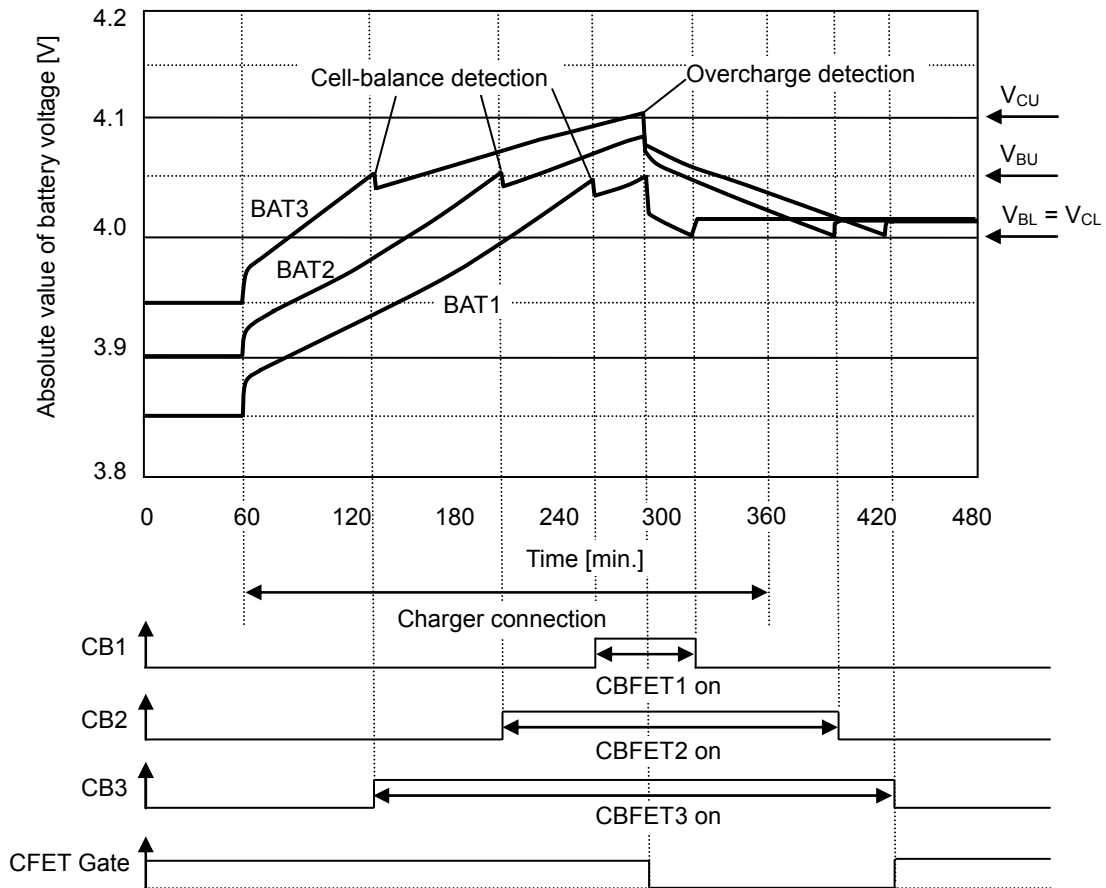


Figure 4

Test conditions

Test circuit: Figure 1

IC: S-8209AAA ($V_{CU} = 4.100\text{ V}$, $V_{CL} = 4.000\text{ V}$, $V_{BU} = 4.050\text{ V}$, $V_{BL} = 4.000\text{ V}$, $V_{DL} = 2.500\text{ V}$, $V_{DU} = 2.700\text{ V}$)

Battery: 3-series cell Lithium ion secondary battery, Nominal capacitance: 2.9 Ah, Size: 18650

$R_{PASS} = 51\ \Omega$ (1 W) \rightarrow Bypass current = $4.1\text{ V} / 51\ \Omega = 80\text{ mA}$

1. 4. 2 Low ratio of bypass current to charge current

When the ratio of bypass current to charge current is low, repeating cell-balance cycle enables to adjust cell-balance.

Charger: a constant current charger (0.1 C = 290 mA)

S-8209AAA charge cell-balance, 0.1 C constant current charger

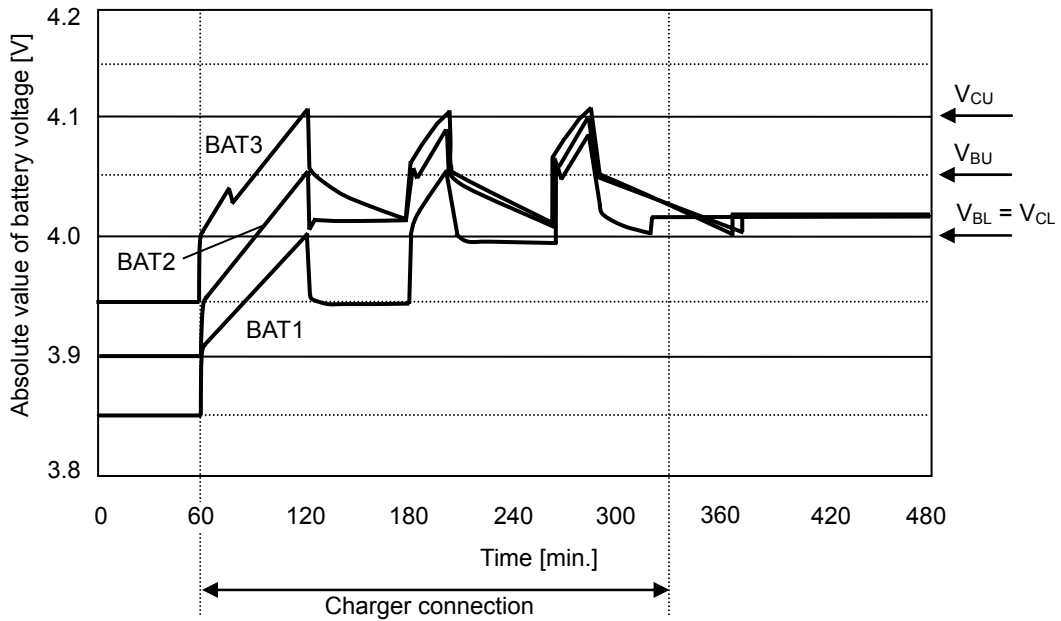


Figure 5

Test conditions

Test circuit: **Figure 1**

IC: S-8209AAA ($V_{CU} = 4.100\text{ V}$, $V_{CL} = 4.000\text{ V}$, $V_{BU} = 4.050\text{ V}$, $V_{BL} = 4.000\text{ V}$, $V_{DL} = 2.500\text{ V}$, $V_{DU} = 2.700\text{ V}$)

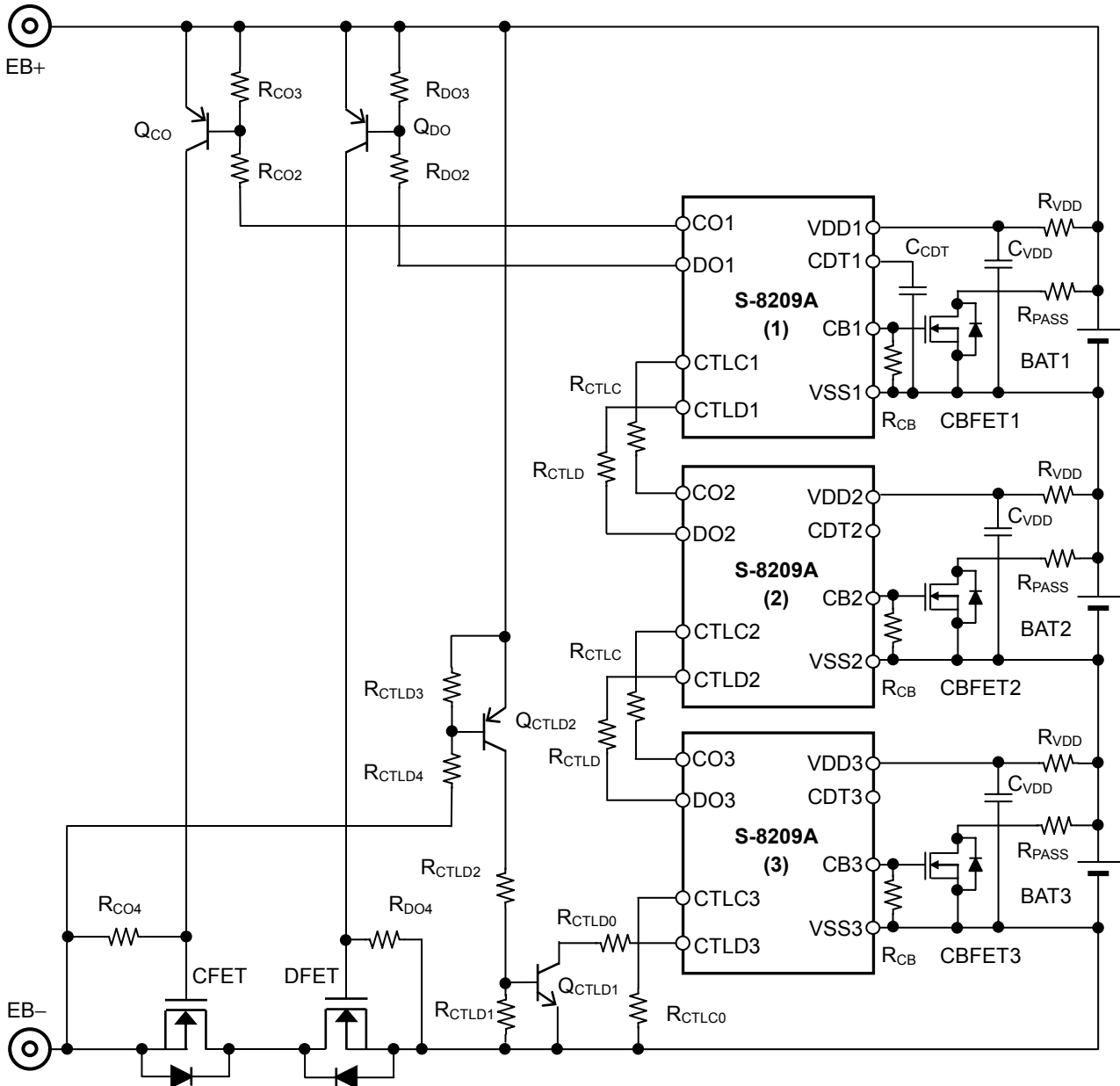
Battery: 3-series cell lithium ion secondary battery, Nominal capacitance: 2.9 Ah, Size: 18650

$R_{PASS} = 51\ \Omega$ (1 W) \rightarrow bypass current = $4.1\text{ V} / 51\ \Omega = 80\text{ mA}$

2. Application circuit, added the function to transmit overdischarge status

2.1 Connection example of battery protection IC

Setting bipolar transistors (Q_{CTLD1} , Q_{CTLD2}) allows adding the function to transmit the overdischarge status from the top (S-8209A (1)) to the bottom (S-8209A (3)).



Remark Refer to “3.5 External parts list” for constants of external parts.

Figure 6

- Caution 1. The above constants may be changed without notice.
- 2. The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

2.2 Operation

The operation of example of protection circuit, in **Figure 6**, with S-8209A for series multi-cells is as follows.

Setting bipolar transistors (Tr3, Tr4) to the circuit in **Figure 1** allows adding the function to transmit the overdischarge status from the top (S-8209A (1)) to the bottom (S-8209A (3)). By this, even if any IC among the S-8209A (1) to (3) first goes in the overdischarge status, it is possible to turn on all other cell-balance control FETs (CBFET) of the S-8209A Series. Thus cell-balance is certainly adjusted.

Following is about the operation in the status to inhibit discharge, when the S-8209A (2) detects overdischarge, and the S-8209A (1), (3) are in the normal status.

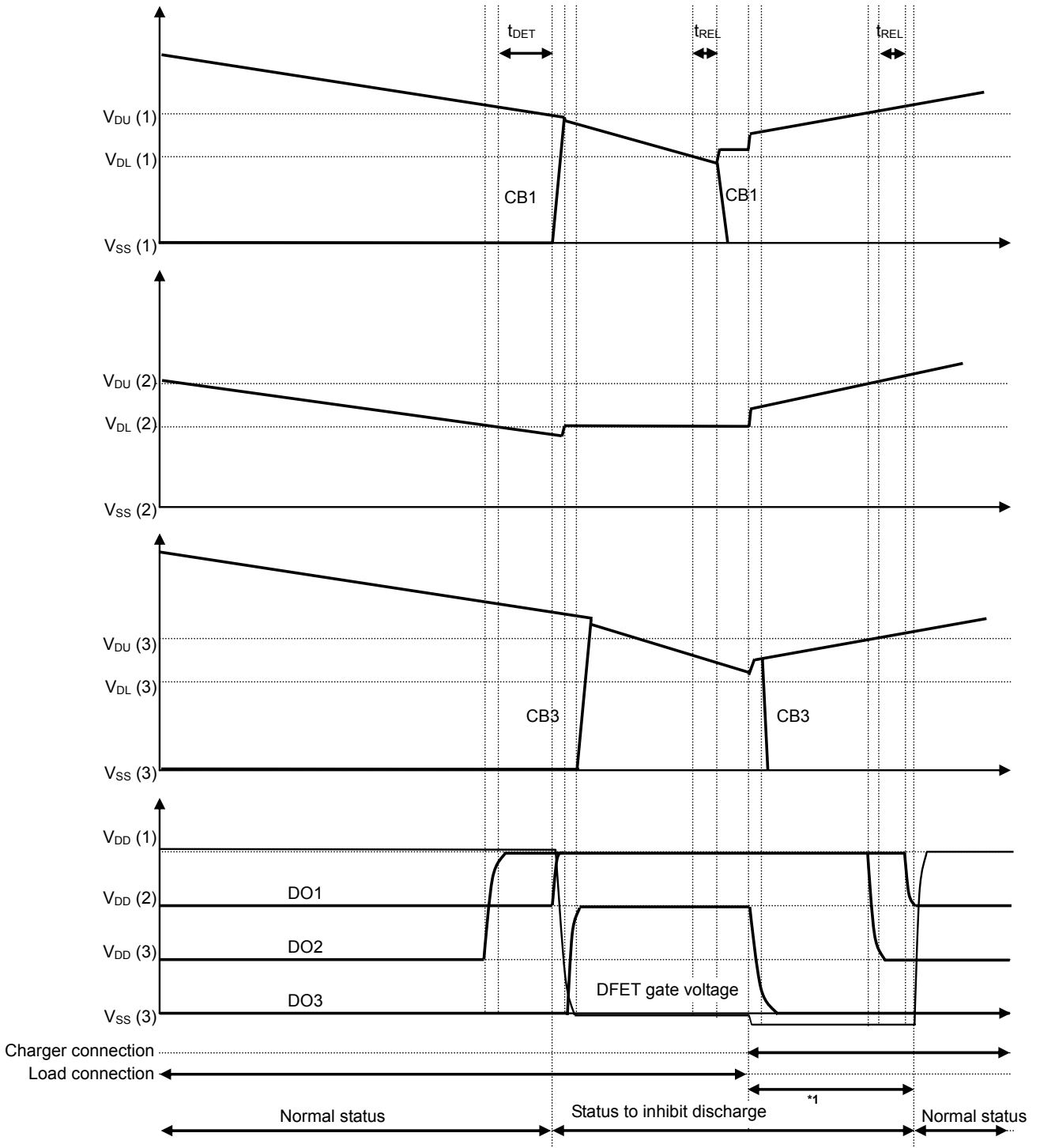
1. The S-8209A (2) goes in the overdischarge status when BAT2 decreases to V_{DL} or less by discharging. The DO2 pin is set in high impedance.
2. The S-8209A (1) also goes in the overdischarge status via the DO2 pin to the CTLD1 pin.
3. The S-8209A (1) turns on the cell-balance control FET (CBFET1) by the discharge cell-balance function.
4. The S-8209A (1) in the overdischarge status turns off DFET via a bipolar transistor (Tr2) and inhibits discharging to a load connected between EB+ and EB-.
5. The EB- pin is pulled up by a load connected between EB+ and EB-.
6. Tr3, Tr4 are turned off and the CTLD3 pin of the S-8209A (3) is set in high impedance.
7. The S-8209A (3) also goes in the overdischarge status. The cell-balance control FET (CBFET3) turns on by the discharge cell-balance function.

As mentioned above, even in case that the S-8209A (2) first detects overdischarge by voltage drop in BAT2, the overdischarge status is transmitted from the S-8209A (1) to S-8209A (3) via Tr3, Tr4. As a result all (1) to (3) of the S-8209A go in the overdischarge status so that cell-balance is adjusted by the discharge cell-balance function, when each BAT is more than V_{DL} . The cell-balance FET which corresponds to each battery turns off by the voltages of BAT1 to 3 that decreased to V_{DL} or less.

And Tr3, Tr4 are turned on by connecting a charger between EB+ and EB- after inhibit discharging, and the CTLD3 pin is pulled down to the level of VSS3. In this case, the cell-balance control FET (CBFET3) turns off although the voltage of BAT3 does not reach V_{DL} or less.

Caution The cell-balance control FET may turn on immediately after connected the battery; although not included a battery having the voltage V_{BL} or more, or a battery having the voltage overdischarge release voltage (V_{DU}) or less among batteries, in composing a protection circuit shown in **Figure 4**. To turn off the cell-balance control FET, connect a charger between EB+ and EB-.

2.3 Timing chart of overdischarge detection



*1. In this period, the charge current flows via a parasitic diode in the DFET.

Figure 7

2.4 Demonstration data of overdischarge cell-balance detection

The demonstration data shows cell-balance for 3-series lithium ion secondary battery using the S-8209AAA.

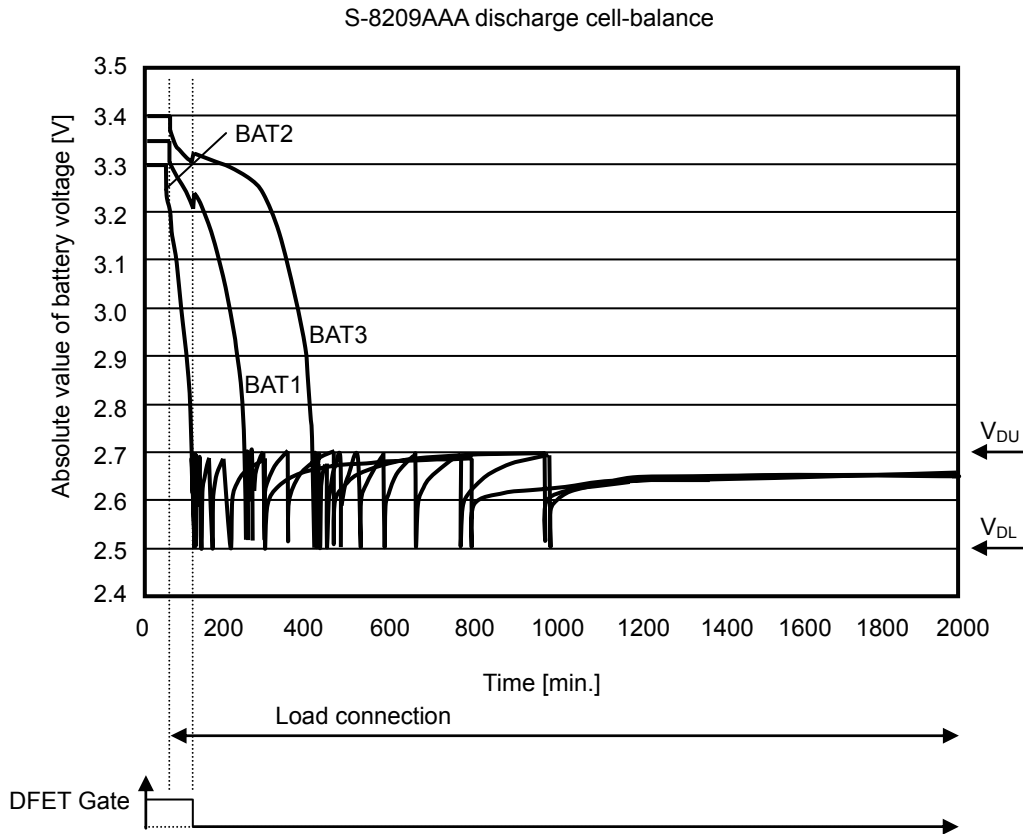


Figure 8

Test conditions

Test circuit: **Figure 6**

IC: S-8209AAA ($V_{CU} = 4.100$ V, $V_{CL} = 4.000$ V, $V_{BU} = 4.050$ V, $V_{BL} = 4.000$ V, $V_{DL} = 2.500$ V, $V_{DU} = 2.700$ V)

Battery: 3-series cell lithium ion secondary battery, Nominal capacitance: 2.9 Ah, Size: 18650

$R_{PASS} = 51 \Omega$ (1 W) \rightarrow bypass current = 2.5 V / $51 \Omega = 49$ mA

Load: 100Ω

Battery voltage's oscillation

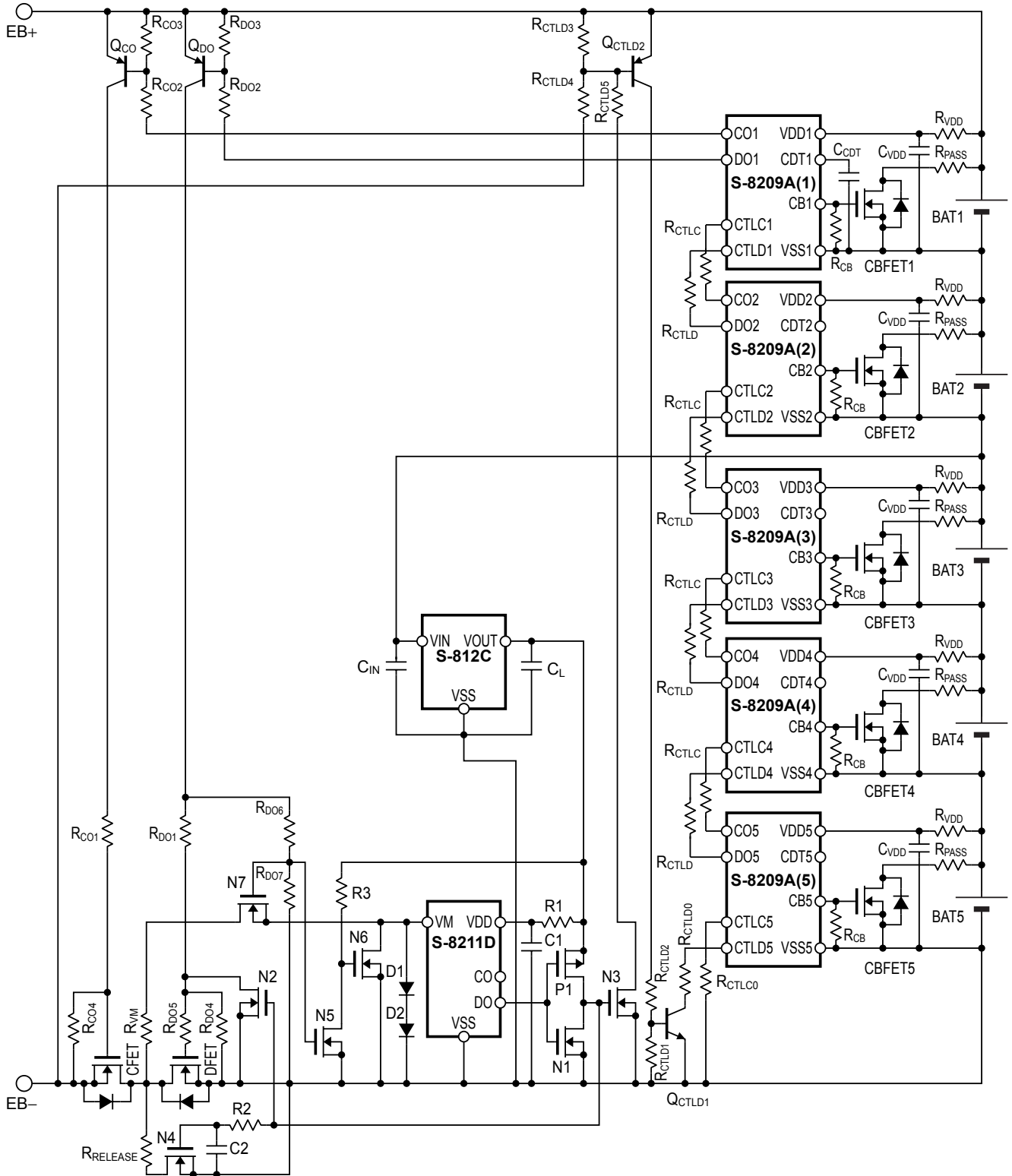
1. The cell-balance control FET turns off when the battery voltage decrease to the overdischarge detection voltage (V_{DL}) or less.
2. Discharge via the cell-balance control FET stops so that the battery voltage rises.
3. The cell-balance control FET turns on when the battery voltage increases to the overdischarge release voltage (V_{DU}) or more.
4. Discharge via the cell-balance control FET starts so that the battery voltage falls.

Repeating the procedures 1 to 4 enables to adjust cell-balance.

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3. Examples of application circuit added the discharge overcurrent protection function

3.1 5-series cell protection circuit added the discharge overcurrent protection function by using an FET (DFET)'s on-resistor (Currents in the same direction in charge and discharge)

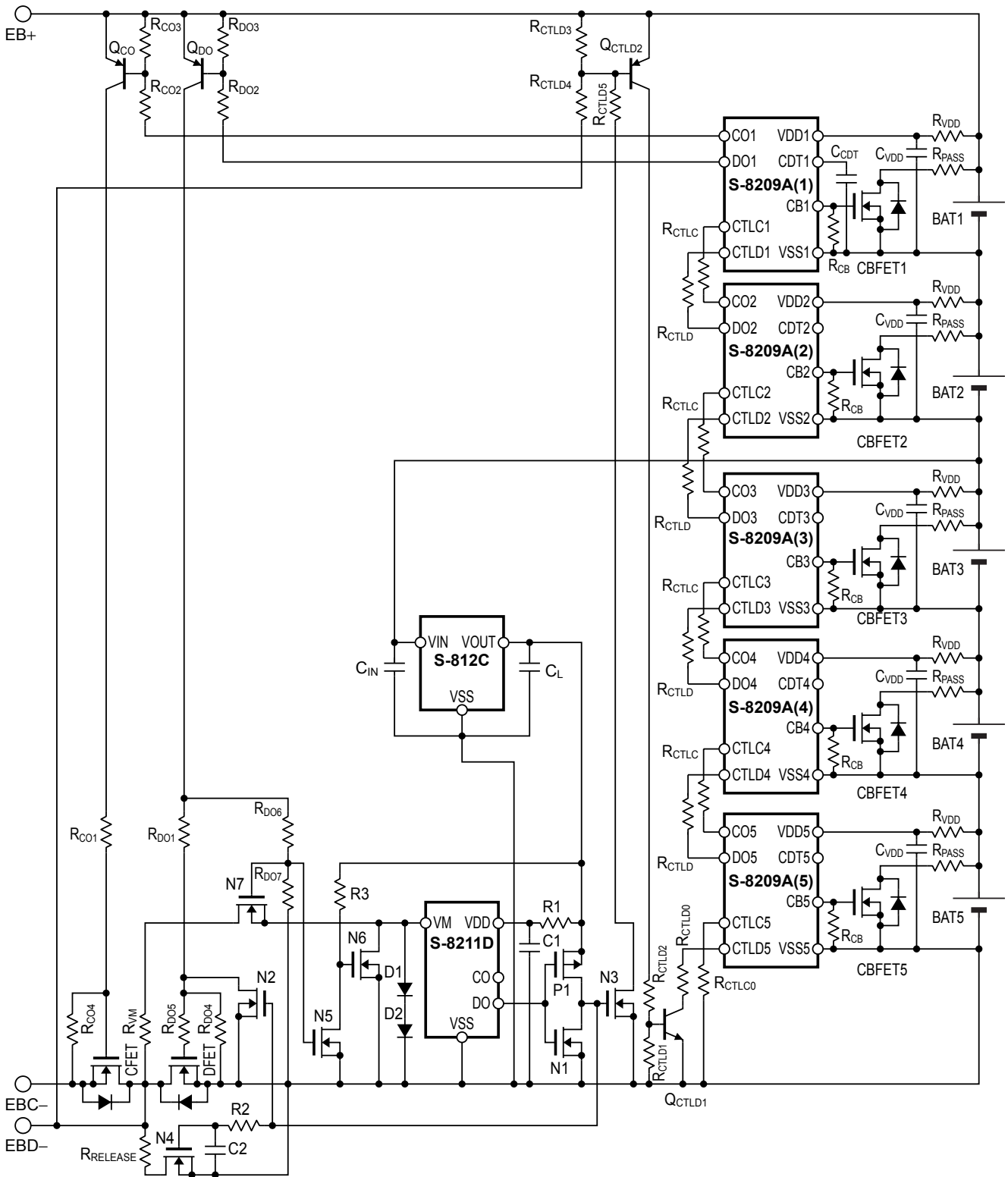


Remark Refer to "3.5 External parts list" for constants of external parts.

Figure 9

- Caution 1.** The above constants may be changed without notice.
- 2.** The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

3.2 5-series cell protection circuit added the discharge overcurrent protection function by using an FET (DFET)'s on-resistor (Currents in the different direction in charge and discharge)



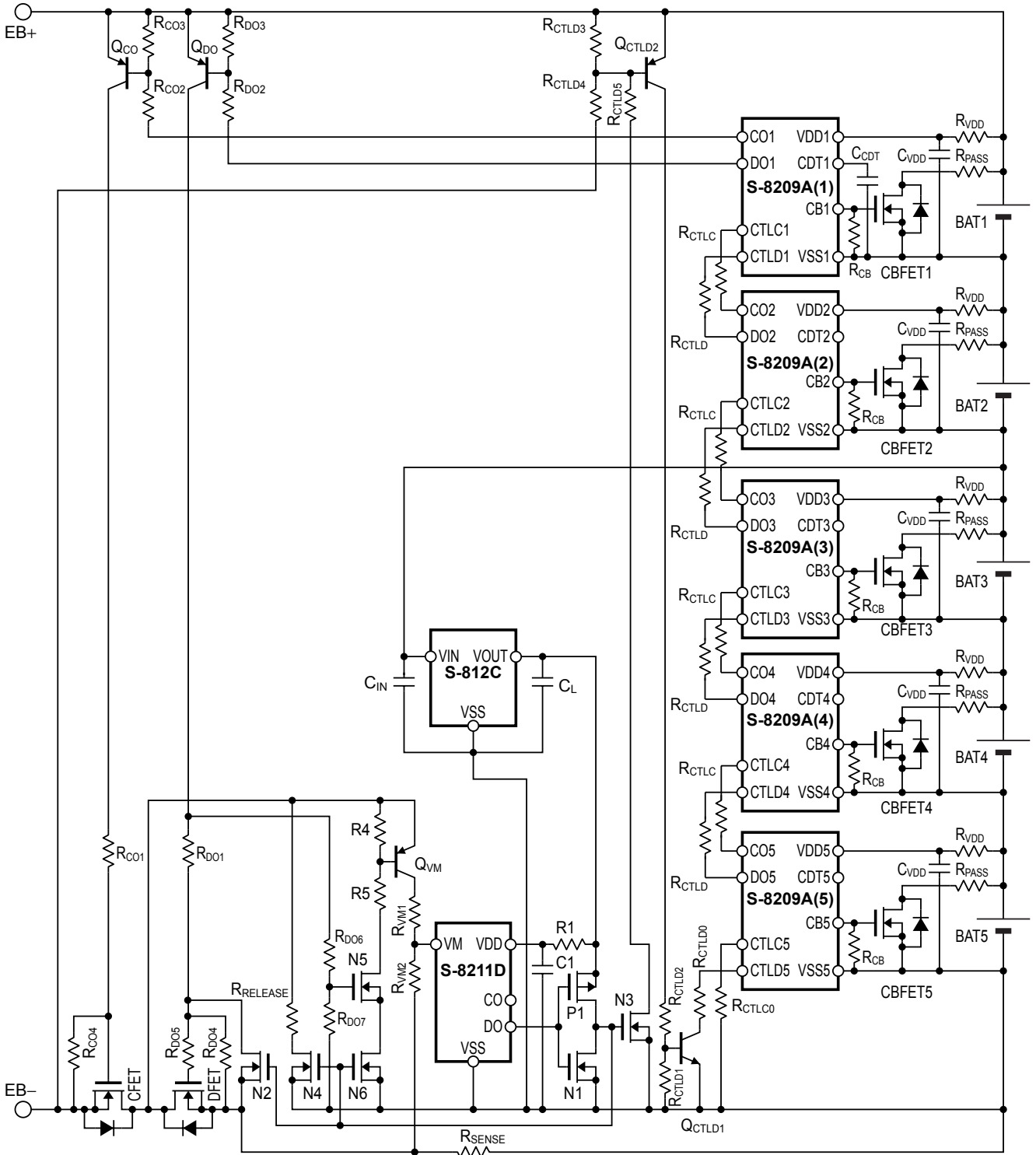
Remark Refer to "3.5 External parts list" for constants of external parts.

Figure 10

- Caution 1.** The above constants may be changed without notice.
2. The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

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3.3 5-series cell protection circuit added the discharge overcurrent protection function by using a sense resistor (R_{SENSE}) (Currents in the same direction in charge and discharge)

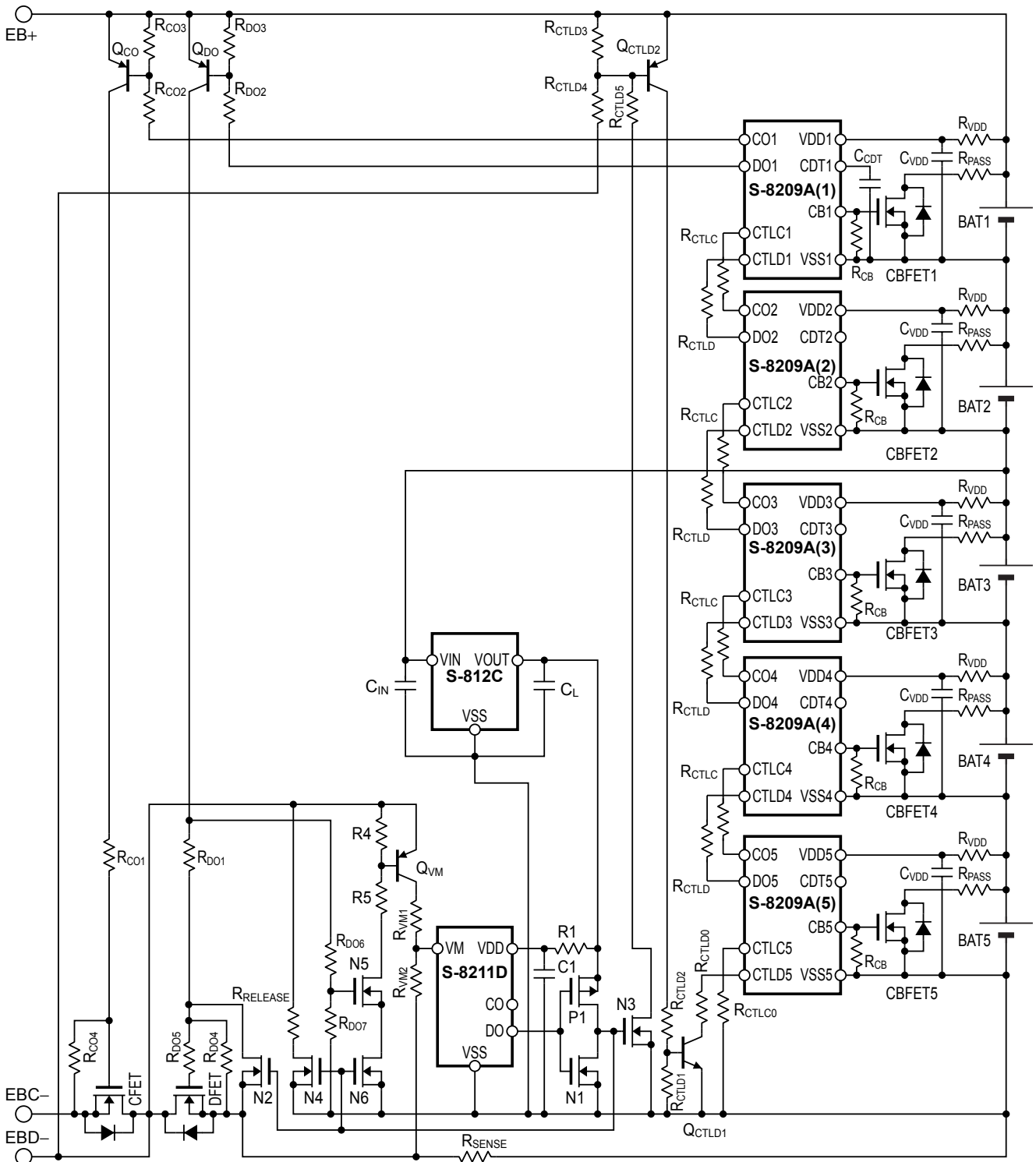


Remark Refer to "3.5 External parts list" for constants of external parts.

Figure 11

- Caution 1.** The above constants may be changed without notice.
2. The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

3.4 5-series cell protection circuit added the discharge overcurrent protection function by using a sense resistor (R_{SENSE}) (Currents in the different direction in charge and discharge)



Remark Refer to "3.5 External parts list" for constants of external parts.

Figure 12

- Caution 1. The above constants may be changed without notice.
 2. The example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

3.5 External parts list

Table 4 shows external parts in the connection examples in Figure 9 to 12.

Table 4 (1 / 2)

Symbol	Typical	Unit	Parts name	Maker
–	–	–	S-8211D ^{*1}	Seiko Instruments Inc.
–	–	–	S-812C ^{*2}	Seiko Instruments Inc.
CBFET1 to CBFET5	–	–	SSM3K301T	TOSHIBA CORPORATION
R _{PASS} ^{*3}	–	–	–	–
R _{VDD}	470	Ω	MCR03	ROHM CO., LTD.
R _{CB}	10	MΩ	MCR03	ROHM CO., LTD.
C _{VDD}	0.1	μF	GRM188	Murata Manufacturing Co., Ltd.
C _{CDT}	0.01	μF	GRM188	Murata Manufacturing Co., Ltd.
Q _{CTLD1}	–	–	2SC2412K	ROHM CO., LTD.
Q _{CTLD2}	–	–	2SA1037AK	ROHM CO., LTD.
Q _{CO}	–	–	2SA1037AK	ROHM CO., LTD.
Q _{DO}	–	–	2SA1037AK	ROHM CO., LTD.
R _{CTLC} ^{*4}	–	–	–	–
R _{CTLD} ^{*4}	–	–	–	–
R _{CTLC0}	1	kΩ	MCR03	ROHM CO., LTD.
R _{CTLD0}	1	kΩ	MCR03	ROHM CO., LTD.
R _{CTLD1}	1	MΩ	MCR03	ROHM CO., LTD.
R _{CTLC0}	4.7	MΩ	MCR03	ROHM CO., LTD.
R _{CTLD3}	1	MΩ	MCR03	ROHM CO., LTD.
R _{CTLD4}	4.7	MΩ	MCR03	ROHM CO., LTD.
R _{CTLD5}	4.7	MΩ	MCR03	ROHM CO., LTD.
R _{CO1}	1	MΩ	MCR03	ROHM CO., LTD.
R _{CO2}	510	kΩ	MCR03	ROHM CO., LTD.
R _{CO3}	1	MΩ	MCR03	ROHM CO., LTD.
R _{CO4}	1	MΩ	MCR03	ROHM CO., LTD.
R _{DO1}	1	MΩ	MCR03	ROHM CO., LTD.
R _{DO2}	510	kΩ	MCR03	ROHM CO., LTD.
R _{DO3}	1	MΩ	MCR03	ROHM CO., LTD.
R _{DO4}	1	MΩ	MCR03	ROHM CO., LTD.
R _{DO5}	10	kΩ	MCR03	ROHM CO., LTD.
R _{DO6}	1	MΩ	MCR03	ROHM CO., LTD.
R _{DO7}	1	MΩ	MCR03	ROHM CO., LTD.
P1	–	–	2SJ210	NEC Electronics Corporation
N1	–	–	2SK1590	NEC Electronics Corporation
N2	–	–	2SK1590	NEC Electronics Corporation
N3	–	–	2SK1590	NEC Electronics Corporation
N4	–	–	2SK1590	NEC Electronics Corporation
N5	–	–	2SK1590	NEC Electronics Corporation
N6	–	–	2SK1590	NEC Electronics Corporation
N7	–	–	2SK1590	NEC Electronics Corporation
D1	–	–	1SS355	ROHM CO., LTD.
D2	–	–	1SS355	ROHM CO., LTD.
R1	220	Ω	MCR03	ROHM CO., LTD.
R2	100	kΩ	MCR03	ROHM CO., LTD.
R3	1	MΩ	MCR03	ROHM CO., LTD.
R4	510	kΩ	MCR03	ROHM CO., LTD.
R5	1	MΩ	MCR03	ROHM CO., LTD.

Table 4 (2 / 2)

Symbol	Typical	Unit	Parts name	Maker
C1	0.1	μF	GRM188	Murata Manufacturing Co., Ltd.
C2	1	μF	GRM188	Murata Manufacturing Co., Ltd.
Q _{VM}	–	–	2SA1037AK	ROHM CO., LTD.
R _{VM} ^{*3}	3.9	kΩ	MCR18	ROHM CO., LTD.
R _{VM1} ^{*5}	–	kΩ	MCR03	ROHM CO., LTD.
R _{VM2} ^{*5}	–	kΩ	MCR03	ROHM CO., LTD.
R _{RELEASE} ^{*3}	10	kΩ	MCR10	ROHM CO., LTD.
R _{SENSE} ^{*3}	–	–	–	–
C _{IN}	1	μF	GRM188	Murata Manufacturing Co., Ltd.
C _L	4.7	μF	GRM21B	Murata Manufacturing Co., Ltd.
CFET	–	–	–	–
DFET	–	–	–	–

- *1. Select this product according to the overcurrent detection voltage that you will use.
For details, refer to datasheet of S-8211D Series.
- *2. Select this product according its output voltage; the overdischarge release voltage or more and the overcharge release voltage or less, of the S-8211D Series selected based on *1.
For details, refer to datasheet of S-812C Series.
- *3. Pay attention to the rated electric powers.
- *4. Select R_{CTLC} and R_{CTLD} from 0 Ω to 1 kΩ.
- *5. Select R_{VM1}, R_{VM2} as follows.
Select R_{VM2} from 300 Ω to 4 kΩ.
Select R_{VM1} from the range calculated by this equation.

$$R_{VM2} \times \frac{V_{BAT(max.)}^{*1} - V_{OUT}^{*2}}{V_{OUT}} < R_{VM1} < R_{VM2} \times \frac{V_{BAT(min.)}^{*3} - V_{DIOV}^{*4}}{V_{DIOV}}$$

- *1. V_{BAT(max.)}: The overcharge detection voltage (V_{CU}) of the S-8209A Series IC × the number of cells
- *2. V_{OUT}: The output voltage of the S-812C Series IC
- *3. V_{BAT(min.)}: The minimum operating voltage (1.5 V) of the S-8209A Series IC × the number of cells
- *4. V_{DIOV}: The overcurrent detection voltage of the S-8211D Series IC

<e.g. : Cell = 5 cells, R_{VM2} = 3.9 kΩ, V_{DIOV} = 0.10 V, V_{OUT} = 3.60 V, V_{CU} = 4.40 V>

$$3.9 \text{ k}\Omega \times \frac{22.0 \text{ V} - 3.60 \text{ V}}{3.60 \text{ V}} < R_{VM1} < 3.9 \text{ k}\Omega \times \frac{7.5 \text{ V} - 0.10 \text{ V}}{0.10 \text{ V}}$$

$$= 19.93 \text{ k}\Omega < R_{VM1} < 288.6 \text{ k}\Omega$$

- Caution 1. The above constants may be changed without notice.**
- 2. The example of connection shown above and the constant do not guarantee proper operation.
Perform thorough evaluation using the actual application to set the constant.
 - 3. Select external parts considering its pressure when configuring a series protection cell with 5 cells or more.

S-8209A Series Usage Guidelines

4. Reference circuit

In applications connecting an intermediate pin using a connector, security enhances by the connection as seen in the reference circuit below, since both of charge and discharge stop if the intermediate pin is disconnected.

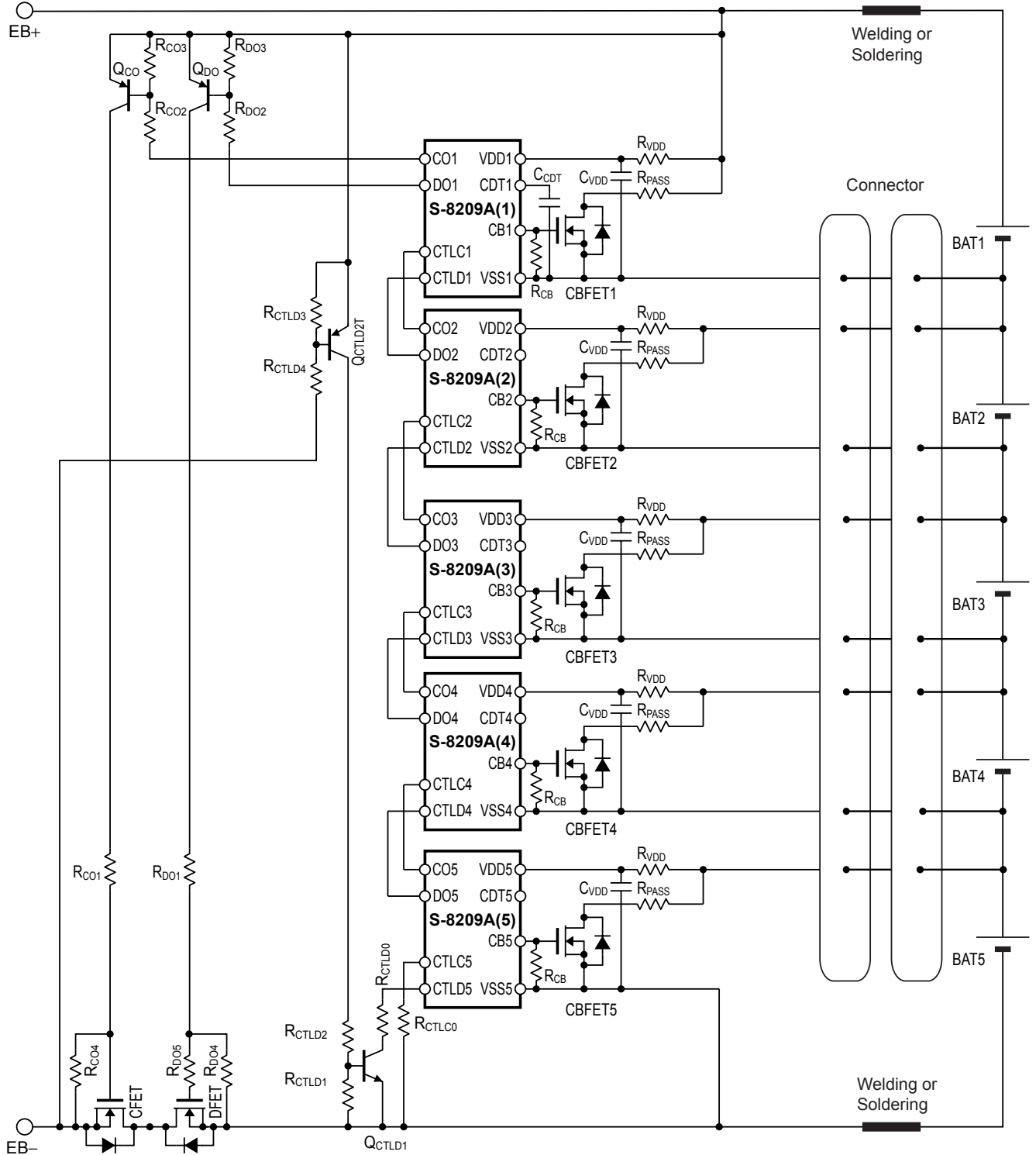


Figure 13

5. Precaution

- The usage described in this application note is typical example with our IC.
Perform evaluation fully before use.
- When designing for mass production using an application circuit described herein, the product deviation and temperature characteristics of the external parts should be taken into consideration. SII shall not bear any responsibility for patent infringements related to products using the circuits described herein.
- SII claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

6. Related source

Refer to the following datasheet for details of the S-8209A Series.

S-8209A Series Datasheet

The information described herein is subject to change without notice.

Regarding the newest version, contact our sales office.

Select product category and product name on our SII semiconductors website, download the PDF file.

www.sii-ic.com SII semiconductors website

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