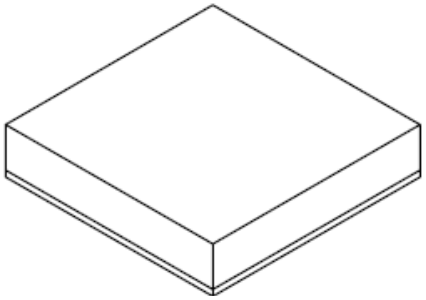
CDMOS Integrated Circuit Silicon Monolithic

TC7710WBG

IC for Battery Charger

1. Outline

The TC7710WBG is a programmable battery charger for lithium-ion and lithium- polymer battery pack. The TC7710WBG supports charge current up to 2.0A. For handheld devices with high capacity battery pack, this IC can charge the battery more quickly compared to the conventional devices.



S-WFBGA25-0303-0.40-001
S-WFBGA25-0303-0.40-002

2. Applications

Mobile phones
Devices with a single cell lithium-ion battery

3. Features

- Input voltage : 4.35V to 6.5V
- Battery Charging Specification 1.2 detection
- Battery shutdown current : 38μA(Typ.)
- Maximum charge current : 2.0A
- Protections and detections
  - Input over voltage protection (IOVP)
  - Under voltage lock out (UVLO)
  - Input current control
  - Battery voltage monitor
  - Battery temperature monitor
- Switching frequency : 3.0MHz
- Package : WCSP25 pin

4. Block Diagram

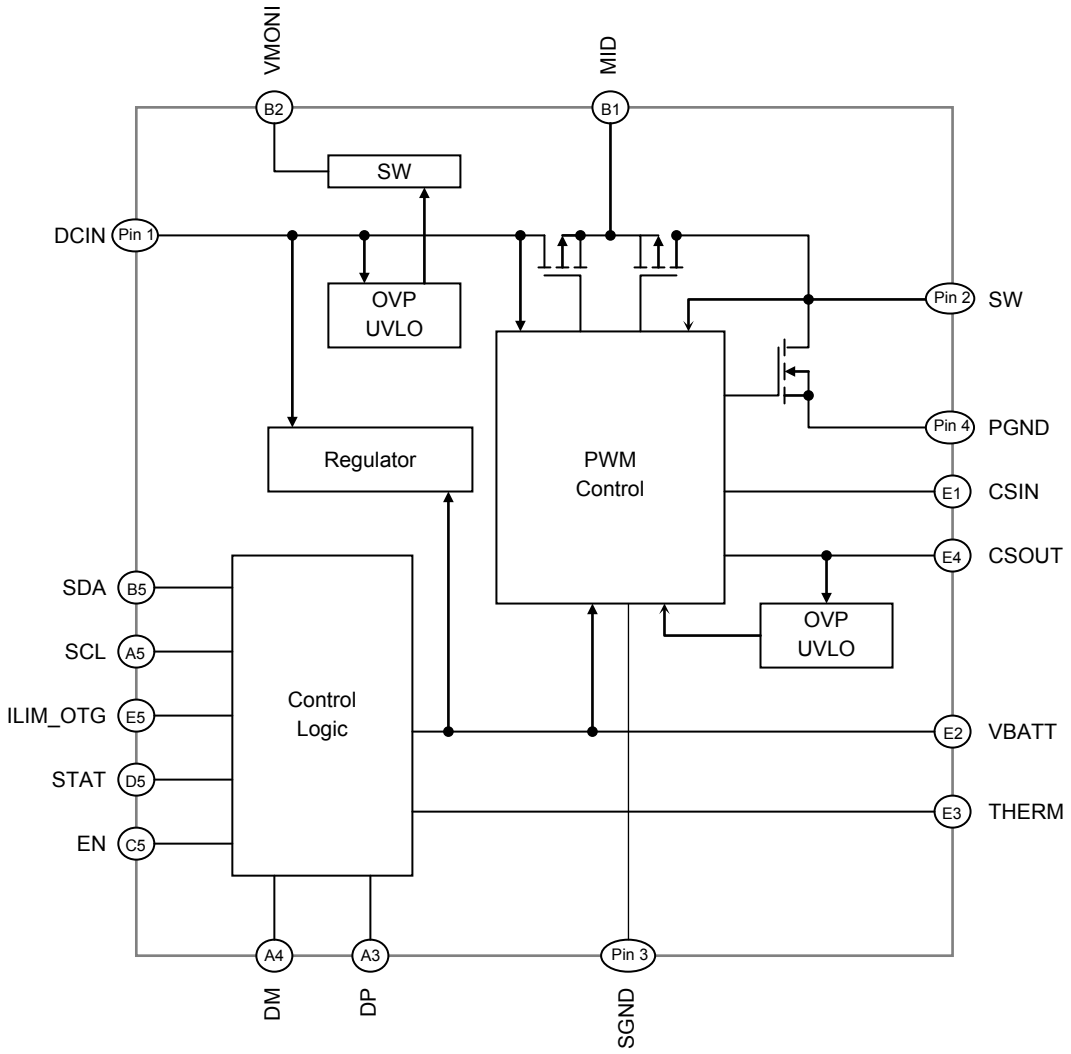


Figure 4-1 Block Diagram

Pin 1 : DCIN pin: A1 and A2.

Pin 2 : SW pin: C1 and C2.

Pin 3 : SGND pin: C3 and D3.

Pin 4 : PGND pin: D1 and D2.

Note. : Please refer to Application Circuit about parts and pin connection.

5. Pin Assignment

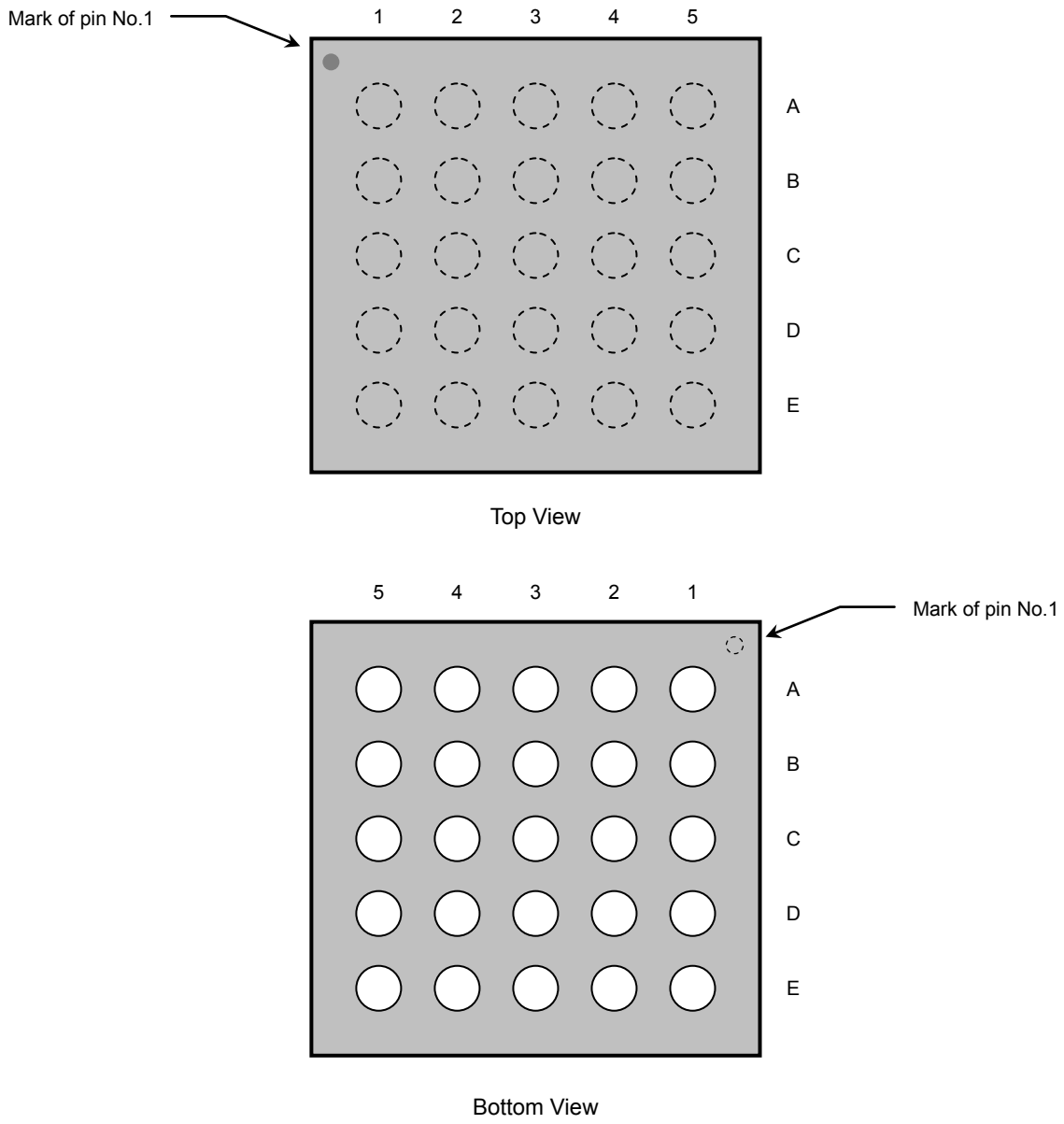


Figure 5-1 Pin Assignment

Note.: Please pay attention that corner pin which is next to the mark of No.1 is A1.

6. Pin Functions

Table 6-1 Pin Functions (1)

<table>
<tr><th>Pin No.</th><th>Pin name</th><th>I/O</th><th>Pin description</th></tr>
<tr><td>A1, A2</td><td>DCIN</td><td>I/O</td><td>I/O pin for USB VBUS / Input pin for AC adapter
<table><tr><td>Charge</td><td>DC voltage input mode (+4.35V to +6.5V)</td></tr><tr><td>OTG</td><td>Voltage 5V output mode</td></tr></table>The capacitor of 1.0μF or more must be connected between DCIN pin and GND to stabilize the voltage.</td></tr>
<tr><td>A3</td><td>DP</td><td>I/O</td><td>I/O pin (+) for power source detection
It is connected to D+ pin of the USB connector.</td></tr>
<tr><td>A4</td><td>DM</td><td>I/O</td><td>I/O pin (-) for power source detection
It is connected to D- pin of the USB connector.</td></tr>
<tr><td>A5</td><td>SCL</td><td>I</td><td>Signal input pin for I^2C bus clock
Input pin of clock signal for serial communication. Pull-up resistance should be connected to SCL pin because it is an open-drain pin.</td></tr>
<tr><td>B1</td><td>MID</td><td>I</td><td>FET midpoint input pin.
Middle-point voltage pin of high side MOSFET. The capacitor of 2.2μF or more should be connected between MID pin and GND to stabilize the voltage.</td></tr>
<tr><td>B2</td><td>VMONI</td><td>O</td><td>Input monitor for DC voltage
The voltage corresponding to DCIN is outputted and monitored in the range of UVLO to OVLO.</td></tr>
<tr><td>B5</td><td>SDA</td><td>I/O</td><td>I/O pin for I^2C bus data signal.
Pull-up resistance should be connected to SDA pin because it is an open-drain pin.</td></tr>
<tr><td>C1, C2</td><td>SW</td><td>O</td><td>PWM signal output pin
PWM signal output pin for DCDC convertor. One-side of the inductor is connected to this pin.</td></tr>
<tr><td>C3, D3</td><td>SGND</td><td>-</td><td>Power supply pin for small signal (GND).</td></tr>
<tr><td>C5</td><td>EN</td><td>I</td><td>Input pin for enable signal.
This is a charge control pin for enable and resume. As for setting logic, polarity can be converted by register data.
<table><tr><td rowspan="2">ENPINPOL
(11H,bit0)</td><td colspan="2">EN signal</td></tr><tr><td>Low</td><td>High</td></tr><tr><td>0</td><td>Charge</td><td>Stop charge</td></tr><tr><td>1</td><td>Stop charge</td><td>Charge</td></tr></table>Pay attention that validity of EN pin changes depending on ENSEL (11H, bit2).</td></tr>
<tr><td>D1, D2</td><td>PGND</td><td>-</td><td>Power supply pin (GND) for large signal.</td></tr>
<tr><td>D5</td><td>STAT</td><td>O</td><td>Status signal output pin
Error and operation state set by register are outputted from STAT pin. When error is generated, the TC7710WBG outputs logic low. Pull-up resistance should be connected to STAT pin because it is an open-drain pin.</td></tr>
</table>

Table 6-2 Pin Functions (2)

Pin No.	Pin name	I/O	Pin description
E1	CSIN	I	Current sense input pin Connect high side of the current sense resistance.
E2	VBATT	I	Sub power supply / Kelvin sense input pin Connect + pin of battery directly.
E3	THERM	I	Battery thermistor sense input pin Temperature can be detected by connecting this pin to “T pin” of ordinary battery pack. Connect this pin to one-side of the thermistor (10 / 25 / 50 / 100kΩ NTC thermistor) which is inside of the battery pack or on the PCB.
E4	CSOUT	I/O	Current sense I/O pin Connect low side of the current sense resistance.
E5	ILIM_OTG	I	Input pin for control input current or Input pin for switching OTG operation This pin sets input current and switches OTG operation. Current level of charging mode is controlled (USB mode / AC mode) or Valid of invalid or OTG mode is switched.
B3, B4, C4, D4	TEST	-	IC test pin. TOSHIBA test pin. It must be open.

7. Functions

7.1 Input current limit

Input current from DCIN pin can be limited to the value set by ILIM_OTG pin or I²C (Refer to the table below.). When input current exceeds the preset value, the TC7710WBG limits current to below the preset value automatically. When DCIN voltage turns into below the threshold voltage set by I²C, the TC7710WBG limits current to the USB100 level (Max 100mA) and indicates an interrupt signal. To resume the current limit to the former level, the interrupt signal must be cleared (Refer to the command: INTCLR5 (15H, bit5).). After clearing the interrupt signal, input current limit is set to the former level quickly. For safe use, input current limit is set to lower value and the interrupt signal can be cleared.

Table 7-1 Command (1)

Command	Register No./ bit No.	Contents
ACILMT4-0	03H,bit7-3	AC input current limit
USB51	13H,bit6	USB mode setting when ILIM_OTG is valid
ATPSDET	13H,bit4	Automatic power source detection
LMT_OTG1-0	13H,bit3-2	Input current limit setting
ILIMLVL1-0	13H,bit1-0	Input current limit setting when I^2C is valid.
ATILMT	13H,bit5	Current limit function by DCIN voltage
INTATIL	20H,bit5	Generated the interrupt factor of input current limit

(1) Forced setting (13H,bit4="1")

Input current limit	Input current limit setting ILIM_OTG pin / I^2C	Source detection DP / DM detection
USB500	USB500	*
USB100	USB100	*
AC	AC	*

(2) USB automatic detection setting (13H,bit4="0")

Input current limit	Input current limit setting ILIM_OTG pin / I^2C	Source detection DP / DM detection
USB500	USB500	Unconnected
	USB500	DCP
USB100	USB100	Unconnected
	*	SDP
	*	CDP
AC	AC	*

Cautions: USB automatic detection setting

- In case input current limit setting is AC, source detection result is ignored.
- In case input current limit setting is USB500 and source detection is SDP or CDP, input current is limited 100mA.
- In case input current limit setting is USB100 and source detection is DCP, input current is limited 100mA.

DCP: Dedicated Charging Port
SDP: Standard Downstream Port
CDP: Charging Downstream Port

7.2 DCIN input voltage protection

When input voltage from DCIN pin exceeds specified voltage (Typ. 6.5V), input is shutdown. Charge is valid when input voltage is higher than the UVLO and lower than the OVLO. As soon as DCIN input supply is removed, charge is invalid automatically. Under the condition that charge is invalid, UVLO / OVLO detection for DCIN pin and OVLO detection for battery voltage are invalid.

7.3 Preliminary charge state

When DCIN input supply is connected, the TC7710WBG check the following items for charge start-up. After starting charge, charge is suspended when one of the following items is outside the limits

(1) DCIN input voltage ≥ UVLO voltage, DCIN input voltage ≤ OVLO voltage

(2) DCIN voltage > Battery voltage + 100mV

(3) Charge is enabled. (Set by I²C or EN pin. Refer to the command: ENSEL(11H,bit2), ENCMD(11H,bit1), ENPINPOL(11H,bit0).)

(4) Battery temperature is between high limit and low limit (Refer to the command: TEMPDET(12H,bit7), BIASCRT1-0(1EH,bit7-6), COLDVTH1-0(1EH,bit3-2), HOTVTH1-0(1EH,bit1-0).).

Table 7-2 Command (2)

Command	Register No./ bit No.	Contents
ENSEL	11H,bit2	EN control
ENCMD	11H,bit1	EN control by I^2C
ENPINPOL	11H,bit0	Polarity of EN pin
TEMPDET	12H,bit7	Battery temperature detection

7.4 Trickle charge

Preliminary charge state is OK, the TC7710WBG starts trickle charge with 50mA (Typ.) if battery voltage is lower than 2.1V.

7.5 Pre-charge

When battery voltage exceeds 2.1V, the TC7710WBG starts pre-charge with the charge current set by the register. Pre-charge continues until the battery voltage reaches the fast charge threshold voltage set by the register (Refer to the command: CCVTH2-0(01H,bit2-0).). If the battery voltage is not exceed the fast charge threshold voltage before the pre-charge timer expires, charge is suspended and an interrupt signal is indicated (Refer to the command: INTCHGER(20H,bit1), ST_TMER1-0(23H,bit1-0).). If battery voltage is lower to the trickle charge level during pre-charge, the TC7710WBG becomes trickle charge mode and indicates an interrupt signal (Refer to the command: INTVBAT(20H,bit6).).In this case, if trickle charge is invalid (12H,bit0= ”1”), the TC7710WBG doesn’t become trickle charge and doesn’t indicate an interrupt signal.

Table 7-3 Command (3)

Command	Register No./ bit No.	Contents
PCI1-0	00H,bit1-0	Pre-charge current
CCVTH2-0	01H,bit2-0	Threshold voltage for fast charge

7.6 Fast charge (Constant Current charge mode)

When fast charge mode is valid, the TC7710WBG starts constant current charge mode if battery voltage exceeds the fast charge threshold voltage set by the register. The TC7710WBG limits charge current to below input current limit value (Refer to the command: CCISET(12H,bit2), PRCCTH(12H,bit1), CCVTH2-0 (01H,bit2-0).). If battery voltage is lower to the pre charge level during fast charge, the TC7710WBG becomes pre-charge mode and indicates an interrupt signal (Refer to the command: INTVBAT(20H,bit6).).

Table 7-4 Command (4)

Command	Register No./ bit No.	Contents
CCI4-0	01H,bit7-3	Fast charge current
CCISET	12H,bit2	Fast charge mode setting

7.7 Fast charge (Constant Voltage charge mode)

The TC7710WBG starts constant voltage charge mode if battery voltage becomes the float voltage set by the register during constant current charge mode (Refer to the command: FLTV6-0(02H,bit6-0).).

Table 7-5 Command (5)

Command	Register No./ bit No.	Contents
FLTV6-0	02H,bit6-0	Float voltage

7.8 Charge completion

When charge completion is valid (Refer to the command: CT(12H,bit3).), charging is completed if charge current is lower than the charge termination current set by the register (Refer to the command: CEI1-0(00H,bit5-4).). If charge timer has expired until charge is completed, the TC7710WBG terminates the charge and indicates an interrupt signal (Refer to the command: INTCHGER(20H,bit1), ST_TMER1-0(23H,bit1-0).). If charge completion is invalid (CT(12H,bit3)=1), the TC7710WBG continues CV charge and doesn't indicate an interrupt signal. In this case, the TC7710WBG is controlled by I^2C to terminate the charge. The status ST_CGED0 (24H,bit4) can be checked if charge current is lower than the current set by the register during CV charge mode.

Table 7-6 Command (6)

Command	Register No./ bit No.	Contents
CT	12H,bit3	Charge completion
CEI1-0	00H,bit5-4	Charge termination current
ST_CGED0	24H,bit4	Charge current is lower than the charge termination current (only CV mode).

7.9 Re-charge

The TC7710WBG recharges the battery when the battery voltage falls by a value set by the register below the float voltage (Refer to the command: FLTV6-0(02H,bit6-0), ATRCHGTH(00H,bit6) is fixed to 140mV.).
The TC7710WBG can recharge only when DCIN input supply is connected, charge is enabled and the charge start-up condition is satisfied before charge. In this case, the TC7710WBG is controlled by command to recharge the battery automatically (Refer to the command: ATRCHG(12H,bit4).).

Table 7-7 Command (7)

Command	Register No./ bit No.	Contents
ATRCHGTH	00H,bit6	Threshold voltage for automatic recharge. *140mV only.
ATRCHG	12H,bit4	Automatic recharge

7.10 Automatic charge

The TC7710WBG can start charge automatically regardless of enable control (Refer to the command: DBATVDET(00H,bit7), ATCHG(11H,bit3).) when battery voltage is lower than dead battery threshold. In case the battery voltage is higher than dead battery threshold, charge is controlled by EN pin / I²C, and in case the battery voltage is lower than dead battery threshold, the TC7710WBG starts charge when DCIN input supply is connected, charge is enabled and the charge start-up condition is satisfied before charge. A charge enable shall be set after 3ms since the float voltage is set. The TC7710WBG continues charge until charge is completed or pre-charge safety timer of 36minutes is expired.

Table 7-8 Command (8)

Command	Register No./ bit No.	Contents
DBATVDET	00H,bit7	Threshold for dead battery
ATCHG	11H,bit3	Automatic charge

7.11 USB OTG

The TC7710WBG can supply a regulated 5V output at the DCIN pin for powering peripherals compliant with the USB OTG specification (Refer to the command: OTGVCTL1-0(04H,bit5-4).). When only a battery is connected (AC adaptor or USB isn't connected) and battery voltage is higher than battery UVLO voltage, OTG control can be enabled by ILIM_OTG pin or I²C (Refer to the command: OTGUVTH1-0(04H,bit1-0), OTGMD(13H,bit7), LMT_OTG1-0(13H,bit3-2).). If battery UVLO, battery current limit and DCIN UVLO are occurred during OTG mode, OTG operation is suspended. OTG operation resumes by ILIM_OTG pin or I²C. During OTG operation, output current is controlled by a value set by the register (Refer to the command: CCI4-0(01H,bit7-3).).When output current exceeds the preset value, the TC7710WBG shuts off the OTG voltage and indicates an interrupt signal (Refer to the command: INTOTGER(20H,bit3), ST_OTGLM(22H,bit1).). When the chip temperature exceeds 135°C during OTG operation, the TC7710WBG shuts off the OTG voltage and indicates an interrupt signal (Refer to the command: INTOTGER(20H,bit3), ST_OTGJCT(22H,bit3).). During OTG operation, a watchdog timer should be valid for system safety. When a watchdog timer is expired, the TC7710WBG shuts off the OTG voltage and indicates an interrupt signal (Refer to the command: OTGWDTM(10H,bit4), INTOTGER(20H,bit3), ST_OTWDT(22H,bit2).).

Table 7-9 Command (9)

Command	Register No./ bit No.	Contents
CCI4-0	01H,bit7-3	OTG battery current limit
OTGVCTL1-0	04H,bit5-4	OTG output voltage
OTGUVTH1-0	04H,bit1-0	Battery UVLO setting in OTG
OTGWDTM	10H,bit4	OTG watchdog timer
OTGMD	13H,bit7	OTG control by I^2C
LMT_OTG1-0	13H,bit3-2	OTG control setting

7.12 Watchdog timer

A watchdog timer is reset with every I²C ACK signal transmitted from a system. If watchdog timer is expired during the charging / OTG operation, the TC7710WBG suspends the charging / OTG operation, indicates an interrupt signal and reset the following registers: 00H-13H, 1EH, and 1FH (e-Fuse data is reloaded.). During OTG operation, a watchdog timer should be valid for system safety. And standby watchdog timer should be valid when the TC7710WBG doesn't charge or supply OTG power (Refer to the command: STBWDTM(10H,bit5), OTGWDTM(10H,bit4), CHGWDTM(10H,bit3).). However both watchdog timers are not valid from a fully charged state to an automatic recharge starts, since the TC7710WBG isn't in a charge mode or a standby mode. To set a charge disable, standby watchdog timer is valid for this time.

Table 7-10 Command (10)

Command	Register No./ bit No.	Contents
OTGWDTM	10H,bit4	OTG watchdog timer
CHGWDTM	10H,bit3	Charge watchdog timer
STBWDTM	10H,bit5	Standby watchdog timer

7.13 Safety timer

The TC7710WBG has a pre-charge timer of 36 minutes and a charge timer of 240 minutes (Refer to the command: PRCHGTM(10H,bit2), CHGSTM(10H,bit1).). A pre-charge timer of 36 minutes is started after preliminary charge state is OK, the TC7710WBG starts trickle charge. And this timer is reset when the mode is changed from pre-charge to fast charge. A charge timer of 240 minutes is also started after preliminary charge state is OK, the TC7710WBG suspends the charging if charge current isn't lower than the charge termination current within a timer. It is possible not to include trickle charge time in the charge timers (Refer to the command: TCSTON(10H,bit0).). Both timers can be cleared by I²C in case charge timers are monitored by system (Refer to the command: CHGTMCLR(10H,bit6).). When the TC7710WBG starts recharge in case an auto recharge is valid, these safety timers aren't valid. Therefore it is recommended that an external timer is applied by system for charge protection.

Table 7-11 Command (11)

Command	Register No./ bit No.	Contents
PRCHGTM	10H,bit2	Pre-charge timer
CHGSTM	10H,bit1	Charge timer
TCSTON	10H,bit0	Include or not include trickle charge time in the timers
CHGTMCLR	10H,bit6	Timer clear

7.14 Operating state

STAT pin is output that indicates operating state. When battery is charging or DCIN voltage is lower than UVLO / higher than OVLO, this pin is asserted low level. A type of state from STAT pin is controlled by command, and the output is invalided controlled by command (Refer to the command: STATMD(14H,bit2), STATOUT(14H,bit1).). STAT pin is open-drain output, a pull-up resistor should be connected to this pin.

Table 7-12 Command (12)

Command	Register No./ bit No.	Contents
STATMD	14H,bit2	Select a type of state from STAT pin
STATOUT	14H,bit1	STAT output ON/OFF

7.15 Interrupt / Abnormal detection

STAT pin is output that indicates seven interrupt signals. Interrupt signal and interrupt mask are set by I²C. The TC7710WBG outputs a pulse signal from STAT pin for 0.8ms every 350ms and indicates an interrupt signal to system. The system checks an interrupt factor, clears the factor and executes the interrupt process according to the factor.

Standby WDT error
OTG error
Re-charge
Charge error
Charge completion
Occurrence of automatic input current limit
Occurrence of charge state back to previous mode

The following tables describe the error recovery.

Table 7-13 Interrupt process

Standby WDT error

Interrupt factor	TC7710WBG process	Recovery process
Timer expired	Registers of 00H-13H, 1EH, and 1FH are initialized. Standby mode transition	Set registers of 00H-13H, 1EH, and 1FH.

OTG error

Interrupt factor	TC7710WBG process	Recovery process
WD Timer expired	Shut off OTG supply. Registers of 00H-13H, 1EH, and 1FH are initialized. Standby mode transition	Set registers of 00H-13H, 1EH, and 1FH.
Exceed current limit	Shut off OTG supply.	Control OTG function disable to enable manually.
Battery UVLO occur	Shut off OTG supply.	Control OTG function disable to enable manually.
Exceed chip temperature	Shut off OTG supply.	Control OTG function disable to enable manually.
Output (DCIN) voltage drop under UVLO	Shut off OTG supply.	Control OTG function disable to enable manually.

Re-charge

Interrupt factor	TC7710WBG process	Recovery process
Vbat < Vfloat - 140mV	Restart charging (ATRCHG=0)	-

Charge error

Interrupt factor	TC7710WBG process	Recovery process
Input OVLO occur	Stop charging.	After charge start-up condition is satisfied, the TC7710WBG restarts charging from standby mode.
Input UVLO occur	Stop charging.	After charge start-up condition is satisfied, the TC7710WBG restarts charging from standby mode. * The TC7710WBG doesn't output an interrupt signal since all registers are initialized for POR.
DCIN < Vbat + 105mV	Stop charging.	After charge start-up condition is satisfied, the TC7710WBG restarts charging from standby mode.
Out of battery temperature limit	Continue charging. (TEMPDET="0")	EN should be turned off manually.
	Suspend charging. (TEMPDET="1")	After charge start-up condition is satisfied, the TC7710WBG resumes charging automatically.
Exceed chip temperature	Continue charging. (OVTLMT="0")	EN should be turned off manually. * It is recommended charging is suspended in this case (OVTLMT(12h,bit6)=1).
	Suspend charging. (OVTLMT="1")	After charge start-up condition is satisfied, the TC7710WBG resumes charging automatically.
Battery OVLO occur	Stop charging. (BATOV="1")	After charge start-up condition is satisfied, EN should be turned on manually.
Unconnected battery	Stop charging.	After charge start-up condition is satisfied, EN should be turned on manually.
Charge WDT expired	Continue charging. Registers of 00H-13H, 1EH, and 1FH are initialized.	Set registers of 00H-13H, 1EH, and 1FH. * Charge timers are running on.
Charge timer expired	Stop charging.	EN should be turned on manually.
Input voltage drop	Continue charging. The TC7710WBG limits current to the 100mA. (ATILMT="0")	To resume the current limit to the former level, the interrupt signal must be cleared.

Charge completion

Interrupt factor	TC7710WBG process	Recovery process
Ichg < Iterm	Charge completion (CT="0")	-

Occurrence of automatic input current limit

Interrupt factor	TC7710WBG process	Recovery process
Exceed input current	Continue charging. The TC7710WBG limits current to the 100mA.	To resume the current limit to the former level, the interrupt signal must be cleared.

Occurrence of charge state back to previous mode

Interrupt factor	TC7710WBG process	Recovery process
Charge state is back to previous mode by battery voltage drop.	-	-

Table 7-14 Command (13)

Command	Register No./ bit No.	Contents
INTOUT	14H,bit3	Select an information from STAT pin.
STATOUT	14H,bit1	Control an output from STAT pin.
INT***	20H,bit6-0	Interrupt factor
ST_***	21H, 22H, 23H	Status information

7.16 Chip temperature monitoring

Chip temperature is monitored during charge/OTG. When chip temperature exceeds 135°C, chip temperature monitoring bit is set high. And when chip temperature falls 115°C, it is set low (Refer to the command: ST_JCTON(21H,bit2).). Charge stops when chip temperature monitoring bit is set high. And charge re-starts automatically when it is set low. (It depends on the set conditions. Refer to the command: OVTLMT(12H,bit6).)) OTG stops when chip temperature monitoring bit is set high (Refer to the command: ST_OTGJCT(22H,bit3).).

Table 7-15 Command (14)

Command	Register No./ bit No.	Contents
ST_JCTON	21H,bit2	Chip temperature state (Charging mode)
ST_OTGJCT	22H,bit3	Chip temperature state (OTG mode)
OVTLMT	12H,bit6	Charge stop in high temperature

7.17 Battery temperature monitoring

Battery temperature is monitored before charging and in charging through THERM pin. When battery temperature exceeds the programmed temperature limit, charge can be suspended (Refer to the command: TEMPDET(12H,bit7).). While battery temperature is out of the limit range, the TC7710WBG stops charge timer indicates charge error interrupt signal (Refer to the command: INTCHGER(20H,bit1), ST_BATHT(21H,bit1), ST_BATCL(21H,bit0).). And when the temperature becomes within the limit range, the TC7710WBG resumes charge and charge timer. As detection range is different depending on a characteristic of NTC thermistor, external resistance which is the same value of R25 is connected in parallel typically. And the intended range of temperature is set (Refer to the command: COLDVTH1-0(1EH,bit3-2), HOTVTH1-0(1EH,bit1-0).). The TC7710WBG supports thermistors which value of R25 is 10kΩ, 25kΩ, 50kΩ, and 100kΩ. A current source of 200μA, 80μA, 40μA, and 20μA is selected depending on the resister (Refer to the command: BIASCRT1-0(1EH,bit7-6).).

Table 7-16 Temperature limit

Vtherm [V]	β								
	3000	3250	3500	3750	4000	4250	4500	4750	5000
0.509	61	58	55	53	51	50	48	47	46
0.574	55	53	50	49	47	46	45	44	43
0.647	49	47	45	44	43	42	41	40	39
0.726	43	42	40	39	39	38	37	36	36
1.000	25	25	25	25	25	25	25	25	25
1.399	1	3	5	6	7	8	9	9	10
1.491	-4	-2	0	1	2	4	5	6	7
1.577	-10	-8	-5	-4	-2	-1	1	2	3
1.654	-16	-13	-10	-8	-7	-5	-3	-2	-1

Table 7-17 Command (15)

Command	Register No./ bit No.	Contents
TEMPDET	12H,bit7	Charge control with battery temperature monitoring
BIASCRT1-0	1EH,bit7-6	Current source value for temperature monitoring
COLDVTH1-0	1EH,bit3-2	Threshold voltage for low temperature detection
HOTVTH1-0	1EH,bit1-0	Threshold voltage for high temperature detection
INTCHGER	20H,bit1	Charge error interrupt
ST_BATHT	21H,bit1	Battery high temperature detection status
ST_BATCL	21H,bit0	Battery low temperature detection status

7.18 Power source detection

The TC7710WBG corresponds to Battery Charging Specification Rev1.2. Automatic power source detection can be set by the register (Refer to the command: ATPSDET(13H,bit4).). Source detection starts as soon as DCIN is connected. There are four kinds of detection results as follows; non-connection, SDP (Standard Downstream Port), CDP (Charging Downstream Port), and DCP (Dedicated Charging Port) (Refer to the command: ST_STYP1-0 (25H,bit1-0).). Input current limit can be set depending on the detection state (Refer to 7.1 Input current limit.).

Table 7-18 Command (16)

Command	Register No./ bit No.	Contents
ATPSDET	13H,bit4	Automatic power source detection
ST_STYP1-0	25H,bit1-0	Source detection result

7.19 Unconnected battery detection

The TC7710WBG executes battery detection through VBATT pin (Refer to the command: BATMSDET(11H,bit4).). When battery voltage is lower than 2.1V, the TC7710WBG starts trickle charge. And when battery voltage exceeds 2.1V, the TC7710WBG starts pre-charge. If battery voltage exceeds 3.3V within 85ms after starting pre-charge, the TC7710WBG detects as unconnected battery (Refer to the command: INTCHGER(20H,bit1), ST_BATMS(21H,bit7).).

Table 7-19 Command (17)

Command	Register No./ bit No.	Contents
BATMSDET	11H,bit4	Execute battery detection
INTCHGER	20H,bit1	Charge error interrupt
ST_BATMS	21H,bit7	Unconnected battery detection

7.20 VMONI output

The TC7710WBG outputs the signal which monitored DCIN input voltage.

Table 7-20 Command (18)

Command	Register No./ bit No.	Contents
VMONICNT	14H,bit4	Output VMONI signal

7.21 Battery save mode

The TC7710WBG becomes battery save mode when DCIN is in UVLO and standby WDT is invalid, or when OTG is disable. If there are I²C signals among the battery save mode, the TC7710WBG changes the mode to the standby mode. Wait time 1ms is necessary to write next I²C signal successively. If there is a DCIN input among the battery save mode, the TC7710WBG enables POR and becomes standby mode.

7.22 I²C Bus

A communication between the TC7710WBG and the host is operated using I²C format. Both the clock line (SCL) and the data line (SDA) provide a communication between the TC7710WBG and the host. There are Start Condition and Stop Condition, when they send and receive the data. The commands are sent between Start Condition and Stop Condition. Refer to the following figure.

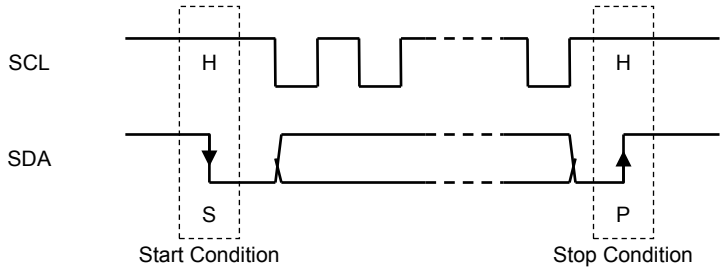


Figure 7-1 Relation between Start Condition and Stop Condition

Table 7-21 List of the protocol symbols

Symbols	Descriptions
S	Start Condition
SR	Repeat Start Condition
P	Stop Condition
Slave Address	Slave Address(high 7 bits)
R	Read mode(TC7710WBG -> HOST)
W	Write mode(HOST -> TC7710WBG)
X	Undefined (1 or 0)
A / A	ACK (HOST -> TC7710WBG). This symbol in gray shows that the TC7710WBG output “Low” level when it receives ACK (TC7710WBG -> HOST)
NA / NA	NACK (HOST -> TC7710WBG). This symbol in gray shows that the TC7710WBG output Hi-Z when it receives NACK(TC7710WBG -> HOST)
COMMAND CODE	Command register for the TC7710WBG
Data Byte Data Byte	This symbol shows 1 byte. This symbol in gray shows data flow from the TC7710WBG to HOST in read.
・・・	This symbol shows that the block (bit or byte, Packet) is continued.

7.22.1 Detailed bits

The TC7710WBG supports the following I²C bus bit sequence.

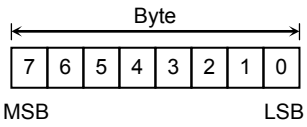


Figure 7-2 bit sequence

7.22.2 Start Condition / Stop Condition

The TC7710WBG is communicated on I²C format. So, the packets divided by Start Condition / Stop Condition are transmitted and received. The communication consists of SCL (clock line) and SDA (data line). If they don't communicate, both clock line and data line are fixed to High level. It goes through Start Condition that data line goes down earlier than clock line. And it goes through Stop Condition that clock line goes down earlier than data line. It is prohibited changing condition of the data line, while the clock line is High level in normal communication.
It regards as the end of the communication, if the receiver doesn't operate that data line with low level in the timing which it receives ACK bit. And, after the end of the communication, it is possible to restart from Start Condition without Stop Condition.

7.22.3 ACK data

The receiver notifies the transceiver of ACK data by receiving 1 byte (8 bits) to indicate its condition. If it is no problems, it operates data line with low level after the clock of byte 8 (LSB) goes down. If the data communication error has occurred by any problems, the TC7710WBG reports NACK.

7.22.4 Slave Address

The TC7710WBG can choose the Slave Address that has 8 types by the fixed e-fuse data.

Table 7-22 Slave Address

	MSB							LSB
Address	0	0	0	1	0	0	1	R / $\overline{W}$
	0	0	0	1	0	0	0	R / $\overline{W}$
	0	0	0	1	0	1	1	R / $\overline{W}$
	0	0	0	1	1	0	1	R / $\overline{W}$
	0	0	1	1	0	0	1	R / $\overline{W}$
	0	1	0	1	0	0	1	R / $\overline{W}$
	1	0	0	1	0	0	1	R / $\overline{W}$

7.22.5 Write bytes

It transmits in order of an Slave Address, COMMAND CODE and Data Byte.

Figure 7-3 Write bytes

7.22.6 Read bytes

If the following bit of Slave Address is set to “1”, the TC7710WBG is selected in Read mode. The TC7710WBG sends the data that is issued by COMMAND CODE to the host, just before selected in Read mode.

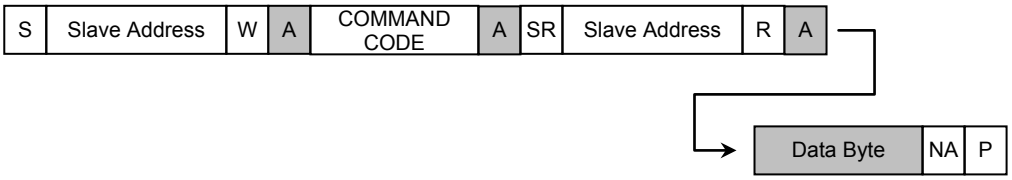


Figure 7-4 Read bytes

7.23 Cautions in writing I²C register

To avoid a transitional response of operating parameter by I²C register rewriting, the TC7710WBG stops an internal operation change for about 250μs after I²C register writing. So if I²C register is written successively in 250μs, internal operation remains stopping in the meantime. And register is written normally.
If programmed parameters are rewritten continuously after writing the charge EN control register and the OTG control register, charge and OTG operation do not start while I²C register is under writing. So rewrite parameter first, then rewrite of the EN control register and the OTG control register.
As for reading of I²C register, internal operation does not stop.

8. Register Map

Address=00H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>DBATVDET</td><td>R/W</td><td>1</td><td>Dead battery voltage threshold
0 VBATT < 3.47V
1 VBATT < 3.54V</td></tr>
<tr><td>6</td><td>ATRCHGTH</td><td>R/W</td><td>0</td><td>Automatic re-charge voltage threshold
0 140mV
1 140mV</td></tr>
<tr><td>5</td><td>CEI1</td><td>R/W</td><td>0</td><td rowspan="2">Charge completion current
00 50mA *Unavailable
01 100mA
10 150mA
11 200mA
Initial state: ”01”=100mA</td></tr>
<tr><td>4</td><td>CEI0</td><td>R/W</td><td>1</td></tr>
<tr><td>3</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>2</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>1</td><td>PCI1</td><td>R/W</td><td>0</td><td rowspan="2">Pre-charge current
00 50mA
01 100mA
10 150mA
11 200mA</td></tr>
<tr><td>0</td><td>PCI0</td><td>R/W</td><td>1</td></tr>
</table>

Address=01H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>CCI4</td><td>R/W</td><td>0</td><td rowspan="4">Fast charge current
<table><tr><td>00000</td><td>300mA</td><td>01001</td><td>1,200mA</td></tr><tr><td>00001</td><td>400mA</td><td>01010</td><td>1,300mA</td></tr><tr><td>00010</td><td>500mA</td><td>01011</td><td>1,400mA</td></tr><tr><td>00011</td><td>600mA</td><td>01100</td><td>1,500mA</td></tr><tr><td>00100</td><td>700mA</td><td>01101</td><td>1,600mA</td></tr><tr><td>00101</td><td>800mA</td><td>01110</td><td>1,700mA</td></tr><tr><td>00110</td><td>900mA</td><td>01111</td><td>1,800mA</td></tr><tr><td>00111</td><td>1,000mA</td><td>10000</td><td>1,900mA</td></tr><tr><td>01000</td><td>1,100mA</td><td>10001</td><td>2,000mA</td></tr></table>Initial value: ”00010”=500mA</td></tr>
<tr><td>6</td><td>CCI3</td><td>R/W</td><td>0</td></tr>
<tr><td>5</td><td>CCI2</td><td>R/W</td><td>0</td></tr>
<tr><td>4</td><td>CCI1</td><td>R/W</td><td>1</td></tr>
<tr><td>3</td><td>CCI0</td><td>R/W</td><td>0</td><td>OTG current limit *only OTG is enabled
<table><tr><td>00010</td><td>500mA</td><td>01100</td><td>1,500mA</td></tr><tr><td>00111</td><td>1000mA</td><td>01111</td><td>1,800mA</td></tr></table>Initial value: ”00010”=500mA</td></tr>
<tr><td>2</td><td>CCVTH2</td><td>R/W</td><td>1</td><td rowspan="3">Threshold voltage from pre-charge to fast charge
<table><tr><td>000</td><td>2.6V</td><td>100</td><td>3.0V</td></tr><tr><td>001</td><td>2.7V</td><td>101</td><td>3.1V</td></tr><tr><td>010</td><td>2.8V</td><td>110</td><td>3.2V</td></tr><tr><td>011</td><td>2.9V</td><td>111</td><td>3.3V</td></tr></table>Initial value is 3.0V.</td></tr>
<tr><td>1</td><td>CCVTH1</td><td>R/W</td><td>0</td></tr>
<tr><td>0</td><td>CCVTH0</td><td>R/W</td><td>0</td></tr>
</table>

Address=02H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>6</td><td>FLTV6</td><td>R/W</td><td>0</td><td rowspan="7">Float voltage
<table><tr><td>0000000</td><td>3.46V</td></tr><tr><td>0000001</td><td>3.47V</td></tr><tr><td>0000010</td><td>3.48V</td></tr><tr><td>:</td><td>:</td></tr><tr><td>1111101</td><td>4.71V</td></tr><tr><td>1111110</td><td>4.72V</td></tr><tr><td>1111111</td><td>4.73V</td></tr></table>Initial value: ”0000100”=3.50V</td></tr>
<tr><td>5</td><td>FLTV5</td><td>R/W</td><td>0</td></tr>
<tr><td>4</td><td>FLTV4</td><td>R/W</td><td>0</td></tr>
<tr><td>3</td><td>FLTV3</td><td>R/W</td><td>0</td></tr>
<tr><td>2</td><td>FLTV2</td><td>R/W</td><td>1</td></tr>
<tr><td>1</td><td>FLTV1</td><td>R/W</td><td>0</td></tr>
<tr><td>0</td><td>FLTV0</td><td>R/W</td><td>0</td></tr>
</table>

Address=03H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>ACILMT4</td><td>R/W</td><td>0</td><td rowspan="5">AC input current limit
<table><tr><td>00000</td><td>300mA</td><td>01001</td><td>1,200mA</td></tr><tr><td>00001</td><td>400mA</td><td>01010</td><td>1,300mA</td></tr><tr><td>00010</td><td>500mA</td><td>01011</td><td>1,400mA</td></tr><tr><td>00011</td><td>600mA</td><td>01100</td><td>1,500mA</td></tr><tr><td>00100</td><td>700mA</td><td>01101</td><td>1,600mA</td></tr><tr><td>00101</td><td>800mA</td><td>01110</td><td>1,700mA</td></tr><tr><td>00110</td><td>900mA</td><td>01111</td><td>1,800mA</td></tr><tr><td>00111</td><td>1,000mA</td><td>10000</td><td>1,900mA</td></tr><tr><td>01000</td><td>1,100mA</td><td>10001</td><td>2,000mA</td></tr></table>Current values in above table are maximum limit current. Initial value is 500mA.</td></tr>
<tr><td>6</td><td>ACILMT3</td><td>R/W</td><td>0</td></tr>
<tr><td>5</td><td>ACILMT2</td><td>R/W</td><td>0</td></tr>
<tr><td>4</td><td>ACILMT1</td><td>R/W</td><td>1</td></tr>
<tr><td>3</td><td>ACILMT0</td><td>R/W</td><td>0</td></tr>
<tr><td>2</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>1</td><td>ATLMTTH1</td><td>R/W</td><td>0</td><td rowspan="2">Automatic input current limit threshold
<table><tr><td>00</td><td>4.25V</td></tr><tr><td>01</td><td>4.50V</td></tr><tr><td>10</td><td>4.75V</td></tr><tr><td>11</td><td>5.00V</td></tr></table>Initial value: ”01”=4.5V</td></tr>
<tr><td>0</td><td>ATLMTTH0</td><td>R/W</td><td>1</td></tr>
</table>

Address=04H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>6</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>5</td><td>OTGVCTL1</td><td>R/W</td><td>0</td><td rowspan="2">OTG output voltage
<table><tr><td>00</td><td>5.0V</td></tr><tr><td>01</td><td>5.1V</td></tr><tr><td>10</td><td>5.2V</td></tr><tr><td>11</td><td>5.3V</td></tr></table>Initial value: ”00”=5.0V</td></tr>
<tr><td>4</td><td>OTGVCTL0</td><td>R/W</td><td>0</td></tr>
<tr><td>3</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>2</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>1</td><td>OTGUVTH1</td><td>R/W</td><td>0</td><td rowspan="2">UVLO threshold in OTG mode
<table><tr><td>00</td><td>2.75V</td></tr><tr><td>01</td><td>3.00V</td></tr><tr><td>10</td><td>3.25V</td></tr><tr><td>11</td><td>3.50V</td></tr></table>Initial value: ”00”=2.75V</td></tr>
<tr><td>0</td><td>OTGUVTH0</td><td>R/W</td><td>0</td></tr>
</table>

Address=05H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>6</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>5</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>4</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>3</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>2</td><td>-</td><td>R</td><td>0</td><td>-</td></tr>
<tr><td>1</td><td>OVTHL1</td><td>R/W</td><td>1</td><td rowspan="2">Over charge threshold voltage
<table><tr><td>00</td><td>200mV</td></tr><tr><td>01</td><td>150mV</td></tr><tr><td>10</td><td>100mV　* Not recommended</td></tr><tr><td>11</td><td>50mV　* Not recommended</td></tr></table>Initial value: ”10”=100mV
Notice: Please use 150mV or 200mV setting instead of initial value.
Over charge threshold voltage: Float voltage + α (setting voltage of this register) corresponds to over-charge voltage threshold.</td></tr>
<tr><td>0</td><td>OVTHL0</td><td>R/W</td><td>0</td></tr>
</table>

Address=10H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	CHGTMCLR	R/W	0	Pre-charge safety timer / Charge safety timer clear 0: Timer operation 1: Both of charge timers are cleared. (Pulse command) In this time, status information of pre-charge and charge timer is cleared.
5	STBWDTM	R/W	0	Standby WD timer 0: 42sec WDT: Invalid 1: 42sec WDT: Valid If the TC7710WBG is controlled by I^2C before DCIN is inputted, standby WD timer should be valid.
4	OTGWDTM	R/W	0	OTG WD timer 0: 42sec WDT: Invalid 1: 42sec WDT: Valid OTG WD timer should be valid in OTG mode.
3	CHGWDTM	R/W	0	Charge WD timer 0: 42sec WDT: Invalid 1: 42sec WDT: Valid
2	PRCHGTM	R/W	0	Pre-charge safety timer 0: 36min timer: Valid 1: 36min timer: Invalid
1	CHGSTM	R/W	0	Charge safety timer 0: 240min timer: Valid 1: 240min timer: Invalid
0	TCSTON	R/W	1	Trickle charge safety timer 0: Pre-charge timer and charge timer do not operate in trickle charging. 1: Pre-charge timer and charge timer operate in trickle charging.

Address=11H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	-	R	0	-
5	-	R	0	-
4	BATMSDET	R/W	1	Unconnected battery detection 0: Invalid 1: Valid
3	ATCHG	R/W	1	Automatic charge control 0: Invalid (OFF in charge disable) 1: Valid (In charge disable, it is charged only when the battery voltage is lower than threshold.) (In charge enable, it is charged regardless of the battery voltage.) It is charged automatically when the battery voltage is lower than dead battery threshold.
2	ENSEL	R/W	0	EN is controlled by I^2C or EN pin. 0: Controlled by EN pin. (Polarity is selected by ENPINPOL) 1: Controlled by I^2C. (Selected by ENCMD.)
1	ENCMD	R/W	1	EN is controlled by I^2C. 0: Enable (charger is tuned on.) 1: Disable (charger is turned off.)
0	ENPINPOL	R/W	0	Polarity of EN control is selected by EN pin. 0: "L" is active. ("L"=Enable, "H"=Disable) 1: "H" is active. ("L"=Disable, "H"=Enable)

Address=12H

bit	Command	R/W	Initial value	Contents
7	TEMPDET	R/W	0	Battery thermal detection 0: Valid (Charging stops when the temperature exceeds the limit value. And charging re-starts automatically when the temperature falls within the range.) 1: Invalid (Charging does not stop though the temperature exceeds limit value.)
6	OVTLMT	R/W	1	IC temperature limit 0: Only status bit: Valid 1: Status bit: Valid. Permission of suspending charge.
5	BATOV	R/W	1	Battery OV 0: Charging cycle does not terminate when battery voltage is OV. 1: Charging cycle terminates when battery voltage is OV.
4	ATRCHG	R/W	0	Auto re-charge 0: Valid 1: Invalid
3	CT	R/W	0	Terminating 0: Permitting termination of charging cycle. 1: Not permitting termination of charging cycle. Charging is completed when charge current is lower than the value set by CEI1-0.
2	CCISET	R/W	1	Fast charge setting (PRCCTH = "1": Valid) 0: Setting forced pre-charge current 1: Permission of setting fast charge current
1	PRCCTH	R/W	0	Threshold voltage from pre-charge to fast charge 0: Valid 1: Invalid
0	TRCHG	R/W	0	Trickle charge 0: Valid 1: Invalid

Address=13H

<table>
<tr><th>bit</th><th>Command</th><th>R/W</th><th>Initial value</th><th>Contents</th></tr>
<tr><td>7</td><td>OTGMD</td><td>R/W</td><td>0</td><td>OTG mode
<table><tr><td>0</td><td>Invalid</td></tr><tr><td>1</td><td>Valid</td></tr></table></td></tr>
<tr><td>6</td><td>USB51</td><td>R/W</td><td>0</td><td>Input current limit level set by ILIM_OTG pin in USB ("L" level).
<table><tr><td>0</td><td>USB500 mode</td></tr><tr><td>1</td><td>USB100 mode</td></tr></table>This setting is valid under the following condition.
LMT_OTG1-0 = "01", ILIM_OTG pin="L".</td></tr>
<tr><td>5</td><td>ATILMT</td><td>R/W</td><td>0</td><td>Automatic input current limit
<table><tr><td>0</td><td>Valid</td></tr><tr><td>1</td><td>Invalid</td></tr></table>Input current limit is set USB100 when DCIN falls to the level set by ATLMTTH1-0. When an interrupt is cleared, it is set to previous limit level.</td></tr>
<tr><td>4</td><td>ATPSDET</td><td>R/W</td><td>0</td><td>Automatic power source detection
<table><tr><td>0</td><td>Valid</td></tr><tr><td>1</td><td>Invalid (Set level = Limit level)</td></tr></table></td></tr>
<tr><td>3</td><td>LMT_OTG1</td><td>R/W</td><td>0</td><td rowspan="2">Input current limit and OTG control are set by pin or I^2C.
<table><tr><td>00</td><td>Input current limit is set by I^2C (ILIMLVL1-0). OTG mode is set by I^2C (OTGMD).</td></tr><tr><td>01</td><td>Input current limit is set by ILIM_OTG pin.
"L"= USB mode, USB51="L" -> USB500 mode
"L"= USB mode, USB51="H" -> USB100 mode
"H"=AC mode (set by ACILMT4-0)
OTG mode is set by I^2C (OTGMD).</td></tr><tr><td>10</td><td>Input current limit is set by I^2C (ILIMLVL1-0). OTG mode is set by ILIM OTG pin ("H" active).
"L": Invalid, "H": Valid</td></tr><tr><td>11</td><td>Input current limit is set by I^2C (ILIMLVL1-0). OTG mode is set by ILIM_OTG pin ("L" active).
"L": Valid, "H": Invalid</td></tr></table></td></tr>
<tr><td>2</td><td>LMT_OTG0</td><td>R/W</td><td>1</td></tr>
<tr><td>1</td><td>ILIMLVL1</td><td>R/W</td><td>1</td><td rowspan="2">Input current limit level in I^2C control.
<table><tr><td>00</td><td>USB500 mode (Typ. = 475mA, Max = 500mA)</td></tr><tr><td>01</td><td>USB100 mode (Typ. = 90mA, Max = 100mA)</td></tr><tr><td>10</td><td>AC mode (Set by ACILMT4-0.)</td></tr><tr><td>11</td><td>AC mode (Set by ACILMT4-0.)</td></tr></table>Initial value: ”10” = AC mode.</td></tr>
<tr><td>0</td><td>ILIMLVL0</td><td>R/W</td><td>0</td></tr>
</table>

Address=14H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	-	R	0	-
5	-	R	0	-
4	VMONICNT	R/W	0	VMONI control 0: Valid 1: Invalid
3	INTOUT	R/W	0	Information from STAT pin is selected. 0: Status information is outputted. (Information is set by STATMD. STATOUT = "0": Output is valid.) 1: Interrupt output (STATOUT = "1": Interrupt information is valid.)
2	STATMD	R/W	0	Information from STAT pin is selected. 0: Charging state is indicated. 1: State of input UV/OV is indicated.
1	STATOUT	R/W	0	Output of STAT pin: ON/OFF 0: ON 1: OFF
0	SFTRST	R/W	0	Soft reset command 0: OFF 1: Internal reset (Pulse command) Register is cleared and default value is reloaded.

Address=15H

bit	Command	R/W	Initial value	Contents
7	INTCLR7	R	0	Interrupt factor is cleared. Interrupt factor for each bit of 20h is cleared. (Pulse command)
6	INTCLR6	R/W	0	
5	INTCLR5	R/W	0	
4	INTCLR4	R/W	0	
3	INTCLR3	R/W	0	
2	INTCLR2	R/W	0	
1	INTCLR1	R/W	0	
0	INTCLR0	R/W	0	

Address=16H

bit	Command	R/W	Initial value	Contents
7	INTMSK7	R	0	Interrupt output from STAT pin is masked. (Interrupt information is active regardless of state of this bit.) 0: Interrupt factor is not masked. 1: Interrupt factor is masked.
6	INTMSK6	R/W	1	
5	INTMSK5	R/W	1	
4	INTMSK4	R/W	1	
3	INTMSK3	R/W	1	
2	INTMSK2	R/W	1	
1	INTMSK1	R/W	1	
0	INTMSK0	R/W	1	

Address=1EH

bit	Command	R/W	Initial value	Contents
7	BIASCRT1	R/W	0	Current source for temperature monitoring 00: 200μA 01: 80μA 10: 40μA 11: 20μA
6	BIASCRT0	R/W	0	
5	-	R	0	-
4	-	R	0	-
3	COLDVTH1	R/W	0	Threshold level for low temperature judge 00: 1.399V 01: 1.491V 10: 1.577V 11: 1.654V
2	COLDVTH0	R/W	0	
1	HOTVTH1	R/W	0	Threshold level for high temperature judge 00: 0.509V 01: 0.574V 10: 0.647V 11: 0.726V
0	HOTVTH0	R/W	1	

Address=1FH

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	-	R	0	-
5	-	R	0	-
4	-	R	0	-
3	-	R	0	-
2	I2CSVAD2	R/W	0	I^2C slave address
1	I2CSVAD1	R/W	0	
0	I2CSVAD0	R/W	0	

000	No conversion -> 0001001
001	Convert bit0 -> 0001000
010	Convert bit1 -> 0001011
011	Convert bit2 -> 0001101
100	Convert bit3 -> 0000001 *Reserved: CBUS address
101	Convert bit4 -> 0011001
110	Convert bit5 -> 0101001
111	Convert bit6 -> 1001001

Address=20H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	INTVBAT	R	0	1: Charge state is back to previous mode by battery voltage drop.
5	INTATIL	R	0	1: Automatic input current limit is occurred.
4	INTSTBER	R	0	Interrupt of standby WDT error 1: WDT error is occurred. Register of 00H - 13H, 1EH and 1FH are initialized.
3	INTOTGER	R	0	Interrupt of OTG error (Interrupt factor should be confirmed 22H) 1: OTG error is occurred.
2	INTRCHG	R	0	Interrupt of re-charge 1: Re-charge
1	INTCHGER	R	0	Interrupt of charge error (Interrupt factor should be confirmed 21H and 23H.) 1: Charge error is occurred.
0	INTTERMN	R	0	Interrupt of charge complete. However, it is valid only when CT (12H, bit3) is "0". 1: Charge completion

Address=21H

bit	Command	R/W	Initial value	Contents
7	ST_BATMS	R	0	Status 1: Unconnected battery detected.
6	ST_VBATN	R	-	Status: Initial value depends on DCIN voltage and battery voltage. 1: DCIN < VBATT
5	ST_BATOV	R	-	Status: Initial value depends on battery voltage. 1: Battery OVLO
4	ST_DCOVL	R	-	Status: Initial value depends on DCIN input voltage. 1: Input OVLO
3	ST_DCUVL	R	-	Status: Initial value depends on DCIN input voltage. 1: Input UVLO
2	ST_JCTON	R	-	Status: Initial value depends on chip temperature. It operates though in charging or OTG mode. Chip temperature ≥ 135°C: 1, Chip temperature ≤ 115°C: 0 1: Internal temperature is limited.
1	ST_BATHT	R	-	Status: Initial value depends on battery temperature. 1: High temperature detected
0	ST_BATCL	R	-	Status: Initial value depends on battery temperature. 1: Low temperature detected

Address=22H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	-	R	0	-
5	-	R	0	-
4	ST_OTGVOL	R	0	Status: It shows “0” for 250ms after starting OTG. 1: Output voltage drops under DCIN UVLO.
3	ST_OTGJCT	R	-	Status: Initial value depends on chip temperature. It operates though in charging or OTG mode. Chip temperature ≥ 135°C: 1, Chip temperature ≤ 115°C: 0. 1: Internal temperature limited.
2	ST_OTWDT	R	0	Status 1: WDT error occurred. OTG supply is shut off. Registers of 00H-13H, 1EH and 1FH are initialized.
1	ST_OTGLM	R	-	Status: Initial value depends on OTG current. 1: OTG current limit reached
0	ST_ OTUVL	R	-	Status: Initial value depends on battery voltage. 1: OTG battery UVLO

Address=23H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	-	R	0	-
5	-	R	0	-
4	-	R	0	-
3	-	R	0	-
2	ST_CHWDT	R	0	Status 1: WDT error occurred. Charging stops. Register of 00H-13H, 1EH and 1FH are initialized. However, only charging timer operates continuously.
1	ST_TMER1	R	1	Status: Safety timer 00 No timeout occurred. 01 Pre-charge timer expired. 10 Charge timer expired. 11 Waiting to start charge
0	ST_TMER0	R	1	

Address=24H

bit	Command	R/W	Initial value	Contents
7	ST_OTGMD	R	0	Status 1: OTG in progress
6	-	R	0	-
5	ST_CGED1	R	0	Status: Charge completion 1: At least, one charge cycle starts and completes.
4	ST_CGED0	R	-	Status: Charge completion Initial value depends on charge current. 1: Charge current is lower than charge completion current (Valid only in CV charge mode.).
3	ST_TRCHG	R	0	Status 1: Trickle charge mode (VBATT < 2.1V)
2	ST_CGMD1	R	0	Status: Charging 00 No charge 01 Pre-charge 10 Constant current charge (CC mode) 11 Constant voltage charge (CV mode)
1	ST_CGMD0	R	0	
0	ST_CHGEN	R	0	Status: Charge valid / invalid 0 Charge invalid 1 Charge valid

Address=25H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	-	R	0	-
5	ST_USB51	R	*	Status: USB5/1 mode Initial value is determined by 13h, 6. 0: USB 100mA mode 1: USB 500mA mode
4	ST_USBAC	R	0	Status: USB / AC mode 0: USB mode 1: AC mode
3	ST_DTBSY	R	0	Status: Power source detection function 0: Not busy 1: Busy
2	ST_PSDST	R	1	Status: Power source detection 0: Detecting 1: Finished (after source detected)
1	ST_STYP1	R	0	Status: Power source type 00: Non connection 01: SDP (Standard Downstream Port) 10: CDP (Charging Downstream Port) 11: DCP (Dedicated Charging Port)
0	ST_STYP0	R	0	

Address=26H

bit	Command	R/W	Initial value	Contents
7	-	R	0	-
6	REVCODE2	R	0	Device revision code 000: #1.0
5	REVCODE1	R	0	
4	REVCODE0	R	0	
3	-	R	0	-
2	-	R	0	-
1	-	R	0	-
0	-	R	0	-

9. Mode Transition Diagram

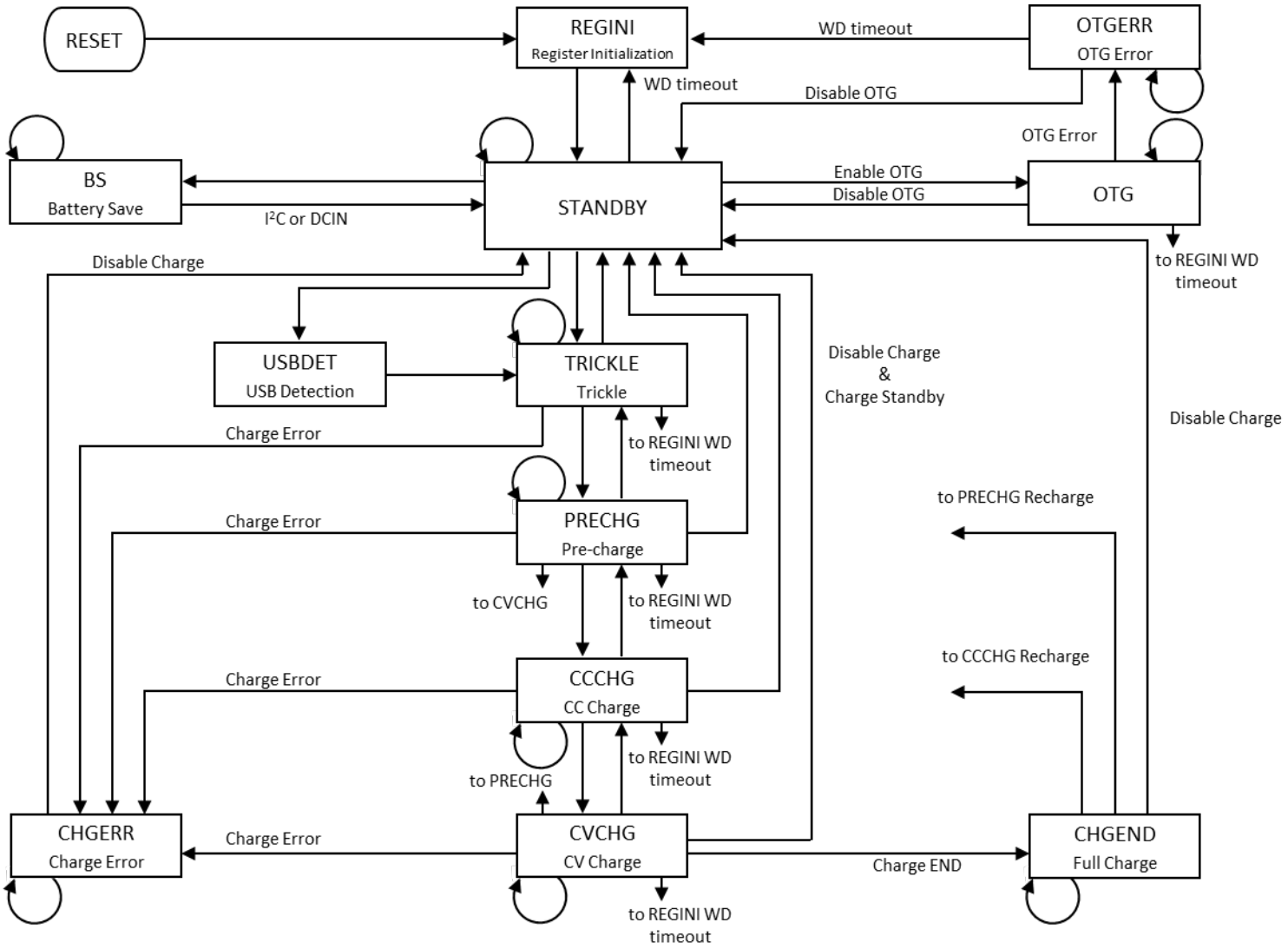


Figure 9-1 Mode transition diagram

10. Flow chart of function

<Before charge>

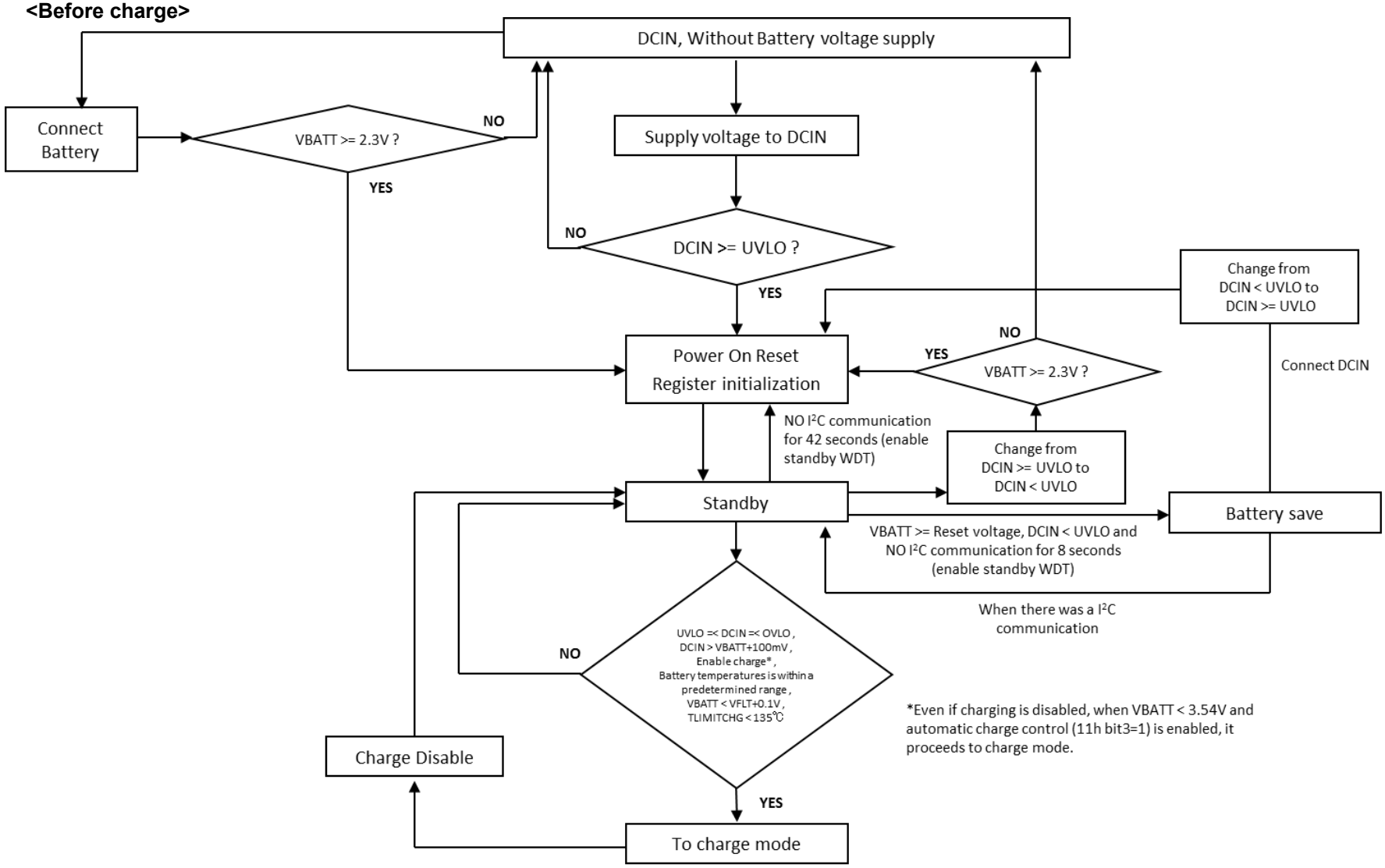


Figure 10-1 Flow chart: Before charge

<After start charging>

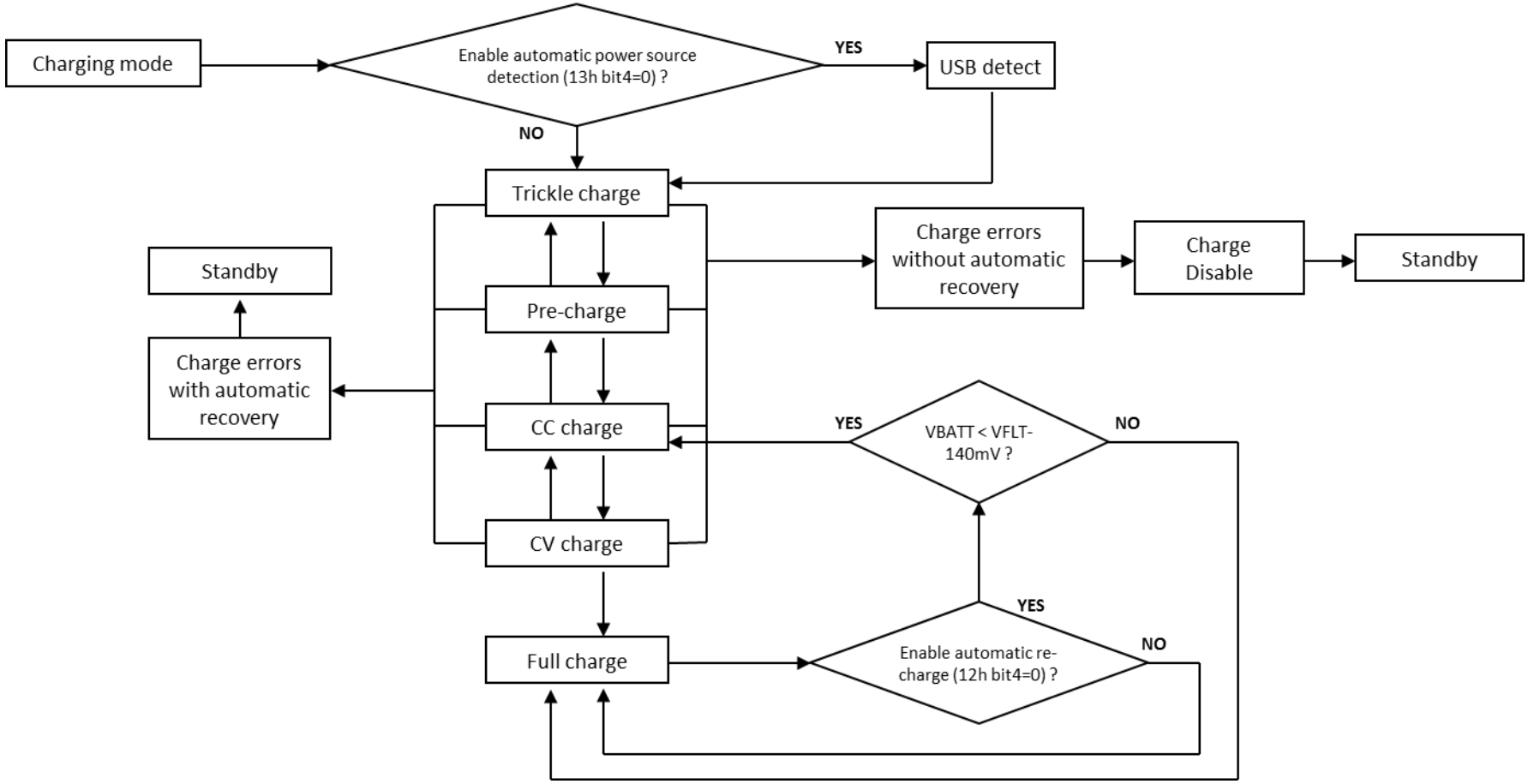


Figure 10-2 Flow chart: After start charging

<Trickle charge>

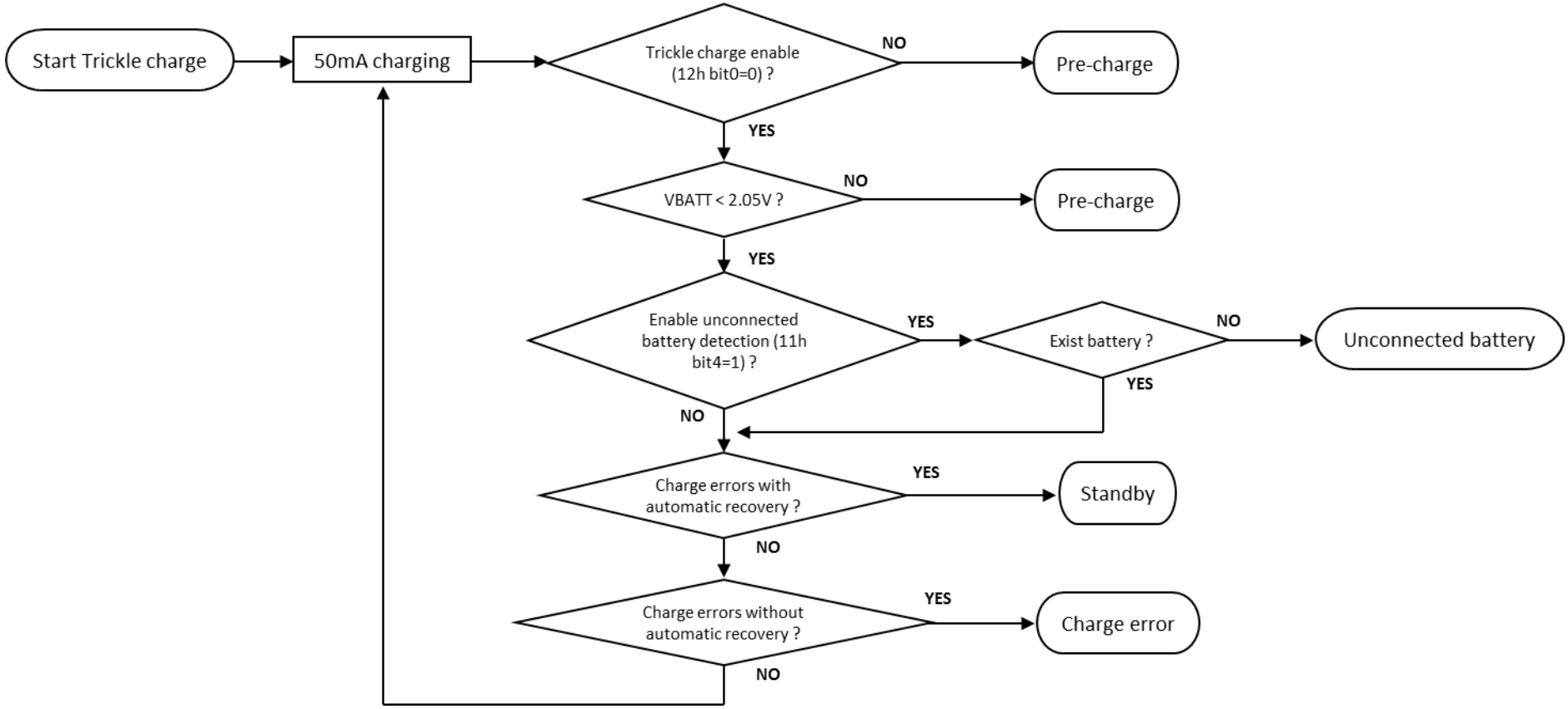


Figure 10-3 Flow chart: Trickle charge

<Pre charge>

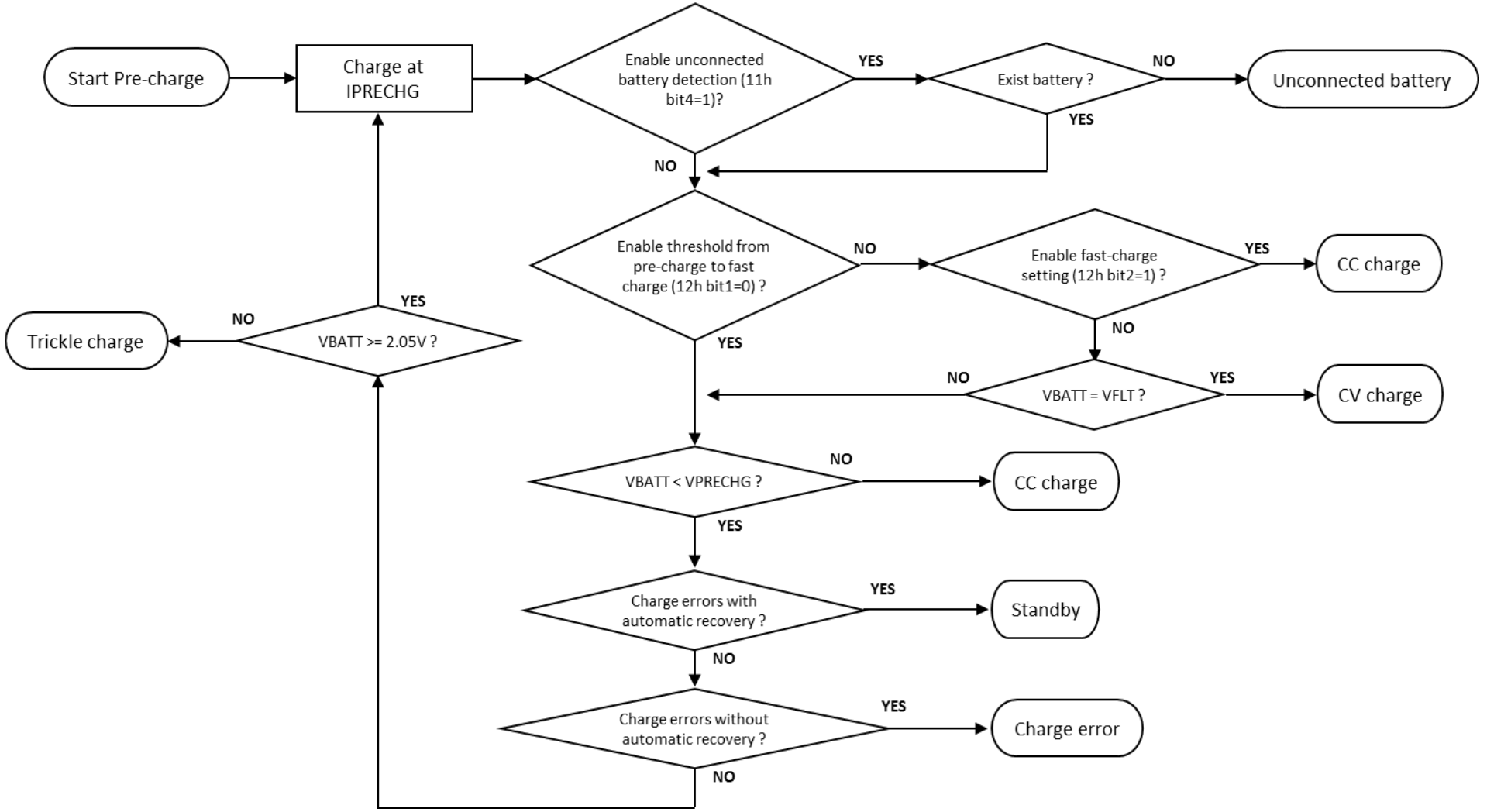


Figure 10-4 Flow chart: Pre-charge

<CC charge>

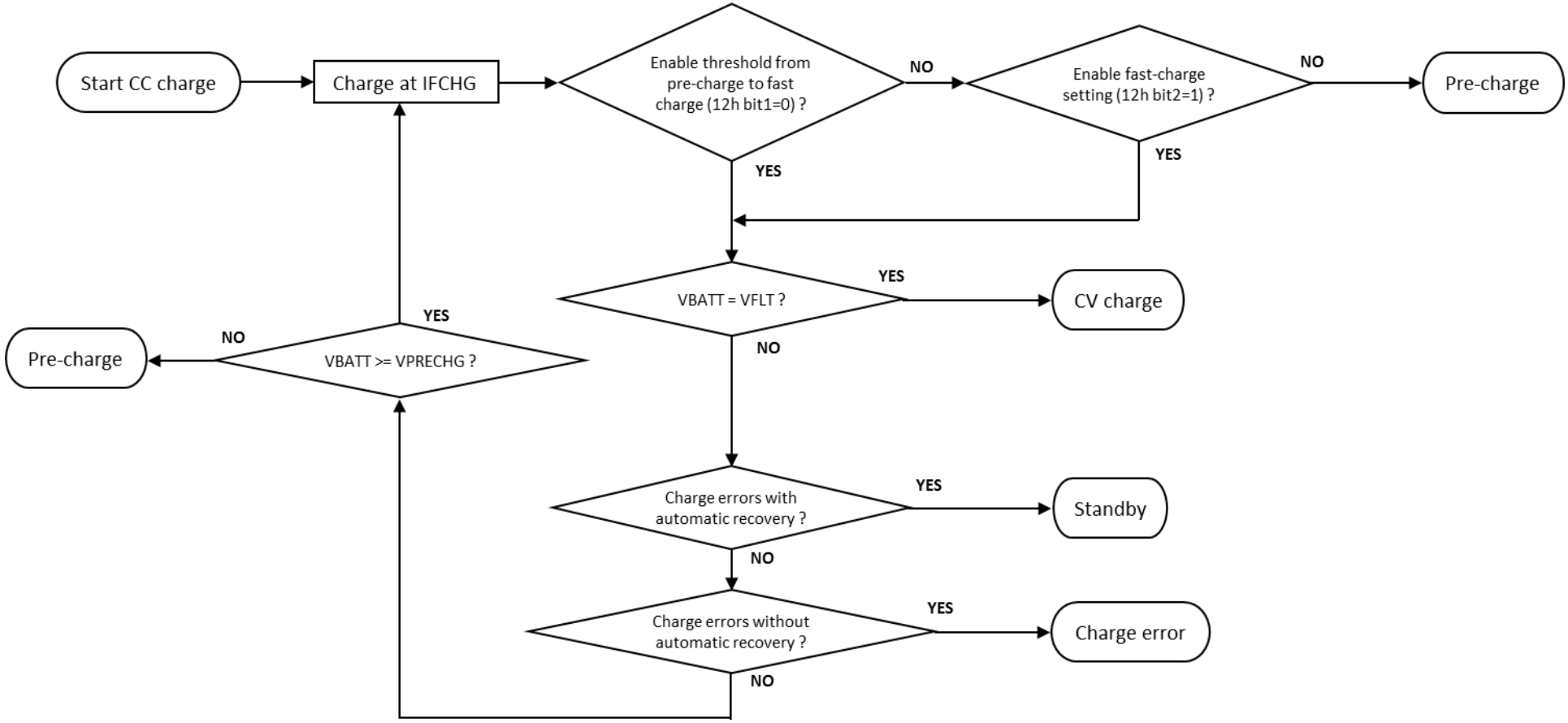


Figure 10-5 Flow chart: CC charge

<CV charge>

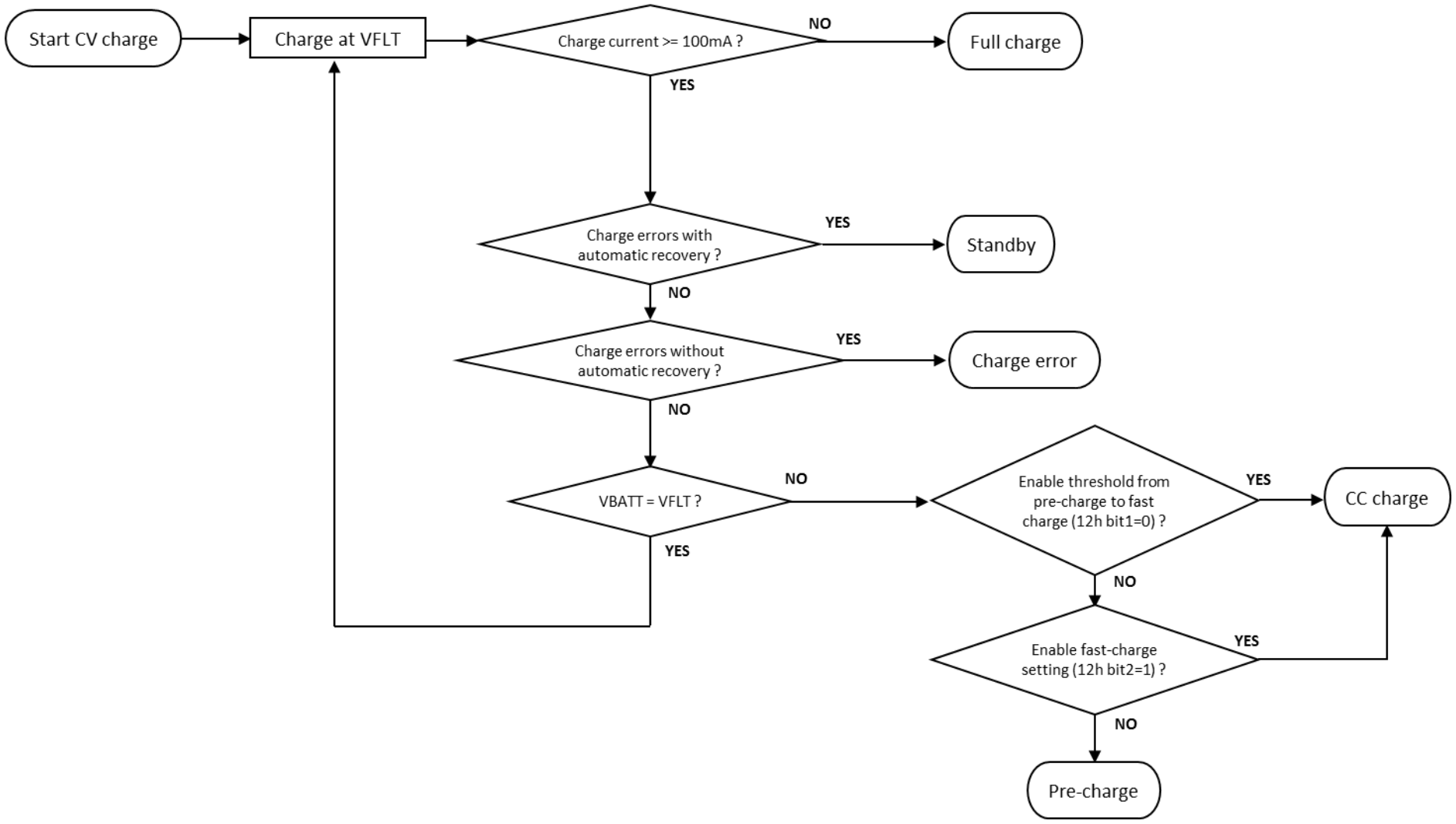


Figure 10-6 Flow chart: CV charge

<Full charge>

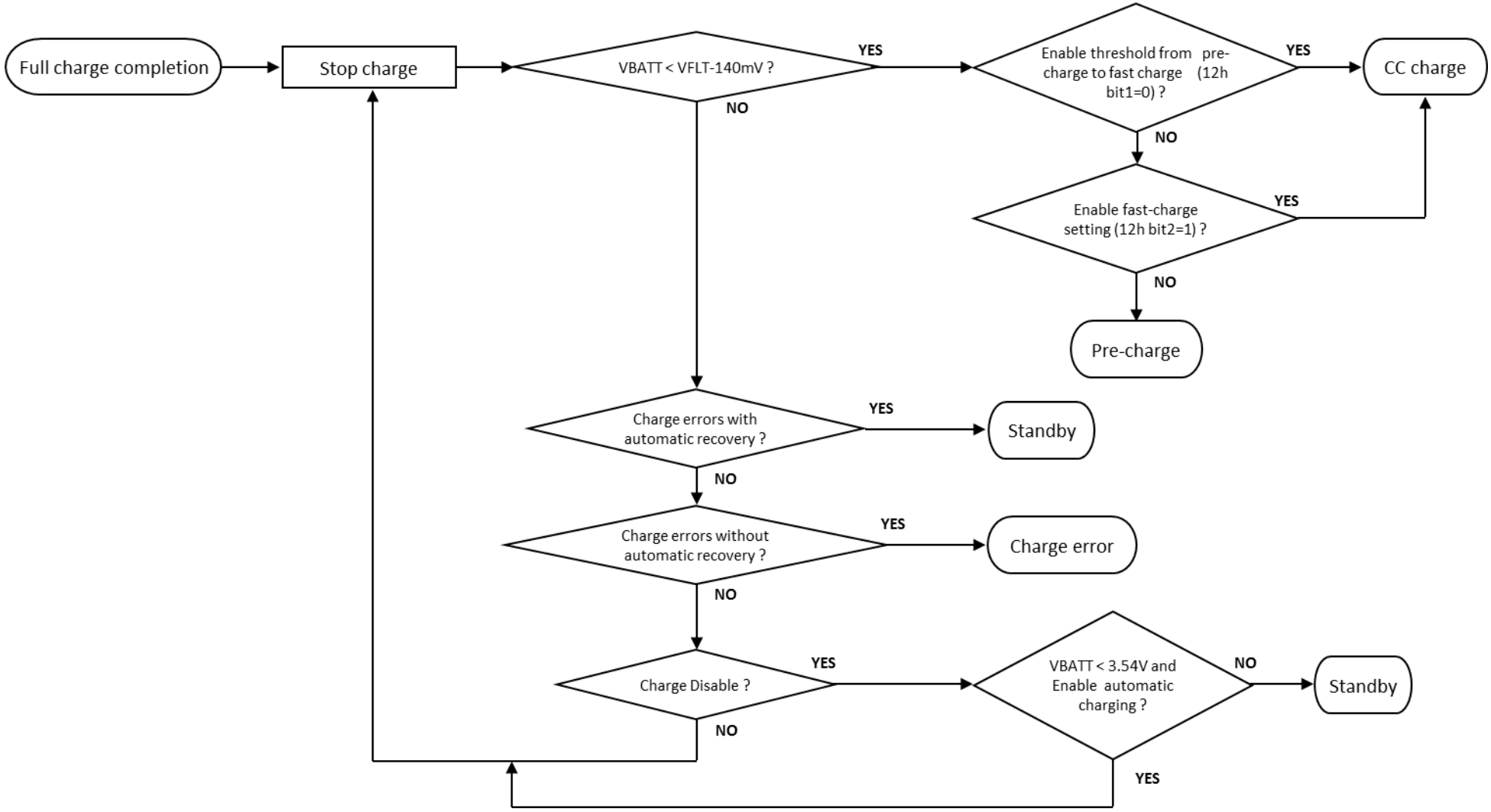


Figure 10-7 Flow chart: Full charge

<Unconnected battery detection>

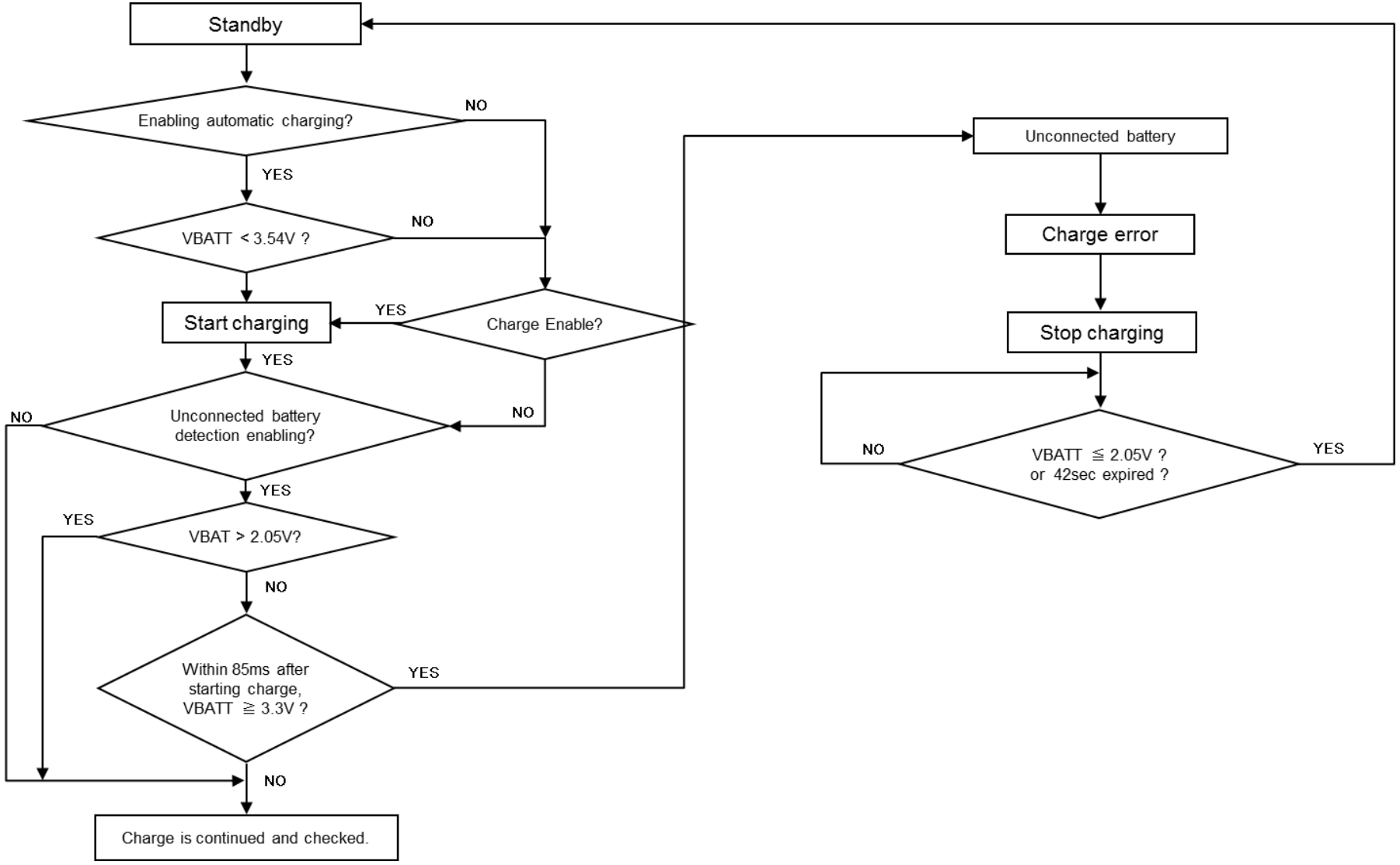


Figure 10-8 Flow chart: Unconnected battery detection

<OTG>

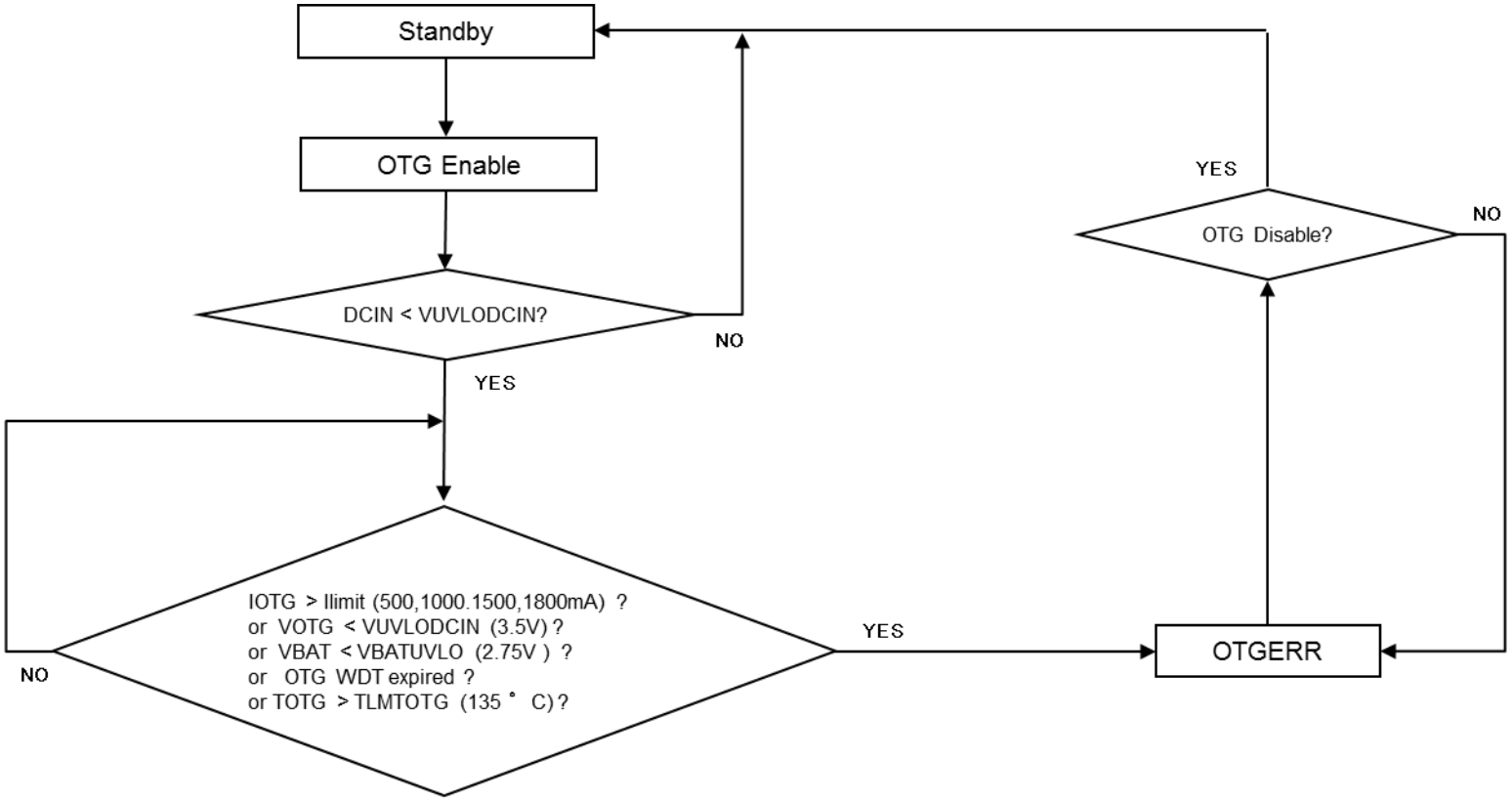
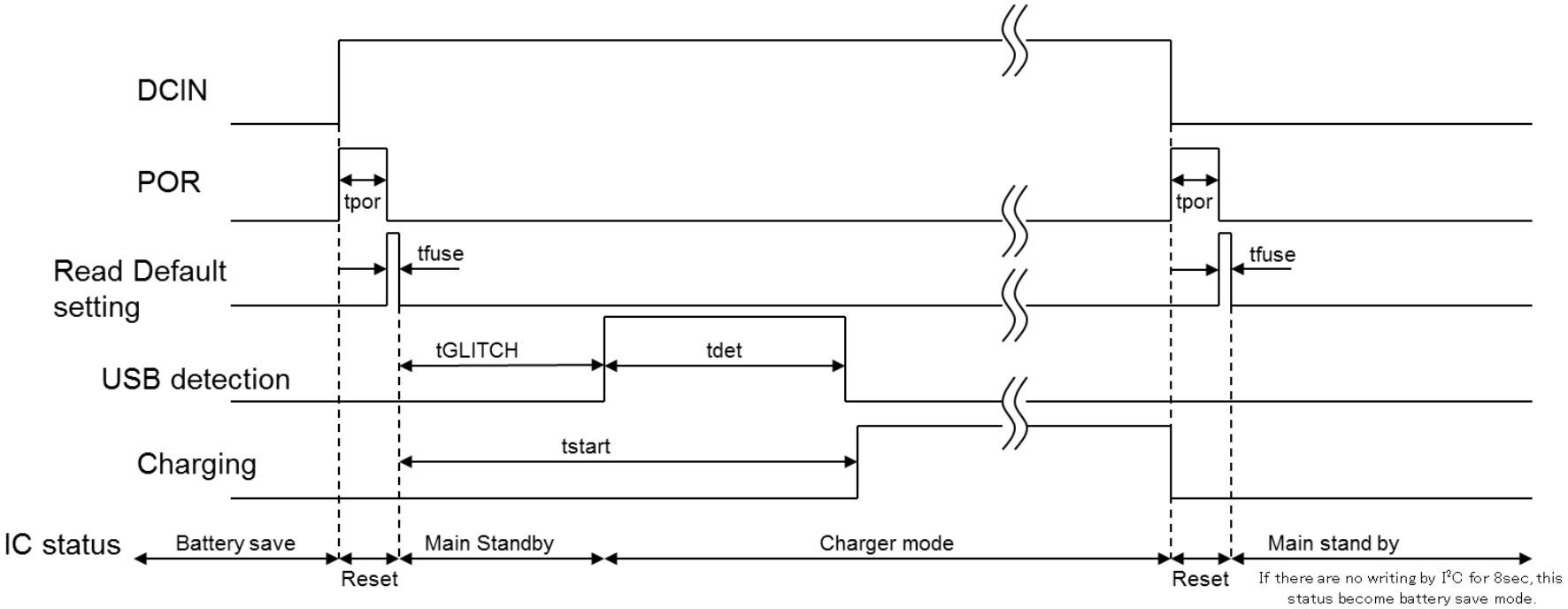


Figure 10-9 Flow chart: OTG

11. Timing chart

<DCIN ON / OFF>



Symbol	Contents	Time
tpor	DCIN～POR time	20ms (Max)
tfuse	Read default setting	5μs (Max)
tGLITCH	Removal Chattering	168ms (Max210ms)
tdet	USB detection time: No connect case	470ms (Max)
	USB detection time: SDP	95ms (Max)
	USB detection time : CDP/DCP	164ms (Max)
tstart	DCIN～start charging	tdchat+tdet+1μs

Figure 11-1 Timing chart: DCIN ON / OFF

<Forced charge termination>

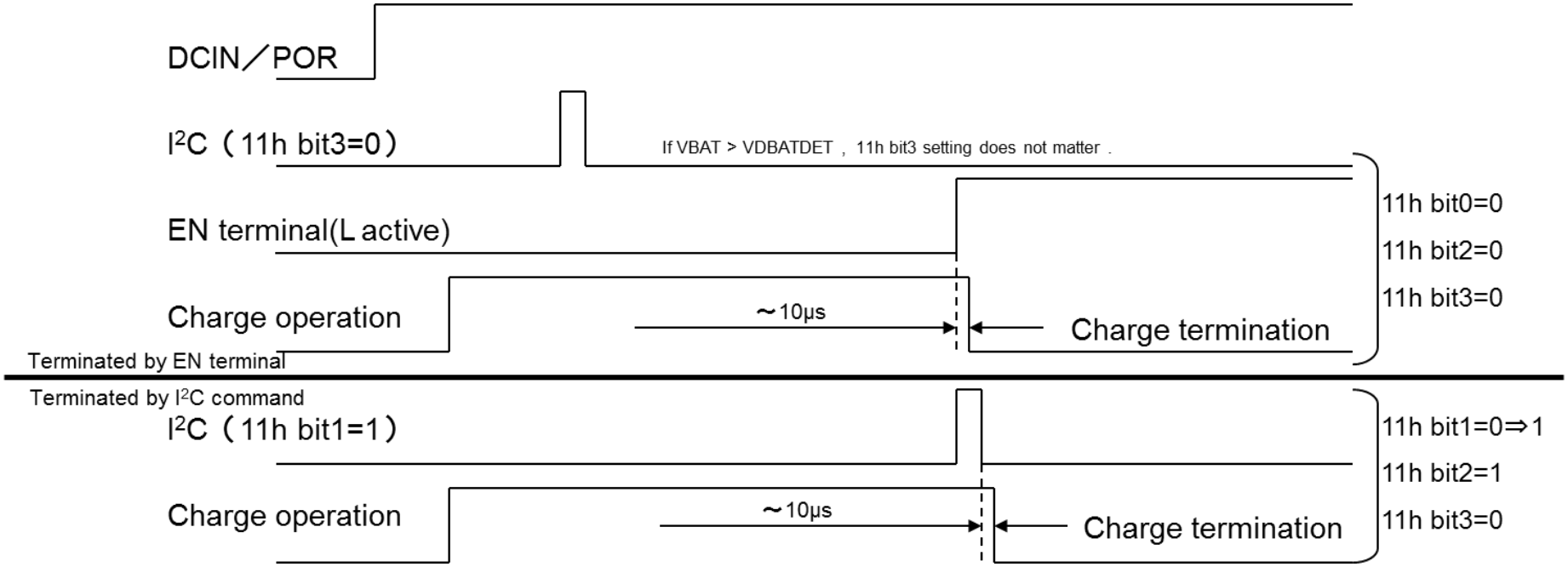


Figure 11-2 Timing chart: Forced charge termination

Auto charge control	11H,bit3=”0”	Set charge disable, forced charge termination.
	11H,bit3=”1”	Set charge disable, charge operates if VBAT < VDBATDET(00H,bit7). [Initial value]
EN control polarity	11H,bit2=”0”	Controlled by EN pin. [Initial value]
	11H,bit2=”1”	Controlled by I^2C command.
EN controlled by I^2C	11H,bit1=”0”	Charge enable
	11H,bit1=”1”	Charge disable
EN pin polarity select	11H,bit0=”0”	L active (EN=L: Enable, H: Disable)
	11H,bit0=”1”	H active (EN=H: Enable, L: Disable)

<I²C>

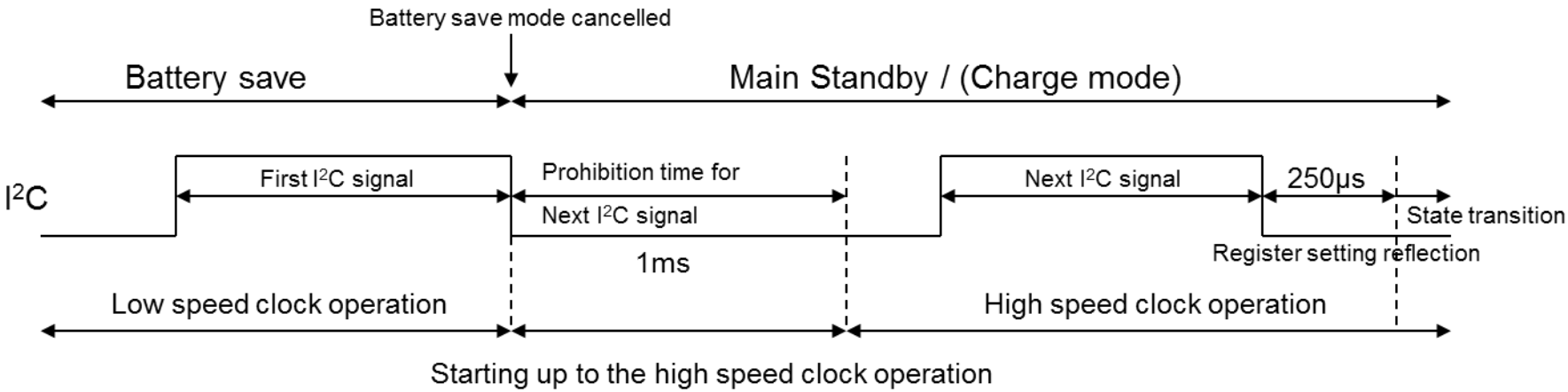


Figure 11-3 Timing chart: I²C

- When DCIN = UVLO and standby WDT is invalid, or OTG = Disable, the TC7710WBG becomes the battery save mode.
- If there is an I²C signal among the battery save mode, the TC7710WBG changes the mode to the standby mode.
  Wait time 1ms is necessary to write next I²C signal successively.
- If standby WDT is valid by command in the battery save mode, the TC7710WBG cannot resume the battery save mode.
- When the TC7710WBG is communicated by I²C in standby mode or charge mode, register setting is reflect soon, but state transition is occurred 250µs after that.
  If I²C command is set successively in 250µs, state transition is occurred 250µs after last communication.

12. Absolute Maximum Ratings

Table 12-1 Absolute maximum ratings

(Unless otherwise specified, Ta = 25°C)

Characteristics	Symbol	Rating	Unit	Remarks
Applied voltage of SW pin	Vin1	-0.3 to 6.5	V	
Applied voltage of DCIN pin, MID pin	Vin2	-1.5 to 10.0	V	
Applied voltage of STAT pin	Vin3	-0.3 to 6.5	V	
Applied voltage of other pins	Vin4	-0.3 to 6.5	V	
Power dissipation 1 (*Note1)	PDmax	1080	mW	
Operating temperature (*Note2)	Topr	-40 to 85	°C	
Junction temperature	Tj	150	°C	
Storage temperature	Tstg	-55 to 150	°C	

Note1: When Ta is 25°C or more, 16.67mW decreases per 1°C rise.

Note2: The operation range of actual use without any problems.

Note3: The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings. Exceeding the rating (s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion. Please use the IC within the specified operating ranges.

13. Electrical Characteristics

DC characteristics (1)

Table 13-1 DC characteristics

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Input voltage	V_{DCIN}		+4.35		+6.5	V
Input UVLO voltage	$V_{UVLODCIN}$	V_{DCIN} rising	3.40	3.60	3.80	V
		V_{DCIN} falling	3.20	3.50	3.70	V
Input OVLO voltage	$V_{OVLODCIN}$	V_{DCIN} rising (no glitch filter)	6.20	6.50	6.90	V
		V_{DCIN} falling	6.10	6.30	6.60	V
VMONI output voltage	$V_{VMONIRNG}$	$V_{UVLODCIN}$ < V_{DCIN} < $V_{OVLODCIN}$,		V_{DCIN}-1.0		V
VMONI output On-resistance	R_{VMONI}			1.7		kΩ
Current limit threshold accuracy	V_{CLACC}	AC mode, V_{CL} = 4.5V	-4		+4	%
Battery OVLO voltage	V_{BOV}	Δ =150mV or 200mV		V_{FLT}+Δ		V
Automatic shutdown threshold	V_{ASHDN}	V_{DCIN} - V_{BATT}, V_{DCIN} rising	60	130	200	mV
		V_{DCIN} - V_{BATT}, V_{DCIN} falling	0	60	130	mV
DCIN current (Active)	$I_{DCIN-ACTIVE}$	Charging, not including ICHG, Linear		1.6		mA
		Charging, not including ICHG, PWM		14		mA
Shutdown current	I_{SHDN}	Charge invalid, V_{DCIN} = 5V, V_{BATT} = 3.7V, no load, DCIN ≥ UVLO, standby mode		1.3	2.5	mA
Battery shutdown current	$I_{AUXSHDN}$	Current from battery DCIN = OPEN, VBATT = 3.7V		38	67	μA
Leakage current	I_{DCINLK}	DCIN current when charge is invalid, V_{DCIN} = 1V, V_{BATT} = 4.2V			2	μA
OTG current	I_{DDMOTG}	OTG valid, V_{BATT} = 3.7V, no load		4		mA
Over temperature threshold, charge mode	$T_{LIMITCHG}$			135		°C
Over temperature threshold hysteresis, charge mode	$T_{HYSTCHG}$			20		°C
Over temperature threshold, OTG mode	$T_{LIMITOTG}$			135		°C
Over temperature threshold hysteresis, OTG mode	$T_{HYSTOTG}$			20		°C

DC characteristics (2) SW mode controller

Table 13-2 DC characteristic (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
FET on-resistance	RRDSON	High-side (DCIN to SW), Note 3		233	367	mΩ
		Low-side (SW to GND), Note 3		125	200	mΩ
Current limit	ILIMIT	VBATT = 3.0V		3		A
Duty cycle	D.C.	Maximum		100		%
		Minimum		0		%

DC characteristics (3) Battery charger

Table 13-3 DC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Trickle charge to Pre-charge voltage threshold	VTRICKLECHG		1.9	2.05	2.2	V
Unconnected battery voltage threshold	VBATMIS		3.15	3.3	3.45	V
Trickle charge current	ITRICKLECHG	VBATT = 1.7V	30	50	80	mA
Dead battery voltage threshold	VBATDEAD	Programmable (2 settings): 3.47V, 3.54V	-4		4	%
Pre-charge to Fast charge voltage threshold	VPRECHG	Programmable VPRECHG = 2.6 to 3.3 V (8steps)	-3.5		3.5	%
USB1 input current limit	IUSB1LMT	Ta = 0 to 70°C, IUSB1LMT = 90mA, Note 2, VMONI off	60	80	100	mA
USB5 input current limit	IUSB5LMT	Ta = 0 to 70°C, IUSB5LMT = 475mA,	400	460	500	mA
AC input current limit (programmable 300mA to 2000mA, 18steps)	IACLMT	Ta = 0 to 70°C, IACLMT = 500mA	-100		55	mA
Constant current sense voltage	VSENSE	IFCHG = 1000mA		68		mV
Pre-charge current (programmable 50mA to 200mA, 50mA/step)	IPRECHG	Ta = 0 to 70°C, IPRECHG = 100mA, Note 1	-30		30	mA
Fast charge current (programmable 300mA to 2000mA, 18steps)	IFCHG	Ta = 0 to 70°C, RSENSE = 68mΩ, IFCHG = 500mA, Note 1	-50		50	mA
Charge termination current (Programmable 100mA to 200mA, 50mA/step)	ITERM	Ta = 0 to 70°C, RSENSE = 68mΩ, ITERM = 100mA	-30		30	mA
Charge termination current (Programmable 100mA to 200mA, 50mA/step)	ITERM	Ta = 0 to 70°C, RSENSE = 68mΩ, ITERM = 150mA, 200mA	-30		30	%
Float voltage (Programmable 3.46V to 4.72V, 10mV/step)	VFLT	Ta = 0 to 70°C, VFLT = 4.0V to 4.42V	-1		1	%
Automatic re-charge threshold voltage	VRECH		70	140	190	mV

DC characteristics (4) Thermal monitor (Factory programmable option)

Table 13-4 DC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
High temperature trip point (Programmable 509mV to 726mV, 4steps)	V_{HOT}	V_{THERM} falling, V_{HOT} = 0.726V, Ta = 0 to 70°C	675	726	776	mV
Low temperature trip point (Programmable 1.399V to 1.654V, 4steps)	V_{COLD}	V_{THERM} rising, V_{COLD} = 1.491V, Ta = 0 to 70°C	1.437	1.491	1.543	V
Current source for NTC thermistor	I_{NTC}	10kΩ NTC, Ta = 0 to 70°C	180	200	220	μA
		25kΩ NTC	72	80	88	μA
		50kΩ NTC	36	40	44	μA
		100kΩ NTC	18	20	22	μA
Current source hysteresis for NTC thermistor	I_{NTCHYS}	High temperature hysteresis, I_{NTC} = 200μA	160	180	198	μA
		Low temperature hysteresis, I_{NTC} = 200μA	198	220	242	μA

DC characteristics (5) Logic inputs / outputs

Table 13-5 DC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Input "L" level	V_{IL}				600	mV
Input "H" level	V_{IH}		1.4			V
SDA / STAT output "L" level	V_{OL}	I_{SINK} = 3mA			300	mV
STAT leakage current	I_{STATLK}				1	μA
EN input bias current	I_{ENBIAS}				1	μA
ILIM_OTG logic level voltage threshold	$V_{ILIMOTG}$	Input logic low-to-high state		0.9		V
ILIM_OTG input bias current	$I_{ILIMOTGBS}$	Input logic low		< 10		nA
		Input logic high, pull-up voltage 3.3V		+5.5	+8	μA

DC characteristics (6) USB OTG power

Table 13-6 DC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Output voltage (DCIN pin)	VOTG	VBATT = 3.6V,programmable 4steps, 5.0V output setting	4.75	5.0	5.25	V
UVLO battery voltage	VBATUVLO	OTG operation (refer to register 04H), 2.75Vsetting	2.63	2.75	2.87	V
UVLO hysteresis	VBATUVLOHY	OTG operation	110	170	230	mV
OTG battery current range	IOTG	VBATT = 3.6V, current from battery, programmable 4steps, CCI4-0=500mA, Note 4	400	500	600	mA
		CCI4-0=1000mA	800	1000	1200	
		CCI4-0=1500mA	1200	1500	1800	
		CCI4-0=1800mA	1440	1800	2160	

DC characteristics (7) Automatic power source detection (DP / DM) Note 5

Table 13-7 DC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Data line leakage voltage	VDAT_LKG		0		3.6	V
Data detection voltage	VDAT_REF		0.25	0.33	0.40	V
D+ source voltage	VDP_SRC		0.50	0.60	0.70	V
D- source voltage	VDM_SRC		0.50	0.60	0.70	V
D+ pull-up voltage	VDP_UP		3.0	3.3	3.6	V
Logic threshold	VLGC		0.8	1.2	2.0	V
D+ sink current	IDP_SINK		25	100	175	μA
D- sink current	IDM_SINK		25	100	175	μA
Current source for data connected detection	IDP_SRC		7	10	13	μA
Data line leakage resistance	RDAT_LKG		300			kΩ
D- pull-down resistance	RDM_DOWN		14.25	20.0	24.80	kΩ
D+ pull-up resistance	RDP_UP		900	1200	1575	Ω

AC characteristics (1) Oscillator

Table 13-8 AC characteristics

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Oscillator frequency 1, Timer frequency	fOSC	Ta = 0 to 70°C	2.40	3.0	3.60	MHz
Start-up time	tSTART				20	ms
Oscillator frequency 2, Start-up timer frequency	fTM	Ta = 0 to 70°C		85		kHz
Pre-charge time out	tPCTOFC	Safety timer	29	36	43	min
Charge completion time out	tCTOFC	Safety timer	204	240	276	min
Charge watchdog timer	tCWD		33.6	42	50.4	sec
OTG power watchdog timer	tOTGWD		33.6	42	50.4	sec
Standby watchdog timer	tSTBYWD	No charging, no OTG power	21	42	63	sec
Unconnected battery timer	tBATMIS		65	86	105	ms
Device glitch filter	tGLITCH	Enabled	130	168	210	ms

AC characteristics (2) Power source detection

Table 13-9 AC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
Data connected detection debounce	tDCD_DBNC	Note 3, 5	10			ms
Data connected detection time out	tDCD_TIMEOUT	Note 3, 5	300			ms
DP source on time	tVDPSRC_ON	Note 3, 5	40			ms
DM source on time	tVDMSRC_ON	Note 3, 5	40			ms

AC characteristics (3) I²C interface @ 400kHz

Table 13-10 AC characteristics (continued)

(Unless otherwise specified, V_{DCIN} = 5.0V, V_{FLT} = 4.2V, V_{BATT} = 3.7V, Ta = -30 to 85°C, all voltages are relative to GND.)

Characteristics	Symbol	Test condition	Min	Typ.	Max	Unit
SCL clock frequency	fSCL		0		400	kHz
SCL clock low period	tLOW		1.3			μs
SCL clock high period	tHIGH		0.6			μs
Bus free time (Stop condition to Start condition)	tBUF	Note 6	1.3			μs
START condition setup time	tSU:STA		0.6			μs
START condition hold time	tHD:STA		0.6			μs
STOP condition setup time	tSU:STO		0.6			μs
SCL / SDA rising time	tR	Note 6	20+0.1Cb		300	ns
SCL / SDA falling time	tF	Note 6	20+0.1Cb		300	ns
Data in setup time	tSU:DAT		100			ns
Data in hold time	tHD:DAT		0		0.9	μs
Noise filter	TI	Noise suppression		80		ns

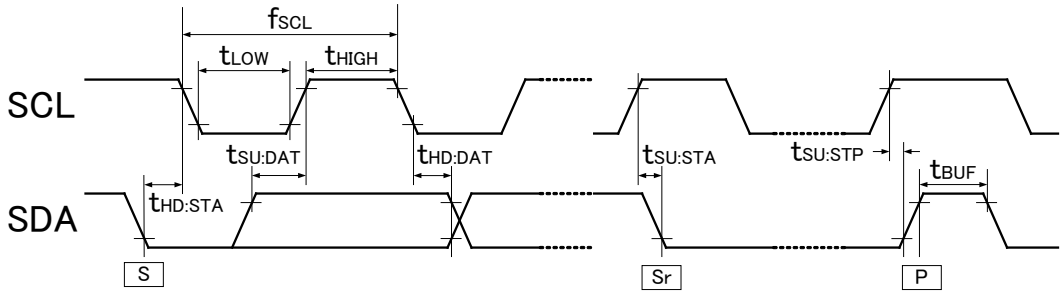


Figure 13-1 I²C interface

Note 1 : Input current limit I_{LIM} is prior to I_{PRECHG} ,I_{FCHG}.

Note 2 : IC is not used as a battery protection.

Note 3 : Design and characteristics are guaranteed. Not 100% test.

Note 4 : OTG power path is shut off after 168ms (glitch filter period) since the selected OTG current limit is reached.
To re-start OTG power path, set OTG mode invalid, and then set it valid.

Note 5 : Refer to Battery Charging Specification Rev1.2.

Note 6 : Guaranteed by design.

14. Application Circuit

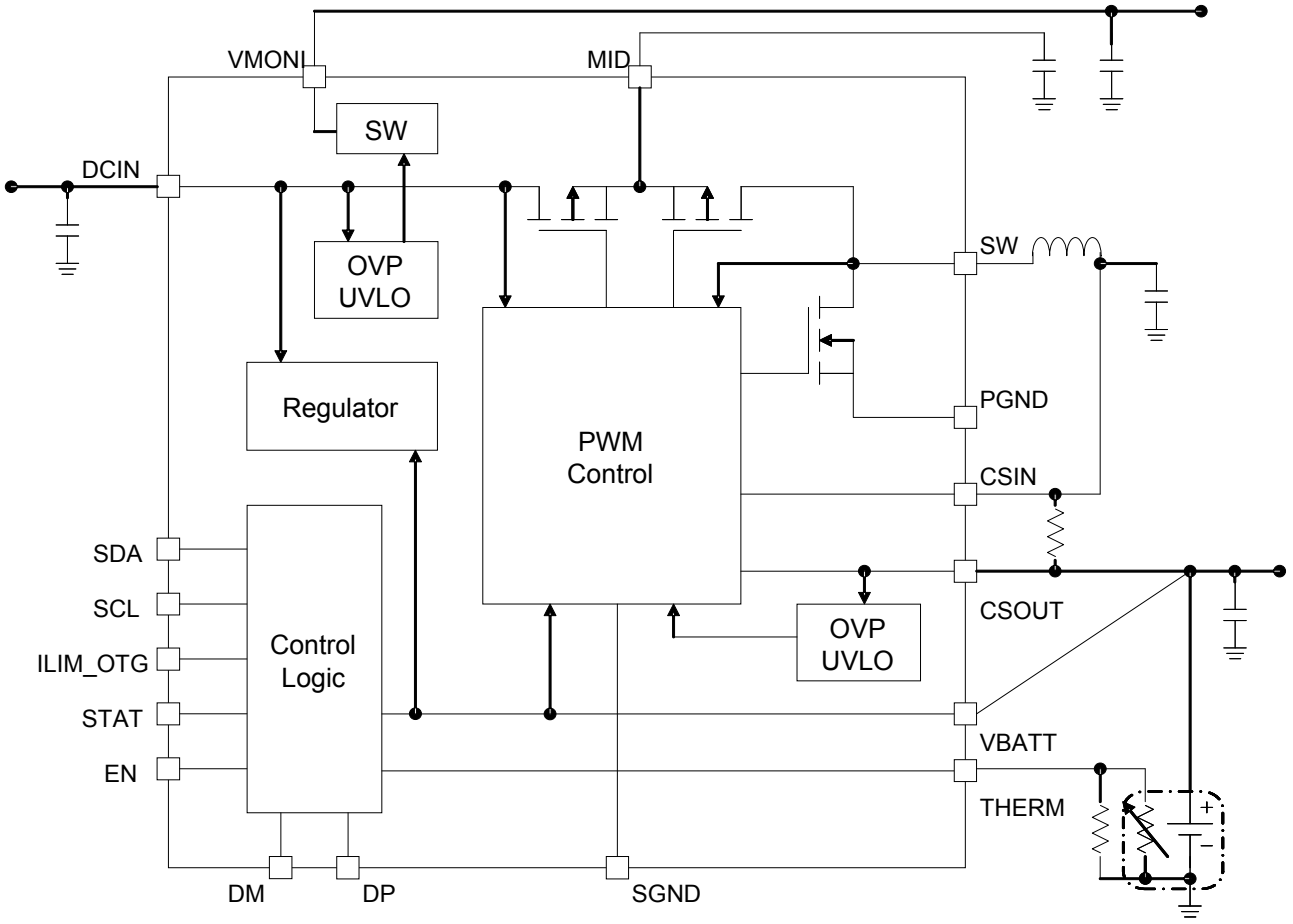
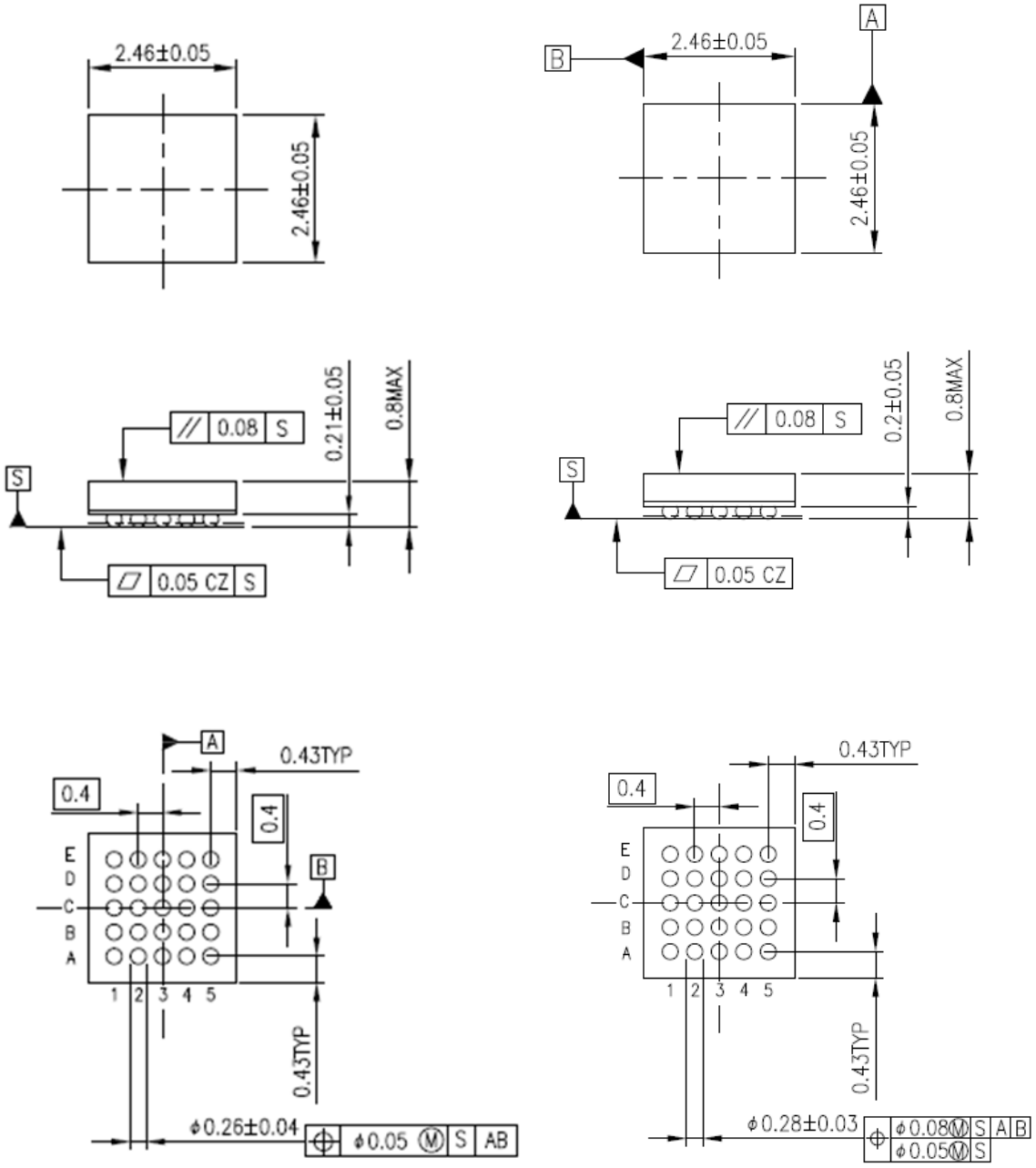


Figure 14-1 Application circuit

15. Outline drawing

15.1 Package Dimensions

Unit: mm



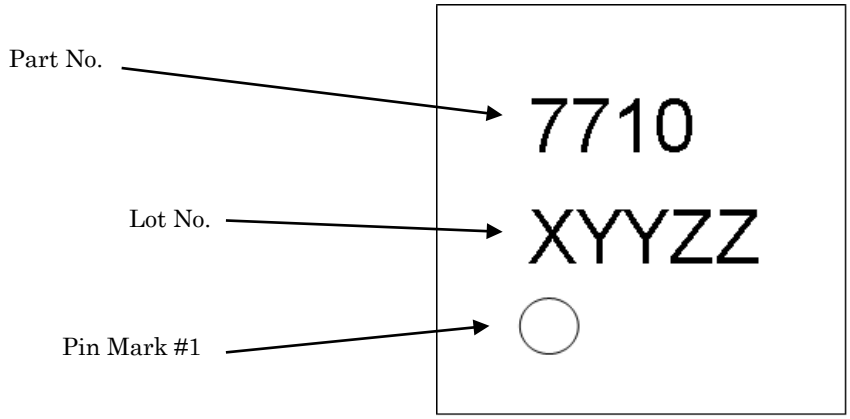
S-WFBGA25-0303-0.40-001
TC7710WBG(O*)

S-WFBGA25-0303-0.40-002
TC7710WBG(Z*)

Weight: 0.009 g (Typ.)

15.2 Marking

TC7710WBG(O*) Marking



TC7710WBG(O*) Lot No.:

X	YY	ZZ
(1)	(2)	(3)

(1) Manufactured year code Annual code expressed as the last digit of year

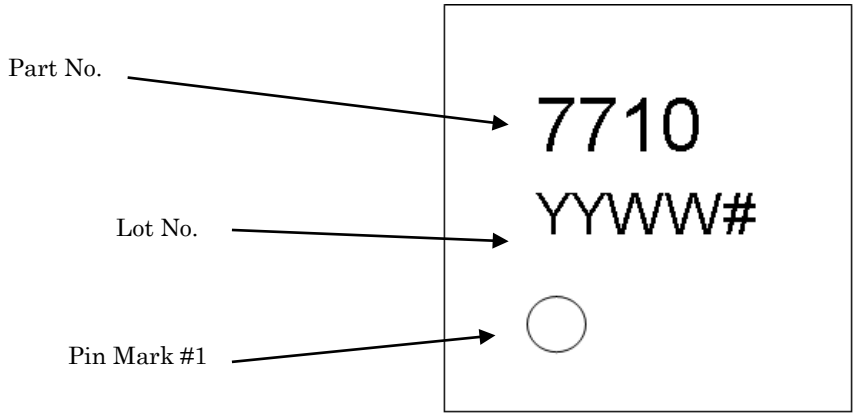
Example

Year	2009	2010	2011	2012	2013
Code	9	0	1	2	3

(2) Manufactured week code Weekly code as the first Thursday of January being determined the first week and accordingly reaches 52nd or 53th week in a year.

(3) Our control number

TC7710WBG(Z*) Marking



TC7710WBG(Z*) Lot No.:

YY	WW	#
(1)	(2)	(3)

(1) Manufactured year code Annual code expressed as the last digit of year

Example

Year	2009	2010	2011	2012	2013
Code	09	10	11	12	13

(2) Manufactured week code Weekly code as the first week of January being determined 01 and accordingly reaches 52nd or 53th week in a year.

(3) Our control number

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