Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

1.5A LED Camera Flash Driver with I²C Compatible Interface

BD7710GWL

●General Description

The BD7710GWL is 1.5A Flash LED Driver with Synchronous rectification step up DC/DC converter that can drive 3LED.
It is possible to set by I2C interface.
With synchronous rectification (no external schottky barrier diode required) and small package, they can save mount space.

●Features

1) Synchronous rectification step-up DC/DC converter.(no external S.B.D.)
2) 3 channel current driver (maximum total 1.6A)
3) It is possible to control register by I2C interface
4) Programmable lighting mode
5) Programmable LED current
6) Programmable Battery drop protection
7) Programmable Flash timer
8) Rich safety function
   - Over Current Protection (OCP)
   - Over Voltage Protection (OVP)
   - VOUT Short Protection
   - LED short/open Protection
   - UVLO
   - TSD
   - Battery drop Protection
   - LED Temperature Monitoring

●Key Specifications

- VBAT Input voltage 2.7V to 5.5V
- Operating temperature range -40℃ to +85℃
- Quiescent Current 3.0μA(MAX)
- LED Current 1.6A(MAX)
- Switching frequency 2MHz(typical)

●Packages

UCSP50L2 1.90 ㎜×2.10 ㎜×0.55 ㎜(MAX)

●Applications

- Single/Dual/Triple White LED Flash Supply for Cell Phones and Smart-Phones
- DSC,DVC
- Video Lighting for Digital Video Applications
- Amusement accessory

●Typical Application Circuits

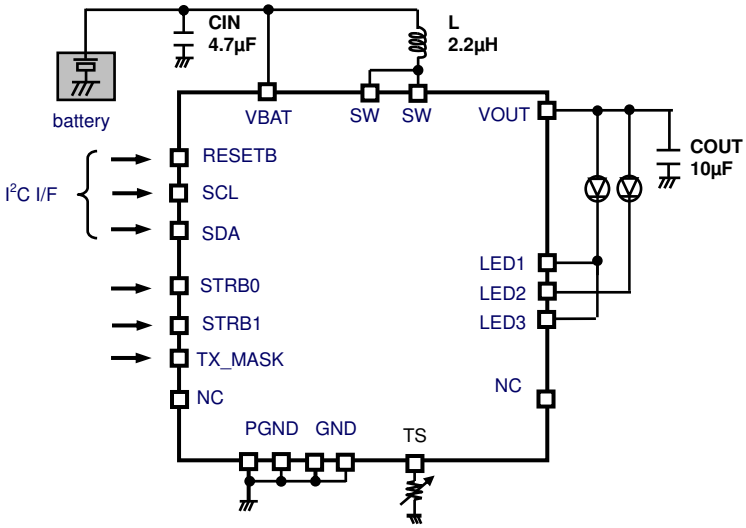

Figure 1. 1.5A application Block diagram

●Pin Configuration [Bottom View]

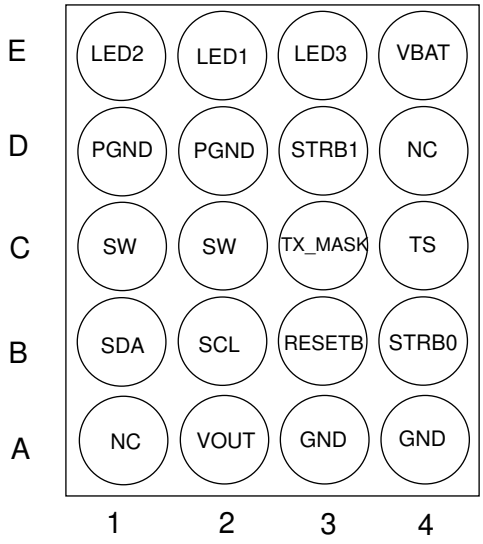

Figure 2. Pin Configuration

● **Absolute Maximum Ratings (Ta=25°C)**

Parameter	Symbol	Limits	Unit
Maximum voltage	VMAX	7	V
Power Dissipation (note1)	Pd	820	mW
Operating Temperature Range	Topr	-40 to +85	℃
Storage Temperature Range	Tstg	-55 to +150	℃

Note1） Power dissipation deleting is 6.56 mW/°C , when it's used in over 25°C.
(ROHM's standard board has been mounted.)
The power dissipation of the IC has to be less than the one of the package.

● **Operating conditions (Ta= -40 to 85°C)**

Parameter	Symbol	Limits	Unit
VBAT input voltage	VBAT	2.7 to 5.5	V

● **Electrical characteristics**

(Unless otherwise noted, Ta = 25°C, VBAT=3.6V)

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
[Supply Current]						
Quiescent Current	Iq	-	0.5	3.0	μA	At OFF
Current Consumption (Device not switching)	Idd1	-	9.5	-	mA	
UVLO Voltage	VUVLO	1.8	2.1	2.4	V	VBAT falling edge
[Switching Regulator]						
SW NMOS on resistance	Ronn	-	180	-	mΩ	
SW PMOS on resistance	Ronp	-	180	-	mΩ	
Switching frequency	Fsw	1.6	2	2.4	MHz	
Duty cycle limit	Duty	-	80	-	%	
Output voltage range	Vo	-	-	5.5	V	
FB Voltage1	VFBT	-	200	300	mV	In Boost On, Torch mode
FB Voltage2	VFBF	-	400	-	mV	In Boost On, Flash mode
Over voltage Protection	VOVP	4.5	4.65	4.8	V	0000≦OVP[3:0] ≦0100
		5.8	6.0	6.2	V	0101≦OVP[3:0] ≦1111
VOUT Short Protection	Vshto	-	1.5	-	V	
Over Current Protection	OCP	-	2.0	-	A	*1 ILIM[4]=1
[LED Temperature monitoring]						
TS Current source	Isource	-	25	-	μA	
TS Resistance (Warning temperature)	Lwarn	-	42.0	-	kΩ	LEDWARN bit = 1
TS Resistance (Hot temperature)	Lhot	-	13.8		kΩ	LEDHOT bit = 1
[Current Driver]						
Torch LED Current accuracy	ITdiff	-10	0	+10	%	ILED=100mA
Flash LED Current accuracy	IFdiff	-7.5	0	+7.5	%	ILED= 400mA
[SDA, SCL]						
L level input voltage	VILI	-0.3	-	0.4	V	
H level input voltage	VIHI	1.4	-	VBAT +0.3	V	
L level output voltage	VOLI	0	-	0.3	V	SDA Pin, IOL=3 mA
[RESETB]						
L level input voltage	VILR	-0.3	-	0.3	V	
H level input voltage	VIHR	1.0	-	VBAT +0.3	V	
Pull-down resistance	R_{PD}	-	400	-	kΩ	
[STRB0 / STRB1 / TX_MASK]						
L level input voltage	VILE	-0.3	-	0.3	V	
H level input voltage	VIHE	1.0	-	VBAT +0.3	V	
Pull-down resistance	R_{PD}	-	400	-	kΩ	

*1 This parameter is tested with dc measurement.

●**Terminals**

No.	Pin Name	In/ Out	Pin circuit diagram	ESD Diode		Description
				For Power	For GND	
A1	NC	-	-	-	-	Non connect pin
A2	VOUT	Out	D	-	GND	Output voltage.
A3	GND	-	G	VBAT	-	Ground
A4	GND	-	G	VBAT	-	Ground
B1	SDA	In/ Out	I	VBAT	GND	Serial interface address/data line.
B2	SCL	In	H	VBAT	GND	Serial interface clock line.
B3	RESETB	In	A	VBAT	GND	Master hardware reset input.
B4	STRB0	In	A	VBAT	GND	LED 1/2/3 enable logic input.
C1	SW	In	E	-	GND	Inductor connection.
C2	SW	In	E	-	GND	Inductor connection.
C3	TX_MASK	In	A	VBAT	GND	LED Current control input with RF PA synchronization.
C4	TS	In	B	VBAT	GND	NTC resistor connection.
D1	PGND	-	G	VBAT	-	Power ground.
D2	PGND	-	G	VBAT	-	Power ground.
D3	STRB1	In	A	VBAT	GND	LED 1/2/3 enable logic input.
D4	NC	-	-	-	-	Non connect pin
E1	LED2	In	C	-	GND	LED2 driver output.
E2	LED1	In	C	-	GND	LED1 driver output.
E3	LED3	In	C	-	GND	LED3 driver output.
E4	VBAT	In	F	-	GND	Battery connection.

Total 20 pin

●Pin Circuit diagram

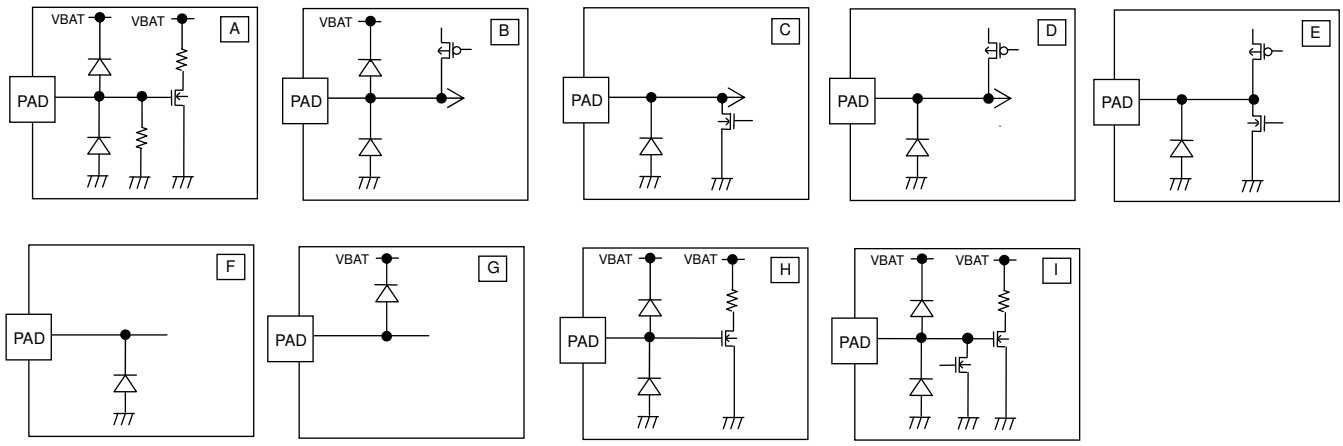

Figure 3. Pin circuit diagram

●Block Diagram

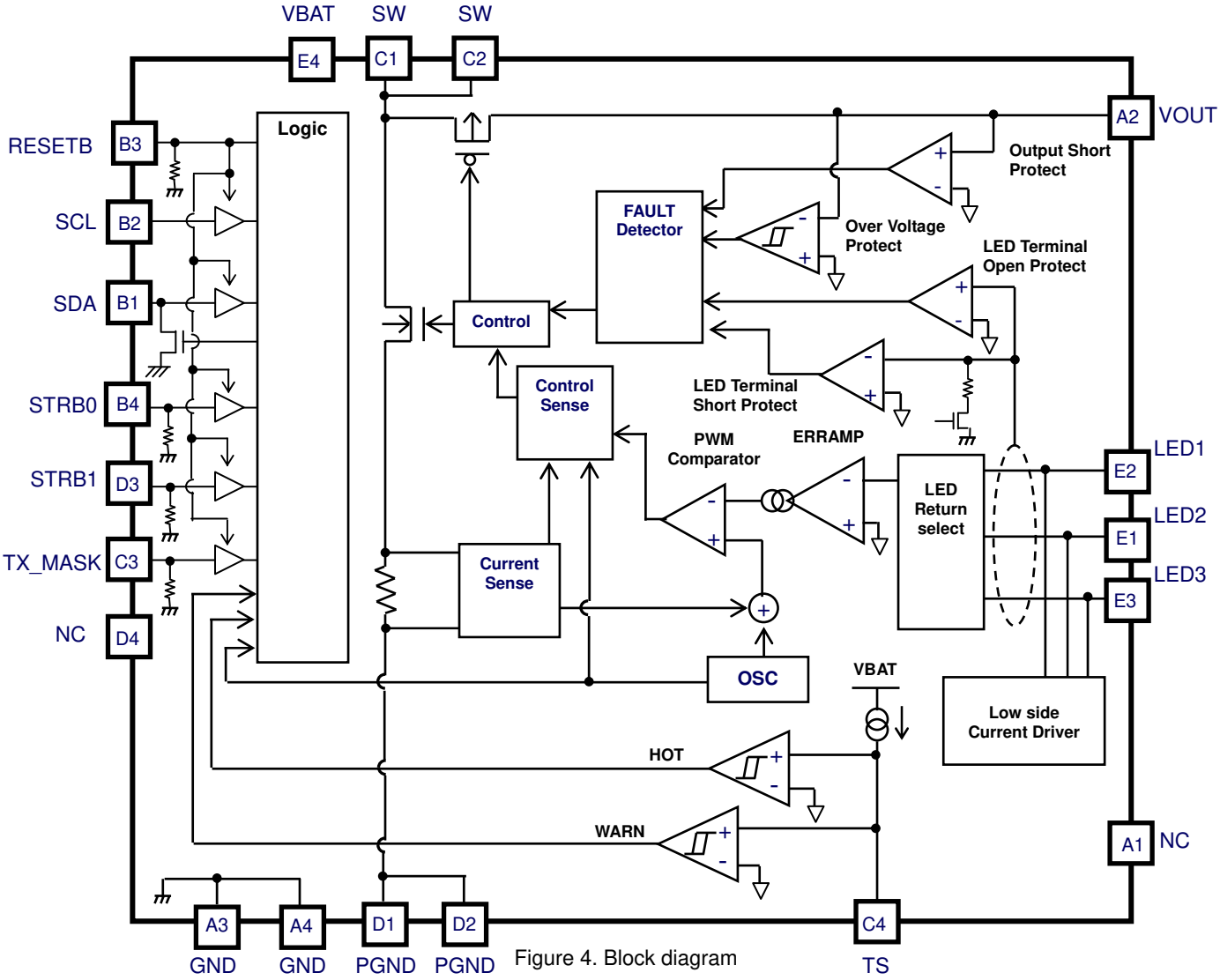

Figure 4. Block diagram

●Typical Characteristics (Reference Data)

Y-axis	X-axis	Figure-No
Quiescent Current	VBAT	Figure5-1
Current Consumption	VBAT	Figure5-2
ILED(100mA)	VBAT	Figure5-3
ILED(400mA)	VBAT	Figure5-4
Efficiency	VBAT	Figure5-5
UVLO	Temperature	Figure5-6
Frequency	VBAT	Figure5-7
Over Voltage Protection (OVP)	VBAT	Figure5-8
VOUT Short Protection	VBAT	Figure5-9
Over Current Protection (OCP)	VBAT	Figure5-10
TS Current source	Temperature	Figure5-11
TS Resistance (Warning temperature)	Temperature	Figure5-12
TS Resistance (Hot temperature)	Temperature	Figure5-13

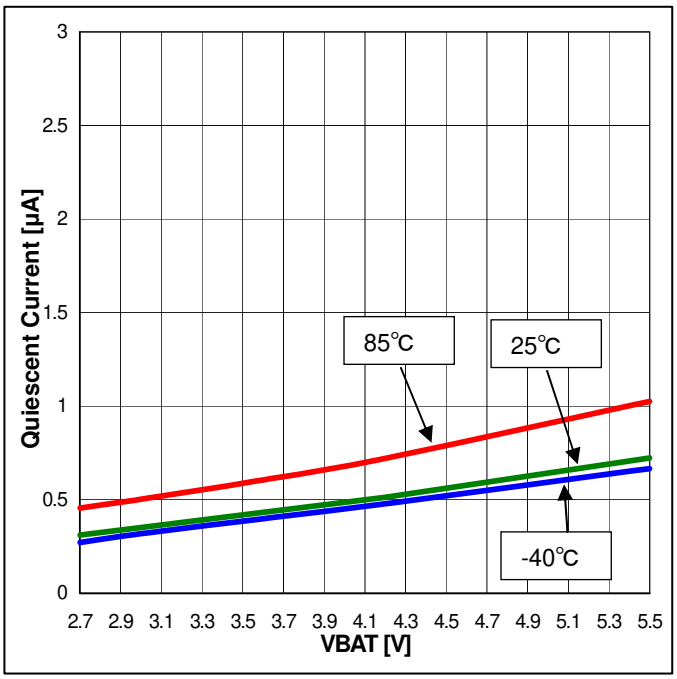

Figure 5-1. Quiescent Current – VBAT

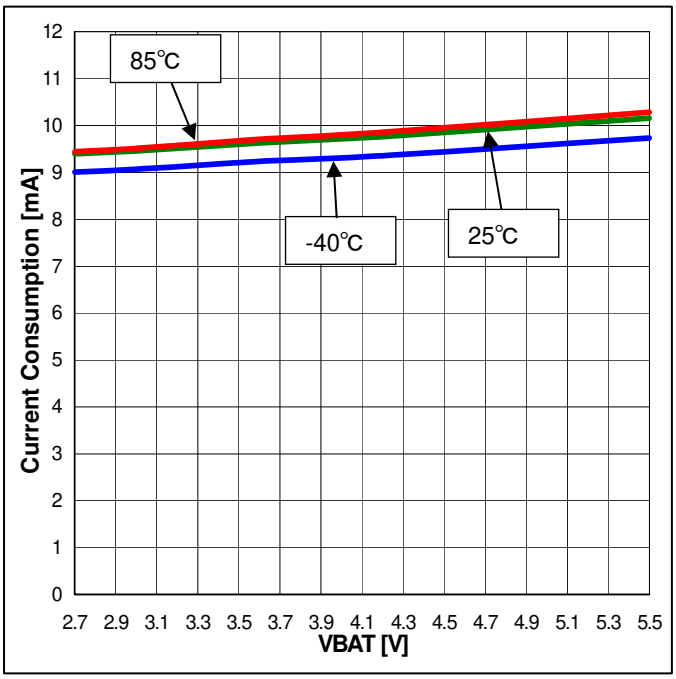

Figure 5-2. Current Consumption - VBAT

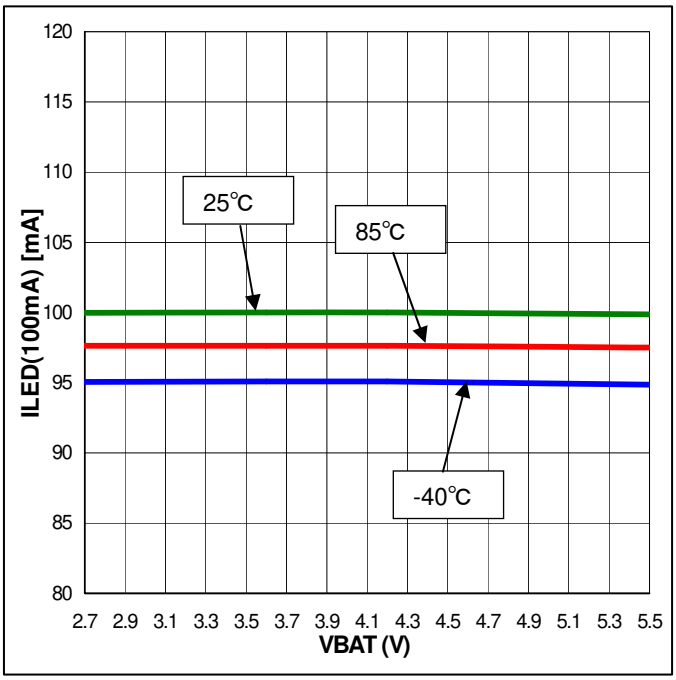

Figure 5-3. ILED(100mA) – VBAT

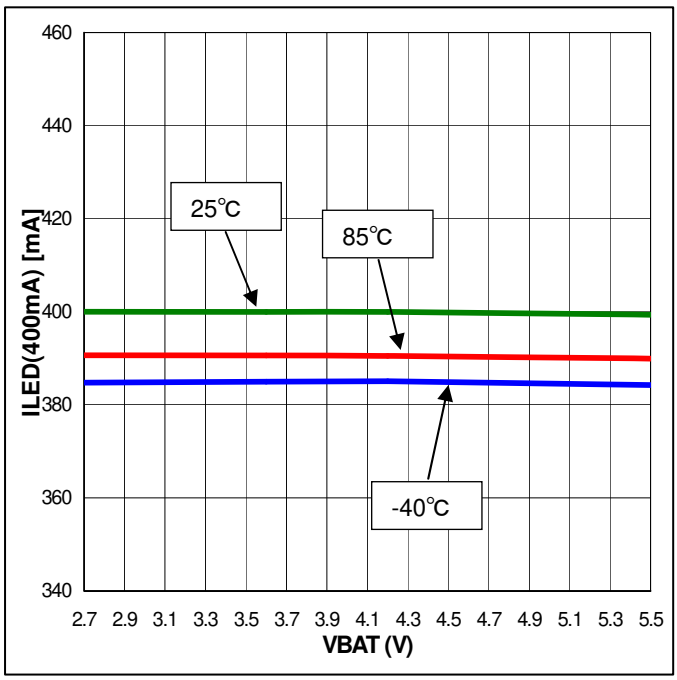

Figure 5-4. ILED(400mA) - VBAT

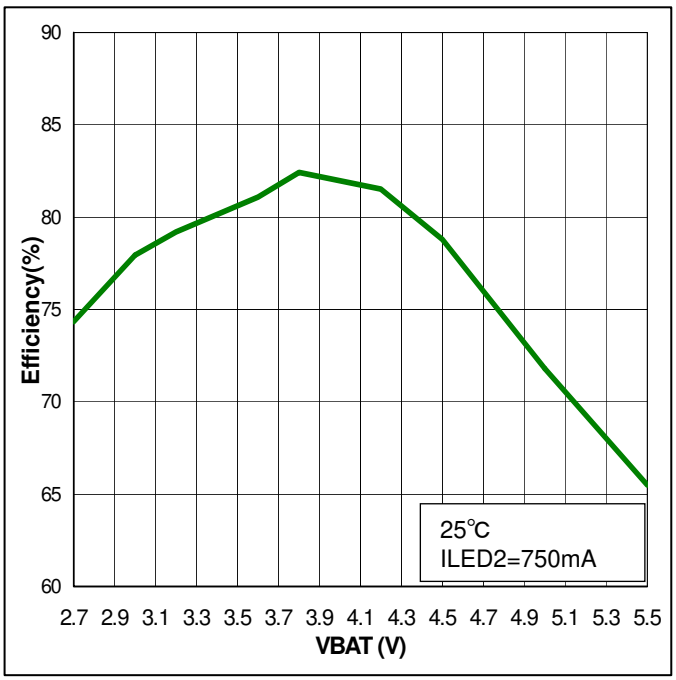

Figure 5-5. Efficiency - VBAT

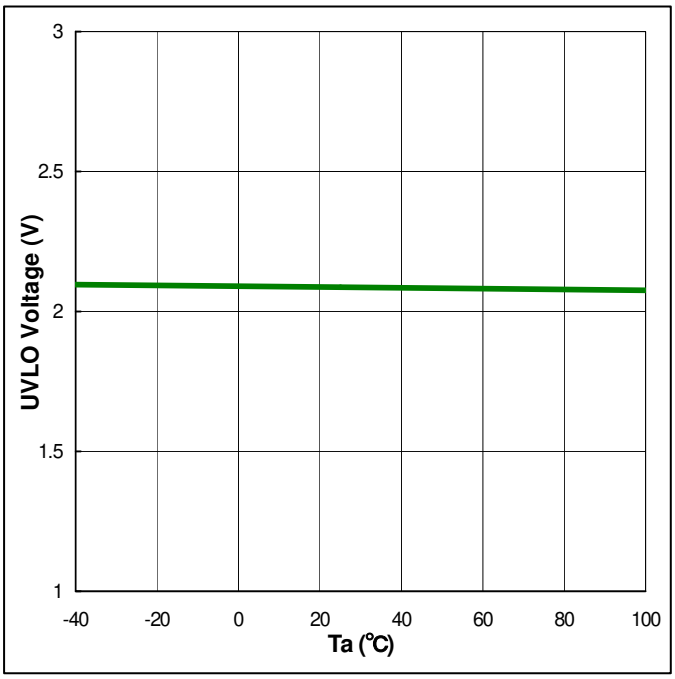

Figure 5-6. UVLO - Temperature

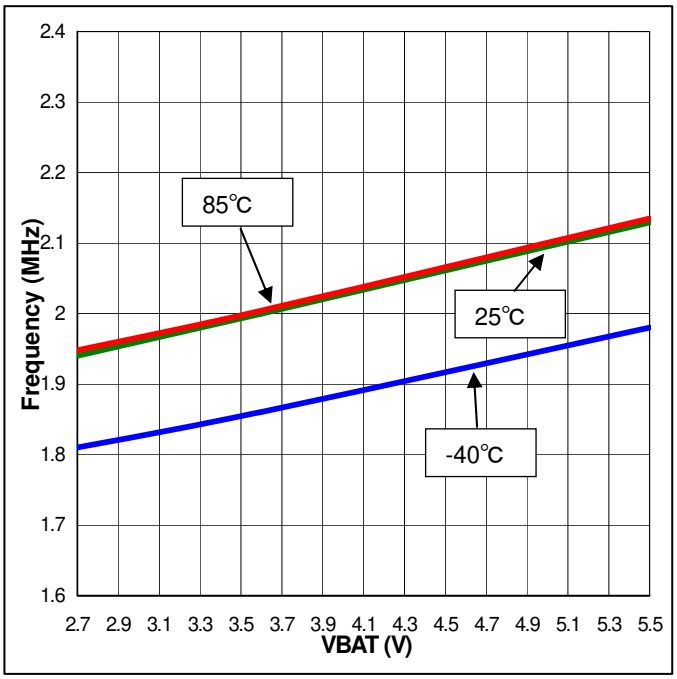

Figure 5-7. Frequency – VBAT

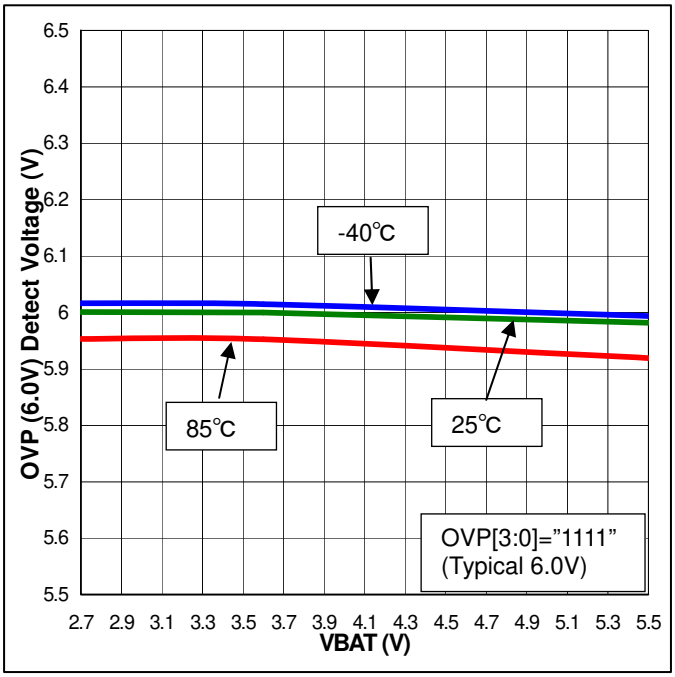

Figure 5-8. Over Voltage Protection (OVP) - VBAT

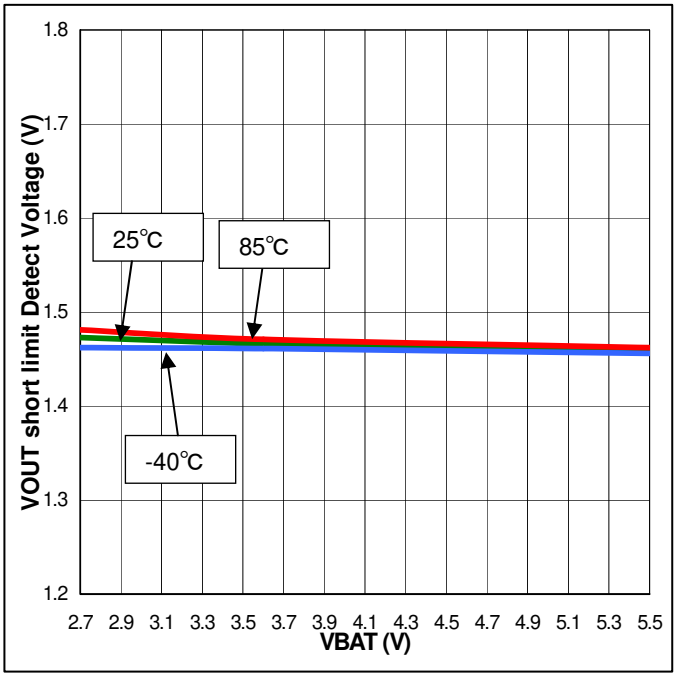

Figure 5-9. VOUT Short Protection – VBAT

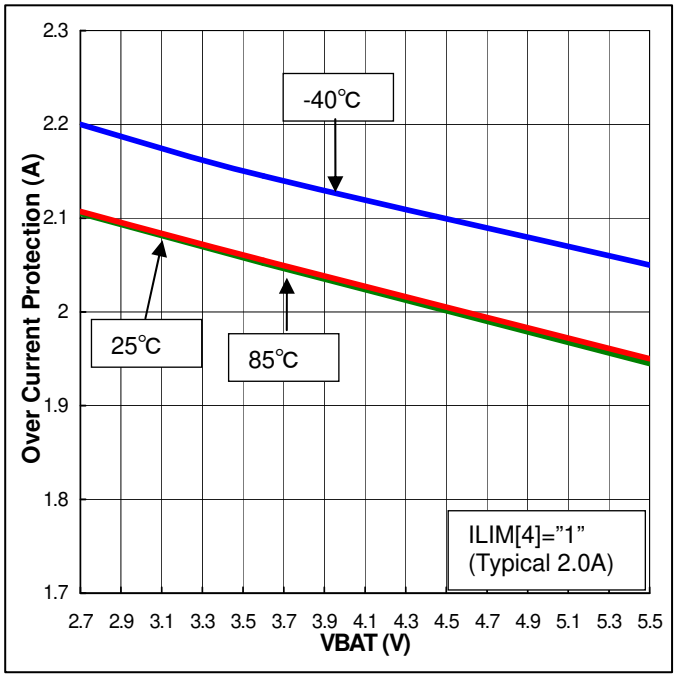

Figure 5-10. Over Current Protection (OCP) – VBAT

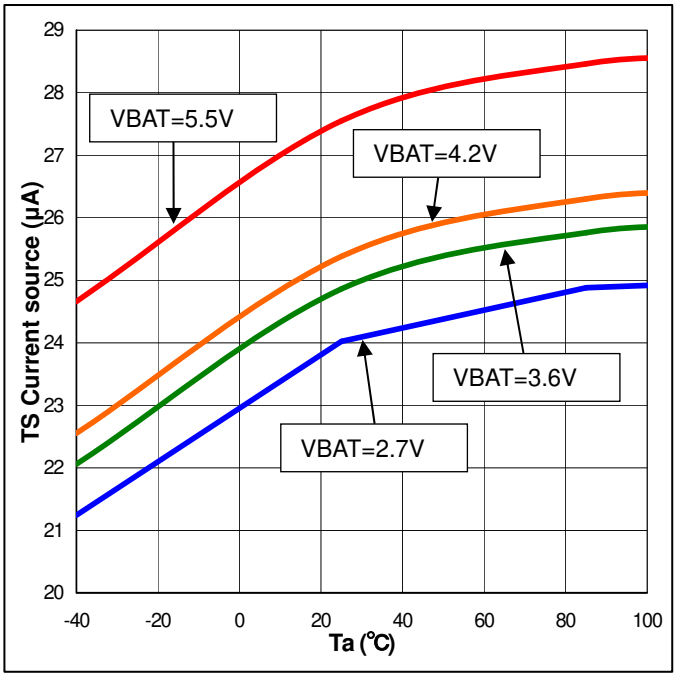

Figure 5-11. TS Current source – Temperature

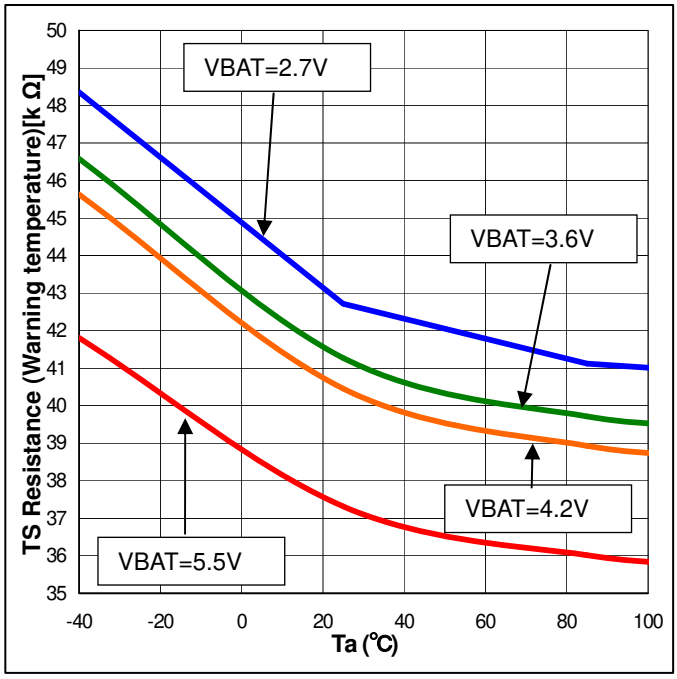

Figure 5-12. TS Resistance (Warning temperature) - Temperature

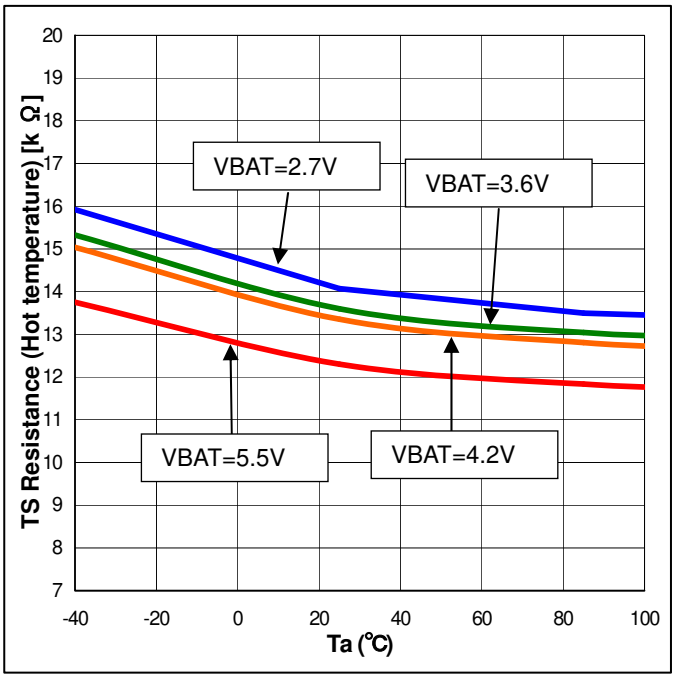

Figure 5-13. TS Resistance (Hot temperature) – Temperature

●**Serial interface**

It can interface with I^2C BUS format compatible.

(1) Slave address

A7	A6	A5	A4	A3	A2	A1	R/W
0	1	1	0	0	1	1	0

(2) Bit Transfer

SCL transfers 1-bit data during H. During H of SCL, SDA cannot be changed at the time of bit transfer. If SDA changes while SCL is H, START conditions or STOP conditions will occur and it will be interpreted as a control signal.

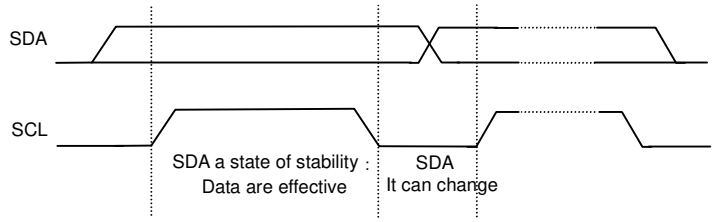

Figure 6. Bit transfer (I^2C format)

(3) START and STOP condition

When SDA and SCL are H, data is not transferred on the I^2C- bus. This condition indicates, if SDA changes from H to L while SCL has been H, it will become START (S) conditions, and an access start, if SDA changes from L to H while SCL has been H, it will become STOP (P) conditions and an access end.

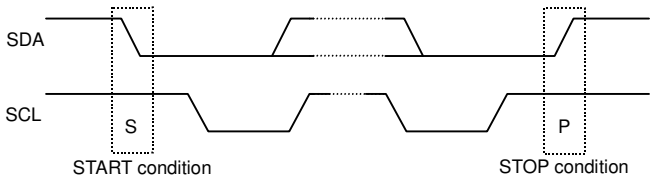

Figure 7. START/STOP condition (I^2C format)

(4) Acknowledge

It transfers data 8 bits each after the occurrence of START condition. A transmitter opens SDA after transfer 8bits data, and a receiver returns the acknowledge signal by setting SDA to L.

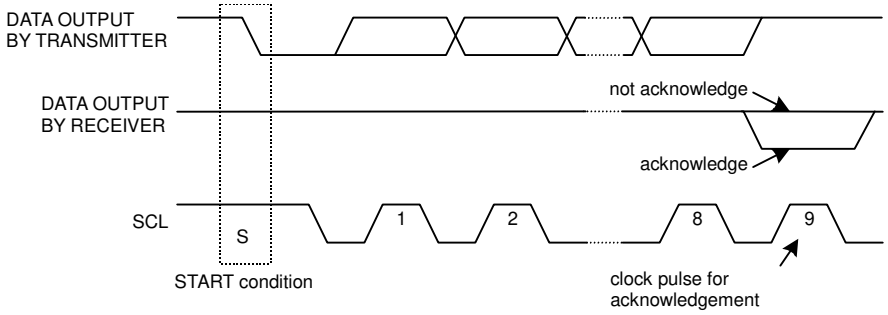

Figure 8. Acknowledge (I^2C format)

(5) Writing protocol

A register address is transferred by the next 1 byte that transferred the slave address and the write-in command. The 3rd byte writes data in the internal register written in by the 2nd byte, and after 4th byte or, the increment of register address is carried out automatically. However, when a register address turns into the last address (07h), it is set to 00h by the next transmission. After the transmission end, the increment of the address is carried out.

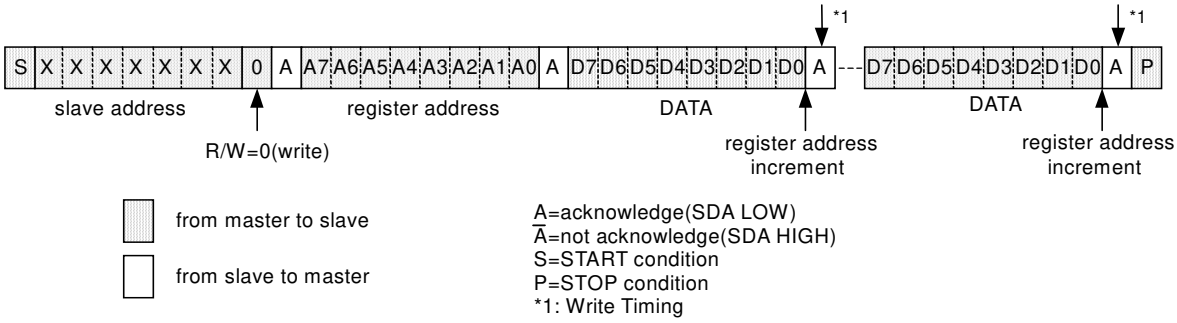

Figure 9. Writing protocol

(6) Reading protocol

It reads from the next byte after writing a slave address and R/W bit. The register to read considers as the following address accessed at the end, and the data of the address that carried out the increment is read after it. If an address turns into the last address, the next byte will read out 00h. After the transmission end, the increment of the address is carried out.

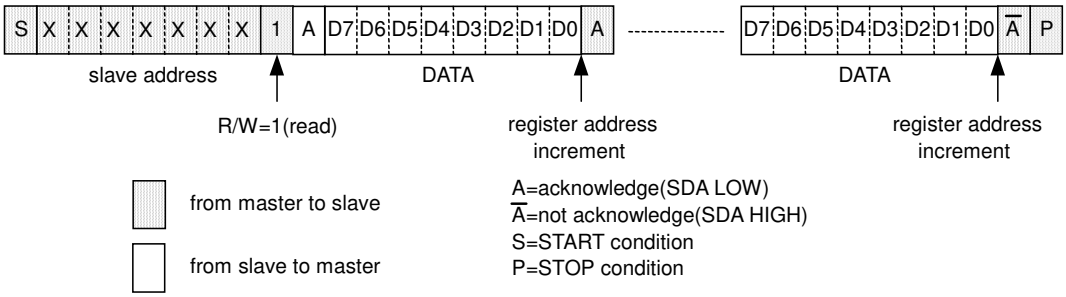

Figure 10. Reading protocol

(7) Multiple reading protocols

After specifying an internal address, it reads by repeated START condition and changing the data transfer direction. The data of the address that carried out the increment is read after it. If an address turns into the last address, the next byte will read out 00h. After the transmission end, the increment of the address is carried out.

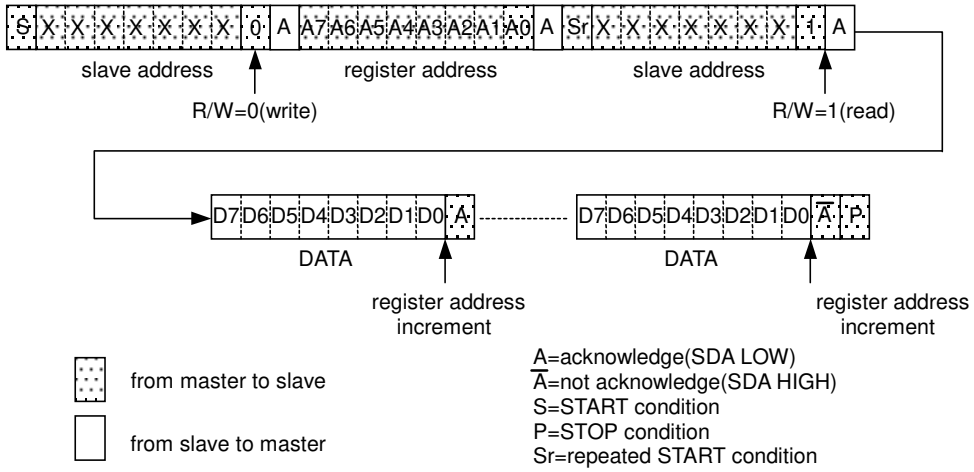

Figure 11. Multiple reading protocols

As for reading protocol and multiple reading protocols, please do A(not acknowledge) after doing the final reading operation. It stops with read when ending by A(acknowledge), and SDA stops in the state of Low when the reading data of that time is 0. However, this state returns usually when SCL is moved, data is read, and A(not acknowledge) is done.

(8) Timing diagram

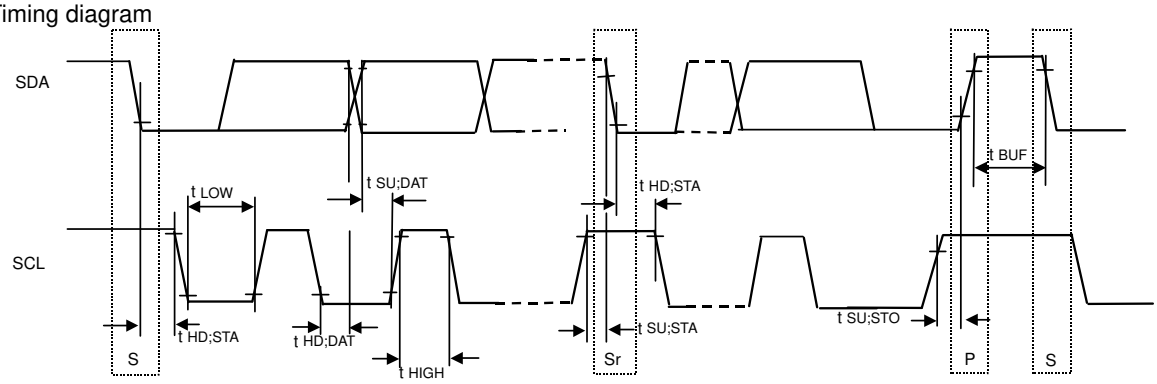

Figure 12. Timing diagram (I^2C format)

(9) Electrical Characteristics (Unless otherwise specified, Ta=25 °C, VBAT=3.6V)

Parameter	Symbol	Standard-mode			Fast-mode			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
I^2C BUS format (F/S-mode)								
SCL clock frequency	F_{SCL}	0	-	100	0	-	400	kHz
LOW period of the SCL clock	t_{LOW}	4.7	-	-	1.3	-	-	µs
HIGH period of the SCL clock	t_{HIGH}	4.0	-	-	0.6	-	-	µs
Hold time (repeated) START condition After this period, the first clock is generated	$t_{HD;STA}$	4.0	-	-	0.6	-	-	µs
Set-up time for a repeated START condition	$t_{SU;STA}$	4.7	-	-	0.6	-	-	µs
Data hold time	$t_{HD;DAT}$	0	-	3.45	0	-	0.9	µs
Data set-up time	$t_{SU;DAT}$	250	-	-	100	-	-	ns
Set-up time for STOP condition	$t_{SU;STO}$	4.0	-	-	0.6	-	-	µs
Bus free time between a STOP and START condition	t_{BUF}	4.7	-	-	1.3	-	-	µs

Parameter	Symbol	C_b=100pF(max)			C_b=400pF			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
I^2C BUS format (Hs-mode)								
SCL (SCLH) clock frequency	F_{SCL}	0	-	3.4	0	-	1.7	MHz
LOW period of the SCL (SCLH) clock	T_{LOW}	160	-	-	320	-	-	ns
HIGH period of the SCL (SCLH) clock	t_{HIGH}	60	-	-	120	-	-	ns
Hold time (repeated) START condition After this period, the first clock is generated	$t_{HD;STA}$	160	-	-	320	-	-	ns
Set-up time for a repeated START condition	$t_{SU;STA}$	160	-	-	320	-	-	ns
Data hold time	$t_{HD;DAT}$	0	-	70	0	-	150	ns
Data set-up time	$t_{SU;DAT}$	10	-	-	10	-	-	ns
Set-up time for STOP condition	$t_{SU;STO}$	160	-	-	320	-	-	ns
Capacitive load for each bus line [SDA (SDAH) and SCL (SCLH) lines]	C_b	-	-	100	-	-	400	pF

(Note) For bus line loads C_b between 100 pF and 400 pF the timing parameters must be linearly interpolated

●**Register List**

Address	R/W	Register data								Function
		D7	D6	D5	D4	D3	D2	D1	D0	
00h	R/W	SFTRST	-	TLED13(2)	TLED13(1)	TLED13(0)	TLED2(2)	TLED2(1)	TLED2(0)	Software Reset Torch LED current setting
01h	R/W	MODE(1)	MODE(0)	FLED2(5)	FLED2(4)	FLED2(3)	FLED2(2)	FLED2(1)	FLED2(0)	Mode control Flash LED current setting
02h	R/W	MODE(1)	MODE(0)	-	FLED13(4)	FLED13(3)	FLED13(2)	FLED13(1)	FLED13(0)	Mode control Flash LED current setting
03h	R/W	FTIM(2)	FTIM(1)	FTIM(0)	HPLF	SELFTIM TO	STT	SFT	TXMASK	Flash timer setting
04h	R/W	-	-		ILIM	-	-	-	-	Over Current Protection setting
05h	R/W	-	ENPSM	STSTRB1	-	-	ENLED3	ENLED2	ENLED1	LED Enable
06h	R/W	ENTS	LEDHOT	LEDWARN	-	OVP(3)	OVP(2)	OVP(1)	OVP(0)	Over Voltage Protection setting LED Temperature Monitoring setting
07h	R/W	ENBATDET	BATDET(2)	BATDET(1)	BATDET(0)	-	-	-	-	Battery drop Protection

Input "0" for "-".
A free address has the possibility to assign it to the register for the test.
Access to the register for the test and the undefined register is prohibited.

●**Register Map**

Address 00h < Software Reset / Torch LED current setting >

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
00h	R/W	SFTRST	-	TLED13(2)	TLED13(1)	TLED13(0)	TLED2(2)	TLED2(1)	TLED2(0)
Initial Value	0Ah	0	-	0	0	1	0	1	0

Bit[2:0] : **TLED2(2:0)** LED2 Torch current setting
"000" : 0mA
"001" : 25mA
"010" : 50mA *initial value
"011" : 75mA
"100" : 100mA
"101" : 125mA
"110" : 150mA
"111" : 175mA

Bit[5:3] : **TLED13(2:0)** LED1,3 Torch current setting
"000" : 0mA
"001" : 25mA *initial value
"010" : 50mA
"011" : 75mA
"100" : 100mA
"101" : 125mA
"110" : 150mA
"111" : 175mA

Bit6 : (Not used)

Bit7 : **SFTRST** Software Reset
"0" : Reset cancel *initial value
"1" : Reset(All register initializing)
Refer to "Reset" for detail.

Address 01h < Mode control / Flash LED current setting >

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
01h	R/W	MODE(1)	MODE(0)	FLED2(5)	FLED2(4)	FLED2(3)	FLED2(2)	FLED2(1)	FLED2(0)
Initial Value	10h	0	0	0	1	0	0	0	0

Bit[5:0] : **FLED2(5:0)** LED2 Flash current setting

"000000" : 0mA
"000001" : 25mA
"000010" : 50mA
"000011" : 75mA
"000100" : 100mA
"000101" : 125mA
"000110" : 150mA
"000111" : 175mA
"001000" : 200mA
"001001" : 225mA
"001010" : 250mA
"001011" : 275mA
"001100" : 300mA
"001101" : 325mA
"001110" : 350mA
"001111" : 375mA
"010000" : 400mA *initial value
"010001" : 425mA
"010010" : 450mA
"010011" : 475mA
"010100" : 500mA
"010101" : 525mA
"010110" : 550mA
"010111" : 575mA
"011000" : 600mA
"011001" : 625mA
"011010" : 650mA
"011011" : 675mA
"011100" : 700mA
"011101" : 725mA
"011110" : 750mA
"011111" : 775mA
"100000" : 800mA
•
•
•
"111111" : 800mA

Bit[7:6] : **MODE(1:0)** control

"00" : shutdown mode *initial value
"01" : Torch mode
"10" : Flash mode
"11" : shutdown mode

To avoid device shutdown by torch safety timeout, MODE(1:0) bits need to be refreshed within less than 13.0s.
Writing to Address01h Bit[7:6] automatically updates Address 02h Bit[7:6].

Address 02h < Mode control / Flash LED current setting >

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
02h	R/W	MODE(1)	MODE(0)	-	FLED13(4)	FLED13(3)	FLED13(2)	FLED13(1)	FLED13(0)
Initial Value	08h	0	0	-	0	1	0	0	0

Bit[4:0] : **FLED13(4:0)** LED1,3 Flash current setting

"00000" : 0mA
"00001" : 25mA
"00010" : 50mA
"00011" : 75mA
"00100" : 100mA
"00101" : 125mA
"00110" : 150mA
"00111" : 175mA
"01000" : 200mA *initial value
"01001" : 225mA
"01010" : 250mA
"01011" : 275mA
"01100" : 300mA
"01101" : 325mA
"01110" : 350mA
"01111" : 375mA
"10000" : 400mA
•
•
•
"11111" : 400mA

Bit5 : (Not used)

Bit[7:6] : **MODE(1:0)** control

"00" : shutdown mode *initial value
"01" : Torch mode
"10" : Flash mode
"11" : shutdown mode

To avoid device shutdown by torch safety timeout, MODE(1:0) bits need to be refreshed within less than 13.0s.
Writing to Address02h Bit[7:6] automatically updates Address 01h Bit[7:6].

Address 03h < Flash timer setting / TX_MASK setting>

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
03h	R/W	FTIM(2)	FTIM(1)	FTIM(0)	HPLF	SELFTIM TO	STT	SFT	TXMASK
Initial Value	C1h	1	1	0	0	0	0	0	1

Bit0 : **TXMASK** TX_MASK pin function setting

"0" : TX_MASK pin doesn't affect for output current

"1" : IF TX_MASK pin =H Flash current is reduced to Torch current.

Bit1 : **SFT** Start/Flash Timer

"0" : No change in the LED current

"1" : LED current ramps to the Flash current level

Bit2 : **STT** Safety Timer Trigger

"0" : FLASH safety timer is level sensitive

"1" : FLASH safety timer is rising edge sensitive

Bit3 : **SELFTIM** Safety Timer Range Selection (write only)

"0" : safety timer range 0

"1" : safety timer range 1

TO Time out flag (**read only**)

"0" : No time-out event occurred

"1" : Time-out event occurred

Bit4 : **HPLF** LED failure flag (read only)

"0" : Normal

"1" : LED failed (open or shorted)

Bit[7:5] : **FTIM(2:0)** Flash timer setting

FTIM(2:0)	RANGE0	RANGE1
000	68.2ms	5.3ms
001	102.2ms	10.7ms
010	136.3ms	16.0ms
011	170.4ms	21.3ms
100	204.5ms	26.6ms
101	340.8ms	32.0ms
110	579.3ms	37.3ms
111	852.0ms	71.5ms

(RANGE0:SELFTIM="0" / RANGE1:SELFTIM="1")

Address 04h < Over Current Protection setting>

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
04h	R/W	-	-	-	ILIM	-	-	-	-
Initial Value	01h	-	-	-	1	-	-	-	-

Bit[3:0] : (Not used)

Bit[4] : **ILIM** Over Current Protection setting
"0" : 1.5A
"1" : 2.0A

Bit[7:5] : (Not used)

Address 05h < LED Enable>

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
05h	R/W	-	ENPSM	STSTRB1	-	-	ENLED3	ENLED2	ENLED1
Initial Value	62h	-	1	1	-	-	0	1	0

Bit0 : **ENLED1** LED1 enable
"0" : LED1 input is disabled
"1" : LED1 input is enabled

Bit1 : **ENLED2** LED2 enable
"0" : LED2 input is disabled
"1" : LED2 input is enabled

Bit2 : **ENLED3** LED3 enable
"0" : LED3 input is disabled
"1" : LED3 input is enabled

Bit[4:3] : (Not used)

Bit5 : **STSTRB1** STRB1 Input Status bit (**read only**)

Bit6 : **ENPSM** Enable Power-save mode
"0", "1" : Power-save mode is enabled

Bit7 : (Not used)

Address 06h < Over Voltage Protection setting, LED Temperature Monitoring setting>

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
06h	R/W	ENTS	LEDHOT	LEDWARN	-	OVP(3)	OVP(2)	OVP(1)	OVP(0)
Initial Value	09h	0	0	0	-	1	0	0	1

Bit[3:0] : **OVP(3:0)** Over Voltage Protect setting

"0000" : 4.65V
"0001" : 4.65V
"0010" : 4.65V
"0011" : 4.65V
"0100" : 4.65V
"0101" : 6.0V
"0110" : 6.0V
"0111" : 6.0V
"1000" : 6.0V
"1001" : 6.0V *initial value
"1010" : 6.0V
"1011" : 6.0V
"1100" : 6.0V
"1101" : 6.0V
"1110" : 6.0V
"1111" : 6.0V

Bit4 (not used)

Bit5 : **LEDWARN** LED Temperature Warning Flag ***(read only)**

This flag is reset after readout.
0 : TS input voltage≧1.05V
1 : TS input voltage＜1.05V

When Detection of "LED temperature Warning" was continued for 20μs at Torch / Flash mode, LEDWARN becomes to '1'.

[NOTE]

Even if this readout nothing, the detect operation of LEDWARN must be performed
.

Bit6 : **LEDHOT** LED Excessive Temperature Flag

This bit can be reset by writing a logic level zero.
0 : TS input voltage≧0.345V
1 : TS input voltage＜0.345V

When Detection of "LED temperature Hot" was continued for 20μs at Torch / Flash mode, LEDHOT becomes to '1'. And This IC goes automatically in shutdown mode to avoid damaging the LED. MODE[1:0] bits are reset. This status(bit="1") is latched until the LEDHOT flag gets cleared by software.

Bit7 : **ENTS** LED Temperature Monitoring setting.

0: LED Temperature Monitoring disable
1: LED Temperature Monitoring enable

Address 07h < Battery drop Protection >

Address	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
07h	R/W	ENBATDET	BATDET(2)	BATDET(1)	BATDET(0)	-	-	-	-
Initial Value	40h	0	1	0	0	-	-	-	-

Bit[3:0] : (Not used)

Bit[6:4] : **BATDET(2:0)** Battery drop Protection
"000" : 50mV
"001" : 75mV
"010" : 100mV
"011" : 125mV
"100" : 150mV *initial value
"101" : 175mV
"110" : 200mV
"111" : 225mV

Bit7 : **ENBATDET** Enable for Battery drop Protection
"0" : Battery drop protection disable
"1" : Battery drop protection enable

●Functional Description

1. Reset

There are two kinds of reset, software reset and hardware reset

(1) Software reset

- All the registers are initialized by SFTRST="1".
- SFTRST is an automatically returned to "0". (Auto Return 0).

(2) Hardware reset

- It shifts to hardware reset by changing RESETB pin “H” → “L”.
- The condition of all the registers under hardware reset pin is returned to the Initial Value, and it stops accepting all address.
  All LED driver turn off.
- It’s possible to release from a state of hardware reset by changing RESETB pin “L” → “H”.

(3) Reset sequence

- When software reset was done during hardware reset, software reset is canceled.(Because the Initial Value of software reset is “0”)

2. Shutdown

Writing 00 to MODE[1:0] bits forces the device into shutdown.

In the Shutdown state:

- The regulator stops switching.
- The high-side PMOS disconnects the load from the input.
- The LEDx pins are high impedance thus eliminating any DC conduction path (Current driver OFF)

3. Power up/down sequence

Please take sufficient wait time for each Power/Control signal.
However, If VBAT<2.6V or On TSD, the command input is not effective because of the protection operation.

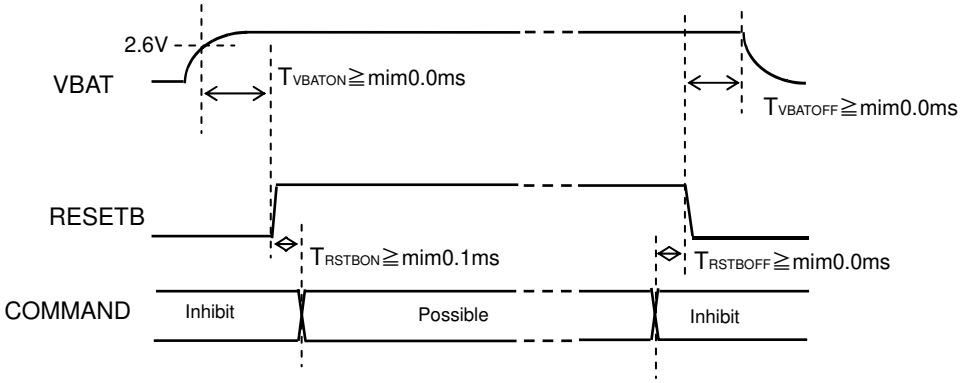

Figure 13. Power up/down sequence

4. PWM current mode DC/DC converter

While this IC is boosting, the lowest voltage of LED1, 2, 3 is detected, PWM duty is decided to be 0.2V (Torch mode) or 0.4V (Flash mode) and output voltage is kept invariably. As for the inputs of the PWM comparator as the feature of the PWM current mode, one is overlapped with error components from the error amplifier, and the other is overlapped with a current sense signal that controls the inductor current into Slope waveform to prevent sub harmonic oscillation. This output controls internal Nch Tr via the RS latch. In the period where internal Nch Tr gate is ON, energy is accumulated in the external inductor, and in the period where internal Nch Tr gate is OFF, energy is transferred to the output capacitor via internal Pch Tr. This IC has many safety functions, and their detection signals stop switching operation at once.

5. Pulse skip control

This IC regulates the output voltage using an improved pulse-skip. In “pulse-skip” mode the error amplifier disables “switching” of the power stages when it detects low output voltage and high input voltage. The oscillator halts and the controller skip switching cycles. The error amplifier reactivates the oscillator and starts switching of the power stages again when this IC detects low input voltage.

The “pulse-skip” regulation minimizes the operating current because this IC does not switch continuously and hence the losses of the switching are reduced. When the error amplifier disables “switching”, the load is also isolated from the input.

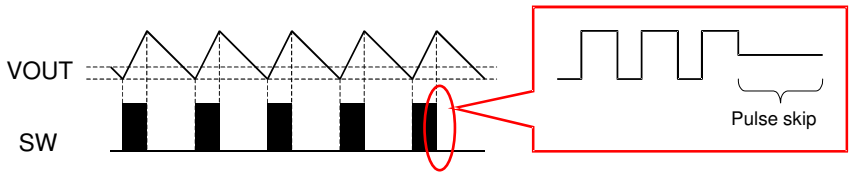

Figure 14. Pulse skip control

6.DC/DC Soft start function

Soft start function will prevent IC from appearing the In-rush current.
The detail of soft start is as following.

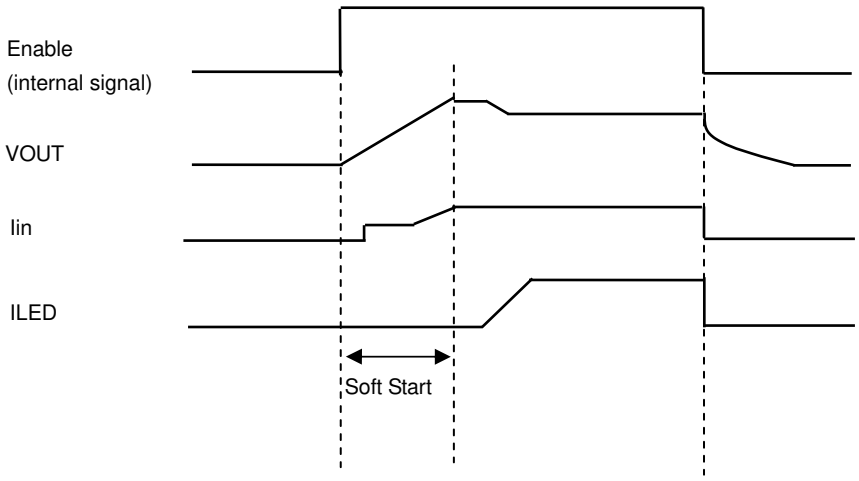

Figure 15. Soft Start with enable signal

7. Flash / Torch mode control

Register (I^2C control)		External pin		State of device	
MODE(1)	MODE(0)	STRB0	STRB1	MODE	behavior
0	0	*	*	shutdown	Stand-by for Flash/Torch
1	1				
0	1	*	0	Torch	Torch with safety timer
		*	1		Torch without safety timer
1	0	0	0	Flash	Stand-by for Flash/Torch
		0	1		
		1	0		Flash
		1	1		Torch without safety timer

Flash/Torch control can be done by I^2C register and external pin.

MODE[1:0]: Mode select
"00" : shutdown mode
"01" : Torch mode
"10" : Flash mode
"11" : shutdown mode

For Torch mode, a watchdog timer is implemented; This must be refreshed within 13.0 seconds. This function can be disabled, as described below.

MODE[1:0] = 01 : The STRB0, STRB1 inputs are disabled. The device regulates the LED current in torch mode(TLED bits) regardless of the STRB0, STRB1 inputs and the START_FLASH/TIMER (SFT) bit. To avoid device shutdown because of the torch safety timeout, MODE[1:0] must be refreshed within less than 13.0 seconds (STRB1=0). The torch watchdog timer can be disabled by pulling the STRB1 signal high.

MODE[1:0] = 10 : The STRB0, STRB1 inputs are enabled. The flash pulse can be triggered by these synchronization signals, or by a software command (START_FLASH/TIMER (SFT) bit). The LEDs are enabled/disabled according to the STRB0, STRB1 input. The flash safety timer is activated, and the torch watchdog timer is disabled.

8. LED Current Ramp-Up / Down (Flash mode)

LED Current Ramp-Up	Istep = 25mA
	Trise = 12µs
LED Current Ramp-Down	Istep = 25mA
	Tfall = 0.5µs

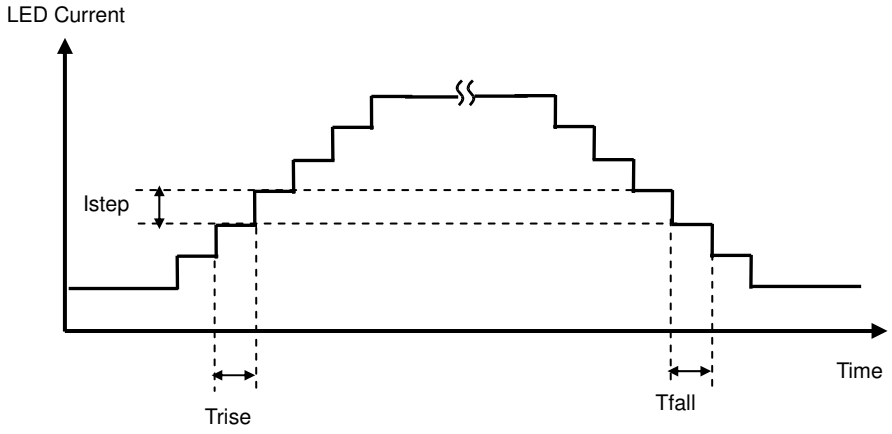

Figure 16. Flash LED current Ramp-Up/Down

9. Example of Flash / Torch mode control

<Torch control example>

Ex1. Torch with safety timer

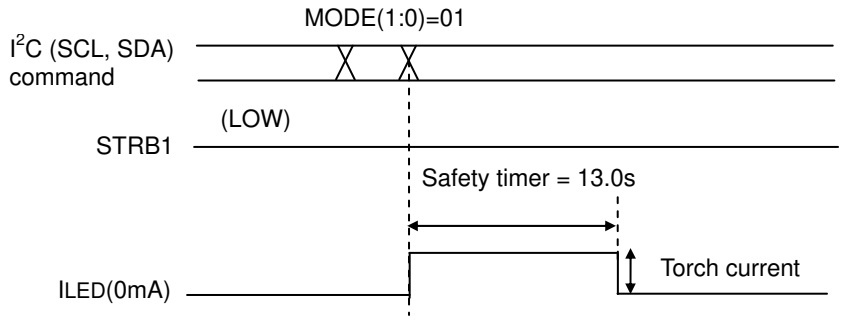

Figure 17. Torch with safety timer

Ex2. Torch without safety timer

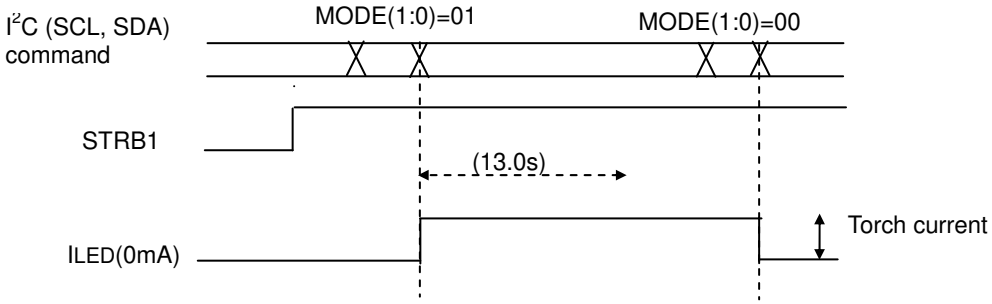

Figure 18. Torch without safety timer

<Flash control example>

(Unless otherwise specified STRB1=0)

Ex3. Flash synchronized with STRB0

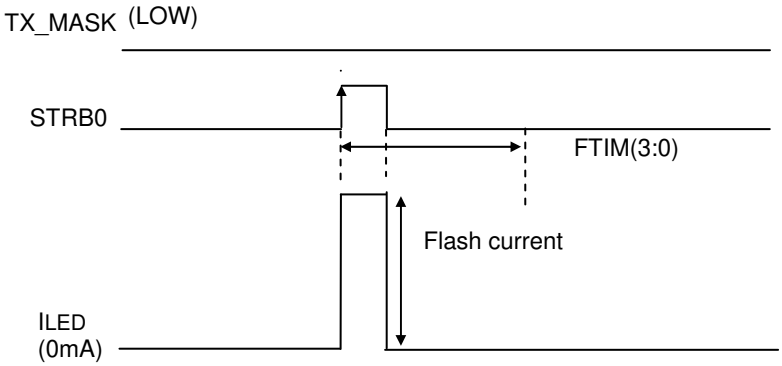

Figure 19. Flash synchronized with STRB0