

***Power Management System Device***

***R5314D001A***

***Specification***

***Ver1.4***

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**RICOH COMPANY, LTD.**

**Electronic Devices Company**

This specification is subject to change without notice.

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## 1. Outline

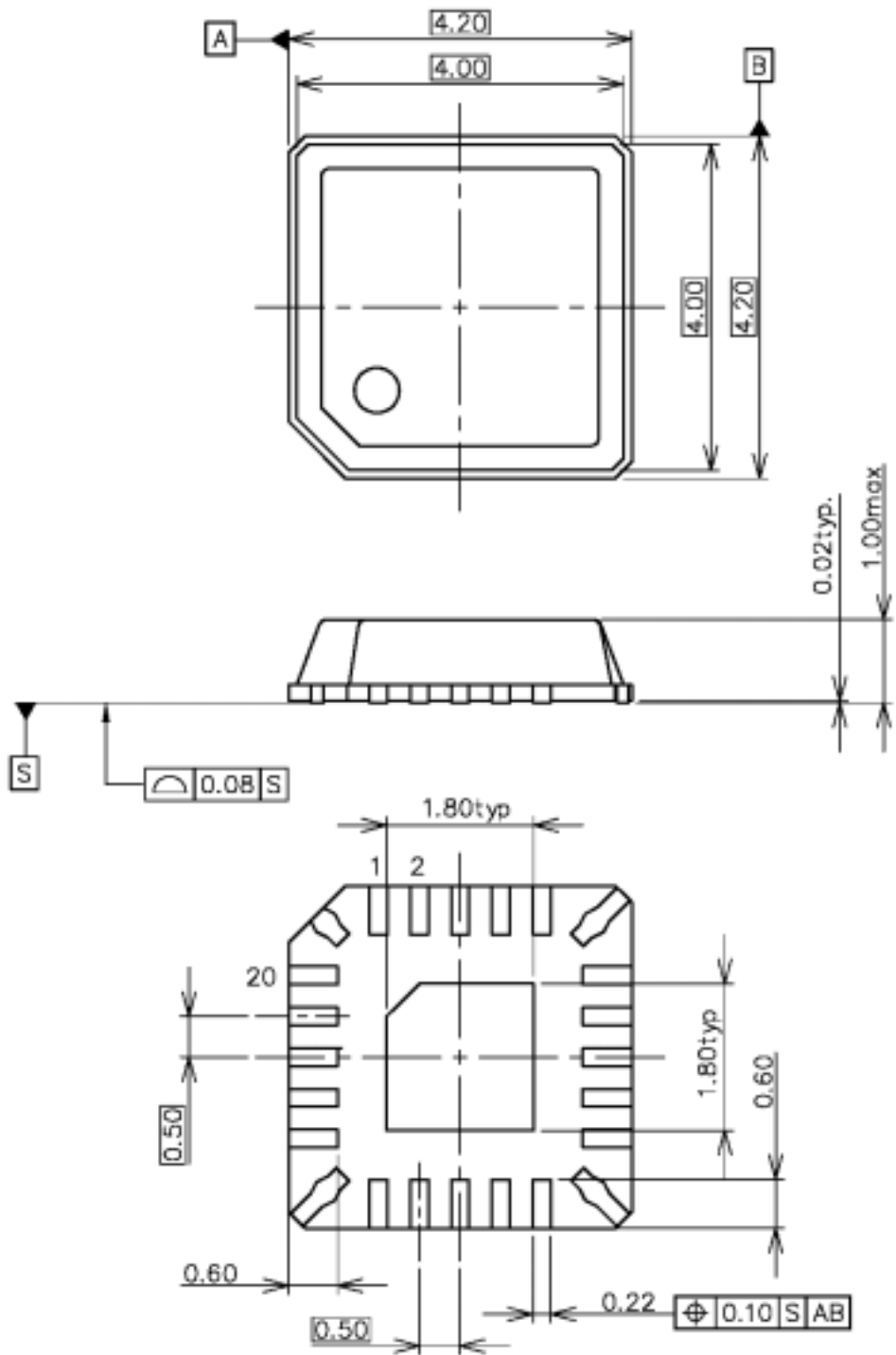
The R5314 chip is a power management system device who consists of 4 voltage regulators , Step-down DC/DC converter, Step-up DC/DC converter for White LED, Reset Generator, several protection circuit and serial interface.

Features:

- 4 Low noise and good PSRR LDO regulators with ECO-mode
- Step-down DC/DC converter  
(with Power Save-mode)
- Step-up DC/DC converter for White LED
- Several Protection Circuit  
( Thermal shut-down, Current limit )
- Reset Generator
- 3 line serial interface
- CMOS process
- 20pin-QFN package (4.2mm×4.2mm)

## 2. Outline of Package

QFN0404-20pin



UNIT: mm

TAB connect to GND

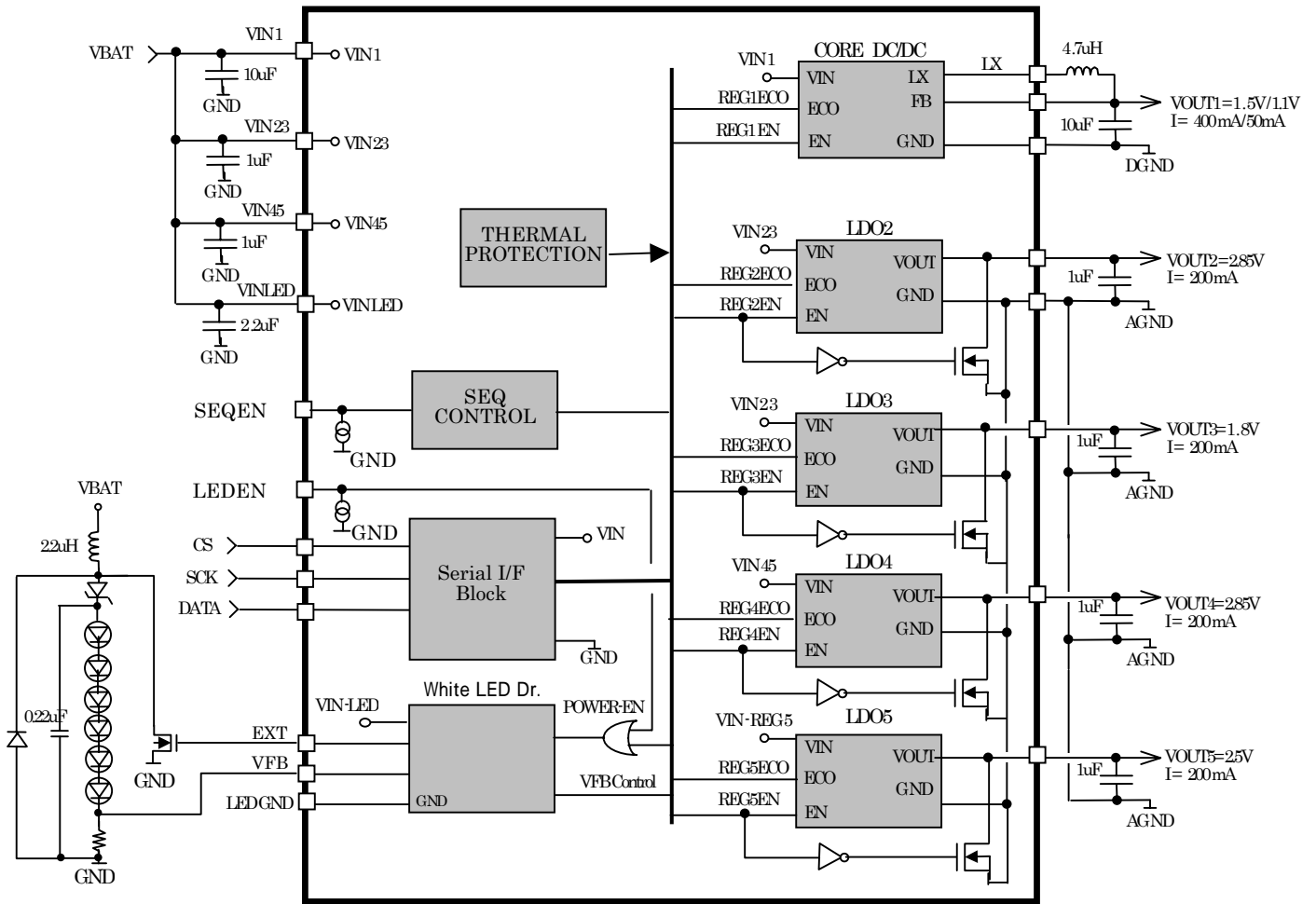
### 3. Pin Description

PIN No.	Symbol	D/A	I/O	I/F circuit	I/F level	Output current	Description	Notes
1	SEQEN	D	I	CMOS	VBAT	-	External of signal for Sequence on/off mode	
2	LEDEN	D	I	CMOS	VBAT	-	External of signal for White LED on/off mode	
3	VOUT1	A	O	A	VOUT1	-	Output/Feedback of REG1	
4	VIN1	-	V	-	VBAT	-	Input of REG1	
5	DGND	-	G	-	-	-	GND of REG1	
6	LX	A	O	A	-	400mA	Output of REG1	
7	CS	D	I	CMOS	VBAT	-	CS	
8	SCK	D	I	CMOS	VBAT	-	SCK	
9	DATA	D	I	CMOS	VBAT	-	DATA	
10	LEDGND	-	G	-	-	-	GND of White LED	
11	EXT	D	O	A	VBAT	-	Output of White LED	
12	VINLED	-	V	-	VBAT	-	Input of White LED	
13	VFB	A	O	A	VFB	-	Output/Feedback of White LED	
14	AGND	-	G	-	-	-	GND of R5314	
15	VOUT5	A	O	A	VOUT5	200mA	Output of REG5	
16	VIN45	-	V	-	VBAT	-	Input of REG4,REG5	
17	VOUT4	A	O	A	VOUT4	200mA	Output of REG4	
18	VOUT3	A	O	A	VOUT3	200mA	Output of REG3	
19	VIN23	-	V	-	VBAT	-	Input of REG2,REG3	
20	VOUT2	A	O	A	VOUT2	200mA	Output of REG2	

### 4. R5314DXXXA Block Diagram

The block diagram of the device is shown below.

QFN0404-20pin



## 5. Functional Blocks

### 5-1. Power Supply Description

#### 5-1-1. Step-down DC/DC converter with ECO mode VR

R5314 has one DC/DC converter (REG1) that has a PWM control circuit, a soft-start circuit, a protection circuit and a Power Save-mode circuit. As protection circuits, Current Limit circuit which limits peak current of Lx at each clock cycle, and Latch type protection circuit which works if the term of Over-current condition keeps on a certain time exist. Latch-type protection circuit works to latch an internal driver with keeping it disable. To release the condition of protection restarts this IC with power-on.

#### ■ Electrical characteristics

##### ○ Normal operating mode

Ta=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Units
Vout	Output voltage	VBAT=3.6V Iout=50mA	2.0%	1.5	2.0%	V
Iss	Supply current	VBAT=3.6V Duty=100%		350		μA
Fosc	Oscillator Frequency	VBAT=3.6V Ta=-20 to 70°C *1	1.10	1.20	1.30	MHz
Tstart	Delay Time by Soft-Start func.	VBAT=3.6V		0.2		ms
Ronp	Lx"H" ON Resistance	VBAT=3.6V		0.55		Ω
Ronn	Lx"L" ON Resistance	VBAT=3.6V		0.55		Ω
Ilxleak	Lx Leakage Current	VBAT=4.2V Lx=0V/4.2V	-1.0		1.0	μA
Maxdty	Maximum Duty Cycle	VOUT1=0V	100			%
Ilim	Lx Limit Current	VBAT=3.6V	400	700		mA
Tprot	Delay Time for Protection cir.	VBAT=3.6V		3.0		ms
$\frac{\Delta V_{out}}{\Delta T_{opt}}$	Output voltage temperature coefficient	-40°C ≤ T <sub>opt</sub> ≤ 85°C		±100		ppm/°C

Output capacitor: 10μF, ceramic, in mounted state

Output coil: 4.7μH

\*1 This specification is guaranteed by design, not production tested.

## ○ Power Save mode

Ta=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Units
Vout	Output voltage	VBAT=3.6V Iout=10mA	1.07	1.1	1.13	V
Iout	Output current	VBAT=3.6V	50			mA
Vdif	Dropout Voltage	Iout=50mA(at Vout=1.8V)		500		mV
$\frac{\Delta V_{out}}{\Delta I_{out}}$	Load Regulation	VBAT=3.6V 10 $\mu$ A $\leq$ Iout $\leq$ 25mA		20	40	mV
Iss	Supply current	VBAT=3.6V Iout=0mA		5		$\mu$ A
Ilim	Short Current Limit	Vout=0V		60		mA
$\frac{\Delta V_{out}}{\Delta V_{in}}$	Line Regulation	3.2V $\leq$ VBAT $\leq$ 4.2V Iout=25mA			0.2	%/V
$\frac{\Delta V_{out}}{\Delta T_{opt}}$	Output voltage temperature coefficient	-40°C $\leq$ Topt $\leq$ 85°C		$\pm$ 100		ppm/ °C

## 5-1-2. White LED Driver

Built-in Latch-type Protection Function (without Over Voltage Protection)

Drives Up to Four LEDs

High Efficiency : 85% Typical

## ■ Electrical characteristics

(T<sub>opt</sub>=25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>FB</sub>	V <sub>FB</sub> Voltage Tolerance	V <sub>BAT</sub> =3.6V Code=(0,0,0) *2		0.2		V
I <sub>ss</sub>	Supply Current	V <sub>BAT</sub> =3.6V, V <sub>FB</sub> =0V EXT at no load		500	900	μA
F <sub>osc</sub>	Oscillator Frequency	V <sub>BAT</sub> =3.6V, V <sub>FB</sub> =0V T <sub>a</sub> =-20 to 70°C *1	TBD	1.20	TBD	MHz
T <sub>start</sub>	Delay Time by Soft-Start func.	V <sub>BAT</sub> =3.6V		100		μs
T <sub>prot</sub>	Delay Time for Protection cir.	V <sub>BAT</sub> =3.6V		1.5		ms

Output capacitor: 0.22μF, ceramic, in mounted state

Output coil: 4.7μH or 2.2μH

\*1 This specification is guaranteed by design, not production tested.

\*2 V<sub>FB</sub> voltage is controlled by serial I/F code.

CODE			V <sub>FB</sub> (V)
D8	D9	D10	
0	0	0	0.20
0	0	1	0.15
0	1	0	0.10
0	1	1	0.07
1	0	0	0.05
1	0	1	0.03
1	1	0	0.02
1	1	1	0.01

## 5-1-3. Low-noise LDO Regulator

R5314 has 4 low-noise & good PSRR LDO regulators (REG2, 3, 4 and 5) that has a current limit circuit, ON/OFF-mode and ECO-mode.

■ Electrical characteristics

Ta=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Units	
Vout	Output voltage	REG2	VBAT=3.6V Iout=1mA REGECO=L	-2.0%	2.85	+2.0%	V
		REG3		-2.0%	1.8	+2.0%	
		REG4		-2.0%	2.85	+2.0%	
		REG5		-2.0%	2.5	+2.0%	
		REG2	VBAT=3.6V Iout=1mA REGECO=H	2.74	2.85	2.96	
		REG3		1.73	1.8	1.87	
		REG4		2.74	2.85	2.96	
		REG5		2.41	2.5	2.59	
Iout	Output current	REG2	VBAT=3.6V	200			mA
		REG3		200			
		REG4		200			
		REG5		200			
Vdif	Dropout Voltage	REG2,4	Iout=100mA		120	200	mV
		REG3			400		
		REG5			200		
$\frac{\Delta V_{out}}{\Delta I_{out}}$	Load Regulation	VBAT=3.6V, REGECO=L 10 $\mu$ A $\leq$ Iout $\leq$ 100mA		10	20	mV	
		VBAT=3.6V, REGECO=H 10 $\mu$ A $\leq$ Iout $\leq$ 100mA		15	30		
Iss	Supply current	VBAT=3.6V, REGECO=L Iout=0mA		50		$\mu$ A	
		VBAT=3.6V, REGECO=H Iout=0mA		4		$\mu$ A	
Ilim	Short Current Limit	Vout=0V		50		mA	
$\frac{\Delta V_{out}}{\Delta V_{in}}$	Line Regulation	3.2V $\leq$ VBAT $\leq$ 4.2V Iout=30mA			0.2	%/V	
RR	Ripple Rejection	VBAT=3.6V+0.2Vp-p, REGECO=L Iout=30mA, f = 1kHz		65		dB	
$\frac{\Delta V_{out}}{\Delta T_{opt}}$	Output voltage temperature coefficient	-40°C $\leq$ Topt $\leq$ 85°C		$\pm$ 100		ppm/°C	
En	Output noise	VBAT=3.6V Iout=50mA BW=10Hz~100kHz		30		$\mu$ Vrms	
Vtd	Power supply delay time	VBAT=3.6V Iout=1mA Vout $\times$ 90% CL=1 $\mu$ F REGECO=L		20		$\mu$ s	
		REGECO=H		30			
Rlow	Nch On Resistance For auto discharge	VBAT=3.6V, REGEN=L, @Vout=Vset		100		$\Omega$	

Output capacitor: 1 $\mu$ F or more, ceramic, in mounted state

## 5-2. Other Circuits Description

### 5-2-1. Thermal Protection

The thermal shutdown circuit consists of two temperature detection circuits and an op-amp.

- Electrical characteristics

VBAT=3.6V

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Units
T <sub>DET</sub>	Detected temperature			140		°C
T <sub>HYS</sub>	Hysteresis temperature			25		°C
I <sub>ss</sub>	Supply current			2		μA

## 6. Electrical Characteristics

### 6-1. Absolute maximum ratings

Item	Symbol	Conditions	Rated value	Units
Power supply voltage 1	VBAT	Battery voltage input pins	-0.3~6.5	V
Input voltage range	Vin	All input pins	-0.3~6.5	V
Output Current	Iout	REG 1 (DC)	500	mA
		REG2/3/4/5	250	mA
Package allowable dissipation	PD	Mounted on board, Ta=85°C; see notes	600	mW
Storage temperature	Tstg		-55~+125	°C

Note: QFN package

Board size: 50mm × 108mm × 1.27mm(FR4)

Wiring density 250%, four layers

Ambient temperature 85°C, Tj=125°C, 66.7°C /W, no air currents

### 6-2. Recommended operating conditions

Item	Symbol	Conditions	Min.	Typ.	Max.	Units
Power supply voltage	VBAT	Battery voltage input pins	2.8	3.6	4.4	V
Operating temperature range	Ta	All block	-40		+85	°C

### 6-3. Power supply consumption

Ta=25°C

Conditions	Enable circuit	Typ.	Max.	Units
Standby (VBAT=4.2V)		1	3	μA
VBAT < 4.4V (All ECO mode without White LED)	REG1 ~ REG5 RESET GENERATOR THERMAL SHUTDOWN	25	40	μA
VBAT < 4.4V (Without White LED)	REG1 ~ REG5 RESET GENERATOR THERMAL SHUTDOWN	550	700	μA

Note 1: load condition(all REG) : Iout=0mA

6-4. I/O characteristics

(1) Digital unit

Ta=25°C

Symbol	Item	Conditions	Specification			Units
			MIN.	TYP.	MAX.	
IIL	"L" input leakage current	VI=0V(pull-down input terminals)	-0.1		0.1	μA
VIH	"H" input voltage	All input pins	1.3			V
VIL	"L" input voltage	All input pins			0.3	V
IPD	Pull-down current	SEQEN,LEDEN	0.15	0.3	0.6	μA

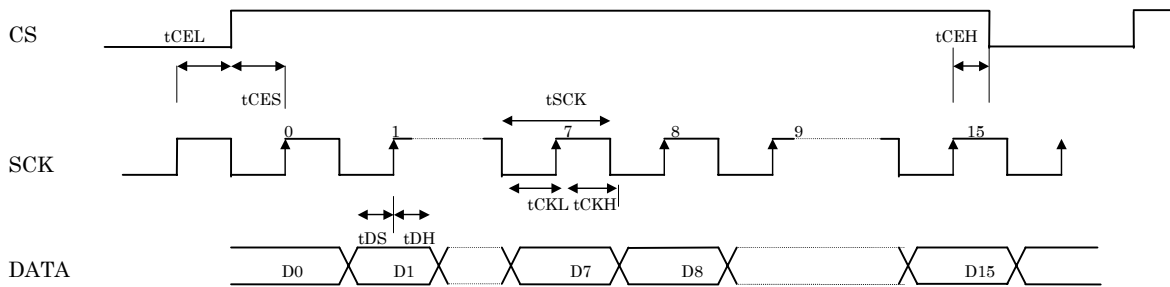
Note 1: Positive current flowing into the LSI

Note 2: Unless otherwise provided, VBAT=3.6V

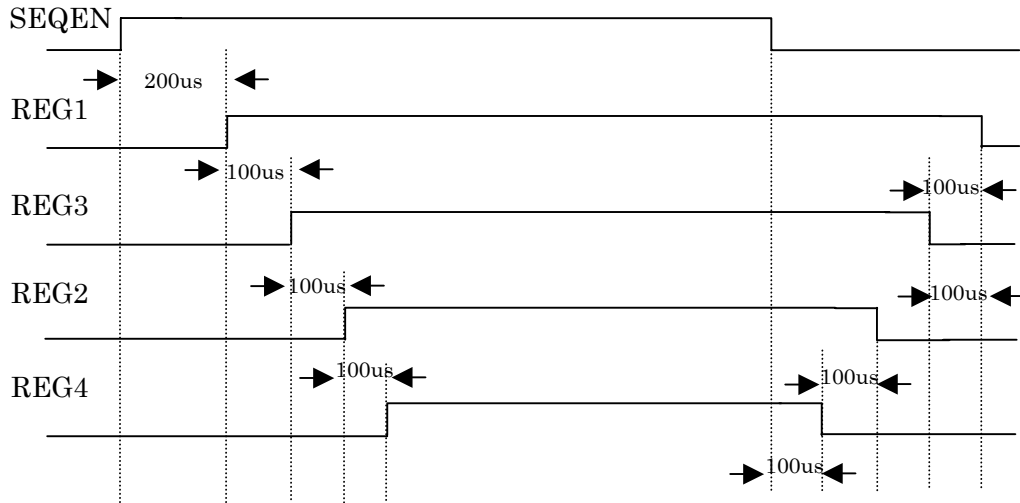
6-5. Timing chart

Digital AC characteristic

Symbol	Item	Measurement condition	MIN.	TYP.	MAX.	Unit
t <sub>CEL</sub>	CS "L"hold time	Application terminal: CS-SCK	100			n s
t <sub>CES</sub>	CS setup time	Application terminal: CS-SCK	40			n s
t <sub>CEH</sub>	CS "H"hold time	Application terminal: CS-SCK	40			n s
t <sub>SCK</sub>	SCK cycle	Application terminal: SCK	200			n s
t <sub>CKL</sub>	SCK "L"time	Application terminal: SCK	100			n s
t <sub>CKH</sub>	SCK "H"time	Application terminal: SCK	100			n s
t <sub>DS</sub>	DATA setup time	Application terminal: DATA-SCK	40			n s
t <sub>DH</sub>	DATA hold time	Application terminal: DATA-SCK	40			n s



6-6. Start up and Start down Sequence



## 6-7. Interface code table (Aver)

Control contents	1st byte	2nd byte
On/off of each block	X01000XX	D8=REG1 switch (1=ON, 0=OFF)
		D9=REG2 switch (1=ON, 0=OFF)
		D10=REG3 switch (1=ON, 0=OFF)
		D11=REG4 switch (1=ON, 0=OFF)
		D12=REG5 switch (1=ON, 0=OFF)
		D13
		D14
		D15=LED switch (1=ON, 0=OFF)
ECO mode of each block	X01001XX	D8=REG1 ECO (1=ON, 0=OFF)
		D9=REG2 ECO (1=ON, 0=OFF)
		D10=REG3 ECO (1=ON, 0=OFF)
		D11=REG4 ECO (1=ON, 0=OFF)
		D12=REG5 ECO (1=ON, 0=OFF)
		D13
		D14
		D15
White LED brightness adjustment	X01011XX	D8=LED_ADJ0
		D9=LED_ADJ1
		D10=LED_ADJ2
		D11
		D12
		D13
		D14
		D15

