DATA SHEET

Part No.	AN32151A
Package Code No.	XBGA049-W-3033AEL

Contents

AN32151A

LED Matrix driver IC

■ Overview

AN32151A is equipped with the driver (7 × 17) for LED matrix, and RAM.

■ Features

- LED matrix driver (7 × 17)
- Internal memory RAM (1-side)
- LDO (1-ch)
- I^2C interface + SPI interface

■ Applications

- LED driver IC for mobile phones

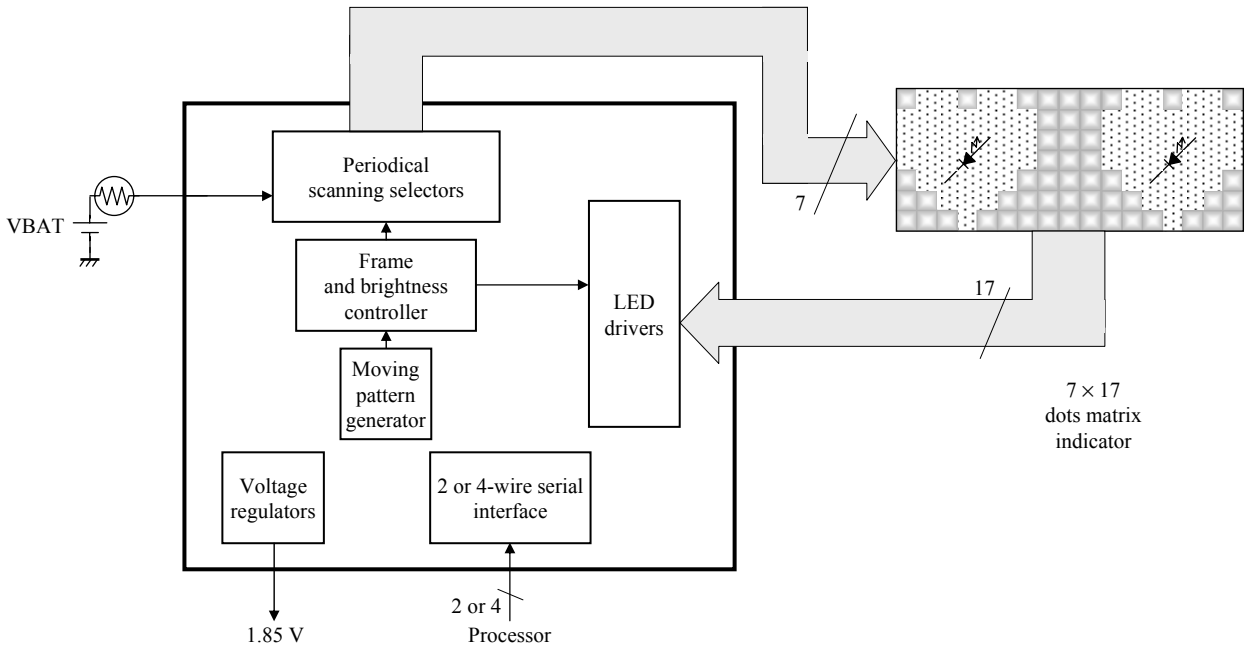
■ Package

- 49 pin Wafer Level Chip Size Package (WLCSP)
  (Size : 3.26 × 2.96 mm, 0.4 mm Pitch)

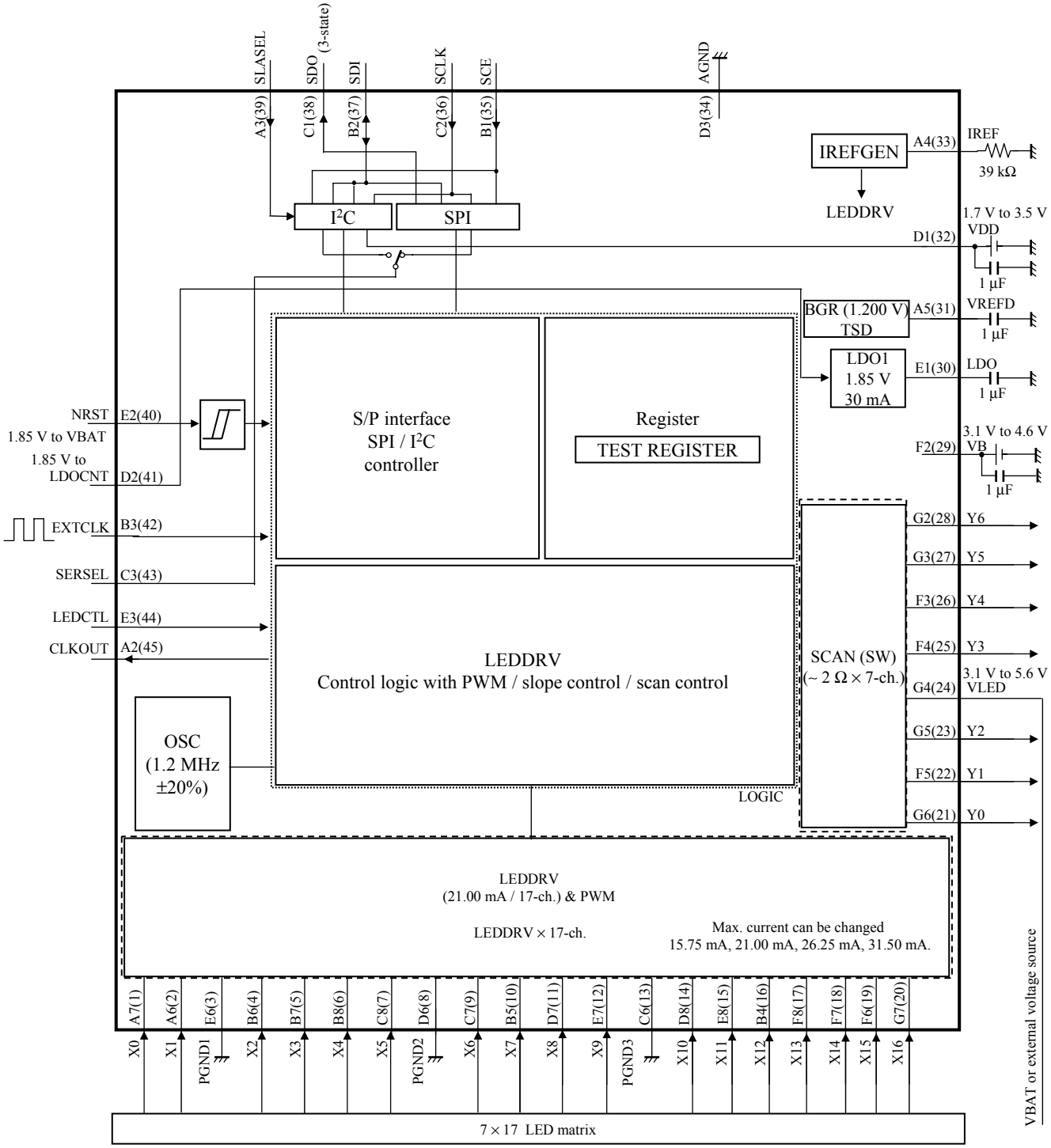
■ Type

- Bi-CMOS IC

■ System Image

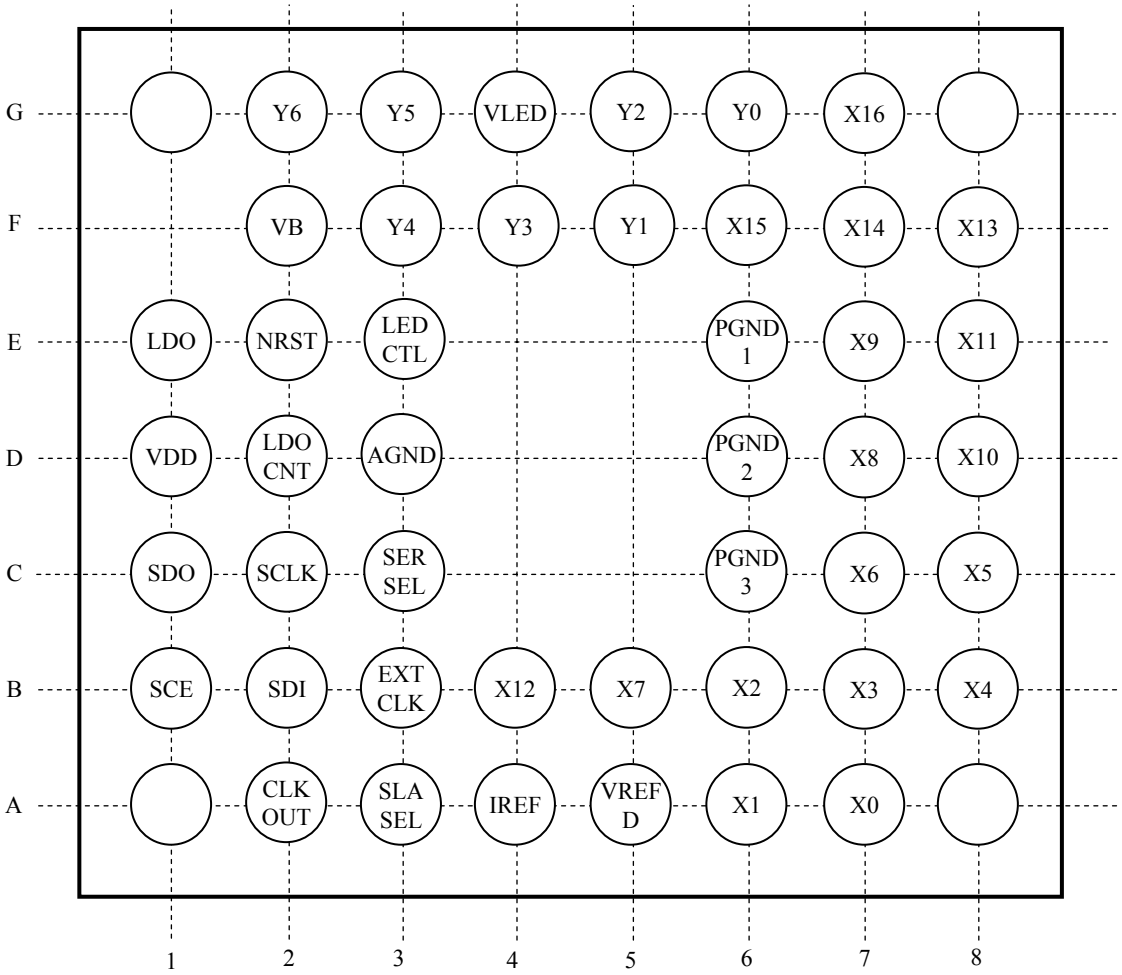


■ Application Circuit Example (Block Diagram)



Notes)
- This application circuit is shown as an example but does not guarantee the design for mass production set.
- This block diagram is for explaining functions. The part of the block diagram may be omitted, or it may be simplified.
- The capacitors of VB and VDD lines are for noise rejection. Please select the concrete values of capacitors depending on the printed-circuit board.
- When the voltage is applied to VLED pin from external power supply, it should be 3.1 V or more.
- It is recommended that ERJ2RHD393X(±0.5%) made by Panasonic for a resistor connected to Pin A4 (IREF) to secure the accuracy of the constant current of each LED is used.

■ Pin Descriptions



Bottom view

Note) Four-cornered pins have been connected to GND.

■ Pin Descriptions (continued)

Pin No. (Pad No.)	Pin name	Type	Description
A7(1)	X0	Output	PWM control output pin with constant current circuit This pin is connected with A column of matrix LED.
A6(2)	X1	Output	PWM control output pin with constant current circuit This pin is connected with B column of matrix LED.
E6(3)	PGND1	Ground	Ground pin for matrix LED
B6(4)	X2	Output	PWM control output pin with constant current circuit This pin is connected with C column of matrix LED.
B7(5)	X3	Output	PWM control output pin with constant current circuit This pin is connected with D column of matrix LED.
B8(6)	X4	Output	PWM control output pin with constant current circuit This pin is connected with E column of matrix LED.
C8(7)	X5	Output	PWM control output pin with constant current circuit This pin is connected with F column of matrix LED.
D6(8)	PGND2	Ground	Ground pin for matrix LED
C7(9)	X6	Output	PWM control output pin with constant current circuit This pin is connected with G column of matrix LED.
B5(10)	X7	Output	PWM control output pin with constant current circuit This pin is connected with H column of matrix LED.
D7(11)	X8	Output	PWM control output pin with constant current circuit This pin is connected with I column of matrix LED.
E7(12)	X9	Output	PWM control output pin with constant current circuit This pin is connected with J column of matrix LED.
C6(13)	PGND3	Ground	Ground pin for matrix LED
D8(14)	X10	Output	PWM control output pin with constant current circuit This pin is connected with K column of matrix LED.
E8(15)	X11	Output	PWM control output pin with constant current circuit This pin is connected with L column of matrix LED.
B4(16)	X12	Output	PWM control output pin with constant current circuit This pin is connected with M column of matrix LED.
F8(17)	X13	Output	PWM control output pin with constant current circuit This pin is connected with N column of matrix LED.
F7(18)	X14	Output	PWM control output pin with constant current circuit This pin is connected with O column of matrix LED.
F6(19)	X15	Output	PWM control output pin with constant current circuit This pin is connected with P column of matrix LED.
G7(20)	X16	Output	PWM control output pin with constant current circuit This pin is connected with Q column of matrix LED.
G6(21)	Y0	Output	PWM control output pin with constant current circuit This pin is connected with the 1st row of matrix LED.

Note) Refer (Pad No.) to Page 4. ((Pad No. is used in Electrical Characteristics.)

■ Pin Descriptions (continued)

Pin No. (Pad No.)	Pin name	Type	Description
F5(22)	Y1	Output	PWM control output pin with constant current circuit This pin is connected with the 2nd row of matrix LED.
G5(23)	Y2	Output	PWM control output pin with constant current circuit This pin is connected with the 3rd row of matrix LED.
G4(24)	VLED	Power supply	Power supply's connection pin for matrix LED This pin should be connected with the output of battery or step-up converter.
F4(25)	Y3	Output	PWM control output pin with constant current circuit This pin is connected with the 4th row of matrix LED.
F3(26)	Y4	Output	PWM control output pin with constant current circuit This pin is connected with the 5th row of matrix LED.
G3(27)	Y5	Output	PWM control output pin with constant current circuit This pin is connected with the 6th row of matrix LED.
G2(28)	Y6	Output	PWM control output pin with constant current circuit This pin is connected with the 7th row of matrix LED.
F2(29)	VB	Power supply	Power supply's connection pin for BGR circuit and LDO circuit
E1(30)	LDO	Output	Power supply's connection pin for serial interface input block and internal logic.
A5(31)	VREFD	Output	BGR circuit output pin
D1(32)	VDD	Power supply	Power supply pin for output interface
A4(33)	IREF	Output	Resistor connection pin for constant current setup
D3(34)	AGND	Ground	Ground pin for analogue circuitry
B1(35)	SCE	Input	SPI interface chip-enable pin (High active) (Slave address selection control pin 1 at I^2C mode)
C2(36)	SCLK	Input	Common clock input pin in both SPI interface and I^2C interface
B2(37)	SDI	Input / Output	Data input pin for SPI interface Data input/output pin for I^2C interface
C1(38)	SDO	Output	Data output pin for SPI interface
A3(39)	SLASEL	Input	Slave address selection control pin 2 at I^2C mode
E2(40)	NRST	Input	Reset input pin (Low active)
D2(41)	LDOCNT	Input	LDO ON/OFF control pin
B3(42)	EXTCLK	Input	External clock input pin
C3(43)	SERSEL	Input	SPI, I^2C selection pin
E3(44)	LEDCTL	Input	LED lit external synchronous input pin
A2(45)	CLKOUT	Output	Internal clock output pin

Note) Refer (Pad No.) to Page 4. ((Pad No. is used in Electrical Characteristics.)

■ Absolute Maximum Ratings

Note) Absolute maximum ratings are limit values which do not result in damages to this IC, and IC operation is not guaranteed at these limit values.

A No.	Parameter	Symbol	Rating	Unit	Notes
1	Supply voltage	VDD_{MAX}	4.3	V	*1
		VB_{MAX}	6.0	V	*1
		$VLED_{MAX}$	6.5	V	*1
2	Supply current	I_{CC}	—	A	—
3	Power dissipation	P_D	66.5	mW	*2
4	Operating ambient temperature	T_{opr}	–30 to +85	°C	*3
5	Storage temperature	T_{stg}	–55 to +125	°C	*3

Notes) *1 : VB_{MAX} = VB, VDD_{MAX} = VDD, $VLED_{MAX}$ = VLED
The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

*2 : The power dissipation shown is the value at T_a = 85°C for the independent (unmounted) IC package without a heat sink.
When using this IC, refer to the $P_D - T_a$ diagram in the ■ Technical Data and design the heat radiation with sufficient margin so that the allowable value might not be exceeded based on the conditions of power supply voltage, load, and ambient temperature.

*3 : Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for T_a = 25°C.

■ Operating Supply Voltage Range

Parameter	Symbol	Range	Unit	Notes
Supply voltage range	VDD	1.7 to 3.5	V	*
	VB	3.1 to 4.6	V	*
	VLED	3.1 to 5.6	V	*

Notes) * : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.
Please apply to power supply in order of VB, VDD, and VLED.

■ Allowable Current and Voltage Range

Notes) • Allowable current and voltage ranges are limit ranges which do not result in damages to this IC, and IC operation is not guaranteed within these limit ranges.
• Voltage values, unless otherwise specified, are with respect to GND. GND is voltage for AGND, PGND1, PGND2, and PGND3. AGND = PGND1 = PGND2 = PGND3.
• VCC1 is voltage for VDD.
• VCC2 is voltage for VB.
• Do not apply external currents or voltages to any pin not specifically mentioned.

Pin No. (Pad No.)	Pin name	Rating	Unit	Notes
E6(3)	PGND1	—	V	—
D6(8)	PGND2	—	V	—
C6(13)	PGND3	—	V	—
G4(24)	VLED	0 to 6.5	V	—
F2(29)	VB	0 to 6.0	V	—
D1(32)	VDD	0 to 4.3	V	—
D3(34)	AGND	—	V	—

Pin No. (Pad No.)	Pin name	Rating	Unit	Notes
B1(35)	SCE	– 0.5 to (VCC1 + 0.5)	V	*1
A3(39)	SLASEL	– 0.5 to (VCC1 + 0.5)	V	*1
C2(36)	SCLK	– 0.5 to (VCC1 + 0.5)	V	*1
B2(37)	SDI	– 0.5 to (VCC1 + 0.5)	V	*1, 2
E2(40)	NRST	– 0.3 to (VCC2 + 0.3)	V	*1
D2(41)	LDOCNT	– 0.3 to (VCC2 + 0.3)	V	*1
B3(42)	EXTCLK	– 0.3 to (VCC2 + 0.3)	V	*1
C3(43)	SERSEL	– 0.3 to (VCC2 + 0.3)	V	*1
E3(44)	LEDCTL	– 0.3 to (VCC2 + 0.3)	V	*1

Notes) *1 : (VCC1 + 0.5) V must not be exceeded 4.3 V, and (VCC2 + 0.3) V must not be exceeded 6.0 V.
*2 : Rating when used for input. External voltage or current must not be applied when used for output.

■ Electrical Characteristics at VDD = 2.6 V, VB = 3.6 V, VLED = 4.9 V

Notes) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Current consumption								
1	Current consumption (1) Off mode	ICC1	VB = 3.6 V LDOCNT = Low ICC1 = IPM	—	0	1	µA	—
2	Current consumption (2) Normal mode	ICC2	VB = 3.6 V LDOCNT = High ILOAD = 0 µA ICC2 = IPM	—	14	20	µA	—
Reference voltage source								
3	Output voltage	VREF	VB = 3.6 V IP31 = 0 µA VREF = VP31	1.17	1.20	1.23	V	—

■ Electrical Characteristics (continued) at VDD = 2.6 V, VB = 3.6 V, VLED = 4.9 V

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
EXTCLK, NRST, LDOCNT, SERSEL, LEDCTL								
4	High-level input voltage range	VIH1	High-level recognition voltage of Pad No.40 to Pad No.44.	1.4	—	VB + 0.3	V	—
5	Low-level input voltage range	VIL1	Low-level recognition voltage of Pad No.40 to Pad No.44.	− 0.3	—	0.4	V	—
6	High-level input current	IIH1	VP 40 to 44 = 1.85 V IIH = IP 40 to 44	—	0	1	µA	—
7	Low-level input current	IIL1	VP 40 to 44 = 0 V IIH = IP 40 to 44	—	0	1	µA	—
SCLK, SDI								
8	High-level input voltage range	VIH2	High-level recognition voltage of Pad No.36 to Pad No.37.	VDD × 0.7	—	VDD_{max} + 0.5	V	—
9	Low-level input voltage range	VIL2	Low-level recognition voltage of Pad No.36 to Pad No.37.	− 0.5	—	VDD × 0.3	V	—
10	High-level input current	IIH2	VP36 to 37 = 1.85 V IIH = IP36 to 37	—	0	1	µA	—
11	Low-level input current	IIL2	VP36 to 37 = 0 V IIH = IP36 to 37	—	0	1	µA	—
12	Low-level output voltage (1)	VOL1	IP37 = 3 mA, VDD > 2 V VOL1 = VP37	0	—	0.4	V	—
13	Low-level output voltage (2)	VOL2	IP37 = 3 mA, VDD < 2 V VOL2 = VP37	0	—	VDD × 0.2	V	—
14	Clock frequency	FSCL	Input frequency at Pad No.36	0	—	400	kHz	—

■ Electrical Characteristics (continued) at VDD = 2.6 V, VB = 3.6 V, VLED = 4.9 V

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
SCE, SLASEL								
15	High-level input voltage range	VIH3	High-level recognition voltage of Pad No.35 to Pad No.39.	VDD × 0.7	—	VDD_{max} + 0.5	V	—
16	Low-level input voltage range	VIL3	Low-level recognition voltage of Pad No.35 to Pad No.39.	– 0.5	—	VDD × 0.3	V	—
17	High-level input current	IIH3	VP35, 39 = 1.85 V IIH = IP35, 39	—	0	1	µA	—
18	Low-level input current	IIL3	VP35, 39 = 0 V IIH = IP35, 39	—	0	1	µA	—
SDO, CLKOUT								
19	High-level output voltage	VOH4	IP38, 45 = –2 mA	VDD × 0.8	—	—	V	—
20	Low-level output voltage	VOL4	IP38, 45 = 2 mA	—	—	VDD × 0.2	V	—

■ Electrical Characteristics (continued) at VDD = 2.6 V, VB = 3.6 V, VLED = 4.9 V

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Constant current source (for matrix LED)								
21	Output current (1)	IMX1	At 1.400 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 20 = 1 V IMX1 = IP1, 2, 4 to 7, 9 to 12, 14 to 20	1.288	1.400	1.512	mA	*1, 2
22	Output current (2)	IMX2	At 2.800 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 20 = 1 V IMX2 = IP1, 2, 4 to 7, 9 to 12, 14 to 20	2.576	2.800	3.024	mA	*1, 2
23	Output current (3)	IMX4	At 5.600 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 20 = 1 V IMX4 = IP1, 2, 4 to 7, 9 to 12, 14 to 20	5.152	5.600	6.048	mA	*1, 2
24	Output current (4)	IMX8	At 11.20 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 20 = 1 V IMX8 = IP1, 2, 4 to 7, 9 to 12, 14 to 20	10.30	11.20	12.10	mA	*1, 2
25	Output current (5)	IMX16	At 21.00 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 20 = 1 V IMX15 = IP1, 2, 4 to 7, 9 to 12, 14 to 20	19.32	21.00	22.68	mA	*1, 2
26	Leak current at Off mode	IMXOFF	At Off setup VP1, 2, 4 to 7, 9 to 12, 14 to 20 = 4.75 V IMXOFF = IP1, 2, 4 to 7, 9 to 12, 14 to 20	—	—	1	µA	—
27	Error between channels	IMXCH	Difference current between the average of all channels and each channel	–5	—	5	%	*2
SCAN switch								
28	Resistance at switch On	RSCAN	VP24= 4.62 V IP21 to 23, 25 to 28 = –5 mA RSCAN = VP21 to 23, 25 to 28 / 5 mA	—	1	2	Ω	—

Notes) *1 : Values when recommended parts (ERJ2RHD393X) are used for IREF pin. The other current settings are combination of above items.

*2 : All of the setting values of matrix block are with absolute accuracy of ±8%, the error between channels of ±5%.

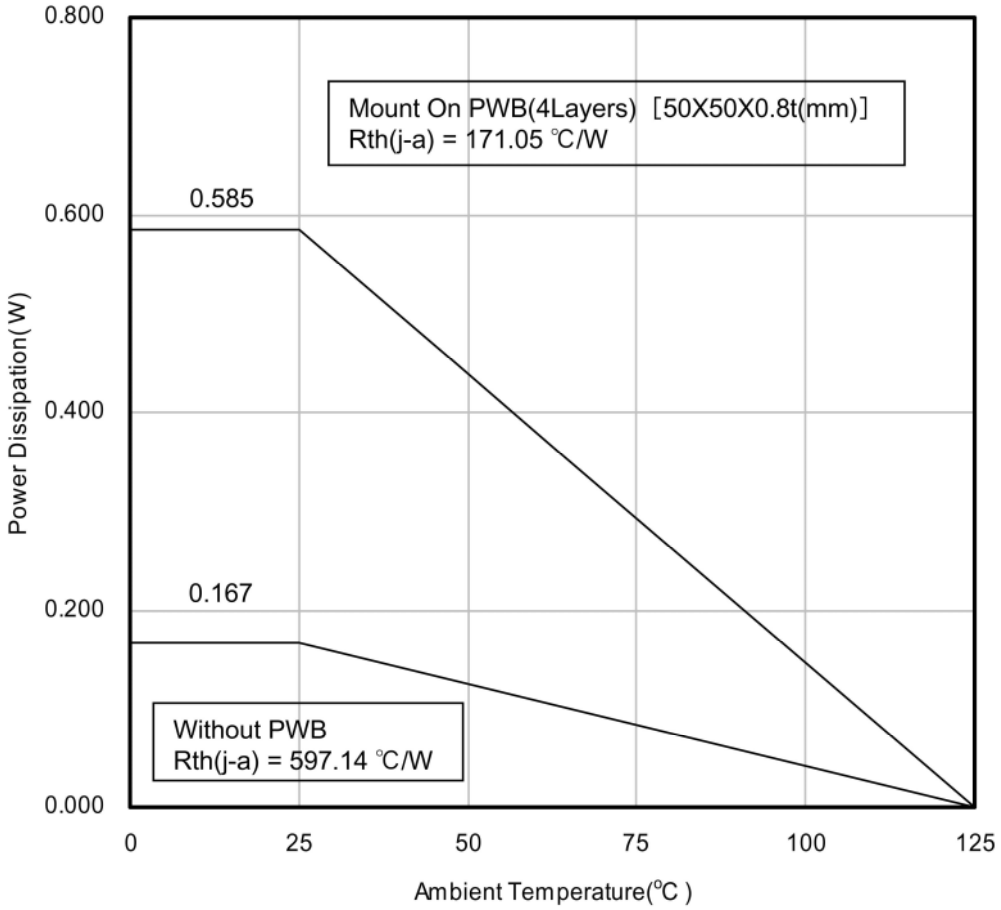
■ Electrical Characteristics (continued) at VDD = 2.6 V, VB = 3.6 V, VLED = 4.9 V

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Constant voltage source (LDO)								
29	Output voltage (1)	VL1	IP30 = –10 µA VL1 = VP30	1.79	1.85	1.91	V	—
30	Output voltage (2)	VL2	VB = 3.1 V IP30 = –30 mA VL1 = VP30	1.79	1.85	1.91	V	—
31	Short-circuit protection current	IPT1	LDOCNT = "H" REG18 = [1] VP30 = 0 V IPT1 = IP30	50	100	200	mA	—
32	Ripple rejection ratio (1)	PSL11	VB = 3.6 V + 0.2 V[p-p] f = 1 kHz IP30 = –15 mA PSL11 = 20log(acVP30 / 0.2)	—	–45	–40	dB	—
33	Ripple rejection ratio (2)	PSL12	VB = 3.6 V + 0.2 V[p-p] f = 10 kHz IP30 = –15 mA PSL12 = 20log(acVP30 / 0.2)	—	–35	–25	dB	—
Oscillator								
34	Oscillation frequency	FOSC	OSCEN = [1]	0.96	1.2	1.44	MHz	—

■ Technical Data

• P_D — T_a diagram



■ Usage Notes

• Special attention and precaution in using

1. This IC is intended to be used for general electronic equipment [Mobile phones].
   Consult our sales staff in advance for information on the following applications:
   - Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.
   - Any applications other than the standard applications intended.
     (1) Space appliance (such as artificial satellite, and rocket)
     (2) Traffic control equipment (such as for automobile, airplane, train, and ship)
     (3) Medical equipment for life support
     (4) Submarine transponder
     (5) Control equipment for power plant
     (6) Disaster prevention and security device
     (7) Weapon
     (8) Others : Applications of which reliability equivalent to (1) to (7) is required
2. Pay attention to the direction of LSI. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might smoke or ignite.
3. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
4. Perform a visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as a solder-bridge between the pins of the semiconductor device. Also, perform a full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the LSI during transportation.
5. Take notice in the use of this product that it might break or occasionally smoke when an abnormal state occurs such as output pin-V_{CC} short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short) .
   And, safety measures such as an installation of fuses are recommended because the extent of the above-mentioned damage and smoke emission will depend on the current capability of the power supply.
6. When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
   Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.
7. When using the LSI for new models, verify the safety including the long-term reliability for each product.
8. When the application system is designed by using this LSI, be sure to confirm notes in this book.
   Be sure to read the notes to descriptions and the usage notes in the book.
9. Due to unshielded structure of this IC, under exposure of light, function and characteristic of the product cannot be guaranteed. During normal operation or even under testing condition, please ensure that IC is not exposed to light.
10. Basically, chip surface is ground potential. Please design to ensure no contact between chip surface and metal shielding.

Request for your special attention and precautions in using the technical information and semiconductors described in this book

(1) If any of the products or technical information described in this book is to be exported or provided to non-residents, the laws and regulations of the exporting country, especially, those with regard to security export control, must be observed.

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Consult our sales staff in advance for information on the following applications:
- Special applications (such as for airplanes, aerospace, automotive equipment, traffic signaling equipment, combustion equipment, life support systems and safety devices) in which exceptional quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or harm the human body.

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(4) The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.

(5) When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.

(6) Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.

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