

DATA SHEET

Part No.	AN32054B
Package Code No.	UBGA050-W-4242AEL

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AN32054B

LED Matrix driver IC

■ Overview

AN32054B is equipped with the driver (7×17) for LED matrix, and RAM.

■ Features

- LED matrix driver (7×17)
- Internal memory RAM (2-side)
- LDO (1-ch)
- I²C interface + SPI interface

■ Applications

- LED driver IC for mobile phones

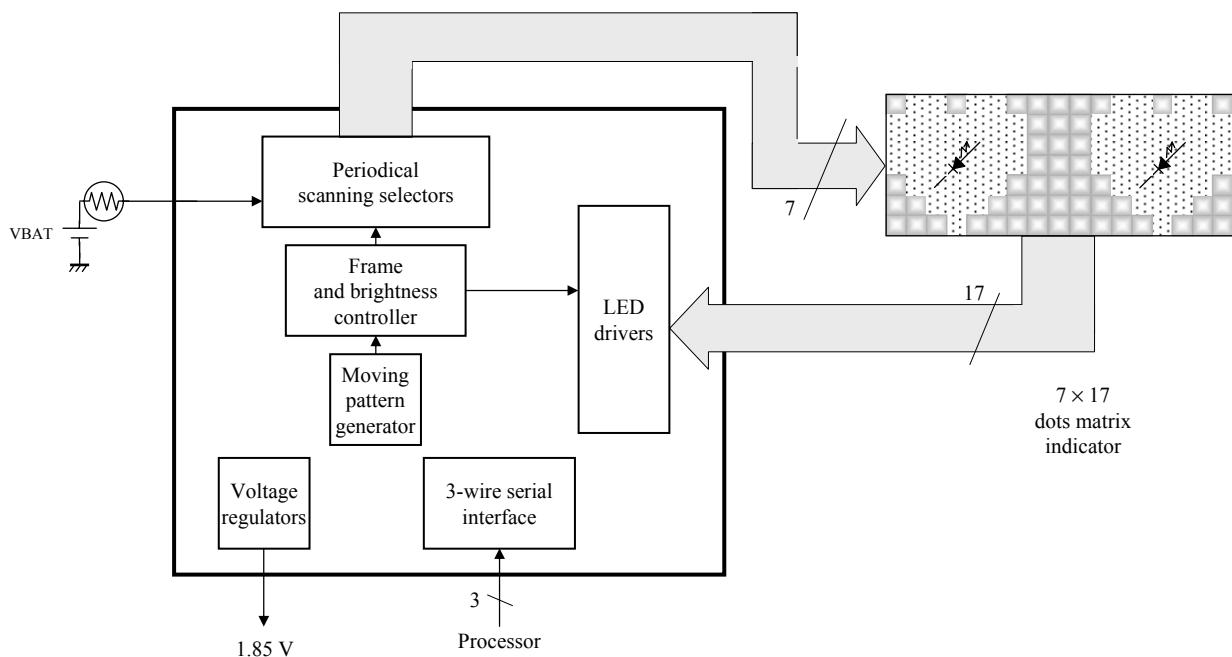
■ Package

- 50 pin Wafer Level Chip Size Package (WLCSP) (Size : $4.16 \text{ mm} \times 4.16 \text{ mm} \times 0.865 \text{ t mm}$, 0.5 mm Pitch)

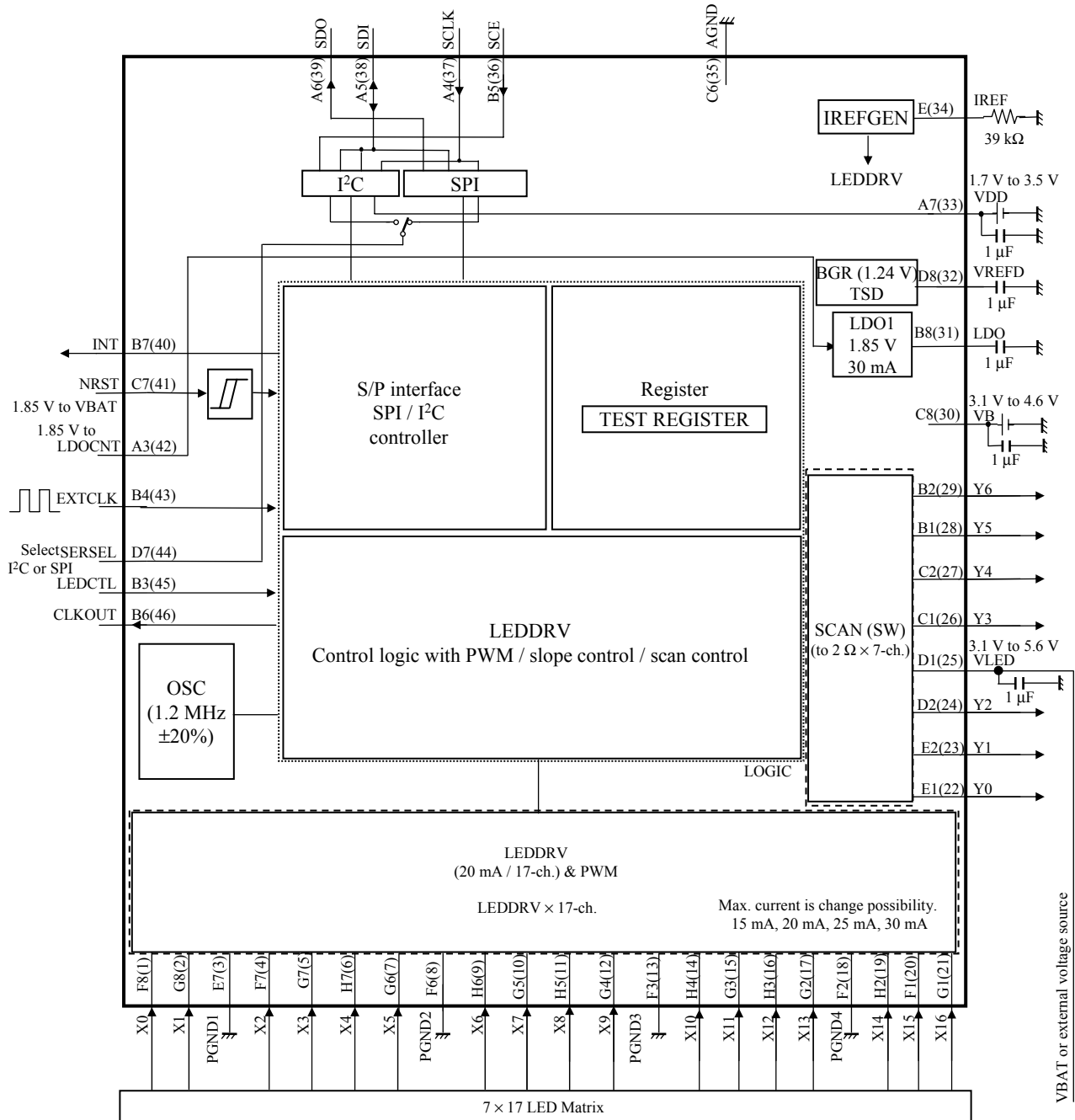
■ Type

- Bi-CMOS IC

■ System image

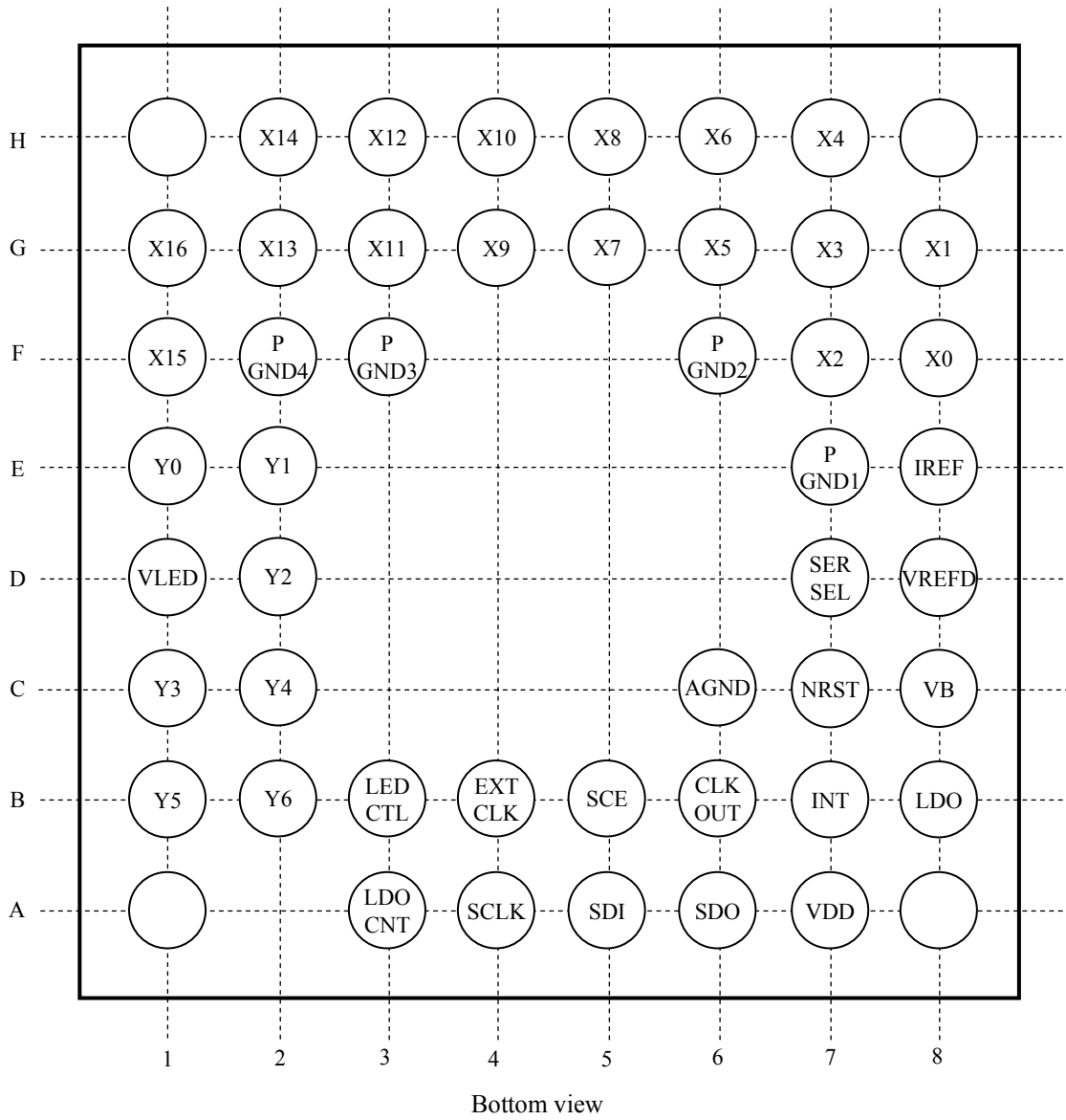


■ Application Circuit Example (Block Diagram)



- 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 capacitor of VB and VDD lines is for removal of noises. Please select the concrete capacitor values according to the PBC.
 - Apply 3.1 V or more of voltages to VLED Pin in case of supplying voltages from the external power supply.
 - Recommend ERJ2RHD393X(±0.5%) for the external resistor of Pin E8(IREF) to secure the accuracy of the constant current of each LED.

■ Pin Descriptions



Note) The pins in the four corner (A1, A8, H1 and H8) are connected to GND.

■ Pin Descriptions (continued)

Pin No. (Pad No.)	Pin name	Type	Description
F8(1)	X0	Output	The output pin of PWM control with constant current circuit. It connects with A column of matrix LED.
G8(2)	X1	Output	The output pin of PWM control with constant current circuit. It connects with B column of matrix LED.
E7(3)	PGND1	Ground	GND for matrix LED
F7(4)	X2	Output	The output pin of PWM control with constant current circuit. It connects with C column of matrix LED.
G7(5)	X3	Output	The output pin of PWM control with constant current circuit. It connects with D column of matrix LED.
H7(6)	X4	Output	The output pin of PWM control with constant current circuit. It connects with E column of matrix LED.
G6(7)	X5	Output	The output pin of PWM control with constant current circuit. It connects with F column of matrix LED.
F6(8)	PGND2	Ground	GND for matrix LED
H6(9)	X6	Output	The output pin of PWM control with constant current circuit. It connects with G column of matrix LED.
G5(10)	X7	Output	The output pin of PWM control with constant current circuit. It connects with H column of matrix LED.
H5(11)	X8	Output	The output pin of PWM control with constant current circuit. It connects with I column of matrix LED.
G4(12)	X9	Output	The output pin of PWM control with constant current circuit. It connects with J column of matrix LED.
F3(13)	PGND3	Ground	GND pin for matrix LED

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

■ Pin Descriptions (continued)

Pin No. (Pad No.)	Pin name	Type	Description
H4(14)	X10	Output	The output pin of PWM control with constant current circuit. It connects with K column of matrix LED.
G3(15)	X11	Output	The output pin of PWM control with constant current circuit. It connects with L column of matrix LED.
H3(16)	X12	Output	The output pin of PWM control with constant current circuit. It connects with M column of matrix LED.
G2(17)	X13	Output	The output pin of PWM control with constant current circuit. It connects with N column of matrix LED.
F2(18)	PGND4	Ground	GND pin for matrix LED
H2(19)	X14	Output	The output pin of PWM control with constant current circuit. It connects with O column of matrix LED.
F1(20)	X15	Output	The output pin of PWM control with constant current circuit. It connects with P column of matrix LED.
G1(21)	X16	Output	The output pin of PWM control with constant current circuit. It connects with Q column of matrix LED.
E1(22)	Y0	Output	The output pin of PWM control with constant current circuit. It connects with the 1st row of matrix LED.
E2(23)	Y1	Output	The output pin of PWM control with constant current circuit. connects with the 2nd row of matrix LED.
D2(24)	Y2	Output	The output pin of PWM control with constant current circuit. It connects with the 3rd row of matrix LED.
D1(25)	VLED	Power supply	Power supply's connect pin for matrix LED Connect with the output of battery or step-up converter.

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

■ Pin Descriptions (continued)

Pin No. (Pad No.)	Pin name	Type	Description
C1(26)	Y3	Output	The output pin of PWM control with constant current circuit. It connects with the 4th row of matrix LED.
C2(27)	Y4	Output	The output pin of PWM control with constant current circuit. It connects with the 5th row of matrix LED.
B1(28)	Y5	Output	The output pin of PWM control with constant current circuit. It connects with the 6th row of matrix LED.
B2(29)	Y6	Output	The output pin of PWM control with constant current circuit. It connects with the 7th row of matrix LED.
C8(30)	VB	Power supply	Power supply's connect pin for BGR circuit and LDO circuit
B8(31)	LDO	Output	Power supply's connect pin for serial interface input block and internal logic
D8(32)	VREFD	Output	BGR circuit output pin
A7(33)	VDD	Power supply	Power supply's connect pin for output interface
E8(34)	IREF	Output	Resistor connection pin for constant current setup
C6(35)	AGND	Ground	GND pin for Analog circuitry
B5(36)	SCE	Input	SPI interface chip-enable pin (High active) (Slave address selection control pin at I ² C mode)
A4(37)	SCLK	Input	Common clock input pin in both SPI interface and I ² C interface
A5(38)	SDI	Input / Output	Data input pin for SPI interface Data input/output pin for I ² C interface
A6(39)	SDO	Output	Data output pin for SPI interface
B7(40)	INT	Output	Interrupt output pin
C7(41)	NRST	Input	Reset input pin (Low active)
A3(42)	LDOCNT	Input	LDO ON/OFF control pin
B4(43)	EXTCLK	Input	External clock input pin
D7(44)	SERSEL	Input	SPI, I ² C selection pin
B3(45)	LEDCTL	Input	LED lit external synchronous input pin
B6(46)	CLKOUT	Output	Internal clock output pin

Note) Refer (Pad No.) to Page 4 ((Pad No.) is used in Electric 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	84.4	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 10. 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	*

Note) * : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

■ Allowable Voltage Range

- Notes)
- Voltage values, unless otherwise specified, are with respect to GND.
GND is voltage for AGND, PGND1, PGND2, PGND3, PGND4.
AGND = PGND1 = PGND2 = PGND3 = PGND4
 - 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
B5(36)	SCE	- 0.3 to (VCC1 + 0.3)	V	*1
A4(37)	SCLK	- 0.3 to (VCC1 + 0.3)	V	*1
A5(38)	SDI	- 0.3 to (VCC1 + 0.3)	V	*1, 2
C7(41)	NRST	- 0.3 to (VCC2 + 0.3)	V	*1
A3(42)	LDOCNT	- 0.3 to (VCC2 + 0.3)	V	*1
B4(43)	EXTCLK	- 0.3 to (VCC2 + 0.3)	V	*1
D7(44)	SERSEL	- 0.3 to (VCC2 + 0.3)	V	*1
B3(45)	LEDCTL	- 0.3 to (VCC2 + 0.3)	V	*1

- Notes) *1 : (VCC1 + 0.3) 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

Note) $T_a = 25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Current consumption								
1	Current consumption (1) Off mode	ICC1	VB = 3.1 V to 4.4 V LDOCNT = Low ICC1 = IPM	—	0	1	μA	—
2	Current consumption (2) Normal mode	ICC2	VB = 3.1 V to 4.4 V LDOCNT = High ILOAD = 0 μA ICC2 = IPM	—	14	20	μA	—
Reference voltage source								
3	Output voltage	VREF	VB = 3.1 V to 4.4 V IP32 = 0 μA VREF = VP32	1.21	1.24	1.27	V	—
Reference current source								
4	Output voltage	VIREF	Connect the register of 39 k Ω between Pad No. 34 and GND. IP34 = 0 μA VIREF = VP34	0.2	0.3	0.4	V	—
EXTCLK, NRST, LDOCNT, SERSEL, LEDCTL								
5	High-level input voltage range	VIH1	High-level recognition voltage of Pad No.41 to Pad No.45	1.4	—	VB + 0.3	V	*
6	Low-level input voltage range	VIL1	Low-level recognition voltage of Pad No.41 to Pad No.45	-0.3	—	0.4	V	—
7	High-level input current	IIH1	VP 41 to 45 = 1.85 V IIH = IP 41 to 45	—	0	1	μA	—
8	Low-level input current	IIL1	VP 41 to 45 = 0 V IIL = IP 41 to 45	—	0	1	μA	—

Notes) * : Please refer to page.80 to design "H" level for SERSEL terminal.

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

Note) $T_a = 25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
SCE, SCLK, SDI								
9	High-level input voltage range	VIH2	High-level recognition voltage of Pad No.36 to Pad No.38	$0.7 \times \text{VDD}$	—	$\text{VDD}_{\text{max}} + 0.5$	V	—
10	Low-level input voltage range	VIL2	Low-level recognition voltage of Pad No.36 to Pad No.38	-0.5	—	$0.3 \times \text{VDD}$	V	—
11	High-level input current	IIH2	VP36 to 38 = 1.85 V IIH = IP36 to 38	—	0	1	μA	—
12	Low-level input current	IIL2	VP36 to 38 = 0 V IIH = IP36 to 38	—	0	1	μA	—
13	Low-level output voltage (1)	VOL1	IP38 = 3 mA, VDD > 2 V VOL1 = VP38	0	—	0.4	V	—
14	Low-level output voltage (2)	VOL2	IP38 = 3 mA, VDD < 2 V VOL2 = VP38	0	—	$0.2 \times \text{VDD}$	V	—
SDO, INT, CLKOUT								
15	High-level output voltage	VOH1	IP39, 40, 46 = -2 mA	$\text{VDD} \times 0.8$	—	—	V	—
16	Low-level output voltage	VOL3	IP39, 40, 46 = 2 mA	—	—	$\text{VDD} \times 0.2$	V	—

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

Note) $T_a = 25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
Current generator (for matrix LED)								
17	Output current (1)	IMX1	At 1.333 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21 = 1 V IMX1 = IP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21	1.226	1.333	1.440	mA	*1, 2
18	Output current (2)	IMX2	At 2.666 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21 = 1 V IMX2 = IP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21	2.452	2.666	2.879	mA	*1, 2
19	Output current (3)	IMX4	At 5.332 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21 = 1 V IMX4 = IP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21	4.905	5.332	5.759	mA	*1, 2
20	Output current (4)	IMX8	At 10.66 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21 = 1 V IMX8 = IP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21	9.81	10.66	11.52	mA	*1, 2
21	Output current (5)	IMX15	At 20.00 mA setup VP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21 = 1 V IMX15 = IP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21	18.40	20.00	21.60	mA	*1, 2
22	Leak current at the time of OFF	IMXOFF	Current OFF setup VP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21 = 4.75 V IMXOFF = IP1, 2, 4 to 7, 9 to 12, 14 to 17, 19 to 21	—	—	1	μA	—
23	The error between channels	IMXCH	Difference current between the average of all channels and each channel.	-5	—	5	%	*2

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

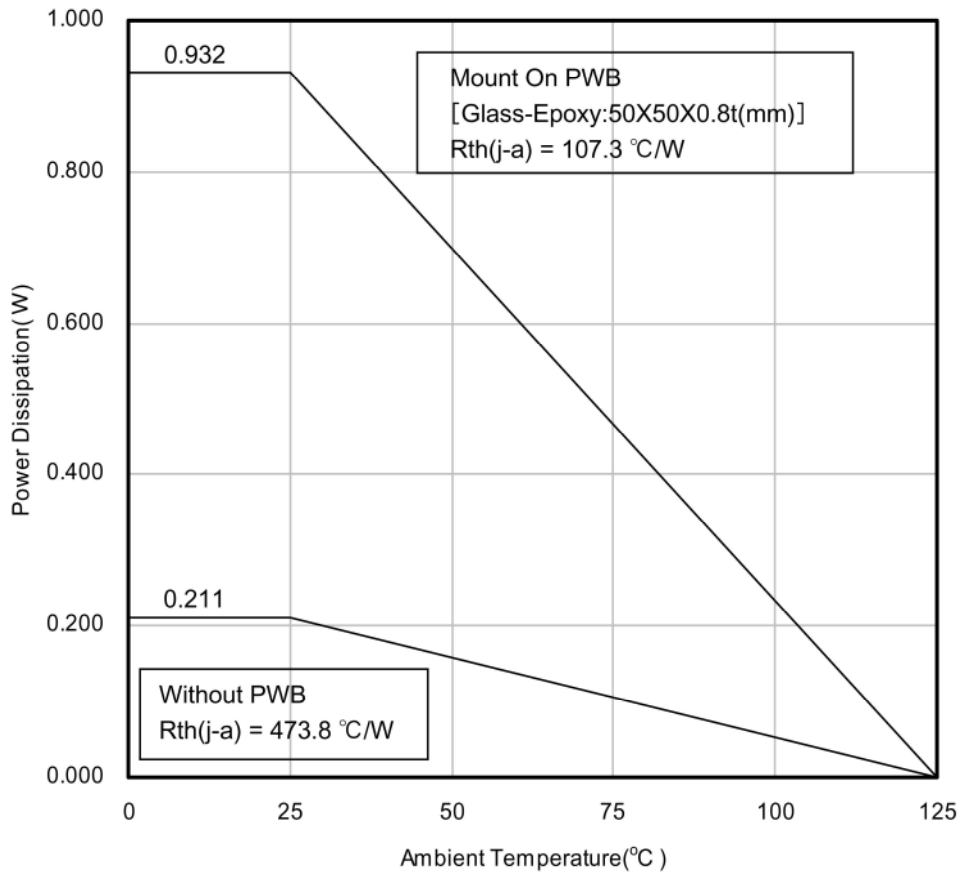
*2 : All of the setting values of matrix block are with absolute accuracy of $\pm 8\%$, the error between channels of $\pm 5\%$.

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

Note) $T_a = 25^{\circ}\text{C} \pm 2^{\circ}\text{C}$ unless otherwise specified.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Notes
				Min	Typ	Max		
SCAN Switch								
24	Resistance at the switch ON	RSCAN	VP25 = VP28 = 4.62 V to 5.57 V IP22 to 24, 26, 27, 29, 30 = 5 mA RSCAN = VP22 to 24, 26, 27, 29, 30 / 5 mA	—	1	2	Ω	—
Voltage regulator (LDO)								
25	Output voltage	VL1	VB = 3.1 V to 4.4 V IP31 = 10 μA to 30 mA VL1 = VP31	1.79	1.85	1.91	V	—
26	Short current protection current	IPT1	LDOCNT = High REG18 = [1] VP31 = 0 V IPT1 = IP31	50	100	200	mA	—
27	Ripple rejection ratio (1)	PSL11	VB = 3.6 V + 0.2 V[p-p] f = 1 kHz IP31 = 15 mA PSL11 = $20\log(\text{acVP31} / 0.2)$	—	-45	-40	dB	—
28	Ripple rejection ratio (2)	PSL12	VB = 3.6 V + 0.2 V[p-p] f = 10 kHz IP31 = 15 mA PSL12 = $20\log(\text{acVP31} / 0.2)$	—	-35	-25	dB	—
Oscillation circuit								
29	Oscillation frequency	FOSC	VB = 3.1 V to 4.4 V 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-VCC 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 using the LSI for new models, verify the safety including the long-term reliability for each product.
7. 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.
8. 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.
9. 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

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- (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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