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REFERENCE

SPEC No. EL193027
ISSUE: Mar. 19, 2007

To: _____

S P E C I F I C A T I O N S

Product Type 24-ch LED Driver IC

Model No. IR2D20U
(IR2D20U1)

※ This specifications contains 24 pages including the cover and appendix.
If you have any objections, please contact us before issuing purchasing order.

CUSTOMERS ACCEPTANCE

DATE: _____

BY: _____

PRESENTED

BY: H. Fujita
H. Fujita
Dept. General Manager

REVIEWED BY: _____ PREPARED BY: _____

Engineering Dept. IV
Opto-Analog Devices Division
Electronic Components Group
SHARP Corporation

IR2D20U
REFERENCE

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(1) The products covered herein are designed and manufactured for the following application areas. When using the products covered herein for the equipment listed in paragraph (2), even for the following application areas, be sure to observe the precautions given in Paragraph (2). Never use the products for the equipment listed in Paragraph (3).

- Office electronics
- Instrumentation and measuring equipment
- Machine tools
- Audiovisual equipment
- Home appliances
- Communication equipment other than for trunk lines

(2) These contemplating using the products covered herein for the following equipment which demands high reliability, should first contact a sales representative of the company and then accept responsibility for incorporating into the design fail-safe operation, redundancy, and other appropriate measures for ensuring reliability and safety of the equipment and the overall system.

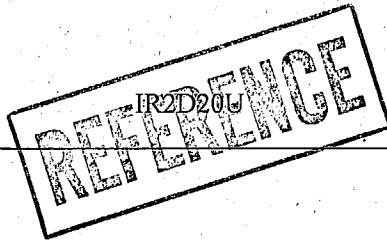
- Control and safety devices for airplanes, trains, automobiles, and other transportation equipment
- Mainframe computers
- traffic control systems
- Gas leak detectors and automatic cutoff devices
- Rescue and security equipment
- Other safety devices and safety equipment, etc.

(3) Do not use the products covered herein for the following equipment which demands extremely high performance in terms of functionality, reliability, or accuracy

- Aerospace equipment
- Communications equipment for trunk lines
- Control equipment for the nuclear power industry
- Medical equipment related to life support, etc.

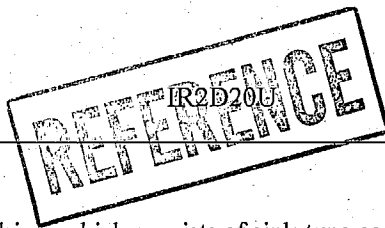
(4) please direct all queries and comments regarding the interpretation of the above three Paragraphs to a sales representative of the company.

- Please direct all queries regarding the products covered herein to a sales representative of the company.



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1. General Description

This IC is constant current LED driver which consists of sink-type constant current output circuit with 24ch variable current and 24bit shift register , latch and gate circuit which can ON/OFF control.

This product is optimum for use as LED illumination application and it can change brightness of LED consecutively by using gradation control circuit.

By using those products (with 3pcs) and RGB LED , it's possible to create gradation colors which change consecutively.

2. Features

- High speed operation : Clock frequency 20MHz (MAX.) , 16.6MHz at cascade connection
- Sink-type constant current output : possible to change 2 to 30mA , 3 lines individually with external 3 resistors
- Logic input / output : CMOS level
- Built in gradation function
- Built in thermal shutdown function (TYP. 175degC)

Radiation resistance designing:

No

Package:

52-pin HQFN package (7.2mm x 7.2mm)

Chip material and wafer board type:

P-type silicon substrate monolithic IC

Lead surface finish:

Lead-free

Process:

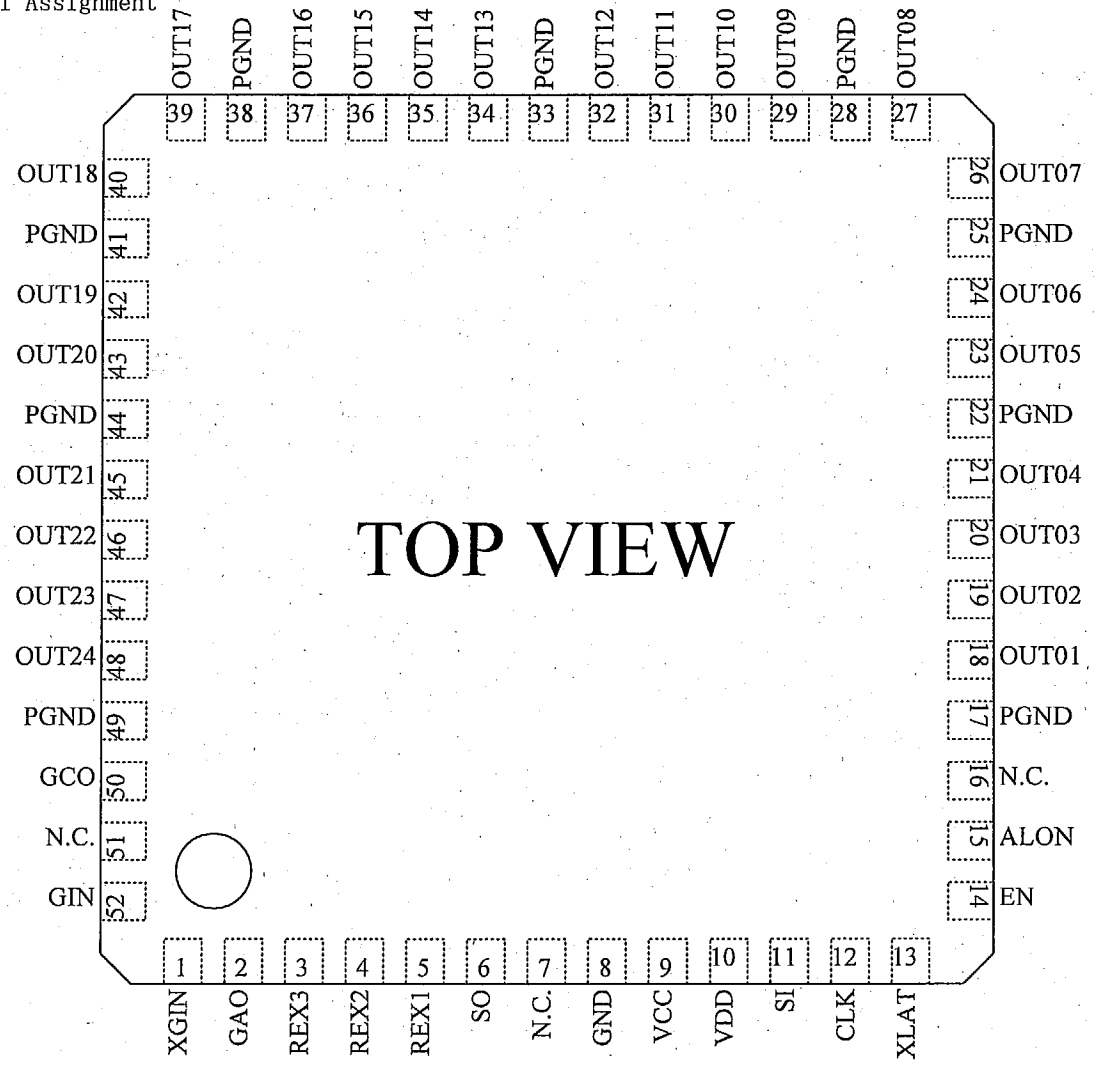
CMOS

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R2D201

3. Terminal Name

No.	Symbol	Name	No.	Symbol	Name	No.	Symbol	Name
1	XGIN	Setting gradation	19	OUT02	Output of current	37	OUT16	Output of current
2	GAO	Output of OP-AMP	20	OUT03	Output of current	38	PGND	GND for driver
3	REX3	Setting output current	21	OUT04	Output of current	39	OUT17	Output of current
4	REX2	Setting output current	22	PGND	GND for driver	40	OUT18	Output of current
5	REX1	Setting output current	23	OUT05	Output of current	41	PGND	GND for driver
6	SO	Output of serial data	24	OUT06	Output of current	42	OUT19	Output of current
7	N.C.	Non connection	25	PGND	GND for driver	43	OUT20	Output of current
8	GND	Gnd for logic	26	OUT07	Output of current	44	PGND	GND for driver
9	VCC	Vcc	27	OUT08	Output of current	45	OUT21	Output of current
10	VDD	Vdd	28	PGND	GND for driver	46	OUT22	Output of current
11	SI	Input of serial data	29	OUT09	Output of current	47	OUT23	Output of current
12	CLK	Input of Clock	30	OUT10	Output of current	48	OUT24	Output of current
13	XLAT	Input of Latch	31	OUT11	Output of current	49	PGND	GND for driver
14	EN	Input of enable	32	OUT12	Output of current	50	GCO	Output of comparator
15	ALON	Controll of all ON	33	PGND	GND for driver	51	N.C.	Non connection
16	N.C.	Non connection	34	OUT13	Output of current	52	GIN	Setting gradation
17	PGND	GND for driver	35	OUT14	Output of current			
18	OUT01	Output of current	36	OUT15	Output of current			

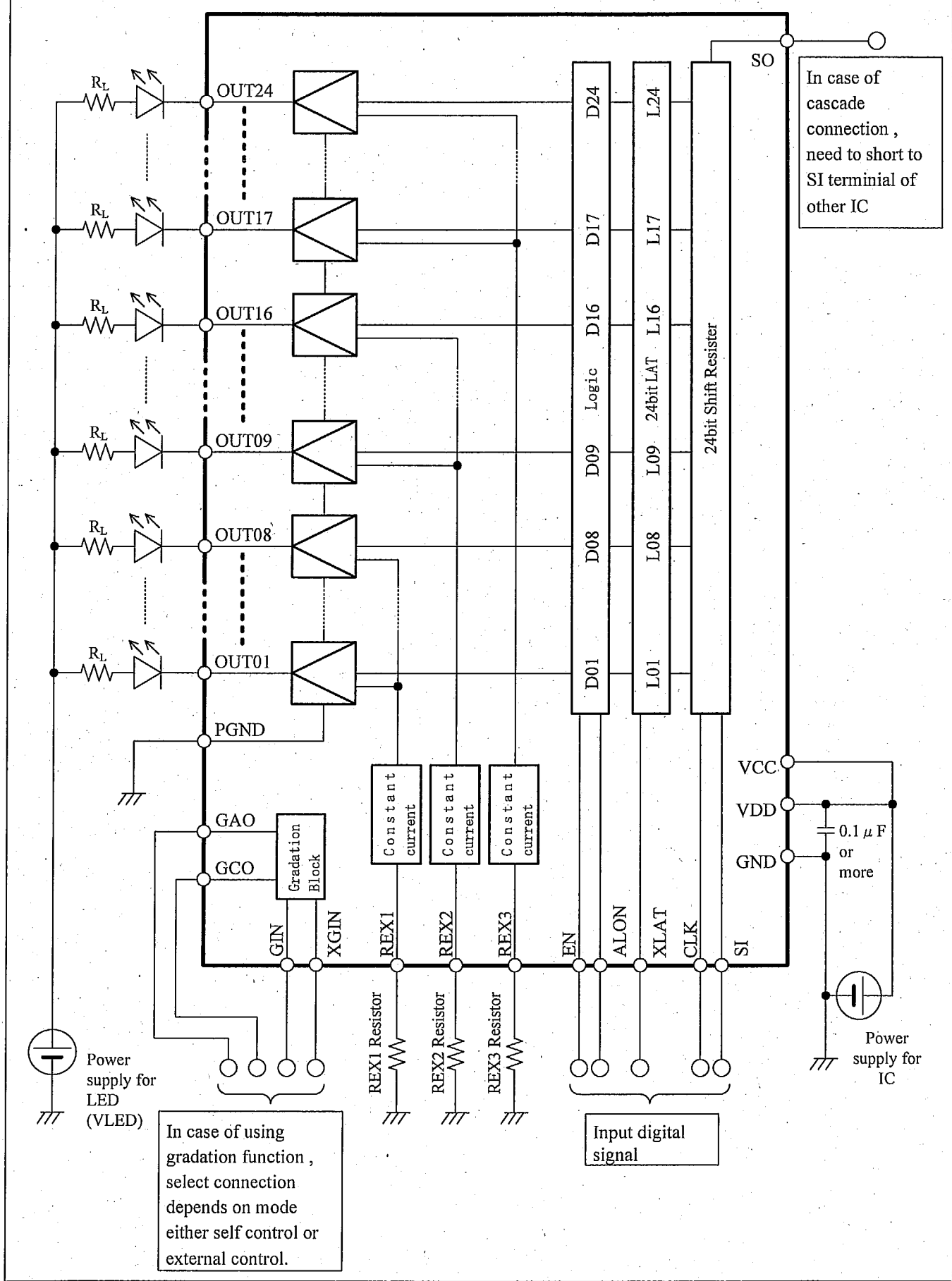
4. Terminal Assignment



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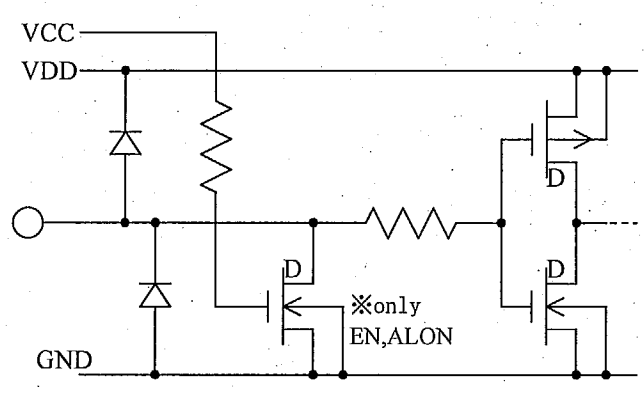
IR2D200

5. Block Diagram and Basic Connection Diagram

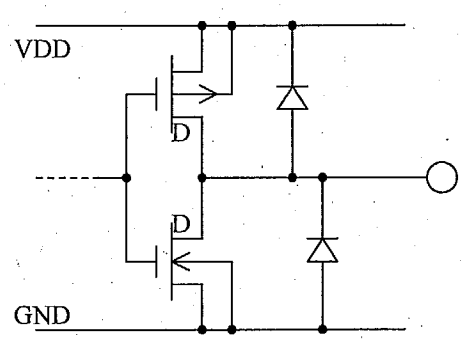


6. Terminal Equivalent Circuit (The element of Electro-Static Discharge measures is contained.)

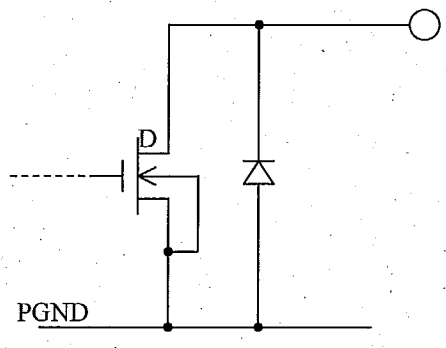
(a) SI, CLK, XLAT, EN, ALON



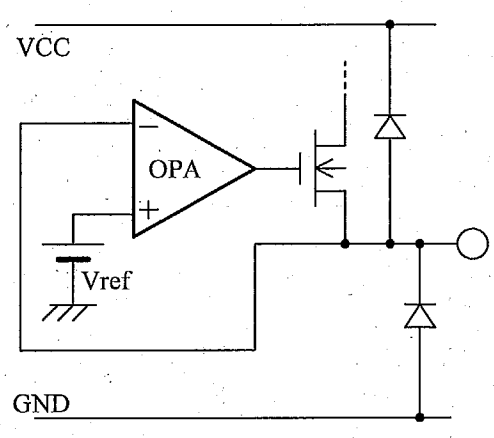
(b) SO



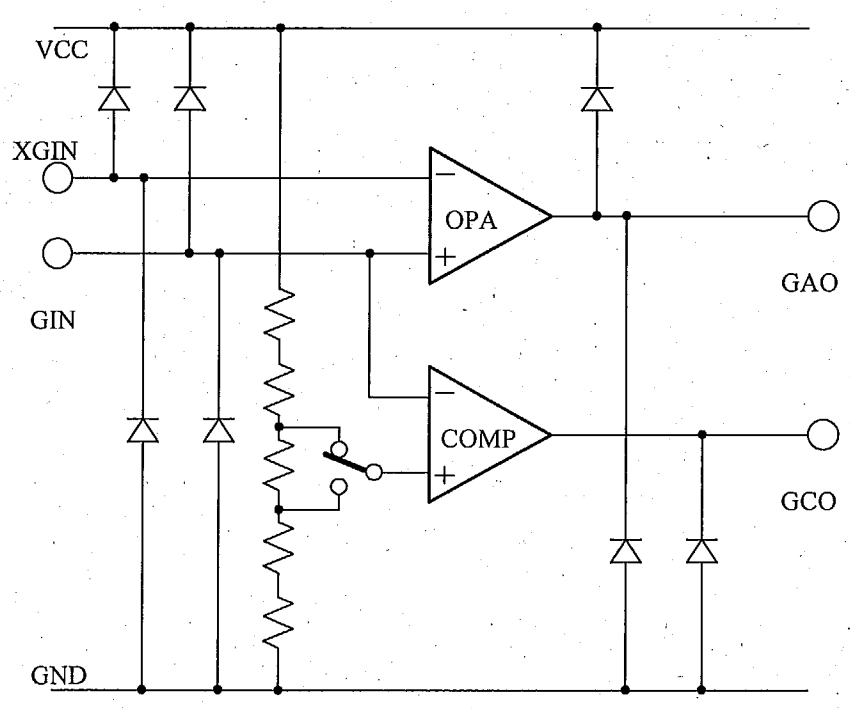
(c) OUTxx



(d) REXx



(e) GIN, XGIN, GAO, GCO





7. Description of Function Operations

7-1. Terminal Description

No.	Symbol	Description
1	XGIN	XGIN : Inverted input terminal of OP-AMP, GAO : Output terminal
2	GAO	In case of R1=resister between XGIN and VDD and R2=resister between XGIN and GAO, possible to control current range which makes self oscillation gradation by ration of R1 and R2. In case of R1=100kohm, R2=68kohm, output current IOUTxx (0 to 100%) which is settled by resistor connected to REXx terminal shall be current range of self oscillation gradation. (Refer to page.12 and to REXx for IOUTxx). <Reference> In case of $100/68 < R1/R2$, upper limit of gradation current range shall be decreased from 100%. In case of $100/68 > R1/R2$, lower limit of gradation current range shall be increased from 0%.
3	REX3	By adding resistor or constant current to between REX3, REX2, REX1 and GND, it can set up IOUT. Resister : $IOUT_{xx} (mA) = (V_{ref}/REX_{xx} \text{ resistor}) * 200$ Constant current source : $IOUT_{xx} (mA) = REX_{xx} \text{ current} * 200$ <Reference> In case of $REX_{xx} = 120\Omega$, REX_{xx} terminal voltage (V_{ref}) = TYP. 1.24V, IOUTxx shall be around $(1.24V/120\Omega) * 200 = 20.7mA$.
4	REX2	
5	REX1	
6	SO	Serial data output terminal for shift register
8	GND	GND terminal for logic and constant current circuit
9	VCC	Power supply for constant current circuit, etc., (TYP. 5V)
10	VDD	Power supply for logic circuit (TYP. 5V)
11	SI	Serial data input terminal for shift register
12	CLK	Clock input terminal for shift register Data shifts at clock rising up
13	XLAT	Input terminal for latch of serial data. Data of shift register at "H" level shall be through F/F of latch. Latch at "L" level.
14	EN	Terminal for output enable. Output shall be "OFF" at "L" level. Output can be "ON" at "H" level.
15	ALON	All output can be "ON" at "H" level by doing "H" level for EN terminal By doing "H" level for EN terminal at "L" level, output shall be ON/OFF by "L"/"H" level signal from SI terminal.
18,19,20,21,23,24,26,27	OUT01 to OUT08	Constant current output terminal with OPEN drain type. Output current shall be fixed by REX1 resistor connected REX1 terminal
29,30,31,32,34,35,36,37	OUT09 to OUT16	Constant current output terminal with OPEN drain type. Output current shall be fixed by REX2 resistor connected REX2 terminal
39,40,42,43,45,46,47,48	OUT17 to OUT24	Constant current output terminal with OPEN drain type. Output current shall be fixed by REX3 resistor connected REX3 terminal
17,22,25,28,33,38,41,44,49	PGND	GND terminal for LED driver
50	GCO	Comparator output terminal for self oscillation gradation. Need to connect resistor for oscillation frequency Be OPEN at external synchronization
52	GIN	Terminal of capacitor and resistor for self oscillation gradation frequency. Need to input external synchronization signal through CR low pass filter at external synchronization.

7-2. Function Table

Input		Internal	Output
EN	ALON	Lxx	OUTxx
L	*	*	OFF
H	H	*	ON
H	L	L	OFF
H	L	H	ON

* : Don't care

7-3. Cautions

- Don't to exceed Absolute rating at anytime during power on and power off.
- It is recommended to install resistor capacitor between output terminal and LED (or between LED and power supply for LED) in order to reduce heat dissipation for IC.
- Continuous running with the maximum output power may be caused exceeding maximum power dissipation. Be careful not to exceed maximum power dissipation in consideration of heat transfer resistance of a mounting board, ambient air temperature, and output electric power.
 - <Example> In case of usage of all 24ch of IR2D20U, $T_a=70\text{degC}$
 $(150\text{degC}-70\text{degC}) * 12.8\text{mW/degC} \geq \text{Output current} * \text{Output voltage} * 24\text{ch}$
Please set up output current and output voltage based on above calculation.
- Don't apply voltage and current directly from power supply to GAO, GCO and SO terminal.
- Don't short for REXx terminal with others because over current may flash.
- It is recommended to connect to GND or GAO terminal because constant current output terminal may cause oscillation when REXx terminal connects to unstable GND level.
- It is recommended to use precision resistor (<1% tolerance) for REXx.
- This device has not power on reset IC. Therefore data of F/F for latch shall not be fixed at power on, it is recommended to apply "L" level for EN signal at power on and after fixing data of F/F for latch, then use "H" level for EN signal.
- Connect the power supply terminals (VDD and VCC terminal) with the shortest distance and set terminals same potential.
- Connect the grounding terminals (GND and PGND terminal) with the shortest distance and set terminals same potential.
- Position a decoupling capacitor between VDD and GND in order to stabilize VDD line close to the IC.
- SI, CLK and XLAT terminals should be "L" or "H" level and don't use OPEN mode.
- SI, CLK, XLAT, EN and ALON terminals are not Hysteresis input, input signal may cause un-stable condition by noise when input signal is in the vicinity of 0.5VDD. Apply any countermeasure against noise.
- All circuit examples are reference, and it's not guaranteed all operation at any conditions. Please be careful and check operation.
- This device has not overvoltage, overcurrent protection circuit inside and use protection circuits if it's necessary.
- It's impossible to make any connections under heat sink of this package besides GND. It's recommended to connect heat sink in order to reduce heat dissipation. And please connect to GND at this time.
- Use patterns with better heat dissipation.

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REFERENCE

8. Absolute Maximum Ratings		(Ta=25°C)		
Parameter	Symbol	Conditions	Rating	Unit
Power supply	VDD	VDD, VCC	6.0	V
Input pin voltage	V _{IN}	SI, CLK, XLAT, EN, ALON	-0.3~VDD+0.3	V
Output current	I _{OUT}	OUTxx	30	mA
Output pin voltage	V _{OUT}	OUTxx	20.0	V
Power dissipation	P _d	Ta ≤ 25°C *1	1.6	W
Derating ratio	ΔPd/°C	Ta > 25°C *1	12.8	mW/°C
Operating temperature range	T _{opr}		-10~+70	°C
Storage temperature range	T _{stg}		-55~+150	°C

*1 : natural convection, on-board, Conformity to SEMI42-996

9. Recommended Operating Conditions		(VDD=VCC=4.5~5.5V, Ta=-10~70°C)				
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power supply	VDD	VDD, VCC	4.5	5.0	5.5	V
Output pin voltage	V _{OUT}	OUTxx	1.8	-	18.0	V
Output current	I _{OUT}	OUTxx	2.0	-	30.0	mA
	I _{SOH}	SO	-	-	-1.0	
	I _{SOL}	SO	-	-	1.0	
	I _{GAO}	GAO	-	-	0.5	
Input pin voltage 1	V _{IN1}	SI,CLK,XLAT,EN,ALON	0.0	-	VDD	V
Input pin voltage 2	V _{IN2}	XGIN,GIN	0.0	-	VDD-1.5	V
Oscillating frequency	f _{CLK}		-	-	20	MHz
		Cascading connection	-	-	16.6	

Note : Please use it by recommended operating conditions. There is a possibility that the reliability of IC is ruined when using it exceeding this condition.

Note : The outflow current from IC is a minus, and the inflow current to IC is a plus.

REFERENCE

R2D20U

10. Electrical Characteristics

The measurement circuit is basic connection diagram of page 4. (However, LED is not connected with the output terminal in the measurement circuit. Only resistance RL is connected between the power supply for LED and the output terminal. The voltage of the power supply for LED is defined as VLED.)

10-1. DC Characteristics

Unless otherwise specified : EN="H" ALON="L" SI, CLK and XLAT input the signal shown on page 11.
The timing condition is shown in 11-2. CLK=20MHz Resistor of REXx is 12kΩ RL=300 VLED=4V

(VDD=VCC=4.5~5.5V, Ta=-10~70°C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit	
"H" level input voltage	V _{IH}		0.7VDD	-	VDD	V	
"L" level input voltage	V _{IL}		GND	-	0.3VDD	V	
"H" level input current	I _{IH}	VIN=5.0V SI, CLK and XLAT are OPEN	-	-	± 10	μA	
		VIN=5.0V EN and ALON are OPEN	-	33	100	μA	
"L" level input current	I _{IL}	VIN=0V	-	-	± 10	μA	
Voltage of comparison	V _{CH}	at GIN	-	0.6VDD	-	V	
	V _{CL}	at GIN	-	0.4VDD	-	V	
Output voltage of SO	V _{OH}	VDD=VCC=5.0V, I _{OH} =-1.0mA	4.4	4.7	-	V	
	V _{OL}	VDD=VCC=5.0V, I _{OL} =1.0mA	-	0.3	0.6	V	
Output leak current	I _{OLEAK}	VLED=18V, EN="L", Current of one output terminal	-	-	10	μA	
Output current	I _{OUT}	VDD=VCC=5.0V R _L =0Ω, VLED=2.0V, SI="H" Ta=25°C	16.5	20.7	24.9	mA	
		Error margin between bit	ΔI _{OL}	-	3	12	± %
Voltage of REXx	V _{ref}	Ta=25°C, CLK=0Hz	VDD=5.0V	1.18	1.24	1.30	V
	Line regulation	EN="L"	VDD=4.5V→5.5V	-10	10	30	mV
Current consumption	I _{DD}	VDD=VCC=5.0V, ALON="H" CLK=0Hz	-	5.5	11	mA	

*1 : Total current of VDD and VCC. Please set it to "ON" of all output terminal.
* : The outflow current from IC is a minus, and the inflow current to IC is a plus.

10-2. Timing Condition

(VDD=VCC=4.5~5.5V, Ta=-10~70°C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Width of clock pulse	PW _{CLK}	Time when VI(CLK) is "H"	20	-	-	ns
		Time when VI(CLK) is "L"	20	-	-	ns
Frequency of clock	f _{CLK}	Duty=50±10%	-	-	20	MHz
Set-up time	t _{STUP}	SI - CLK ↑	10	-	-	ns
Hold time	t _{HOLD}	CLK ↑ - SI	5	-	-	ns
CLK ↑ - XLAT ↓	t _{C-L}	CLK ↑ - XLAT ↓	40	-	-	ns
XLAT ↓ - CLK ↑	t _{L-C}	XLAT ↓ - CLK ↑	40	-	-	ns
XLAT ↑ - EN ↑	t _{L-EN}	XLAT ↑ - EN ↑	40	-	-	ns
Width of latch pulse	PW _{LAT}	Time when XLAT is "H"	20	-	-	ns
Rise time of clock / rise time of latch	t _r		-	-	500	ns
Fall time of clock / fall time of latch	t _f		-	-	500	ns

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REFERENCE

10-3. AC Characteristic

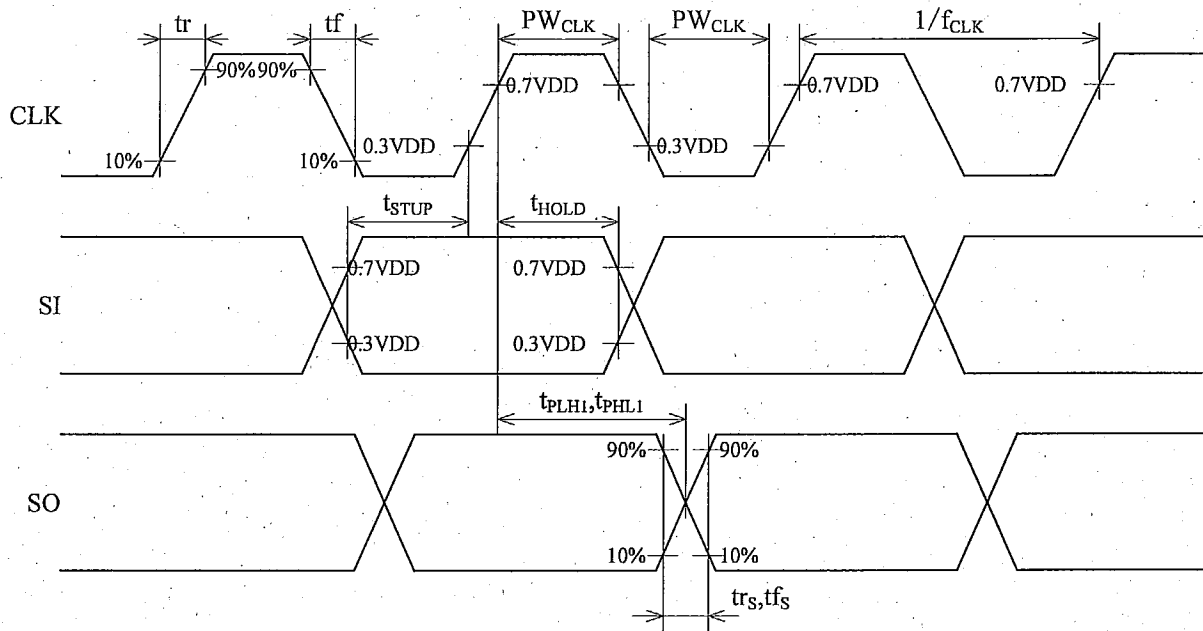
(VDD=VCC=4.5~5.5V, Ta=-10~70°C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Propagation delay time of output data rising	t _{PLH1}	CLK ↑ - SO ↑ CL=10pF *1	5	20	50	ns
Propagation delay time of output data falling	t _{PHL1}	CLK ↑ - SO ↓ CL=10pF *1	5	20	50	ns
Propagation delay time of output driver rising	t _{PLH2}	EN ↓ - OUT _{xx} ↑, R _L =300 Resistor of R-EXT is 12kΩ	-	-	500	μs
Propagation delay time of output driver falling	t _{PHL2}	EN ↑ - OUT _{xx} ↓, R _L =300 Resistor of R-EXT is 12kΩ	-	-	500	μs
Rise time of output data	t _{rs}	CL=10pF *1	-	-	30	ns
Fall time of output data	t _{fs}	CL=10pF *1	-	-	30	ns

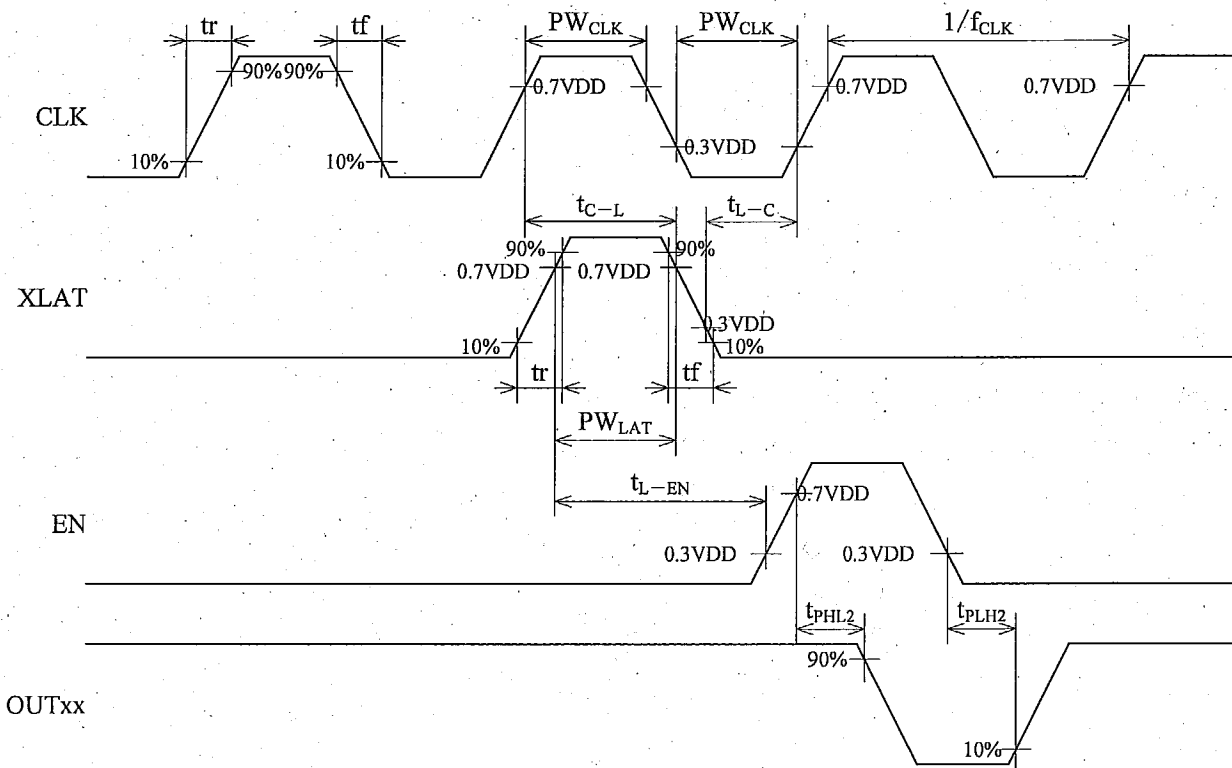
*1 : CL is capacitor connected between SO and GND when you measure AC characteristic

10-4. Timing Chart

(1) Timing 1

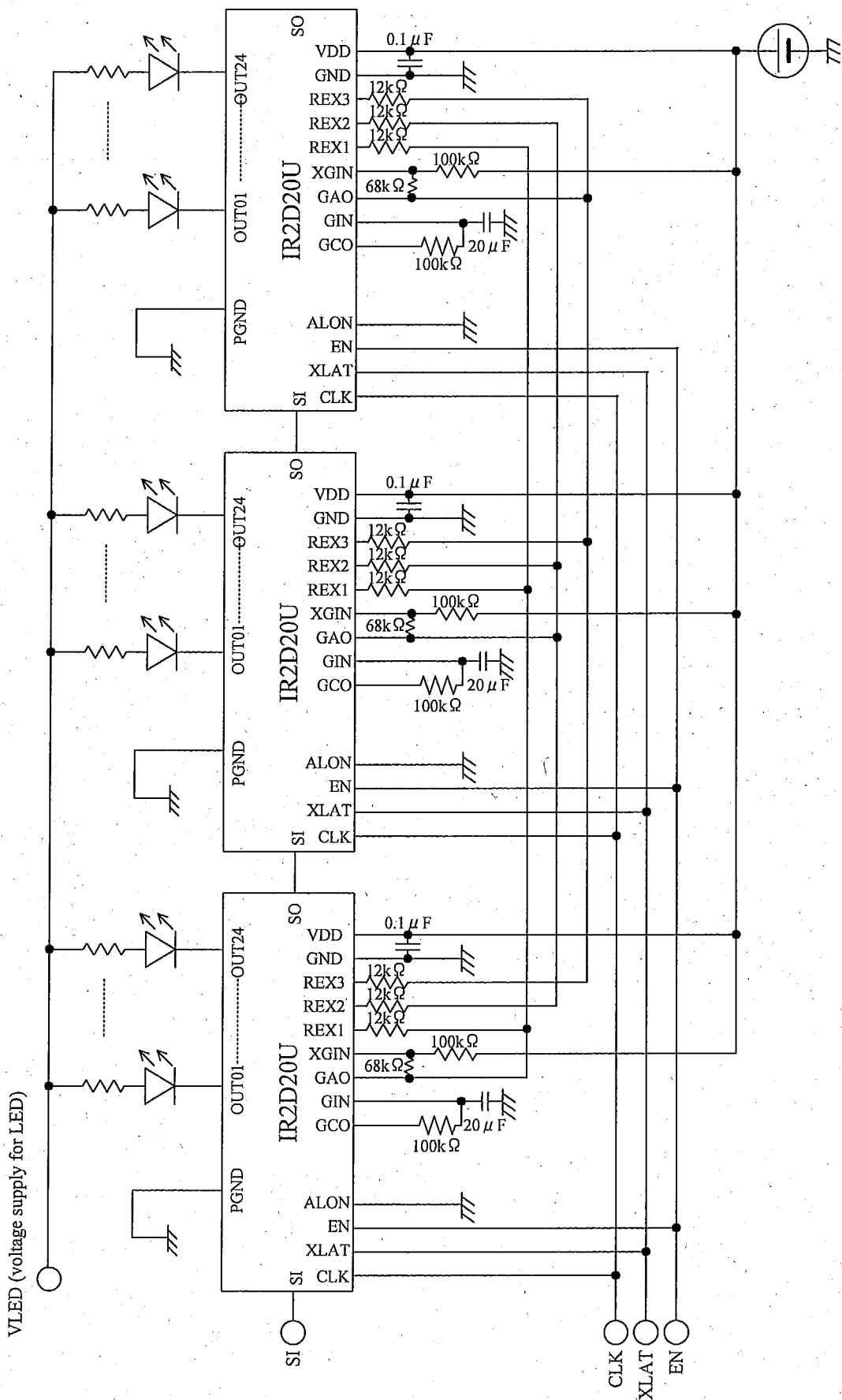


(2) Timing 2



REFERENCE
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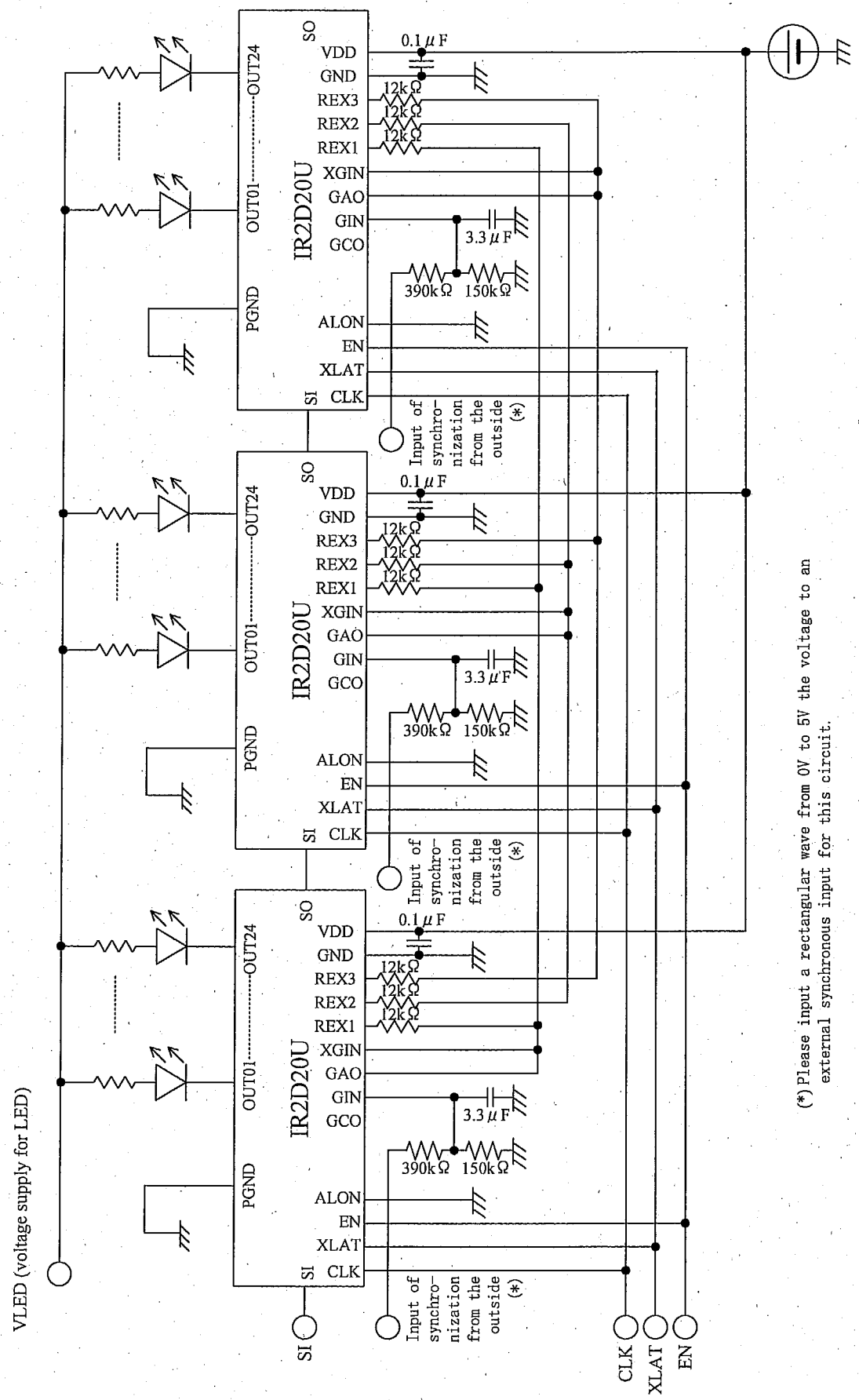
11. Application Circuit Example
(Gradation of individual RGB)
11-1. Gradation of self oscillation



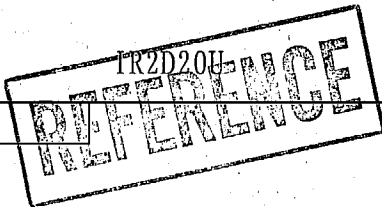
REFERENCE

IR2D20U

11-2. Gradation of External Synchronization



(*) Please input a rectangular wave from 0V to 5V the voltage to an external synchronous input for this circuit.



12 Package and packing specification

[Applicability]

This specification applies to an IC package of the LEAD-FREE delivered as a standard specification.

1.Storage Conditions.

1-1.Storage conditions required before opening the dry packing.

- Normal temperature : 5~40°C
- Normal humidity : 80% (Relative humidity) max.
- Storage period : One year max.

*"Humidity" means "Relative humidity"

1-2.Storage conditions required after opening the dry packing.

In order to prevent moisture absorption after opening, ensure the following storage conditions apply:

(1) Storage conditions for one-time soldering. (Convection reflow^{*1}, IR/Convection reflow.^{*1})

- Temperature : 5~25°C
- Humidity : 60% max.
- Period : 72 hours max. after opening.

(2) Storage conditions for two-time soldering. (Convection reflow^{*1}, IR/Convection reflow.^{*1})

a. Storage conditions following opening and prior to performing the 1st reflow.

- Temperature : 5~25°C
- Humidity : 60% max.
- Period : 72 hours max. after opening.

b. Storage conditions following completion of the 1st reflow and prior to performing the 2nd reflow.

- Temperature : 5~25°C
- Humidity : 60% max.
- Period : 72 hours max. after completion of the 1st reflow.

*1:Air or nitrogen environment.

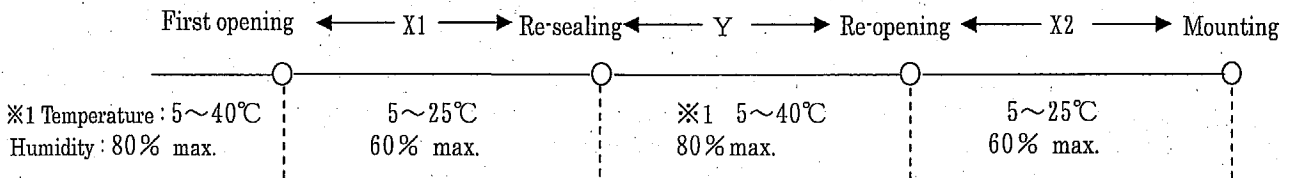
1-3.Temporary storage after opening.

To re-store the devices before soldering, do so only once and use a dry box or place desiccant (with a blue humidity indicator) with the devices and perform dry packing again using heat-sealing.

The storage period, temperature and humidity must be as follows :

(1) Storage temperature and humidity.

※1 : External atmosphere temperature and humidity of the dry packing.



(2) Storage period.

- X1 + X2 : Refer to Section 1-2(1) and (2)a , depending on the mounting method.
- Y : Two weeks max.

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2. Baking Condition.

(1) Situations requiring baking before mounting.

- Storage conditions exceed the limits specified in Section 1-2 or 1-3.
- Humidity indicator in the desiccant was already red (pink) when opened.
(Also for re-opening.)

(2) Recommended baking conditions.

- Baking temperature and period :
120+10/-0°C for 2~3 hours.
- The above baking conditions apply since the trays are heat-resistant.

(3) Storage after baking.

- After baking, store the devices in the environment specified in Section 1-2 and mount immediately.

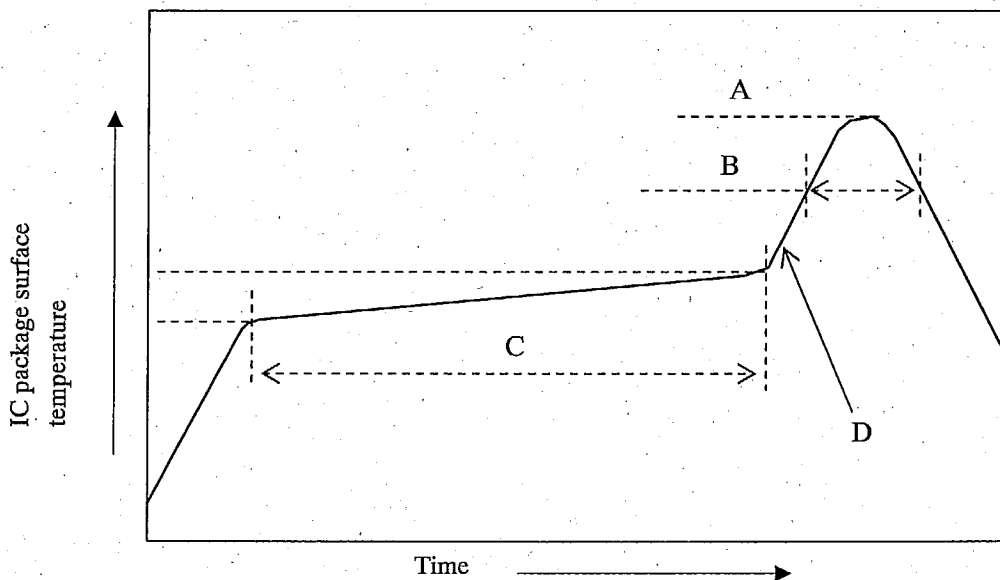
3. Surface mount conditions.

The following soldering conditions are recommended to ensure device quality.

3-1. Soldering.

(1) Convection reflow or IR/Convection reflow. (one-time soldering or two-time soldering in air or nitrogen environment)

- Temperature and period :
 - A) Peak temperature. 250°C max.
 - B) Heating temperature. 40 to 60 seconds as 220°C
 - C) Preheat temperature. It is 150 to 200°C, and is 120±30 seconds
 - D) Temperature increase rate. It is 1 to 3°C/seconds
- Measuring point : IC package surface.
- Temperature profile :



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4. Condition for removal of residual flux.

- (1) Ultrasonic washing power : 25 watts / liter max.
- (2) Washing time : Total 1 minute max.
- (3) Solvent temperature : 15~40°C

5. Package outline specification.

5-1. Package outline.

Refer to the attached drawing.

(Plastic body dimensions do include burr of resin.)

5-2. LEAD FINISH or BALL TYPE

LEAD FREE TYPE · (Sn-2%Bi) 10 μ m TYP.(Min. 5 μ m)

5-3. Package weight.

0.12g/pcs. About.

6. Markings.

6-1. Marking details. (The information on the package should be given as follows.)

- (1) Product name : IR2D20U
- (2) Company name : SHARP
- (3) Date code : (Example) YYWW XX
YY → Denotes the production year. (Last two digits of the year.)
WW → Denotes the production week. (01 · 02 · ~ · 52 · 53)
XX → Denotes the production ref code.
- (4) "JAPAN" indicates the country of origin.

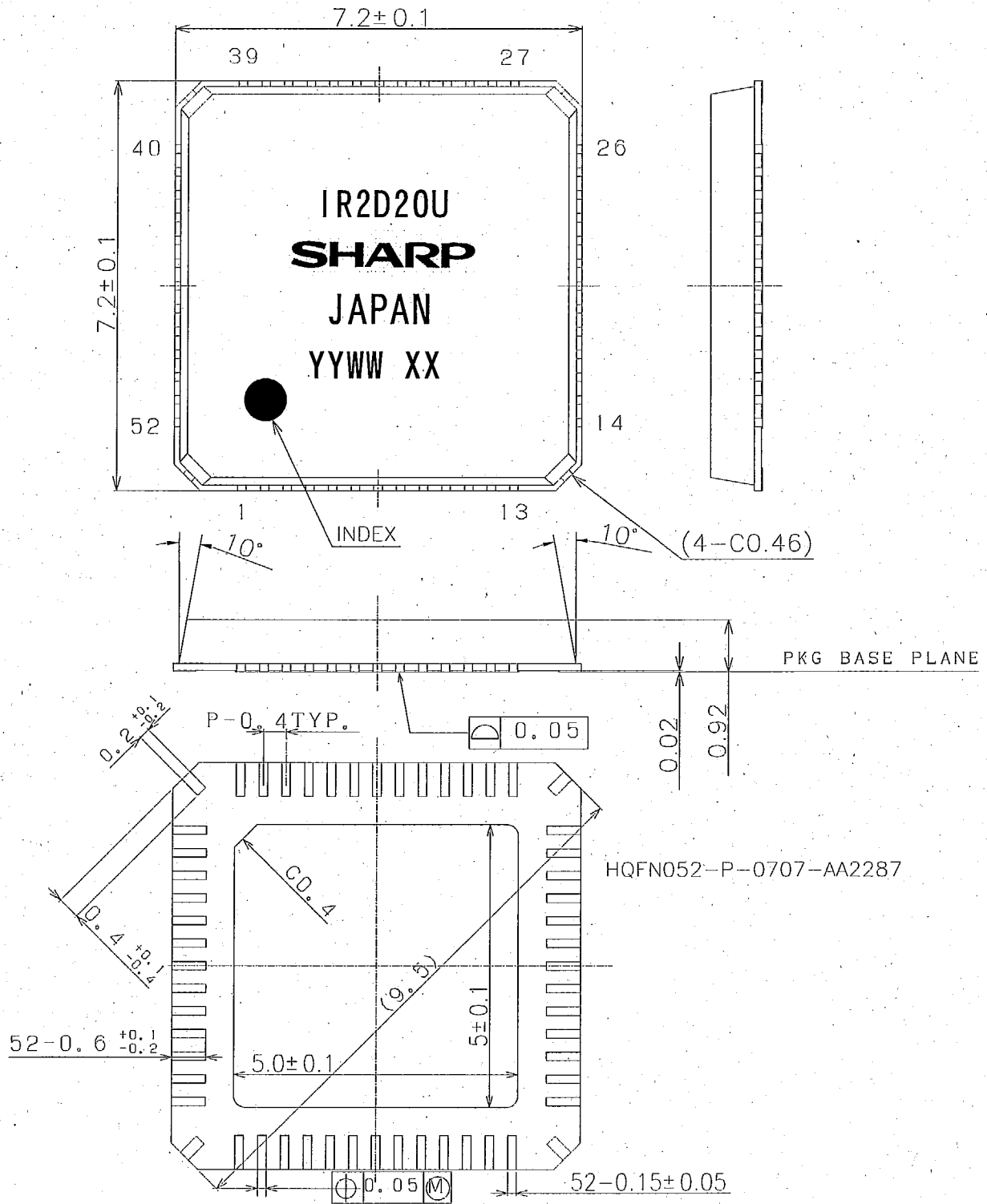
6-2. Marking layout.

The layout is shown in the attached drawing.

(However, this layout does not specify the size of the marking character and marking position.)

REFERENCE

(Note) It is those with an underline printing in a date code because of a LEAD FREE type.



LEAD TYPE	LEAD FINISH		LEAD MATERIAL	
	Sn-2%Bi PLATING 10μm TYP.(Min. 5μm)		Cu	
NAME	HQFN052-P-0707		NOTE : Plastic body dimensions do include burr of resin.	
DRAWING NO.	AA2287	UNIT		

REV 201
REFERENCE

7.Packing Specifications (Dry packing for surface mount packages.)

7-1.Packing materials.

Material name	Material specifications	Purpose
Inner carton	Cardboard (3480 devices / inner carton max.)	Packing the devices. (10 trays / inner carton)
Tray	Conductive plastic (348 devices / tray)	Securing the devices.
Upper cover tray	Conductive plastic (1 tray / inner carton)	Securing the devices.
Laminated aluminum bag	Aluminum polyethylene	Keeping the devices dry.
Desiccant	Silica gel	Keeping the devices dry.
Label	Paper	Indicates part number, quantity, and packed date.
PP band	Polypropylene (3 pcs. / inner carton)	Securing the devices.
Outer carton	Cardboard (13920 devices / outer carton max.)	Outer packing.

(Devices must be placed on the tray in the same direction.)

7-2.Outline dimension of tray.

Refer to the attached drawing.

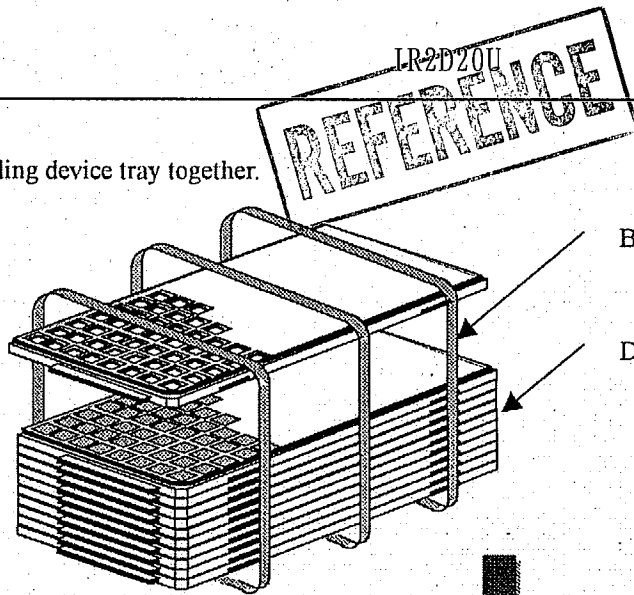
7-3.Outline dimension of carton.

Refer to the attached drawing.

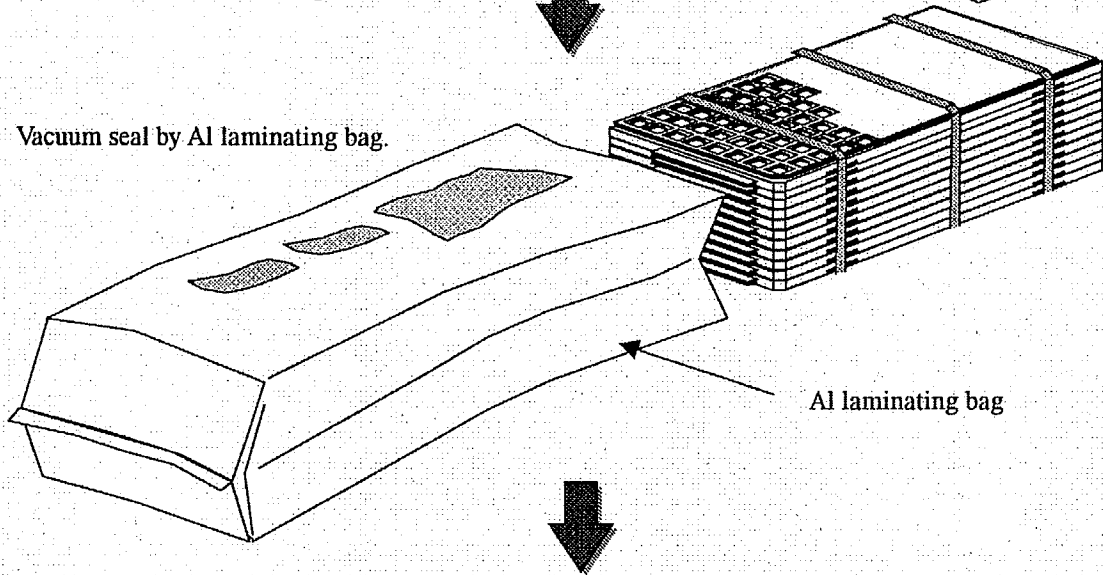
8. Precautions for use.

- (1) Opening must be done on an anti-ESD treated workbench.
All workers must also have undergone anti-ESD treatment.
- (2) The trays have undergone either conductive or anti-ESD treatment.
If another tray is used, make sure it has also undergone conductive or anti-ESD treatment.
- (3) The devices should be mounted within one year of the date of delivery.

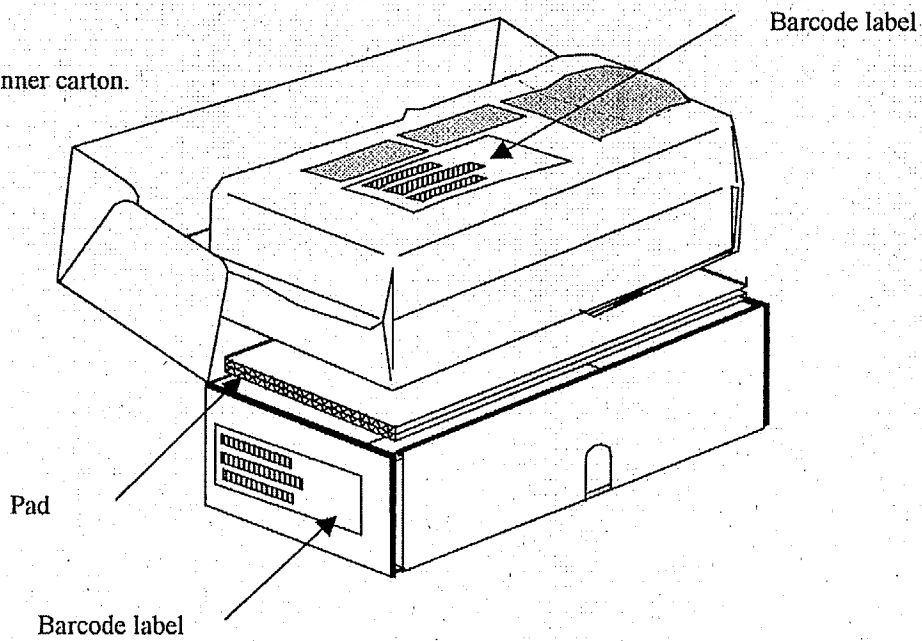
(1) Banding device tray together.



(2) Vacuum seal by Al laminating bag.

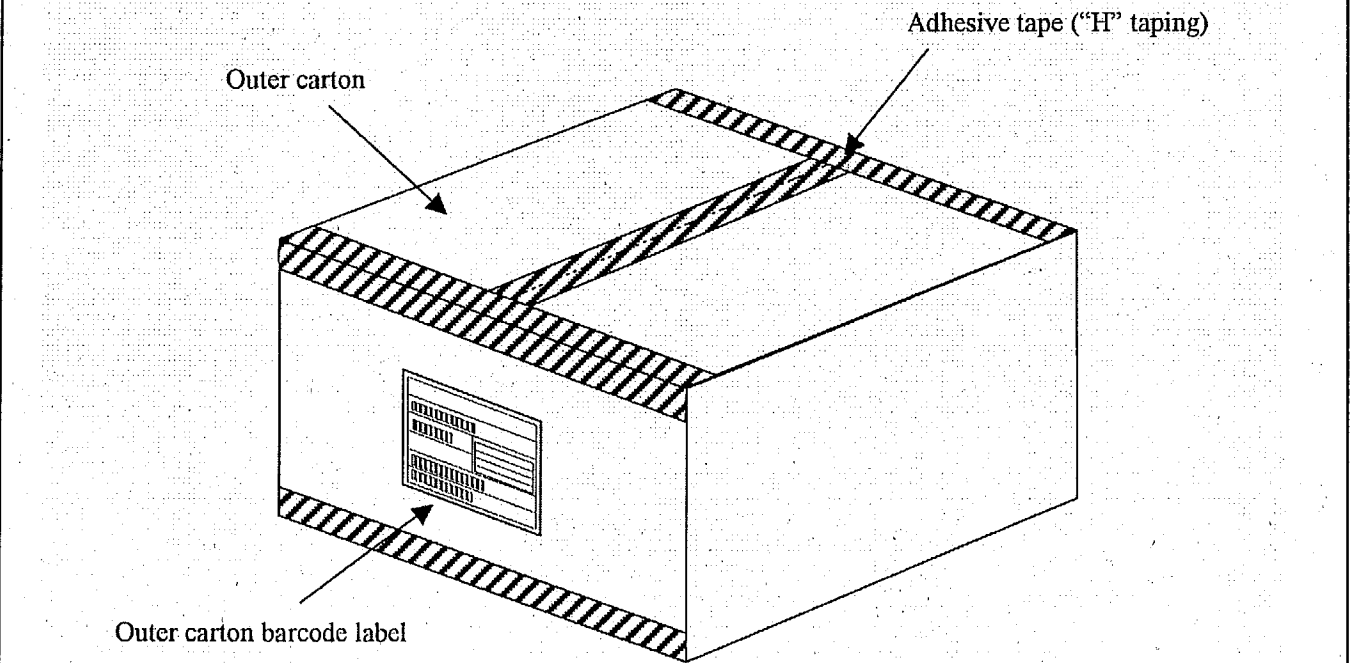
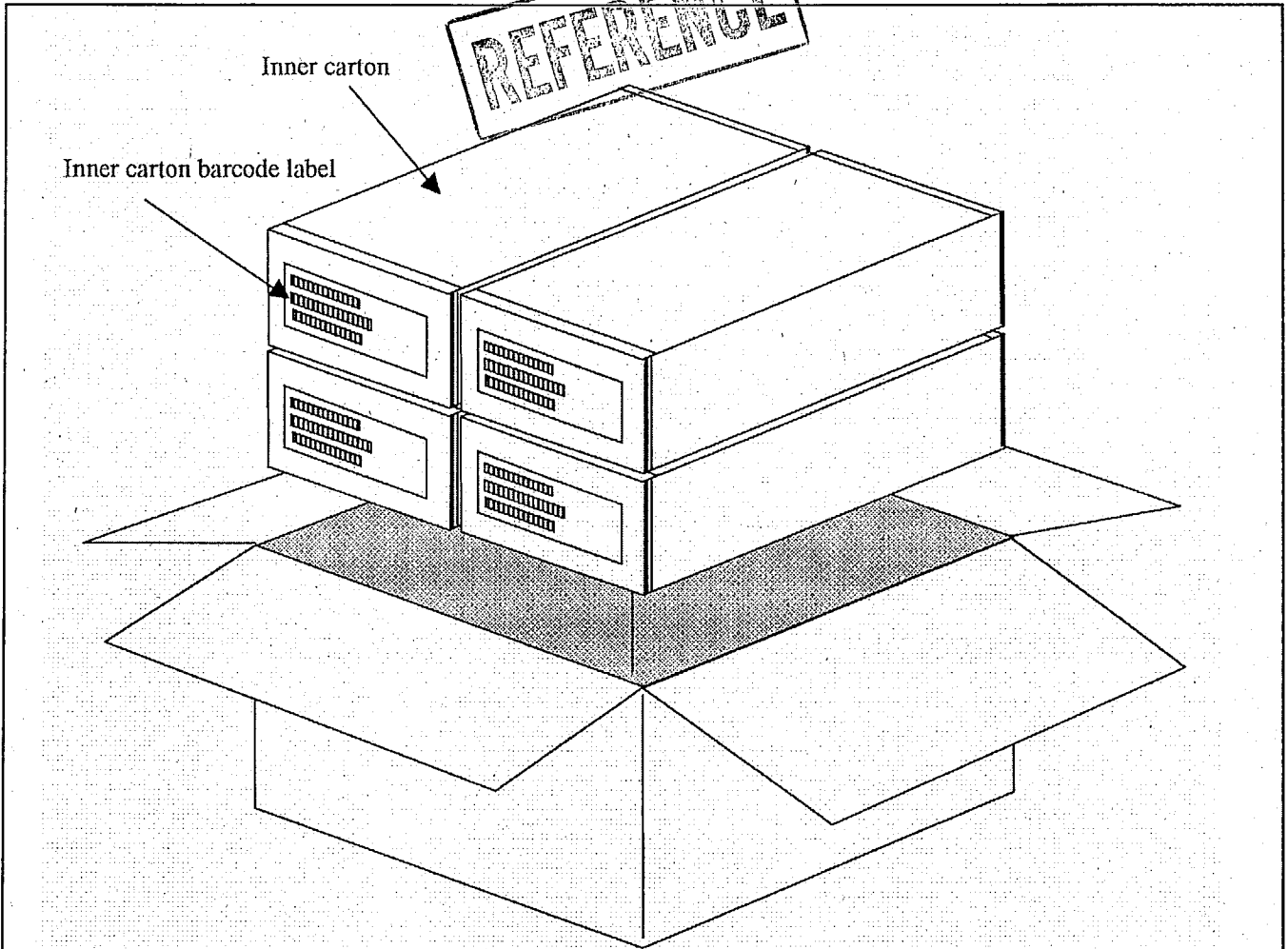


(3) Packing by Inner carton.



NAME	Packing specifications		
DRAWING NO.	BJ433c	UNIT	mm

NOTE There is a possibility different from this specification when the number of shipments is fractions.



L × W × H

Inner carton - Outer dimensions : 360×150×95

Outer carton - Outer dimensions : 390×335×230

NOTE There is a possibility different from this specification when the number of shipments is fractions.

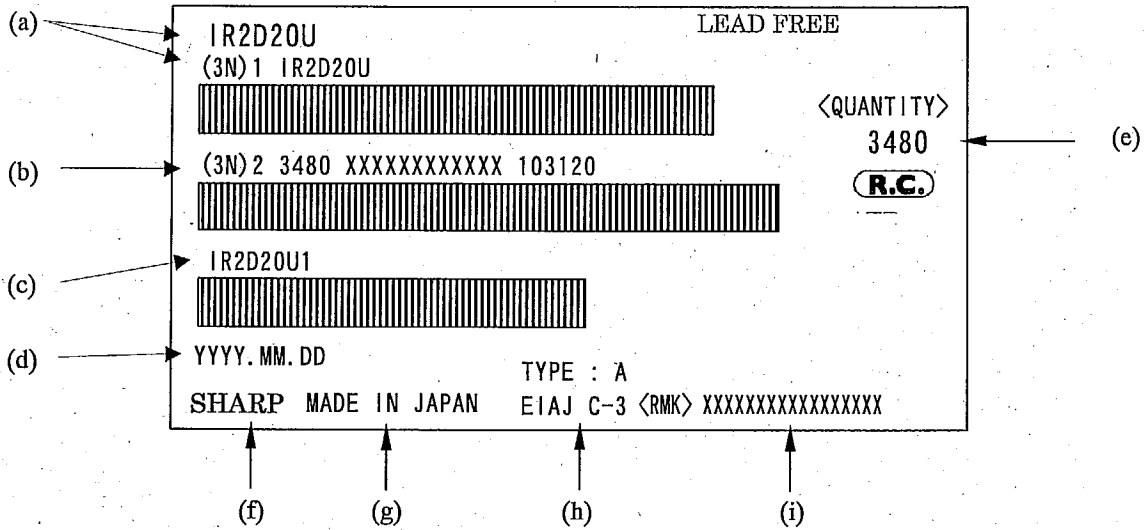
NAME	Packing specifications		
DRAWING NO.	BJ433d	UNIT	mm

REFERENCE

(Note) The << LEAD FREE >> display shows a lead free article.

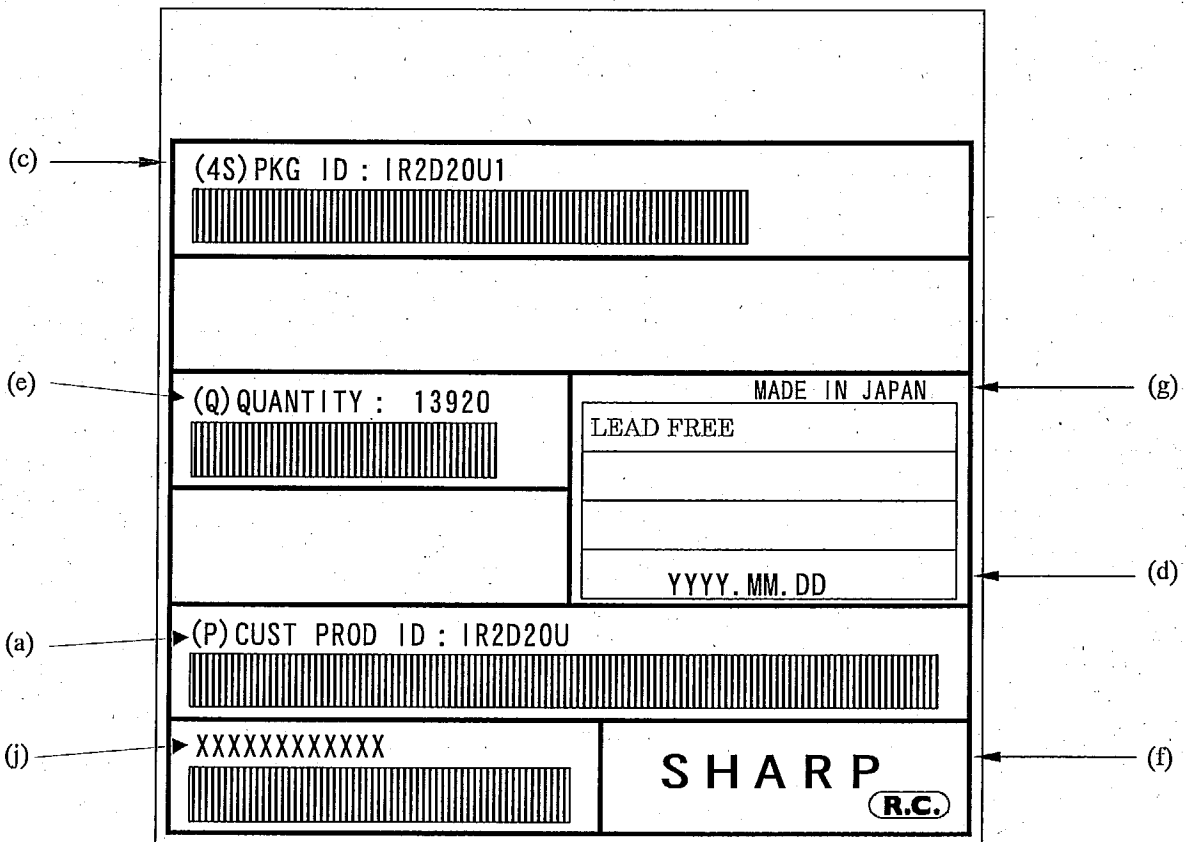
"R.C." is Sharp's corporate logo indicating that the product is RoHS compliant.

Inner carton label



Outer carton label

(Former) EIAJ B Standard conforming



- | | |
|------------------------------------|-------------------------------------|
| (a) Product name | (g) The country of origin |
| (b) Quantity, PD lot, Company code | (h) Type name (Conformity standard) |
| (c) Part No. (SHARP) | (i) Assembly management No. |
| (d) Packed date | (j) Shipment lot |
| (e) Quantity | |
| (f) "SHARP" Logo | |