
34 V Constant-Current LED Driver Controller for Industrial Applications

No. EY-365-221129

OUTLINE

The R1580N is a 34-V constant-current LED driver controller. Internally, this device consists of a linear dimming controller using a PWM input signal, a thermal shutdown circuit (TSD), and an undervoltage lockout circuit (UVLO) in addition to the basic constant-current control circuits. A flicker-free wide-dimming constant-current LED driver can be configured by only adding an Nch MOSFET, a current sensing resistor and capacitors to the R1580N. The FET to control current flow is placed externally, so that the R1580N will not give any influence on the current range capable of dealing with. The R1580N is linear dimmable with using a PWM signal on the DIM pin. The R1580N is capable of performing a constant-current control corresponding to the different PWM duty cycles. The R1580N002A is linear dimmable as low as 0.5% PWM duty cycle and the R1580N001A/R1580N003A is linear dimmable as low as 1% PWM duty cycle. Unlike other LED drivers with PWM dimming, the R1580N can provide a smooth flicker-free dimming operation using linear dimming. The R1580N is offered in a small 6-pin SOT-23-6 package. This is a high-reliability semiconductor device for industrial applications (-Y) that has passed both the screening at high temperature and the reliability test with extended hours.

FEATURES**R1580N001A/ R1580N002A/ R1580N003A**

- Input Voltage Range (Max. Rating): 3.6 V to 34.0 V (36.0 V)
- Operating Temperature Range: -40°C to 105°C
- Line Regulation: Typ. 0.01%/V
- SOURCE Pin Voltage Temperature Coefficient (100% PWM Duty): Typ. ± 100 ppm/°C
- Thermal Shutdown Protection
- Linear Dimmable Using a PWM Signal
- Package: SOT-23-6

R1580N001A (Comparator Input, 1.0% PWM Duty)

- Max. SOURCE Pin Voltage Accuracy (100% PWM Duty): Typ. 400 mV ± 8 mV
- Min. SOURCE Pin Voltage Accuracy (1.0% PWM Duty): Typ. 4 mV ± 2 mV
- Supply Current: Typ. 320 μ A, Standby Current: Typ. 140 μ A

R1580N002A (Comparator Input, 0.5% PWM Duty)

- Max. SOURCE Pin Voltage Accuracy (100% PWM Duty): Typ. 800 mV ± 16 mV
- Min. SOURCE Pin Voltage Accuracy (0.5% PWM Duty): Typ. 4 mV ± 2 mV
- Supply Current: Typ. 320 μ A, Standby Current: Typ. 140 μ A

R1580N003A (Inverter Input, 1.0% PWM Duty)

- Max. SOURCE Pin Voltage Accuracy (100% PWM Duty): Typ. 400 mV ± 8 mV
- Min. SOURCE Pin Voltage Accuracy (1.0% PWM Duty): Typ. 4 mV ± 2 mV
- Supply Current: Typ. 320 μ A, Standby Current: Typ. 28 μ A

APPLICATIONS

- LED Lightings for Industrial Equipment
- LED Lightings for Inspection Devices

SELECTION GUIDE

The interface of the DIM pin and the voltage level of the ISET pin are user-selectable options.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1580NxxxA-TR-YE	SOT-23-6	3,000 pcs	Yes	Yes

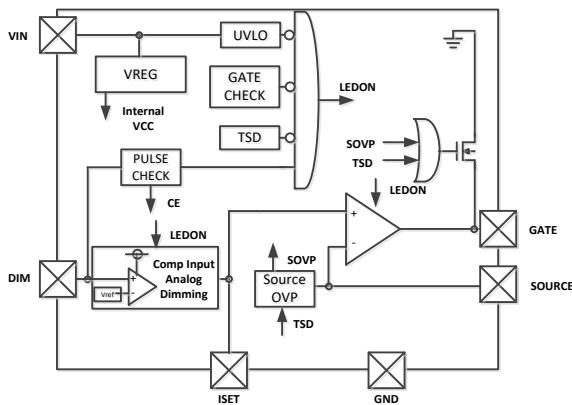
xxx: The interface of the DIM pin and the voltage level of the ISET pin.

001: ISET Pin Voltage = 0.4 V, DIM Pin Interface = Comparator Input,
High Accuracy PWM Signal Threshold Voltage

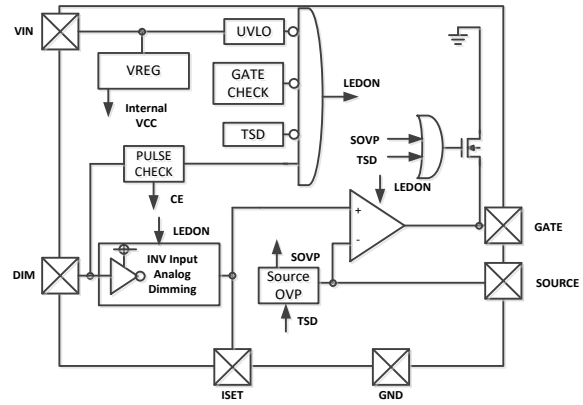
002: ISET Pin Voltage = 0.8 V, DIM Pin Interface = Comparator Input,
High Accuracy PWM Signal Threshold Voltage

003: ISET Pin Voltage = 0.4 V, DIM Pin Interface = Inverter Input

BLOCK DIAGRAMS

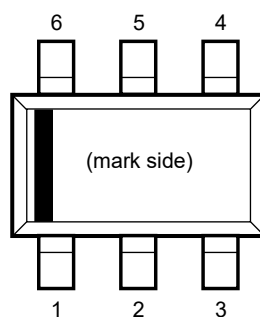


R1580N001A, R1580N002A Block Diagram



R1580N003A Block Diagram

PIN DESCRIPTIONS

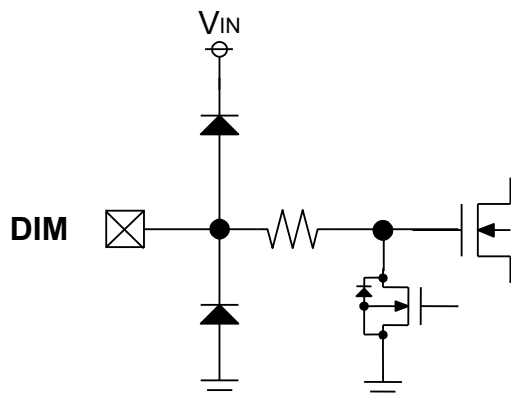


SOT-23-6 Pin Configuration

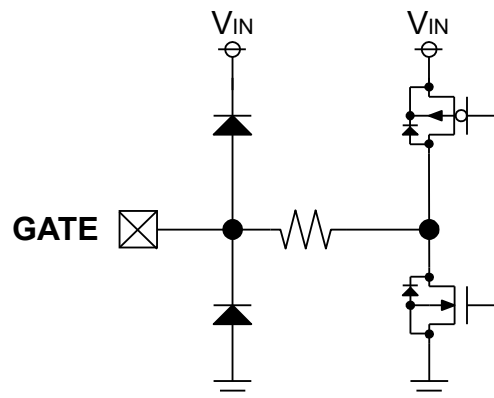
SOT-23-6 Pin Description

Pin No.	Pin Name	Description
1	ISET	Current Setting Pin
2	SOURCE	Nch MOSFET Source Input Pin
3	GATE	Nch MOSFET Gate Output Pin
4	VIN	Power Supply Pin
5	GND	Ground Pin
6	DIM	PWM Signal Input Pin

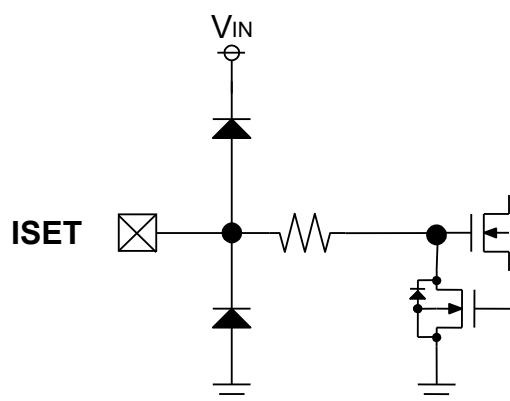
Equivalent Circuits of Individual Pins



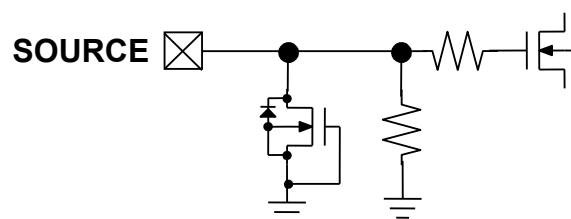
Equivalent Circuit for DIM Pin



Equivalent Circuit for GATE Pin



Equivalent Circuit for ISET Pin



Equivalent Circuit for SOURCE Pin

An ESD diode is connected between the DIM pin and the VIN pin, the GATE pin and the VIN pin, and the ISET pin and the VIN pin. If a voltage is applied to the individual pin while the VIN pin is open, the voltage will flow into the VIN pin via the ESD protection diode and cause an unintended operation of device. To prevent this, apply a voltage to the VIN pin.

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

Symbol	Parameter			Rating	Unit
V_{IN}	VIN Pin Voltage			-0.3 to 36	V
V_{DIM}	DIM Pin Voltage			-0.3 to $V_{IN} + 0.3$	V
V_{ISET}	ISET Pin Voltage			-0.3 to $V_{IN} + 0.3$	V
V_{SOURCE}	SOURCE Pin Voltage			-0.3 to 6.5	V
V_{GATE}	GATE Pin Voltage			-0.3 to $V_{IN} + 0.3$	V
I_{DIM}	DIM Pin Current			20	mA
P_D	Power Dissipation ⁽¹⁾	SOT-23-6	JEDEC STD.51-7	830	mW
T_j	Junction Temperature Range			-40 to 150	°C
T_{stg}	Storage Temperature Range			-55 to 150	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings are not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

Symbol	Parameter			Rating	Unit
V_{IN}	Operating Input Voltage			3.6 to 34	V
T_a	Operating Temperature Range			-40 to 105	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

⁽¹⁾ Refer to *POWER DISSIPATION* for detailed information.

ELECTRICAL CHARACTERISTICS

PWM Frequency = 1 kHz, PWM Duty = 100%, unless otherwise noted.

The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$.

R1580N Electrical Characteristics

($T_a = 25^{\circ}\text{C}$)

Symbol	Parameter	Test Conditions/ Comments	Min.	Typ.	Max.	Unit
Istandby	Standby Current (001, 002)	$V_{IN} = 34\text{ V}, V_{DIM} = 0\text{ V}$		140	200	μA
	Standby Current (003)	$V_{IN} = 34\text{ V}, V_{DIM} = 0\text{ V}$		28	50	μA
I _{SS}	Supply Current	$V_{IN} = 34\text{ V}, V_{DIM} = 34\text{ V}$		320	500	μA
V _{UVLO1}	UVLO Detector Threshold Voltage	V_{IN} Falling	2.8	3.0		V
V _{UVLO2}		V_{IN} Rising		V _{UVLO1} +0.15	3.3	V
R _{GATEDOWN}	GATE Pin Pull-down Resistance	$V_{DIM} = 0\text{ V}$		20		k Ω
R _{SOURCEDOWN}	SOURCE Pin Pull-down Resistance	$V_{DIM} = 0\text{ V}$		4		k Ω
R _{RESETDOWN}	ISET Pin Pull-down Resistance	$V_{DIM} = 0\text{ V}$		13		k Ω
t _{LEDONDLY}	LEDON Delay Time	$V_{IN} = 15\text{ V}$	5	20	30	msec
f _{DIMMIN}	Min. PWM Signal Input Frequency	$V_{IN} = 15\text{ V}$			500	Hz
t _{MINON}	Min. PWM Signal ON Time	$V_{IN} = 15\text{ V}$		100		nsec
I _{GATEH}	GATE Pin "High" Output Current	PWM Duty = 100%, $V_{GATE} = 4\text{ V}, V_{SOURCE} = 0\text{ V}$	40	80	160	μA
I _{GATEL}	GATE Pin "Low" Output Current (001, 003)	PWM Duty = 100%, $V_{GATE} = 4\text{ V}, V_{SOURCE} = 0.5\text{ V}$		1		mA
	GATE Pin "Low" Output Current (002)	PWM Duty = 100%, $V_{GATE} = 4\text{ V}, V_{SOURCE} = 0.9\text{ V}$		1		mA
V _{SOURCEMAX}	Max. SOURCE Pin Voltage (001, 003)	PWM Duty = 100%, $R_{SET} = \text{Open}$	388	400	408	mV
	Max. SOURCE Pin Voltage (002)	PWM Duty = 100%, $R_{SET} = \text{Open}$	776	800	816	mV
V _{SOURCEMIN}	Min. SOURCE Pin Voltage (001, 003)	PWM Duty = 1.0%, $R_{SET} = \text{Open}, T_a = 25^{\circ}\text{C}$	2.0	4.0	6.0	mV
		PWM Duty = 1.0%, $R_{SET} = \text{Open}$	1.0	4.0	7.0	mV
	Min. SOURCE Pin Voltage (002)	PWM Duty = 0.5%, $R_{SET} = \text{Open}, T_a = 25^{\circ}\text{C}$	2.0	4.0	6.0	mV
		PWM Duty = 0.5%, $R_{SET} = \text{Open}$	1.0	4.0	7.0	mV

All parameters are tested under the pulse load condition ($T_j \approx T_a = 25^{\circ}\text{C}$) except SOURCE Pin Voltage Temperature Coefficient.

ELECTRICAL CHARACTERISTICS (continued)

PWM Frequency = 1 kHz, PWM Duty = 100%, unless otherwise noted.

The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$.

R1580N Electrical Characteristics

($T_a = 25^{\circ}\text{C}$)

Symbol	Parameter	Test Conditions/ Comments	Min.	Typ.	Max.	Unit
$\Delta V_{\text{SOURCE}} / \Delta V_{\text{IN}}$	SOURCE Pin Voltage Line Regulation	PWM Duty = 100%, $R_{\text{SET}} = \text{Open}$		0.01		%/V
R_{INSET}	ISET Pin Internal Resistance		291	300	309	k Ω
I_{DIM}	DIM Pin Pull-down Current (001, 002)	$V_{\text{DIM}} = 34 \text{ V}$		1.0	2.0	μA
R_{DIM}	DIM Pin Pull-down Resistance (003)	$V_{\text{DIM}} = 2 \text{ V}$	200	600	1200	k Ω
V_{THDIMH}	PWM Signal Threshold Voltage (001, 002)	$V_{\text{IN}} = 15 \text{ V}$, DIM Rising		1.2	1.3	V
V_{THDIML}		$V_{\text{IN}} = 15 \text{ V}$, DIM Falling	1.0	1.1		V
V_{THDIMH}	PWM Signal Threshold Voltage (003)	$V_{\text{IN}} = 15 \text{ V}$, DIM Rising			1.2	V
V_{THDIML}		$V_{\text{IN}} = 15 \text{ V}$, DIM Falling	0.4			V
V_{SOVP1}	SOURCE Pin Overvoltage Protection Threshold Voltage (001, 003)	$V_{\text{IN}} = 15 \text{ V}$, Rising	0.56	0.63	0.70	V
V_{SOVP2}		$V_{\text{IN}} = 15 \text{ V}$, Falling	0.51	0.58	0.65	V
V_{SOVP1}	SOURCE Pin Overvoltage Protection Threshold Voltage (002)	$V_{\text{IN}} = 15 \text{ V}$, Rising	1.23	1.3	1.37	V
V_{SOVP2}		$V_{\text{IN}} = 15 \text{ V}$, Falling	1.13	1.2	1.27	V
T_{TSD}	Thermal Shutdown Threshold Temperature	T_a Rising		160		$^{\circ}\text{C}$
T_{TSR}		T_a Falling		140		$^{\circ}\text{C}$

All parameters are tested under the pulse load condition ($T_j \approx T_a = 25^{\circ}\text{C}$) except SOURCE Pin Voltage Temperature Coefficient.

THEORY OF OPERATION

Under Voltage Lockout (UVLO)

The UVLO turns the output of the GATE pin low which means the Nch MOSFET is turned off, in the event of the input voltage (V_{IN}) dropping below the UVLO threshold voltage, falling (V_{UVLO1}), so that the whole system will go into the reset state.

Short Circuit Detection between the GATE Pin of Nch MOSFET and the DRAIN Pin

GATE pin is pulled down by the resistor. When the GATE pin voltage increases 1 V or more at a start-up, the R1580 determines as the short circuit between the GATE pin of Nch MOSFET and the DRAIN pin. When it is determined as the short circuit, the device does not move to the sequence of flowing LED current (I_{LED}). Once the short circuit is released, the device moves to the sequence of making a set LED current (I_{LEDSET}) flow.

Overvoltage Protection for Source Pin (Source OVP)

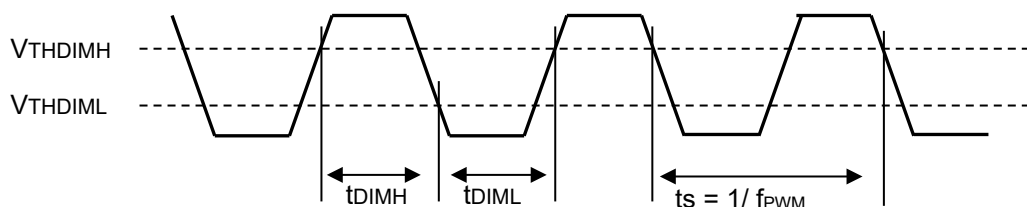
The SOURCE pin voltage (V_{SOURCE}) of the R1580N001A/ R1580N003A is controlled to be less than 0.7 V by the GATE pin of Nch MOSFET, and V_{SOURCE} of the R1580N002A is controlled to be less than 1.4 V. If V_{SOURCE} exceeds the SOURCE pin OVP threshold voltage, rising (V_{SOVP1}), the device assumes that the external voltage is applied, so it moves to the protection sequence. During the protection sequence, the device turns the output of the GATE pin low which means the Nch MOSFET is turned off.

If V_{SOURCE} falls below the SOURCE pin OVP threshold voltage, falling (V_{SOVP2}), the device assumes that the overvoltage conditions is removed and restarts the regulation of Nch MOSFET. In the event of short circuit between the DRAIN pin and the SOURCE pin or the DRAIN pin and GATE pin of Nch MOSFET, V_{SOURCE} rises even if the output of the GATE pin is low. As a result, the current continuously flows into the current sensing resistor (R_{SNS}). If the short circuit current exceeds the rated current of LED, connect a current fuse to the LED array in series.

Thermal Shutdown

The thermal shutdown turns the output of the GATE pin low which means the Nch MOSFET is turned off if the junction temperature exceeds the thermal shutdown threshold temperature, rising (T_{TSD}). Once the junction temperature falls below the thermal shutdown threshold temperature, falling (T_{TSR}), the device goes into the reset state and restarts the regulation of Nch MOSFET.

Timing Chart of PWM Signal



Timing Chart of PWM Signal

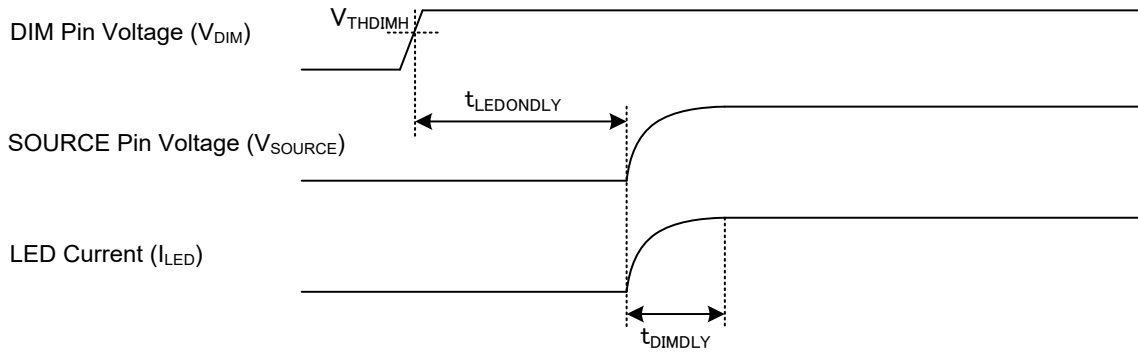
The R1580N recognizes that a high signal is sent to the DIM pin during the period of time which starts when the DIM pin voltage (V_{DIM}) exceeds the PWM signal threshold voltage, rising (V_{THDIMH}), and ends when V_{DIM} falls below the PWM signal threshold voltage, falling (V_{THDIML}). On the contrary, the R1580N recognizes that a low signal is sent to the DIM pin during the period of time which starts when V_{DIM} falls below V_{THDIML} , and ends when V_{DIM} exceeds V_{THDIMH} .

When V_{DIM} exceeds V_{THDIMH} , the R1580N starts the operation. After the device start-up, the DIM pin pulse judging circuit starts the operation. The LEDON signal becomes high if the DIM pin pulse is sent for more than the LEDON delay time ($t_{LEDONDLY} = \text{Typ. } 20 \text{ msec}$) with one of the following conditions:

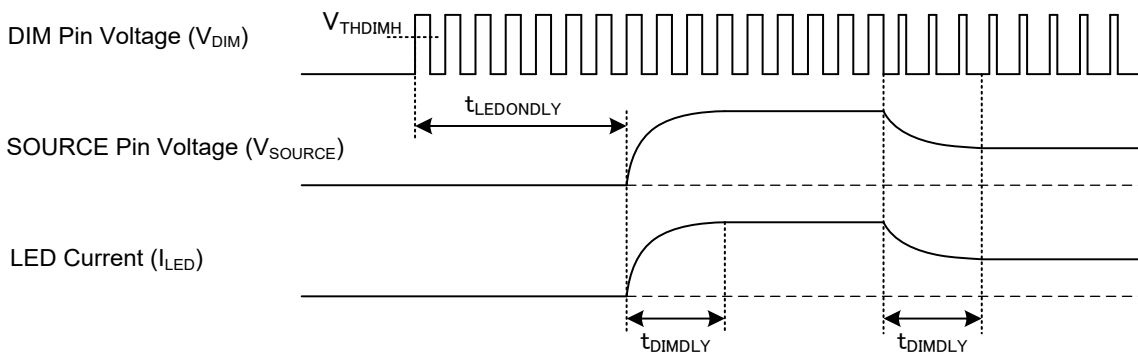
1. $t_{DIML} \leq 10 \mu\text{sec}$ & $t_{DIMH} \geq t_{MINON}$ or $V_{DIM} = \text{"H"}$ (PWM Duty $\approx 100\%$)
2. PWM Frequency (f_{PWM}) $\geq 500 \text{ Hz}$ & $t_{DIMH} \geq t_{MINON}$

When the LEDON signal becomes high, the ISET pin voltage (V_{ISET}) gradually goes up along with the SOURCE pin voltage (V_{SOURCE}). After the PWM signal response time (t_{DIMDLY}), the LED current (I_{LED}) becomes $\pm 5\%$ of a set LED current (I_{LEDSET}). The R1580N goes into standby state and turns the LEDs off by inputting a low signal to the DIM pin.

1. $V_{DIM} = H$, PWM Duty $\approx 100\%$, Refer to *Timing Chart of PWM Signal*



2. $V_{DIM} = \text{Pulse}$, PWM Frequency ($f_{PWM} \geq 500 \text{ Hz}$ & $t_{DIMH} \geq t_{MINON}$)



PWM Signal Response Time (t_{DIMDLY})

The PWM signal response time (t_{DIMDLY}) can be calculated as follows using the LED current setting resistor (R_{SET}) and the capacitor (C_{SET}).

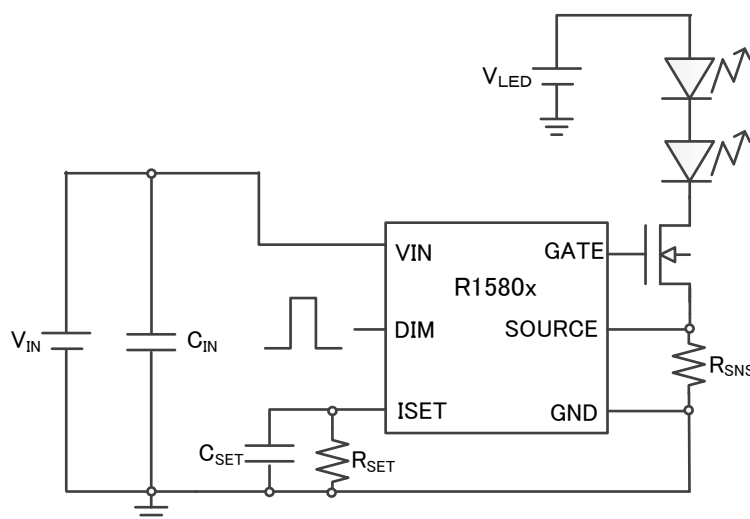
$R_{set} \neq \text{OPEN}$:

$$2.5 \times (C_{SET} \times (R_{SET} \times R_{INSET}) / (R_{SET} + R_{INSET})) \leq t_{DIMDLY} [\text{sec}] \leq 3.5 \times (C_{SET} \times (R_{SET} \times R_{INSET}) / (R_{SET} + R_{INSET}))$$

$R_{set} = \text{OPEN}$:

$$2.5 \times C_{SET} \times R_{INSET} \leq t_{DIMDLY} [\text{sec}] \leq 3.5 \times C_{SET} \times R_{INSET}$$

APPLICATION INFORMATION



R1580NxxxA Typical Application Circuit

Recommended Components

Symbol	Description
C _{IN}	Bypass Capacitor, 0.1 μ F or more, 50 V Rated Voltage
C _{SET}	Capacitor, 0.01 μ F or more ⁽¹⁾ , 6.3 V Rate Voltage
R _{SET}	LED Current Setting Resistor
R _{SNS}	Current Sensing Resistor

⁽¹⁾ The recommended value for the capacitor can be changed depending on the PWM frequency.

LED Current Setting at 100% PWM Duty Cycle

The LED current (I_{LED}) at PWM duty = 100 % can be programmed by placing a current setting resistor (R_{SET}) between the ISET pin and GND, and a current sensing resistor (R_{SNS}) between the SOURCE pin and GND. When using R_{SET} , note that the variation in the ISET internal resistance (R_{INSET}) influences the LED current accuracy. The set LED current (I_{LEDSET}) can be calculated as follows:

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Rset ≠ OPEN:

$$I_{LEDSET} = 0.4 / R_{SNS} \times R_{SET} / (R_{INSET} + R_{SET})$$

Rset = OPEN:

$$I_{LEDSET} = 0.4 / R_{SNS}$$

R1580N002A

Rset ≠ OPEN:

$$I_{LEDSET} = 0.8 / R_{SNS} \times R_{SET} / (R_{INSET} + R_{SET})$$

Rset = OPEN:

$$I_{LEDSET} = 0.8 / R_{SNS}$$

For example, with the R1580N001A, if R_{SET} is open and $R_{SNS} = 1 \Omega$, the R_{SNS} current at PWM Duty = 100% will be set to 400 mA. When using R_{SET} , it should be 100 k Ω or more.

LED Dimming Control

I_{LED} can be controlled using a PWM signal on the DIM pin. I_{LED} can be calculated by using a duty cycle of PWM signal in high state (Hduty) as follows:

$$I_{LED} = Hduty \times I_{LEDSET}$$

Hduty should be determined so as to achieve that the pulse width of PWM frequency (f_{PWM}) in high state is more than the minimum on time of PWM input (t_{MINON}).

$$Hduty / f_{PWM} \geq t_{MINON}$$

PWM Frequency

The PWM frequency (f_{PWM}) on the DIM pin should be set in the range of 500 Hz to 100 kHz. Placing a capacitor (C_{SET}) and a current setting resistor (R_{SET}) between the ISET pin and GND can attenuate the PWM frequency components in the LED current (I_{LED}). The optimum time constant (τ) varies with f_{PWM} . The optimum time constant (τ) can be calculated as follows using C_{SET} and R_{SET} :

$$\tau RC [\text{sec}] = (C_{\text{SET}} \times (R_{\text{SET}} \times R_{\text{INSET}}) / (R_{\text{SET}} + R_{\text{INSET}})) \geq 30 [\text{sec}] / f_{\text{PWM}} [\text{Hz}]$$

$$C_{\text{SET}} [\mu\text{F}] \geq 30 [\text{sec}] / f_{\text{PWM}} [\text{Hz}] \times 10^6 \times (R_{\text{SET}} [\Omega] + R_{\text{INSET}}) / (R_{\text{SET}} [\Omega] \times R_{\text{INSET}}) \geq 0.01 [\mu\text{F}]^{(1)}$$

For example, if R_{SET} is open and $f_{\text{PWM}} = 1 \text{ kHz}$, C_{SET} can be calculated as follows:

$$C_{\text{SET}} [\mu\text{F}] \geq 30 [\text{sec}] / 1000 \times 10^6 \times 1 / 300 \text{ k} = 0.1 [\mu\text{F}] \geq 0.01 [\mu\text{F}]^{(1)}$$

Thus, C_{SET} should be set to 0.1 μF or more. It is important to place C_{SET} between the ISET pin and GND to attenuate f_{PWM} .

As mentioned in *LED Dimming Control*, Hduty should be determined on the condition that the pulse width of PWM frequency (f_{PWM}) in high state is more than the min. PWM signal on time (t_{MINON}). It is necessary that f_{PWM} be increased so that Hduty of the required brightness becomes more than t_{MINON} . Also, it is necessary that f_{PWM} be decreased if the high-accuracy dimming in low brightness is required.

Capacitor Selection

A 0.1- μF or more bypass capacitor (C_{IN}) should be placed between the VIN pin and GND with shortest-distance wiring.

DIM Pin Voltage

The ESD protection diode for the VIN pin is connected to the DIM pin. If the DIM pin voltage (V_{DIM}) becomes higher than the VIN voltage (V_{IN}), a large current will flow from the DIM pin to the VIN pin. To prevent this, it is recommended that a resistor be connected to the DIM pin. The resistor connected to the DIM pin filters the voltage waveform of the DIM pin and creates the rounding waveform. As a result, I_{LED} will be deviated from the calculated value. If the deviation of I_{LED} is not in an allowable range, remove the resistor for the DIM pin and make the input voltage lower than V_{IN} , or place a 100- Ω or more resistor (R_{IN}) between the VIN pin and the primary power source and suppress the current flowing into the DIM pin lower than 20 mA.

⁽¹⁾ 0.01 μF or more is recommended.

Rated Voltage for Nch MOSFET

Select an Nch MOSFET with low drain cut-off current to prevent the LEDs to emit light during standby state. The GATE pin voltage (V_{GATE}) may go up to the maximum VIN pin voltage (V_{IN}) level. To prevent the destruction of Nch MOSFET due to V_{IN} becoming higher than the VGS absolute maximum rating of Nch MOSFET, connect a zener diode between the GATE pin and GND.

In the event of the LED current (I_{LED}) becoming 0 mA while the LED anode voltage is becoming maximum, the DRAIN pin voltage of Nch MOSFET instantaneously goes up close to the LED anode voltage. To prevent the destruction of Nch MOSFET due to the LED anode voltage becoming higher than the VDS absolute maximum rating of Nch MOSFET, connect a zener diode between the DRAIN pin of Nch MOSFET and GND. Select an Nch MOSFET that can operate within the rated voltage.

Thermal Design for Nch MOSFET

The heat loss can be influenced by a power loss associated with the potential difference between the DRAIN pin and the SOURCE pin (V_{DS}) and I_{LED} . The power loss in Nch MOSFET (P_{FET}) can be calculated as follows:

$$P_{FET} [W] = V_{DS} \times I_{LED}$$

Select an Nch MOSFET that can operate within the rated power. It is recommended that an Nch MOSFET satisfying the following conditions be selected:

$$T_j_FET \geq \theta_{ja_FET} \times P_{FET} + T_a$$

Minimum DRAIN Pin Voltage for Nch MOSFET

The minimum DRAIN pin voltage of Nch MOSFET (V_{DRAIN}) can be calculated as follows using the On resistance of Nch MOSFET (R_{ON}) and the maximum SOURCE pin voltage (V_{SMAX}):

$$V_{DRAIN} [V] \geq R_{ON} \times I_{LED} + V_{SMAX}$$

$$V_{SMAX} = V_{SOURCEMAX} \times R_{SET} / (R_{SET} + R_{INSET})$$

Current Sense Resistor Selection

A current sensing resistor (R_{SNS}) should be placed between the SOURCE pin of Nch MOSFET and GND of the device with shortest-distance wiring. To reduce the influence of the wiring resistance on the accuracy of LED current, make the wiring as wide as possible.

Choose an appropriate value for R_{SNS} that best fits the application. The power loss generated by R_{SNS} (P_{SNS}) can be calculated as follows. To suppress P_{SNS} , place a current setting resistor (R_{SET}) which reduces the maximum SOURCE pin voltage.

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Rset ≠ OPEN:

$$P_{SNS} [W] = \{0.4 \times R_{SET} / (R_{SET} + R_{INSET})\}^2 / R_{SNS}$$

Rset = OPEN:

$$P_{SNS} [W] = (0.4)^2 / R_{SNS}$$

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Rset ≠ OPEN:

$$P_{SNS} [W] = \{0.8 \times R_{SET} / (R_{SET} + R_{INSET})\}^2 / R_{SNS}$$

Rset = OPEN:

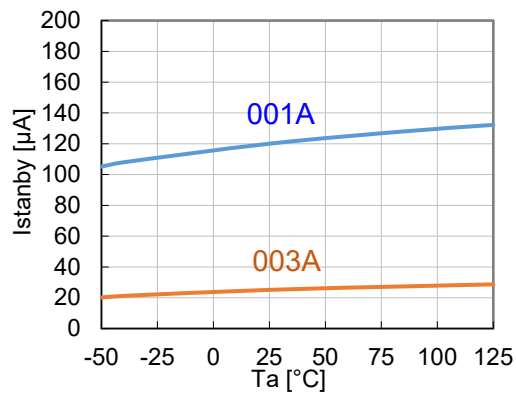
$$P_{SNS} [W] = (0.8)^2 / R_{SNS}$$

TYPICAL PERFORMANCE CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

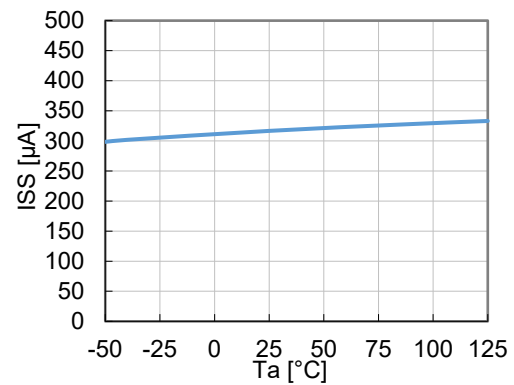
Standby Current vs. Ambient Temp.

R1580N001A, 003A, $V_{IN} = 34\text{ V}$, $V_{DIM} = 0\text{ V}$



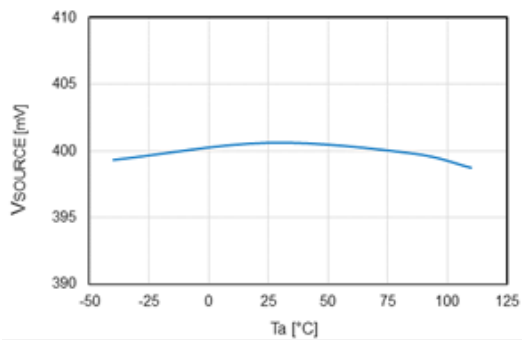
Supply Current vs. Ambient Temp.

R1580N001A, $V_{IN} = 34\text{ V}$, $V_{DIM} = 34\text{ V}$



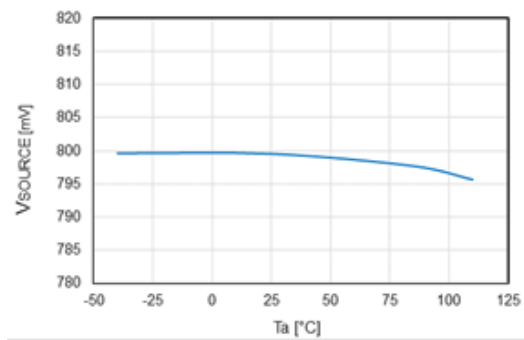
Max. SOURCE Pin Voltage vs. Ambient Temp.

R1580N001A, PWM Duty = 100%, $R_{SET} = OPEN$



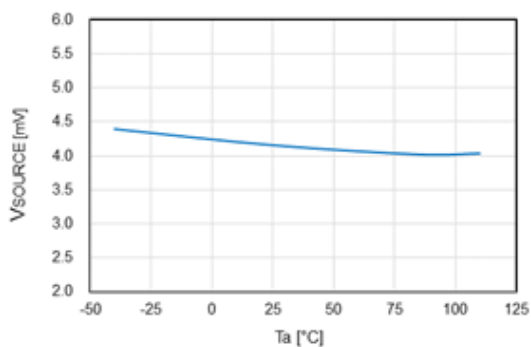
Max. SOURCE Pin Voltage vs. Ambient Temp.

R1580N002A, PWM Duty = 100%, $R_{SET} = OPEN$



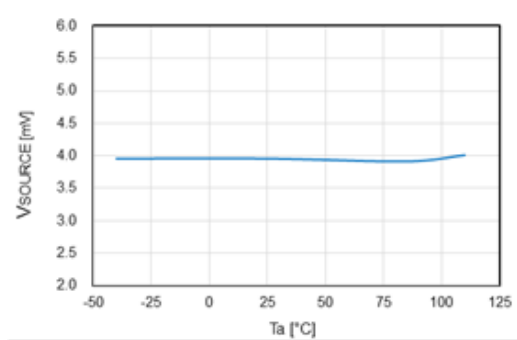
Min. SOURCE Pin Voltage vs. Ambient Temp.

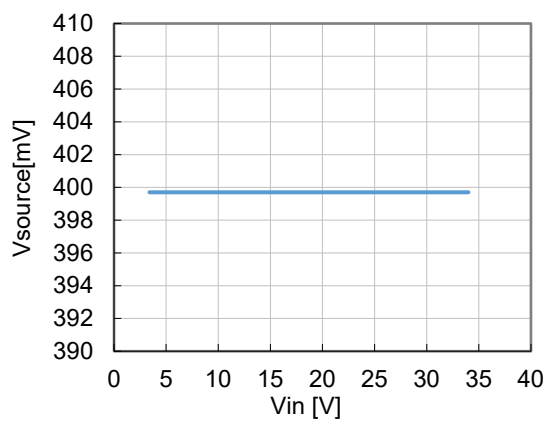
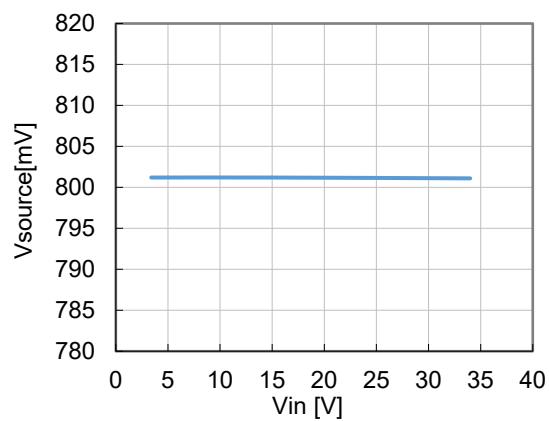
R1580N001A, PWM Duty = 1.0%, $R_{SET} = OPEN$



Min. SOURCE Pin Voltage vs. Ambient Temp.

R1580N002A, PWM Duty = 0.5%, $R_{SET} = OPEN$



Max. SOURCE Pin Voltage vs. Input VoltageR1580N001A, PWM Duty = 100%, R_{SET} = OPEN**Max. SOURCE Pin Voltage vs. Input Voltage**R1580N002A, PWM Duty = 100%, R_{SET} = OPEN

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	φ 0.3 mm × 7 pcs

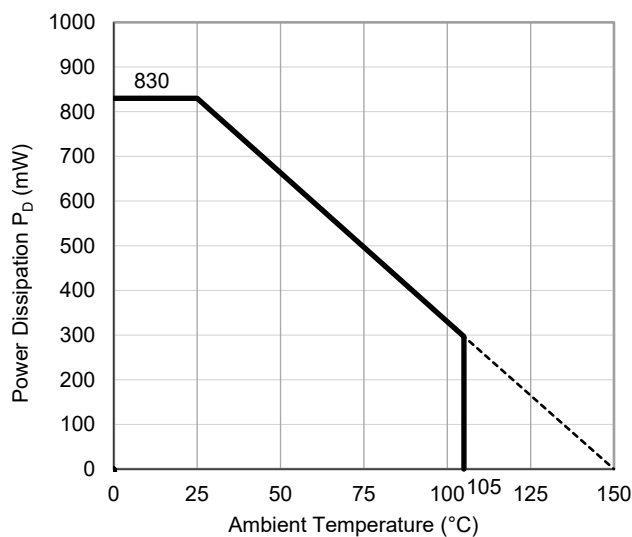
Measurement Result

(Ta = 25°C, Tjmax = 150°C)

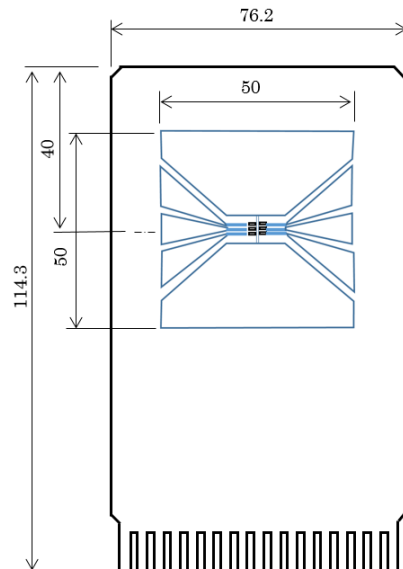
Item	Measurement Result
Power Dissipation	830 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

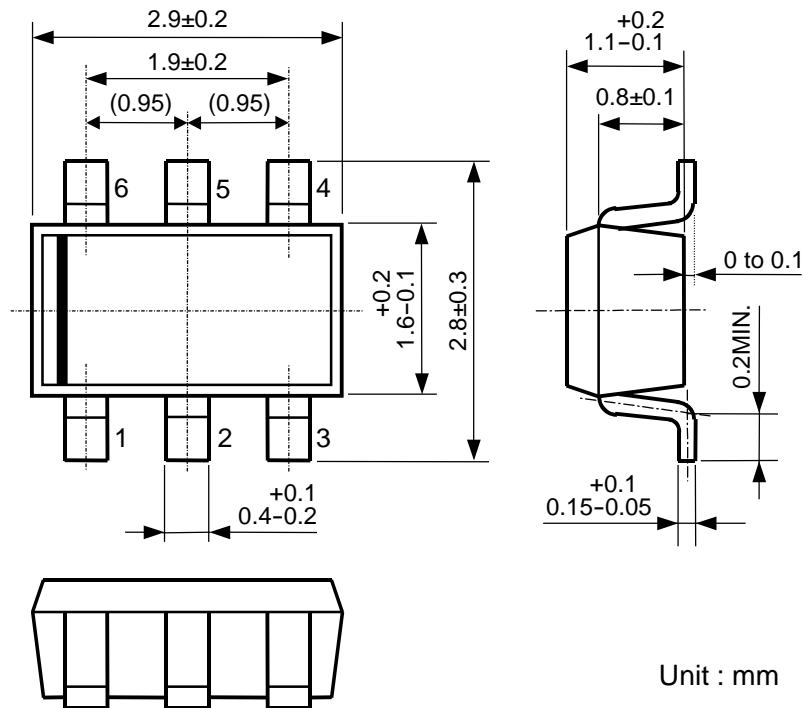
ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



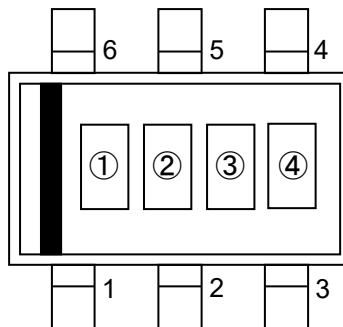
Measurement Board Pattern



SOT-23-6 Package Dimensions (Unit: mm)

①②: Product Code ... Refer to *Part Marking List*

③④: Lot Number ... Alphanumeric Serial Number



SOT-23-6 Part Markings

NOTICE

There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI.

R1580N Part Marking List

Product Name	①②	③④
R1580N001A	FA	Lot No.
R1580N002A	FB	Lot No.
R1580N003A	FC	Lot No.

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without the prior written consent of us.
3. This product and any technical information relating thereto are subject to complementary export controls (so-called KNOW controls) under the Foreign Exchange and Foreign Trade Law, and related politics ministerial ordinance of the law. (Note that the complementary export controls are inapplicable to any application-specific products, except rockets and pilotless aircraft, that are insusceptible to design or program changes.) Accordingly, when exporting or carrying abroad this product, follow the Foreign Exchange and Foreign Trade Control Law and its related regulations with respect to the complementary export controls.
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5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death should first contact us.
 - Aerospace Equipment
 - Equipment Used in the Deep Sea
 - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
 - Life Maintenance Medical Equipment
 - Fire Alarms / Intruder Detectors
 - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
 - Various Safety Devices
 - Traffic control system
 - Combustion equipment

In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.

6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. **Quality Warranty**
 - 8-1. **Quality Warranty Period**

In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
 - 8-2. **Quality Warranty Remedies**

When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.

Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
 - 8-3. **Remedies after Quality Warranty Period**

With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



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