

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC659A

## 8-BIT A/D CONVERTER FOR VIDEO PROCESSING WITH REFERENCE GENERATOR AND CLAMP CIRCUIT

The  $\mu$ PC659A is a 8-bit A/D converter for video signal processing, the power consumption of which is lower than the  $\mu$ PC659. The high speed and high quality bipolar processing technology has enabled fast conversion rate and high resolution to be achieved. Conversion rate is up to 20 Msps (sampling per second) and linearity error within  $\pm 0.5$  LSB while operating at low power consumption. Wide variety of application can be realized in digital application field such as digital TV system and high speed facsimile.

Also, this IC includes sample and hold circuit, clamp circuit and reference voltage generator, which enable simple external circuit to be constructed.

The  $\mu$ PC659A and the  $\mu$ PC659 are different in the number of clock pulses till transformed data is output after analog signal is captured. This should be taken into consideration when using the  $\mu$ PC659A instead of the  $\mu$ PC659. For details, refer to the timing chart.

### FEATURES

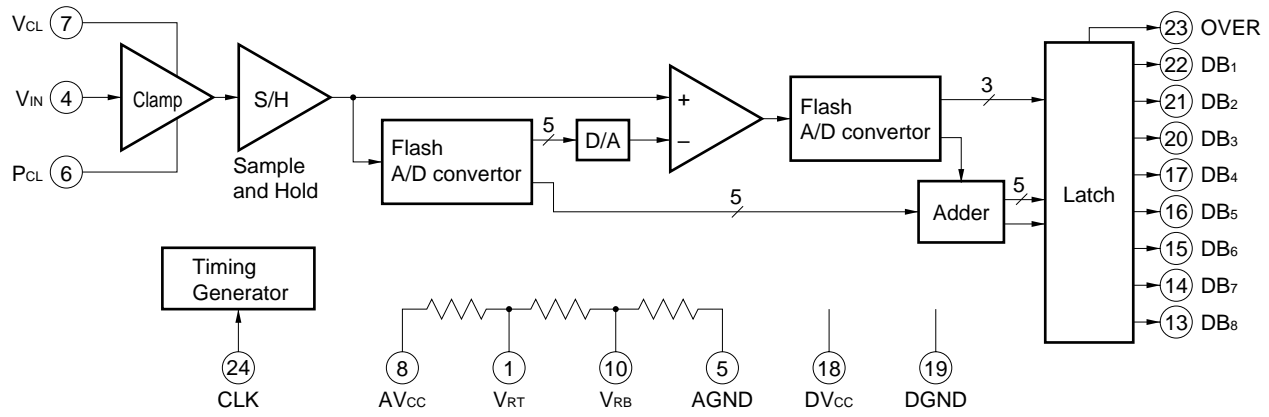
- Resolution : 8-bit
- Conversion rate : 20 Msps
- Differential non-linearity :  $\pm 0.5$  LSB MAX.
- Power supply : +5 V
- Analog input voltage : 1.0 V<sub>p-p</sub>
- Power consumption : 215 mW TYP.
- Built-in circuit : Sample and hold circuit  
Clamp circuit (Clamp voltage and clamp pulse must be supplied.)  
Reference voltage generator ( $V_{RB} = 2.3$  V,  $V_{RT} = 3.3$  V TYP.)

### ORDERING INFORMATION

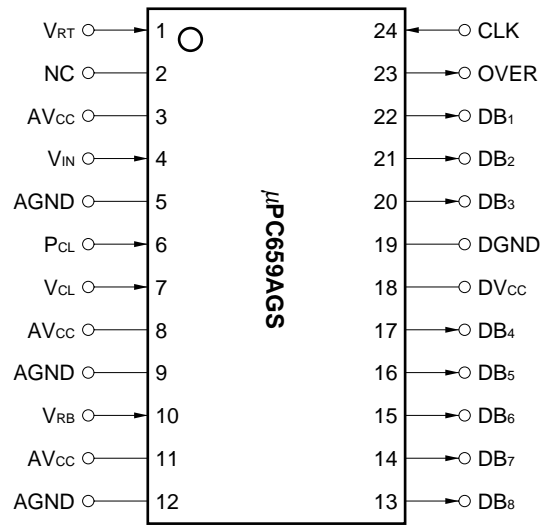
Part Number	Package
$\mu$ PC659AGS	24-pin plastic SOP (300 mil)

The information in this document is subject to change without notice.

**BLOCK DIAGRAM**



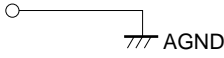
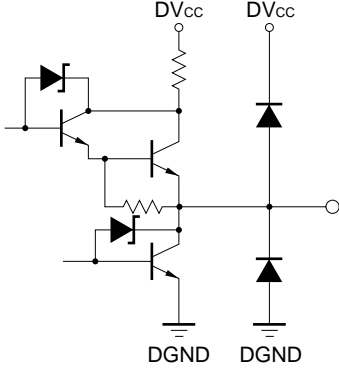

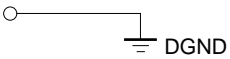

PIN CONFIGURATION (Top View)



- AGND : Ground for Analog Circuit
- AVCC : Power Supply for Analog Circuit
- CLK : Clock
- DB<sub>8</sub> to DB<sub>1</sub> : Digital Data Bus
- DGND : Ground for Digital Circuit
- DVCC : Power Supply for Digital Circuit
- NC : No Connection
- OVER : Digital Over Range
- PCL : Clamp Pulse
- VCL : Clamp Voltage
- VIN : Analog Signal
- VRB : Reference Voltage (Bottom)
- VRT : Reference Voltage (Top)

PIN FUNCTIONS

Pin Name	Pin No.	Input/ Output	Function	Equivalent Circuit
V <sub>RT</sub>	1	Input	Reference voltage (Top)	
V <sub>RB</sub>	10	Input	Reference voltage (Bottom)	
V <sub>IN</sub>	4	Input	Analog signal Input analog signal from this pin. The signal is read at rising edge of the clock. The clamp function also will be worked on this pin. So it's necessary to connect capacitance and low impedance signal source. The burst signal is protected at pedestal clamp because of soft clamp circuit.	
P <sub>CL</sub>	6	Input	Clamp pulse Analog signal input from analog input pin is clamped to the voltage; V <sub>CL</sub> according to the high level term of this pulse. During high level signal is input, analog input pin voltage is nearly clamped to voltage V <sub>CL</sub> .	
V <sub>CL</sub>	7	Input	Clamp voltage Set voltage at clamping analog input signal. Analog input signal is clamped nearly to this input voltage V <sub>CL</sub> according to the clamp pulse P <sub>CL</sub> high level period.	
CLK	24	Input	Clock Analog data acquisition and digital data out are synchronized with the rising edge of this clock.	
AV <sub>CC</sub>	3, 8, 11	-	Power supply for analog circuit	

Pin Name	Pin No.	Input/ Output	Function	Equivalent Circuit
AGND	5, 9, 12	–	Ground for analog circuit	
DB <sub>8</sub> to DB <sub>4</sub> DB <sub>3</sub> to DB <sub>1</sub>	13 to 17, 20 to 22	Output	Digital signal DB <sub>8</sub> is LSB, DB <sub>1</sub> is MSB.	
OVER	23	Output	Digital over range Overflow (active high).	
DVcc	18	–	Power supply for digital circuit	
DGND	19	–	Ground for digital circuit	
NC	2	–	No Connection	

**ELECTRICAL SPECIFICATIONS**

**Absolute Maximum Ratings (T<sub>A</sub> = 25 °C)**

Parameter	Symbol	Ratings	Unit
Supply voltage	AV <sub>CC</sub> , DV <sub>CC</sub>	-0.3 to +6.0	V
Digital input voltage	V <sub>IND</sub>	-0.3 to DV <sub>CC</sub> + 0.3	V
Analog input voltage	V <sub>INA</sub>	-0.3 to AV <sub>CC</sub> + 0.3	V
Reference input voltage	V <sub>RT</sub> , V <sub>RB</sub>	-0.3 to AV <sub>CC</sub> + 0.3	V
Clamp voltage	V <sub>CL</sub>	-0.3 to AV <sub>CC</sub> + 0.3	V
Clamp pulse input voltage	V <sub>PCL</sub>	-0.3 to AV <sub>CC</sub> + 0.3	V
★ Operating ambient temperature	T <sub>A</sub>	-20 to +70	°C
Storage temperature	T <sub>stg</sub>	-40 to +150	°C
Power dissipation	P <sub>d</sub>	560	mW

**Caution** Exposure to Absolute Maximum Ratings for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The parameters apply independently. The device should be operated within the limits specified under DC and AC Characteristics.

**Recommended Operating Conditions (T<sub>A</sub> = -20 to +70 °C)**

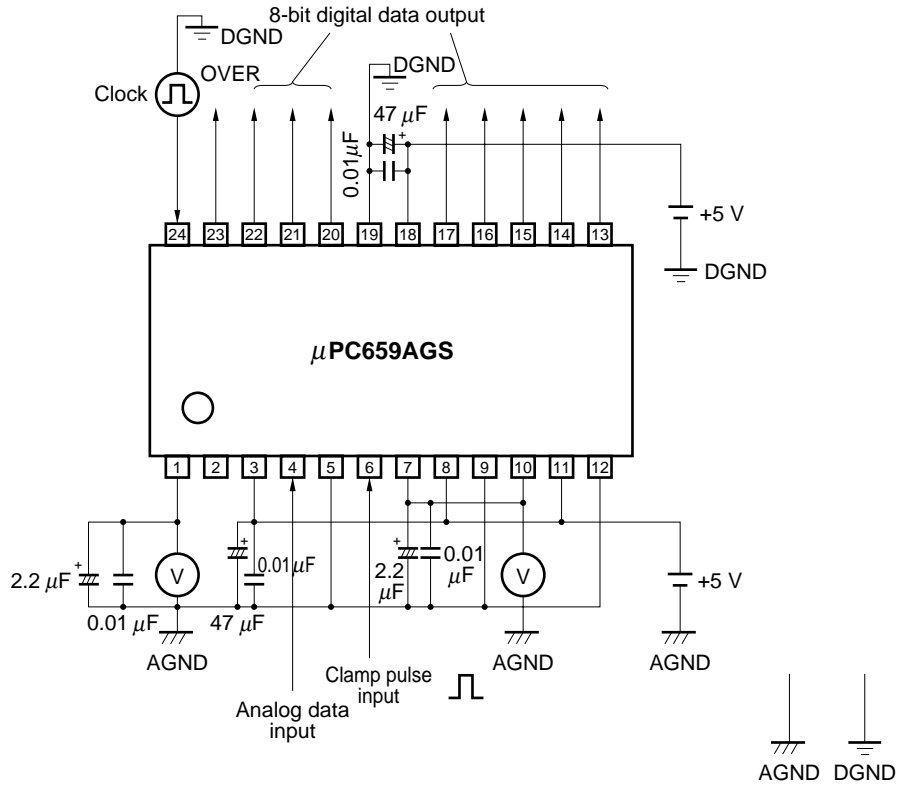
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply voltage	AV <sub>CC</sub> , DV <sub>CC</sub>	AGND=DGND = 0 V	4.7	5.0	5.3	V
★ Supply voltage difference	AV <sub>CC</sub> -DV <sub>CC</sub>	AGND=DGND = 0 V		0	0.1	V
Analog input voltage	V <sub>INA</sub>	V <sub>CC</sub> = 5.0 V	V <sub>RB</sub> - 0.4		V <sub>RT</sub> + 0.4	V
Clamp input voltage	V <sub>CL</sub>	V <sub>CC</sub> = 5.0 V	V <sub>RB</sub> - 0.4		V <sub>RT</sub> + 0.4	V
Sampling clock	f <sub>samp</sub>		1		20	MHz
Sampling clock high level pulse width	t <sub>PWH</sub>		25		500	ns
Sampling clock low level pulse width	t <sub>PWL</sub>		25		500	ns
Clock input high level voltage	V <sub>CKH</sub>		2.0			V
Clock input low level voltage	V <sub>CKL</sub>				0.8	V
Clamp pulse width	t <sub>PWCL</sub>		1.0			μs
Clamp pulse input high level voltage	V <sub>PCLH</sub>		2.0			V
Clamp pulse input low level voltage	V <sub>PCLL</sub>				0.8	V
Clamp capacitance	C <sub>CL</sub>			10		μF
Maximum analog input frequency	f <sub>AIN</sub>			8		MHz

DC Characteristics and AC Characteristics ( $T_A = -20$  to  $+70$  °C,  $AV_{CC} = DV_{CC} = 5.0 \pm 0.3$  V)

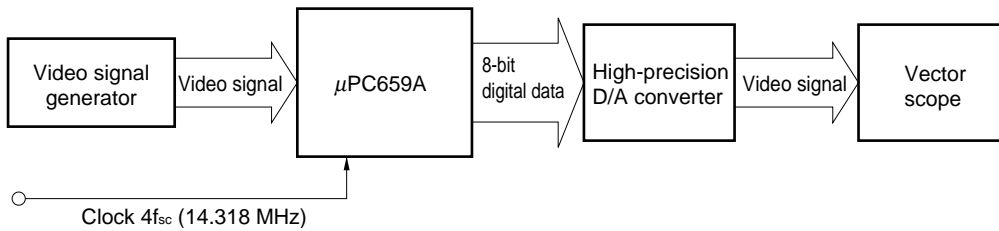
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply current	$I_{CC}$	$V_{CC} = 5.0$ V, $T_A = 25$ °C	26	43	62	mA
Resolution	RES			8		bit
Non-linearity	NL	$V_{CC} = 5.0$ V, $T_A = 25$ °C $V_{IN} = 1.0$ V <sub>p-p</sub> , $f_{samp} = 20$ MHz			$\pm 1.5$	LSB
Differential non-linearity	DNL	$V_{CC} = 5.0$ V, $T_A = 25$ °C $V_{IN} = 1.0$ V <sub>p-p</sub> , $f_{samp} = 20$ MHz			$\pm 0.5$	LSB
Differential gain	DG	$f_{samp} = 14.318$ MHz NTSC ramp wave (40 IRE)		1.5	3	%
Differential phase	DP	$f_{samp} = 14.318$ MHz NTSC ramp wave (40 IRE)		0.8	3	deg
Digital data output delay time	$t_D$	Delay time from rising edge of sampling clock. DB <sub>1</sub> to DB <sub>8</sub> , OVER, $C_L = 15$ pF	12	20	35	ns
Digital output low level voltage	$V_{OL}$	$I_{OL} = 1.6$ mA DB <sub>1</sub> to DB <sub>8</sub> , OVER			0.4	V
Digital output high level voltage	$V_{OH}$	$I_{OH} = -400$ $\mu$ A DB <sub>1</sub> to DB <sub>8</sub> , OVER	2.7			V
Digital input low level current	$I_{INDL}$	$V_{IN} = 0.8$ V			-200	$\mu$ A
Digital input high level current	$I_{INDH}$	$V_{IN} = 2.0$ V			10	$\mu$ A
Analog input current	$I_{INA}$	Measure input current from analog input pin		10	35	$\mu$ A
Reference voltage (Bottom)	$V_{RB}$	$V_{CC} = 5.0$ V	2.1	2.3	2.5	V
Reference voltage (Top)	$V_{RT}$	$V_{CC} = 5.0$ V	3.1	3.3	3.5	V
Analog input equivalent capacitance	$C_{IN}$	$V_{IN} = V_{RB}$		3		pF
Clock input equivalent capacitance	$C_{CLK}$			2		pF
Reference voltage (Difference)	$V_{REF}$	$V_{RT} - V_{RB}$ , $V_{CC} = 5.0$ V		1		V

**Caution** The values of  $I_{CC}$  and  $t_D$  are different between the  $\mu$ PC659 and the  $\mu$ PC659A

Test Circuit



DG, DP Test Block



**Remark** The video signal from the video signal generator is NTSC, 40 IRE ramp signal.

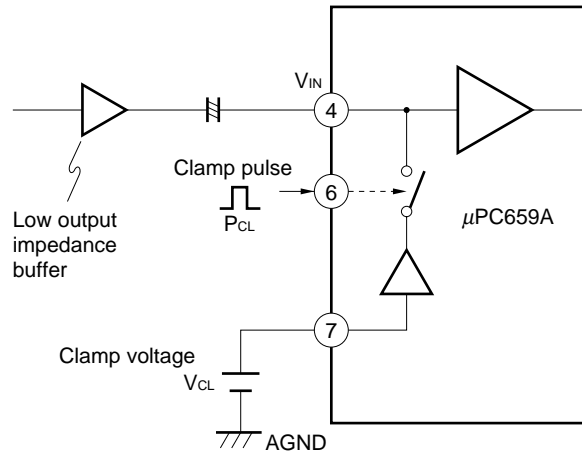






**ATTENTION FOR APPLICATION**

- **Converted data output**  
Analog signal is captured at the rising edge, and converted data will be output at the rising edge after 1 clock pulse. For the μPC659, 2 clock pulses.
- **Analog input terminal**  
In case the pedestal level is clamped, the clamp circuit uses the soft clamp circuit to protect the burst level. However, if a high impedance output is connected to the V<sub>IN</sub> pin (pin 4), the burst level will be reduced (for example, for an external impedance of 10 Ω, the burst level is reduced by approx. 3 %). Therefore, connect the lowest possible impedance signal to the analog signal input pin.



- **If don't use the clamp circuit**  
P<sub>CL</sub> pin (pin 6) and GND must be short-circuit. And insert by-pass capacitor of about 0.1 μF between the V<sub>CL</sub> pin (pin 7) and GND. Input analog signal to V<sub>IN</sub> pin (pin 4).  
In case an external clamp circuit is used, connect the P<sub>CL</sub> pin (pin 6) to GND, and leave the V<sub>CL</sub> pin (pin 7) unconnected. Set the voltage of the V<sub>IN</sub> pin (pin 4) between 2.3 V and 3.3 V.
- **Clamp voltage**  
There is a few difference clamp voltage between the supply clamp voltage V<sub>CL</sub> (pin 7) and really clamp voltage.  
Really clamp voltage = V<sub>CL</sub> + α  
Take account of the α (about ±20 mV) at supply V<sub>CL</sub> to pin 7.
- When reference voltage is set from external, V<sub>RB</sub> (pin 10) = 2.3 V, V<sub>RT</sub> (pin 1) = 3.3 V .
- **Circuit current**

	TYP. (Unit: mA)
Analog circuit current	37
Digital circuit current	6
Sum	43

- Set the sampling clock frequency between 1 MHz and 20 MHz. If a frequency outside this range is used, the internal sample-and-hold circuit will not function properly.
- First apply 5 V to the AV<sub>CC</sub> pins (pins 3 and 11) and the DV<sub>CC</sub> pin (pin 18), then input the analog signal to the V<sub>IN</sub> pin (pin 4). If the analog signal is input first, the output data may latch up.

**DIFFERENCE BETWEEN THE  $\mu$ PC659 AND THE  $\mu$ PC659A**

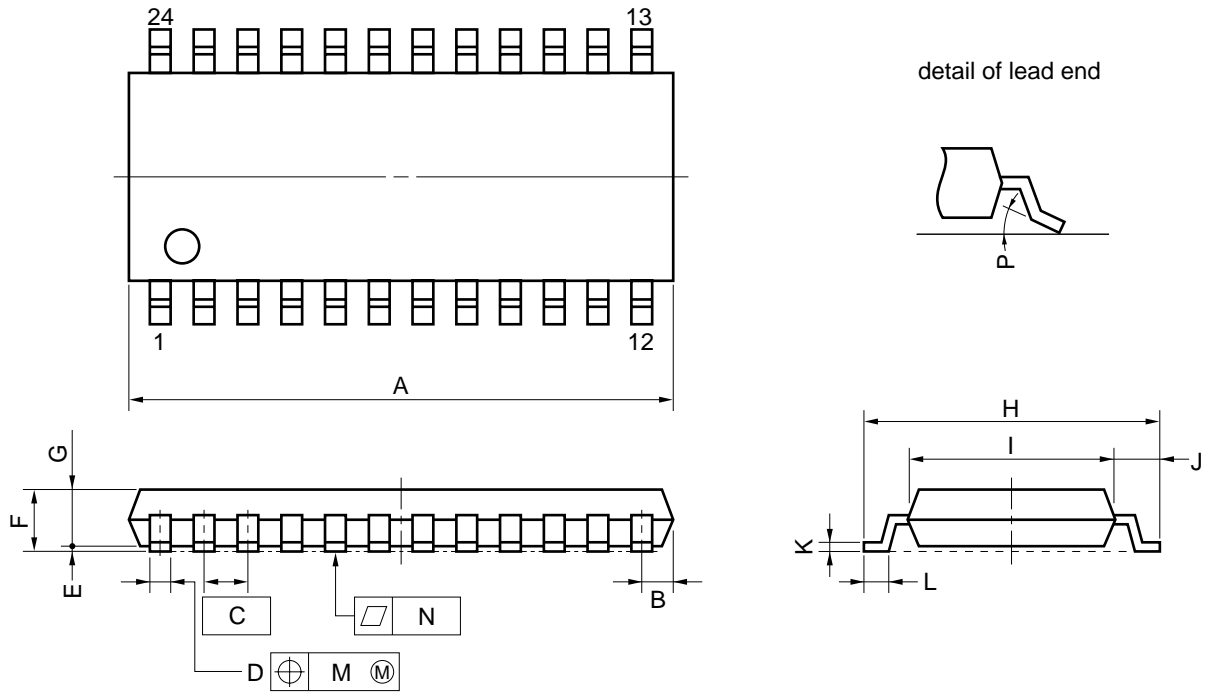
The following table shows the differences between the  $\mu$ PC659 and the  $\mu$ PC659A.

This should be taken into consideration when using the  $\mu$ PC659A instead of the  $\mu$ PC659.

Parameter			$\mu$ PC659	$\mu$ PC659A
Supply current $I_{CC}$ $(V_{CC} = 5.0 V)$ $(T_A = 25 ^\circ C)$	MIN.		50 mA	26 mA
	TYP.		79 mA	43 mA
	MAX.		110 mA	62 mA
Digital data output delay time $t_D$	TYP.		12 ns	20 ns
	MAX.		20 ns	35 ns
Internal reference resistance $V_{RT}$ pin (pin 1), $V_{RB}$ pin (pin 10)				
Timing chart				

PACKAGE DRAWING

24 PIN PLASTIC SOP (300 mil)



NOTE

Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	15.54 MAX.	0.612 MAX.
B	0.78 MAX.	0.031 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	0.40 <sup>+0.10</sup> <sub>-0.05</sub>	0.016 <sup>+0.004</sup> <sub>-0.003</sub>
E	0.1±0.1	0.004±0.004
F	1.8 MAX.	0.071 MAX.
G	1.55	0.061
H	7.7±0.3	0.303±0.012
I	5.6	0.220
J	1.1	0.043
K	0.20 <sup>+0.10</sup> <sub>-0.05</sub>	0.008 <sup>+0.004</sup> <sub>-0.002</sub>
L	0.6±0.2	0.024 <sup>+0.008</sup> <sub>-0.009</sub>
M	0.12	0.005
N	0.10	0.004
P	3° <sup>+7°</sup> <sub>-3°</sub>	3° <sup>+7°</sup> <sub>-3°</sub>

P24GM-50-300B-4

## RECOMMENDED SOLDERING CONDITIONS

When soldering this product, it is highly recommended to observe the conditions as shown below. If other soldering processes are used, or if the soldering is performed under different conditions, please make sure to consult with our sales offices.

For more details, refer to our document “**SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL**” (C10535E).

### Surface mount device

#### μPC659AGS : 24-pin plastic SOP (300 mil)

Process	Conditions	Symbol
Infrared ray reflow	Peak temperature: 235 °C or below (Package surface temperature), Reflow time: 30 seconds or less (at 210 °C or higher), Maximum number of reflow processes: 2 times.	IR35-00-2
Vapor phase soldering	Peak temperature: 215 °C or below (Package surface temperature), Reflow time: 40 seconds or less (at 200 °C or higher), Maximum number of reflow processes: 2 times.	VP15-00-2
Wave Soldering	Solder temperature: 260 °C or below, Flow time: 10 seconds or less, Pre-heating temperature: 120 °C or below (Package surface temperature), Maximum number of flow processes: 1 time.	WS60-00-1
Partial heating method	Pin terminal temperature: 300 °C or below, Heat time: 3 seconds or less (Per each side of the device).	—

**Caution** Apply only one kind of soldering condition to a device, except for “partial heating method”, or the device will be damaged by heat stress.

[MEMO]

The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

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Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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Anti-radioactive design is not implemented in this product.