RICOH

R1525x Series

200 mA 42 V Ultra Low Supply Current Voltage Regulator

NO. EA-520-180822

OVERVIEW

The R1525x is a low supply current voltage regulator featuring 200mA output current and up to 42 V input voltage. By providing excellent noise immunity, this device is suitable for the power source for control unit used under the electromagnetic environment.

KEY BENEFITS

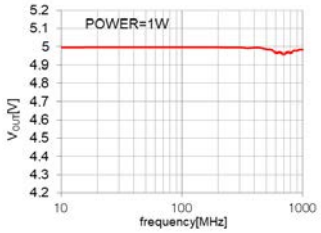
- Achieves low-supply current of 2.2µA (Typ.) with the LDO at maximum rating 50 V (Peak Inrush Voltage: 60 V).
- Ensures the design margin by the output voltage with high-accuracy of ±0.6% (Ta=25°C).
- Protects the output voltage variations in high-frequency noise band (10MHz to 1GHz).

KEY SPECIFICATIONS

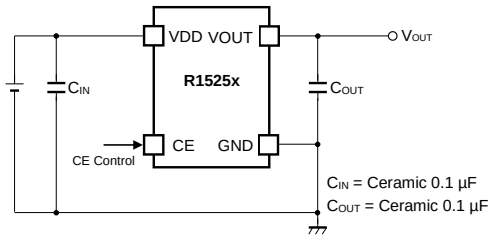
- Input Voltage Range: 3.5 V to 42.0 V
- Maximum Rating: 50 V
  (Peak Inrush Voltage: 60 V@200ms or less)
- Operating Temperature Range: −40°C to 105°C
- Supply Current: Typ. 2.2 µA (Typ. 0.1 µA at Standby)
- Dropout Voltage: Typ. 0.6 V (I_{OUT} = 200 mA, V_{OUT} = 5.0 V)
- Output Voltage Range: 1.8 V, 2.5 V, 2.8 V, 3.0 V, 3.3 V, 3.4 V, 5.0 V, 5.5 V, 6.0 V, 6.4 V, 7.5 V, 8.0 V, 8.5 V, 9.0 V
- Output Voltage Accuracy: ±0.6% (Ta = 25°C)
  ±1.6% (−40°C ≤ Ta ≤ 105°C)
- Input Stability: Typ. 0.01%/V (V_{SET} + 1 V ≤ V_{IN} ≤ 42 V)
- Short-circuit Protection: Limited to Typ. 80 mA
- Overcurrent Protection: Limited to Typ. 350 mA
- Thermal Shutdown: Detected at Typ.160°C

CHRACTERISTICS

Noise Immunity Characteristic

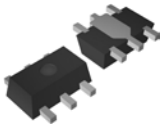


TYPICAL APPLICATIONS



PACKAGES (unit: mm)

SOT-23-5
2.9 x 2.8 x 1.1



SOT-89-5
4.5 x 4.35 x 1.5

HSOP-6J
5.02 x 6.0 x 1.5

HSOP-8E
5.2 x 6.2 x 1.45

APPLICATIONS

- Power source for home appliances such as refrigerators, rice cookers, and electric hot-water pot.
- Power source for notebook PCs, digital TVs, cordless phones, and private LAN system.
- Power source for office equipment machines such as copiers, printers, facsimiles, scanners, and projectors.

SELECTION GUIDE

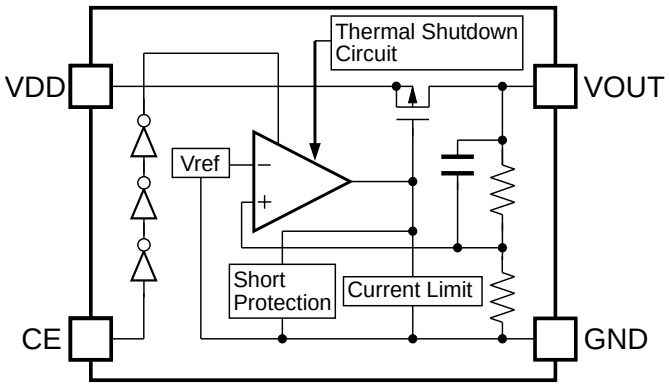
The set output voltage, the package type, and the quality class are user-selectable.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1525NxxxB-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
R1525HxxxB-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes
R1525SxxxB-E2-FE	HSOP-6J	1,000 pcs	Yes	Yes
R1525SxxxH-E2-FE	HSOP-8E	1,000 pcs	Yes	Yes

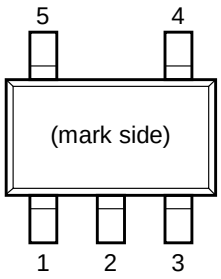
xxx : Specify the set output voltage (V_{SET})
1.8 V (018) / 2.5 V (025) / 2.8 V (028) / 3.0 V (030) / 3.3 V (033) / 3.4 V (034) / 5.0 V (050) /
5.5 V (055) / 6.0 V (060) / 6.4 V (064) / 7.5 V (075) / 8.0 V (080) / 8.5 V (085) / 9.0 V (090)

BLOCK DIAGRAM

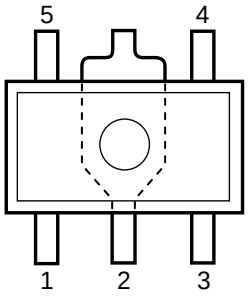


R1525x Block Diagram

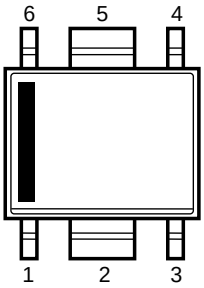
PIN DESCRIPTIONS



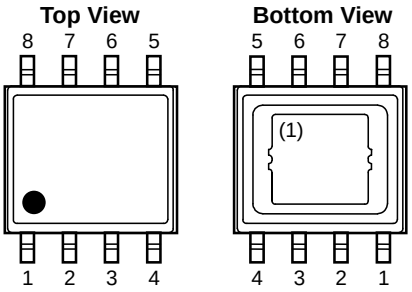
R1525N (SOT-23-5) Pin Configuration



R1525H (SOT-89-5) Pin Configuration



R1525S (HSOP-6J) Pin Configuration



R1525S (HSOP-8E) Pin Configuration

R1525N Pin Description

Pin No.	Pin Name	Description
1	GND(2)	Ground Pin
2	GND(2)	Ground Pin
3	CE	Chip Enable Pin (Active-high)
4	VOUT	Output Pin
5	VDD	Input Pin

R1525H Pin Description

Pin No.	Pin Name	Description
1	VOUT	Output Pin
2	GND(2)	Ground Pin
3	CE	Chip Enable Pin (Active-high)
4	GND(2)	Ground Pin
5	VDD	Input Pin

(1) The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left open.

(2) The GND pin must be wired together when it is mounted on board.

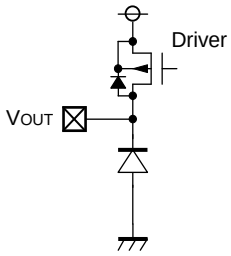
R1525S (HSOP-6J) Pin Description

Pin No.	Pin Name	Description
1	VOUT	Output Pin
2	GND(1)	Ground Pin
3	CE	Chip Enable Pin (Active-high)
4	GND(1)	Ground Pin
5	GND(1)	Ground Pin
6	VDD	Input Pin

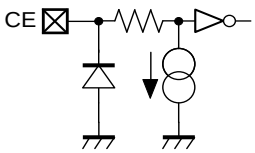
R1525S (HSOP-8E) Pin Description

Pin No.	Pin Name	Description
1	VOUT	Output Pin
2	NC	No Connection
3	NC	No Connection
4	CE	Chip Enable Pin (Active-high)
5	GND	Ground Pin
6	NC	No Connection
7	NC	No Connection
8	VDD	Input Pin

Pin Equivalent Circuit Diagrams



VOUT Pin Equivalent Circuit Diagram



CE Pin Equivalent Circuit Diagram

(1) The GND pins are connected to each other on the board.

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
V_{IN}	Input Voltage		−0.3 to 50	V
V_{IN}	Peak Inrush Voltage[1]		60	V
V_{CE}	CE Pin Input Voltage		−0.3 to 50	V
V_{OUT}	Output Voltage		−0.3 to V_{IN} + 0.3 ≤ 50	V
I_{OUT}	Output Current		300	mA
P_D	Power Dissipation[2] (JEDEC STD. 51-7)	SOT-23-5	660	mW
		SOT-89-5	2600	
		HSOP-6J	2700	
		HSOP-8E	2900	
Tj	Junction Temperature		−40 to 125	°C
Tstg	Storage Temperature Range		−55 to 125	°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 is not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

Symbol	Parameter	Rating	Unit
V_{IN}	Input Voltage	3.5 to 42	V
Ta	Operating Temperature Range	−40 to 105	°C

RECOMMENDED OPERATING CONDITONS

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) Duration: 200 ms or less

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

ELECTRICAL CHARACTERISTICS

C_{IN} = C_{OUT} = 0.1 µF, unless otherwise noted.

The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

R1525x Electrical Characteristics (Ta = 25°C)

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
I_{SS}	Supply Current	V_{IN} = 14 V, I_{OUT} = 0 mA	V_{SET} ≤ 5.0 V		2.2	[6.5]	µA
			5.0 V < V_{SET}		2.5	[6.8]	
Istandby	Supply Current	V_{IN} = 42 V, V_{CE} = 0 V			0.1	1.0	µA
V_{OUT}	Output Voltage	V_{SET} + 1 V ≤ V_{IN} ≤ 42 V, I_{OUT} = 1 mA	Ta = 25°C	×0.994		×1.006	V
			−40°C ≤ Ta ≤ 105°C	[×0.984]		[×1.016]	
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	V_{IN} = V_{SET} + 3.0 V, 1 mA ≤ I_{OUT} ≤ 200 mA		Refer to Product-specific Electrical Characteristics			
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET} + 1 V ≤ V_{IN} ≤ 42 V, I_{OUT} = 1 mA	V_{SET} < 3.3 V	[-20]	5	[20]	mV
			3.3 V ≤ V_{SET}	[-0.02]	0.01	[0.02]	%/V
V_{DIF}	Dropout Voltage	I_{OUT} = 200 mA		Refer to Product-specific Electrical Characteristics			
I_{LIM}	Output Current Limit	V_{IN} = V_{SET} + 3.0 V		[220]	350	[420]	mA
I_{SC}	Short-circuit Current	V_{OUT} = 0 V		[60]	80	[110]	mA
V_{CEH}	CE Input Voltage, high			[2.0]		42	V
V_{CEL}	CE Input Voltage, low			0		[1.0]	V
I_{PD}	CE Pull-down Current				0.2	[0.6]	µA
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature			160		°C
T_{TSR}	Thermal Shutdown Release Temperature	Junction Temperature			135		°C

All parameters are tested under the pulse load condition (Tj ≈ Ta = 25°C).

The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 105°C.

R1525x Product-specific Electrical Characteristics (Ta = 25°C)

Product Name	V_{OUT} (V) (Ta = 25°C)			V_{OUT} (V) (−40°C ≤ Ta ≤ 105°C)			$\Delta V_{OUT}/\Delta I_{OUT}$ (mV)			V_{DIF} (V)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
R1525x018x	1.7892	1.80	1.8108	1.7712	1.80	1.8288	-10	10	40	1.6	2.5
R1525x025x	2.4850	2.50	2.5150	2.4600	2.50	2.5400				1.2	2.2
R1525x028x	2.7832	2.80	2.8168	2.7552	2.80	2.8448					
R1525x030x	2.9820	3.00	3.0180	2.9520	3.00	3.0480					
R1525x033x	3.2802	3.30	3.3198	3.2472	3.30	3.3528				0.8	2.0
R1525x034x	3.3796	3.40	3.4204	3.3456	3.40	3.4544					
R1525x050x	4.9700	5.00	5.0300	4.9200	5.00	5.0800				0.6	1.2
R1525x055x	5.4670	5.50	5.5330	5.4120	5.50	5.5880	-18	18	72		
R1525x060x	5.9640	6.00	6.0360	5.9040	6.00	6.0960					
R1525x064x	6.3616	6.40	6.4384	6.2976	6.40	6.5024					
R1525x080x	7.9520	8.00	8.0480	7.8720	8.00	8.1280				0.5	1.3
R1525x085x	8.4490	8.50	8.5510	8.3640	8.50	8.6360					
R1525x090x	8.9460	9.00	9.0540	8.8560	9.00	9.1440					

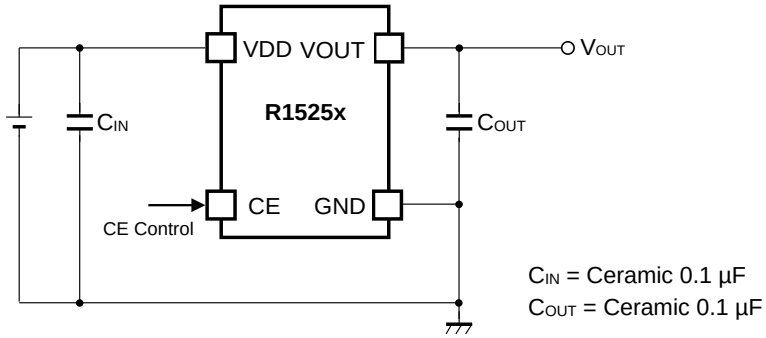
THEORY OF OPERATION

Thermal Shutdown

When the junction temperature of this device exceeds 160°C (Typ.), the built-in thermal shutdown circuit stops the regulator operation. After that, when the temperature drops to 135°C (Typ.) or lower, the regulator restarts the operation. Unless eliminating the overheating problem, the regulator turns on and off repeatedly and a pulse shaped output voltage occurs as result.

APPLICATION INFORMATION

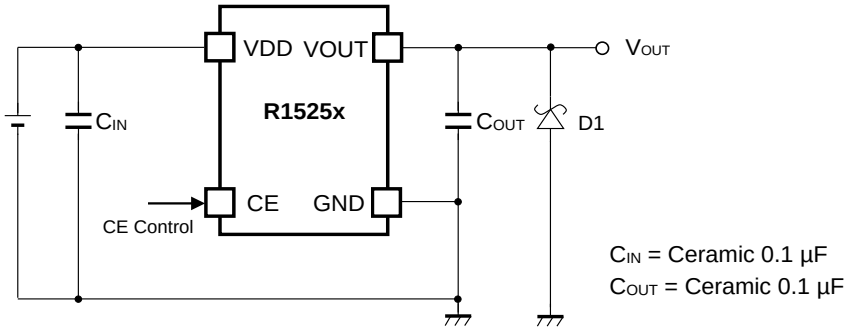
Typical Applications



R1525x Typical Applications

Typical Application for IC Chip Breakdown Prevention

When a sudden surge of electrical current travels along the VOUT pin and GND due to a short-circuit, electrical resonance of a circuit involving an output capacitor and a short circuit inductor generates a negative voltage and may damage the device or the load devices. Connecting a schottky diode (D1) between the VOUT pin and GND has the effect of preventing damage to them.



R1525x Typical Application for IC Chip Breakdown Prevention

TECHNICAL NOTES

Phase Compensation

Phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, make sure to use 0.1 µF or more of a capacitor (C_{OUT}). In case of using a tantalum type capacitor and the ESR (Equivalent Series Resistance) value of the capacitor is large, the output might be unstable. Evaluate the circuit including consideration of frequency characteristics. Connect 0.1 µF or more of a capacitor (C_{IN}) between V_{DD} and GND, and as close as possible to the pins.

PCB Layout

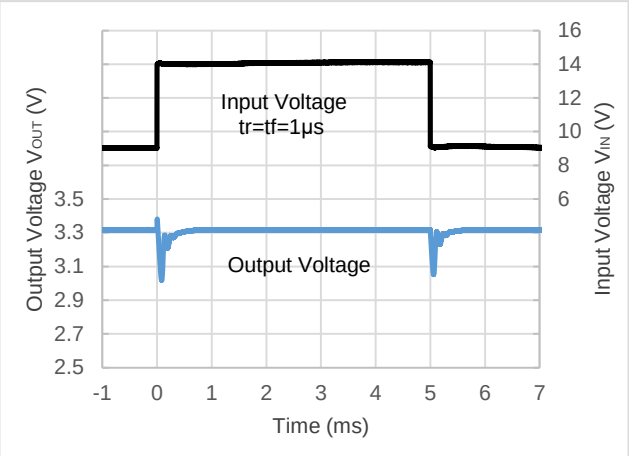
For SOT-23-5 package type, wire the following GND pins together: No. 1 and No. 2
For SOT-89-5 package type, wire the following GND pins together: No. 2 and No. 4.
For HSOP-6J package type, wire the following GND pins together: No. 2, No. 4, and No. 5.

Input Transient / Load Transient vs. Output Capacity (C_{OUT})

R1525x performs a stable operation by using 0.1 µF of ceramic capacitor as the output capacitor. However, the variation of output voltage may not meet the demand of the system when input voltage and load current vary. In such cases, the variation of output voltage can be minimized significantly by using 10 µF or higher ceramic capacitor. When using an electrolytic capacitor for the output line, place the electrolytic capacitor outer side of the ceramic capacitor arranged close to the IC.

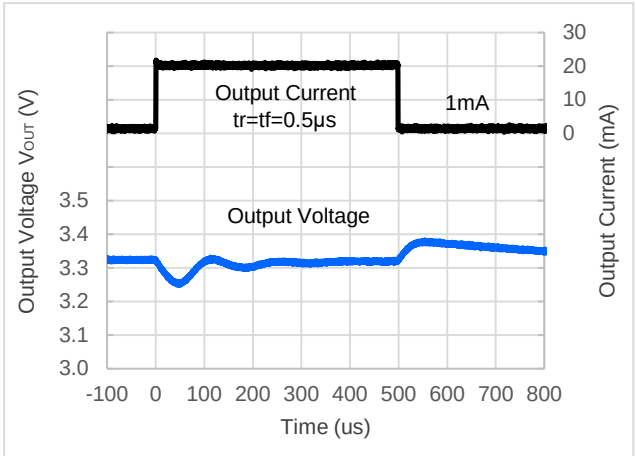
<Input Transient Response>

R1525x033B



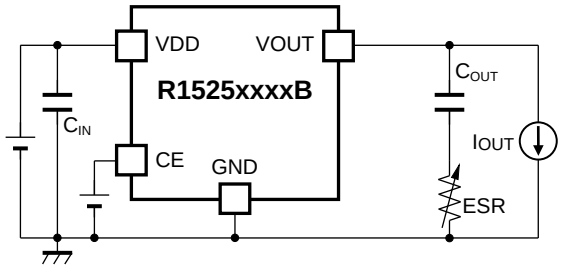
<Load Transient Response>

R1525x033B



ESR vs. Output Current

Using a ceramic type capacitor is recommended for this device, but also other type capacitors having lower ESR can be used. The relation between the output current (I_{OUT}) and the ESR of output capacitor is shown below.

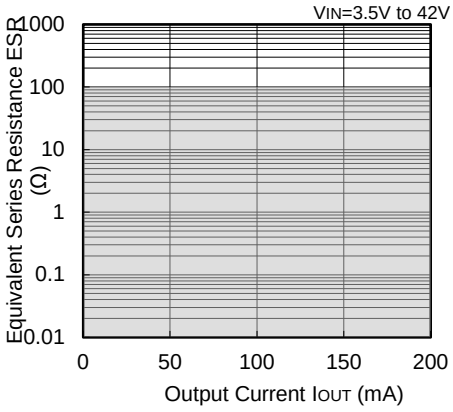


C_{IN} = Ceramic 0.1 µF,
C_{OUT} = Ceramic 0.1 µF

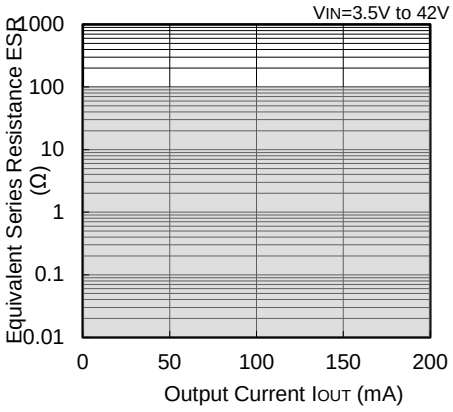
Measurement Conditions

Frequency Band: 10 Hz to 2 MHz
Measurement Temperature: −40°C to 105°C
Noise Level in Hatched Area: 40 µV (average) or below
Ceramic Capacitors: C_{IN} = 0.1 µF, C_{OUT} = 0.1 µF

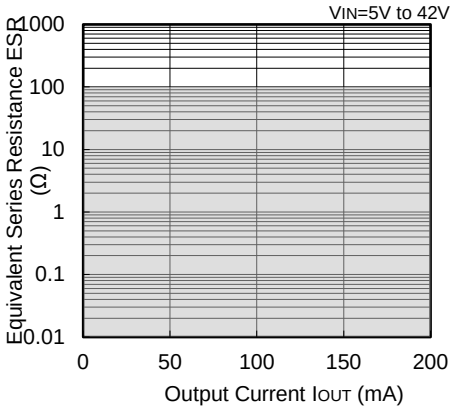
R1525x018B



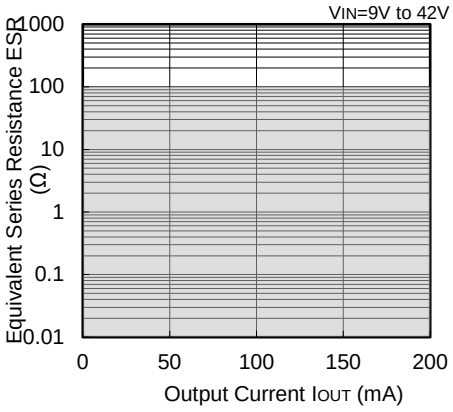
R1525x033B



R1525x050B



R1525x090B



Ver. A

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

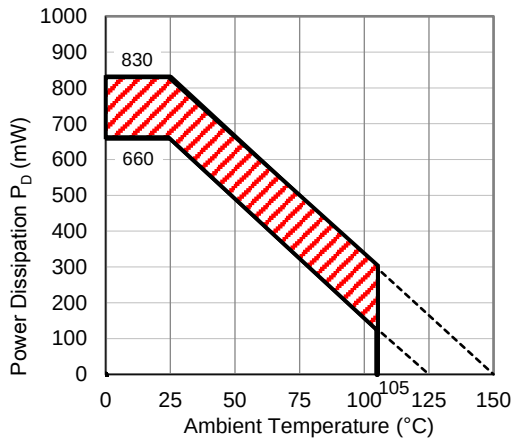
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 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 = 125°C)

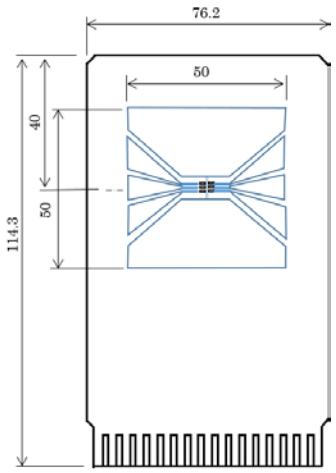
Item	Measurement Result
Power Dissipation	660 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



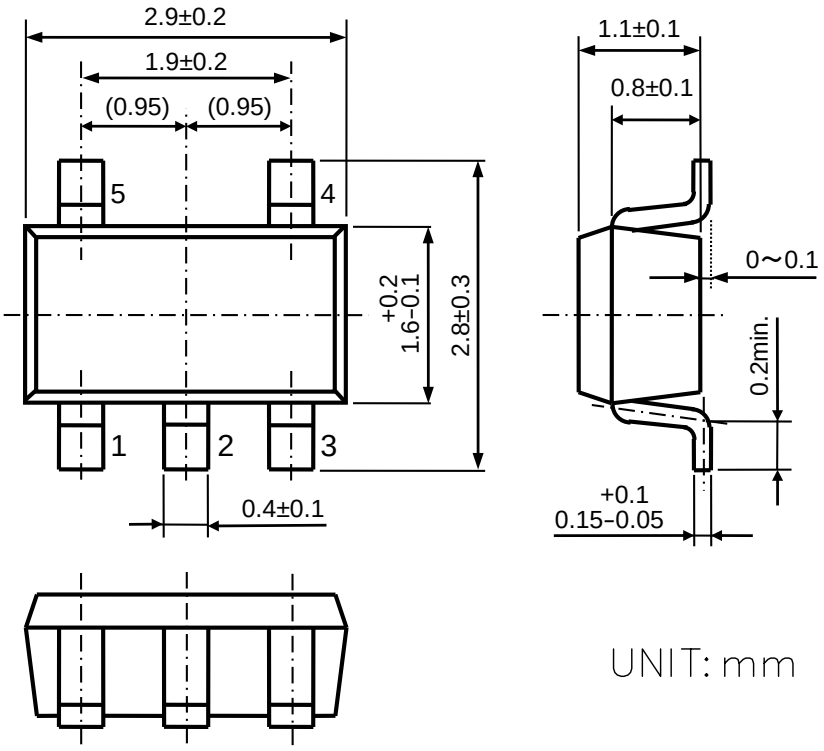
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



SOT-23-5 Package Dimensions

Ver. A

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

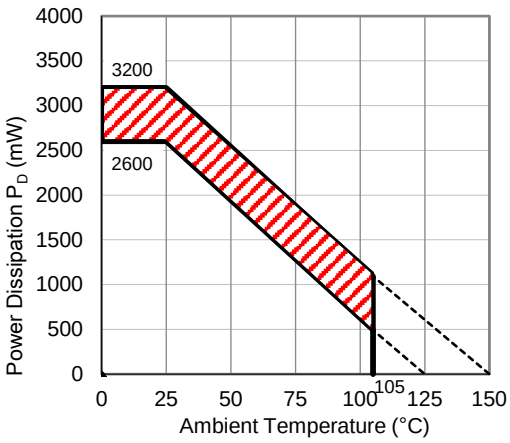
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 13 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

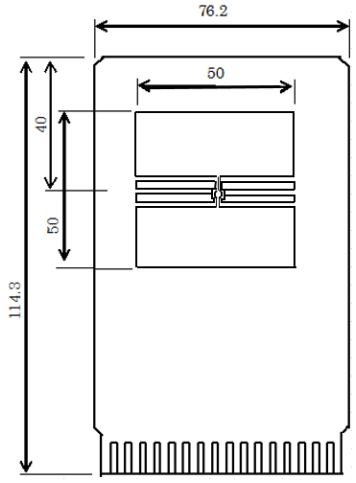
Item	Measurement Result
Power Dissipation	2600 mW
Thermal Resistance (θja)	θja = 38°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 13°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



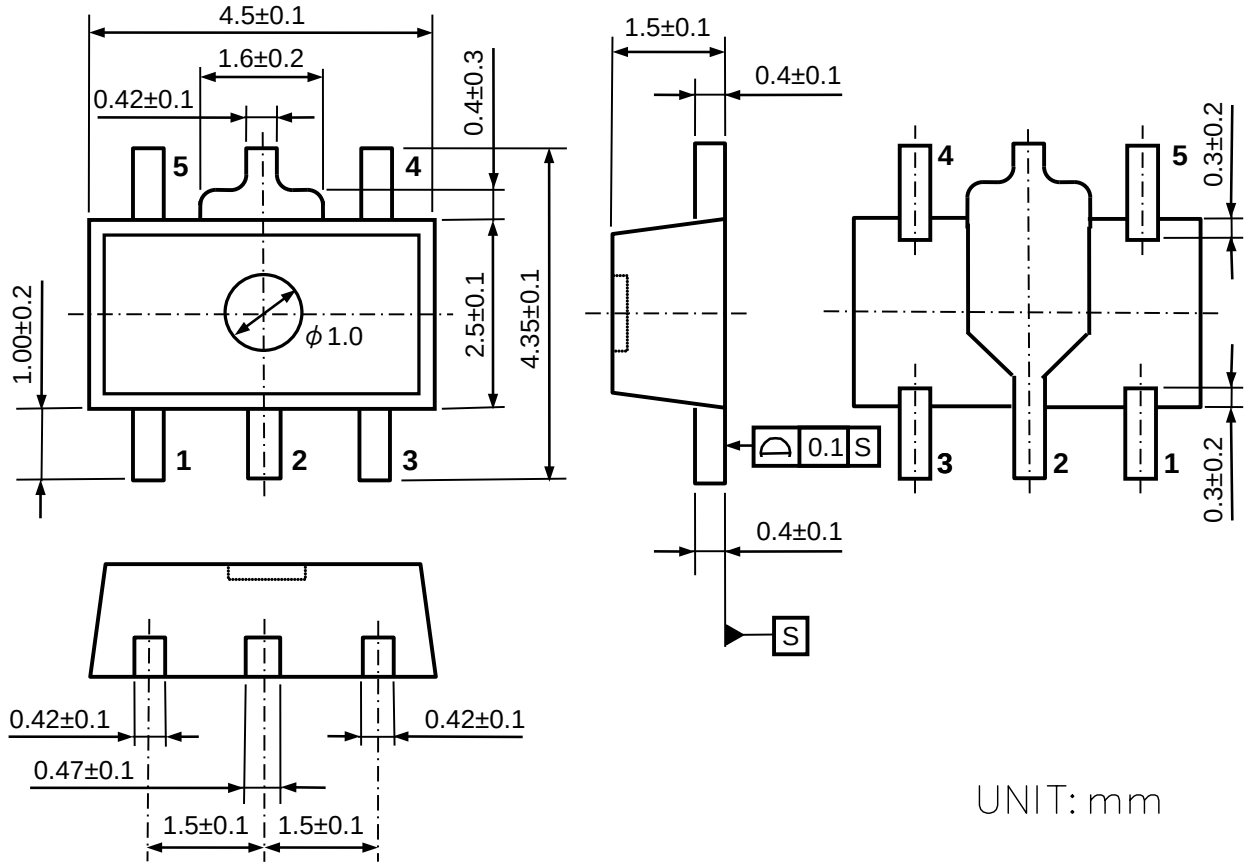
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



SOT-89-5 Package Dimensions

Ver. A

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

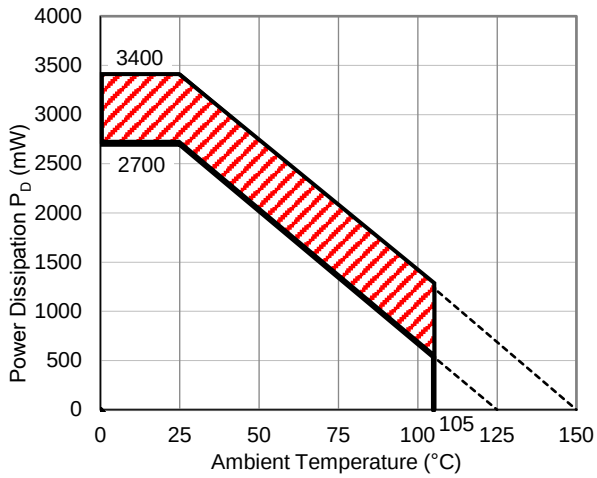
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 28 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

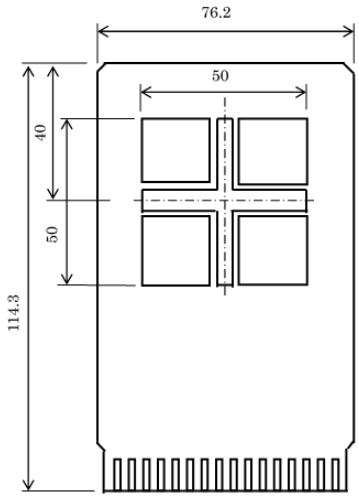
Item	Measurement Result
Power Dissipation	2700 mW
Thermal Resistance (θja)	θja = 37°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 7°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



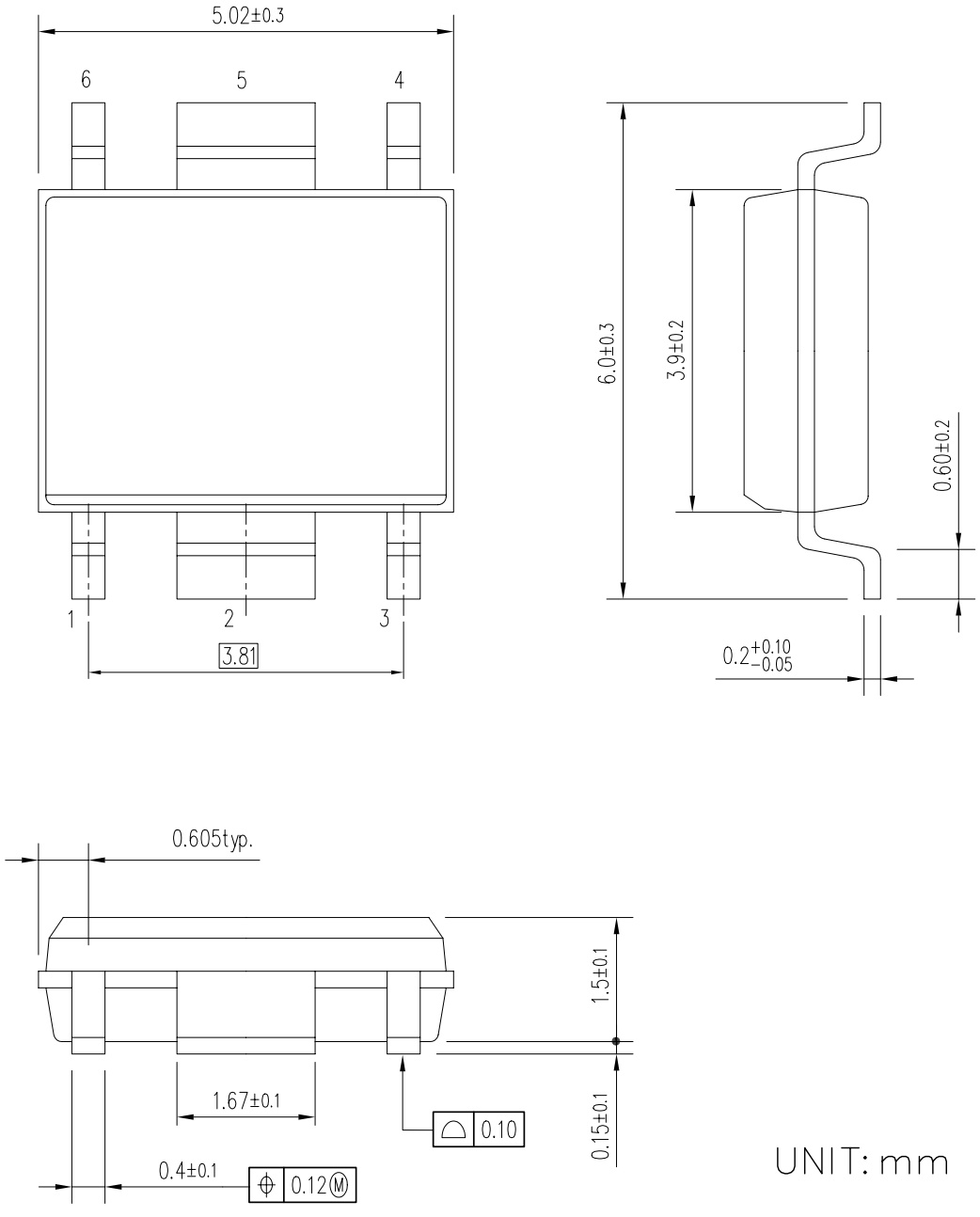
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



HSOP-6J Package Dimensions

Ver. B

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

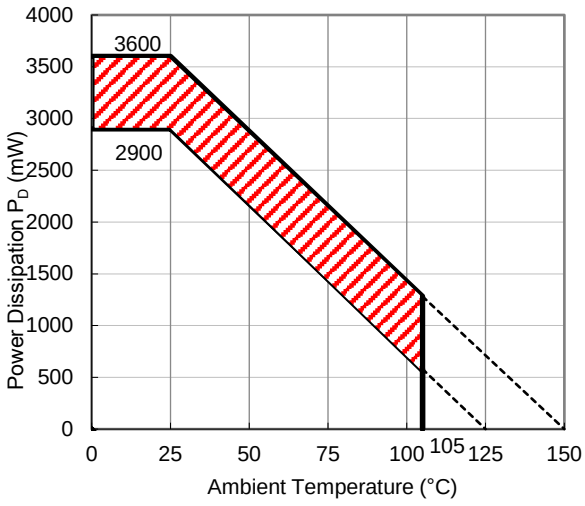
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 21 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

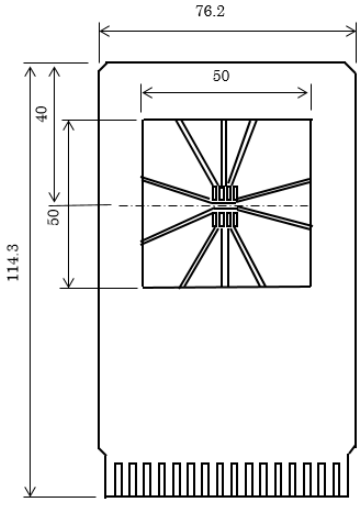
Item	Measurement Result
Power Dissipation	2900 mW
Thermal Resistance (θja)	θja = 34.5°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 10 °C/W

θja: Junction-to–ambient thermal resistance.

ψjt: Junction–to-top of package thermal characterization parameter.



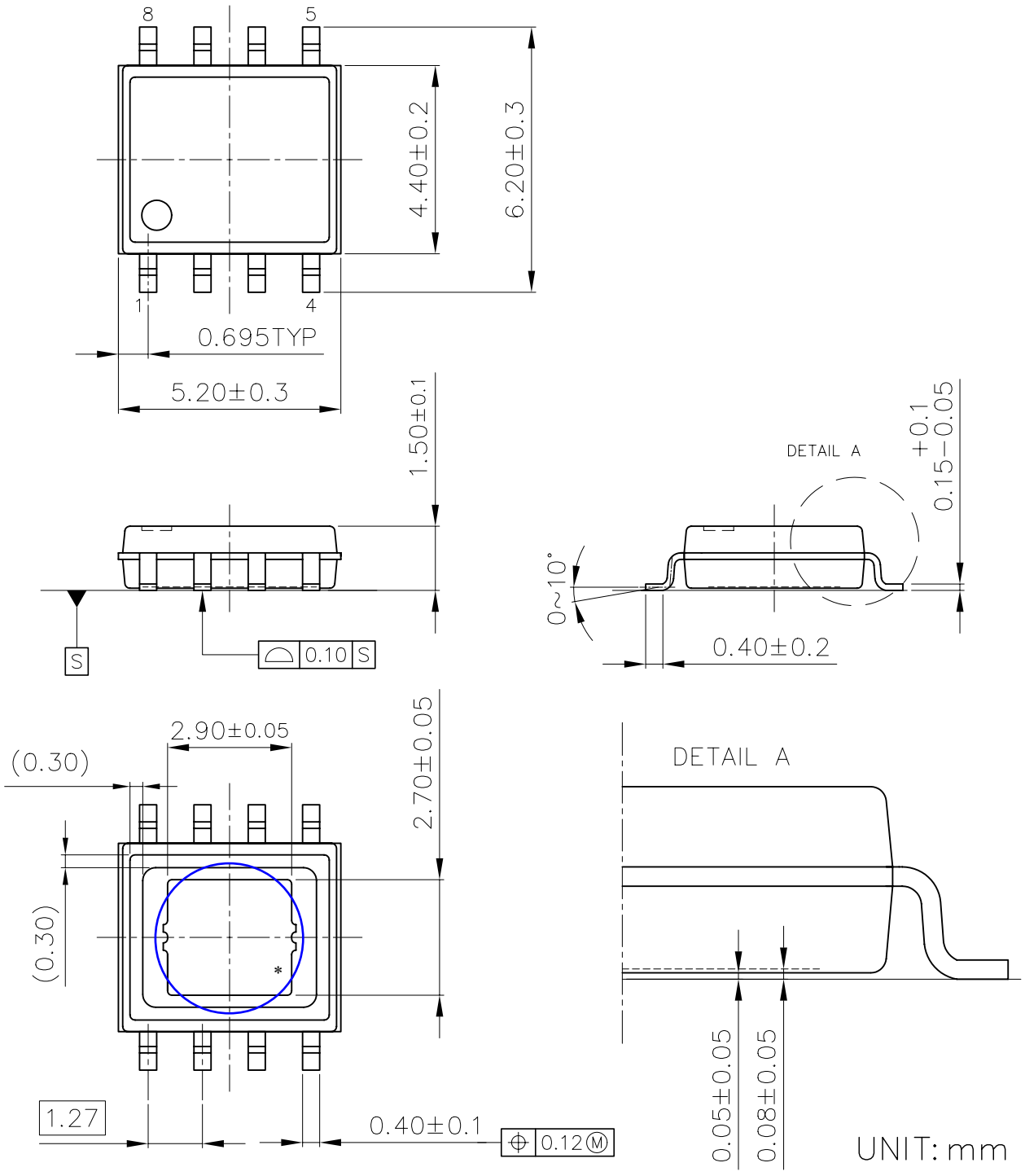
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



HSOP-8E Package Dimensions

∗ The tab on the bottom of the package shown by blue circle is substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.

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