

# HIGH-PRECISION ANTI-SURGE THICK FILM CHIP RESISTOR

## - HWR SERIES -

### SCOPE

This specification for approval relates to High-Precision Anti-Surge Thick Film Chip Resistors (Lead Free) manufactured by CAL-CHIP. The test items follow the test standard of AEC-Q200 Grade 4.

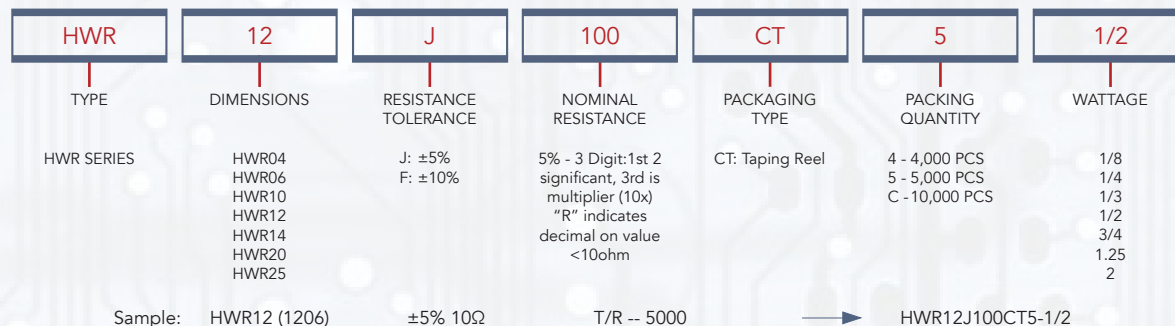


### TYPE DESIGNATION

The type designation shall be in the following form:

TYPE	RESISTANCE TOLERANCE	NOMINAL RESISTANCE
HWR12 (1206)	F, J	10 Ω

### PART NUMBERING GUIDE



### RATINGS

TYPE	HWR04 (0402)	HWR06 (0603)	HWR10 (0805)	HWR12 (1206)	HWR14 (1210)	HWR20 (2010)	HWR25 (2512)
POWER RATING	1/8W	1/4W	1/3W, 1/2W	1/2W	3/4W	1.25W	2W
MAX. WORKING VOLTAGE	50 V	50 V	150 V	200 V	200 V	400 V	500 V
MAX OVERLOAD VOLTAGE	100 V	100 V	300 V	400 V	500 V	800 V	1000 V
DIELECTRIC WITHSTANDING VOLTAGE	100 V	300 V	500 V	500 V	500 V	500 V	500 V
TEMPERATURE RANGE	-55°C ~ +155°C						
AMBIENT TEMPERATURE	70°C						

## NOMINAL RESISTANCE

Effective figures of nominal resistance shall be in accordance:

E-24 values – these are preferred and will have standard MOQ

E-96 values – are available on case by case basis and availability and MOQ need to be confirmed with factory first

## VOLTAGE RATING

Resistors shall have a rated direct-current (DC) continuous working voltage or an approximate sine-wave-root-mean-square (RMS) alternating-current (AC) continuous working voltage at commercial line frequency and waveform corresponding to the power rating, as determined from the following formula:

$$RCWV = \sqrt{P \times R}$$

Note : Max. Working Voltage or  $\sqrt{P \times R}$  whichever is lesser

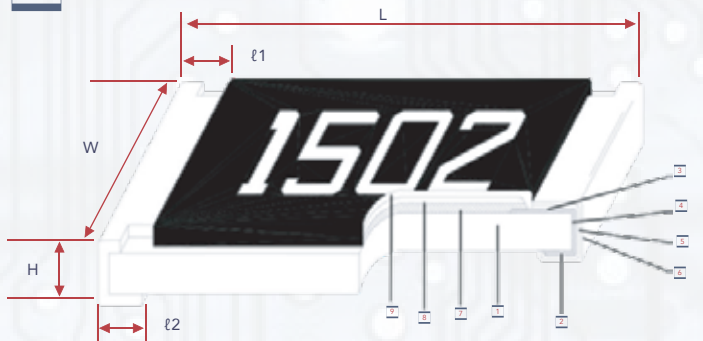
Max. Overload Voltage or  $2.5\sqrt{P \times R}$  whichever is lesser

Where: RCWV = Rated DC or RMS AC continuous working voltage at commercial-line frequency and waveform (volt)

P = Power Rating (watt)

R = Nominal Resistance (ohm)

## CONSTRUCTION

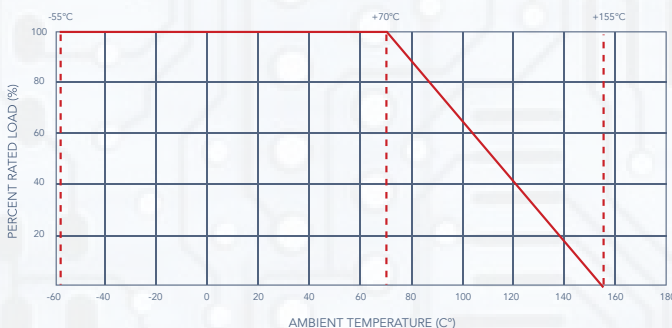


- 1 Alumina Substrate
- 2 Bottom Electrode (Ag)
- 3 Top Electrode (Ag-pd)
- 4 Edge Electrode (NiCr)
- 5 Barrier Layer (Ni)
- 6 External Electrode (Sn)
- 7 Resistor Layer
- 8 Primary Overcoat (glass)
- 9 Secondary Overcoat (Epoxy)

TYPE	DIMENSION (MM)				
	L	W	H	l1	l2
HWR04 (0402)	1.00 ± 0.10	0.50 ± 0.05	0.35 ± 0.05	0.20 ± 0.10	0.25 ± 0.10
HWR06 (0603)	1.60 ± 0.10	0.80 ± 0.10	0.45 ± 0.10	0.30 ± 0.20	0.30 ± 0.20
HWR10 (0805)	2.00 ± 0.15	1.25 + 0.15 - 0.10	0.55 ± 0.10	0.40 ± 0.20	0.40 ± 0.20
HWR12 (1206)	3.10 ± 0.15	1.55 + 0.15 - 0.10		0.45 ± 0.20	0.45 ± 0.20
HWR14 (1210)	3.10 ± 0.10	2.60 ± 0.20		0.50 ± 0.25	
HWR20 (2010)	5.00 ± 0.10	2.50 ± 0.20		0.60 ± 0.25	0.50 ± 0.20
HWR25 (2512)	6.35 ± 0.10	3.20 ± 0.20			

## POWER RATING AND DIMENSIONS

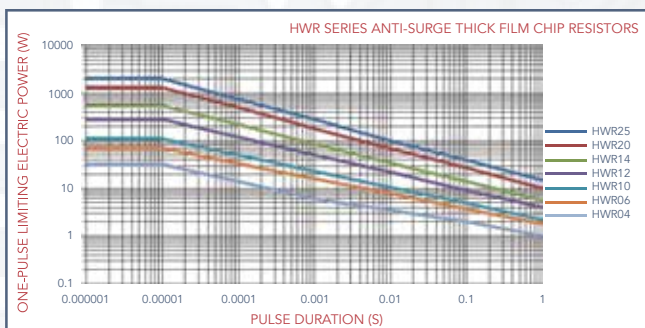
Power rating: Resistors shall have a power rating based on continuous load operation at an ambient temperature of 70°. For temperature in excess of 70°C, The load shall be derate as shown in figure 1.



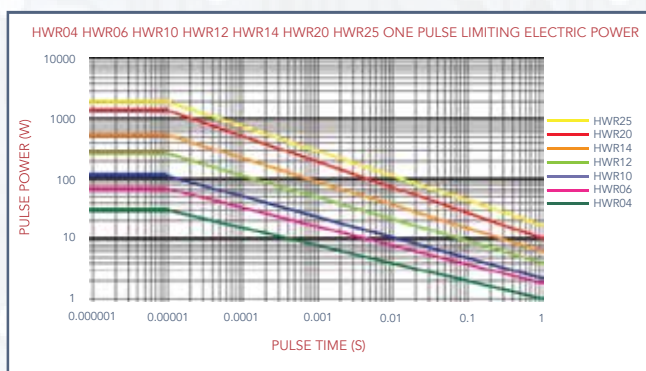
TYPE	POWER RATING AT 70°C	TOLERANCE %	RESISTANCE RANGE	T.C.R. (PPM / °C)	STANDARD SERIES
HWR04 (0402)	1/8 W	±5% ±1%	1Ω ~ 10MΩ	±400	±5%; E-24 ±1%; E-96
			10.1Ω ~ 100Ω	±200	
			100.1Ω ~ 10MΩ	±100	
HWR06 (0603)	1/4 W	1Ω ~ 10MΩ	±100		
HWR10 (0805)	1/3 W				
HWR12 (1206)	1/2 W	0.1Ω ~ 10MΩ	±100		
HWR14 (1210)	3/4 W				
HWR20 (2010)	1.25 W	1Ω ~ 10MΩ			
HWR25 (2512)	2W	0.1Ω ~ 10MΩ			



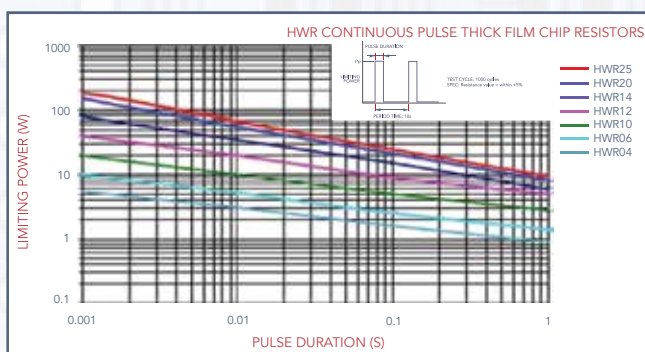
**CURVE OF PULSE DURATION**



**PULSE WITHSTANDING CAPACITY (SINGLE PULSE)**



**PULSE WITHSTANDING CAPACITY (CONTINUOUS PULSE)**



## MARKING

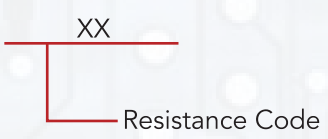
- Resistors

- A. Chip Resistors type HWR04 No marking
- B. Standard E-96 series values(±1% tolerance) of HWR06 size. Due the small size of the resistor's body, 3 digits marking will be used to indicate the accurate resistance value by using the following multiplier & resistance code.

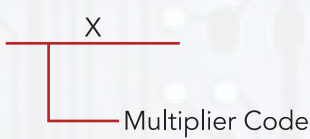
## MULTIPLIER CODE

CODE	A	B	C	D	E	F	G	H	X	Y	Z
MULTIPLIER	10 <sup>0</sup>	10 <sup>1</sup>	10 <sup>2</sup>	10 <sup>3</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>-1</sup>	10 <sup>-2</sup>	10 <sup>-3</sup>

CODING



FORMULA



EXAMPLE

$$10.2K\Omega = 102 \underset{02}{X} \underset{C}{10^2} \Omega = 02C$$

$$33.2\Omega = 332 \underset{51}{X} \underset{X}{10^{-1}} \Omega = 51X$$

VALUE	CODE	VALUE	CODE	VALUE	CODE	VALUE	CODE	VALUE	CODE
100	01	162	21	261	41	422	61	681	81
102	02	165	22	267	42	432	62	698	82
105	03	169	23	274	43	442	63	715	83
107	04	174	24	280	44	453	64	732	84
110	05	178	25	287	45	464	65	750	85
113	06	182	26	294	46	475	66	768	86
115	07	187	27	301	47	487	67	787	87
118	08	191	28	309	48	499	68	806	88
121	09	196	29	316	49	511	69	825	89
124	10	200	30	324	50	523	70	845	90
127	11	205	31	332	51	536	71	866	91
130	12	210	32	340	52	549	72	887	92
133	13	215	33	348	53	562	73	909	93
137	14	221	34	357	54	576	74	931	94
140	15	226	35	365	55	590	75	953	95
143	16	232	36	374	56	604	76	976	96
147	17	237	37	383	57	619	77		
150	18	243	38	392	58	634	78		
154	19	249	39	402	59	649	79		
158	20	255	40	412	60	665	80		

\*Marking for HWR06 E-96 series, the resistance value that no have multiplier code indicate marking follow this:  
 The first two digits are significant figures of resistance and the third one denoted number of zeros and under line the marking letters.



**MARKING**

- C. Marking for E-96 series in HWR10, HWR12, HWR1, HWR20, HWR25 size : 4 Digits  
 \*The first 3 digits are significant figures of resistance and the 4th digit denotes number of zeros.



\*For ohmic values below 100  $\Omega$ , letter "R" is for decimal point.



- D. Marking for E-24 series in HWR06, HWR10, HWR12, HWR14, HWR20, HWR25 size : 3 Digits  
 \*The first two digits are significant figures of resistance and the third digit denoted number of zeros

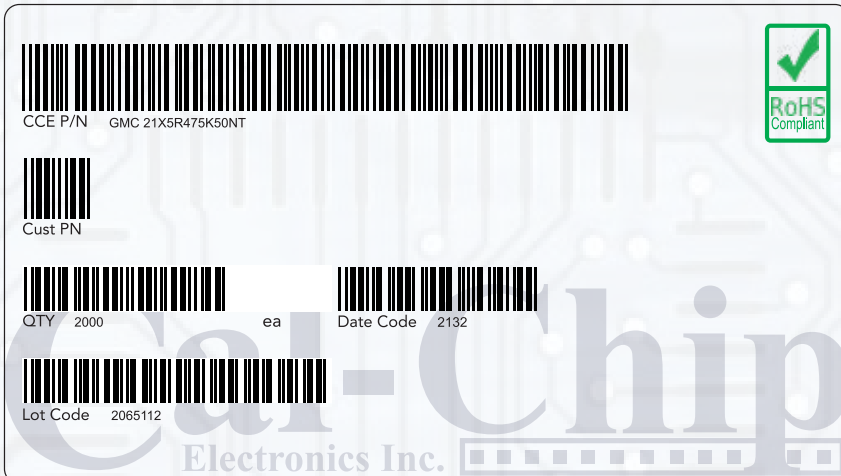


\*For ohmic values below 10  $\Omega$ , letter "R" is for decimal point.



- Label shall be marked with the following item:

- A. Nominal Resistance and Resistance Tolerance
- B. Quantity
- C. Part No.
- D. Lot No.



The label includes the following information:

- Top barcode: CCE P/N GMC 21X5R475K50NT
- RoHS Compliant logo (green checkmark)
- Second barcode: Cust PN
- Third barcode: QTY 2000 ea Date Code 2132
- Bottom barcode: Lot Code 2065112
- Watermark: Cal-Chip Electronics Inc.



## PERFORMANCE SPECIFICATION

Anti-Surge Thick Film Chip Resistors (Lead Free) AEC-Q200 Compliant

CHARACTERISTICS	LIMITS	TEST METHODS
Operational Life	Resistance change rate is $\pm 1\%: \pm(1\%+0.1\Omega)\text{Max.}$   $\pm 5\%: \pm(3\%+0.1\Omega)\text{Max.}$	125°C, at 35% of operating power, 1000H (1.5 hours "ON", 0.5 hour "OFF"). (MIL-STD-202 Method 108)
Temperature Coefficient	HWR04 1Ω~10Ω : $\pm 400$ PPM/°C 10.1Ω~100Ω : $\pm 200$ PPM/°C >100Ω : $\pm 100$ PPM/°C  HWR06, HWR10, HWR12, HWR14, HWR20, HWR25 $\pm 100$ PPM/°C	4.8 Natural resistance change per temp. degree centigrade.  R2-R1 $\times 10^6$ (PPM/°C)  R1 (t2-t1)  R1: Resistance value at room temperature (T1) R2: Resistance value at room temp. plus 100°C (T2) Test pattern: room temp. (T1), room temp. +100°C (T2)
External Visual	No Mechanical Damage	Electrical test not required. Inspect device construction, marking and workmanship (MIL-STD-883 Method 2009)
Physical Dimension	Reference 2.0 Dimension Standards	Verify physical dimensions to the applicable device detail specification. Note: User(s) and Suppliers spec. Electrical test not required. (JESD22 MH Method JB-100)
Resistance to Solvent	Marking Unsmear	Note: Add Aqueous wash chemical – OKEM Clean or equivalent. Do not use banned solvents. (MIL-STD-202 Method 215)
Terminal Strength	Not broken	Force of 1.8kg for 60 seconds. (MIL-STD-202 Method 213)
High Temperature Exposure (Storage)	Resistance change rate is $\pm(1\%+0.1W)$ max	1000hrs. at T=155°C. Unpowered. Measurement at 24±2 hours after test conclusion. (MIL-STD-202 Method 108)
Temperature Cycling	Resistance change rate is $\pm 1\%: \pm(1.0\%+0.1\Omega)$ Max.   $\pm 5\%: \pm(3.0\%+0.1\Omega)$ Max.	1000 Cycles (-55°C to +155°C). Measurement at 24±2 hours after test conclusion. (JESD22 Method JA-104)
Solderability	95% coverage Min.	For both leaded & SMD. Electrical test not required. Magnification 50X. Conditions: (J-STD-002)
Soldering Temperature Reference	Electrical characteristics shall be satisfied. Without distinct deformation in appearance. (95% coverage Min.)	Wave soldering condition: (2 cycles Max.) Pre-heat : 100 ~ 120°C, 30 ± 5 sec. Suggestion solder temp.: 235 ~ 255°C 10 sec. (Max.) Peak temp.: 260°C Reflow soldering condition: (2 cycles Max.) Pre-heat : 150 ~ 180°C, 90 ~ 120 sec. Suggestion solder temp.: 235 ~ 255°C, 20 ~ 40 sec. Peak temp.: 260°C  Hand soldering condition: The soldering iron tip temperature should be less than 300°C and maximum contact time should be 5 sec.
Mechanical Shock	Resistance change rate is $\pm 1\%: \pm(1.0\%+0.1\Omega)$ Max.   $\pm 5\%: \pm(3.0\%+0.1\Omega)$ Max.	Wave Form: Tolerance for half sine shock pulse. Peak value is 100g's. Normal duration (D) is 6. (MIL-STD-202 Method 213)
Vibration	Resistance change rate is $\pm 1\%: \pm(1.0\%+0.1\Omega)$ Max.   $\pm 5\%: \pm(3.0\%+0.1\Omega)$ Max.	5g's for 20 min., 12 cycle each of 3 orientations. Note: Use 8"×5" PCB. 031" thick 7 secure points (on one) long side and 2 secure points at corners of opposite sides. Parts mounted within 2' from any secure point. Test from 10-2000Hz. (MIL-STD-202 Method 204)
Biased Humidity	Resistance change rate is $\pm 1\%: \pm(1.0\%+0.1\Omega)$ Max.   $\pm 5\%: \pm(3.0\%+0.1\Omega)$ Max.	10% rated power, 85°C/85%RH, 1000H, Measurement at 24 hours after test conclusion. (MIL-STD-202 Method 103)
ESD	Resistance change rate is $\pm(10\%+0.1\Omega)$ max	With the electrometer in direct contact with the discharge tip, verify the voltage setting at levels of ±500V, ±1KV, ±2KV, ±4KV, ±8KV, The electrometer reading shall be within ±10% for voltages from 500V to 800V. (AEC-Q200-002 or ISO/DIS 10605)



# PERFORMANCE SPECIFICATION

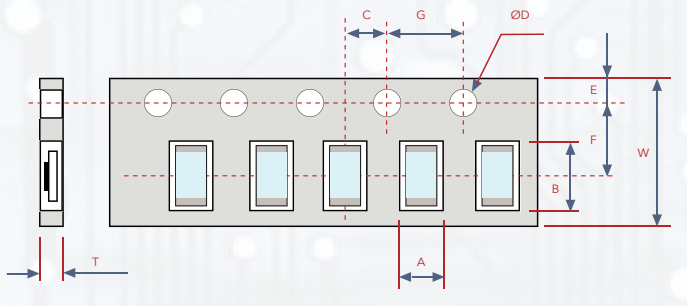
Anti-Surge Thick Film Chip Resistors (Lead Free) AEC-Q200 Compliant

CHARACTERISTICS	LIMITS	TEST METHODS
Flammability		V-0 or V-1 are acceptable. Electrical test not required. (UL-94)
Board Flex	$\pm 1\%: \pm (1.0\%+0.1\Omega)$ Max.   $\pm 5\%: \pm (3.0\%+0.1\Omega)$ Max.	60 seconds minimum holding time. (JIS-C-6429)
Flame Retardance	No Flame	Temperature sensing at 500°C, Voltage power subjected to 32VDC current clamped up to 500ADC and decreased in 1.0VDC/hour. (AEC-Q200-001)
Resistance to Soldering Heat	Resistance change rate is $\pm(1\%+0.05\Omega)$ max.	Condition B No per-heat of samples. Note: Single Wave Solder-Procedure 2 for SMD and Procedure 1 for Leaded with solder within 1.5mm of device body. (MIL-STD-202 Method 210)

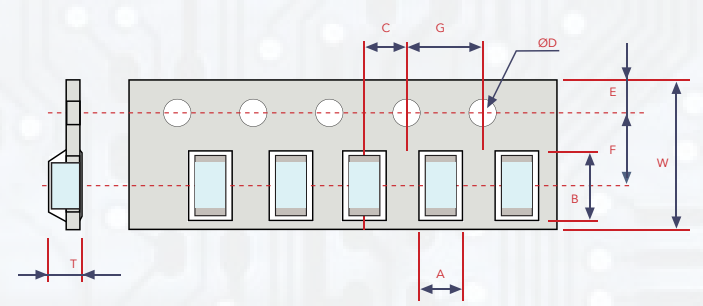
\* Sulfuration test: H<sub>2</sub>S 3~5PPM 50°C±2°C 91%~93%RH 1000H

# PACKAGING

- Taping Dimension (MM)



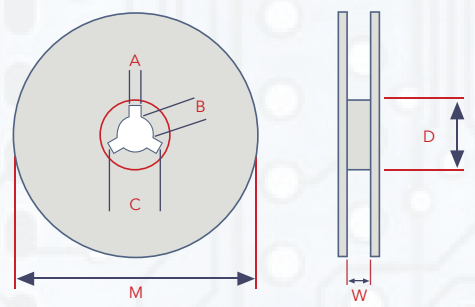
- Embossed Taping



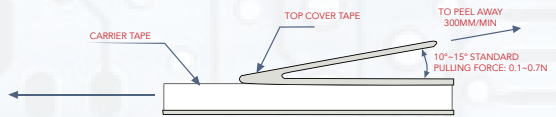
TYPE	A ± 0.2	B ± 0.2	C ± 0.05	ØD +1 -0	E ± 0.1	F ± 0.05	G ± 0.1	W ± 0.2	T ± 0.1
HWR04	0.65 ± 0.1	1.2 ± 0.1	2.0	1.5	1.75	3.5	4.0	8.0	0.42 ± 0.05
HWR06	1.10	1.90							0.67
HWR10	1.65	2.40							0.81
HWR12	2.00	3.60							0.75
HWR14	2.80	3.50							

TYPE	A ± 0.2	B ± 0.2	C ± 0.05	ØD +1 -0	E ± 0.1	F ± 0.05	G ± 0.1	W ± 0.2	ØD1 +1 -0	T ± 0.1
HWR20	2.90	5.60	2.0	1.5	1.75	5.5	4.0	12.0	1.5	1.0
HWR25	3.50	6.70								

- Peeling Strength of Top Cover Tape
- Test Condition: 0.1 to 0.7 N at a peel-off speed of 300mm / min



TYPE	PACKAGING	QTY PER REEL	A±0.5	B±0.5	C±0.5	D±1	M±2	W±1
HWR04	Paper	10,000 pcs	2	13	21	60	178	10
HWR06		5,000 pcs						
HWR10								
HWR12								
HWR14		4,000 pcs						13.8
HWR20								
HWR25	Embossed							



## ■ ENVIRONMENT RELATED SUBSTANCE

This product complies to EU RoHS directive, EU PAHs directive, EU PFOS directive and Halogen free.

Ozone layer depleting substances.

Ozone depleting substances are not used in our manufacturing process of this product. This product is not manufactured using Chloro fluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), Hydrobromofluorocarbons (HBFCs) or other ozone depleting substances in any phase of the manufacturing process.

## ■ STORAGE CONDITION (MSL1)

The performance of these products, including the solderability, is guaranteed for a year from the date of arrival at your company, provided that they remain packed as they were when delivered and stored at a temperature of  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$  and a relative humidity of  $60\%RH \pm 10\%RH$ , chemical and dust free atmosphere

Even within the above guarantee periods, do not store these products in the following conditions. Otherwise, their electrical performance and/or solderability may be deteriorated, and the packaging materials (e.g. taping materials) may be deformed or deteriorated, resulting in mounting failures.

1. In salty air or in air with a high concentration of corrosive gas, such as  $\text{Cl}_2$ ,  $\text{H}_2\text{S}$ ,  $\text{NH}_3$ ,  $\text{SO}_2$ , or  $\text{NO}_2$
2. In direct sunlight

This production is used for automotive electronics, Cal-Chip Electronics will not be responsible for any damage, expense or loss caused by the use of this specification in any special environment. This series of product are suitable for automotive electronics applications, as show below, if there are other application, you need to confirm with Cal-Chip Electronics whether they are applicable:

- a. Control unit for information, entertainment, navigation, audio;
- b. Control unit for comfortable doors, windows, seat;
- c. Control unit for internal lighting.

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