Varistors(SMD)

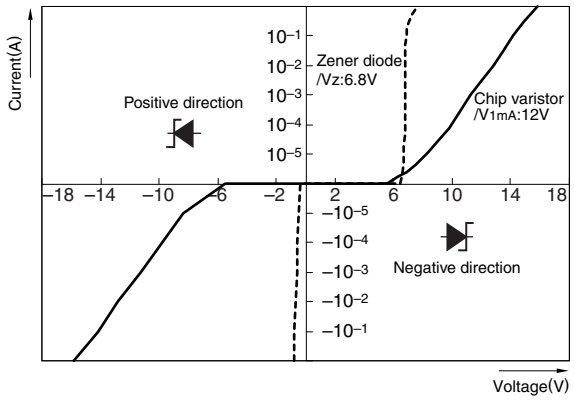
Conformity to RoHS Directive

Countermeasure for Surge Voltage and Static Electricity

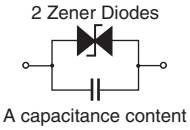
AVR Series AVR-M, AVRL Types

Varistors are voltage dependent nonlinear resistive elements with a resistance that decreases rapidly when the voltage is over the constant value.
Varistor is equivalent with Zener diode of two series connection. Therefore, do not have polarity.

CURRENT vs. VOLTAGE CHARACTERISTICS



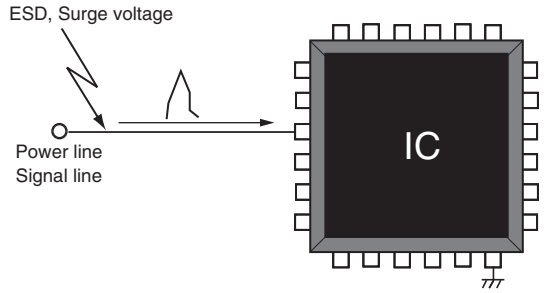
EQUIVALENT CIRCUIT



THE EFFECT OF THE VARISTOR

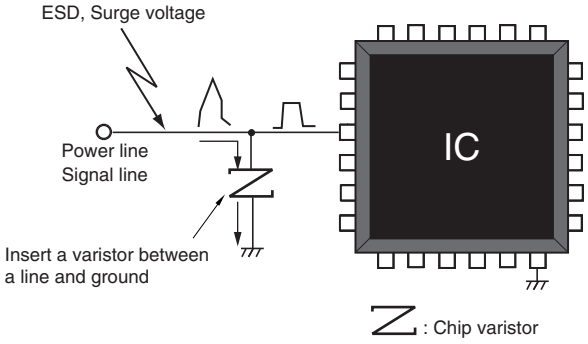
WITHOUT VARISTOR

A malfunction and failure of electronic equipment



WITH VARISTOR

Suppress abnormal voltage by inserting varistor in a circuit



FEATURES

- No polarity, due to symmetrical current-voltage characteristics.
  Equivalent to anode common type Zener diode.
- Excellent electrostatic absorption capability.
  Response is as good or better than Zener diode.
  Keeps symmetrical current-voltage characteristics even after electrostatic absorption.
- Adopted the inner electrodes lamination structure.
  Wide range of varistor voltages are available in series (6.8 to 39V).
  Low capacitance items are available in series (1.1pF to).
  World's smallest 0402-, 0603-, 1005-, 1608-, 2012-chip types are available in series.
- Excellent mount reliability. Good for Pb-free soldering.
  Adopted (Ni/Sn) electroplating.
  Achieved good solderability and solder heat resistance.
- Can replace a Zener diode + capacitor combination.
  Reduced footprint and total mounting cost.

APPLICATIONS

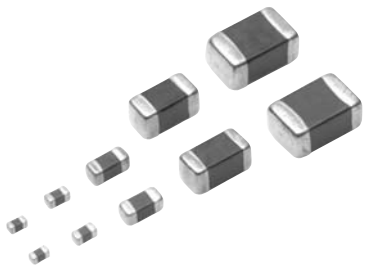
- Electrostatic absorption
- Pulse noise absorption

TEMPERATURE RANGES

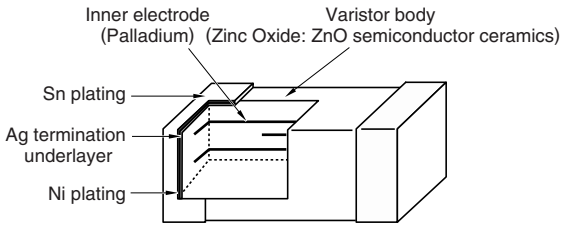
Type	AVR-M1005/1608/2012	AVR-M0402/0603/AVRL
Operating	–40 to +125°C	–40 to +85°C
Storage	–40 to +125°C	–40 to +85°C

APPLICATION EXAMPLES

Consumer product	Application
Mobile phone	Data terminal
Digital video camera	LCD panel
Digital camera	Touch panel
PDA	Button and switch unit
Note PC	Battery terminal
DVD-ROM, CD-ROM	Audio-Video input-output terminal
CD/MD/MP3 player	Microphone/receiver unit
Game machine	Controller unit
In-car equipment	CAN-BUS ECU Connector Air conditioner panel Car audio Car navigation

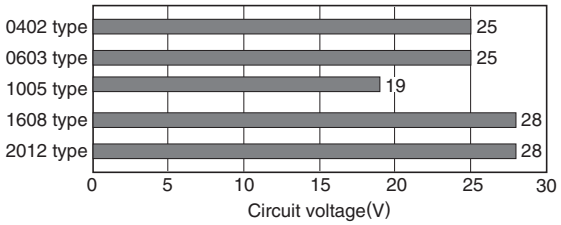


INTERNAL STRUCTURE

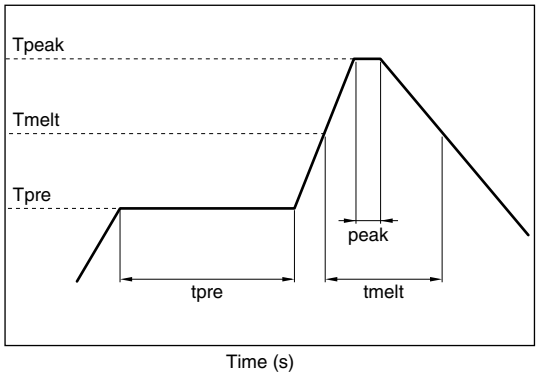


CIRCUITS SYMBOL

OPERATIONAL VOLTAGE RANGES



RECOMMENDED REFLOW SOLDERING CONDITIONS



Item		Specification	
		For eutectic solder	For lead-free solder
Tpre	Preheating temperature	160 to 180°C	150 to 180°C
Tmelt	Solder melting temperature	200°C	230°C
Tpeak	Peak temperature	240°C max.	260°C max.
tpre	Preheating time	100s max.	120s max.
tmelt	Time to reach higher than the solder melting temperature	30s max.	40s max.
	Number of possible reflow cycles	2 max.	2 max.

AVR-M TYPE

PRODUCT IDENTIFICATION

AVR-M	1005	C	270	M	T	AAB
(1)	(2)	(3)	(4)	(5)	(6)	(7)

AVRM	1005	C	6R8	N	T	101	N
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

(1) Series name

(2) Dimensions L×W

0402	0.4×0.2mm
0603	0.6×0.3mm
1005	1.0×0.5mm
1608	1.6×0.8mm
2012	2.0×1.2mm

(3) Structure code

(4) Varistor voltage

270	27×10^{0}V

(5) Varistor voltage tolerance

K	±10%
M	±20%
N	±30%

(6) Packaging style

T	Taping

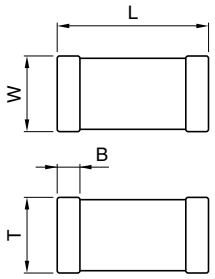
(7) Capacitance and TDK internal code

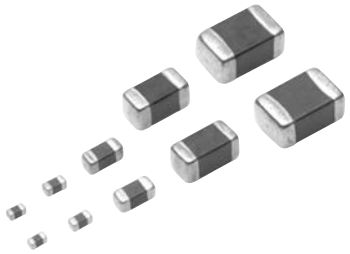
(5) Capacitance tolerance

N	±30%

SHAPES AND DIMENSIONS

0402/0603/1005/1608/2012 TYPES

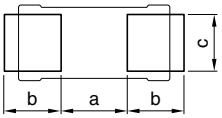




Dimensions in mm

Type	L	W	T	B min.	Weight (mg)typ.
0402	0.4±0.02	0.2±0.02	0.2±0.02	0.07	0.1
0603	0.6±0.03	0.3±0.03	0.3±0.03	0.1	0.2
1005	1.0±0.05	0.5±0.05	0.5±0.05	0.1	1.2
1608	1.6±0.1	0.8±0.1	0.8±0.1	0.2	5
2012	2.0±0.2	1.25±0.2	1.0±0.2	0.2	15

RECOMMENDED PC BOARD PATTERN



Dimensions in mm

Type	a	b	c
0402	0.2	0.15 to 0.2	0.18 to 0.2
0603	0.25 to 0.35	0.2 to 0.3	0.25 to 0.35
1005	0.3 to 0.5	0.35 to 0.45	0.4 to 0.6
1608	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8
2012	0.9 to 1.2	0.7 to 0.9	0.9 to 1.2

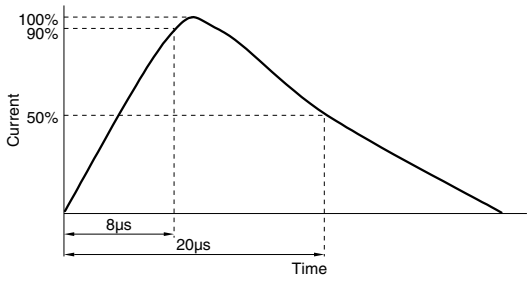
ELECTRICAL CHARACTERISTICS

Part No.	Varistor voltage (Breakdown voltage) V_{1mA}(V)[DC1mA]		Maximum continuous voltage (Rated voltage) Vdc(V) max.	Clamping voltage Vcl(V) [8/20μs]	Maximum energy E(Joule) [10/1000μs] max.	Maximum peak current Ip(A) [8/20μs] max.	Capacitance C(pF) [1kHz, 1Vrms] typ.	Packaging quantities (Taping) (pieces/reel)
0402 type								
AVRM0402C6R8NT101N	6.8	(4.76 to 8.84)	3.5	15[1A]	0.01	4	100 (70 to 130)	20,000
AVRM0402C120MT330N	12	(9.6 to 14.4)	5.5	20[1A]	0.005	1	33 (23.1 to 43.9)	
0603 type								
AVRM0603C6R8NT331N	6.8	(4.76 to 8.84)	3.5	14[1A]	0.02	16	330 (231 to 429)	15,000
AVRM0603C6R8NT101N	6.8	(4.76 to 8.84)	3.5	14[1A]	0.01	10	100 (70 to 130)	
AVRM0603C080MT101N	8	(6.4 to 9.6)	5.5	17[1A]	0.01	4	100 (70 to 130)	
AVRM0603C120MT101N	12.8	(10 to 15.6)	5.5	20[1A]	0.01	5	100 (70 to 130)	
AVR-M0603C120MTAAB	12	(9.6 to 14.4)	7.5	23[1A]	0.01	1	33	
AVRM0603C120MT150N	12.8	(10 to 15.6)	5.5	35[1A]	0.003	1	15 (10.5 to 19.5)	
AVRM0603C200MT150N	20	(16.0 to 24.0)	12	40[1A]	0.01	1	15 (10.5 to 19.5) [1MHz]	
1005 type								
AVRM1005C6R8NT331N	6.8	(4.76 to 8.84)	3.5	15[1A]	0.008	24	330 (231 to 429)	10,000
AVRM1005C6R8NT101N	6.8	(4.76 to 8.84)	3.5	14[1A]	0.02	10	100 (70 to 130)	
AVR-M1005C080MTAAB	8	(6.4 to 9.6)	5.5	14[1A]	0.04	25	650	
AVR-M1005C080MTADB	8	(6.4 to 9.6)	5.5	14[1A]	0.04	25	480	
AVR-M1005C080MTABB	8	(6.4 to 9.6)	5.5	15[1A]	0.02	3	100	
AVR-M1005C080MTACB	8	(6.4 to 9.6)	5.5	19[1A]	0.01	1	33	
AVR-M1005C120MTACC	12	(9.6 to 14.4)	7.5	21[1A]	0.01	24	460 [1MHz]	
AVR-M1005C120MTAAB	12	(9.6 to 14.4)	7.5	20[1A]	0.05	10	130	
AVR-M1005C180MTAAB	18	(14.4 to 21.6)	11	30[1A]	0.06	16	120 [1MHz]	
AVRM1005C270KT101N	27	(24 to 30)	19	44[1A]	0.06	4	100 (70 to 130)	
AVR-M1005C270MTAAB	27	(21.6 to 32.4)	15	47[1A]	0.06	4	40	
AVR-M1005C270MTABB	27	(21.6 to 32.4)	15	49[1A]	0.05	1	15	
1608 type								
AVR-M1608C080MTAAB	8	(6.4 to 9.6)	5.5	15[2A]	0.09	30	650	4,000
AVR-M1608C120MT6AB	12	(9.6 to 14.4)	7.5	20[2A]	0.09	50	1050	
AVR-M1608C120MT2AB	12	(9.6 to 14.4)	7.5	20[2A]	0.06	15	400	
AVR-M1608C180MT6AB	18	(14.4 to 21.6)	11	30[2A]	0.1	30	600	
AVR-M1608C220KT6AB	22	(19.8 to 24.2)	16	34[2A]	0.1	30	560	
AVR-M1608C220KT2AB	22	(19.8 to 24.2)	16	37[2A]	0.03	10	210	
AVR-M1608C270KT6AB	27	(24 to 30)	19	42[2A]	0.1	48	430	
AVR-M1608C270KT2AB	27	(24 to 30)	19	42[2A]	0.1	20	160	
AVR-M1608C270KTACB	27	(24 to 30)	19	54[2A]	0.05	10	60	
AVRM1608C270KT800M	27	(24 to 30)	19	53[2A]	0.02	28	80 (64 to 96)	
AVR-M1608C270MTAAB	27	(21.6 to 32.4)	17	52[2A]	0.05	2	30	
AVR-M1608C270MTABB	27	(21.6 to 32.4)	17	52[2A]	0.05	2	15	
AVRM1608C390KT271N	39	(35 to 43)	28	69[2A]	0.1	78	270 (189 to 351)	
2012 type								
AVR-M2012C120MT6AB	12	(9.6 to 14.4)	7.5	20[5A]	0.2	60	1000	2,000
AVR-M2012C220KT6AB	22	(19.8 to 24.2)	16	38[5A]	0.3	100	800	
AVR-M2012C390KT6AB	39	(35 to 43)	28	62[5A]	0.3	100	430	

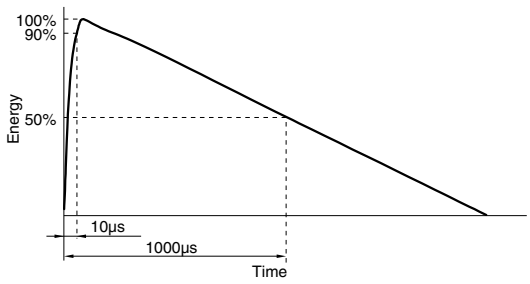
TERMINOLOGY

Item	Unit	Terminology
Varistor voltage (Breakdown voltage)	V_{1mA} (V)	Voltage measured across the varistor when DC1mA is applied.
Maximum continuous voltage (Rated voltage)	Vdc (V)	Maximum DC voltage that can be applied continuously. Varistor leakage current: 50μA max. (Within the range of maximum allowable circuit voltage)
Clamping voltage	Vcl (V)	Voltage appearing across the varistor when a pulse current (8/20μs*1) of specified peak value is applied.
Maximum energy	E (Joule)	Maximum energy that can be absorbed without deteriorating varistor characteristics when an impulse (10/1000μs*2) is applied once.
Maximum peak current	Ip (A)	Maximum current that can be withstood without deteriorating varistor characteristics when an impulse current (8/20μs*1) is applied once.
Capacitance	C (pF)	Capacitance measured at 1kHz (or 1MHz) of oscillator frequency and 1Vrms of oscillator voltage.

*1 8/20μs test waveform



*2 10/1000μs test waveform



• All specifications are subject to change without notice.

AVRL TYPE

PRODUCT IDENTIFICATION

AVRL	10	1A	3R3	F	T	A
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(1) Series name

(2) Dimensions L×W

04	0.4×0.2mm
06	0.6×0.3mm
10	1.0×0.5mm
16	1.6×0.8mm

(3) Maximum continuous voltage

1A	10Vdc
1C	16Vdc
1E	25Vdc

(4) Capacitance

1R1	1.1pF
2R2	2.2pF
3R3	3.3pF
6R8	6.8pF

(5) Capacitance tolerance

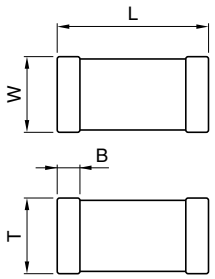
N	±0.3pF
D	±0.5pF
F	±1pF
G	±2pF

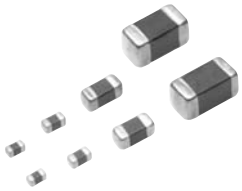
(6) Packaging style

T	Taping

(7) Varistor voltage and TDK internal code

SHAPES AND DIMENSIONS

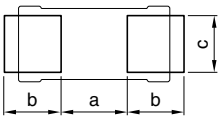




Dimensions in mm

Type	L	W	T	B min.	Weight (mg)typ.
0402	0.4±0.02	0.2±0.02	0.2±0.02	0.07	0.1
0603	0.6±0.03	0.3±0.03	0.3±0.03	0.1	0.2
1005	1.0±0.05	0.5±0.05	0.5±0.05	0.1	1.2
1608	1.6±0.1	0.8±0.1	0.8±0.1	0.2	5

RECOMMENDED PC BOARD PATTERN



Dimensions in mm

Type	a	b	c
0402	0.2	0.15 to 0.2	0.18 to 0.2
0603	0.25 to 0.35	0.2 to 0.3	0.25 to 0.35
1005	0.3 to 0.5	0.35 to 0.45	0.4 to 0.6
1608	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8

ELECTRICAL CHARACTERISTICS

Part No.	Capacitance C(pF) [1MHz, 1Vrms]	Maximum continuous voltage (Rated voltage) Vdc(V) max.	Insulation resistance Rdc(MΩ) [3Vrms] min.	Varistor voltage V_{1mA}(V)[DC1mA] typ.	Packaging quantities (Taping) (pieces/reel)
0402 type					
AVRL041E1R1NTA	1.1[0.8 to 1.4]	25	10	39	20,000
0603 type					
AVRL061E1R1NTA	1.1[0.8 to 1.4]	25	10	39	15,000
1005 type					
AVRL101A1R1NTA	1.1[0.8 to 1.4]	10	10	90	10,000
AVRL101A1R1NTB	1.1[0.8 to 1.4]	10	10	39	
AVRL101C2R2DTA	2.2[1.7 to 2.7]	16	10	90	
AVRL101A3R3FTA	3.3[2.3 to 4.3]	10	10	27	
AVRL101A6R8GTA	6.8[4.8 to 8.8]	10	10	27	
1608 type					
AVRL161A1R1NTA	1.1[0.8 to 1.4]	10	10	90	4,000
AVRL161A1R1NTB	1.1[0.8 to 1.4]	10	10	39	
AVRL161A3R3FTA	3.3[2.3 to 4.3]	10	10	27	
AVRL161A6R8GTA	6.8[4.8 to 8.8]	10	10	27	

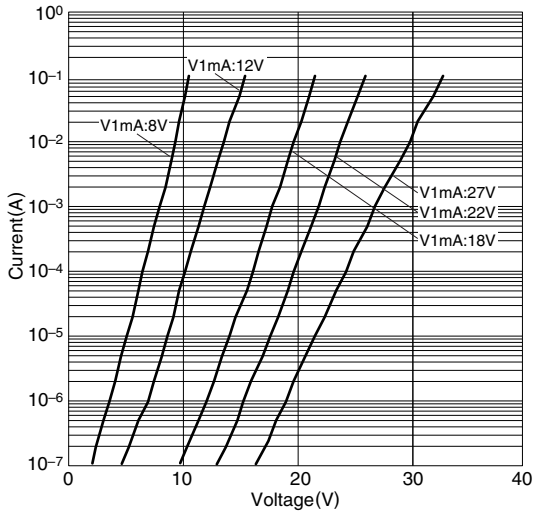
TERMINOLOGY

Item	Unit	Terminology
Capacitance	C (pF)	Capacitance measured at 1MHz of oscillator frequency and 1Vrms of oscillator voltage.
Maximum continuous voltage (Rated voltage)	Vdc (V)	Maximum DC voltage that can be applied continuously. Varistor leakage current: 50μA max. (Within the range of maximum allowable circuit voltage)
Insulation resistance	Rdc (MΩ)	Insulation resistance appearing across the varistor when specified voltage is applied.
Varistor voltage (Breakdown voltage)	V_{1mA} (V)	Voltage measured across the varistor when DC1mA is applied.

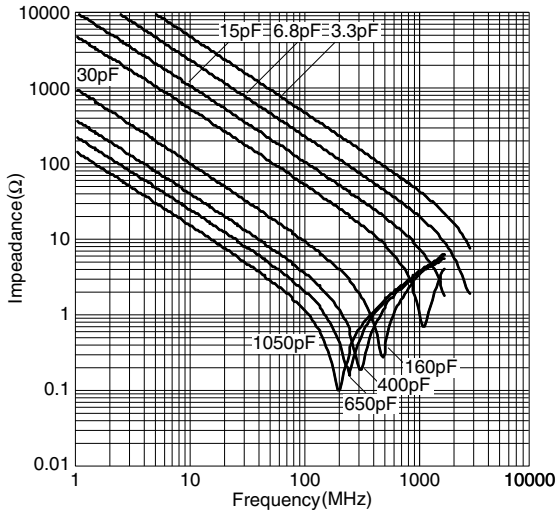
• All specifications are subject to change without notice.

TYPICAL ELECTRICAL CHARACTERISTICS

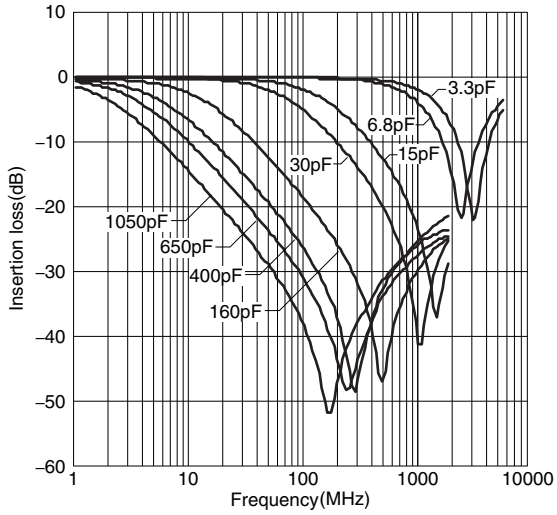
CURRENT vs. VOLTAGE CHARACTERISTICS



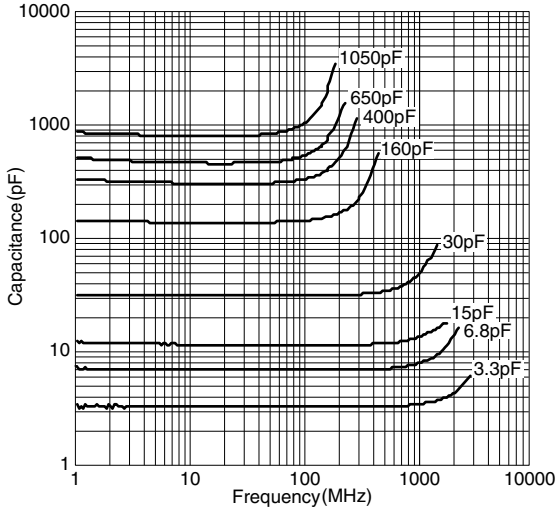
IMPEDANCE vs. FREQUENCY CHARACTERISTICS



TRANSMISSION CHARACTERISTICS



CAPACITANCE vs. FREQUENCY CHARACTERISTICS



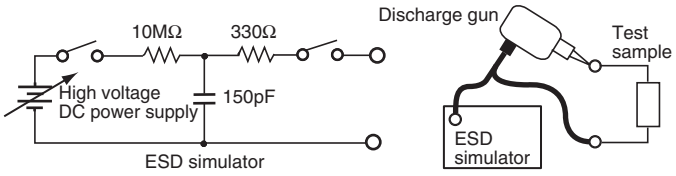
ELECTROSTATIC DISCHARGE TESTS

TEST CONDITIONS

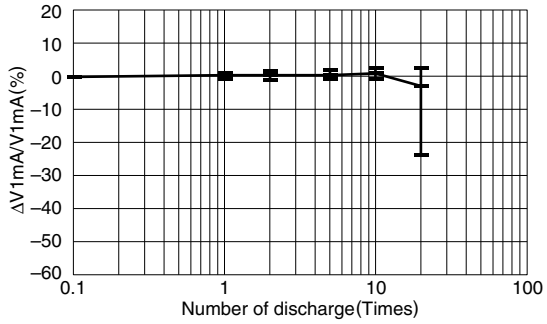
150pF, 330Ω contact discharge

Charged voltage /8kV, 0.1s interval

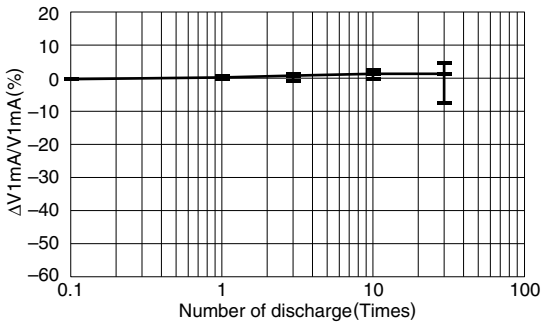
MEASURING CIRCUIT



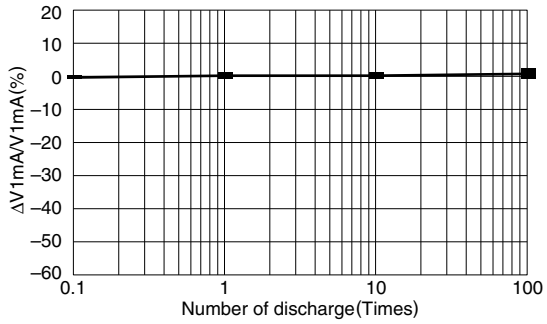
AVR-M0603 TYPE



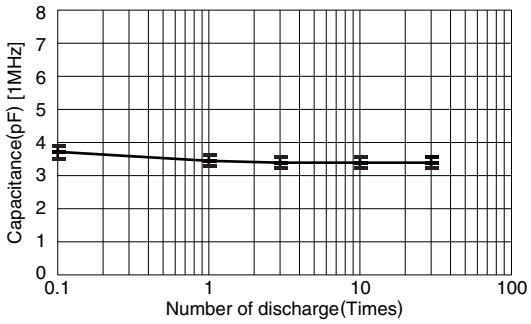
AVR-M1005 TYPE



AVR-M1608 TYPE

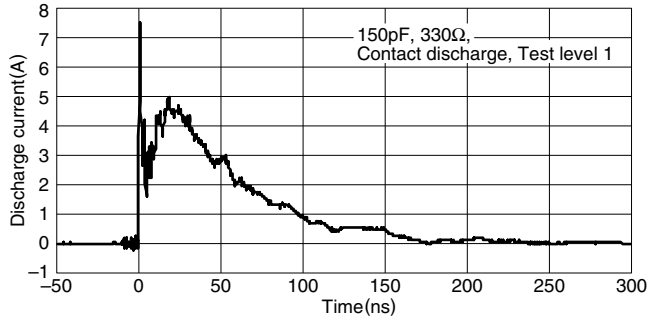


AVRL101A3R3F

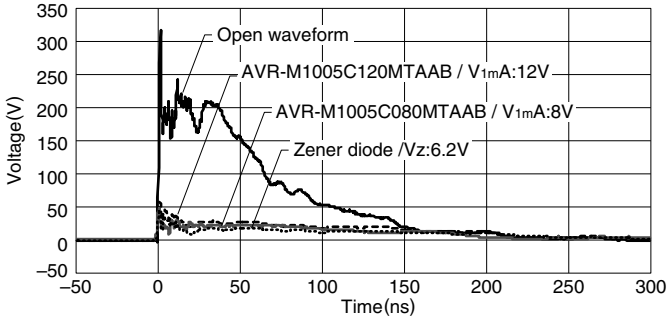


ELECTROSTATIC ABSORPTION CHARACTERISTICS

DISCHARGE CURRENT WAVEFORM



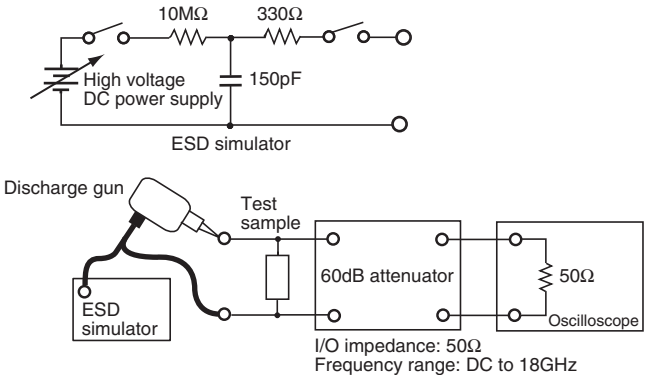
DISCHARGE VOLTAGE WAVEFORM



WAVEFORM PARAMETERS [IEC61000-4-2]

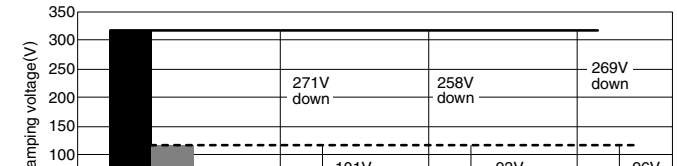
Test level	ESD Charge voltage (kV)	First peak current of discharge (A)	Rise time (ns)
1	2	7.5	0.7 to 1.0
2	4	15	0.7 to 1.0
3	6	22.5	0.7 to 1.0
4	8	30	0.7 to 1.0

MEASURING CIRCUIT

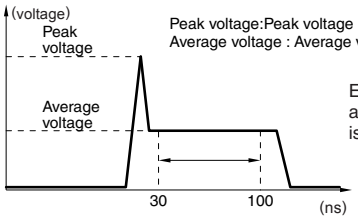


ESD ABSORPTION CHARACTERISTICS

COMPARISON OF VARIOUS ELEMENTS



	Open waveform	AVR-M1005C080MTAAB	AVR-M1005C120MTAAB	Zener diode/Vz:6.2V
■Peak	316	45	58	47
■Average	117	16	24	21



Peak voltage:Peak voltage of standing up part
Average voltage : Average voltage of 30 to 100ns

ESD (Electro Static Discharge) absorption characteristics of V1mA-8V is superior to Vz-6.2V Zener diode.

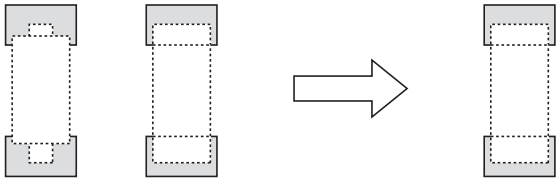
MERITS OF REPLACEMENT FROM ZENER DIODE

(1) Reduction in the number of parts

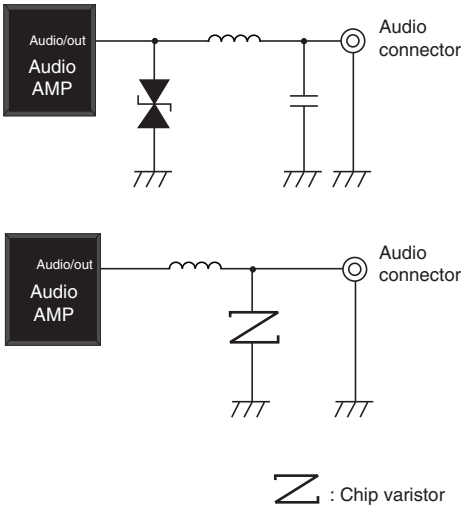
REDUCTION EXAMPLES

Zener diode+capacitor

Chip varistor

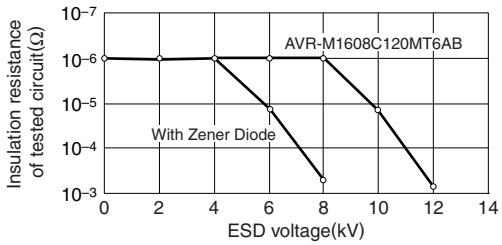


EXAMPLE OF REPLACEMENT AT AUDIO TERMINAL



(2) Improved electrostatic absorption capability

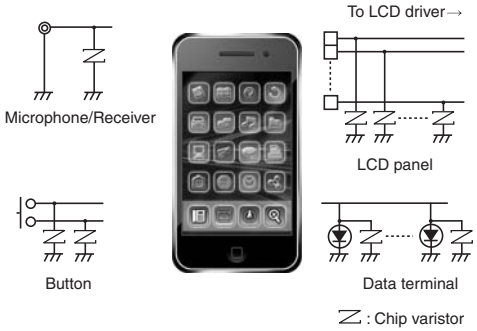
COMPARE DATA OF CHIP VARISTOR AND ZENER DIODE ABOUT IC PROTECTION



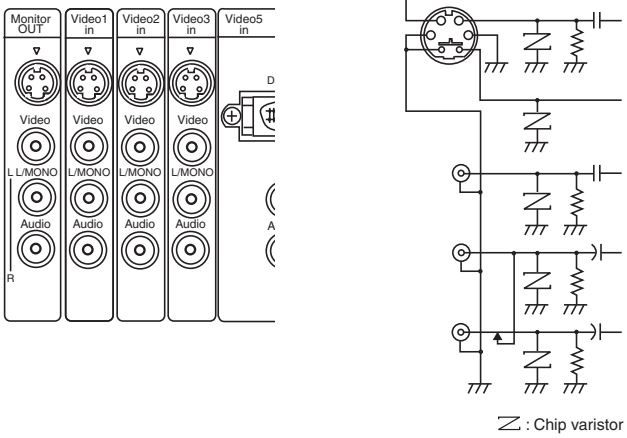
CMOS: D74HC04C
ESD generator : Noise Laboratory Co.,Ltd., ESS -630A
200pF-0Ω method model equipment
Contact type discharge
ESD applied point: Vcc-ground

APPLICATION EXAMPLES

SMART PHONE

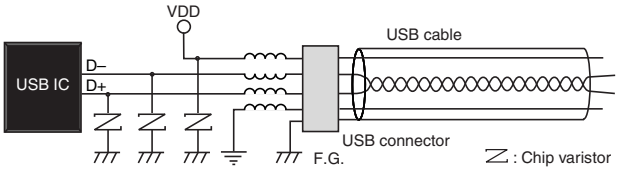


AUDIO/VIDEO

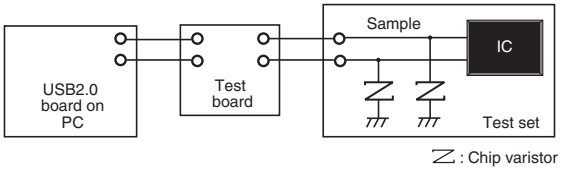


APPLICATION EXAMPLES

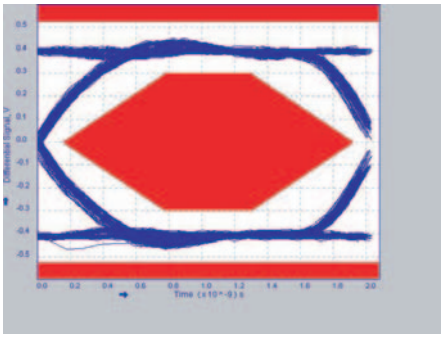
USB 2.0



MEASURING CIRCUIT

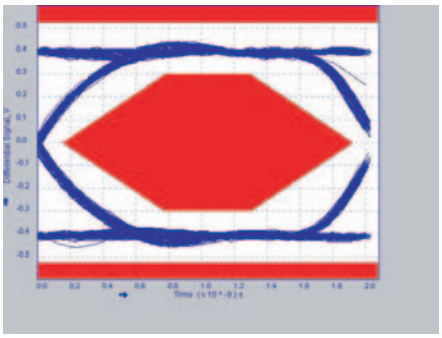


WITHOUT VARISTOR



WITH VARISTOR

AVRL101A3R3FTA (3.3pF)



AVRL101A6R8GTA (6.8pF)