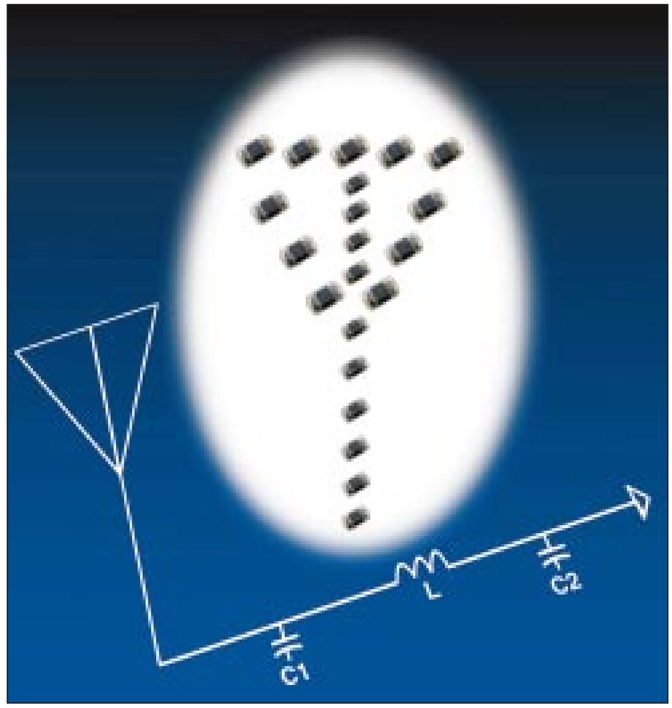
AntennaGuard 0402/0603

AVX Multilayer Ceramic Transient Voltage Suppressors
ESD Protection for Antennas

GENERAL DESCRIPTION



RF antenna/RF amplifier protection against ESD events is a growing concern of RF circuit designers today, given the combination of increased signal "gain" demands, coupled with the required downsizing of the transistor package. The ability to achieve both objectives is tied to a reduced thickness of the SiO_2 gate insulator layer within the semiconductor. The corresponding result of such a change increases the transistor's vulnerability to ESD strikes — a common event with handheld electronic products with RF transmitting and/or receiving features.

AVX's 0402/0603 AntennaGuard products are an ultra-low capacitance extension of the proven TransGuard TVS (transient voltage suppression) line of multilayer varistors. RF designers now have a single chip option over conventional protection methods (passive filters or diode clamps), which not only gives superior performance over traditional schemes, but also provides the added benefits of reduced PCB real estate and lower installation costs.

AVX's AntennaGuard products are available in capacitance ratings of ≤3pF (0402 & 0603 chips) and ≤12pF (0603 chip). These low capacitance values maintain RF signal strength at acceptable levels, as well as give other TransGuard advantages such as small size, sub-nanosecond response time, low leakage currents and unsurpassed reliability (FIT Rate of 0.2) compared to diodes.

FEATURES

- Smallest TVS Component
- Standard EIA Chip Sizes
- Chip Placement Compatible
- Fastest Response Time to ESD Strikes
- Two Cap Values (≤3 and ≤12pF)

APPLICATION

- ESD Protection for RF Amplifiers

HOW TO ORDER

VC	04	AG	18	3R0	Y	A	1	x	x
Varistor Chip	**Chip Size** 04 = 0402 06 = 0603	**Varistor Series** AntennaGuard	**Working Voltage** (DC)	**Capacitance** 3pF = 3R0 12pF = 120	**Non-Std. Cap Tolerance** (Maximum)	**Not Applicable**	**Termination** 1 = PtPdAg T = Plated Ni and Solder	**Reel Size** 1 = 7" 3 = 10"	**Reel Quantity** A = 4,000 or 10,000 (i.e., 1A = 4,000 3A = 10,000)

CATALOG PART NUMBERS/ELECTRICAL VALUES

AVX Part Number	Working Voltage I_L < 100nA	Capacitance Value 1 MHz, 0.5V RMS	Cap Tolerance	Inductance (Typical) di/dt = 0.1 A/nS
VC04AG183R0YA1	18 VDC	3 pF	Maximum	< 1.0
VC06AG183R0YA1	18 VDC	3 pF	Maximum	< 1.0
VC06AG18120YA1	18 VDC	12 pF	Maximum	< 1.0

PHYSICAL DIMENSIONS

millimeters (inches)

	0402	0603
Length	1.0 (0.039") ±0.1 (0.004")	1.6 (0.063") ±0.15 (0.006")
Width	0.5 (0.020") ±0.1 (0.004")	0.8 (0.031") ±0.15 (0.006")
Thickness	0.6 Max. (0.024")	0.9 Max. (0.035")
Termination Band Width	0.25 (0.010") ±0.15 (0.006")	0.35 (0.014") ±0.15 (0.006")
Termination Separation	0.3 Min. (0.012")	0.7 Min. (0.028")

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Antenna Varistors

AVX announces a series of 0402 and 0603 chip varistors, designated the AntennaGuard series, for RF antenna/RF amplifier protection. These devices offer ultra-low capacitance (<3pF in 0402 chips, and ≤3pF & ≤12pF in 0603 packages), as well as low insertion loss. Antenna varistors can replace output capacitors and provide ESD suppression in cell phones, pagers and wireless LANs.

It is very common to employ some form of a FET in many types of efficient/miniature RF amplifiers. Typically, these RF transistors have nearly ideal input gate impedance and outstanding noise figures. However, FETs are very susceptible to ESD damage due to the very thin layer of SiO_2 uses as the gate insulator. The ultra-thin SiO_2 layer is required to improve the gain of the transistor. In other words, the upside of the performance enhancement becomes the downside of the transistors survival when subjected to an ESD event.

ESD damage to the RF Field Effect Transistors (FETs) is a growing concern among RF designers due to the following trends: (1) RF amplifiers continue to shrink in size, and (2) FET gains figures continue to increase. Both trends relate to decreasing gate oxide thickness, which in turn, is directly proportional to increased ESD sensitivity. As miniaturization trends accelerate, the traditional methods to protect against ESD damage (i.e., PC board layout, passive filters, and diode clamps) are becoming less and less effective.

AVX's AntennaGuard varistor can be used to protect the FET and offer superior performance to the previously mentioned protection methods given above. The standard EIA 0603 chip size, and particularly the 0402 chip, offer designers an ESD protection solution consistent with today's downsizing trend in portable electronic products. Savings in component volume up to 86%, and PC board footprint savings up to 83% are realistic expectations. These percentages are based upon the following table and Figures 1A and 1B.

millimeters (inches)

Suppression Device	Pad Dimensions				
	D1	D2	D3	D4	D5
0402 TransGuard	1.79 (0.070)	0.51 (0.020)	0.51 (0.020)	0.51 (0.020)	0.51 (0.020)
0603 TransGuard	2.29 (0.090)	0.76 (0.030)	0.76 (0.030)	0.76 (0.030)	0.76 (0.030)
SOT23 Diode	See Below				

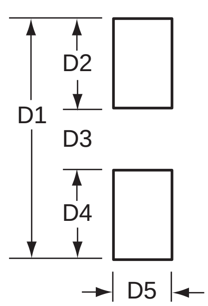


Figure 1A. 0402/0603 IR Solder Pad Layout

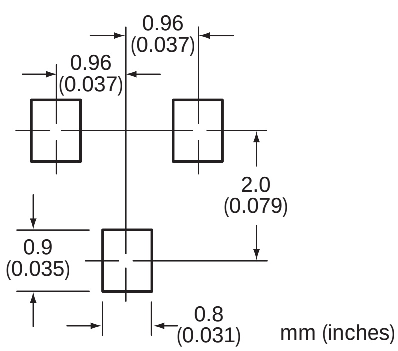


Figure 1B. SOT23 - Solder Pad Layout

AntennaGuard 0402/0603

AVX Multilayer Ceramic Transient Voltage Suppressors
ESD Protection for Antennas

Antenna varistors offer excellent ESD repetitive strike capability compared to a SOT23 diode when subjected to IEC 1000-4-2 8kV contact discharge. A performance summary is shown in Figure 2.

ESD TEST OF ANTENNAGUARD RATINGS

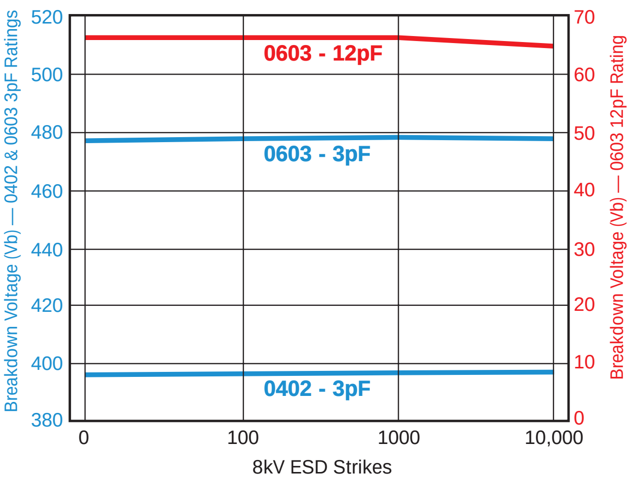


Figure 2. Repetitive 8kV ESD Strike

Antenna varistors also turn on and divert ESD overvoltages at a much faster rate than SOT23 devices (typically 300pS vs 1500pS - 5000pS). See Figure 3.

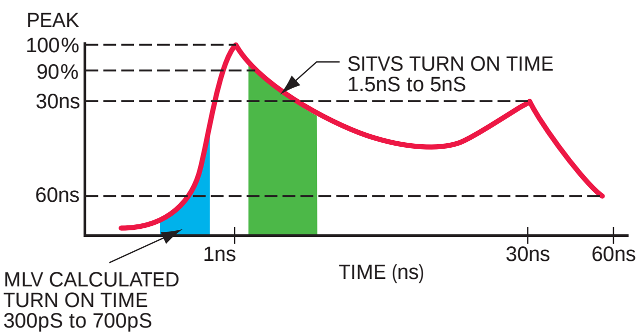
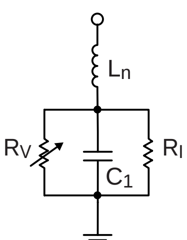


Figure 3. Turn On Time

The equivalent circuit model for a typical antenna varistor is shown in Figure 4.



L_n = 100V INDUCTANCE

C_1 = DEVICE CAPACITANCE

R_V = VOLTAGE VARIABLE RESISTOR

R_I = INSULATION RESISTANCE

Figure 4. Antenna Varistor

The varistor shown exhibits a capacitance of ≤3pF which can be used to replace the parallel capacitance typically found prior to the antenna output of an RF amplifier. In the off state, the varistor acts as a capacitor and helps to filter RF output. The varistor is not affected by RF output power or voltage and has little insertion loss. See Figure 5.

ANTENNA VARISTOR S21

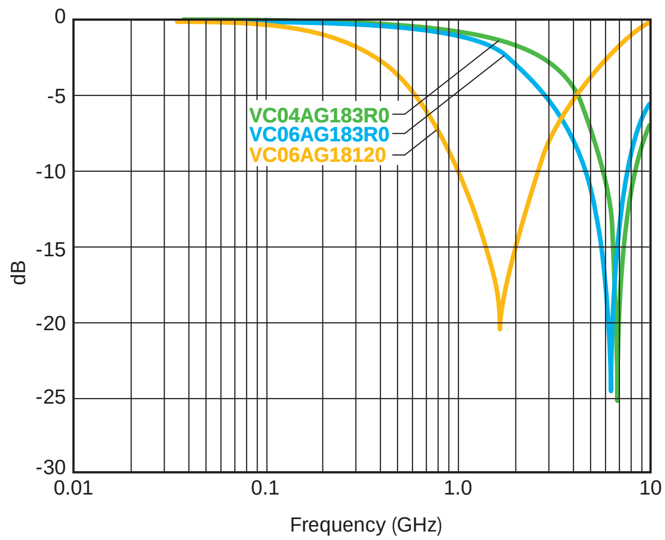


Figure 5. Attenuation vs Frequency

Typical implementations of the antenna varistors are shown for use in cell phone, pager and wireless LAN applications in Figures 6A, 6B and 6C.

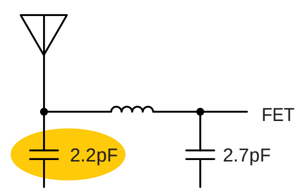


Figure 6A. Cell Phone

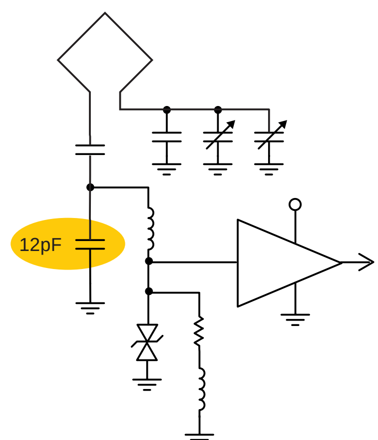
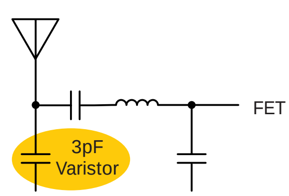


Figure 6B. Pager



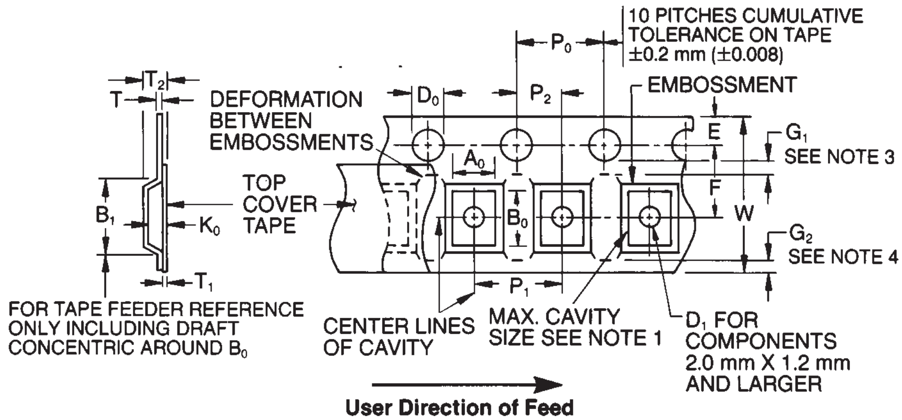
AVX TransGuard®

PACKAGING

- Chips
- Axial Leads

TransGuard®

AVX Multilayer Ceramic Transient Voltage Suppressors
Packaging - Chips / Embossed Carrier Configuration 8mm Tape Only



8mm Embossed Tape
Metric Dimensions Will Govern

CONSTANT DIMENSIONS

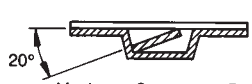
Tape Size	D_0	E	P_0	P_2	T Max.	T_1	G_1	G_2
8mm	$8.4^{+0.10}_{-0.0}$ ($0.059^{+0.004}_{-0.0}$)	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.600 (0.024)	0.10 (0.004) Max.	0.75 (0.030) Min. See Note 3	0.75 (0.030) Min. See Note 4

VARIABLE DIMENSIONS

Tape Size	B_1 Max. See Note 6	D_1 Min. See Note 5	F	P_1	R Min. See Note 2	T_2	W	A_0 B_0 K_0
8mm	4.55 (0.179)	1.0 (0.039)	3.5 ± 0.05 (0.138 ± 0.002)	4.0 ± 0.10 (0.157 ± 0.004)	25 (0.984)	2.5 Max. (0.098)	$8.0^{+0.3}_{-0.1}$ ($0.315^{+.012}_{-0.004}$)	See Note 1

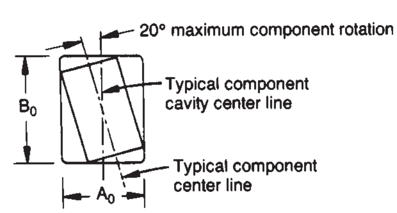
NOTES:

1. A_0, B_0, and K_0 are determined by the max. dimensions to the ends of the terminals extending from the component body and/or the body dimensions of the component. The clearance between the end of the terminals or body of the component to the sides and depth of the cavity (A_0, B_0, and K_0) must be within 0.05 mm (0.002) min. and 0.50 mm (0.020) max. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20 degrees (see sketches C & D).
2. Tape with components shall pass around radius "R" without damage.
3. G_1 dimension is the flat area from the edge of the sprocket hole to either the outward deformation of the carrier tape between the embossed cavities or to the edge of the cavity whichever is less.
4. G_2 dimension is the flat area from the edge of the carrier tape opposite the sprocket holes to either the outward deformation of the carrier tape between the embossed cavity or to the edge of the cavity whichever is less.
5. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
6. B_1 dimension is a reference dimension for tape feeder clearance only.



Maximum Component Rotation

Side or Front Sectional View
Sketch "C"

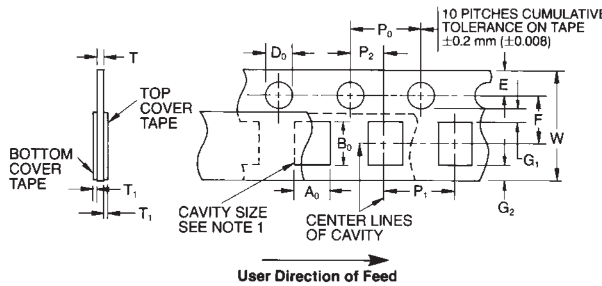


Top View
Sketch "D"

TransGuard®

AVX Multilayer Ceramic Transient Voltage Suppressors
Packaging - Chips / Punched Carrier Configuration 8mm Tape Only

8mm Punched Tape
Metric Dimensions Will Govern



CONSTANT DIMENSIONS

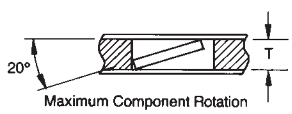
Tape Size	D_0	E	P_0	P_2	T_1	G_1	G_2	R MIN.
8mm	$1.5^{+0.1}_{-0.0}$ $(0.059^{+0.004}_{-0.000})$	1.75 ± 0.10 (0.069 ± 0.004)	4.0 ± 0.10 (0.157 ± 0.004)	2.0 ± 0.05 (0.079 ± 0.002)	0.10 (0.004) Max.	0.75 (0.030) Min.	0.75 (0.030) Min.	25 (0.984) See Note 2

VARIABLE DIMENSIONS

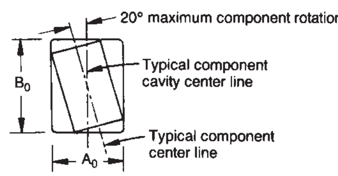
Tape Size	P_1	F	W	A_0 B_0	T
8mm	4.0 ± 0.10 (0.157 ± 0.004)	3.5 ± 0.05 (0.138 ± 0.002)	$8.0^{+0.3}_{-0.1}$ $(0.315^{+0.012}_{-0.004})$	See Note 1	See Note 3

NOTES:

1. A_0, B_0, and T are determined by the max. dimensions to the ends of the terminals extending from the component body and/or the body dimensions of the component. The clearance between the ends of the terminals or body of the component to the sides and depth of the cavity (A_0, B_0, and T) must be within 0.05 mm (0.002) min. and 0.50 mm (0.020) max. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20 degrees (see sketches A & B).
2. Tape with components shall pass around radius “R” without damage.
3. 1.1 mm (0.043) Base Tape and 1.6 mm (0.063) Max. for Non-Paper Base Compositions.

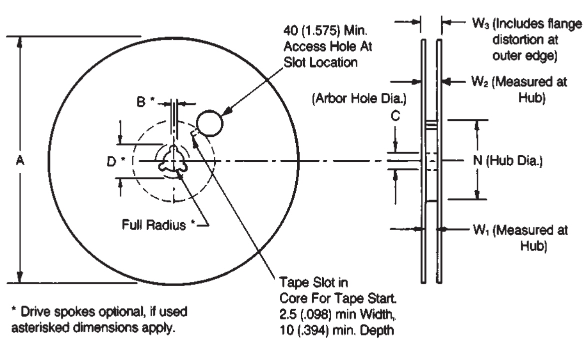


Side or Front Sectional View
Sketch “A”



Top View
Sketch “B”

REEL DIMENSIONS



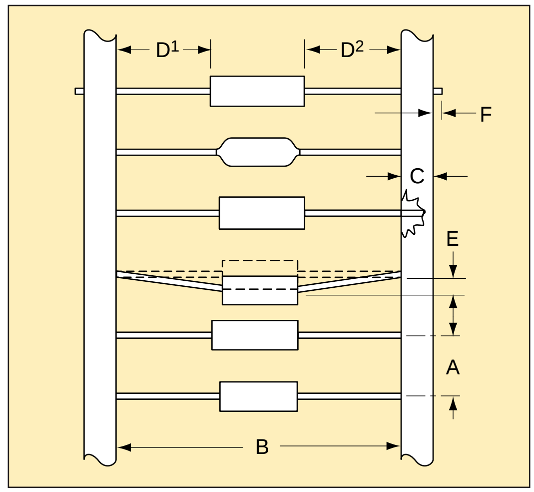
Tape Size	A Max.	B* Min.	C	D* Min.	N Min.	W_1	W_2 Max.	W_3
8mm	330 (12.992)	1.5 (0.059)	13.0±0.20 (0.512±0.008)	20.2 (0.795)	50 (1.969)	$8.4^{+1.0}_{-0.0}$ $(0.331^{+0.060}_{-0.0})$	14.4 (0.567)	7.9 Min. (0.311) 10.9 Max. (0.429)

Metric dimensions will govern.
English measurements rounded and for reference only.

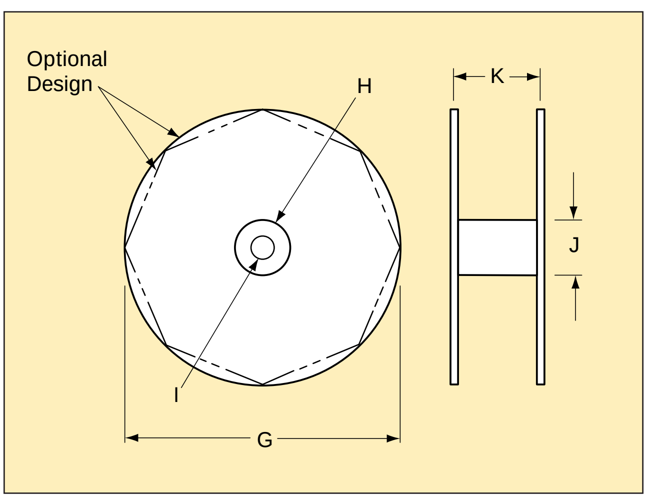
BAR CODE LABELING STANDARD

AVX bar code labeling is available and follows latest version of EIA-556.

CLASS I / RS-296	
A.	5mm ± 0.5mm (0.200" ± 0.020")
B*.	52.4mm ± 1.5mm (2.063" ± 0.059")
C.	6.35mm ± 0.4mm (0.250" ± 0.016")
D^1-D^2.	1.4mm (0.055" MAX.)
E.	1.2mm (0.047" MAX.)
F.	1.6mm (0.063" MAX.)
G.	356mm (14.00")
H.	76mm (3.000")
I.	25.4mm (1.000")
J.	84mm (3.300")
K.	70mm (2.750")



Leader Tape: 300mm min. (12")
Splicing: Tape Only
Missing Parts: 0.25% of component count max.- No consecutive missing parts



AVX TECHNICAL SERVICES AND TESTING FACILITY

The AVX test lab has the capability to perform ESD and a variety of other fast wave form tests on finished assemblies, subassemblies and components for performance to ESD per IEC 1000-4-2 contact/air discharge and a number of other transient voltage specifications.

Components can be tested for:

- Pre/post current draw
- Pre/post output driving voltage
- Pre/post receiver sensitivity levels
- TVS turn on time characterization

Finished assemblies and subassemblies can be tested for:

- System functionality under repetitive ESD strikes
- Pre/post output voltages
- Pre/post receiver sensitivity levels

For details on specific lab test capabilities and costs, contact: Jack Bush @ (843) 946-0244