



## Application Note

### ESD Precautions for ANADIGICS GaAs MMIC Users Rev 1

#### THE IMPORTANCE OF ESD PRECAUTIONS

ESD or Electro Static Discharge is the leading cause of electronic component failure during and after the manufacturing process. High frequency and highly miniaturized active components are especially prone to damage by ESD. GaAs MMICs are not immune, and deserve every possible ESD precaution.

ESD can damage all electronic parts, components, and subassemblies at all manufacturing and handling stages. It affects production yields, manufacturing costs, product quality, reliability, and profitability. And while only a few components will be catastrophically damaged to an extent where they fail completely, many more may suffer damage that is not immediately apparent. These latent failures will cause premature failure in the field, with huge associated costs.

Thus, ESD impacts productivity and product reliability in all aspects of the electronic environment. In view of all this, the importance of effective ESD prevention cannot be overemphasized.

#### THE NATURE OF ESD

Static electricity is the accumulation of an electric charge caused by an imbalance of electrons on the surface of a material. This accumulation most commonly occurs when two similar or dissimilar materials come into contact and are separated, involving the transfer of electrons and known as "triboelectric charging."

For instance, a person walking generates static electricity as shoe soles contact and then separate from the floor. Alternatively, an electronic device sliding in and out of a bag or tube experiences multiple contacts and separations with the surface of the container generating and perhaps retaining a static charge.

The amount of charge created depends on the area of contact, the speed of separation, relative humidity and other factors. The type of material determines how much charge is generated, where the charge goes and how quickly. Materials can roughly be

classified into three groups:

##### 1. *Insulating*

These do not conduct electricity and can generate a considerable amount of charge, both positive and negative (even simultaneously, in different areas), that remains in place for a long time.

##### 2. *Conductive.*

Here the charge is quickly equalized so that only a single polarity results and if it is grounded the charge is quickly dissipated or "neutralized". However, if a charged conductor is insulated from ground, it is still a potent source of ESD.

##### 3. *Static-dissipative.*

These materials are somewhere between insulators and conductors in that the charge is equalized or dissipated (if grounded), but much more slowly than in conductors.

Electrostatic discharge or ESD is defined as an event in which the transfer of static charge occurs between bodies that are at different electrical potentials.

For a person to feel "static," a charge of more than 3000 Volts is necessary, but electronic devices can be damaged by as little as 20 Volts. However, a person walking across a carpet in a dry environment can generate (and discharge) as much as 35,000 Volts!

Device damage can occur in three ways:

1. Discharge from a human to a device. This occurs when person who has accumulated a charge, for instance by walking across a floor, touches the device and causes a discharge to it. A test to simulate this type of ESD is known as the Human Body Model.

A similar discharge can occur from contact of a charged metallic device, held by a human, such

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as a tool or fixture. This event is simulated by the Machine Model, which is more severe than the Human Body Model.

2. Discharge from a charged device to a person or object that is at a different potential. Here a device may become charged, by perhaps sliding down a feeder or chute. If it then contacts another conductive surface, a rapid discharge will occur. This type of ESD event is more likely in an automated assembly environment and is simulated by the Charged Device Model.

3. Field effects. These are rare and can only occur if a device acquires a charge by being placed in a strong electrostatic field and then discharged. CRT screens can be the source of such fields.

### GENERAL ESD PRECAUTIONS

General ESD precautions center on measures that can be taken to minimize electrostatic charge build-up. Reducing static generating processes throughout the manufacturing flow should be the goal. Contact and separation of dissimilar materials and common plastics should be avoided as much as possible in the work environment. In addition, general measures to dissipate and neutralize charges should be instituted.

These include:

1. **Humidity Control.** Charge accumulation is minimized if environmental humidity levels are kept high. Forty percent relative humidity is recommended.

For instance, picking up a poly bag from a bench can generate up to 20,000 Volts of charge at less than 25% Relative Humidity, but will generate less than 1,200 Volts if the Relative Humidity is kept between 65% and 90%.

2. **Ionizers.** In situations where we have to deal with isolated conductors that cannot be grounded, and with most common plastics, air ionization can neutralize the static charge. Because only air is required for ionization to be effective, air ionizers can and should be used wherever it is not possible to ground everything. Ionizers should also be used as a backup where grounding and other methods are also employed.

3. **Wrist straps.** Since the main cause of static is people, the importance of wrist-straps in the fight against ESD cannot be over-emphasized. A wrist-strap, when properly grounded, keeps a person wearing it near ground potential and static charges do not accumulate. Wrist-straps should be worn by all personnel in all ESD Protected Areas, that is, where ESD susceptible devices and end products containing them are assembled, manufactured, handled and packaged.

Further ESD protection, similar to wrist-straps, involves the use of ESD protective floors in conjunction with ESD control footwear or foot-straps. Static control garments (smocks) give additional protection, especially in clean room environments.

4. **Work Areas.** All areas where components that are not in ESD protective packaging are handled should be designated as ESD Protective Areas. Access to such areas should be controlled, and only entered if protective measures, such as wrist-straps and ESD footwear are employed by all personnel. Workstations in such areas should have a static-dissipative work surface with a common ground for it and the worker's wrist-strap.

### DETAILED RECOMMENDATIONS

#### Handling

We recommend the following handling procedures to ANADIGICS customers for use when handling ANADIGICS GaAs products, referred to as "The Product". These procedures will cover the areas of receiving, stock room, transportation and manufacturing.

Material Transportation containers, if used, should be constructed entirely of an electrically conductive material and should not have an insulating coating or finish of any kind.

Material Transportation Carts, if used, should be constructed entirely of an electrically conductive material including all wheels and not have an insulating coating or finish of any kind.

All procedures that involve the handling of The Product, except transportation, should be carried out

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in an ESD safe area as outlined below.

Persons involved in handling The Product should always wear a static-dissipative garment and either conductive or non-insulating (leather soled) shoes. They should also always wear a grounded wrist strap provided with monitoring facilities.

Persons involved in transportation of The Product within the customer's facility should always wear a static-dissipative garment and either conductive or non-insulating (leather soled) shoes.

Persons involved in transportation of The Product within the customer's facility and while transferring The Product to and from the transportation container should always wear a properly grounded wrist strap.

The Product should always be stored in an ESD safe area as defined below.

### Preparation

A clean, "ESD safe" area, consisting of the following items, should be established in any location in the customer's facility where The Product is to be handled in any way.

- A properly grounded static-dissipative surface on which to place The Product.
- Static-dissipative floor or floor mat.
- A properly grounded conductive wrist strap for each person or persons to wear while in the process handling The Product.
- A properly balanced Ionizer mounted above the static-dissipative surface, at a height above the static-dissipative surface recommended by the Ion Generator Manufacturer, with its airflow directed downward toward the static-dissipative surface.

### Unpacking

Turn on the Ionizer.

Place the Shipping Container onto the static-dissipative surface. Wait about 15 seconds before continuing to allow any external static charges to be dissipated by the Ionizer and the static-dissipative surface.

Using the Utility Knife, cut the taped seams on the side of the Shipping container to be opened. Open the container and allow the Ionizer to blow inside to dissipate any internal static charges. Wait 15 seconds before continuing.

Remove The Product from the shipping container, placing the contents onto the static dissipative surface along with any accompanying documentation. Remove any packing material from the ESD protective packaging containing The Product and dispose of the packing material and the shipping container in an appropriate method.

### Opening

Turn on the Ionizer.

Place the ESD protective packaging, containing The Product to be opened, on to the static-dissipative surface.

Open the ESD protective package in the following manner:

If The Product is packaged in a static shielding box, i.e. tape and reel product, cut the sealing tape using a utility knife, then open.

If The Product is packaged in a heat sealed static shielding bag, cut open the end of the bag near the ANADIGICS label, as close to the end as possible, using scissors.

If The Product is shipped in a zipper type static shielding bag or static-dissipative bag, pull the zipper closure open.

If The Product is packaged in an IC shipping tube, cut the tape sealing the cap on one end only, using the utility knife. Remove the end cap.

Remove The Product from the ESD protective packaging material, placing it directly on to the static-dissipative surface. Save all ESD protective packaging material for later use if necessary.

### Inspection

Perform procedure outlined above to remove the Product from the packaging.

The customer should perform any required visual inspections at this time.

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ANADIGICS does not recommend further unpacking at this time. Removing The Product from IC carrier tubes or Tape and Reel carrier tape to perform electrical tests may expose The Product to damaging electrostatic fields or voltages. If samples of The Product must be tested at this time, these samples should not be returned to the customers production inventory.

Following the inspection, The Product should be returned to the ESD protective packaging material in which it was received from ANADIGICS, and then sealed, if necessary.

### Transport

The Product should always be sealed within the ESD protective packaging material as received from ANADIGICS while transporting.

The Product should only be moved from and to ESD safe areas as specified in this document.

The transportation container and/or cart should be connected electrically to an acceptable earth ground connection before and during the loading and unloading of the product to and from the container or cart.

### ANADIGICS recommended procedure for handling The Product during the manufacturing process:

The Customer should follow the procedure outlined above for the opening and removal of The Product from the ESD protective packaging.

The Product may be dispensed from IC carrier tubes or tape and reel feed carrier tape.

IC carrier tubes may be opened by using a metal tweezers to remove one of the end plugs from the carrier tube. The Product may then be dispensed as per customer requirements.

For tape and reel, dispensing the customer will need to remove a piece of anti-static adhesive tape in order to free the lead end of the carrier tape. This can most easily be done with the fingers or a metal tweezers. The Product may then be installed onto the

customer's SMD press as per the manufacturer's specifications.

The customer should consider any product assembly containing The Product to be ESD sensitive and therefore should continue the practices set forth in this document, where ever possible, throughout the manufacturing and delivery process of any product containing The Product. Static sensitive components are still susceptible to ESD even after insertion into the circuit.

One significant source of ESD damage is when statically charged components are inserted into the Printed Circuit Board after the static sensitive device, such as the Product. This static charge dumps into the PCB and can affect or damage any semiconductor in its path since most semiconductors on a PCB are connected to ground and are susceptible, because during the assembly the ground may be floating. Therefore, the Product should be placed into the circuit last.

In addition, static charges should be neutralized from even non-semiconductor devices, i. e. capacitors, ferrites, ceramics, crystals, etc. To facilitate this, one should specify conductive carrier tape for these non-semiconductor devices. Residual charges should be neutralized by the use of balanced ionizers.

### Maintenance

The air stream ion generators should be installed and maintained according to the manufacturer's requirements.

An out of balance ion generator will actually charge surfaces and components thereby causing damage to ESD sensitive devices.

The static-dissipative surfaces should be cleaned and tested at regular intervals to ensure effective and replaced when necessary.

The conductive wrist straps should be tested at regular intervals and replaced when necessary. The static-dissipative garments should be cleaned and treated at regular intervals as required.

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### **IMPORTANT NOTICE**

ANADIGICS, Inc. reserves the right to make changes to its products or to discontinue any product at any time without notice. The product specifications contained in Advanced Product Information sheets and Preliminary Data Sheets are subject to change prior to a product's formal introduction. Information in Data Sheets have been carefully checked and are assumed to be reliable; however, ANADIGICS assumes no responsibilities for inaccuracies. ANADIGICS strongly urges customers to verify that the information they are using is current before placing orders.

### **WARNING**

ANADIGICS products are not intended for use in life support appliances, devices or systems. Use of an ANADIGICS product in any such application without written consent is prohibited.



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