

## ESD Protection of Broadband GaAs CATV & FTTx Amplifiers

Rev. V2

### Introduction

Increasing protection from electrostatic discharge (ESD) for GaAs devices in various applications is critical to long term reliability of the final products. This application note explains how a simple anti-parallel pair of diodes delivers protection levels of 8kV contact discharge Human Body Model (HBM) as per the commercial IEC-61000-4-2 specification.

### The Protection Components

The ESD protection circuit is an inexpensive pair of anti-parallel diodes, either Fairchild Semiconductor BAV99 or LL4148. The BAV99 is an anti-parallel diode pair packaged in a single SOT-23 package. The LL4148 is a single diode per package requiring two with opposite polarity. See the Fairchild Semiconductor website for complete product information.

### Implementation

The level of protection provided is independent of diode pair location. Placement can be adjacent to the external signal input (connector input) or near the broadband amplifier requiring protection. However it is good ESD protection practice to locate the protection device as physically close as possible to the physical input source of the ESD strike so as to shunt the ESD energy to ground as early as possible in the system.

The schematic diagrams in Figures 1 & 2 show examples using the MAAMSS0042 broadband amplifier which operates from 50 to 1000 MHz (see MAAMSS0042 data sheet for off-chip component values). The protection location is shown for two different applications. Figure 1 shows the diode pair located on the input of the broadband amplifier for a typical CATV set-top box (STB). In this application the RF input is exposed to potentially harmful external signals through an F-type connector on the input to the system. Figure 2 shows the location of the diode pair for FTTx applications where the RF output of the broadband amplifier is exposed to external signals through a SMB connector at the output.

It is critical in both applications that the diodes be located electrically outside of the series DC blocking capacitors as shown in Figures 1 & 2. The BAV99 device (single part) is shown in red in Figures 3 & 5. The LL4148 (two parts) is shown in blue in Figures 4 & 6.

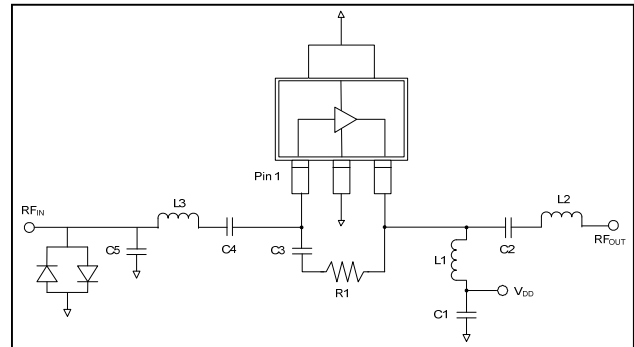


Figure 1. Diode pair location in CATV STB applications

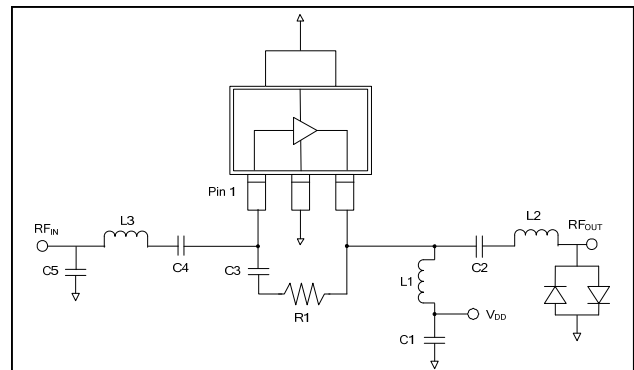


Figure 2. Diode pair location in FTTx applications

### Verification & Results

The level of ESD protection provided was verified through a design of experiments (DOE). This DOE varied component placement and component type. The variations included:

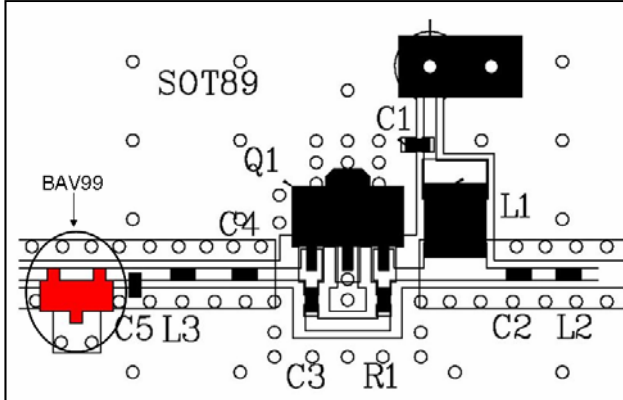
- BAV99 adjacent to connector
- LL4148 pair adjacent to connector
- BAV99 adjacent to amplifier
- LL4148 pair adjacent to amplifier

All amplifier circuit variations with either choice of diode pair remained functional after 25 ESD strikes of 8kV (HBM) contact discharge.

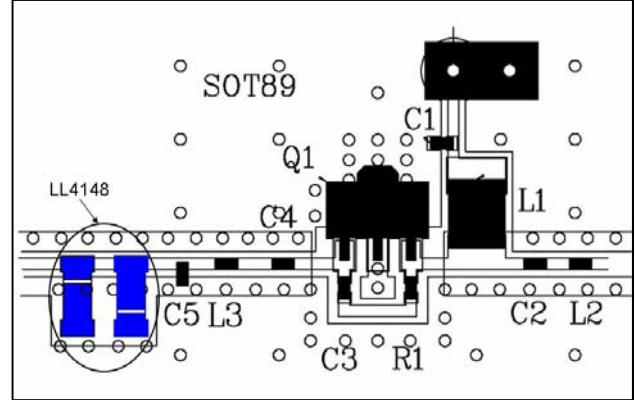
### Recommendation

For ESD protection of broadband (50-1000 MHz) amplifiers, an anti-parallel diode pair is placed in shunt along the RF transmission line requiring protection. The component location is flexible, and since these devices are available in small outlines, little additional board space is required to implement this circuit.

**Recommend PCB layout for CATV Set-Top Box applications**

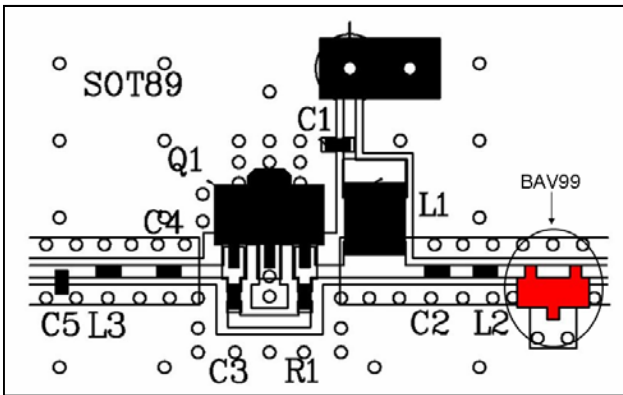


**Fig 3.** BAV99 located on the RF input

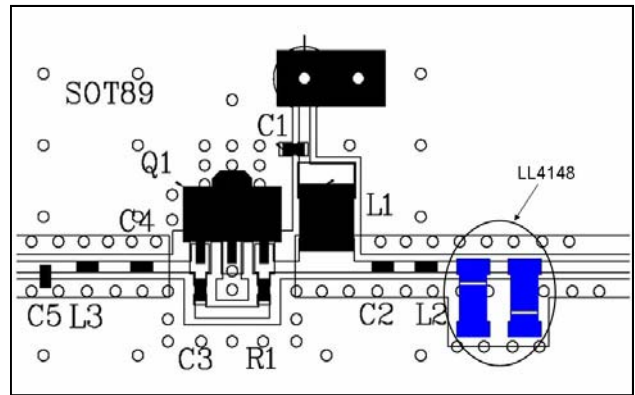


**Fig 4.** LL4148 located on the RF input (note polarity)

**Recommend PCB layout for FTTx applications**



**Fig 5.** BAV99 located on the RF output



**Fig 6.** LL4148 located on the RF output (note polarity)