



Preliminary

# Cryogenic Differential Amplifier

## KEY FEATURES

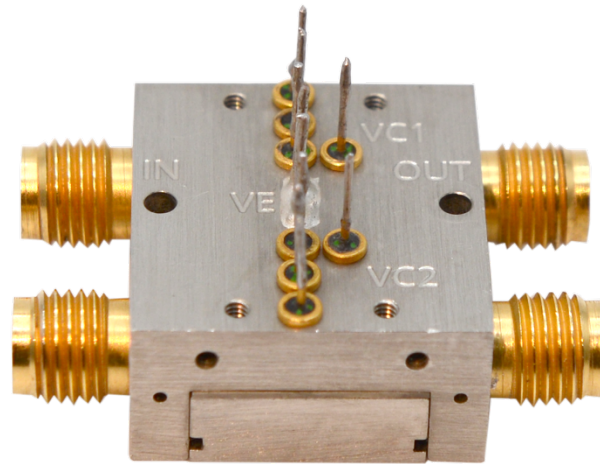
- AC and DC Coupled Versions
- Single Supply for AC Coupled Version
- Dual Supply Required for DC Coupled Version
- Fully Differential Input/Output
- Integrated Bias Tees for SNSPD
- Multi-Channel Assemblies Available Soon
- MMIC Based

## TYPICAL SPECIFICATIONS

- 3 MHz to 1.5 GHz (Usable to 2GHz)
- Typical Gain
  - 22 dB
- Return loss all ports
  - <-10 dB
- Noise temperature
  - 10-13 Kelvin
- Typical Bias
  - 3V @ 5 mA

## APPLICATIONS

- ✓ Long range space craft communications
- ✓ Long range communication networks such as cloud data and back haul systems
- ✓ Medical imaging



## Description

Cosmic Microwave Technology, Inc. has been developing cryogenic, low noise differential amplifiers primarily for integration with Superconducting Nanowire Single Photon Detectors (SNSPD). The structure of the SNSPD consists of a meandering line embedded on a super-conducting material that is cooled to 1K. The meandering line structure is inherently differential. As a photon strikes the SNSPD, both a positive and negative spike is generated. The differential amplifier allows detection of both pulses.

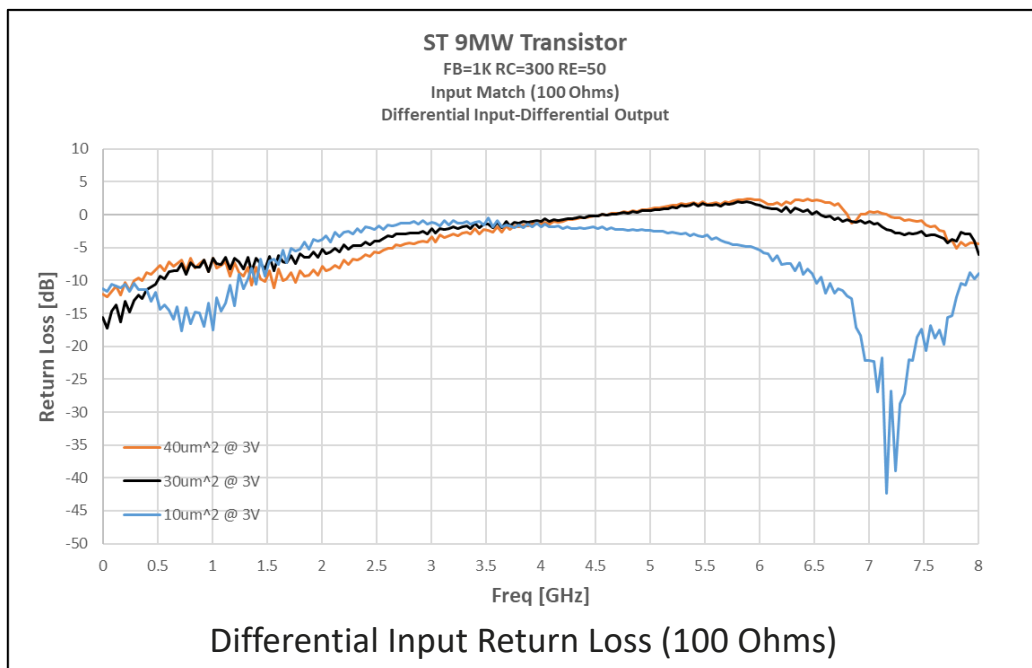
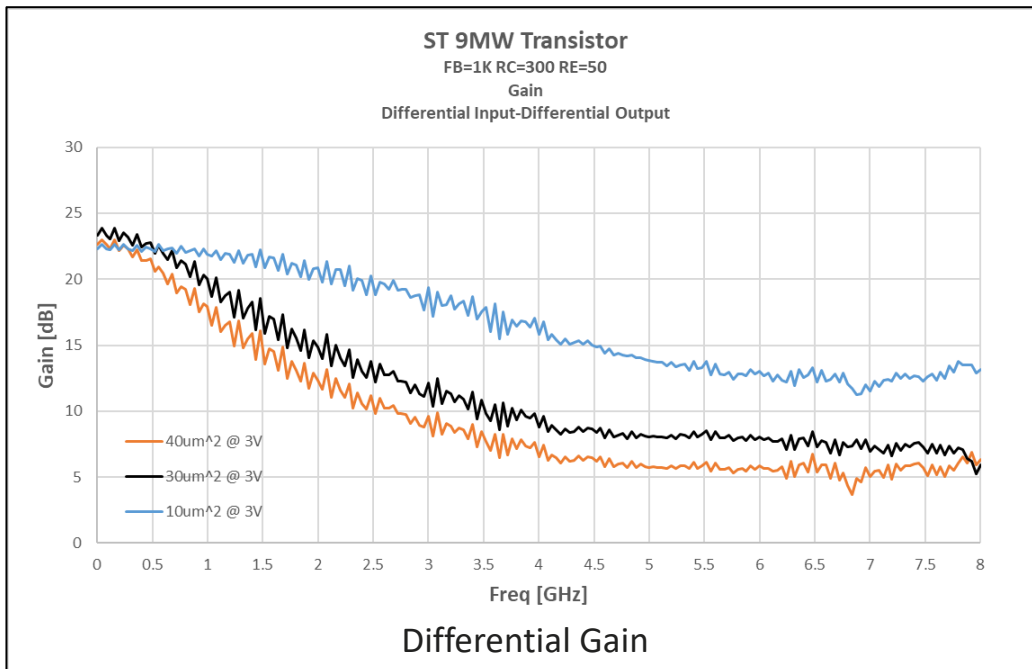
The low noise of the differential amplifier will result in reducing the timing jitter of the pulses and dramatically improve the performance of the optical links. Higher data rates are achievable resulting in higher resolution images.

Currently, two versions of the cryogenic differential amplifiers are available. The AC coupled version is self-biasing and requires only a single supply voltage. This bias arrangement is simple to implement.

A DC coupled version is also available. This version is suited for high data rates since the DC offset caused by AC coupling integration is eliminated. This version requires an additional current source for bias of the base junctions of the transistors.

# AC Coupled Differential Amplifier Operating from a Single Voltage Supply

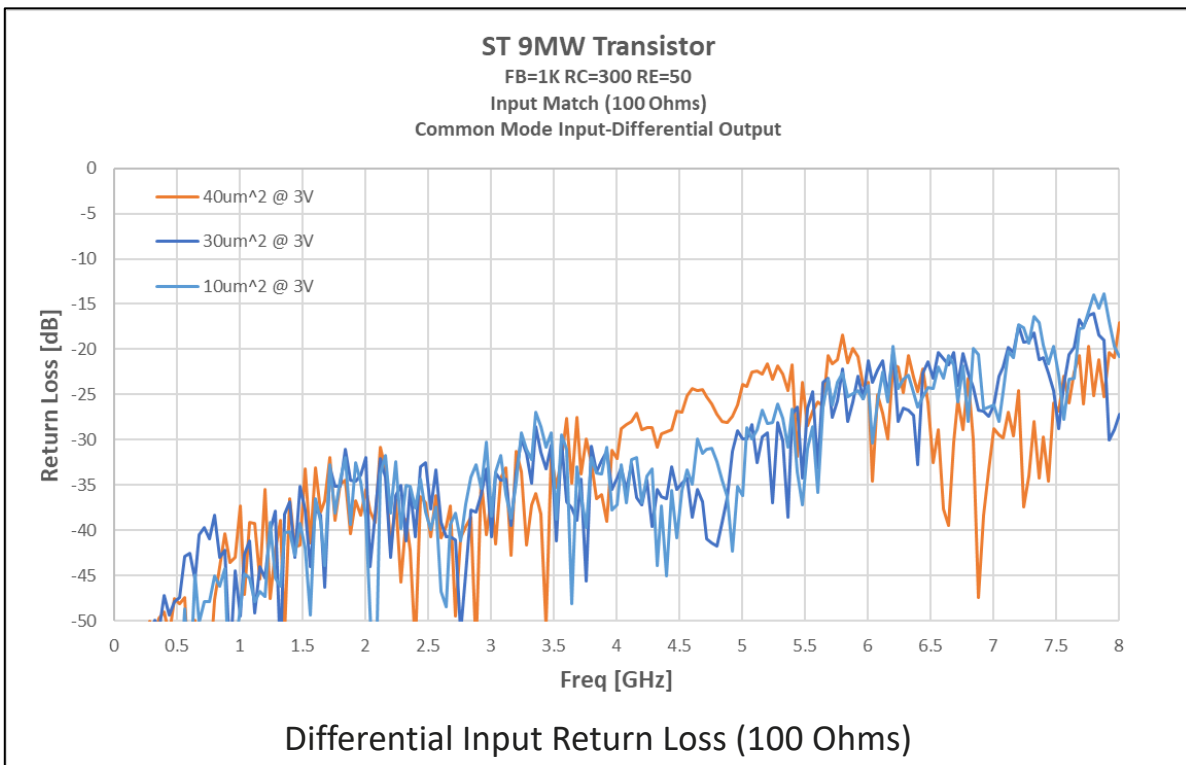
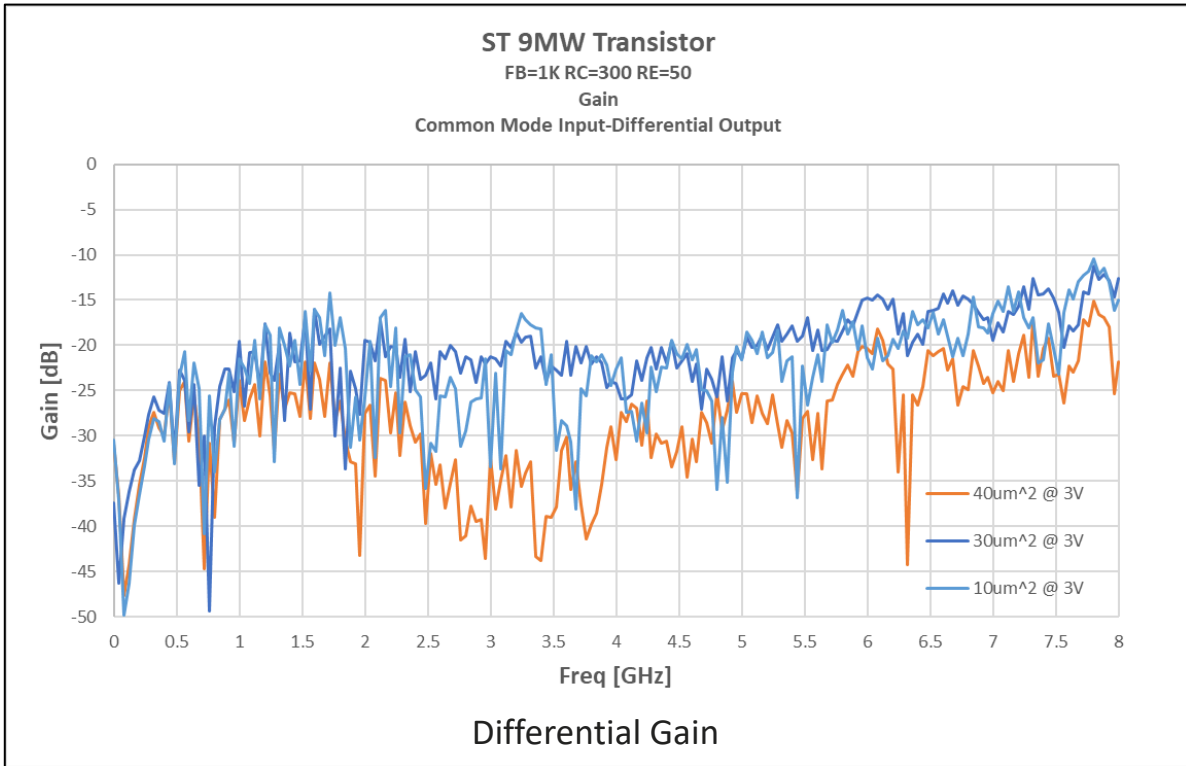
Differential Amplifier Gain and Input Return Loss  
Differential Input-Differential Output  
AC Coupled Amplifier with Single Bias



# Differential Amplifier Gain and Input Return Loss

## Common Mode Input-Differential Output

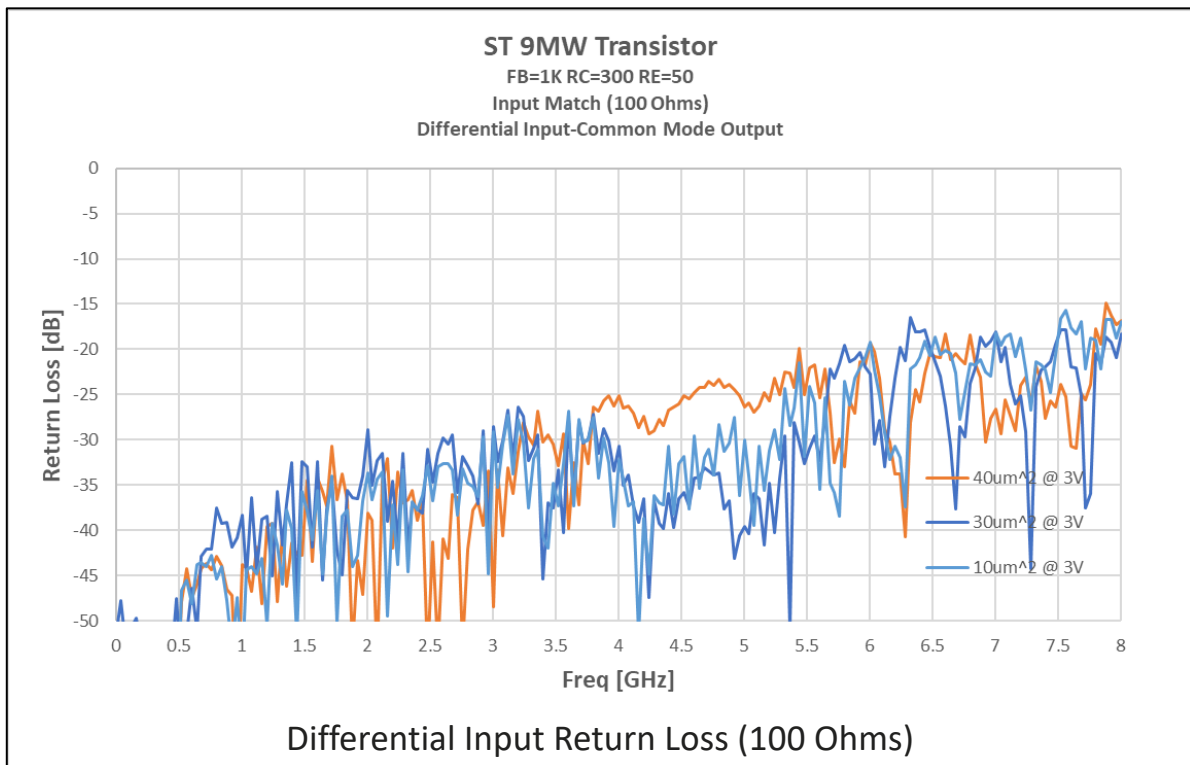
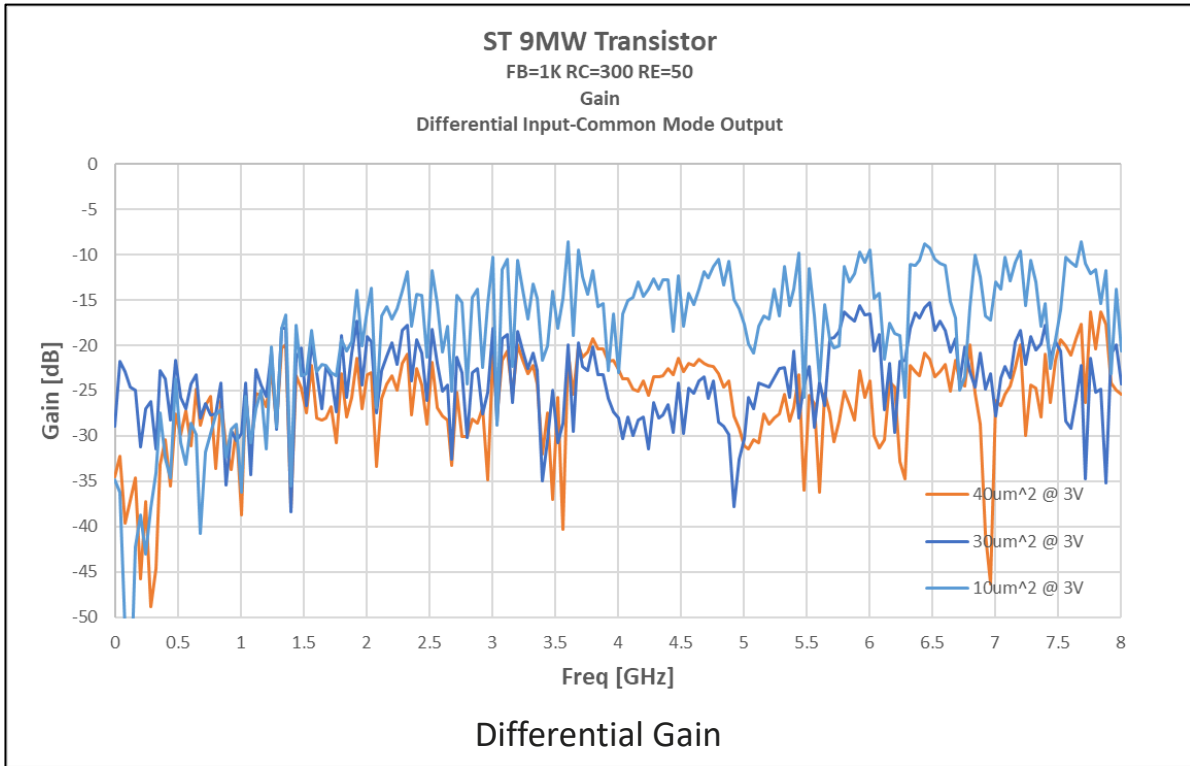
### AC Coupled Amplifier with Single Bias



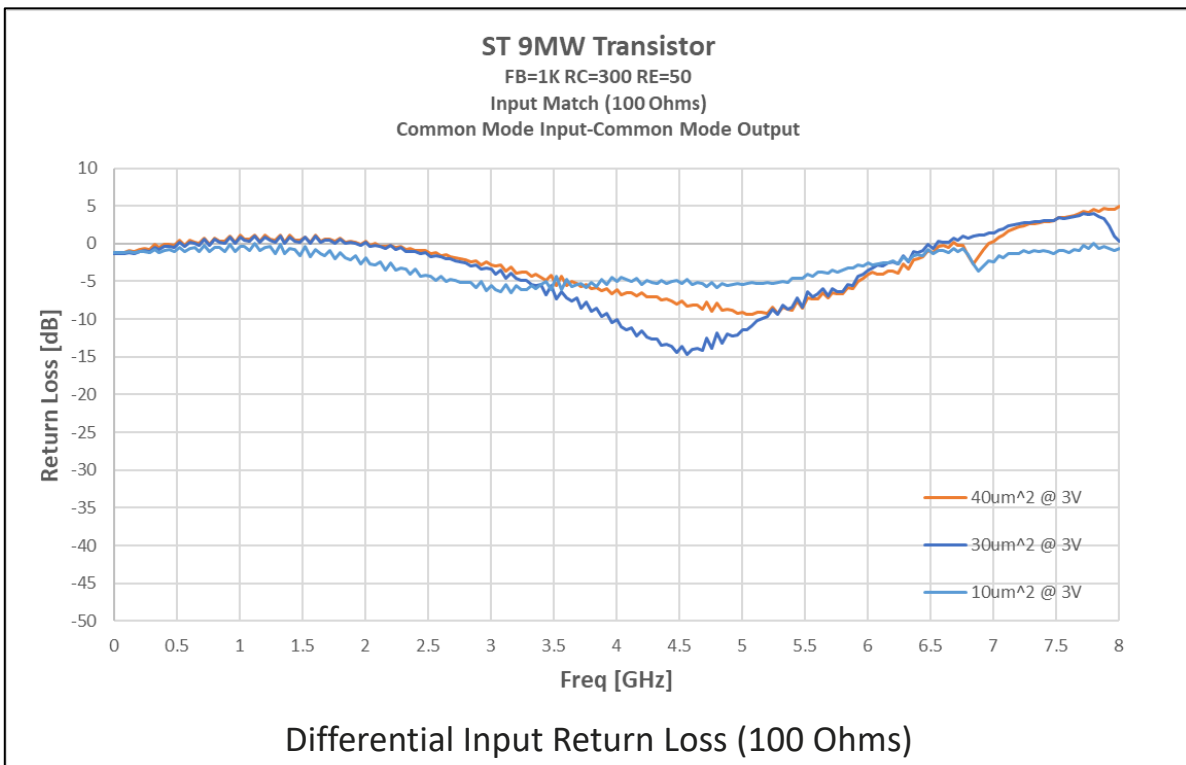
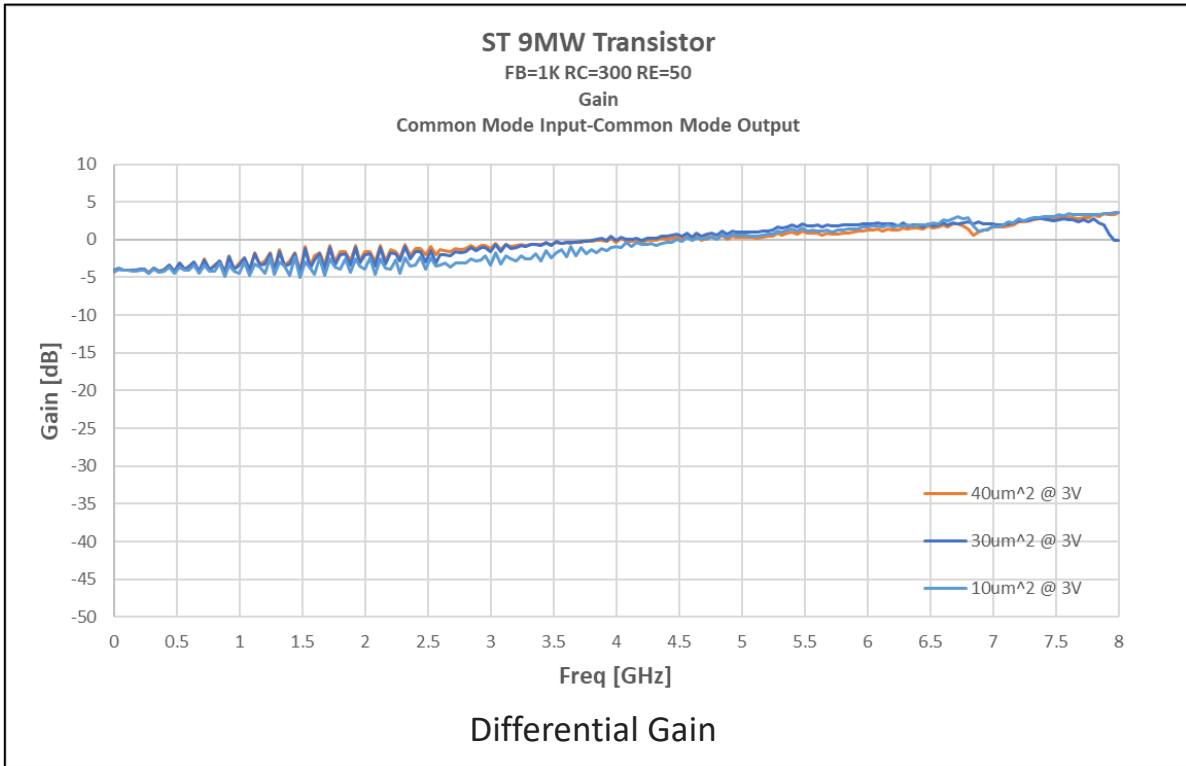
# Differential Amplifier Gain and Input Return Loss

## Differential Input-Common Mode Output

### AC Coupled Amplifier with Single Bias



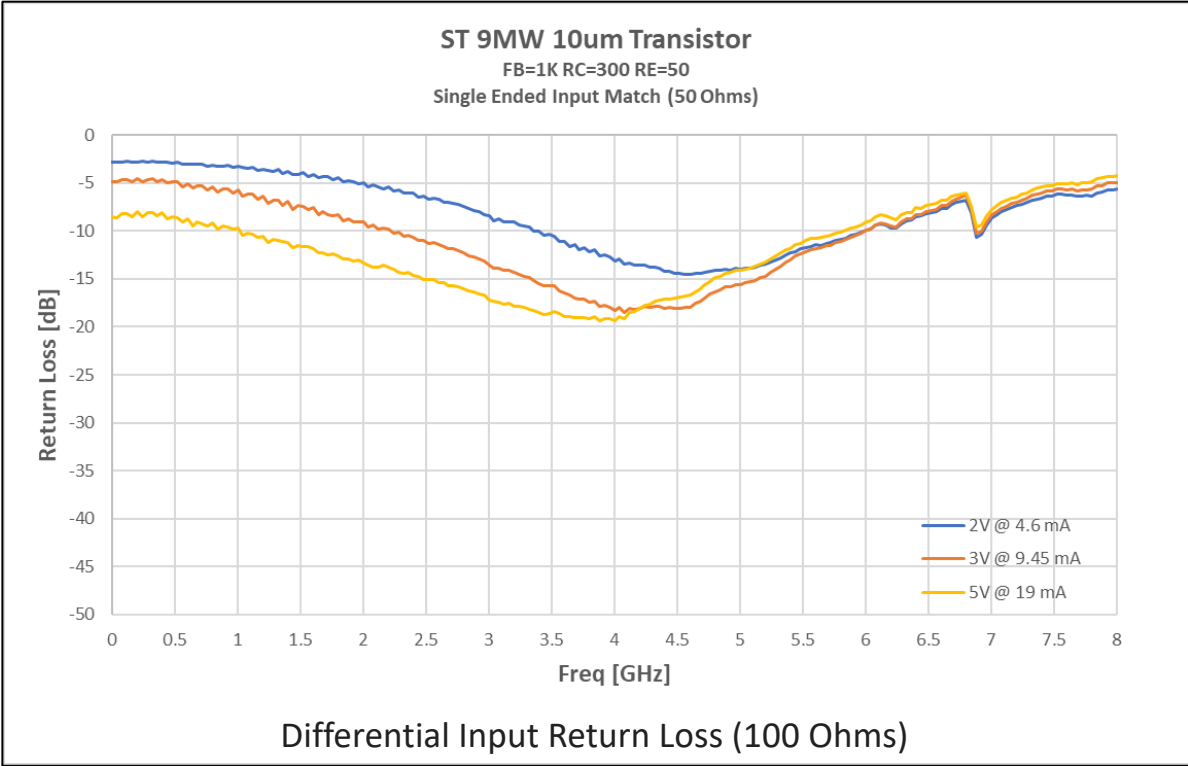
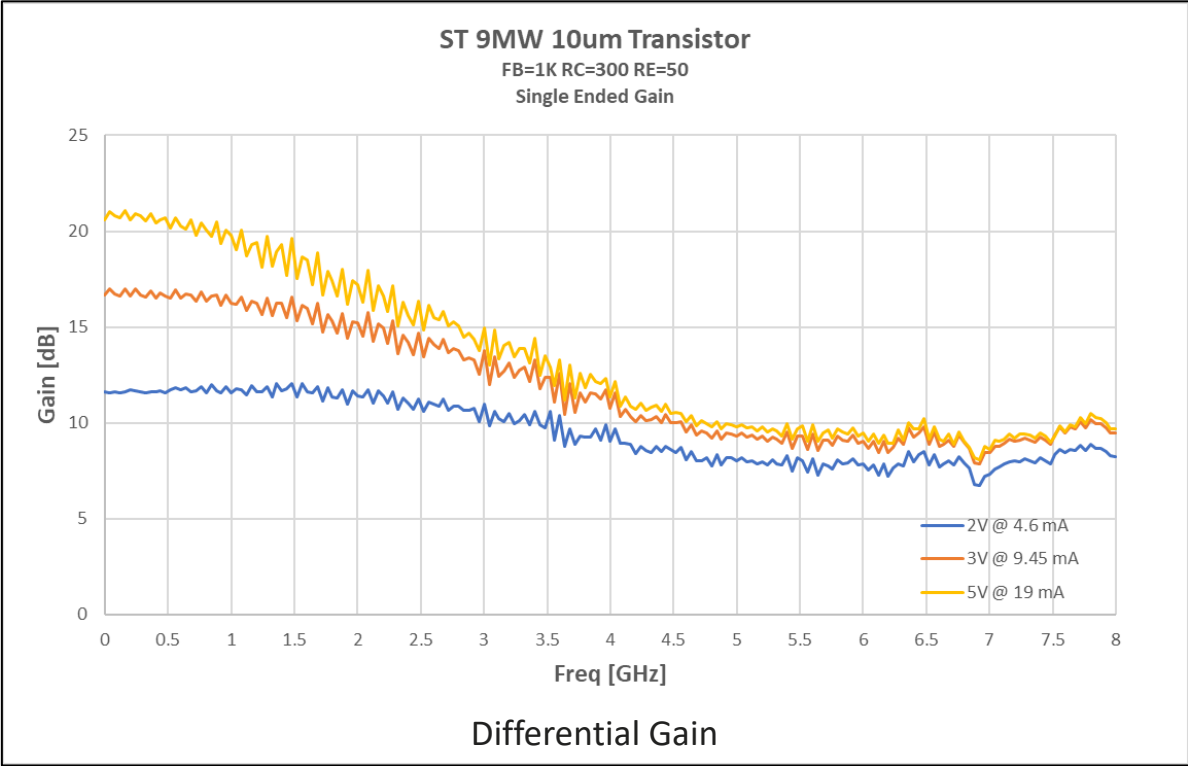
# Differential Amplifier Gain and Input Return Loss Common Mode Input-Common Mode Output AC Coupled Amplifier with Single Bias



# Differential Amplifier Gain and Input Return Loss

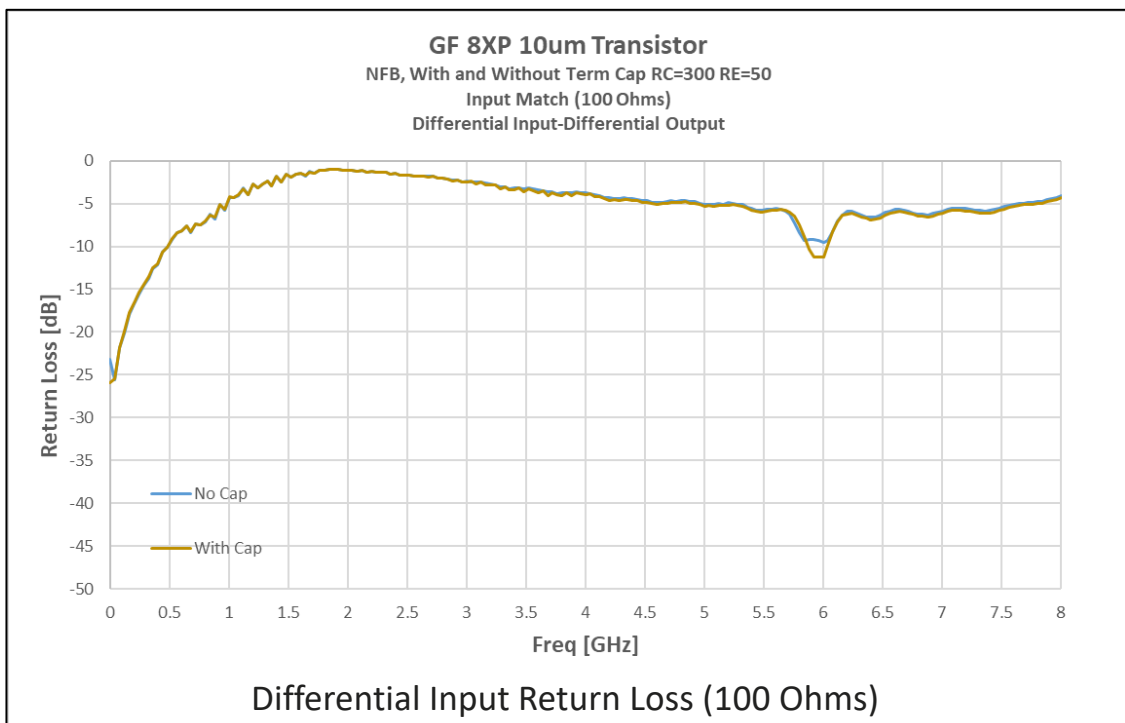
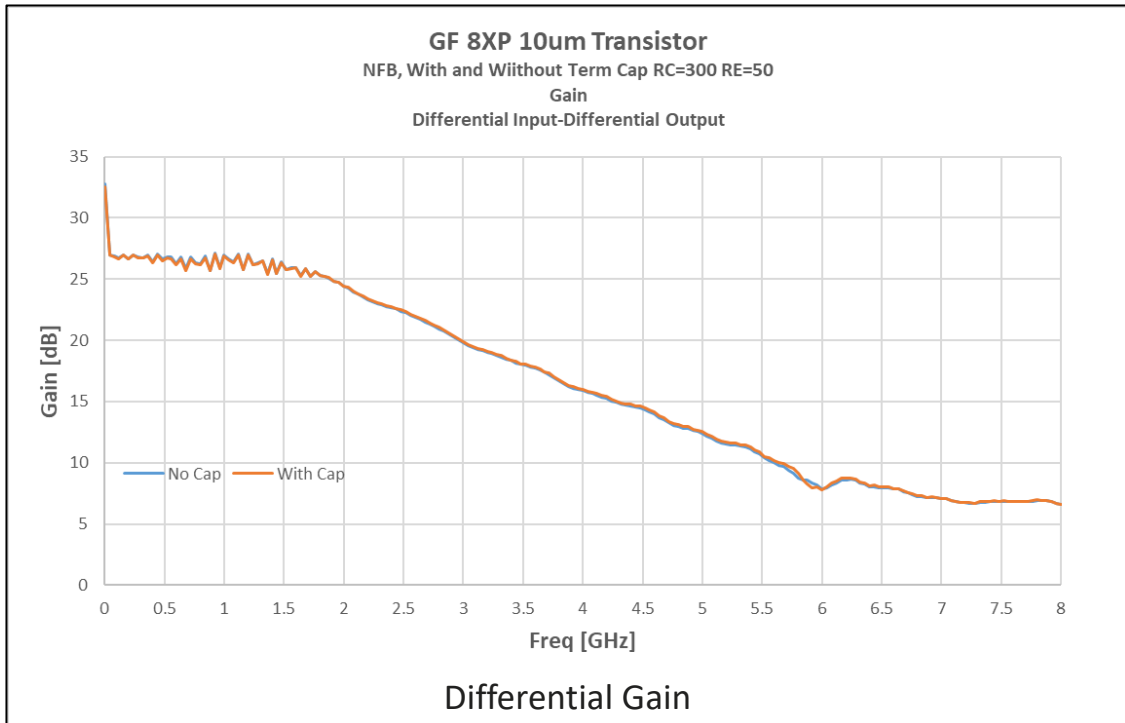
## Single Ended-Single Ended

### AC Coupled Amplifier with Single Bias

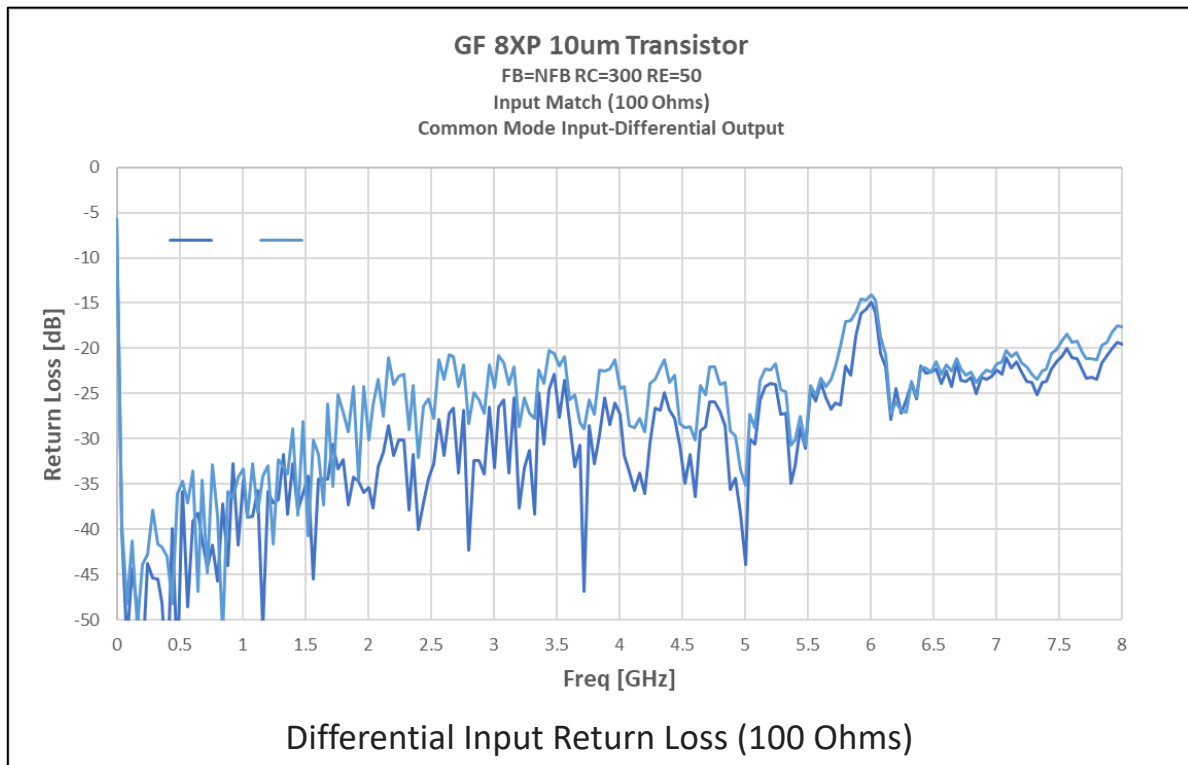
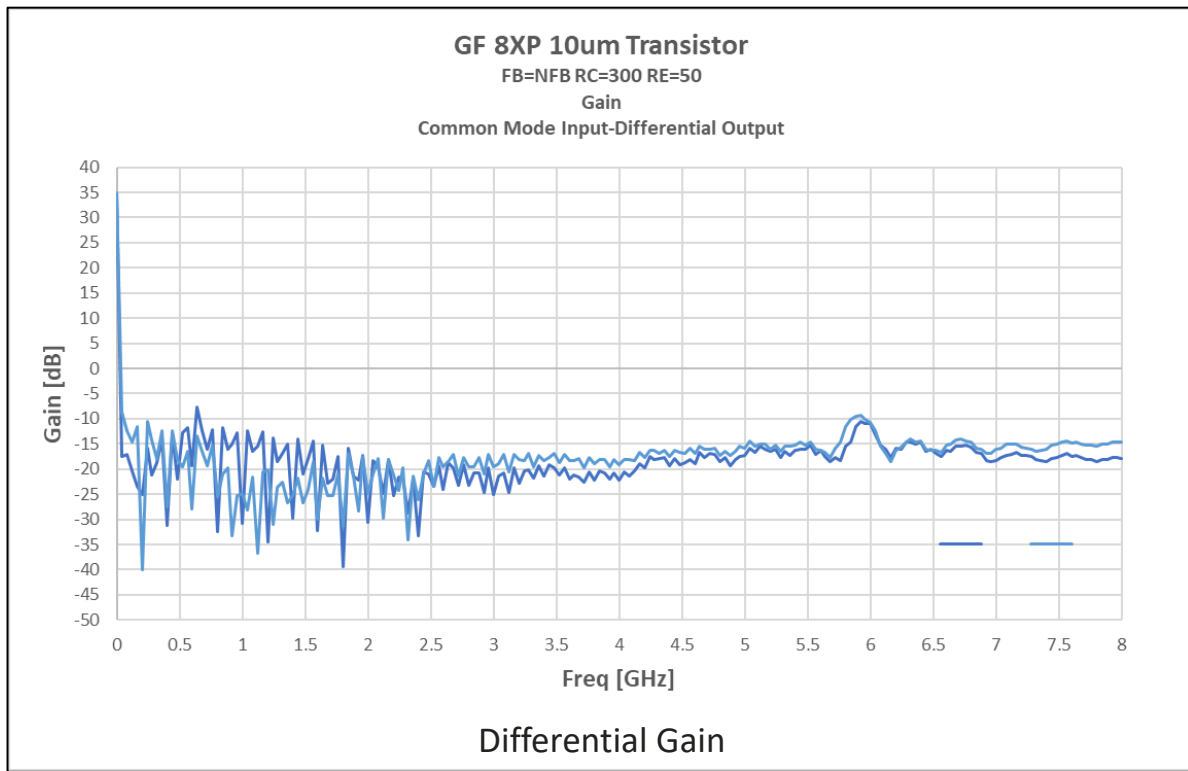


# DC Coupled Differential Amplifier Operating from a Voltage Supply for VC and a Current Supply for IB

Differential Amplifier Gain and Input Return Loss  
Differential Input-Differential Output  
DC Coupled Amplifier with Dual Bias

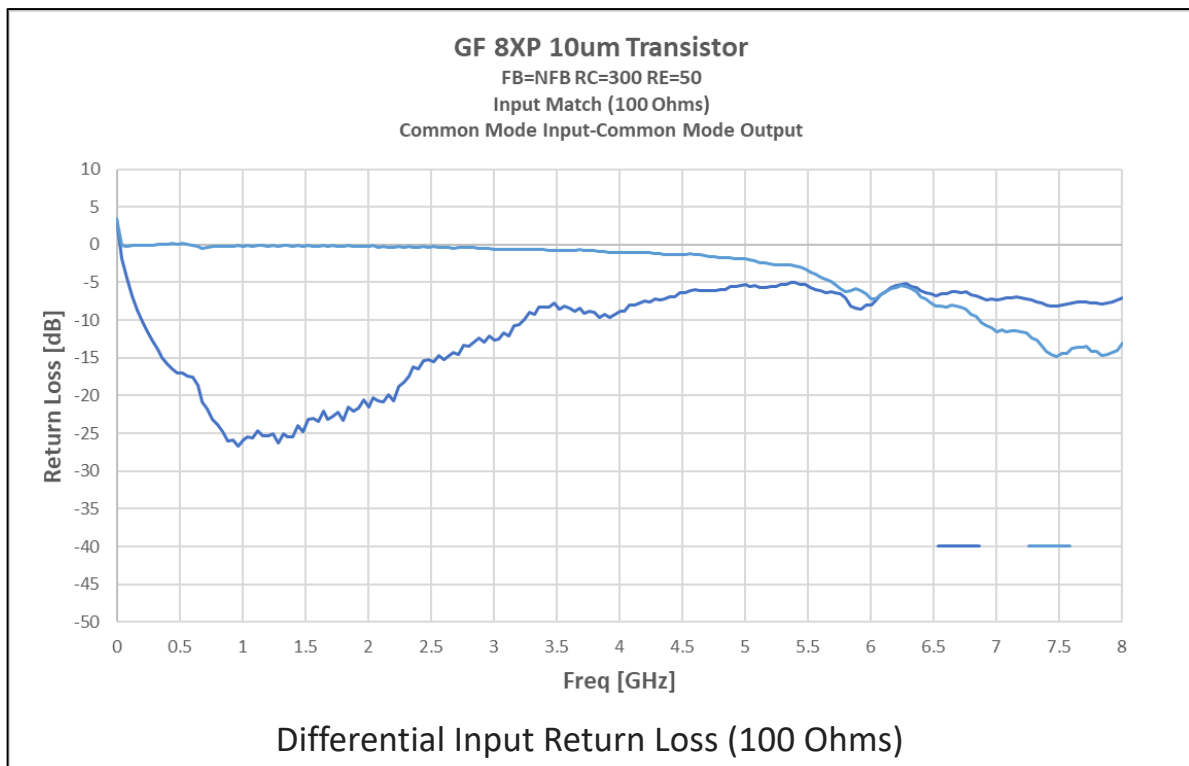
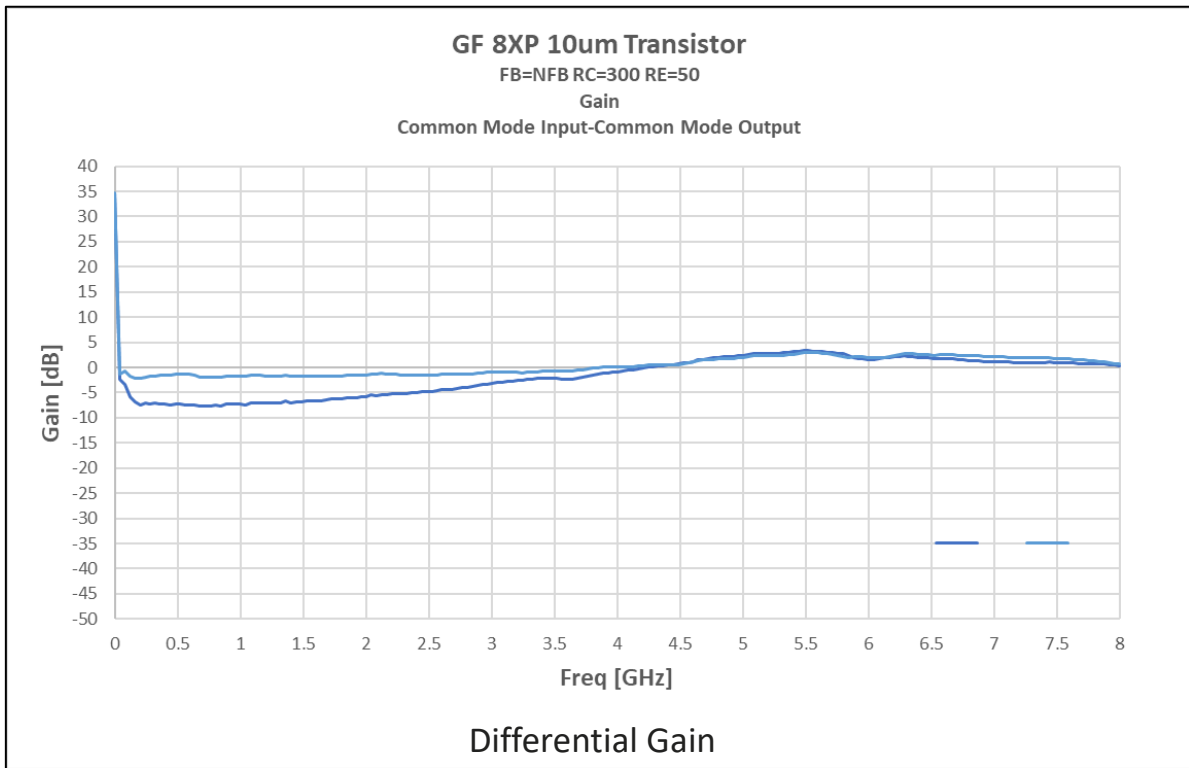


# Differential Amplifier Gain and Input Return Loss Common Mode Input-Differential Output DC Coupled Amplifier with Dual Bias





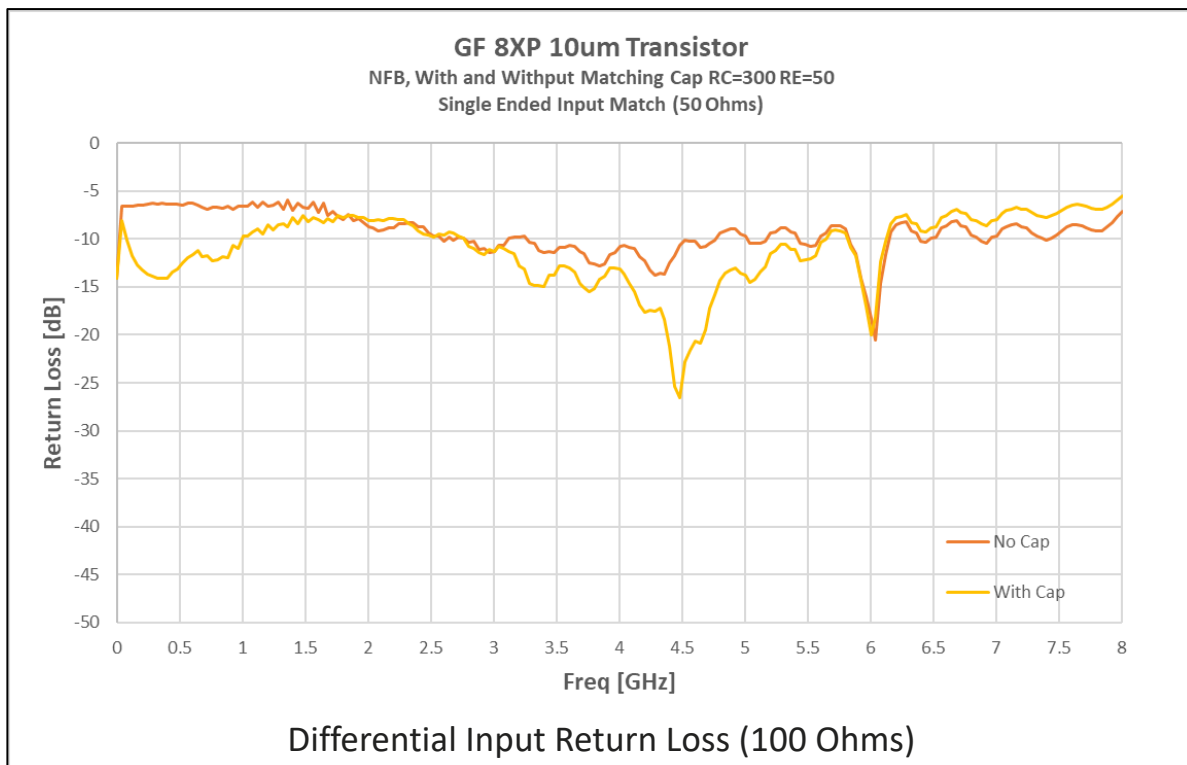
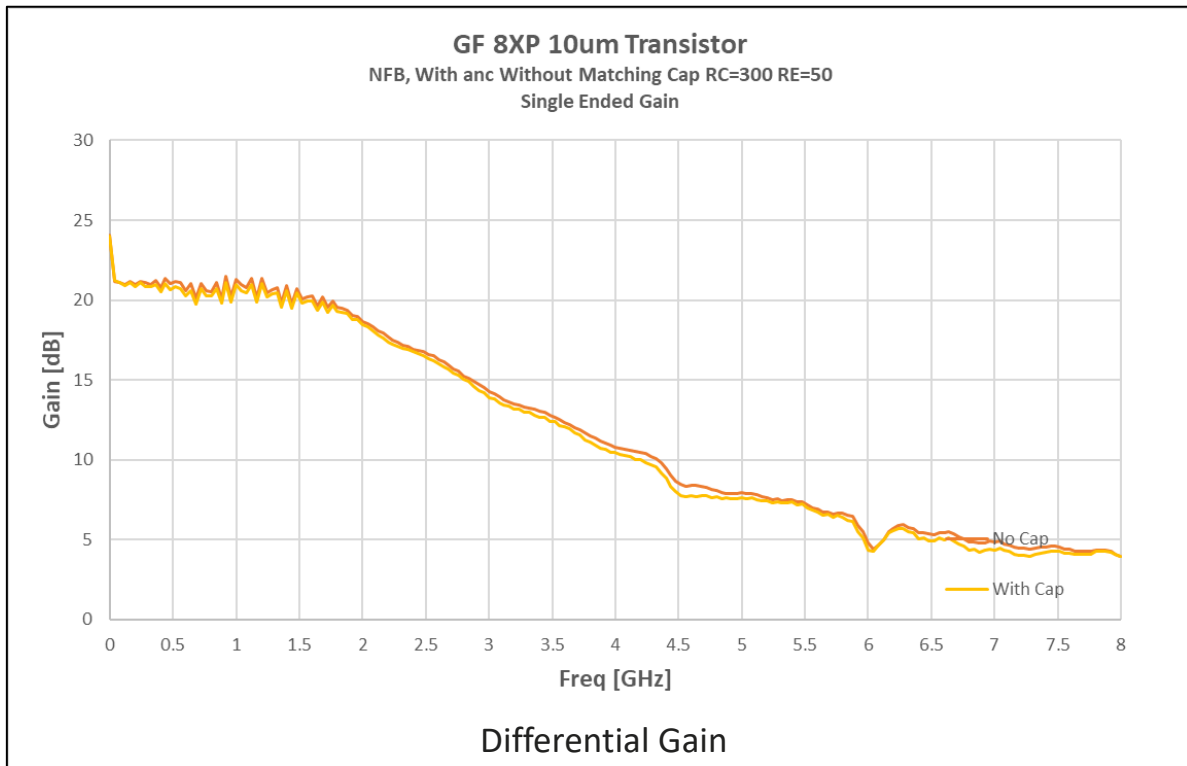
# Differential Amplifier Gain and Input Return Loss Common Mode Input-Common Mode Output DC Coupled Amplifier with Dual Bias



# Differential Amplifier Gain and Input Return Loss

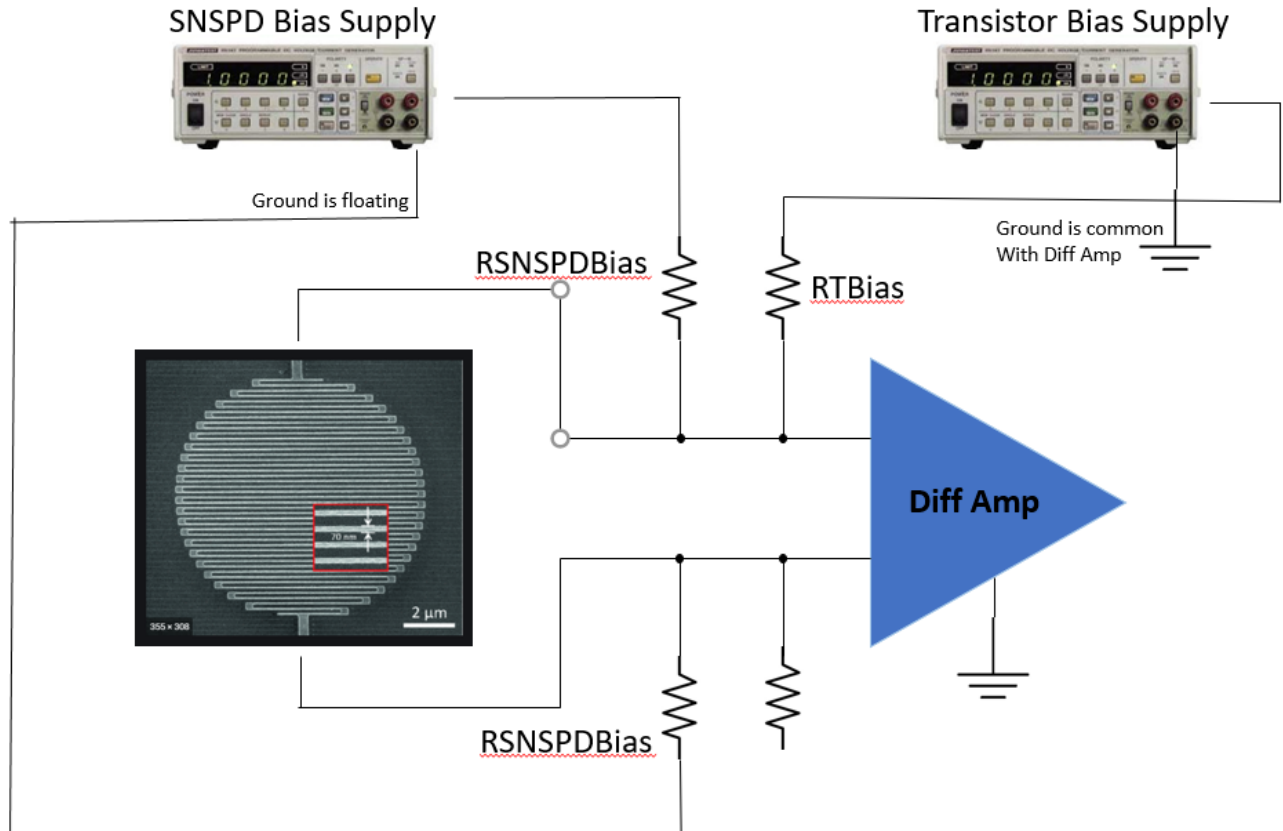
## Single Ended-Single Ended

### DC Coupled Amplifier with Dual Bias

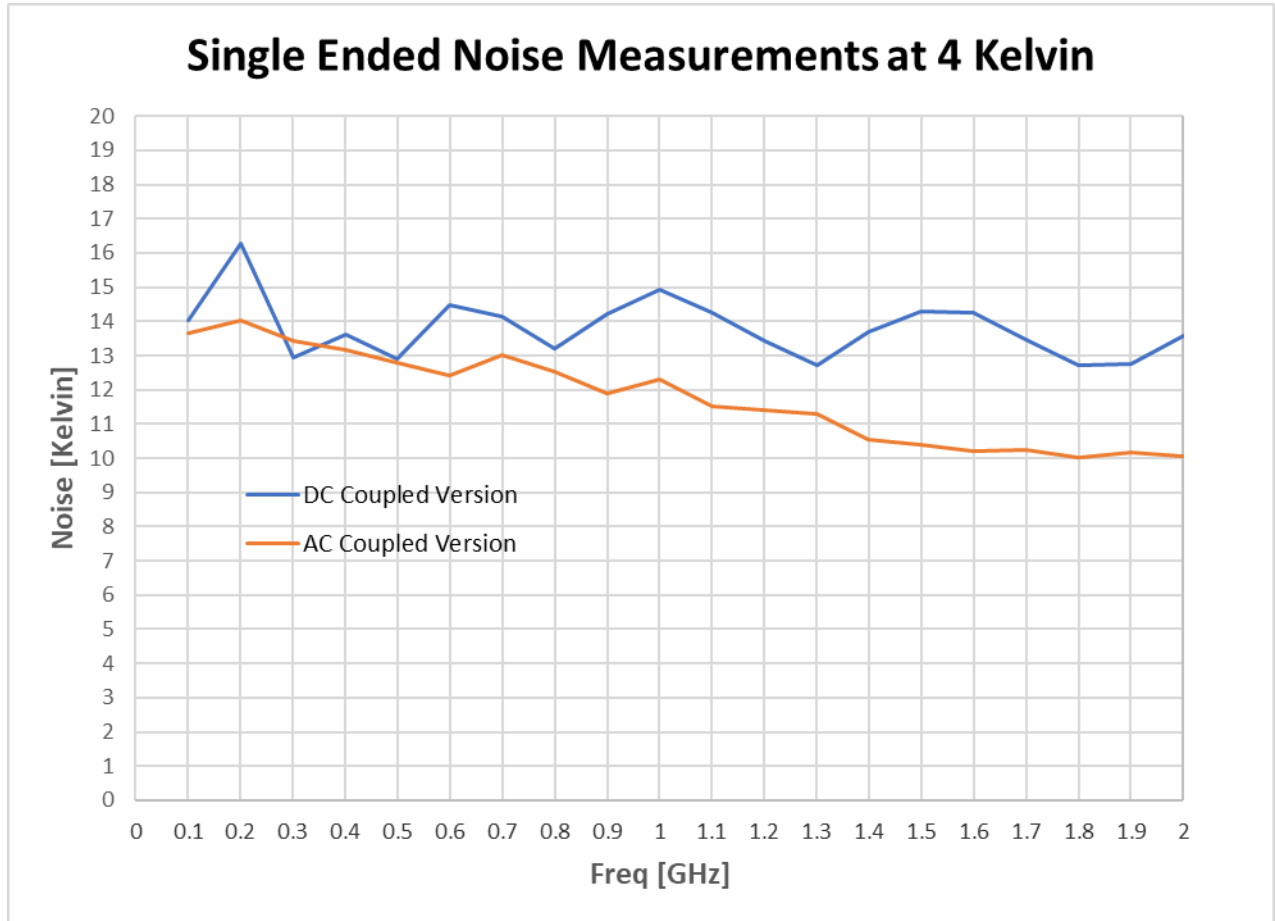


# Recommended Bias Configuration for DC Coupled with Dual Bias

## DC Coupled Differential Amplifier Bias Schematic

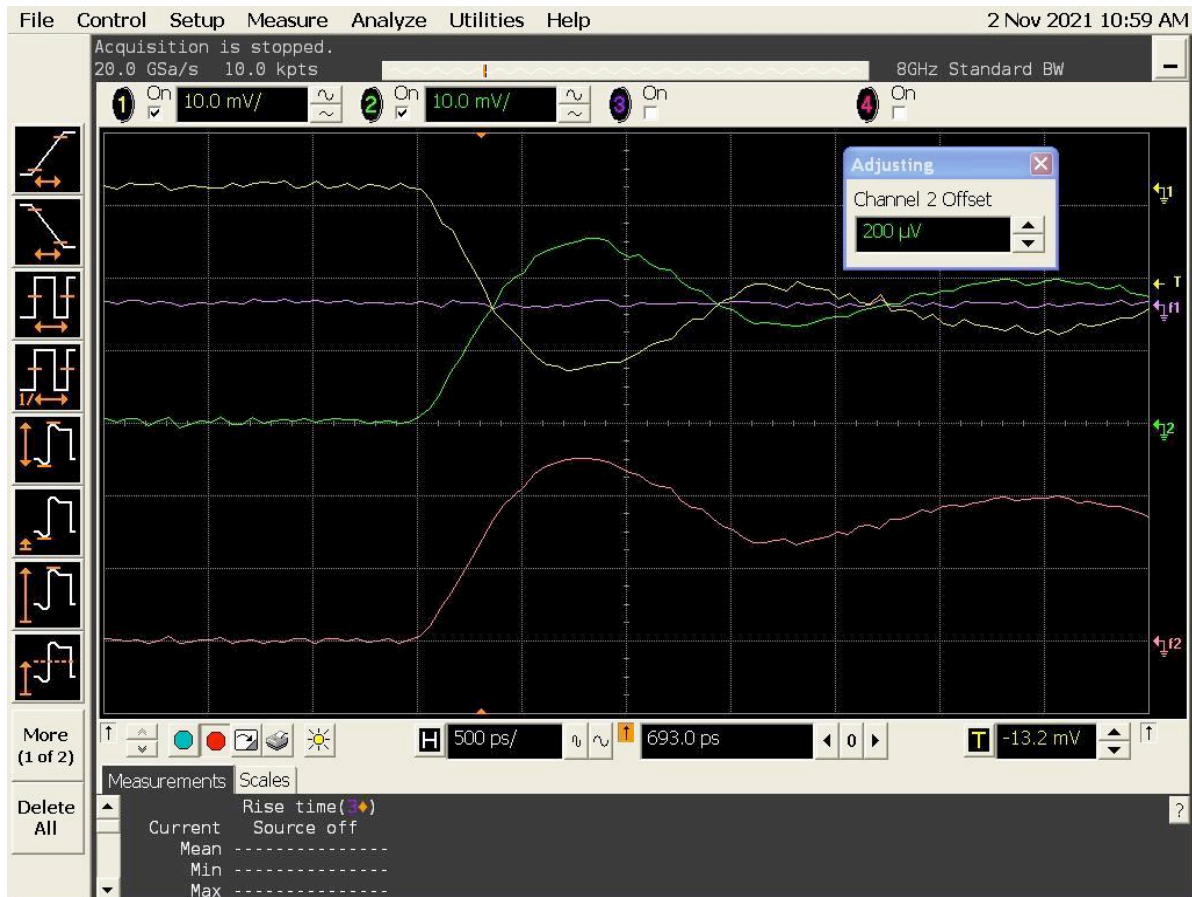


# Typical Noise Response



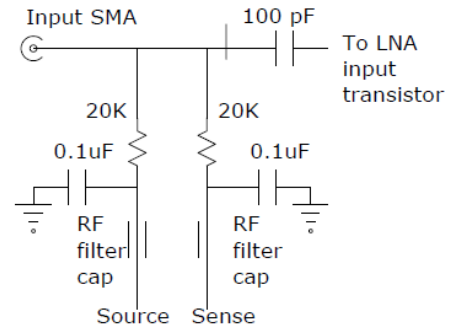
# Pulse Response of the DC Coupled Differential Amplifier

Source=Super Conducting Nanowire Single Photon  
Detector Horz=500pS/Div

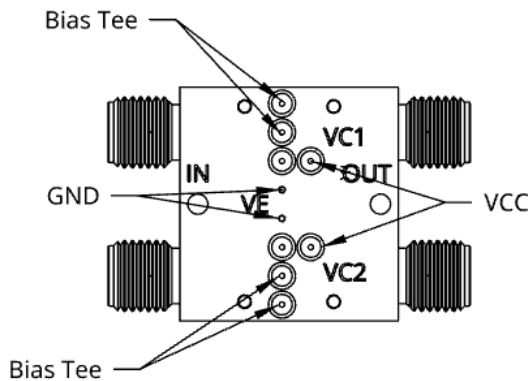
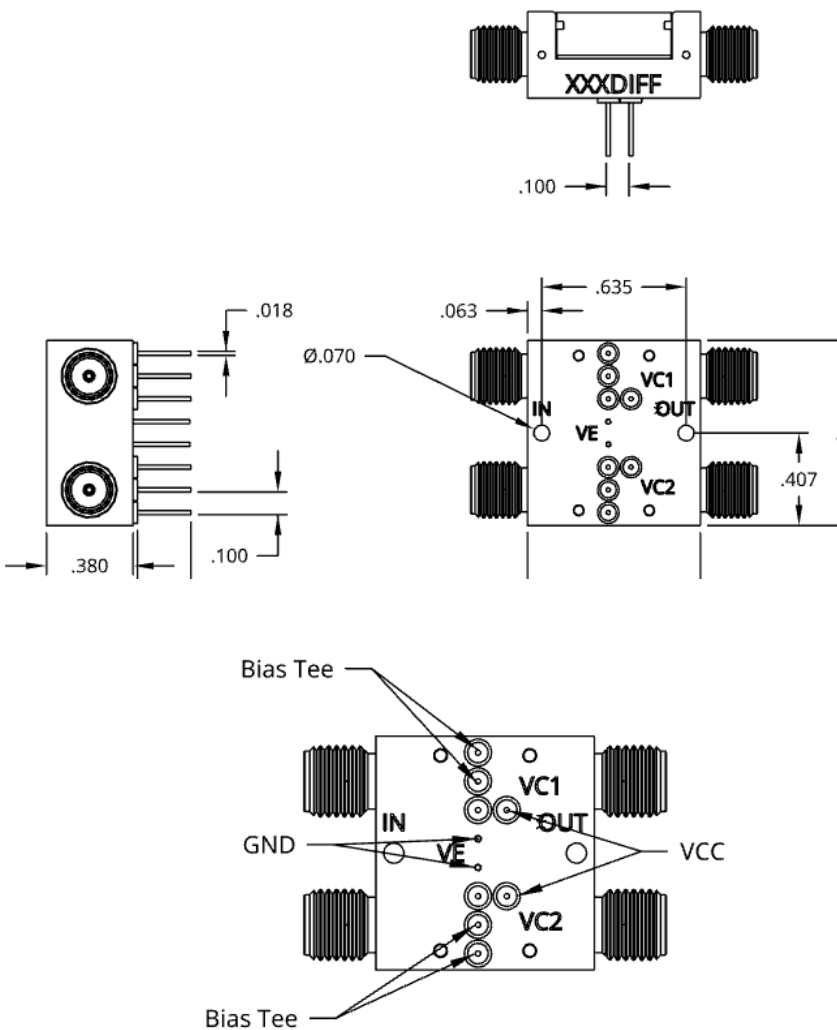


## Input Bias Tees

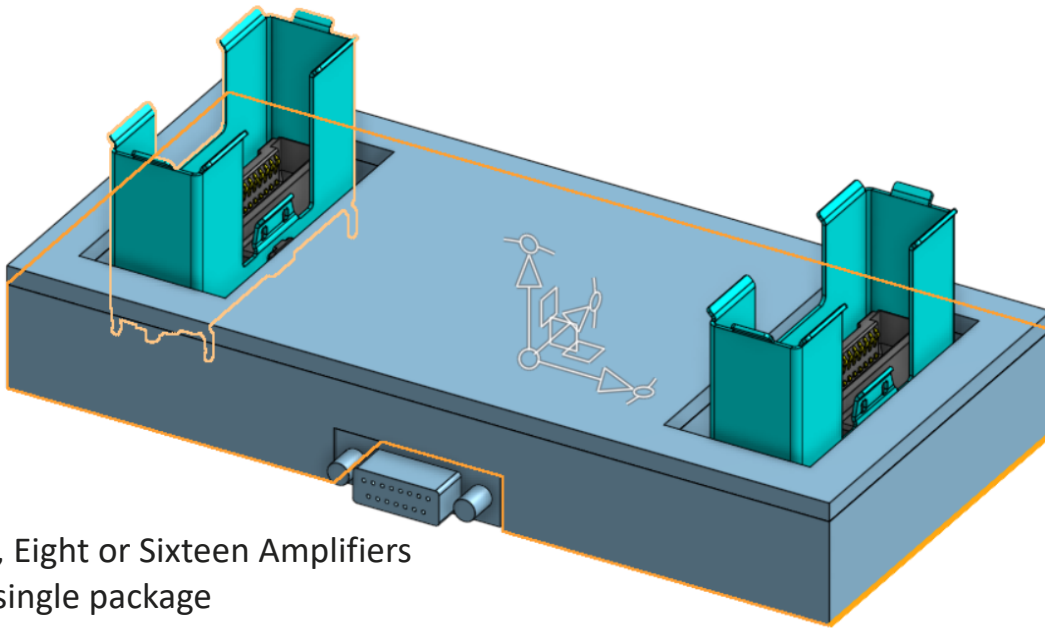
The Differential Amplifier can be supplied with DC bias tees for a SNSPD connected to the amplifier input. The bias tee is formed by two (2) resistors connected to the input; as shown in Figure 1. One (1) resistor can be used as a source of current and the other senses the voltage across the external device.



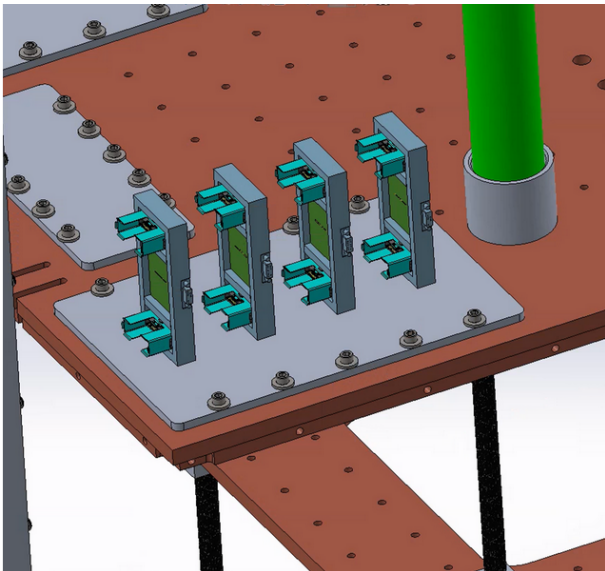
## Outline Drawing



## Multi-Channel Differential Amplifier Packages (Under Development)



Four, Eight or Sixteen Amplifiers  
in a single package



64 Channels in Cryostat

# Contact Information

## Sales & Quotes

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