

## 5-30GHz ATTENUATOR

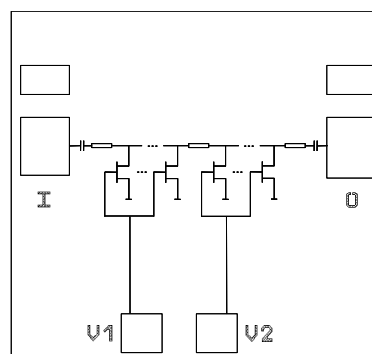
### GaAs Monolithic Microwave IC

#### Description

The CHT4690-99F is a variable 5-30GHz attenuator designed for a wide range of applications, from military to commercial communication systems. The backside of the chip is both RF and DC grounds. This helps simplify the assembly process.

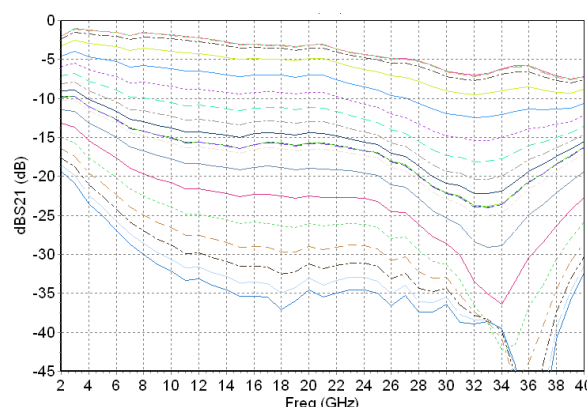
The circuit is manufactured with a MESFET process, 0.7μm gate length, via holes through the substrate and air bridges.

It is supplied in chip form.



#### Main Features

- Broadband performance: 5-30GHz
- 25dBm typical input 1dB compression point (any attenuation)
- 30dB dynamic range
- DC bias : -5V<V1<0V ; -5V<V2<0V
- Chip size: 1.5x1.5x0.1mm



#### Main Characteristics

Tamb. = 25°C

| Symbol   | Parameter                                     | Min | Typ | Max | Unit |
|----------|-----------------------------------------------|-----|-----|-----|------|
| Fin      | Input frequency range                         | 5   |     | 30  | GHz  |
| Min Att. | S21  (V1=-5V;V2=-5V) ( 5 to 12GHz)            |     | 2.5 | 3   | dB   |
|          | S21  (V1=-5V;V2=-5V) ( 12 to 30GHz)           |     | 6.5 | 7.5 | dB   |
| Max Att. | S21  (V1=0V;V2=0V) (5 to 12GHz)               | 22  | 25  |     | dB   |
|          | S21  (V1=0V;V2=0V) (12 to 30GHz)              | 27  | 34  |     | dB   |
| Pin1dB   | Input 1dB compression point (any attenuation) | 24  | 25  |     | dBm  |

ESD Protection: Electrostatic discharge sensitive device. Observe handling precautions!

## Electrical Characteristics

Tamb. = 25°C

| Symbol   | Parameter                                             | Min | Typ | Max | Unit |
|----------|-------------------------------------------------------|-----|-----|-----|------|
| Fin      | Input frequency range                                 | 5   |     | 30  | GHz  |
| Min Att. | S21  (V1=-5V;V2=-5V) ( 5 to 12GHz)                    |     | 2.5 | 3   | dB   |
|          | S21  (V1=-5V;V2=-5V) ( 12 to 30GHz)                   |     | 6.5 | 7.5 | dB   |
| Max Att. | S21  (V1=0V;V2=0V) (5 to 12GHz)                       | 22  | 25  |     | dB   |
|          | S21  (V1=0V;V2=0V) (12 to 30GHz)                      | 27  | 34  |     | dB   |
| RLin     | Input Return loss (any Att) (5 to 30GHz)              |     |     | -8  | dB   |
| RLout    | Ouput Return loss (any Att) (5 to 8GHz)               |     |     | -4  | dB   |
|          | Ouput Return loss (any Att) (8 to 30GHz)              |     |     | -7  | dB   |
| Pin1dB   | Input 1dB compression point (any Att)<br>(5 to 25GHz) | 24  | 25  |     | dBm  |
| C/I3     | C/I3 @ Pin/tone=12dBm (any Att)<br>(up to 26GHz)      | 36  | 40  |     | dB   |

## Absolute Maximum Ratings <sup>(1)</sup>

Tamb. = +25°C

| Symbol | Parameter                   | Values       | Unit |
|--------|-----------------------------|--------------|------|
| V1     | V1 control voltage          | -6V to +0.6V | V    |
| V2     | V2 control voltage          | -6V to +0.6V | V    |
| Pin    | RF input power              | 30           | dBm  |
| Ta     | Operating temperature range | -40 to +95   | °C   |
| Tstg   | Storage temperature range   | -55 to +155  | °C   |

(1) Operation of this device above anyone of these parameters may cause permanent damage.

## Typical Bias Conditions

Temperature = +25°C

| Symbol | Parameter          | Values  | Unit |
|--------|--------------------|---------|------|
| V1     | V1 control voltage | -5 to 0 | V    |
| V2     | V2 control voltage | -5 to 0 | V    |

## Typical results

Chip Typical Response (On wafer Sij)

Tamb = +25°C, V1 = -5V &amp; V2= -5V

| Freq<br>(GHz) | dBS11<br>(dB) | PhS11<br>(°) | dBS12<br>(dB) | PhS12<br>(°) | dBS21<br>(dB) | PhS21<br>(°) | dBS22<br>(dB) | PhS22<br>(°) |
|---------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|
| 2             | -6.29         | -104.78      | -2.01         | -9.01        | -1.98         | -9.34        | -6.22         | -97.53       |
| 3             | -13.90        | -142.32      | -1.08         | -46.74       | -1.04         | -47.05       | -13.82        | -126.13      |
| 4             | -33.49        | 103.94       | -1.27         | -78.74       | -1.25         | -79.12       | -27.95        | -69.61       |
| 5             | -18.92        | -5.76        | -1.42         | -104.45      | -1.38         | -104.65      | -19.19        | -18.49       |
| 6             | -15.43        | -27.95       | -1.52         | -131.80      | -1.49         | -131.98      | -14.88        | -52.69       |
| 7             | -13.73        | -53.65       | -1.94         | -155.91      | -1.89         | -156.07      | -14.92        | -74.29       |
| 8             | -15.09        | -68.43       | -1.58         | 179.46       | -1.55         | 179.18       | -15.12        | -102.17      |
| 9             | -16.08        | -74.62       | -1.72         | 153.40       | -1.68         | 153.18       | -19.19        | -140.64      |
| 10            | -16.59        | -73.62       | -1.86         | 127.70       | -1.80         | 127.51       | -26.46        | 148.17       |
| 11            | -16.95        | -64.41       | -2.11         | 103.34       | -2.04         | 103.15       | -19.90        | 42.75        |
| 12            | -14.53        | -70.07       | -2.26         | 78.02        | -2.20         | 77.64        | -15.17        | 4.12         |
| 13            | -13.73        | -75.66       | -2.50         | 53.37        | -2.44         | 53.10        | -12.54        | -20.65       |
| 14            | -12.55        | -82.11       | -2.82         | 29.21        | -2.76         | 28.89        | -10.75        | -41.79       |
| 15            | -11.30        | -89.63       | -3.08         | 7.21         | -3.02         | 6.92         | -9.48         | -62.60       |
| 16            | -11.29        | -108.06      | -3.06         | -16.89       | -3.00         | -17.20       | -9.80         | -84.27       |
| 17            | -11.56        | -127.91      | -3.17         | -38.98       | -3.12         | -39.35       | -10.69        | -104.87      |
| 18            | -14.44        | -138.27      | -3.19         | -63.43       | -3.14         | -63.66       | -12.57        | -123.19      |
| 19            | -18.03        | -154.90      | -3.42         | -85.65       | -3.37         | -85.77       | -17.85        | -136.13      |
| 20            | -31.46        | -65.09       | -3.15         | -107.92      | -3.09         | -108.07      | -24.60        | -74.92       |
| 21            | -15.91        | -56.73       | -3.11         | -135.35      | -3.06         | -135.53      | -15.74        | -46.79       |
| 22            | -11.85        | -81.87       | -3.65         | -160.66      | -3.62         | -160.76      | -11.06        | -67.33       |
| 23            | -11.09        | -104.33      | -4.13         | 176.26       | -4.05         | 176.14       | -9.92         | -88.92       |
| 24            | -12.09        | -121.81      | -4.38         | 153.99       | -4.32         | 153.77       | -9.57         | -105.06      |
| 25            | -13.45        | -129.91      | -4.60         | 130.21       | -4.54         | 129.98       | -10.03        | -120.22      |
| 26            | -15.14        | -142.57      | -4.93         | 105.98       | -4.87         | 105.80       | -11.49        | -132.20      |
| 27            | -20.61        | -151.15      | -4.98         | 81.66        | -4.90         | 81.38        | -13.59        | -133.90      |
| 28            | -22.21        | -48.69       | -5.19         | 53.71        | -5.14         | 53.38        | -14.94        | -123.67      |
| 29            | -13.40        | -56.86       | -5.84         | 26.74        | -5.76         | 26.39        | -13.19        | -115.78      |
| 30            | -9.33         | -83.86       | -6.53         | 1.04         | -6.47         | 0.67         | -11.12        | -124.99      |
| 31            | -9.26         | -107.23      | -6.86         | -23.20       | -6.81         | -23.52       | -10.14        | -136.08      |
| 32            | -9.16         | -124.74      | -7.10         | -48.20       | -7.04         | -48.73       | -9.70         | -155.88      |
| 33            | -10.96        | -143.12      | -6.87         | -72.14       | -6.79         | -72.51       | -11.28        | -173.54      |
| 34            | -15.41        | -159.05      | -6.31         | -99.51       | -6.23         | -99.96       | -13.59        | 160.74       |
| 35            | -24.19        | -104.04      | -5.88         | -128.72      | -5.81         | -129.15      | -23.56        | 143.93       |
| 36            | -14.66        | -71.35       | -5.85         | -159.29      | -5.77         | -159.70      | -22.62        | -104.16      |
| 37            | -10.13        | -86.82       | -6.58         | 173.48       | -6.50         | 173.15       | -13.93        | -110.93      |
| 38            | -8.18         | -105.93      | -7.22         | 150.56       | -7.12         | 150.10       | -11.22        | -138.54      |
| 39            | -7.36         | -123.76      | -7.60         | 131.28       | -7.49         | 131.09       | -10.42        | -158.76      |
| 40            | -7.57         | -143.67      | -7.27         | 115.53       | -7.17         | 115.09       | -9.23         | 176.23       |

## Typical results

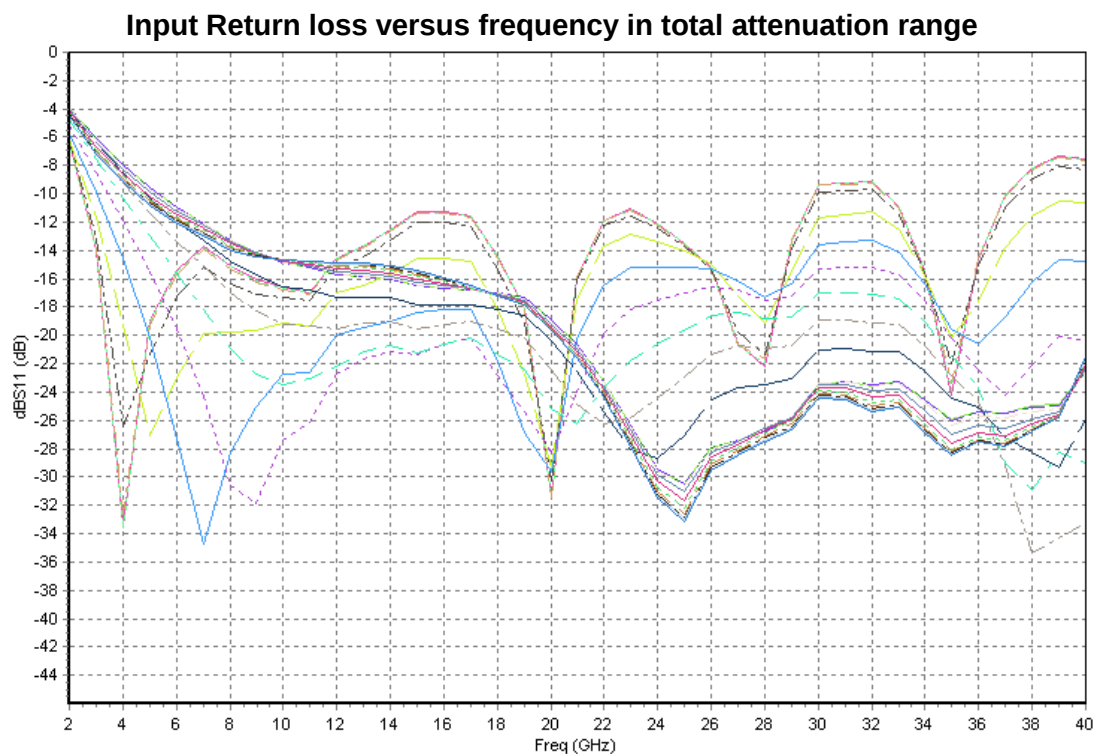
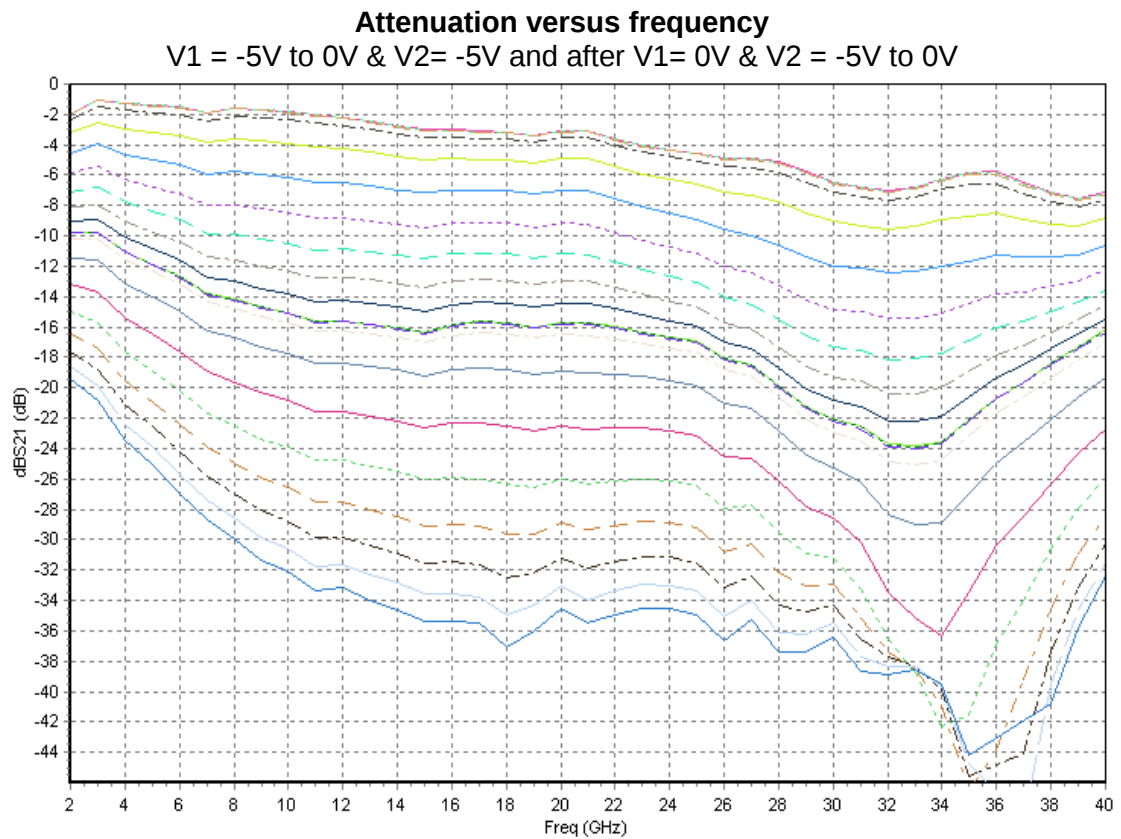
Chip Typical Response (On wafer Sij)

Tamb = +25°C, V1 = 0V & V2= 0V

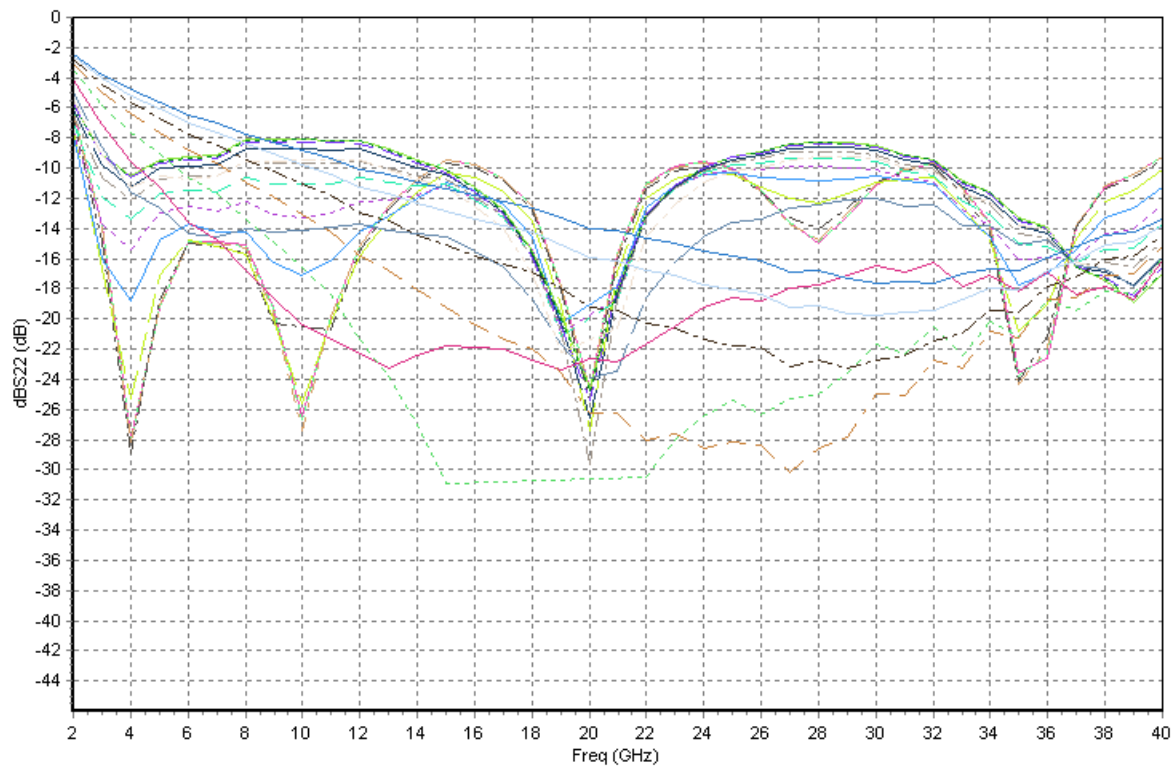
| Freq<br>(GHz) | dBS11<br>(dB) | PhS11<br>(°) | dBS12<br>(dB) | PhS12<br>(°) | dBS21<br>(dB) | PhS21<br>(°) | dBS22<br>(dB) | PhS22<br>(°) |
|---------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|
| 2             | -4.44         | -143.24      | -19.44        | -26.13       | -19.40        | -26.38       | -2.40         | -126.78      |
| 3             | -7.20         | -171.22      | -20.89        | -76.86       | -20.86        | -77.07       | -3.79         | -155.50      |
| 4             | -9.10         | 174.49       | -23.49        | -113.84      | -23.47        | -114.12      | -4.82         | -173.85      |
| 5             | -10.80        | 164.52       | -25.09        | -145.87      | -25.05        | -146.02      | -5.67         | 172.68       |
| 6             | -12.09        | 159.75       | -26.99        | -173.25      | -26.95        | -173.28      | -6.45         | 162.93       |
| 7             | -12.93        | 156.90       | -28.74        | 160.34       | -28.69        | 160.31       | -7.04         | 154.27       |
| 8             | -13.99        | 154.84       | -30.05        | 136.61       | -30.01        | 136.37       | -7.72         | 147.14       |
| 9             | -14.44        | 154.65       | -31.34        | 112.68       | -31.30        | 112.60       | -8.25         | 140.61       |
| 10            | -14.69        | 154.72       | -32.15        | 90.56        | -32.10        | 90.54        | -8.84         | 134.77       |
| 11            | -14.72        | 151.66       | -33.42        | 71.27        | -33.35        | 71.25        | -9.35         | 129.86       |
| 12            | -14.91        | 150.39       | -33.25        | 49.61        | -33.19        | 49.38        | -10.10        | 125.48       |
| 13            | -14.90        | 146.38       | -34.01        | 29.42        | -33.95        | 29.35        | -10.42        | 122.02       |
| 14            | -15.05        | 141.41       | -34.69        | 10.49        | -34.61        | 10.53        | -10.97        | 117.52       |
| 15            | -15.44        | 134.90       | -35.49        | -9.63        | -35.42        | -9.82        | -11.41        | 113.26       |
| 16            | -15.91        | 127.63       | -35.48        | -22.24       | -35.33        | -22.55       | -11.81        | 108.79       |
| 17            | -16.49        | 121.21       | -35.64        | -38.98       | -35.50        | -39.00       | -12.21        | 104.88       |
| 18            | -17.20        | 112.41       | -37.09        | -55.23       | -37.06        | -55.58       | -12.61        | 98.91        |
| 19            | -17.85        | 101.71       | -35.96        | -62.20       | -35.97        | -62.19       | -13.29        | 95.15        |
| 20            | -19.65        | 85.00        | -34.60        | -84.28       | -34.55        | -84.31       | -14.01        | 90.96        |
| 21            | -21.55        | 71.59        | -35.62        | -104.90      | -35.48        | -104.90      | -14.15        | 88.83        |
| 22            | -24.36        | 50.12        | -35.06        | -121.53      | -34.97        | -121.54      | -14.66        | 83.28        |
| 23            | -27.84        | 26.69        | -34.63        | -142.27      | -34.55        | -142.68      | -14.93        | 81.81        |
| 24            | -31.47        | -8.22        | -34.59        | -161.79      | -34.52        | -162.19      | -15.47        | 77.97        |
| 25            | -33.10        | -47.36       | -34.97        | 176.00       | -34.95        | 176.30       | -15.86        | 74.21        |
| 26            | -29.54        | -67.08       | -36.67        | 170.42       | -36.60        | 170.40       | -16.13        | 68.56        |
| 27            | -28.46        | -98.46       | -35.44        | 152.57       | -35.32        | 152.17       | -16.87        | 64.47        |
| 28            | -27.50        | -97.94       | -37.59        | 134.66       | -37.42        | 134.22       | -16.78        | 62.16        |
| 29            | -26.66        | -105.16      | -37.41        | 137.29       | -37.37        | 136.97       | -17.33        | 59.71        |
| 30            | -24.45        | -120.07      | -36.45        | 118.83       | -36.43        | 118.60       | -17.65        | 62.80        |
| 31            | -24.56        | -139.96      | -38.67        | 102.14       | -38.69        | 101.74       | -17.51        | 57.70        |
| 32            | -25.41        | -148.35      | -38.96        | 107.86       | -38.89        | 107.48       | -17.68        | 60.32        |
| 33            | -25.09        | -152.31      | -38.69        | 93.25        | -38.58        | 93.33        | -17.01        | 50.49        |
| 34            | -26.83        | -175.25      | -39.68        | 75.15        | -39.48        | 75.61        | -16.68        | 54.96        |
| 35            | -28.46        | 168.50       | -44.22        | 42.32        | -44.23        | 40.54        | -16.74        | 48.74        |
| 36            | -27.53        | 140.64       | -57.99        | 14.39        | -57.42        | 15.21        | -15.91        | 53.83        |
| 37            | -27.82        | 106.98       | -51.31        | -100.68      | -51.46        | -100.36      | -15.24        | 45.02        |
| 38            | -26.79        | 80.89        | -40.98        | -130.65      | -40.84        | -130.90      | -14.40        | 42.19        |
| 39            | -25.83        | 57.55        | -35.91        | -158.28      | -35.85        | -158.46      | -14.25        | 35.29        |
| 40            | -21.50        | 51.16        | -32.54        | -174.93      | -32.44        | -174.88      | -13.39        | 44.33        |

## Typical Results on wafer

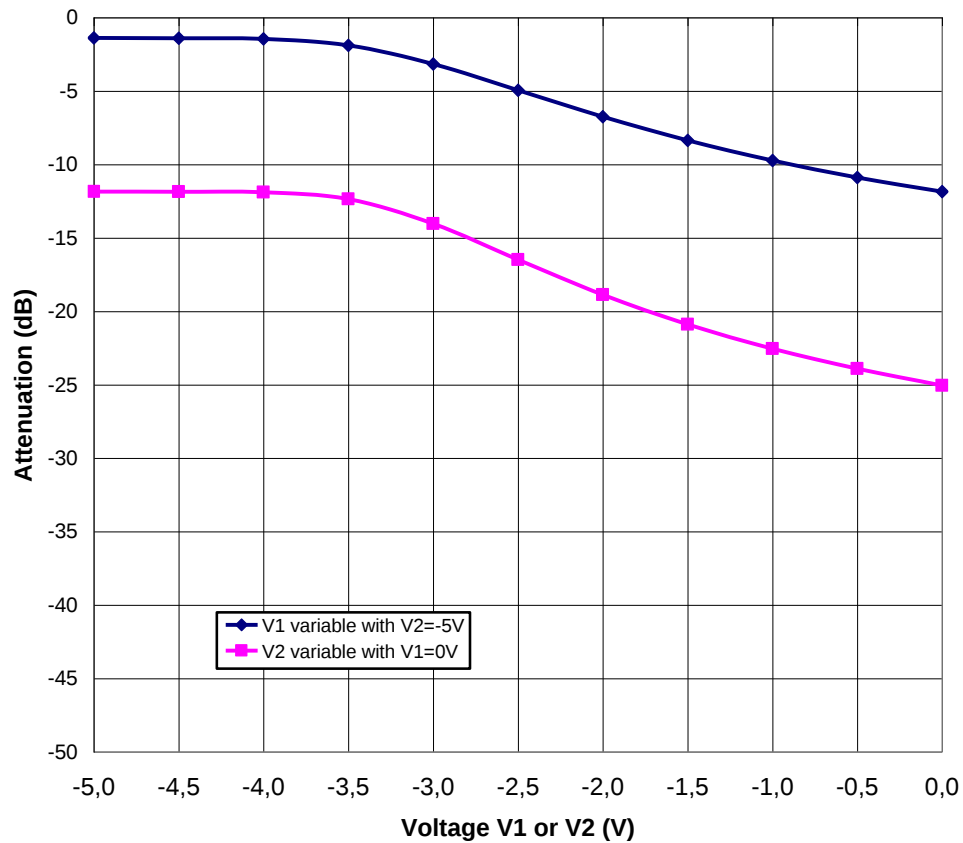
Tamb = +25°C



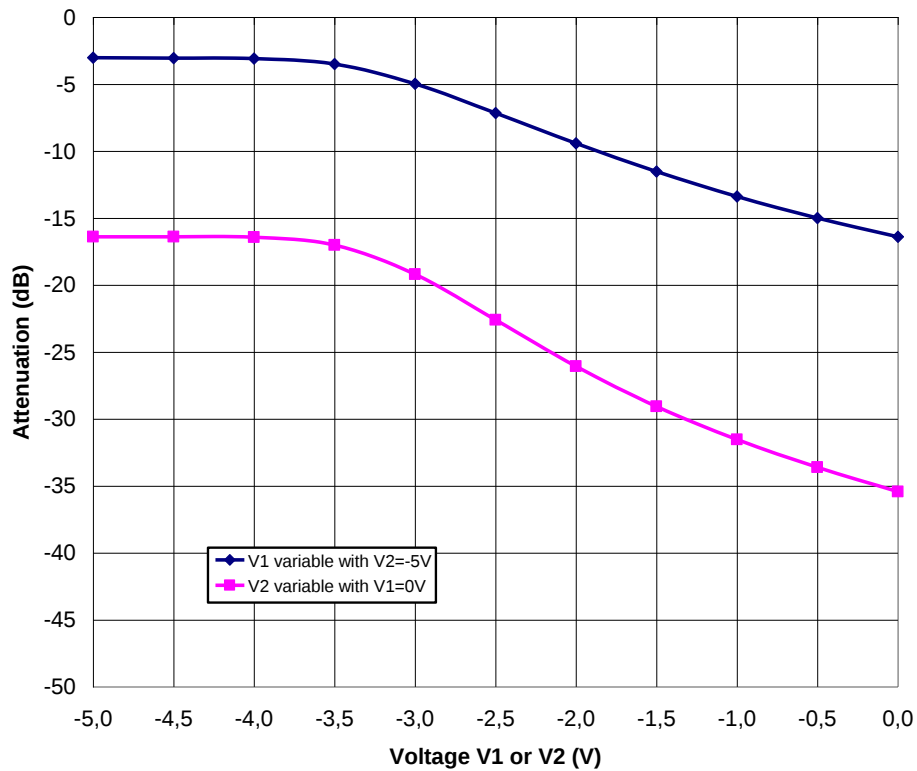
Output Return loss versus frequency in total attenuation range



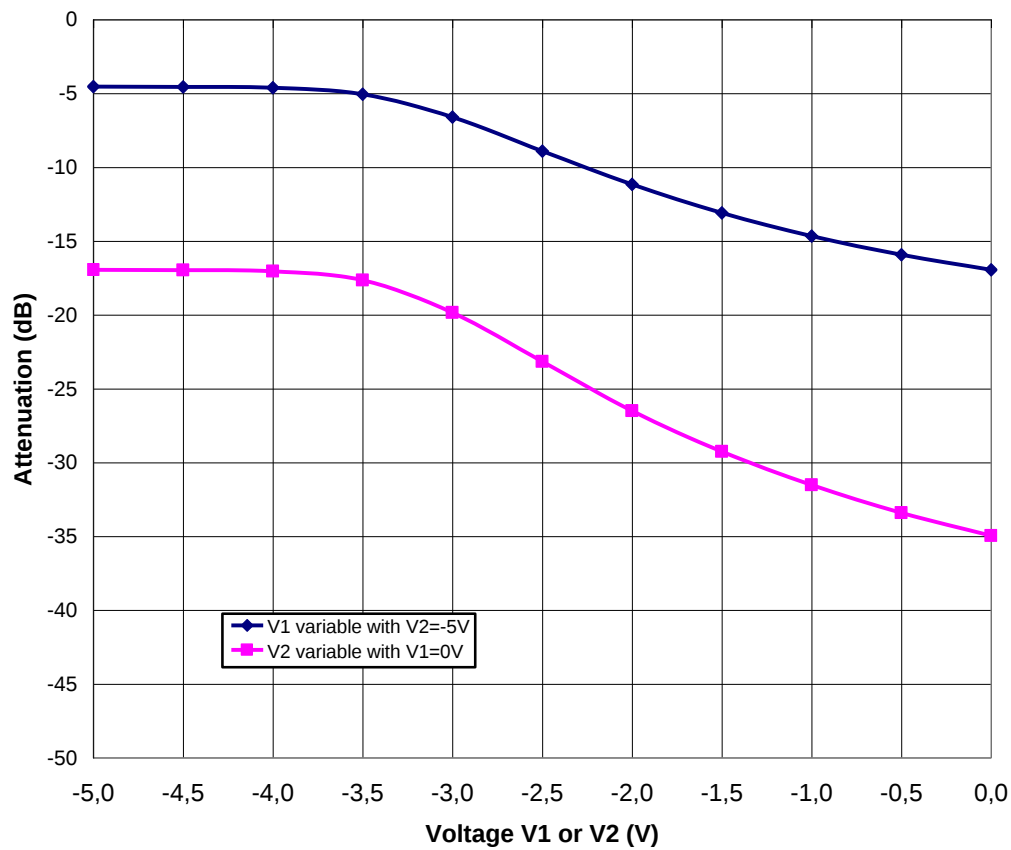
Attenuation control at 5GHz



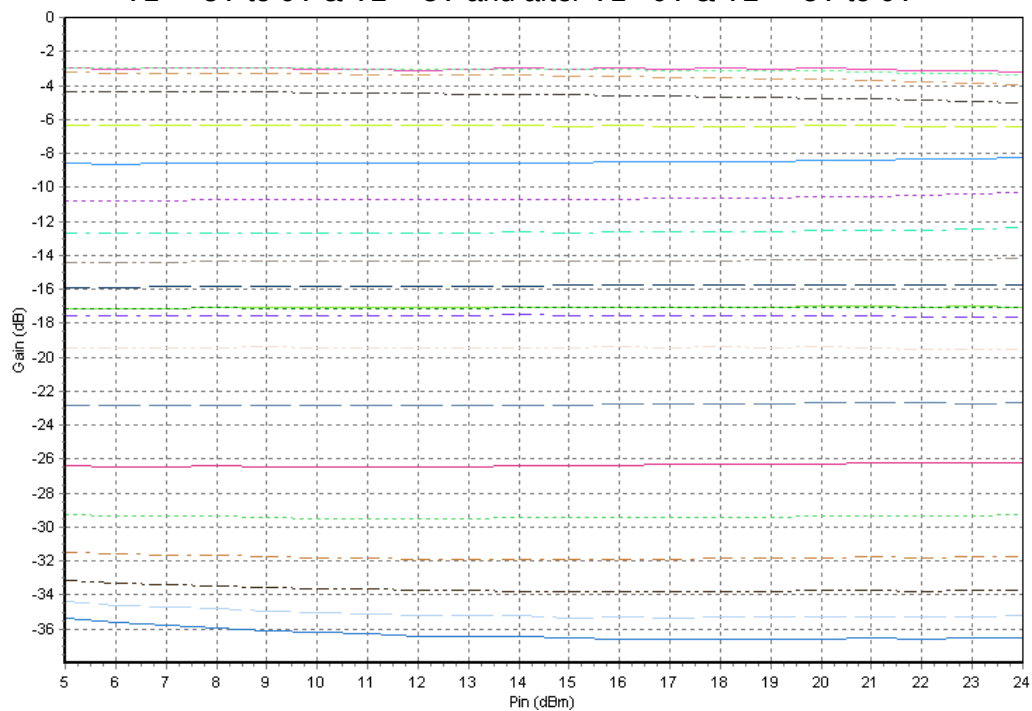
Attenuation control at 15GHz



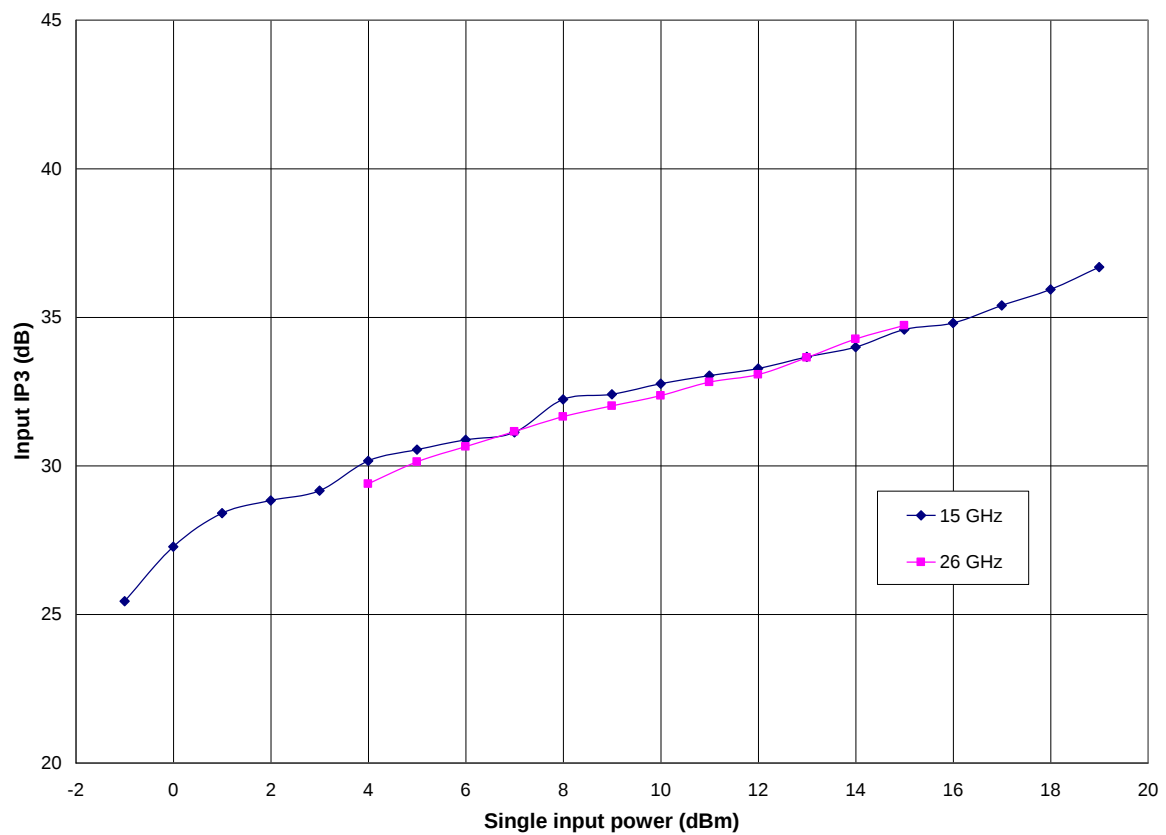
## Attenuation control at 25GHz



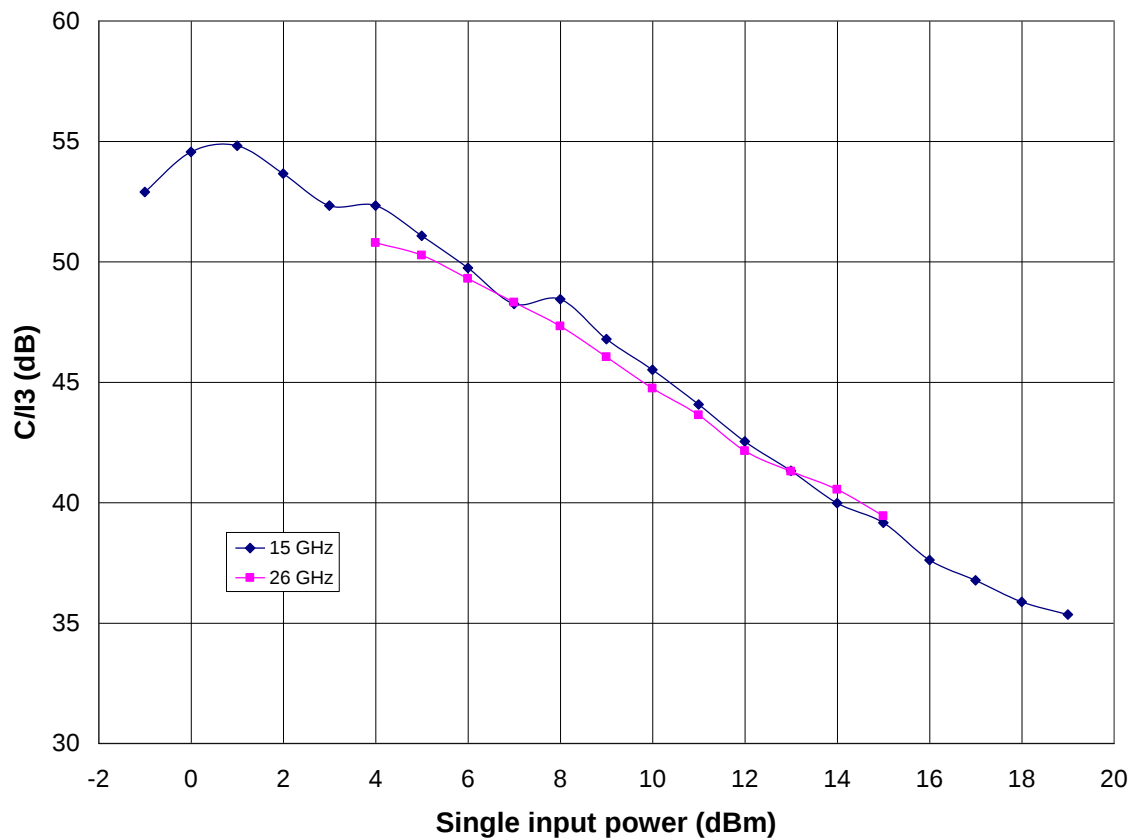
## Attenuation versus input power @ 20GHz V1 = -5V to 0V & V2= -5V and after V1= 0V & V2 = -5V to 0V



**Input IP3 versus input power**  
V1 = -3.5V & V2= -5V (worst case area for the linearity)



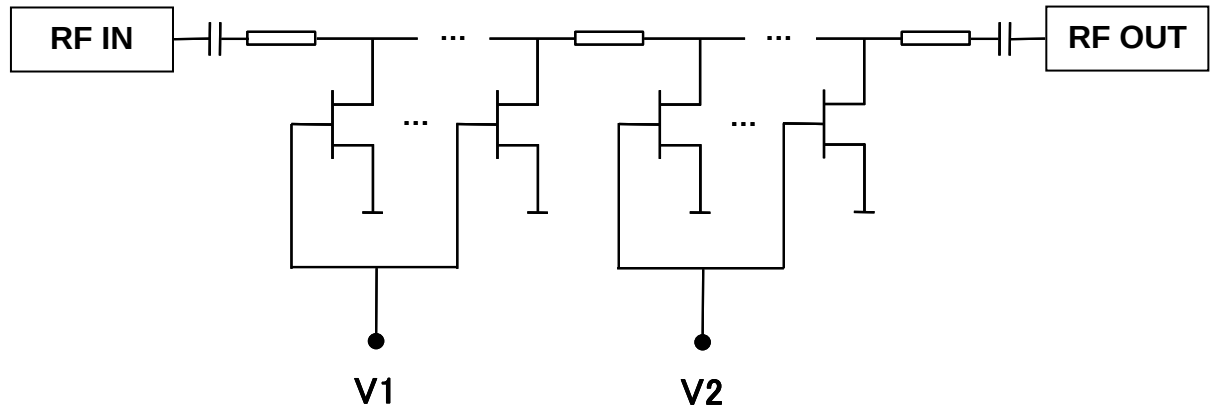
**C/I3 versus input power**  
V1 = -3.5V & V2= -5V (worst case area for the linearity)



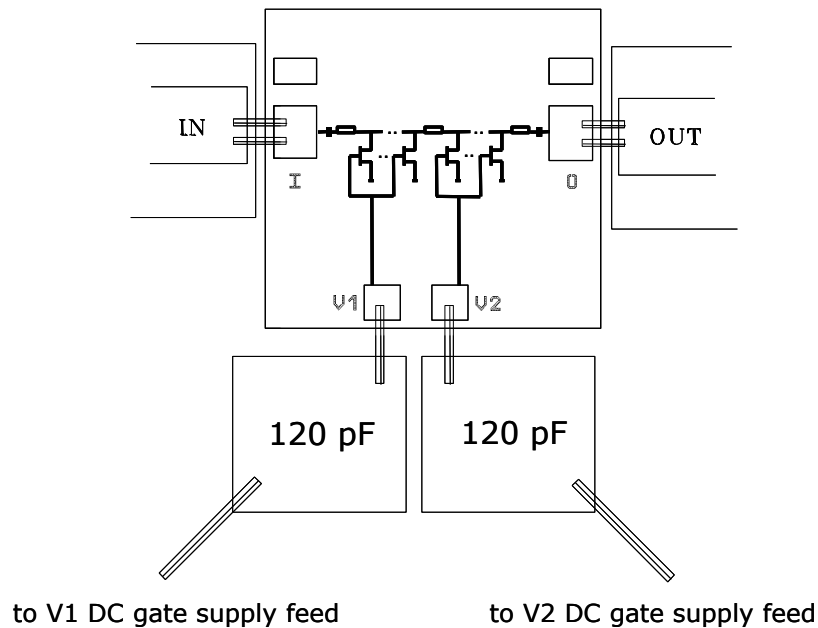
## Biasing sequence

To obtain good performances in linearity, biasing voltage should be applied as following:

- Control of 1<sup>st</sup> stage attenuation with V1 from -5V to 0V, with V2 fixed at -5V
- Control of 2<sup>nd</sup> stage with V2 from -5V to 0V, with V1 fixed at 0V

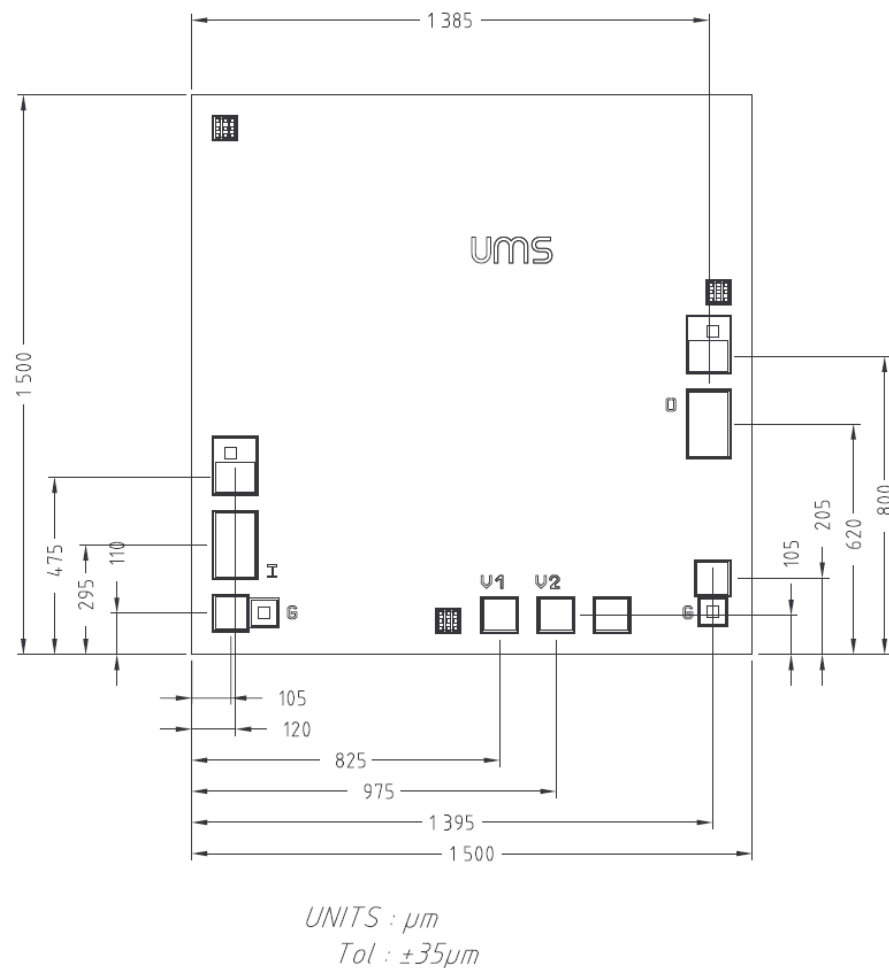


## Chip Assembly and Mechanical Data



Note: Supply feed might be capacitively bypassed. 25μm diameter gold wire is to be preferred.

## Bonding pad positions



(Chip thickness: 100 $\mu\text{m}$ . All dimensions are in micrometers)

## Ordering Information

Chip form:

CHT4690-99F/00

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