# Application Note

**The Communications Edge ™**

**Performance Evaluation for the 'new' AH22 and 'old' AH22** *Product Information*

## Background

Recently WJ has issued a product notification for the AH22 which stated that a change was made to the epi-material used for the AH22 semiconductor wafers. This change has several effects for customers' applications. The change to the product improves on the variation of process and performance parameters (lower standard deviation) for the product. The change improves greatly on the 2nd order linearity performance for the product (CSO / OIP2) and has a slight improvement on the 3rd order linearity performance (CTB / OIP3). The change also has a negative effect on the output return loss for a typical circuit configuration for the AH22 used in a push-pull configuration. The scope of this application note is to investigate the changes to the performance of the 'old' and 'new' AH22 device with various application circuit configurations.

## 'Old' AH22 with R1=R2=560Ω feedback resistors

On the AH22 datasheet for the February 2004 and earlier, the recommended application circuit for an AH22 used in push-pull configuration is as shown in Figure 1. The main external component that affects the performance the most is the 560Ω feedback resistor (for R1 and R2). Using the 'old' AH22 in this circuit configuration, the typical performance is shown in Table 2.

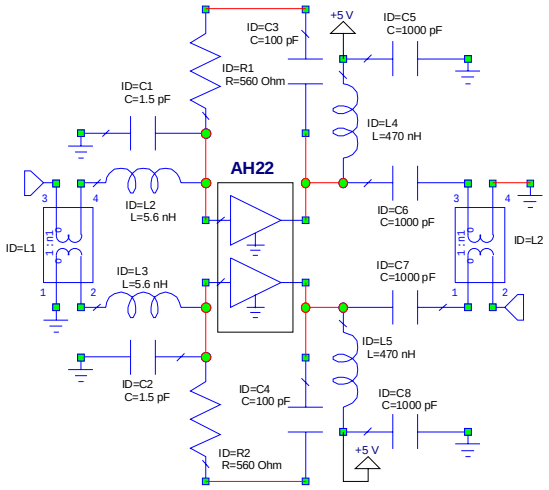


Figure 1: Circuit configuration shown on AH22 datasheets (Feb. 2004 and earlier). Also shown as 'Configuration B' on the AH22 datasheet (June 2004 revision and newer).

| Parameter | Units | Typical | | | |
|---|---|---|---|---|---|
| Frequency | MHz | 50 | 250 | 450 | 860 |
| Gain | dB | 11.2 | 10.9 | 10.9 | 10.6 |
| Input Return Loss | dB | 12.4 | 11.6 | 29.8 | 14.6 |
| Output Return Loss | dB | 17.4 | 14.4 | 18.1 | 12.4 |
| CTB | dBc | -71 | -68 | -68 | |
| CSO | dBc | -71 | -74 | -70 | |
| XMOD | dBc | -67 | -67 | -66 | |
| Output P1dB | dBm | +25.2 | +24.5 | +24.1 | +23 |
| Output IP2 | dBm | +72 | +71 | +70 | +70 |
| Output IP3 | dBm | +42 | +42 | +43 | +40 |
| Noise Figure | dB | 5.5 | 4.5 | 4.3 | 4.3 |
| Device Bias | | +5 V @ 300 mA | | | |

Table 1: 'Old' AH22 performance using the circuit configuration as shown in Figure 1, with R1=R2=560Ω.

## 'New AH22 with R1=R2=560Ω feedback resistors

When the 'new' AH22 is used in the same circuit configuration, the changes in performance are apparent: improved 2nd and 3rd order linearity performance, but a slight degradation in output return loss. The performance data is shown and described in the AH22 datasheet (June 2004 revision) as 'Configuration B'. While the gain and input return loss has essentially remained the same, the output return loss has degraded slightly by about 2 dB from a typical value of 14 dB across the entire band to about 12 dB. The main advantage of the 'new' AH22 device is the marked improvement in CSO and CTB performances from a typical value of -68 dBc to -74 dBc for CTB and from -71 dBc to -75 dBc for CSO.

| Parameter | Units | Typical | | | |
|---|---|---|---|---|---|
| Frequency | MHz | 50 | 250 | 450 | 860 |
| Gain | dB | 11 | 10.8 | 10.9 | 10.5 |
| Input Return Loss | dB | 11.8 | 11.7 | 12.5 | 14.3 |
| Output Return Loss | dB | 13.6 | 12.7 | 12.0 | 17.1 |
| CTB | dBc | -77 | -74 | -74 | |
| CSO | dBc | -72 | -80 | -75 | |
| XMOD | dBc | -64 | -64 | -64 | |
| Output P1dB | dBm | +25.2 | +24.5 | +24.1 | +23 |
| Output IP2 | dBm | +76 | +75 | +77 | +76 |
| Output IP3 | dBm | +43 | +45 | +42 | +42 |
| Noise Figure | dB | 5.5 | 4.5 | 4.6 | 4.6 |
| Device Bias | | +5 V @ 300 mA | | | |

Table 2: 'New' AH22 performance using the circuit configuration as shown in Figure 1, with R1=R2=560Ω.

## 'New AH22 with R1=R2=390Ω feedback resistors

In order to improve upon the output return loss performance, a configuration using 390Ω feedback resistors (R1 and R2) was implemented and shown in the AH22 datasheet as 'Configuration A'. Output return loss improved from a value of 12 dB typically to 17 dB. By reducing the feedback resistor though, the gain of the push-pull circuit has been reduced by 1.2 dB. No other changes in component values or PCB layout was made to the circuit.

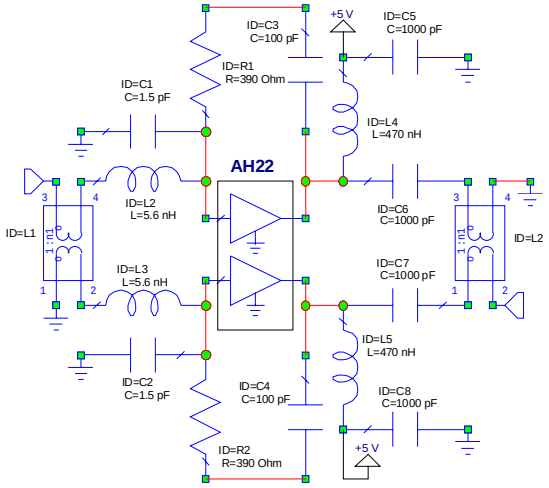


Figure 2: 'Configuration A' on the AH22 datasheet (June 2004 revision and newer).

| Parameter | Units | Typical | | | |
|---|---|---|---|---|---|
| Frequency | MHz | 50 | 250 | 450 | 860 |
| Gain | dB | 9.8 | 9.6 | 9.6 | 9.3 |
| Input Return Loss | dB | 14 | 14 | 14.3 | 15.5 |
| Output Return Loss | dB | 16 | 17 | 17 | 23 |
| CTB | dBc | -77 | -74 | -74 | |
| CSO | dBc | -72 | -80 | -75 | |
| XMOD | dBc | -64 | -64 | -64 | |
| Output P1dB | dBm | +25.2 | +24.5 | +24.1 | +23 |
| Output IP2 | dBm | +76 | +75 | +77 | +76 |
| Output IP3 | dBm | +43 | +45 | +42 | +42 |
| Noise Figure | dB | 5.5 | 4.5 | 4.6 | 4.6 |
| Device Bias | | +5 V @ 300 mA | | | |

Table 3: 'New' AH22 performance using the circuit configuration as shown in Figure 1, with R1=R2=390Ω.

## Summary

It is believed that the 'new' and improved AH22 offers linearity and process variation improvement advantages over the 'old' AH22 device. 2nd order linearity (CSO) has been improved dramatically by 5 dB while 3rd order linearity (CTB) has been improved by 6 dB. A new circuit configuration involving only a change in the feedback resistor values has been shown in the updated AH22 datasheet to compensate for the slight degradation in output return loss for the 'new' AH22. By using 390Ω feedback resistors, the output return loss was measured to be better than 17 dB across the CATV band. Ultimately, the customer can vary the value of the feedback resistor from 560Ω to 390Ω to achieve the desired output VSWR and targeted gain for the AH22 used in a push-pull configuration. Decreasing the value for the feedback resistors improves on the output VSWR, but lowers the gain for the circuit. The performance for the AH22 used in a push-pull configuration is shown on the datasheet using both the 560Ω and 390Ω values as Configuration B and Configuration A, respectively. A summary table of the AH22 in the various circuit configurations is shown below:

| Device<br>R1 / R2 value | | 'old' AH22<br>560Ω | 'new' AH22<br>560Ω | 'new' AH22<br>390Ω |
|---|---|---|---|---|
| Frequency | MHz | 250 | 250 | 250 |
| Gain | dB | 10.9 | 10.8 | 9.6 |
| Input Return Loss | dB | 11.6 | 11.7 | 14 |
| Output Return Loss | dB | 14.4 | 12.7 | 17 |
| CTB | dBc | -68 | -74 | -74 |
| CSO | dBc | -74 | -80 | -80 |
| XMOD | dBc | -67 | -64 | -64 |
| Output P1dB | dBm | +24.5 | +24.5 | +24.5 |
| Output IP2 | dBm | +71 | +75 | +75 |
| Output IP3 | dBm | +42 | +45 | +45 |
| Noise Figure | dB | 4.5 | 4.5 | 4.5 |

Table 4: Summary of performance values for various circuit configurations with the 'old' and 'new' AH22.