AP4 Application Circuit for U-NII Bands and IEEE 802.11a W-LAN

(Preliminary)

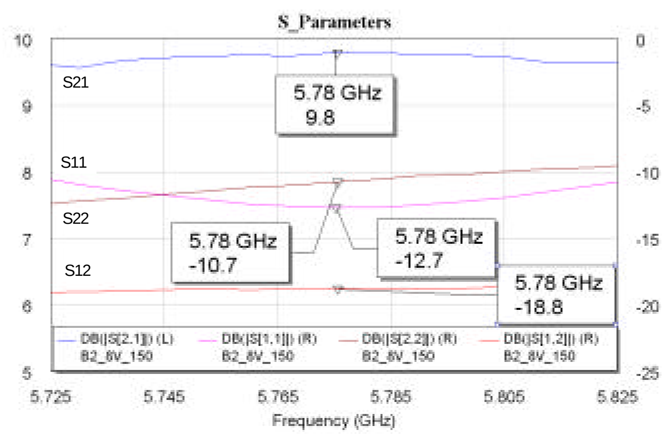
Summary:

This application note details the operation and schematic of an application circuit using a WJ Communications' **AP4** device optimized for the U-NII band. This circuit offers excellent performance with unconditional stability using the WJ Communications' low-cost FET between 5.725 – 5.825 GHz. Over 1 Watt of 1 dB compressed output power can be achieved through the use of the circuit in a balanced configuration. This circuit is ideal with applications for fixed wireless communications using the U-NII band or with applications for wireless LAN using the IEEE 802.11a standard. A separate application note details the performance of the AP4 optimized for the 5.15 – 5.35 GHz frequency band to cover the entire frequency allocation for applications using the IEEE 802.11a standard. Performance of an 802.11a OFDM signal though this amplifier is shown on the next page.

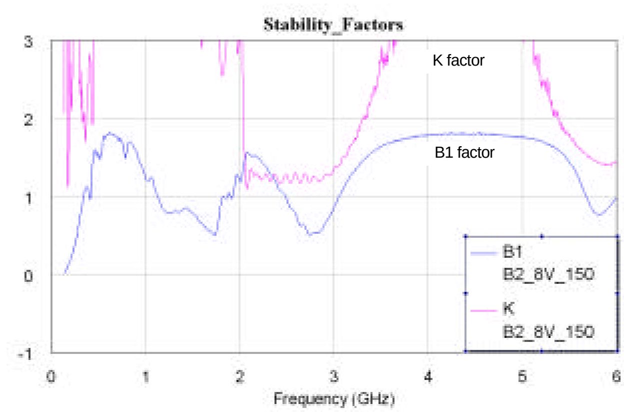
Frequency Bandwidth	5.725 - 5.825 GHz
Frequency	5.775 GHz
S21 - Gain	9.8 dB
S11 - Input R.L.	-12.7 dB
S22 - Output R.L.	-10.7 dB
S12 - Isolation	-18.8 dB
Output P1dB	28.1 dBm
Output IP3[1]	42 dBm
Bias	+8.0 V @ 150 mA

Details:

A circuit was designed and tested between 5.725 – 5.825 GHz. Measurements were performed over a broadband frequency range in addition, with a spectrum analyzer, to determine that the circuit is unconditional stable (K>1 and B1>0). The circuit schematic is shown in Figure 5, while the board layout showing the input and output matching networks in detail is shown in Figure 6. The RF shunt blocks in Figure 1 are shown to be radial stubs in the layout to conserve costs to the end customer and for broadband bypass performance, but bypass capacitors or a buried stripline stub can also be used as a replacement. The circuit can be used in a balanced configuration (to be soon released in a future revision to this application note) to have an amplifier with a P1dB = +31 dBm. The DC blocking capacitors are recommended to be AT Ceramics' 500 series Broadband Microwave Capacitors because of their low insertion loss and high self-resonant frequencies.



An optional temperature-compensation active-bias circuit is recommended for use with the application circuit, which requires two standard voltage supplies (+8 V and -5 V). The circuit schematic, shown in Figure 7, uses dual PNP transistors to provide a constant drain current into the FET. Temperature compensation is achieved by tracking the voltage variation with the temperature of the emitter-to-base junction of the PNP transistors. Thus the transistor emitter voltage adjusts the voltage incident at the gate of the FET so that the device draws a constant current, regardless of the temperature. Two fixed voltage supplies are needed for operation. A Rohm dual transistor, UMT1N, and a dual chip resistor (8.2 kΩ) are recommended to minimize board space. The active-bias circuit can directly be attached to the voltage supply ports in Figure 1 (V_{dd} and V_{gg}).



Measurement data with an 802.11a signal:

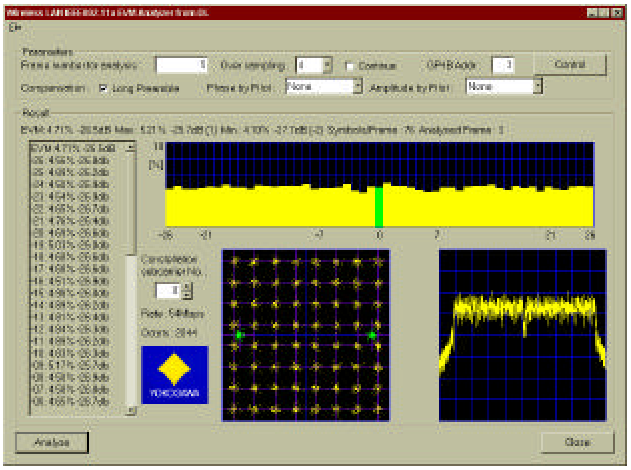


Figure 1. 802.11a response of the A4 amplifier using Yukagowa measurement hardware (V_d = 8V, I_d = 130mA, P_{out} = 20 dBm, P1dB=28 dBm).

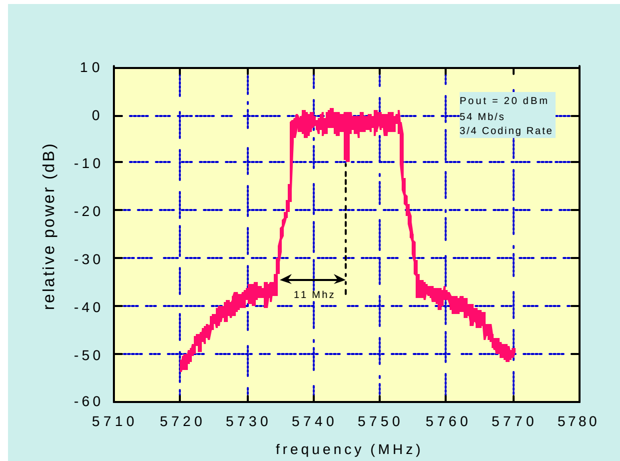


Figure 2. 802.11a Signal spectrum of the A4 amplifier (V_d = 8V, I_d = 130mA, Pout = 20 dBm, 54 Mbits/s signal)

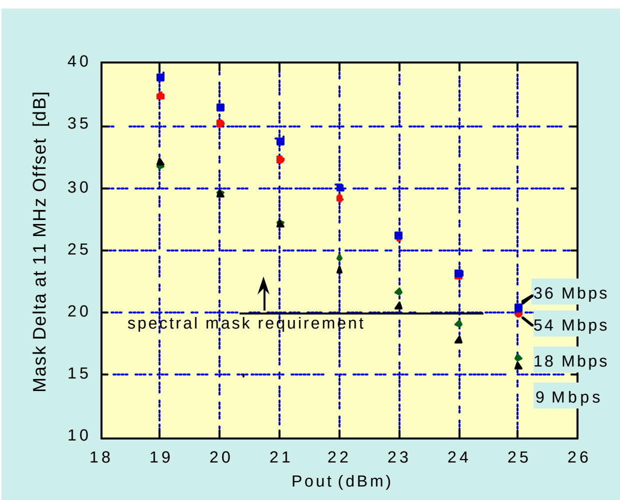


Figure 3. Relative power level (dBc) at 11 MHz away from f_c for various output power levels of the A4 amplifier and signal data rate schemes (V_d = 8V, I_d = 130mA). In 802.11a, there is a null at f_c. The relative power level is computed from the average of the signal power surrounding f_c. The spectral mask requirement for 802.11a is graphed. It is shown that for any data rate scheme, a maximum power of 23 dBm (efficiency = 0.192) can be achieved with the A4 amplifier to meet the spectral regrowth requirements for 802.11a.

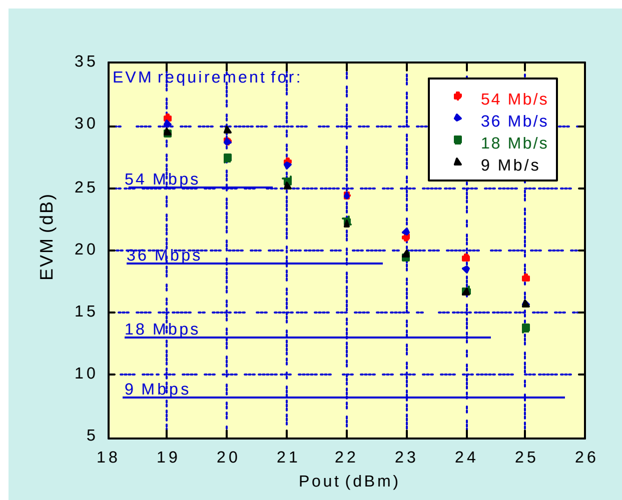


Figure 4. EVM for various output power levels of the A4 amplifier and signal data rate schemes. (V_d = 8V, I_d = 130mA) The EVM requirements for various data rate schemes are graphed. It is shown that for any data rate scheme, a maximum power of 21 dBm (efficiency = 0.121) can be achieved with the A4 amplifier to meet the spectral regrowth requirements for 802.11a. It can be seen that the EVM does not have a strong correlation with the data rate scheme.

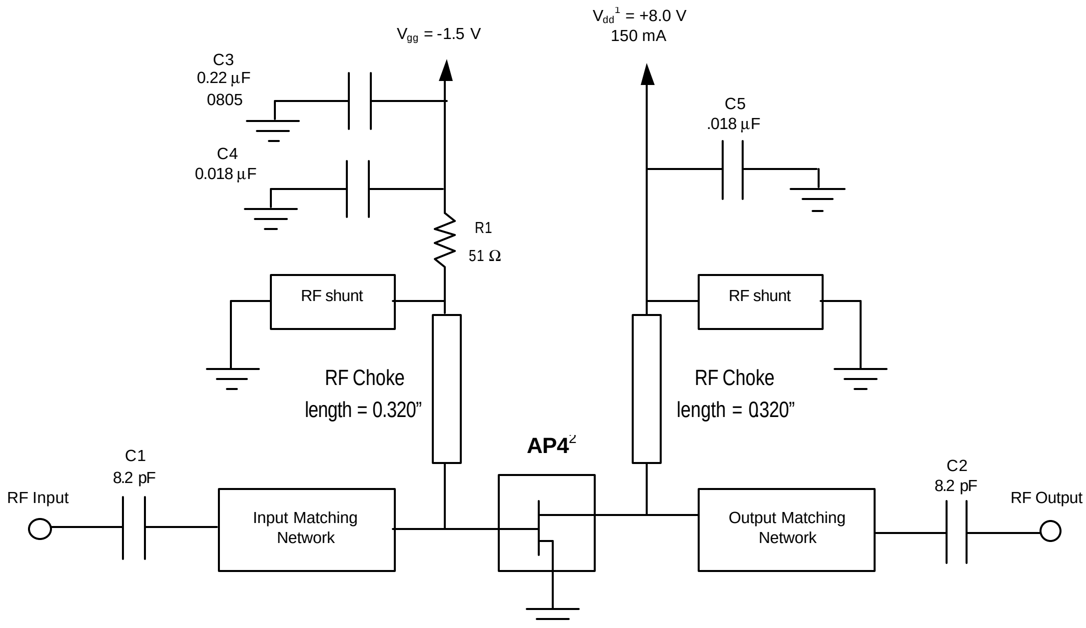


Figure 5. 5.725 - 5.825 GHz AP4 Application Circuit Schematic

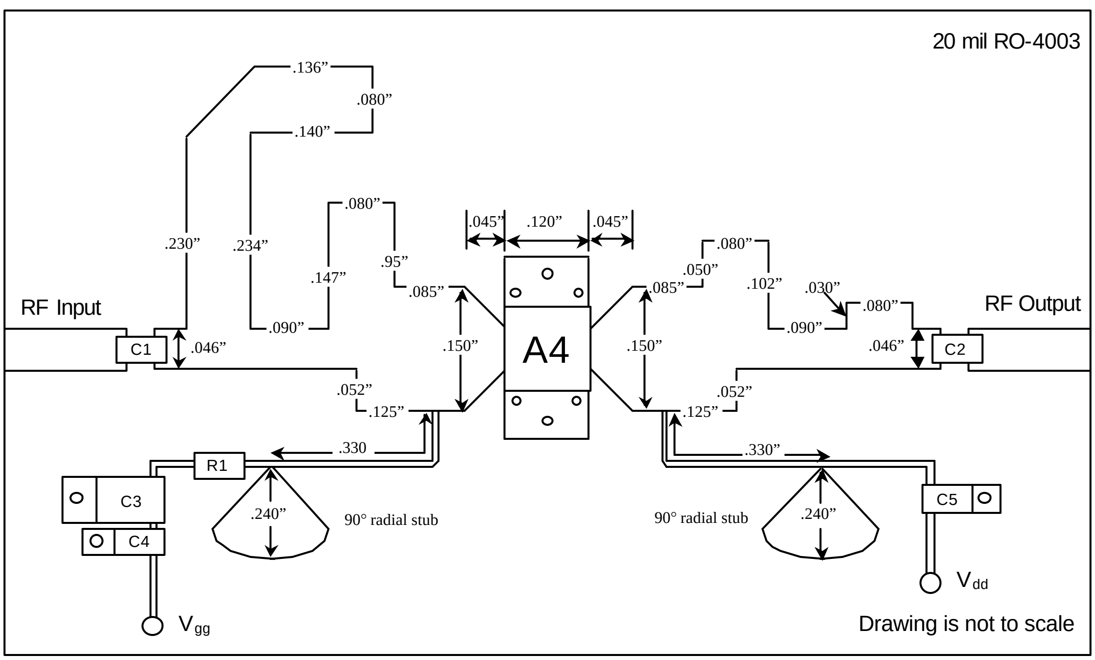


Figure 6. 5.725 - 5.825 GHz AP4 Application Circuit Layout

1 The application circuit should be biased directly into a constant voltage DC regulator. A dropping resistor is NOT required for biasing this device.
2 The AP4 should be mounted as recommended in the AP4 datasheet.
3 All components are 0603 size unless specified.
4 C1 and C2 are recommended to be AT Ceramics' 500 series Broadband Microwave Capacitors because of their low insertion loss and high self-resonant frequencies All other capacitors can be of standard chip types.

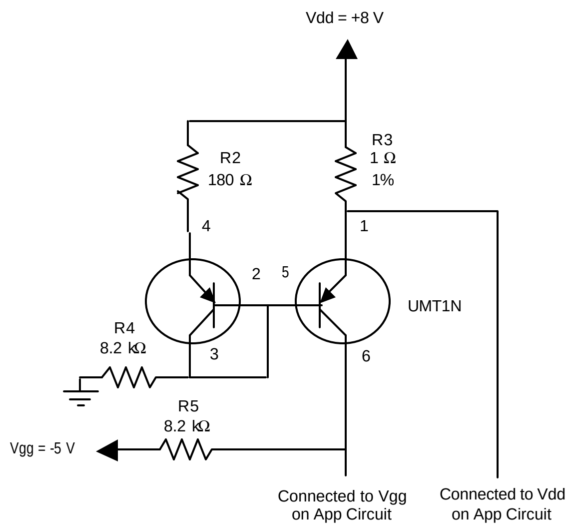


Figure 7. Optional Temperature Compensation Active-Bias Circuit Schematic

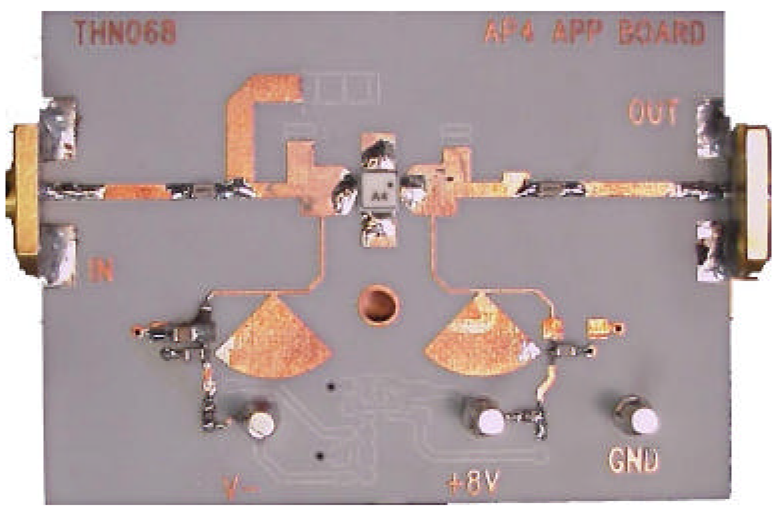


Figure 8. Picture of 5.725 – 5.825 GHz AP4 Application Circuit Layout